Final Programmatic Environmental Impact Statement/
Environmental Impact Report

San Francisco Estuary Invasive Spartina Project: Spartina Control Program

Volume 1:
Final Programmatic Environmental Impact Statement/ Environmental Impact Report

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TABLE OF CONTENTS

FIGURES

TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

μg/m^3 micrograms per cubic meter
μm micrometers
ABAG Association of Bay Area Governments
AMPA aminophosphoric acid
ATV all-terrain vehicle
BAAQMD Bay Area Air Quality Management District
BAF bioaccumulation factor
Bay San Francisco Bay
Bay-Delta San Francisco Bay-Sacramento San Joaquin River Delta
BCDC San Francisco Bay Conservation and Development Commission
BP years before the present
BPTCP Bay Protection and Toxic Cleanup Program
CAA Clean Air Act (Federal)
CAAS California Ambient Air Quality Standards
CalEPPC California Exotic Pest Plant Council
CARB California Air Resources Board
CDFG California Department of Fish and Game
CEQ President's Council on Environmental Quality
CEQA California Environmental Quality Act
CESA California Endangered Species Act
CFR Code of Federal Regulations
cfs cubic feet per second
cm centimeters
CNEL community noise equivalent level
CNDDB California Natural Diversity Database
CNL considered but not listed
CNPS California Native Plant Society
CO carbon monoxide
Conservancy California Coastal Conservancy
Council National Invasive Species Council
CPRC California Public Resources Code
CSC California species of concern/species of special concern
CVRWQCB Central Valley Regional Water Quality Control Board
CWA Clean Water Act
CZMA Coastal Zone Management Act
dB decibel
dBA sound level weighted for human hearing
DDT dicholoro diphenyl tricholoroethane
Delta Sacramento-San Joaquin Delta
DO dissolved oxygen
EA environmental assessment
EBRPD East Bay Regional Park District
EFH essential fish habitat
EIR environmental impact report (State)
EIS environmental impact statement (Federal)
EPA United States Environmental Protection Agency
ER-L effects range-low
ER-M effects range-median
ESA Federal Endangered Species Act
Estuary San Francisco Estuary
FD De-listed under the Federal Endangered Species Act
FE Federally-listed Endangered
FPE Species proposed for Federal listing as Endangered
FPT Species proposed for Federal listing as Threatened
FSC Federal species of concern/species of special concern
FT Federally-listed threatened species
FWCA Fish and Wildlife Coordination Act
H_2S hydrogen sulfide
Hz frequency in hertz
IEP CALFED's Interagency Ecological Program
ISP San Francisco Estuary Invasive *Spartina* Project
IVM integrated vegetation management
LEQ average noise level
LOEC lowest observable effect concentration
LTMS San Francisco Long-term Management Strategy for Disposal and Reuse of Dredged Material
MBTA Migratory Bird Treaty Act
mcy million cubic yards
MEI maximally exposed individual
mg/kg-day milligrams per kilogram per day
mg/L milligrams per liter
mgd million gallons per day
MHHW mean higher high water
mL milliliters
MMPA Marine Mammal Protection Act
MOU Memorandum of Understanding
mph miles per hour
MPRSA National Marine Protection, Research, and Sanctuaries Act
MSFCMA Magnuson-Stevenson Fishery Conservation and Management Act
NAAQS national ambient air quality standard
NEPA National Environmental Policy Act
NHPA National Historic Preservation Act
NMFS National Marine Fisheries Service
NNG N-nitroso-glyphosate
NOAA National Oceanic and Atmospheric Administration
NOEC no observable effect concentration
NOI Notice of Intent (CEQA term)
NOP Notice of Preparation (NEPA term)
NO_x nitrogen oxides
NPDES National Pollutant Discharge Elimination System
NPEO nonylphenol polyethoxylate
NPL National Priorities List
O_2 ozone
OHP California Office of Historic Preservation
OSHA California Occupational Safety and Health Administration
PAHs polycyclic aromatic hydrocarbons
PCBs polychlorinated biphenyls
PM_{10} small diameter particles
ppb parts per billion
ppm parts per million
ppq parts per quadrillion
ppt parts per thousand
pptr parts per trillion
PRC Public Resource Code
RfD reference dose
RHA Rivers and Harbors Act
RMP San Francisco Bay Regional Monitoring Program
ROD Record of Decision (NEPA term)
ROI Region of Influence (NEPA term)
RWQCB Regional Water Quality Control Board
SCP *Spartina* Control Program
SE state-listed endangered species
Service U.S. Fish and Wildlife Service
SFBRWQCB San Francisco Bay Regional Water Quality Control Board
SFEI San Francisco Estuary Institute
SFEP San Francisco Estuary Project
SHPO State Historic Preservation Officer
SIP State Implementation Plan (air quality)
SLC State Lands Commission
SO_2 sulfur dioxide
SO_x sulfur oxides
SPCC Spill Prevention, Control and Countermeasures
SR State-listed rare
SWRCB State Water Resources Control Board
ST state-listed threatened species
TSS total suspended solids
USACE United States Army Corps of Engineers
USDA United States Department of Agriculture
USFWS United States Fish and Wildlife Service
USGS United States Geological Survey
VOC volatile organic compound
WDR waste discharge requirement

EXECUTIVE SUMMARY

INTRODUCTION

The San Francisco Bay Estuary (Estuary) supports the largest and most ecologically important expanses of tidal mudflats and salt marshes in the contiguous western United States. This environment supports a diverse array of native plants and animals. Over the years, many non-native species of plants and animals have been introduced to the Estuary, and some now threaten to cause fundamental changes in the structure, function, and value of the Estuary's tidal lands. Among these threatening invaders are several species of salt marsh cordgrass (genus *Spartina*). In recent decades, populations of non-native cordgrasses were introduced to the Estuary and began to spread rapidly. Though valuable in their native settings, these introduced cordgrasses are highly aggressive in this new environment, and frequently become the dominant plant species in areas they invade.

One of the non-native cordgrass species in particular, Atlantic smooth cordgrass, and its hybrids (formed when this species crosses with the native Pacific cordgrass) are now threatening the ecological balance of the Estuary and are likely to eventually cause the extinction of native Pacific cordgrass, choke tidal creeks, dominate newly restored tidal marshes, and displace thousands of acres of existing shorebird habitat. Once established in this Estuary, invasive cordgrasses could rapidly spread to other estuaries along the California coast through seed dispersal on the tides. Non-native invasive cordgrasses dominate greater than 500 acres of San Francisco Estuary mudflats and tidal marsh – on State, Federal, municipal, and private lands – and are spreading rapidly. The *Spartina* Control Program (Control Program) proposes to implement a coordinated, region-wide eradication program, comprising a number of on-the-ground treatment techniques to stave off this invasion. The Control Program will be focused within the nearly 40,000 acres of tidal marsh and 29,000 acres of tidal flats that comprise the shoreline areas of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, Sonoma, and Sacramento counties.

The California State Coastal Conservancy (Conservancy), as the lead agency under the California Environmental Quality Act (CEQA), and the U.S. Fish and Wildlife Service (Service or USFWS), as the lead agency under the National Environmental Policy Act (NEPA), have jointly prepared this Environmental Impact Statement/Report EIS/R to address the environmental impacts of the proposed Control Program. This document is a "Programmatic" EIS/R (NEPA Regulations Section 1508.18 and CEQA Guidelines Section 15168) because it analyzes the potential effects of implementing treatment methods for a regional program, rather than the impacts of an individual treatment project.

PURPOSE AND NEED

The purpose of the *Spartina* Control Program is to arrest and reverse the spread of invasive non-native cordgrass species in the Estuary to preserve and restore the ecological integrity of the Estuary's intertidal habitats and estuarine ecosystem.

The Control Program is needed to prevent further degradation and loss of the natural ecological structure and function of the Estuary. Within decades, half of the existing intertidal flats are likely to be replaced with dense, invasive non-native cordgrass marsh, and much of the native diverse salt-marsh vegetation replaced with nearly single-species stands of invasive non-native cordgrass marsh.

Potential effects of non-native cordgrass invasion include:

- Genetic assimilation and extinction of native Pacific cordgrass;
- Extensive regional loss of tidal flats;
- Elimination of critical foraging habitat for migratory shorebirds;
- Failure of efforts to restore native tidal marsh vegetation in diked baylands;
- Interference with natural sedimentation processes to support restoration of diked baylands;
- Regional loss of tidal sloughs and channels;
- Stabilization of estuarine beaches and beach-forming processes;
- Marginalization of endangered California clapper rail habitat;
- Reduction or elimination of endangered salt marsh harvest mouse habitat;
- Interference with recovery of endangered California sea-blite;
- Increased need for dredging and flood control;
- Production of massive piles of vegetative debris; and,
- Spread of non-native cordgrasses to other California estuaries.

Arresting and reversing the invasion of non-native cordgrasses may become infeasible once these species have spread and become established, due to the aerial extent of the invasion and the effects of hybridization. Therefore, the Control Program will take immediate and aggressive action to optimize the potential for success.

PROGRAM ALTERNATIVES

The lead agencies evaluated a number of approaches and a variety of treatment methods that may achieve the project goal. Three alternatives were ultimately selected for full evaluation. The two "action alternatives," Alternatives 1 (Regional Eradication Using All Available Control Methods) and 2 (Regional Eradication Using Only Non-Chemical Control Methods), would employ a variety of manual and mechanical treatment methods, including:

- Hand-pulling and manual excavation;
- Mechanical excavation and dredging;
- Pruning, burning, and mowing;
- Smothering (blanketing); and
- Drowning.

In addition to these methods, Alternative 1, the preferred alternative, would also employ application of herbicides in suitable situations.

Both Alternatives 1 and 2 would incorporate a modified Integrated Vegetation Management (IVM) approach. The IVM approach will integrate scientific information regarding cordgrass and the estuarine ecosystem with awareness of the likely economic, ecological, and sociological consequences of the cordgrass invasion, to assure a program that is effective, economical, and protective of public and environmental health.

Consistent with NEPA and CEQA requirements, a no-action alternative, Alternatives 3, also was developed and evaluated. Under Alternative 3, no regional program to control non-native invasive cordgrasses would be adopted, however the current approach of limited uncoordinated control efforts would continue. **Table S-1** provides an abbreviated description of the three alternatives for reference.

ENVIRONMENTAL IMPACTS, AND MITIGATION MEASURES

The environmental impacts of the project and alternatives are summarized on **Table S-2** and are briefly described by topic below.

Geomorphology and Hydrology

Manual and mechanical treatment under Alternatives 1, 2, and 3 could have adverse effects of increased erosion (in some limited circumstances) and competition for limited sediment disposal sites during treatment. These impacts would either be less than significant or could be mitigated to less than significant levels by implementation of mitigation measures identified in this EIS/R. These alternatives would have a beneficial effect on flows of water in tidal channels.

Water Quality

Implementation of Alternatives 1 and 3 could adversely affect water quality due to herbicide application, spills of herbicides and petroleum products, and remobilization of contaminants in sediments. Alternative 2 would not have herbicide-related impacts, but would share approximately the same level of other water quality-related potential impacts as Alternatives 1 and 3. Under all of the alternatives, impacts to water quality would either be less than significant or could be mitigated to less than significant levels by implementation of mitigation measures identified in this EIS/R.

Biological Resources

In general, Alternatives 1 and 2 would have significant adverse short-term impacts, while Alternative 3 would have significant unavoidable long-term impacts associated with the conversion of habitat resulting from the spread of non-native cordgrasses, as summarized below:

- Alternatives 1, 2, and 3 could have significant but mitigable effects on non-target plant species in infested areas, primarily as a result of disturbance required to eradicate the invasive plants.
- These alternatives also could have short-term adverse significant and mitigable impacts to submerged aquatic plant communities, shorebird and waterfowl habitat, harbor seal haul

Table S-1. Alternatives Analyzed in This EIS/R

Alternative	*Description*
1	Proposed Action/ Proposed Project - Regional Eradication Using All Available Control Methods
2	Regional Eradication Using Only Non-Chemical Control Methods
3	No Action – Continued Limited, Regionally Uncoordinated Treatment

outs, and special status plants. In the long term, Alternatives 1 and 2 would not adversely affect these biotic resources, while Alternative 3 would significantly and unavoidably adversely affect them.

- Alternatives 1, 2, and 3 would have significant short-term impacts to the salt marsh harvest mouse and tidal shrew species due to habitat disturbance resulting from treatment activities. However, long-term spread of non-native cordgrasses significantly adversely affect these species under Alternative 3.
- California clapper rail and black rail populations would be significantly adversely and unavoidably affected in the short-term by treatment activities under Alternatives 1 and 2, and in the long-term under Alternative 3.
- Estuarine fishes and anadromous salmonids would be subject to significant but mitigable adverse short-term impacts from treatment activities under Alternatives 1, 2, and 3, and to significant unavoidable long-term impacts under Alternatives 3.
- San Francisco garter snake, California red-legged frogs, and tidewater gobies would not be significantly affected under any alternatives.
- All alternatives would have either less than significant or significant but mitigable effects on increased mosquito production.

Air Quality

Alternatives 1, 2, and 3 would have less than significant effects on emissions of air contaminants and dust with the exception of herbicides, which could be significant but mitigable under Alternatives 1 and 3.

Noise

Sensitive noise receptors could experience significant but mitigable impacts as a result of noise generated by treatment activities under Alternatives 1, 2, and 3.

Human Health and Safety

Workers involved in herbicide treatment could be subject to significant but mitigable health risks under Alternatives 1 and 3. All other human health and safety impacts would be either less than significant or non-existent under all alternatives.

Visual Resources

Removal of large areas of invasive cordgrass could have significant, unmitigable temporary adverse visual impacts under Alternatives 1, 2, and 3. Conversely, Alternatives 3 would result in long-term, significant, unavoidable visual impacts resulting from elimination of mudflats and the native-like variation in visual character that currently characterizes the Bay margins.

Land Use

Herbicide use under Alternatives 1 and 3 could result in significant adverse temporary land use conflicts with residents and recreational users in the vicinity of the areas to be sprayed. This is mitigable by implementation of notification and herbicide control measures identified in this EIS/R. Alternative 2 would avoid this impact.

Cultural Resources

Treatment activities under Alternatives 1, 2, and 3 could adversely affect historic or prehistoric cultural resources. However these potentially significant impacts could be reduced to less than significant by implementation of monitoring and avoidance measures identified in this EIS/R.

Socioeconomics

None of the alternatives would have a significant effect, either beneficial or adverse, on socioeconomic conditions.

Environmental Justice

None of the alternatives would have a significant effect on environmental justice issues.

Cumulative Impacts

Three types of projects have potential significant cumulative interactions with the Control Program: (1) other aquatic weed control programs in the Bay-Delta (Sacramento-San Francisco River Delta) region; (2) mosquito abatement activities in tidal marshes of the Bay region; and (3) restoration and management projects affecting tidal marshes of the San Francisco Estuary. A risk of significant damage to marsh plain vegetation from cumulative vehicle use from mosquito abatement activities and the Control Program could occur. Mitigations that reduce this impact to less than significant levels are identified in this document.

In addition, proposed wetland restoration projects could accelerate the spread of non-native cordgrass, which in turn, could interfere with the effectiveness of the Control Program. This would result in significant and adverse effects on biological resources, Estuary hydrology, and geomorphology. This is mitigable via proper sequencing of restoration projects and the Control Program.

Unavoidable Significant Impacts

The Control Program would result in significant unavoidable impacts to the salt-marsh harvest mouse, tidal shrew, California clapper rail, California black rail, and short-term visual quality of treated marshes.

COMPARISON OF ALTERNATIVES

There is a strong contrast in the comparisons of alternatives from the perspectives of long-term versus short-term environmental consequences. Normally, with private development or public works projects, the “no action” alternative is associated with more environmentally benign protection or conservation of existing natural resources. In this case, the existing natural resources are undergoing long-term degradation because of “biological pollution” caused by non-native invasive cordgrass species.

Alternatives 1 and 2 cause significantly more adverse short-term, direct, and indirect environmental impacts than the no action Alternative 3, which would still have potentially significant treatment impacts. These short-term impacts are the inevitable consequences of eradication methods that devegetate tidal wetlands invaded by non-native cordgrass. Alternatives 1 and 2, and to a lesser extent Alternative 3 eliminate or displace the wildlife that inhabit them, and cause significant short-term side effects from operation of vehicles and equipment. Alternative 2 would have no short-term, direct, and indirect impacts related to application of aquatic herbicides, such as operation of helicopters and vehicles, and risk of spray drift, overspray and accidental spillage. However, repeated physical eradication methods that may be necessary to replace chemical herbicides, the potential ground and vegetation disturbance impacts under Alternative 2 would increase. This would shift some impacts from aquatic environments (potential herbicide dispersion impacts) to marsh environments (increased intensity, frequency, and duration of mechanical disturbance). Thus, Alternative 2 could prolong wetland degradation and ultimately exceed the net impact of combined use of manual, mechanical, and chemical methods proposed in Alternative 1. Alternative 3's lack of coordination would exacerbate this impact, compared with Alternative 2.

Alternative 2 also has a higher risk of failure to control and eventually eradicate invasive cordgrasses compared to Alternative 1. If Alternative 2 failed to control these invasives, it eventually would result in the same long-term environmental consequence as described below for Alternative 3. Alternative 3's lack of regional coordination would allow the continued and quickening spread of Atlantic smooth cordgrass. This would result in diminishing local control effectiveness and increasing local costs for non-native cordgrass "maintenance" control over time. Probably within one to two decades, only flood control and navigation interests would have incentives and resources to combat overwhelming invasion rates of Atlantic smooth cordgrass hybrids, especially if tidally restored salt ponds generate vast new hybrid populations and seed sources.

Environmentally Superior (CEQA) and Preferred (NEPA) Alternative

Because the project is, in effect, an environmental restoration and protection project, its primary adverse impacts are short-term, during the treatment process. As described above, Alternatives 2 could have somewhat less environmental impacts than Alternative 1 because it would exclude impacts related to application of aquatic herbicides.. However, these reduced impacts could be offset by the need for additional mechanical treatment if chemicals are not used, and by the potential impacts resulting from repeated treatment under Alternative 2. In addition, Alternative 2 also has a lower probability of achieving the project's ultimate environmental benefits than Alternative 1. Similarly, Alternative 3 would somewhat reduce treatment impacts, but is likely to ultimately fail, resulting in far greater long-term impacts than Alternative 1 and, likely, Alternative 2. Therefore this EIR considers the CEQA Environmentally Superior Alternative to be a mitigated version of Alternative 1 in which all mitigations in this EIS/R have been incorporated into the program. This Environmentally Superior Alternative is identified as the Mitigated Project Alternative.

Similarly, the Federal lead agencies have concluded that Alternative 1 is most likely to achieve long-term protective benefits for California's estuarine environments, and provide the most favorable ratio of environmental costs to benefits. Therefore, Alternative 1 with inclusion of EIS-identified mitigation measures is identified as the NEPA Environmentally Preferred Alternative.

Table S-2. Comparison of Impacts of Project Alternatives*

Impact	***Alternative 1:*** *Regional Eradication Using All Available Control Methods (current/ future)*	***Alternative 2:*** *Regional Eradication Using Non-Chemical Control Methods (current/ future)*	***Alternative 3:*** *No Action – Continued Uncoordinated Treatment (current/ future)*
Hydrology and Geomorphology			
GEO-1: Erosion or deposition of sediment at sites of cordgrass eradication	◐/○	◐/○	◐/○
GEO-2: Erosion or topographic change of marsh and mudflats by vehicles used in eradication	◐/○	◐/○	◐/○
GEO-3: Remobilization of sand in cord-grass-stabilized estuarine beaches	◐/○	◐/○	◐/○
GEO-4: Increased demand for sediment disposal and potential spread of invasive cordgrass via sediment disposal	◐/○	◐/○	◐/○
GEO-5: Increased volume and velocity of tidal currents in channels due to the re-moval of invasive cordgrass	+/○	+/○	+/●
GEO-6: Increased depth and turbulence of tidewaters in salt marsh pans	+/○	+/○	○/◐
Water Quality			
WQ-1: Degradation of water quality due to herbicide application	⦶/○	○/○	⦶/○
WQ-2: Degradation of water quality due to herbicide spills	◐/○	○/○	◐/○
WQ-3: Degradation of water quality due to fuel or petroleum spills	◐/○	◐/○	◐/○
WQ-4: Degradation of water quality due to contaminant remobilization	◐/○	◐/○	◐/○
Biological Resources			
BIO-1.1: Effects of alternative on salt-meadow cordgrass and English cordgrass infested tidal marsh plant communities	◐/○	◐/○	●/●
BIO-1.2: Effects of alternative on Atlantic smooth cordgrass (and its hybrids) in-fested tidal marsh plant communities	◐/○	◐/○	●/●
BIO-1.3: Effects of alternative on Chilean cordgrass infested tidal marsh plant com-munities	◐/○	◐/○	●/●
BIO-1.4: Effects of alternative on sub-merged aquatic plant communities	◐/○	◐/○	◐/●
BIO-2: Effects of alternative on special status plants	◐/○	◐/○	◐/●

* All Impacts are compared to current (2002) conditions. Impact significance indicated in this table is based on the reasonable worst case effects; some impacts identified as adverse also may have beneficial aspects that are addressed in the EIS/R text.

KEY:

● = Significant and not mitigable impact
⦶ = Less than significant impact
\+ = Beneficial impact
◐ = Significant and mitigable impact
○ = No impact

Impact	***Alternative 1:*** *Regional Eradication Using All Available Control Methods (current/ future)*	***Alternative 2:*** *Regional Eradication Using Non-Chemical Control Methods (current/ future)*	***Alternative 3:*** *No Action – Continued Uncoordinated Treatment (current/ future)*
BIO-3: Effects of alternative on non special status shorebirds and waterfowl	◑/○	◑/○	◑/●
BIO-4.1: Effects of alternative on salt marsh harvest mouse and tidal shrew	●/○	●/○	●/●
BIO-4.2: Effects of alternative on resident harbor seal colonies in San Francisco Bay	◑/○	◑/○	◑/●
BIO-4.3: Effects of alternative on the southern sea otter	○/○	○/○	○/●
BIO-5.1: Effects of alternative on California clapper rail	●/○	●/○	◑/●
BIO-5.2: Effects of alternative on California black rail	●/○	●/○	◑/●
BIO-5.3: Effects of alternative on tidal marsh song sparrow subspecies and salt marsh common yellowthroat	◑/○	◑/○	◑/●
BIO-5.4: Effects of alternative on California least terns and western snowy plovers	◑/○	◑/○	◑/●
BIO-5.5: Effects of alternative on raptors	◑/○	◑/○	⦶/●
BIO-6.1: Effects of alternative on anadromous salmonids	◑/○	◑/○	◑/●
BIO-6.2: Effects of alternative on delta smelt and Sacramento splittail	⦶/○	⦶/○	⦶/●
BIO-6.3: Effects of alternative on tidewater goby	○/○	○/○	○/○
BIO-6.4: Effects of alternative on estuarine fish populations of shallow submerged intertidal mudflats and channels	◑/○	◑/○	◑/●
BIO-7: Effects of alternative on California red-legged frog and San Francisco garter snake	○/○	○/○	○/○
BIO-8: Effects of alternative on mosquito production	⦶/○	⦶/○	⦶/◑
BIO-9: Effects of alternative on tiger beetle species	+/○	+/○	+/⦶
Air Quality			
AQ-1: Dust emissions	⦶/○	⦶/○	⦶/○
AQ-2: Smoke emissions	◑/○	◑/○	◑/○

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AQ-3: Herbicide effects on air quality	◑/○	○/○	◑/○
AQ-4: Ozone precursor emissions	⦶/○	⦶/○	⦶/○
AQ-5: Carbon monoxide emissions	⦶/○	⦶/○	⦶/○
Noise			
N-1: Disturbance of sensitive receptors	◑/○	◑/○	◑/○
Human Health and Safety			
HS-1: Worker injury from accidents associated with manual and mechanical aspects of treatment	◑/○	◑/○	◑/○
HS-2: Worker health effects from herbicide application	◑/○	○/○	◑/○
HS-3: Health effects to the public from herbicide application	⦶/○	○/○	⦶/○
HS-4: Health effects to the public from accidents associated with chemical treatment	◑/○	○/○	◑/○
Visual Resources			
VIS-1: Alteration of views from removal of non-native cordgrass	●/○	●/○	⦶/○
VIS-2: Change in views from native marsh, mudflat, and open water to non-native cordgrass meadows and monocultures	○/○	○/○	○/●
Land Use			
LU-1: Land use conflicts between herbicide use and sensitive receptors	◑/○	○/○	◑/○
LU-2: Land use conflicts from mechanical and burning treatment methods	◑/○	◑/○	◑/○
Cultural Resources			
CUL-1: Disturbance and destruction of cultural resources from access and treatment	◑/○	◑/○	◑/○
CUL-2: Loss of cultural resources from erosion	◑/○	◑/○	◑/○

* All Impacts are compared to current (2002) conditions. Impact significance indicated in this table is based on the reasonable worst case effects; some impacts identified as adverse also may have beneficial aspects that are addressed in the EIS/R text.

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Impact	***Alternative 1:*** *Regional Eradication Using All Available Control Methods (current/ future)*	***Alternative 2:*** *Regional Eradication Using Non-Chemical Control Methods (current/ future)*	***Alternative 3:*** *No Action – Continued Uncoordinated Treatment (current/ future)*
Socioeconomics	⦶/○	⦶/○	⦶/○
Environmental Justice	○/○	○/○	○/○
Cumulative Impacts			
CUM-1: Effects of wetland restoration projects on spread of non-native cord-grass.	⦶/◑	⦶/◑	⦶/●
CUM-2: Cumulative damage to marsh plain vegetation.	◐/○	◐/○	◐/○

1.0 INTRODUCTION

The San Francisco Bay Estuary (San Francisco Estuary or Estuary) supports the largest and most ecologically important expanses of tidal mudflats and salt marshes in the contiguous western United States. This environment naturally supports a diverse array of native plants and animals. Over the years, many non-native species of plants and animals have been introduced to the Estuary, and some now threaten to cause fundamental changes in the structure, function, and value of the Estuary's tidal lands. Among these threatening invaders are several species of salt marsh cordgrass (genus *Spartina*). In recent decades, populations of non-native cordgrasses were introduced to the Estuary and began to spread rapidly. Though valuable in their native settings, these introduced cordgrasses are highly aggressive in this new environment, and frequently become the dominant plant species in areas they invade.

One of the non-native cordgrass species, Atlantic smooth cordgrass (*Spartina alterniflora*), is rapidly spreading throughout the Estuary, particularly in the South San Francisco Bay (South Bay). Atlantic smooth cordgrass and its hybrids (formed when this species crosses with the native Pacific cordgrass, *Spartina foliosa*) are now threatening the ecological balance of the Estuary. Based on a century of international studies of comparable cordgrass invasions, they are likely to eventually cause the extinction of native Pacific cordgrass, choke tidal creeks, dominate newly restored tidal marshes, and displace thousands of acres of existing shorebird habitat. Once established in this estuary, invasive cordgrasses could rapidly spread to other estuaries along the California coast through seed dispersal on the tides. Non-native invasive cordgrasses currently dominate approximately 500 acres of the San Francisco Estuary in seven counties — on State, Federal, municipal, and private lands — and are spreading at a startling rate.

1.1 THE *SPARTINA* CONTROL PROGRAM

The *Spartina* Control Program is the "action arm" of the San Francisco Estuary Invasive *Spartina* Project (*Spartina* Project or ISP). The California State Coastal Conservancy (Conservancy) initiated the ISP in 2000 to stave off the invasion of non-native cordgrass and its potential impacts. The ISP is a regionally coordinated effort of Federal, State, and local agencies, private landowners, and other interested parties, with the ultimate goal of arresting and reversing the spread of non-native cordgrasses in the San Francisco Estuary. When fully implemented, the ISP will provide opportunities to maximize resources, effectively disseminate information, facilitate regional monitoring, and reduce the occurrence of cordgrass re-infestation. The geographic focus of the ISP includes the nearly 40,000 acres of tidal marsh and 29,000 acres of tidal flats that comprise the shoreline areas of the nine Bay Area counties, including Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties, and Sacramento County (**Figure 1-1**).

The ISP is comprised of a number of components including public education and outreach, scientific research, monitoring and mapping, regulatory coordination, and eradication (**Figure 1-2**). The eradication component of the ISP, under which on-the-ground treatment of vegetation will occur (and funding for such treatment will be allocated), is called the *Spartina* Control Program. The *Spartina* Control Program also is referred to in this document as the SCP or Control Program. The ISP is an existing, ongoing effort, while the *Spartina* Control Program is in the planning phases. The Control Program proposes to implement a number of treatment techniques to eradicate the four invasive non-native cordgrass species.

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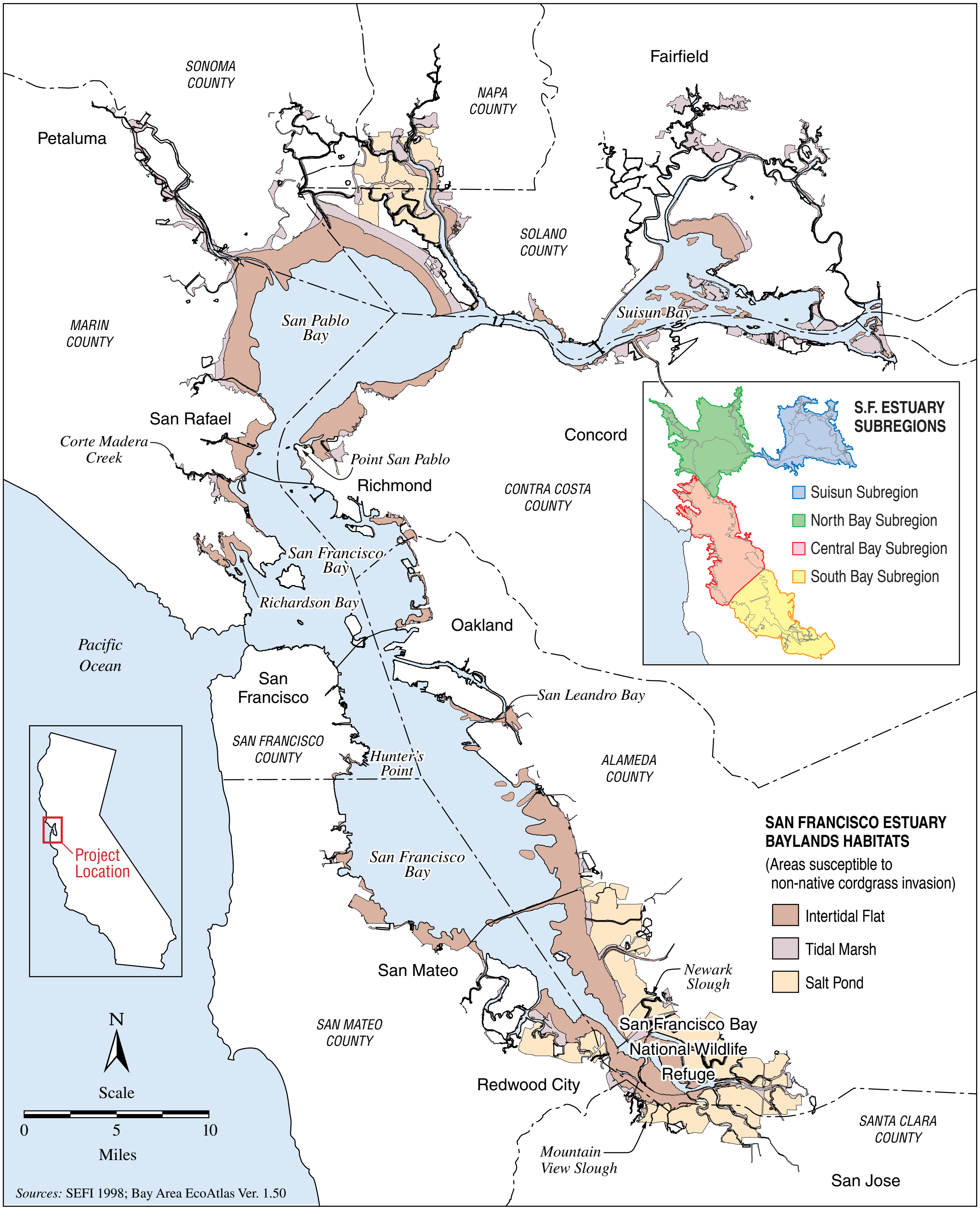

Figure 1-1. *Spartina* Control Program Region

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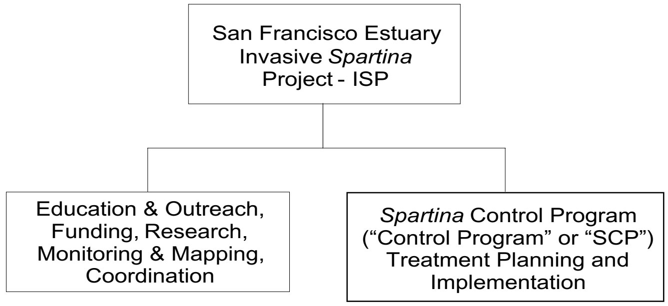

Figure 1-2. Components of the San Francisco Estuary Invasive *Spartina* Project

The proposed treatment techniques, ranging from mowing, pulling, or smothering plants to spraying with herbicides, are described in detail in Chapter 2, *Program Alternatives*. It is the potential impacts of the *Spartina* Control Program and the proposed treatment techniques that are the subject of this Programmatic Environmental Impact Statement/Report (EIS/R).

1.2 PURPOSE AND NEED

1.2.1 Statement of Purpose and Need

The purpose of the *Spartina* Control Program is to arrest and reverse the spread of invasive non-native cordgrass species in the San Francisco Estuary to preserve and restore the ecological integrity of the Estuary's intertidal habitats and estuarine ecosystem.

The Control Program is needed to prevent further degradation and loss of the natural ecological structure and function of the San Francisco Estuary. In the absence of any coordinated and wide-ranging control program, within decades significant portions of the existing higher tidal flats are likely to be replaced with dense, invasive cordgrass marsh, and much of the native diverse salt-marsh vegetation replaced with nearly homogeneous stands of non-native cordgrass. This ecological conversion is likely to alter the structure and function of the Estuary, affecting fisheries, migratory shorebirds and waterfowl, marine mammals, endangered fish, wildlife, and plants, tidal sediment transport, and the rate, pattern, and magnitude of tidal flows. In addition, invasive cordgrasses may impede or preclude plans to restore up to 20,000 acres of diked baylands to native tidal marsh. Arresting and reversing the invasion of non-native cordgrasses may not be feasible once these species have spread and become established, due to the expansive scale of the invasion and the effects of hybridization. To avoid these consequences, the ISP proposes a rapidly implemented, regionally coordinated, long-term management program.

1.2.2 Ecology of the San Francisco Estuary Tidal Lands

The tidal lands of the San Francisco Estuary include an intertidal zone at lower elevations, and a tidal marsh plain at higher elevations. Like most Pacific estuaries, the majority of the intertidal zone of the San Francisco Estuary naturally consists of unvegetated tidal flats, or mudflats. Native California tidal marsh vegetation is limited to the upper intertidal zones, above mean sea level in San Francisco and San Pablo Bays. Below mean sea level, waves erode and redeposit the upper layers of bay mud with each tidal cycle. Rich deposits of fine silt and clay from the Sacramento-San Joaquin Delta have accumulated in the Estuary to form highly productive mudflats, with abundant benthic invertebrates. The mudflats provide a critical source of nutrition and energy for migratory shorebirds and waterfowl, with more than one million shorebirds using the Estuary's mudflats and salt ponds during migration, and over half of the west-coast migratory diving ducks making this estuary their winter home.

At elevations above the intertidal zone (in areas that have not been diked and removed from tidal action), are the Estuary's tidal salt and brackish marshes. Pacific salt marsh vegetation is more diverse in plant species than its Atlantic counterpart. Until recent decades, the native Pacific cordgrass exclusively occupied the lower reaches of the Estuary's tidal salt marshes. At slightly higher elevations, a relatively flat tidal marsh plain (reaching near the average level of the higher daily tides), is dominated by low-growing, mostly perennial plants such as pickleweed, saltgrass, and other salt-tolerant herbs. The tidal marsh plain is punctuated by salty shallow ponds (pans), and dissected by irregular tidal creeks. Above the tidal marsh plain, at the uppermost edges of the marsh, are an even greater number of plant species.

Many endemic (unique to the area) plant and animal species, including many rare or endangered species, survive only in the Estuary's remaining tidal marshes. They remain at risk of extinction because of the severe decline over the past century in the abundance, distribution, and quality of tidal marshes. Most of the Estuary's rare species have narrow or specific habitat requirements, and the health of their populations usually is sensitive to structural changes in their habitats – particularly the condition of the marsh vegetation. Strong dominance of the vegetation by one or more plant species necessarily results in lower overall species diversity, and can push rarer species to local extinction.

1.2.3 Characteristics of Native and Non-native Cordgrasses of the San Francisco Estuary

There are one native and four non-native species of cordgrass in the San Francisco Estuary. The native species is Pacific cordgrass (*Spartina foliosa*). The non-natives species are Atlantic smooth cordgrass (*S. alterniflora)*, English cordgrass (*S. anglica)*, Chilean cordgrass (*S. densiflora)*, and salt-meadow cordgrass (*S. patens)*. The non-native Atlantic smooth cordgrass hybridizes with the native Pacific cordgrass, and their offspring (referred to in this document as "Atlantic smooth cordgrass hybrids" or "hybrids") are also invasive and considered non-native. Key aspects of the cordgrass species found in the Estuary are contrasted below. The biological contrasts among these species and their roles in their native habitats help to demonstrate how non-native cordgrasses are likely to alter the Estuary's salt marsh ecosystem. First described is the native Pacific cordgrass, followed by the non-native species. Photographs of each of these species are shown immediately following the descriptions in **Figure 1-3**.

Pacific Cordgrass, *Spartina foliosa* (Native)

The historic range of Pacific cordgrass was confined to estuaries from Point Reyes to Baja California, with large gaps in between; for example, it is historically absent in Monterey Bay and Morro Bay. Most of the Pacific cordgrass population exists in San Francisco and San Pablo Bays. Its northern limit is now Bodega Bay, a small and recent natural population. It even more recently established in Tomales Bay, where its population surged following major flood and depositional events of the mid-1990s.

Pacific cordgrass is a perennial, salt-tolerant marsh grass, which spreads both sexually, by seed dispersal, and asexually, by long, creeping rhizomes (underground stems, or runners) that propagate small clusters of leafy shoots. Clonal (asexual) growth of rhizomes allows individual plants to form extensive colonies without being pollinated by another plant. A colony thus formed is referred to as a "clone." The slender leafy shoots with seed-heads seldom exceed five feet in height, and most shoots range from about one to three feet tall. The height of the cordgrass plant is related to how well it tolerates submersion in tidewaters, and thus how low in the intertidal zone it can grow. The relatively short stature of Pacific cordgrass corresponds with its limited occupation of lower elevations within the intertidal zone.

Pacific cordgrass is genetically very similar to Atlantic smooth cordgrass, but the two species also have significant differences. In size, growth rate, production, and ecological tolerances, Pacific cordgrass is much less robust than Atlantic smooth cordgrass (Smart and Barko 1978, Callaway 1990, Boyer, Callaway and Zedler 2000). Pacific cordgrass grows more luxuriantly in clayey mud than sand, but it naturally grows in substrates ranging from sand and mud to peat. Its leaves and stems wither in fall and are shed in winter, as the clones die back to young shoots and buds near the mud surface. The sparse remains of Pacific cordgrass stands in winter are relatively ineffective in trapping sediment.

Pacific cordgrass is generally restricted to a narrow portion of the intertidal zone, between an elevation just above mean sea level and an elevation near the level of the average higher daily tide (mean higher high water, "MHHW"). It tends to fail in competition with plants like pickleweed on the marsh plain, which, in California estuaries, approaches the elevation of the MHHW. This modest range in tidal elevation restricts Pacific cordgrass to the sloping banks of tidal creeks, and the gently sloping upper edges of mudflats where sediment accumulates. This leaves the vast acreages of Pacific tidal flats below mean sea level entirely free of emergent vegetation in natural historic conditions. The vegetated marsh plain (middle to high marsh zone) supports either sparse Pacific cordgrass in lower areas, or none at all.

Early experiments with Pacific cordgrass demonstrated that its slender, widely spaced leafy shoots and rhizomes are not as effective at stabilizing sediment compared with Atlantic smooth cordgrass, especially under exposed conditions at the bay's edge (Newcombe et al. 1979). Seedlings of Pacific cordgrass are seldom found in established marshes, and appear only intermittently in sheltered upper mudflats.

Pacific cordgrass is particularly valued as habitat for the endangered California clapper rail, which spends most of its time foraging for food within, or close to, the protective canopy of cordgrass. Rails can move within Pacific cordgrass stands, and spend most of their time under cover of the cordgrass foliar canopy, usually selecting prey items such as invertebrates inhabiting the cordgrass stands and their edges. In contrast to the clapper rail of southern California tidal marshes, San Francisco Bay clapper rails generally do not construct "floating nests" in Pacific cordgrass; instead, they tend to build nests in gumplants or pickleweed in the higher marsh.

Atlantic Smooth Cordgrass, *Spartina alterniflora,* and its Hybrids

Smooth cordgrass is the closely related sibling to Pacific cordgrass. In the United States, it occurs along both the Atlantic and Gulf Coasts (Gleason and Cronquest 1991). It is unique among the world's cordgrass species in terms of its growth potential and ecological breadth, and it is the parent species of the other most invasive cordgrass species of hybrid origin, English cordgrass (*Spartina anglica*; Adam 1990). The San Francisco Estuary population of Atlantic smooth cordgrass was founded by seed from Maryland in the mid-1970s, introduced experimentally for one of the first tidal marsh restoration projects on the west coast (Faber 2000). We refer to the San Francisco Bay population of smooth cordgrass as Atlantic smooth cordgrass.

Atlantic smooth cordgrass is a coarse perennial grass that, like its Pacific relative, spreads both by seed dispersal and by creeping rhizomes that form extensive clonal colonies. In parts of the San Francisco Estuary, the rate of lateral spread by rhizomes averages between 3.3 and 6.6 feet per year, in contrast with native Pacific cordgrass, which spreads only 0.6 to 2.4 feet per year in the same marshes (Josselyn *et al.* 1993). Similar rates of lateral spread of this species and its hybrids have been recorded more recently in Cogswell Marsh on the Hayward Shoreline (K. Zaremba, M. Taylor, pers. comm.)

The size range of Atlantic smooth cordgrass is wide and highly variable, depending on its local genetics and environment. In nutrient-rich, well-drained marsh sediment, such as along tidal creek banks and on newly colonized tidal flats, extensive dense stands can reach nearly 10 feet in height. On poorly drained marsh flats, its vegetation is typically sparse and short, but its dense root and rhizome network maintains pure stands and effectively binds marsh sediments. The "tall form" and "short form" of this species were so strikingly different that they were long assumed to be distinct varieties, rather than environmentally-caused variations. Modern research indicates that factors related to marsh drainage, such as waterlogged soil chemistry (especially accumulation of toxic soil sulfides), excessive salinity, and nutrient deficiency interact to cause the dramatic differences in growth-forms of Atlantic smooth cordgrass (Bradley and Dunn 1989, Mendelssohn and Seneca 1980, Valiela *et al.* 1978, Smart and Barko 1978). Genetic variations in height forms of Atlantic smooth cordgrass also have been confirmed in San Francisco Bay (Daehler *et al.* 1999)

In the salt marshes of the Atlantic coastal plain, Atlantic smooth cordgrass is dominant over most of the intertidal zone. Depending on local tidal range, it can grow to and below mean low water (McKee and Patrick 1988), and it can occupy, and even dominate, the marsh plain and the low marsh. Vast, homogeneous stands of Atlantic smooth cordgrass are the characteristic signature of the Atlantic region's tidal marshes (Dame et al. 2000, Adam 1990, Chapman 1964, 1977).

In contrast with Pacific cordgrass, Atlantic smooth cordgrass freely establishes in relatively exposed shorelines with significant wave action, including estuarine sand beaches. It is planted in its native range to stabilize shorelines and to trap and accumulate sediments, and the high density of its tall stems is highly effective at reducing estuarine wave energy (Gleason et al. 1979, Knutson and Woodhouse 1988, Knutson et al. 1990)

In other environmental tolerances, Atlantic smooth cordgrass is also highly resilient. It can survive in salinity over 45 parts per thousand (well above ocean salinity), and grow luxuriantly in dilute brackish water. If buried, it can regenerate from up to about one foot of burial by deposited sediment (Zaremba 1978). Atlantic smooth cordgrass, like other low marsh species, can supply air to its roots in oxygen-free waterlogged mud, using porous air-filled chambers linking its foliage to roots and rhizomes. Atlantic smooth cordgrass can also tolerate the severe waterlogging and hypersalinity that develops in poorly drained depressions in the salt marsh, including salt marsh pans. Salt marsh pans are frequent and well-developed features of historic San Francisco Estuary marshes, and important habitat for migratory waterbirds (Goals Project 1999). Along the Hayward shoreline of San Francisco Bay, Atlantic smooth cordgrass has colonized many pre-existing pans, converting them to solid cordgrass marsh (P. Baye, D. Smith, pers. observ.)

In the San Francisco Estuary, Atlantic smooth cordgrass has displayed many of the ecological traits typical of its performance in its native salt marsh habitat, and some highly novel phenomena as well. Most colonies in the San Francisco Estuary are young, often forming nearly circular, discrete, expanding colonies, which merge into irregular patterns, resembling mold colonies in a petri dish. The edges of the colonies are tall and robust, while the centers often exhibit early symptoms of dieback or "short form" growth habits. The "donut" shape of colonies, in fact, is one of the species' signatures for identification in aerial photographs of San Francisco Bay. This trait is not typical of mature Atlantic salt marshes. In the mild Pacific winters, Atlantic smooth cordgrass shoots tend to retain green leaves and persistent dead leaves through much of the winter. This is an important contrast with native Pacific cordgrass: combined with the invader's much greater stem size and shoot density, year-round dense foliage gives Atlantic smooth cordgrass exceptionally high potential to accumulate and trap estuarine sediment during winter storms or floods.

The San Francisco population of Atlantic smooth cordgrass has generated some unusual growth forms with strikingly atypical appearance. The dwarf form develops a profusion of short lateral shoots instead of a tall main stem, forming pure stands with complete ground cover of dense, low turf-like ankle-high vegetation on the marsh plain. The growth rate of the dwarf form is, however, vigorous. The dwarf form is genetic, not environmentally induced; it occurs in the same local environments that support luxuriant, tall stands of Atlantic smooth cordgrass, often contiguous with the dwarf patches. It has established at multiple locations in San Francisco Bay (Daehler et al. 1999). A comparable dwarf form of its hybrid daughter species, English cordgrass, independently evolved in Britain and New Zealand (Chater 1965, Bascand 1970).

Hybridization of Atlantic smooth cordgrass with native Pacific cordgrass. Perhaps the most novel and significant phenomenon of the San Francisco population of Atlantic smooth cordgrass is the rapid evolution of an aggressively expanding hybrid swarm formed by cross pollination with the native Pacific cordgrass (Daehler and Strong 1997). The hybrid swarm includes first-generation crosses between Atlantic smooth cordgrass and Pacific cordgrass with both species acting as pollen-parents and seed parents. Because the two species' pollination periods overlap little, first-generation crosses are infrequent. Hybrids, however, have a wide range of flowering times, and act as an effective reproductive bridge between the species. The hybrids produce pollen in much greater abundance (21 times greater) and with higher fertility than the native Pacific cordgrass. Superior hybrid pollen production and fertility so overwhelm populations of Pacific cordgrass ("pollen swamping") that native stands of cordgrass produce mostly hybrid back-cross seeds in the presence of flowering hybrid colonies, and fail to reproduce the species sexually (Ayres et al. 1999, Antilla et al. 2000). This process alone, called hybrid assimilation, can result in the extinction of the invaded species (Levin et al. 1996, Rhymer and Simberloff 1996).

Genetic analysis has revealed that numerous large populations of presumed Atlantic smooth cordgrass in the Estuary are predominantly hybrids and back-crosses (introgressants). The ecologically invasive, dominant traits of Atlantic smooth cordgrass appear to be prevalent in the hybrid swarm. "Pure" Atlantic smooth cordgrass is now a minority in most of the rapidly evolving hybrid swarms, and trends suggest that hybrids will eventually replace both parent species, as the hybrid-origin species English cordgrass did in Britain (see English Cordgrass, below). This recently discovered threat of genetic extinction to a native cordgrass from an alien cordgrass invasion is unique to the San Francisco Estuary. No native cordgrasses existed where Atlantic smooth cordgrass invaded Washington and Oregon estuaries, and the cordgrasses native to Europe are genetically isolated from their hybrids.

Atlantic smooth cordgrass, and its hybrids with similar appearance and behavior, are now widely distributed in the Central and South Bay, but they have not yet been detected in the North Bay or Suisun, despite intensive searches. The northern limit of its distribution in 2001 was the west shore bay of Point Pinole (Giant Marsh). The abundance of Atlantic smooth cordgrass and hybrids remains greatest near the point of its original introduction circa 1977 (Pond 3, Hayward Shoreline, Alameda County), and sites of early transplanting (Colma Creek, San Mateo County), early pioneer colonies (Oakland, San Leandro Bay, Hayward Shoreline), and areas of subsequent transplanting (Cogswell Marsh, Hayward). It now is nearly the exclusive marsh plant species of recently formed or restored tidal marshes along the San Leandro-

Hayward shoreline, and this trend is expected to increase. Even as the Bay edge salt marshes and levees are eroding landward through wave action, Atlantic smooth cordgrass marsh is spreading in the opposite direction below the wave-cut marsh cliff. Its distribution becomes patchier south of the Dumbarton Bridge, decreasing in size and frequency to Alviso, where it is still relatively rare. It is well established as scattered, large but discrete colonies in the Dumbarton-Mowry Marsh, Newark, mostly in sloughs and disturbed marsh, or recently colonized mudflats. It is a common or dominant feature in marshes from San Bruno, the San Francisco Airport, south to Foster City, and is scattered in variable frequency along the Redwood City shoreline. The Napa-Sonoma and Petaluma Marshes are currently free from the Atlantic smooth cordgrass invasion, but young colonies have recently been detected in Bolinas Lagoon and Drakes Estero on the Point Reyes peninsula (K. Zaremba, pers. comm. 2001).

English Cordgrass, *Spartina anglica*

English cordgrass is an aggressive invader of mudflats and salt marshes in Britain, New Zealand, Australia, and the Pacific Northwest, and thrives in cool temperate climates. It originated in Britain as a fertile hybrid derived from introduced Atlantic smooth cordgrass and common cordgrass (*S. maritima*), a small, slow-growing creeping cordgrass native to European coasts, now greatly reduced in abundance. Within a century after its origin, English cordgrass became the dominant salt marsh grass in Britain (Lee and Partridge 1983, Gray et al. 1990). It is shorter and more grayish than Atlantic smooth cordgrass, but partly shares other traits of its parent, such as vigorously spreading rhizomes, ability to transform mudflats into vast stands of low marsh vegetation, and ability to dominate and displace associated plant species. It was introduced to the San Francisco Estuary at Creekside Park, Corte Madera, Marin County, along with Chilean cordgrass, in 1976. Unlike Atlantic smooth cordgrass and Chilean cordgrass, this species failed (so far) to disperse from its point of introduction. It may be at or near its southern climatic limit on the Pacific Coast in San Francisco Estuary.

Chilean Cordgrass, *Spartina densiflora*

Chilean cordgrass (also called dense-flowered cordgrass) is a distinctive cordgrass species native to South America. It has a bunchgrass growth habit, forming tight clumps or tussocks with short creeping rhizomes, and narrow, firm, in-rolled leaves (Spicher 1984), resembling European beachgrass (*Ammophila arenaria*). It is generally restricted to the middle marsh plain and high marsh zones where pickleweed, saltgrass, jaumea, and other low-growing herbs otherwise prevail. It does not spread into the low marsh where Pacific cordgrass and mudflats naturally dominate the Estuary (Kittleson and Boyd 1997). Chilean cordgrass lacks well-developed tissues specialized for transporting air from foliage to roots (Spicher 1984), a feature common to cordgrasses adapted to low marsh environments.

Chilean cordgrass, along with other South American coastal species, was probably accidentally introduced to Humboldt Bay, California by ship ballast containing seeds from South American ports that traded lumber (Spicher 1984). For most of the 20th Century, Chilean cordgrass was erroneously treated as an "ecotype," or minor geographic variation, of the native Pacific cordgrass, despite the lack of diagnostic traits matching this species. In the late 1970s, the presumed native "Humboldt Bay form" of Pacific cordgrass was deliberately transplanted to salt marsh restoration and landscaping sites at Creekside Park, Corte Madera, Marin County (Faber 2000). Within the salt marshes fringing Corte Madera Creek, it has since become a locally dominant component of the middle and high salt marsh vegetation, displacing even robust pickleweed.

A second population of Chilean cordgrass spontaneously established across the Bay from Creekside Park in the ancient marsh plain at Point Pinole (Whittell Marsh), Contra Costa County. The Point Pinole population was discovered in the mid-1990s, and has been largely eradicated (D. Smith, pers. comm.). A single, large, individual clump of Chilean cordgrass established in a very young restored tidal marsh (breached 1995) at the former Salt Pond 2A, Napa Marsh (P. Baye, pers. observ. 2001). That pioneer plant was also eradicated.

Salt-Meadow Cordgrass, *Spartina patens*

Salt-meadow cordgrass is another rhizome-forming creeping cordgrass of Atlantic salt marshes, but unlike Atlantic smooth cordgrass, it has fine stems with narrow, soft, in-rolled leaves, and is intolerant of waterlogged mud. It is naturally confined to the well-drained high salt marsh and relatively moist sandy depressions at or above tidal influence. Two distinctive geographic and ecological types have been recognized, and in the past have been treated as distinct taxonomic varieties. In peaty high salt marshes of the northeastern Atlantic coast, a relatively low form with lax, slender stems forming dense matted turfs with "cowlicks" was once treated as *S. patens* var. *monogyna* (Fernald 1950). These dense salt marsh turfs are often nearly pure stands of salt-meadow cordgrass crowding out most potentially associated species that occupy gaps in the cover caused by winter ice or drifted wracks. In sandy marshes associated with large barrier beaches and wash-over fans from Cape Cod through the Atlantic coastal plain, a coarser, erect type, formerly recognized as *S. patens* var. *juncea*, is prevalent. Intermediate forms are common.

Between the 1959 publication of *A California Flora* (Munz and Keck 1959) and its 1970 supplement (Munz 1970), salt-meadow cordgrass was reported in Southampton Bay, Benicia, Solano County. The time and mode of introduction is unclear. Salt-meadow cordgrass at Southampton occupies large, discrete patches in pure and exceptionally thick stands compared with its native marshes. The patches are distributed close to tidal sloughs, a pattern suggesting local transport by currents. One large stand is spreading into a high marsh site (pickleweed-saltgrass vegetation) that supports a population of an endangered annual plant, soft bird's-beak (*Cordylanthus mollis* ssp. *mollis*). The Southampton Bay cordgrass population appears to match the type description of "variety *monogyna*," the fine-stem type of northeastern Atlantic marshes. (P. Baye, S. Klohr, unpubl. data 2000).

A population of salt-meadow cordgrass was reported in San Bruno, but was not detected in recent intensive searches. It is possible that a relatively unfamiliar native salt marsh grass, *Puccinelia nutkaensis*, could be mistaken for vegetative salt-meadow cordgrass. However, salt-meadow cordgrass was confirmed from a batch of grasses collected as unknowns from tidal marshes in the vicinity of Tolay Creek, Tubbs Island, Sonoma County, in 2001 (H. Spautz, pers. Comm.). The exact location of the collection has not been recovered, but this observation indicates that some spread to San Pablo Bay has occurred (P. Baye, unpubl. data 2001).

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Native Pacific cordgrass meadow at Blackie's Pasture, Marin County.

A tall stand of Atlantic smooth cordgrass hybrids invading a native pacific cordgrass meadow near Tiburon, Marin County.

Figure 1-3. Cordgrass Species

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A patch of English cordgrass at Creekside Park, Marin County.

Robust stands of Chilean cordgrass along Corte Madera Creek in Marin County.

Hummocks of Salt-meadow cordgrass at Southampton Marsh, Solano County.

Figure 1-3. Cordgrass Species

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Table 1-1. Net and Gross Area Invaded by Non-native Cordgrass Species (2000-2001)

Species	Net* Acreage (acres)	Gross* Acreage (acres)
Atlantic Smooth Cordgrass (and hybrids)	469	5,016
English Cordgrass	0.1	1
Chilean Cordgrass	13	263
Salt-meadow Cordgrass	0.6	16
Total	483	5,287

Source: Ayres, Smith, Zaremba, Klohr, and Strong (In Press)
* "Net area" is area with 100% cover by non-native cordgrass
"Gross area" is area in which non-native cordgrasses occur

1.2.4 Long-term Effects of Non-native Invasive Cordgrass

Recent cordgrass monitoring and mapping efforts by the ISP and University of California, Davis, have concluded that over 5,000 acres of the Estuary's tidal flats and marshes have been invaded by stands of non-native cordgrass (including hybrids), with total area coverage of nearly 500 acres (Ayers *et al.*, *In Press*). The area invaded by stands of non-native cordgrass is referred to as "gross area," while the actual area covered by the stands (i.e., with greater than 90% coverage) is referred to as "net area." **Table 1-1** shows the net and gross area of each cordgrass species, and **Table 1-2** shows the net area of each cordgrass species by subregion. The current gross invaded area accounts for less than eight percent of the total area of existing tidal flats and marshes in the San Francisco Estuary (Ayers *et al.*, *In Press*); however, the gross invaded area in the South Bay accounts for greater than 15 percent of the existing tidal flats and marshes. **Figure 1-4** shows the current distribution of non-native cordgrass in the San Francisco Estuary. The rate of expansion of each of the species varies. English cordgrass has not spread beyond its original 1970s introduction site, Chilean cordgrass has spread to cover 13 acres at three sites in the Central Bay, salt-meadow cordgrass has expanded from two plants in 1970 to 42 plants at one site, and Atlantic smooth cordgrass and its hybrids has spread from two sites planted in Fremont and Alameda Island in the 1970s to cover nearly 500 net acres (5,000 gross acres) today.

Based on the characteristic cordgrass behavior described in the previous section, the spread of non-native invasive cordgrasses could have tremendous long-term effects on the natural ecology of the San Francisco Estuary. Left uncontrolled, these effects would likely include the following long-term consequences:

Table 1-2. Net Area (in Acres) of Non-native Cordgrass Species by Bay Subregion (2000-2001)

Species	Suisun Bay	North Bay	Central Bay	South Bay: Dunbarton Bridge North	South Bay: Dunbarton Bridge South	Total Acres
Atlantic Smooth Cordgrass (and hybrids)	0	0	111	361	11	483
English Cordgrass	*0*	*0*	*0.1*	*0*	*0*	*0.1*
Chilean Cordgrass	0	0	13	0	0	13
Salt-meadow Cordgrass	0.6	0	0	0	0	0.6

Source: Invasive Spartina Project, 2002
* "Net area" is area with 100% cover by non-native cordgrass

- **Genetic assimilation and extinction of native Pacific cordgrass (*Spartina foliosa*).** Native Pacific cordgrass cannot effectively reproduce by seed in the presence of Atlantic smooth cordgrass hybrids. The much larger pollen loads and the greater fertility of the pollen of hybrids results in "swamping" of the native species. Thus, seeds produced by native plants that are in the vicinity of Atlantic smooth cordgrass hybrids are themselves hybrid. The net result is continued and accelerated formation of hybrid seeds, and progressive decline in native cordgrass seed reproduction. Pacific cordgrass, though not previously threatened, may now be endangered due to aggressive hybridization and outright displacement by the competitively superior invader. This process has already been scientifically documented at many sites in the Estuary (D. Ayres, pers. Comm.).

- **Extensive regional loss of tidal flats.** Native Pacific cordgrass, with rare exceptions, doesn't tend to colonize open tidal flats that are subject to high wind and wave energy**.** Atlantic smooth cordgrass and its hybrids do, and they would likely eventually invade a significanrt portion of existing higher tidal flats in the Central and South Bays. This potential was demonstrated in an area of San Leandro, where in 10 years, non-native cordgrass invaded and completely covered large segments of a half-mile-wide stretch of tidal flat along the shoreline. Extensive invasion of tidal flats bty Atlantic smooth cordgrass is also occuring on a larger scale in the channel off of Alameda Island (**Figure 1-5a**).

- **Elimination of critical foraging habitat for migratory shorebirds.** During the spring and fall, the Estuary is an important feeding stopover on the Pacific Flyway for many migrating birds. These birds require extensive open intertidal mudflats for foraging. The invasion of the Estuary by Atlantic smooth cordgrass and its hybrids would transform these feeding areas into dense meadows, with no foraging value. This process is already underway (**Figure 1-5b**).

- **Failure of efforts to restore native tidal marsh vegetation in diked baylands.** Attempts to restore naturally diverse native tidal marsh vegetation and structure in the San Francisco Estuary would result instead in establishment of persistent stands of hybrid Atlantic smooth cordgrass, as has already occurred at several marsh restoration sites on the eastern San Francisco Bay shoreline. Greater than 10,000 acres of diked baylands (former commercial salt ponds) are slated for restoration to tidal marsh in the coming decade, and these areas would be lost to non-native cordgrass (**Figure 1-5c**).

- **Alteration of natural sedimentation processes to support restoration of diked baylands.** Abundant sediment supply will be critical for restoring the Estuary's thousands of acres of deeply subsided diked baylands. The Bay waters typically carry large amounts of fine sediment suspended in the water column, which naturally deposits in calm areas and forms the marsh plains. Because the dense foliage of Atlantic smooth cordgrass and its hybrids readily trap and retain sediment suspended in the Bay water, the presence of these plants in vast acreage would trap and "lock up" suspended sediments that would otherwise nourish restored tidal marsh. Stabilization of mudflats by extensive invasion of smooth cordgrass could significantly retard salt marsh restoration in tidally restored salt ponds.

- **Regional loss of tidal sloughs and channels.** Small tidal sloughs, essential to the movement of wildlife and habitat for native estuarine fish, would become choked with

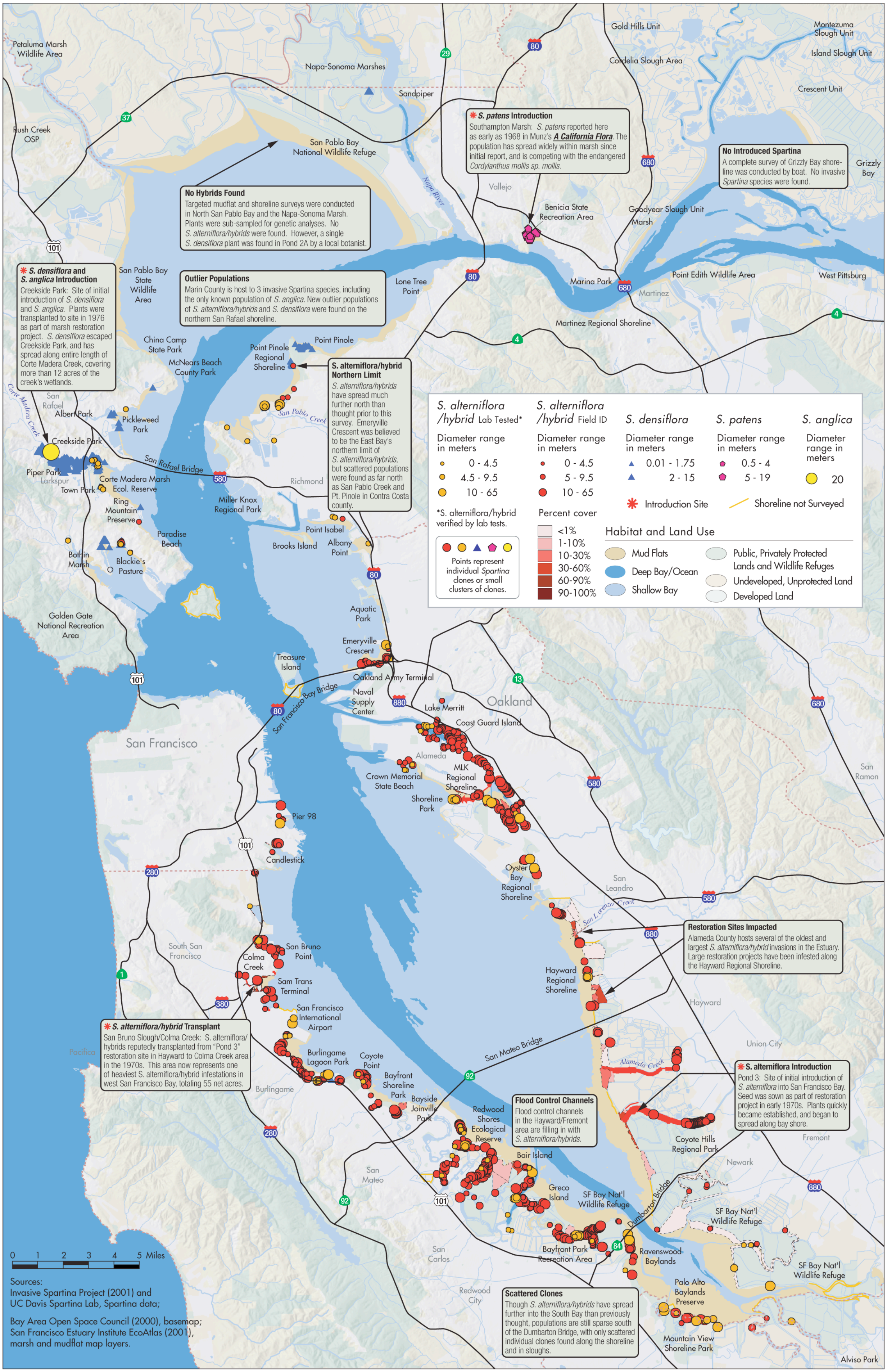

Figure 1-4. Distribution of Non-native Cordgrass in San Francisco Estuary (2000 - 2001 Survey)

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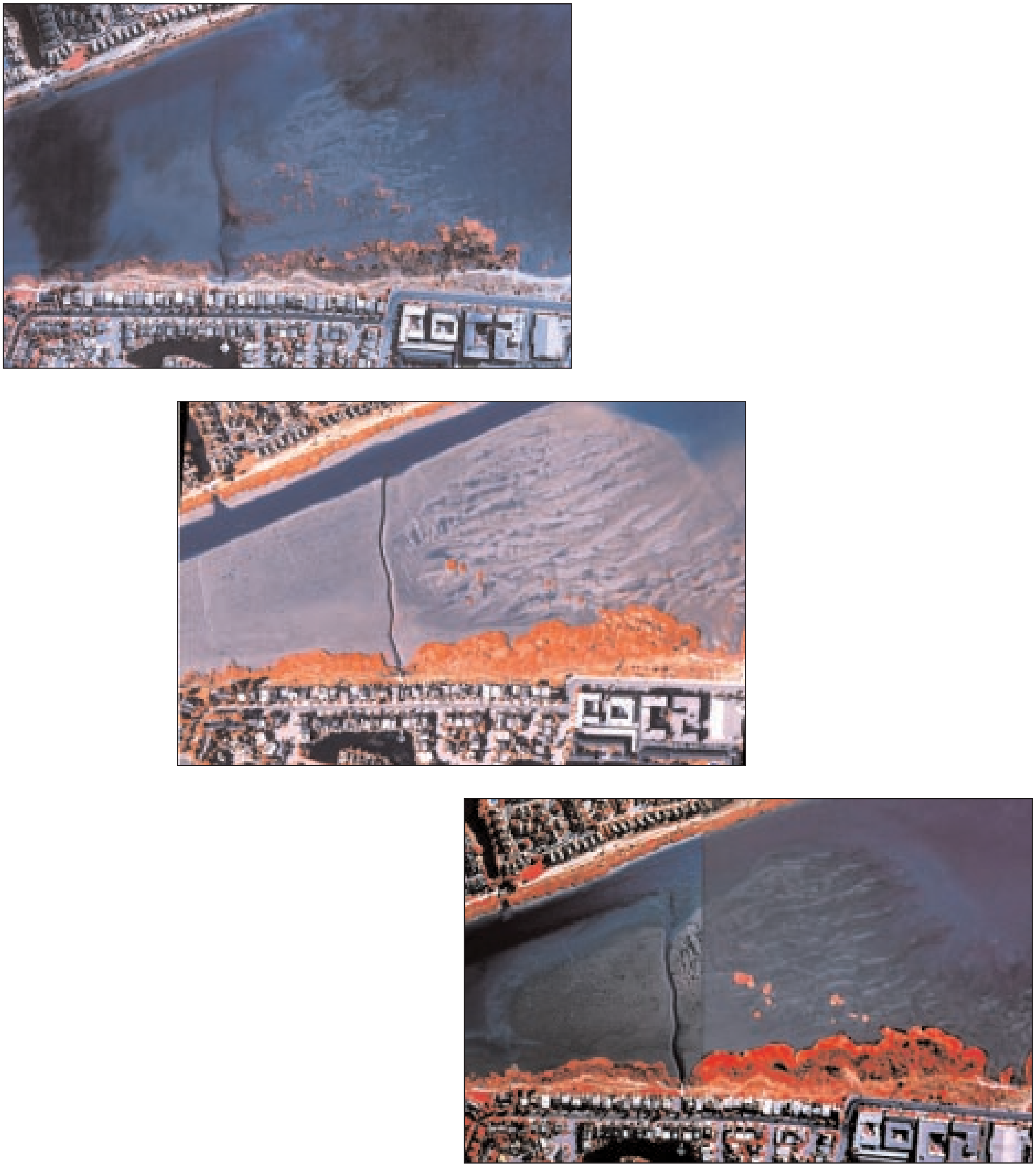

Elsie Romer Bird Sanctuary, Alameda Shoreline, in 1991, 1998, and 2000. These infrared photographs show the progression of Atlantic smooth cordgrass from the shoreline down onto the tidal flats and up onto the adjacent upper shoreline, over a nine year period.

Figure 1-5. Effects of Non-native Cordgrass on the San Francisco Estuary

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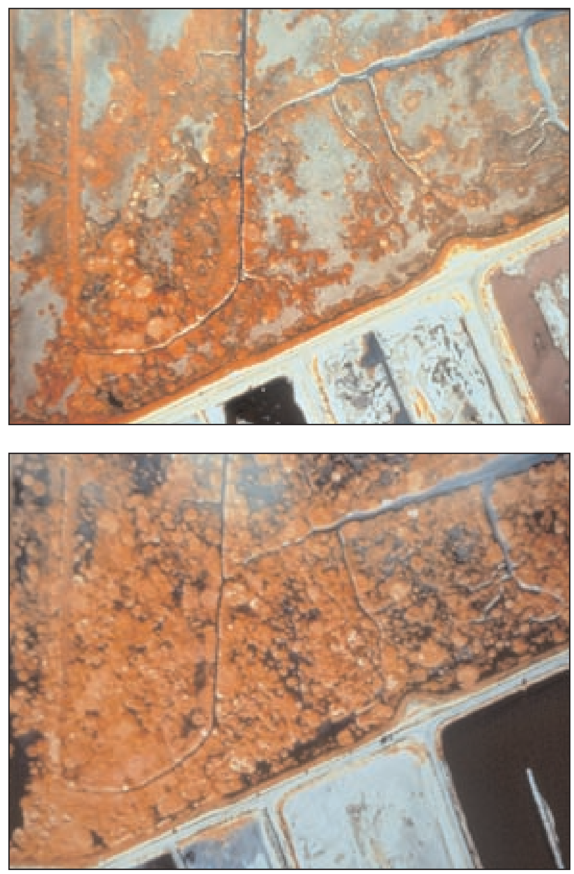
These shorebirds are shown foraging in the tidal flat that has been invaded by a flourishing Atlantic smooth cordgrass clone. Clones have been documented to spread a t a rate of greater than six feet per year.

Atlantic smooth cordgrass hybrids (circular growth pattern on mudflat) colonized this 49 acre restoration site near Whale's Tail Marsh in Hayward soon after restoration. *(Photo: Stephen Joseph)*



Cogswell Marsh, Hayward, was restored beginning in 1980, and is now almost completely invaded by Atlantic smooth cordgrass hybrids. These infrared photographs show the marsh in 1996 and 1998 - the red circular patterns are Atlantic smooth cordgrass.

Figure 1-5. Effects of Non-native Cordgrass on the San Francisco Estuary

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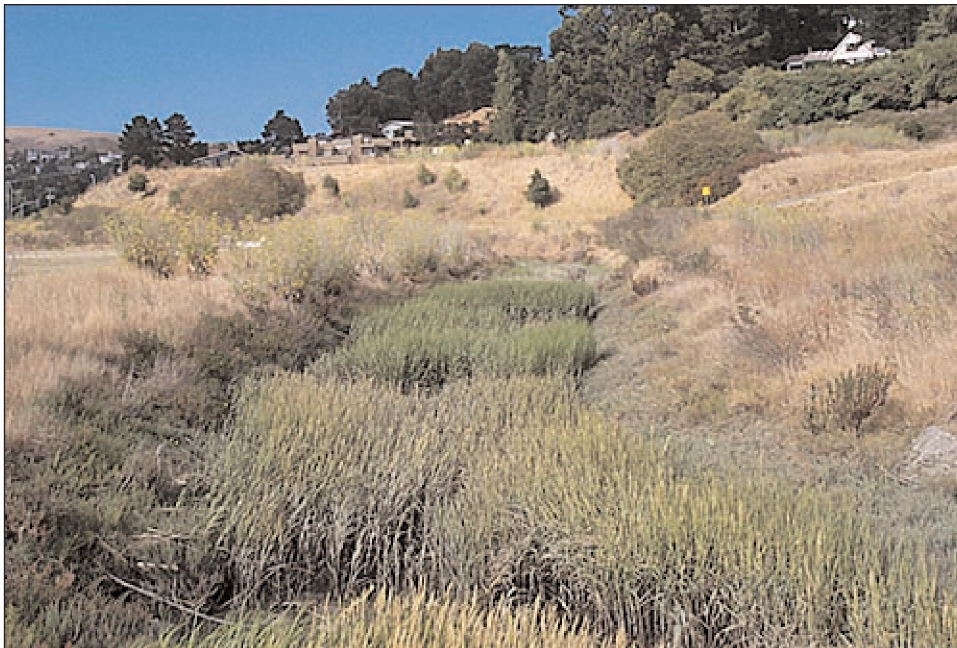

Small and medium channels being invaded by Atlantic smooth cordgrass hybrids, which have a tendency then to trap sediment and fill the channel. The phot at righft shows a stand of Atlantic smooth cordgrass colonizing a tidal channel. Note the wrack (accumulated debris) on top.

Atlantic smooth cordgrass hybrids will establish in high-energy environments along open bay shoreline. Here it has established at the tip of sand bars along the San Leandro shoreline, and is altering the natural beach-forming processes.
(Photo: Stephen Joseph)

Figure 1-5. Effects of Non-native Cordgrass on the San Francisco Estuary

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non-native cordgrass and trapped sediment. Larger sloughs and the mouths of larger creeks would eventually become clogged, causing slowed river discharge and upstream flooding. Choking and infilling of tidal creeks by Atlantic smooth cordgrass has been observed at many sites in the East Bay (**Figure 1-5d**).

- **Increased need for dredging and flood control.** Atlantic smooth cordgrass may invade sloughs and channels, trapping sediment and eventually causing significant reduction in channel capacity. The need for maintenance dredging of tidal reaches of flood control and navigational channels probably would increase significantly, particularly where channels cross what are now broad intertidal flats, where the cordgrass can easily invade the channel. Invasive smooth cordgrass also attracts endangered clapper rails during early stages of colonization, which could affect regulatory requirements for dredging (**Figure 1-5d**).
- **Alteration of estuarine beaches and beach-forming processes.** Atlantic smooth cordgrass freely establishes along exposed shorelines and in sandy substrates, and it has colonized tidal flats in front of beaches and along sand spits in the Estuary. The presence of cordgrass precludes the natural beach-forming processes along the shoreline (**Figure 1-5e**). Today, there are few remaining sand beach areas in the Estuary that have not established rapidly growing stands of Atlantic smooth cordgrass and its hybrids.
- **Marginalization of endangered California clapper rail habitat.** In the early stages of Atlantic smooth cordgrass invasion, habitat alterations appear to favor the California clapper rail by providing additional nesting and foraging habitat in the young, tall cordgrass stands. However, in long-term succession of the cordgrass in its native range, the tall, robust plants are eventually replaced by short, sparse stands, which have little or no value for clapper rails – except along the fringes of the stand where the young, tall plants continue to grow (Meanley 1985). In addition, cordgrass meadows would eventually spread to cover much of the remaining mudflat and eliminate foraging opportunities for the bird. Thus, the habitat structure and distribution of the clapper rail in future the San Francisco Estuary's marshes may be radically altered and reduced by long-term invasion of smooth cordgrass
- **Reduction or elimination of salt marsh harvest mouse habitat.** Pickleweed habitat essential to the endangered salt marsh harvest mouse would be replaced in lower tidal reaches by "short form" hybrid Atlantic smooth cordgrass, and upper tidal reaches by Chilean cordgrass and salt-meadow cordgrass. At best, this would reduce the mouse's potential for recovery in its native ecosystem, and at worst, it could push the species to local extinction in the remaining tidal marshes it inhabits.
- **Precluded Recovery of California sea-blite and other endangered plants.** The recovery of federally endangered Californian sea-blite depends on the species' reestablishment in the San Francisco Estuary. Reestablishment of independent populations in the Estuary depends on protection and restoration of local sandy high tide lines between sandy beaches and salt marsh. These important features cannot be established or sustained in the presence of wave-damping, sediment-trapping Atlantic smooth cordgrass. Salt meadow cordgrass threatens local populations of another endangered plant, soft bird's-beak.
- **Production of massive deposits of vegetative debris.** Atlantic cordgrass produces large amounts of standing biomass and leaf litter, which becomes floating "wrack" (rafted tidal debris) in the winter. Massive wrack deposition can interfere with operation of water intake structures (tidegates), smother and induce large barren areas in high salt

marsh, and create periodic nuisances in sheltered recreational beaches, shorelines, and marinas.

- **Spread of invasive cordgrasses to other California estuaries.** The San Francisco Estuary would become a dispersal source of invasive hybrid Atlantic cordgrass, threatening vulnerable and relatively pristine estuaries of the central California coast. Pioneer colonies of invasive cordgrass species have already been discovered in all of the estuaries along the Marin County shoreline, and are believed to be spread from the San Francisco Estuary (**Figure 1-6**).

Figure 1-7 shows examples of locations that non-native invasive cordgrasses are typically found in the Estuary, and contrasts the characteristics of native Pacific cordgrass with Atlantic smooth cordgrass.

1.3 PURPOSE AND USE OF THIS PROGRAMMATIC EIS/R

The California State Coastal Conservancy (Conservancy), as the lead agency under the California Environmental Quality Act (CEQA), and the U.S. Fish and Wildlife Service (Service), as the lead agency under the National Environmental Policy Act (NEPA), have jointly prepared this EIS/R to address the environmental impacts of the proposed *Spartina* Control Program. This

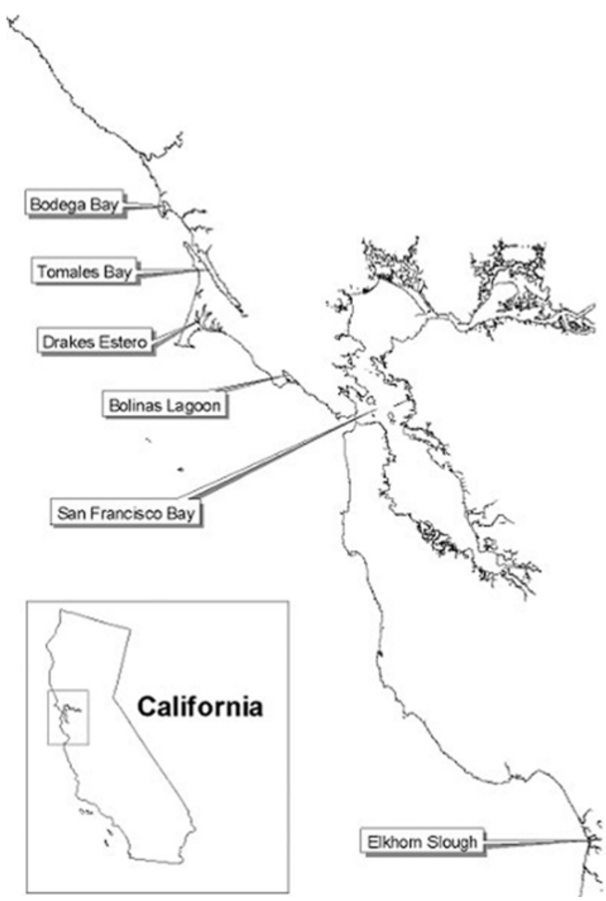
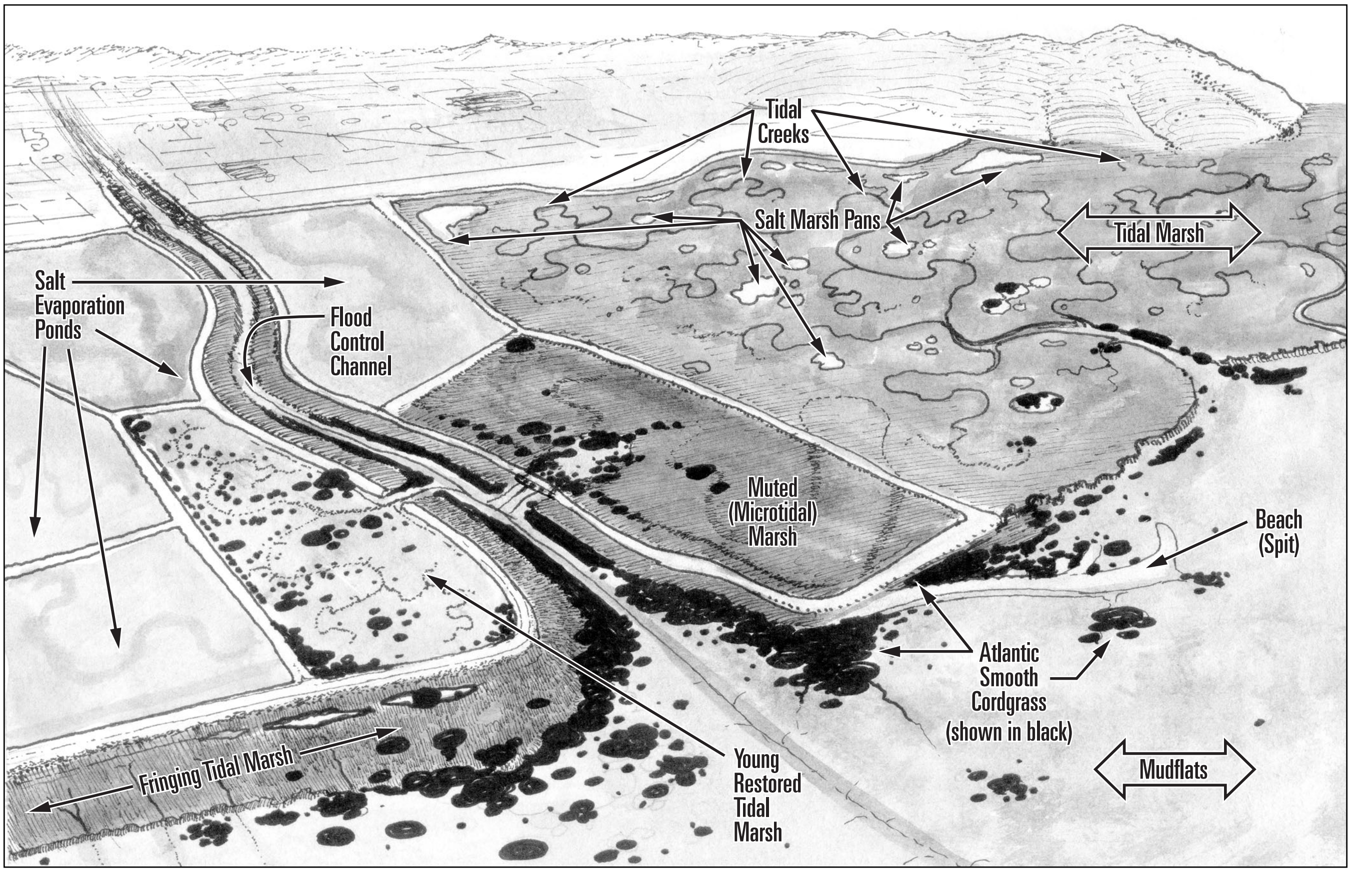
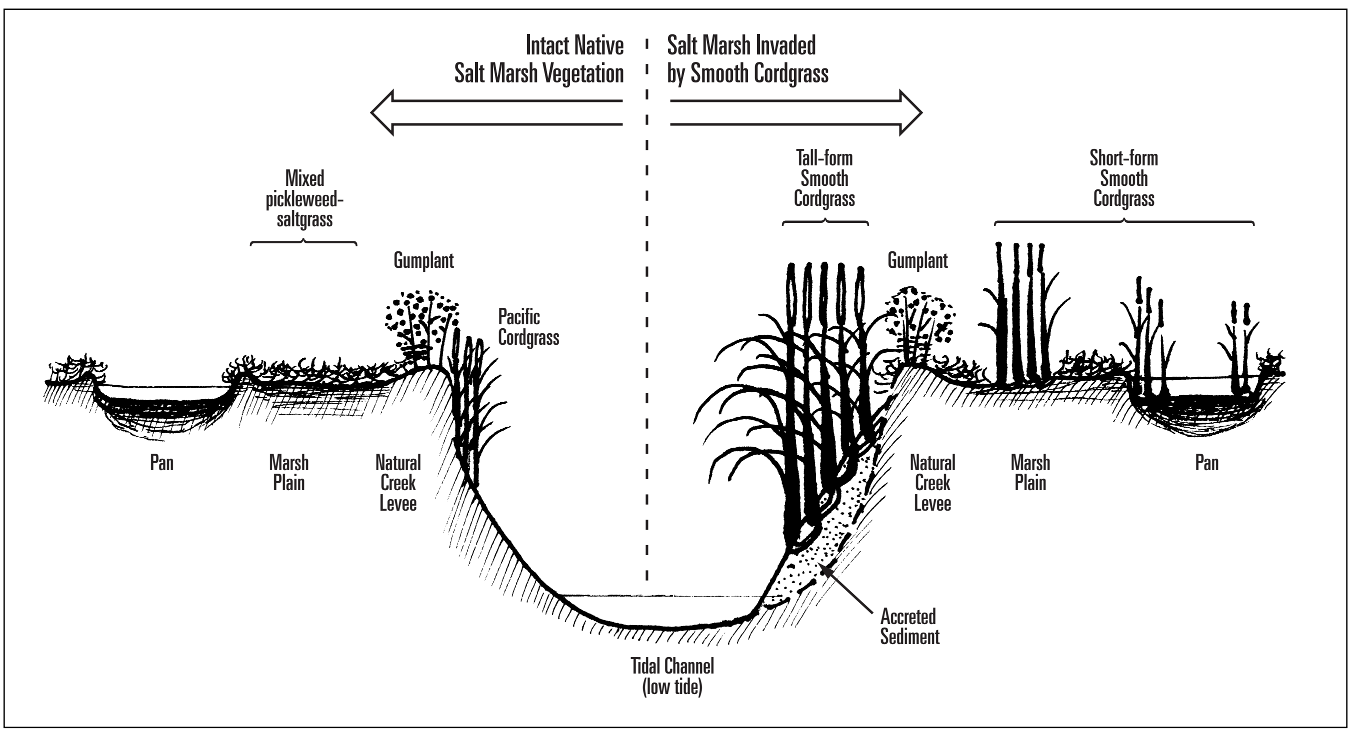


Figure 1-6. California Shoreline with Estuaries North and South of San Francisco Bay



Generalized composite illustration of SF Bay tidal habitats invaded by Atlantic Smooth Cordgrass.



Generalized conceptual model of consolidated tidal marsh subsequently invaded by smooth cordgrass, compared with intact native tidal marsh vegetation. Not to scale.

Figure 1-7. Typical San Francisco Estuary habitats invaded by Atlantic Smooth Cordgrass.
(Illustrations by Peter Baye)

document satisfies the procedural, analytical, and public disclosure requirements of CEQA and nia Environmental Quality Act (CEQA), and the U.S. Fish and Wildlife Service (Service), as the lead agency under the National Environmental Policy Act (NEPA), have jointly prepared this EIS/R to address the environmental impacts of the proposed *Spartina* Control Program. This document satisfies the procedural, analytical, and public disclosure requirements of CEQA and NEPA. The Conservancy and the Service have prepared this document pursuant to the National Environmental Policy Act (NEPA) (42 United States Code Secs. 4321 *etseq.*) Sections 1506.2 and 1506.4 of the President's Council on Environmental Quality (CEQ) regulations on implementing NEPA (40 Code of Federal Regulations 1500 *et.seq.*) and the California Environmental Quality Act Statutes (Public Resources Code Sections 21000, *et. seq.*) and implementing Guidelines (14 California Code of Regulations Sections 15000 et. seq.). Guidelines and regulations for implementing both CEQA and NEPA encourage the preparation of joint documents. Because NEPA and CEQA are somewhat different with regard to procedural and content requirements, the document has been prepared to comply with the more stringent requirements.

This document is a Programmatic EIS/R (NEPA Regulations Section 1508.18 and CEQA Guidelines Section 15168) in that it analyzes the potential effects of implementing treatment methods for a regional program, rather than the impacts of an individual project. This program-level EIS/R identifies mitigation measures that will be applied to reduce or eliminate impacts at treatment locations. The Conservancy will use this document to evaluate the Control Program for approval, and the Service will use it to evaluate any necessary Incidental Take Permits under Section 7 of the Federal Endangered Species Act. The National Marine Fisheries Service (NMFS) may use this EIS/R when considering Federal Endangered Species permits for take of protected marine species under its jurisdiction. The US Army Corps of Engineers also may use this document as NEPA documentation for any required permits under Section 404 of the Clean Water Act.

The Regional Water Quality Control Board (RWQCB) may use this document for any necessary National Pollutant Discharge Elimination System (NPDES) Permits for application of herbicides, and the California Department of Fish and Game may use it for its Streambed Alteration Agreements and any permits required under the State Endangered Species Act. The San Francisco Bay Conservation and Development Commission (BCDC) may use this document if BCDC permits are required for the project. Approval and permitting requirements are described in detail in Chapter 5.0, *Environmental Compliance.*

This EIS/R also is intended to address cumulative effects of specific cordgrass control activities throughout the Estuary. It may be used by other local agencies for CEQA compliance for local decisions and permits required to implement subsequent non-native cordgrass control activities. CEQA lead agencies intending to use this document for future site-specific projects will prepare Initial Study checklists to determine if there could be site-specific impacts beyond those identified in this document. Provided the environmental impacts of future activities are adequately addressed in this document, additional CEQA documentation may not be required for some individual projects. If additional environmental analysis is required for future activities and newly identified impacts, or to introduce new mitigation measures, subsequent environmental documents would be tiered from the analyses contained herein (CEQA Guidelines Section 15168 [c] and Section 15177).

Responsible Agencies under CEQA must consider the EIR prior to reaching their own conclusions on whether and how to approve a project. Those agencies may, at their discretion, follow the responsible agency requirements found in Section 15096 by considering the document (15096(f)), mitigating or avoiding only the direct or indirect environmental effects of those parts of the project which it decides to carry out, finance, or approve (15096(g)), adopting findings

(15096(h)), and filing a Notice of Determination (15096(i)) Responsible agencies also may prepare a subsequent or supplemental EIR as provided for in CEQA Guidelines Sections 15162 and 15163, respectively. Since this EIS/R is a programmatic document, in addition to adoption of the EIS/R, the Responsible Agency will also have to determine whether further tiered environmental documentation, such as a mitigated negative declaration, is required for the site-specific project. See CEQA Guidelines section 15168(c) and (d).

1.4 DOCUMENT ORGANIZATION

The Final EIS/R consists of a revised Draft EIS/R that incorporates changes in response to comments on the draft, as well as the Comments and Responses, and two new appendices: Appendix J, the US Fish and Wildlife Service Biological Opinion and NOAA Fisheries concurrence letter, and Appendix K, the CEQA-mandated Mitigation Monitoring and Reporting Program. The Final EIS/R is published in two volumes; Volume 1 is the revised EIS/R text, including comments and responses, and Volume 2 is the complete set of appendices. Contents of each chapter and appendix are outlined below.

Chapter 1, Introduction, describes the project background, and EIS/R purpose, need, and organization.

Chapter 2, Alternatives, describes the process used to develop alternatives to the SCP, as well as descriptions of each alternative, and the alternatives that were not carried forward for further analysis in this document.

Chapter 3, Environmental Setting, Impacts, and Mitigation Measures, includes descriptions of the environmental setting, and the impacts that may occur on each resource as a result of implementation of the SCP. Mitigation measures for potentially significant impacts are identified, and residual impacts (following application of mitigation measures) are discussed.

Chapter 4, Evaluation of Alternatives, This section provides a comparison of the impacts or effects of each alternative analyzed in the document, and identifies the NEPA “environmentally preferred” and the CEQA “environmentally superior” alternative. It also summarizes any unavoidable significant adverse impacts.

Chapter 5, Environmental Compliance, summarizes applicable federal, state, and local regulations, and describes permits and approvals that may be required. A discussion of relevant regional invasive species policies is also included.

Chapter 6, Public Involvement, discusses public involvement that has occurred to date and is expected to occur prior to certification of the EIR by the Conservancy and the Record of Decision on the EIS by the Service.

Chapter 7, List of Preparers, identifies the preparers of this document.

Chapter 8, Definitions, defines words used in the document.

Chapter 9, References, is the list of references cited in the document.

Chapter 10, Comments and Responses on the Draft EIS/R

Volume 2: Appendices. The appendices provide additional information on the environmental review process and technical information that was used in the EIS/R analyses. Pursuant to CEQA requirements, materials and literature referenced in the EIS/R, but not included in Appendices, are maintained at the Conservancy offices in Oakland, California.

Appendix A – Notice of Intent (NOI)

Appendix B – Notice of Preparation (NOP)

Appendix C – CEQA Initial Study

Appendix D – NOP/NOI Public Comment Letters

Appendix E – Herbicide and Surfactant Information

Appendix F – Sensitive Species Table

Appendix G – Best Management Practices for the California Clapper Rail

Appendix H – List of Document Recipients

Appendix I – *Spartina* Control Program Possible First Year Pilot and Demonstration Projects

Appendix J – Biological Opinion

Appendix K – Mitigation Monitoring and Reporting Program

2.0 PROGRAM ALTERNATIVES

2.1 DEVELOPMENT OF ALTERNATIVES FOR EVALUATION

National Environmental Policy Act (NEPA) Regulations Section 1502.14, and California Environmental Quality Act (CEQA) Guidelines Section 15126.6 require that an Environmental Impact Statement/Report (EIS/R) consider a reasonable range of feasible alternatives that would achieve most of the project's goals while reducing or eliminating some or all of the adverse environmental impacts of the project. The goal of the *Spartina* Control Program, as described in Chapter 1, *Introduction*, is:

> *"to arrest and reverse the spread of invasive, non-native cordgrasses to preserve and restore the ecological integrity of the intertidal habitats and estuarine ecosystem in the San Francisco Estuary."*

The lead agencies evaluated a number of approaches to meeting this goal. The approaches included programs that would limit the area of treatment, vary the treatment tools, and limit the target species proposed for treatment.

Alternatives that focused on limiting the treatment area or the species of cordgrass to be treated were eliminated from further consideration because it was determined that they would be ineffective in controlling, reducing, or eliminating the spread of these invasive weeds, and would not preserve native native salt marsh vegetation and habitat structure (see Section 2.3). Seed dispersal and hybridization from residual untreated cordgrass stands would reinfest treated areas and continue the spread of non-native invasive species and their hybrids throughout the Estuary and beyond, thereby rendering control efforts fruitless. Single-treatment method (tool) approaches (e.g. chemical treatment only) were rejected because they would not provide the flexibility needed to address site-specific constraints (for example, different size infestations or infestations near residences) and would ultimately result in an expensive and unsuccessful program. Therefore, the alternatives search focused on multi-tool approaches that could be used to treat all invasive cordgrass species throughout the Estuary in a flexible and cost effective way.

A number of potential treatment methods were considered, and many were carried through for inclusion in the alternatives evaluated in this EIS/R. These include a range of manual, mechanical, and chemical techniques. A discussion of control methods that were considered and rejected for further analysis follows the description of alternatives below.

Two "action" alternatives were formulated for evaluation in this EIS/R, Alternatives 1 and 2. Alternatives 1 and 2 incorporate all or most of the tools in the cordgrass control "toolbox," and would be expected to achieve all or most of the program goals. Both alternatives propose to implement the control methods in a modified program of "Integrated Vegetation Management" (IVM; described below) to remove or otherwise control invasive cordgrass species. These alternatives are identical except that Alternative 2 excludes chemical treatment methods from the toolbox, relying only on manual and mechanical methods.

Consistent with NEPA and CEQA requirements, a no-action alternative, Alternative 3, also was developed and evaluated. Under Alternative 3, no regional program to control non-native invasive cordgrasses would be adopted, and the current approach of limited uncoordinated control efforts would continue.

2.2 DESCRIPTION OF ALTERNATIVES

Alternative 1 – Regional Eradication Using All Available Control Methods (Proposed Action/Proposed Project)

Alternative 1, which proposes to use all available tools, is the NEPA "Preferred Alternative" and the CEQA "Project." This action is the implementation of a regionally coordinated strategy to arrest and reverse the spread of four invasive cordgrass species (*Spartina alterniflora*, *S. densiflora*, *S. patens* and *S. anglica)* from the San Francisco Estuary. The regional management strategy would prioritize treatment sites based on the most currently available knowledge regarding the biological and physical processes contributing to the spread of invasive cordgrass populations, the prevention of further spread, and the protection of important habitats. Over time, if full eradication proves infeasible under this alternative, the goal would be to reduce and maintain population levels as close to eradication as possible.

Proposed Control Methods

Control methods proposed for use under Alternative 1 include a range of manual, mechanical, and chemical methods. Some of these methods are aimed at killing or removing target cordgrass populations, while some are "support techniques," which facilitate implementation of a removal method or providing temporary control pending a more permanent solution. Each of these control methods is described below. Because the field of marsh weed eradication is new, a universally recognized set of terms has not yet been developed. For example, a machine that one person calls a "flailer," another might call a "macerater," and a technique called "smothering" by one person might be called "covering" by another. This document attempts to use terms most descriptive of the activity, however, a thorough reading of the text will be required to gain a full understanding of the methods being proposed. Photographs of some of the control methods are shown in **Figure 2-1,** and the methods are summarized in **Table 2-1**.

Hand-pulling and manual excavation. Manual removal methods are the simplest technology for removal of cordgrass. Manual removal includes pulling cordgrass plants out of marsh sediments or using hand-tools such as spades, mattocks, or similar tools to cut away as much cordgrass as possible within reach **(Figure 2-1a)**. Manual removal methods are effective primarily at removing aboveground plant parts, but are less effective at removing belowground rhizomes (a horizontal underground stem that sends out roots and shoots from buds) that rapidly regenerate shoots. Unless digging removes the entire marsh soil profile containing viable rhizomes and buds, its effect is equivalent to pruning (see *Mowing, burning, pruning, and flaming,* below). The vigor with which remaining rhizomes resprout and regrow is often proportional with the severity of the disturbance. Frequent re-digging and maintenance is needed to exhaust rhizome reserves of energy and nutrition, and the population of buds capable of resprouting.

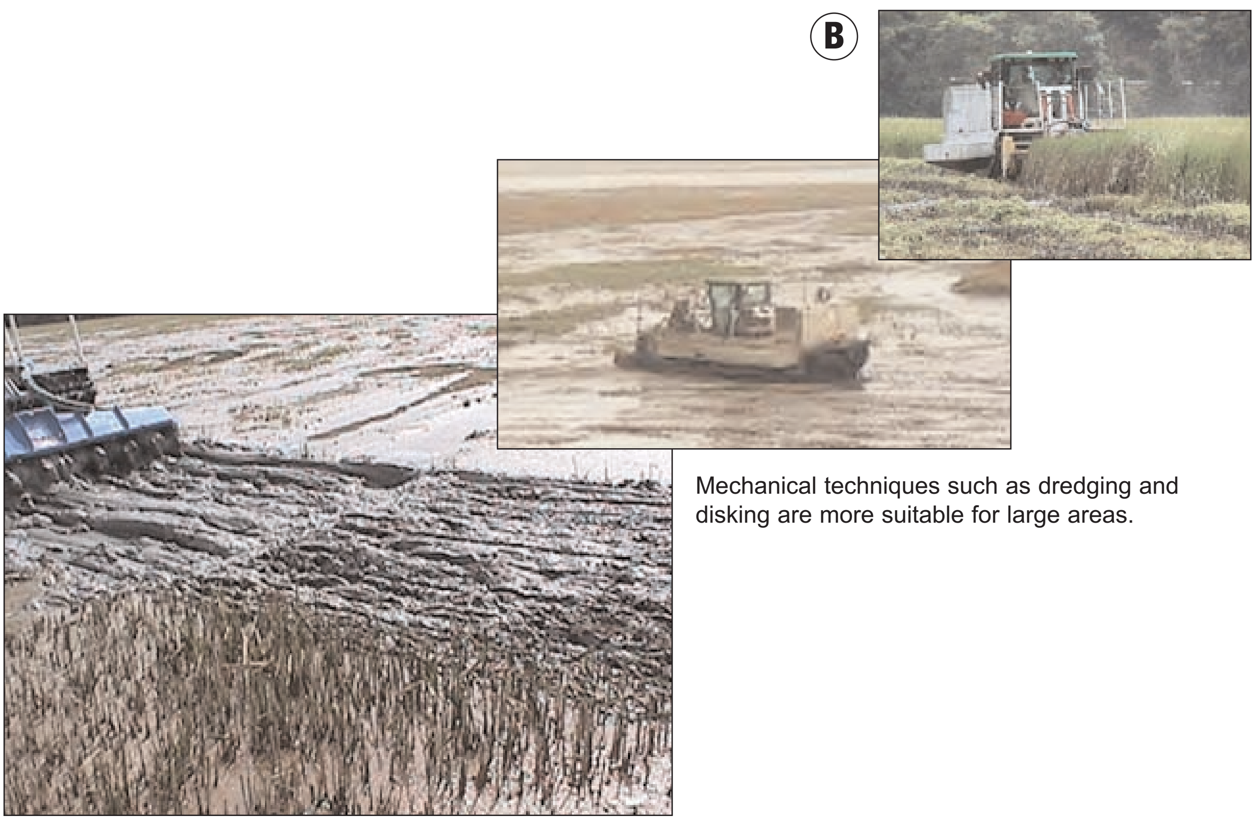
Manual removal is most effective on isolated seedlings, or very young discrete clones (asexually reproduced colonies of cordgrass) or clumps, where they are infrequent. Manual excavation in tidal marshes is extremely labor-intensive. Most cordgrass colonies occur in soft mud in which footing needed for digging is impossible or hazardous, even for workers on platforms, mats, or snowshoe-like boots adapted for walking on mudflats. Dug plants with roots left in contact with moist soil may retain viability and regenerate in place or disperse to establish new populations.

Disposal of manually removed material, especially root/rhizome systems, is problematic. On-site disposal in marshes may cause additional marsh disturbance and may result in spread of invasive

A

Manual removal of cordgrass is suitable for single plants and small clones. Here a Chilean cordgrass plant is removed by digging.

B



Mechanical techniques such as dredging and disking are more suitable for large areas.

Figure 2-1. Examples of Methods that may be used to Control Non-native Cordgrass

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C

Mowing and pruning can be used to remove biomass and reduce seedset, but will not easily result in eradicating stands of cordgrass.

D

Crushing with tracked vehicles can smother cordgrass and significantly reduce regrowth of mown area.

E

Discrete clones of cordgrass can be covered with plastic, depriving the plants of sunlight and oxygen and raising soil temperatures beyond plant tolerances.

Figure 2-1. Examples of Methods that may be used to Control Non-native Cordgrass

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F

Inflatable geotextile tubes may be used to dam water and drown cordgrass.

G

Small to medium sized clones of cordgrass can be treated by application of herbicide with low-volume hand sprayers.

H

Areas near roadways and levees may be accessible for herbicide treatment by truck.

I

Large meadows in areas away from sensitive receptors may be treated by herbicides sprayed from helicopters.

Figure 2-1. Examples of Methods that may be used to Control Non-native Cordgrass

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cordgrass by regeneration of viable roots. Where manual removal occurs next to levees, salt ponds, or other nontidal environments, local disposal may be feasible. Disposal of manually removed materials may also be accomplished with specialized low-ground-pressure equipment (amphibious vehicles), but the number of passes needed to transport materials also increases marsh disturbance.

Mechanical excavation and dredging. Mechanical removal in marshes would use equipment specially designed for working in semi-terrestrial, semi-aquatic wetland environments. Excavation and dredging would be accomplished using (1) amphibious dredges fitted with excavators, clamshells, or "cutterhead" dredges, or (2) excavators working from mats (large wood pile supports placed flat on geotextile fabric placed over the marsh surface). Some locations would allow use of conventional shallow-draft, barge-mounted dredging equipment working within reach of marsh from the margins of navigable channels, particularly at high tide. Where cordgrass colonies lie within the limited reach of track-mounted excavators working from levees, mechanical removal also can be performed without entry of equipment to aquatic or wetland environments.

Another mechanical removal technique that may be used is maceration or pulping of sediments and plant remains on site using modified agricultural equipment, "chewing" them into particles too small to be viable or regenerate **(Figure 2-1b)**. Floating maceration equipment has been used in inland waterways to control submerged aquatic vegetation. The Control Program may support research and development of this method for use in the baylands environment, and would utilize this method if it were shown to be effective and reliable with mitigable impacts. Possible impacts of this method are evaluated in this EIS/R.

Mechanical excavation working to the full depth of the rhizome system (up to 1 foot) in tidal marshes has the potential to be significantly more effective than manual excavation. Similarly, maceration techniques that almost completely destroy both aboveground and belowground living mass of cordgrass have high potential effectiveness. Both techniques also have significant limitations in the San Francisco Estuary, however. Excavators working from levees have an inherent limitation of short reach or access distance, usually a working distance of less than 20 feet for the size equipment that typical levees could bear. Floating barges with clamshell or cutterhead dredges, in contrast, would need to work at high tides within about 70 feet of the leading edge of cordgrass vegetation. Excavators have sufficient reach to dispose of excavated marsh soil and biomass in nonwetland areas, on levees, or in aquatic habitats such as salt ponds, which lack vegetation.

Heavy equipment often is used within the Estuary's tidal marshes for purposes other than eradication of cordgrass, including removal of large debris hazards and contaminated materials, and construction or maintenance of ditches or canals. Most of this work is done on mats, to distribute the weight of equipment and protect underlying vegetation. These actions are usually aimed at operations that are highly localized (points or narrow alignments) in the marsh, and usually on the relatively firm marsh plain. Even there, equipment may become mired in soft spots, and removal of mired equipment can damage the marsh. In contrast to maintenance-type work, removal of invasive cordgrass involves a mosaic pattern for operations, and occurs most often in the low marsh and mudflats, which do not easily support mats and geotextile fabrics. Thus, control methods based on excavators working on mats would be most applicable to localized, large patches of invasive cordgrass on the marsh plain. Some tidal flats invaded by cordgrass occur on sandy deltas with intertidal sand bars (e.g., San Leandro, San Lorenzo Creek) where equipment could be staged, but this situation is unusual in San Francisco Bay, where bay mud prevails over sand in most tidal flats. The feasibility of using mechanical excavation or dredging methods at a particular location would be determined based on site-specific conditions.

Excavated or dredged materials would be disposed either to a suitable upland location or to an approved diked bayland site. Cutterhead dredges can discharge slurries of sediment, bay water, and detritus into barges, or pipe them to either upland or behind-dike disposal sites. Clamshell-dredged material can also be "slurried" and piped to barges or a suitable disposal location.

Where feasible, the Control Program would "beneficially re-use" excavated or dredged materials from cordgrass eradication sites to facilitate restoration of diked baylands. The ground surface of abandoned commercial salt evaporation ponds, where thousands of acres of tidal marsh restoration is proposed, are usually subsided below the desirable level for restoration, and requires filling. In addition, salt pond conditions following discontinuance of salt production operations are usually dry or hypersaline or both; these are lethal to cordgrass. Disposal of dredged material from navigational and flood control projects to diked bayland restoration projects has proven both feasible and cost effective. Based on the similarity of the operations, Control Program planners are optimistic that disposal of materials from eradication projects to assist wetland restoration may also be feasible. "Disposal" of material from cordgrass eradication sites would thus serve the dual purpose of restoring a site lost to invasive non-native cordgrass and expediting restoration of commercial salt ponds to native tidal marsh, both consistent with the Baylands Ecosystem Habitat Goals. The Control Program would coordinate with the San Francisco Estuary Baylands Ecosystem Restoration Program (sponsored by the U.S. Environmental Protection Agency and the California Resources Agency), and would actively seek opportunities to "pilot" this approach. The Control Program would carefully monitor and evaluate the efficacy of any such pilot effort.

Mowing, burning, pruning, and flaming. Cordgrasses are well adapted to disturbances that "crop" or otherwise remove aboveground biomass. A single event that removes living or dead aboveground cordgrass biomass generally stimulates cordgrass growth, and as soon as a cordgrass stand refoliates, it begins to "recharge" its roots and rhizomes with new food reserves. If vegetation is removed with frequency, roots and rhizomes are prevented from regenerating reserves of energy and nutrition and cordgrass begins to die back as its organs of regeneration and storage become exhausted. If the cordgrass is mown close to the mud surface, it also severs the connections between leaves and roots that transport gases to roots growing in extremely anoxic (oxygen-deprived) waterlogged sediment and further stress the plant.

Repeated close mowing **(Figure 2-1c)** may be used to increase physiological stress to a point that cordgrass cannot regenerate; frequent burning would have similar effects. The use of pruning, burning, and mowing for cordgrass eradication in open mudflats and marshes would require very frequent treatment of all aboveground growth until the cordgrass rhizome/root systems become exhausted. For robust stands of Atlantic smooth cordgrass, this may require more than monthly treatment for more than one growth season.

Controlled burning may be used in some situations to remove vegetation prior to other treatments, or to prevent pollen and seed dispersal in founder colonies invading new sites. Burning would be used only in suitable locations, and only during periods of low-wind conditions (especially early morning), when fire hazards in succulent vegetation of tidal pickleweed marshes would be manageable. Ignition, however, may be difficult in cordgrass stands on mudflats.

Selective pruning (partial mowing with "weed-whackers" **[Figure 2-1c]** or flaming with hand torches) may be used to remove flowerheads and seedheads of discrete colonies to prevent flow of pollen from contaminating seed production of native cordgrass, and to prevent seed production within founding colonies. However, pruning would have little or no effect on the clone's growth rate and must be followed up with other methods to control spread.

Mown vegetation without viable seeds or propagules may be left in place or removed from the site. Vegetation containing viable seeds or propagules would require removal from the treatment site and disposal in a suitable area not conducive to cordgrass growth.

Crushing and mechanical smothering. This method uses amphibious track vehicles to trample new plant shoots and stems, and cover them with a layer of sediment **(Figure 2-1d)**. The objective is to smother the plant by preventing the use of stems to transport oxygen to its roots and rhizomes. Fine-textured bay mud losing aeration from cordgrass stems quickly becomes anoxic, increasing root-toxicity of waterlogged soil conditions (black, sulfide-rich mud). The method would typically be used in the fall, and ideally a period of time after mowing, when young shoots and stems have developed. This method has been used with some success in Washington State, but has not yet been used in the San Francisco Estuary.

Covering/blanketing. This is another technique that is aimed at exhausting the reserves of energy and nutrition in cordgrass roots and rhizomes and increasing environmental and disease stress **(Figure 2-1e)**. Covering typically involves pegging opaque geotextile fabric completely around a patch of cordgrass. This excludes light essential to photosynthesis (transformation of solar energy to food energy), and "bakes" the covered grass in a tent of high temperature and humidity.

This technique may be used for discrete colonies (clones) where the geotextile fabric can be fastened to the marsh surface securely with stakes for a sufficiently long period of time. High tides, high winds, and tide-transported debris common in tidal marshes often make this difficult or impossible in some situations. Care must be taken to cover the entire clone to a distance sufficient to cover all rhizomes. If rhizomes spread beyond the reach of the blanketing cover, rhizome connections to exposed, healthy stems can translocate (pipe) foods to the stressed, starving connected portions of the clone under the fabric, and increase overall survival. Staking geotextile tents on soft mudflats is very difficult, and may make this method infeasible in many situations.

Wrack (piles or lines of drifted debris and detritus from tidal sources) also is capable of smothering cordgrass and other salt marsh plants. Wrack can be created artificially by placing temporary debris piles on the marsh surface, but cannot be stabilized for long – usually no longer than the highest December-January or June tides, or storm surges. Their duration at any position in the marsh depends on the frequency and height of tides. The lower in the intertidal zone, the less stable the position of a wrack pile is likely to be. This technique would be used only for small colonies, and would depend on locally available accumulations of organic tidal debris.

Flooding and draining. Flooding and draining techniques entail constructing temporary dikes or other structures to impound standing water or remove water to kill emergent vegetation. Cordgrasses are intolerant of permanently flooded or stable, dry conditions, and are generally absent in the diked nontidal salt marshes of the Estuary. Salt evaporation ponds, managed waterfowl ponds, and completely diked pickleweed marsh exclude cordgrasses, native and non-native alike. Atlantic smooth cordgrass and English cordgrass are capable of invading tidal marsh pools (salt pans) subject to irregular tidal influence (Campbell et al. 1990, P. Baye, pers. observ.), but they are not likely to survive in typical diked wetlands.

When tidal marshes are diked and drained rather than flooded, they undergo rapid physical and chemical changes. Organic matter decomposes when microbes are exposed to air; clays shrink when dewatered; and sulfides formed in oxygen-free mud transform to sulfates forming strong acids (Portnoy, 1999). Therefore, diking and draining, although conceivably effective for killing cordgrass, would adversely impact marsh soils and restoration, and the longer salt marsh soils are diked and drained the more difficult these adverse soil changes are to reverse. For these reasons, diking and draining only would be used in critical situations where no other method is feasible, and only after careful evaluation and planned mitigation. Diked salt marsh soils that remain permanently flooded undergo relatively slower and less significant changes. Diked flooded salt marshes would eliminate existing standing vegetation, but are readily re-colonized by youthful salt marsh vegetation if the diking is brief.

Isolating the treatment area for flooding or draining may be accomplished by constructing temporary dikes or by closing openings in existing dikes. Temporary constructed dikes need not be large to accomplish treatment. Low earthen berms (about one foot above marsh plain elevation), constructed using low-ground pressure amphibious excavators, could be built around large colonies of cordgrass within open marsh plains. Alternatively, water-filled geotextile tubes ("inflatable dams"), analogous with inflatable cofferdams used in aquatic construction/dewatering operations, may be used **(Figure 2-1f)**. Upon completion of treatment, berms would be graded down to marsh surface elevation, and inflatable dams removed. Temporary dike structures may be difficult to construct in tidal mudflats. Mudflat sediments are usually too soft to "stack" into berms, and firmer material placed on fluid or plastic muds simply subsides into the flats. Similarly, inflatable dams may not be feasible for softer tidal flats.

Many populations of non-native cordgrasses have invaded marshes restored by breaching dikes within former diked baylands, where most of the original dikes remain. In these situations, a dike-enclosed tidal marsh could be temporarily re-closed ("choked") by placing a sheetpile barrier in the existing breach, thus creating a temporary lagoon and effecting mass cordgrass eradication. Water control structures (adjustable tidegates) may be installed to enable marsh managers to maintain water depths lethal to cordgrass, suitable diving duck habitat, and adequate water quality. Marsh recolonization is expected to proceed rapidly following restoration of tidal flows.

An alternative form of treatment, intermediate between flooding and draining, would be to combine impoundment of water with deliberate solar evaporation, creating hypersaline lagoons. Hypersaline conditions would make the habitat transformation even more rapidly lethal for invasive cordgrass. Restoring tidal flows to temporary salt ponds, however, may require dilution of brines, which could increase cost.

The Control Program would evaluate each potential impoundment treatment opportunity individually and apply the method with the fewest adverse impacts in each situation.

Herbicide application. Herbicides have proven highly effective in eradicating populations of cordgrasses. Glyphosate, the herbicide proposed for use in the Control Program, is the only herbicide currently approved by the US Environmental Protection Agency for use in estuarine aquatic habitats.

<u>Description of proposed herbicide and additives</u>. Glyphosate is the active ingredient in the retail products "Rodeo" (Dow Chemical Company) and "Aquamaster" (Monsanto Corporation). Glyphosate works by poisoning the plant's protein production system and disrupting the plant's metabolic functions, particularly energy use and growth. It is a non-selective herbicide, generally affecting all species of vascular plants. It is derived from an amino acid (building-block of protein); technically, it is a "phosphono amino acid," specifically N-(phosophomethyl) glycine. It is systemic in action, transferred through the plant's vascular system from the tissues that absorb it to all parts of

Table 2-1. Summary of Proposed Treatment Methods

	Hand-pulling and Manual Excavation	Covering/Blanketing	Flooding/Draining	Burning
Alter-native	**1, 2, and 3**	**1, 2, and 3**	**1, 2, and 3**	**1, 2, and 3**
Appropriate Setting	Seedlings, particularly in newly infested areas. Appropriate for small clumps and isolated clones, or sparse infestations.	Small to medium size clones. Larger stands are not easily covered due to the labor-intensive nature of transporting and installing the fabric.	Infestations in diked areas recently restored to tidal action by breaching dikes, areas behind sand or shell spits, and areas that can be isolated by temporary earthen or inflatable berms.	Close clusters of medium to large clones or meadows. Reduces biomass and can be used in conjunction with other control methods.
Removal Technique	Removal of plant and below ground material up to 3.9 feet deep.	Covering blocks light from reaching the plants and interrupts photosynthesis.	Create dike, pump water in or out. Hypersaline water is quickly lethal. Flooding or draining for periods of weeks leads to plant mortality.	Colonies are ignited to incinerate above-ground portions of plants or clusters of plants in a self-sustaining fire.
Equipment Requirements	Shovels, trowels, bags, wheelbarrows, handcarts, sleds, trucks for transport of removed material.	Geo-textile fabric or black plastic, grommets, stakes.	Sheetpiles, inflatable dikes that fill with water during an outgoing tide. Dams, trucks, cranes, pumps.	Propane may be used as fuel for ignition. Stems and leaves of *Spartina* fuel the fire if sufficiently dry. Hay can be used to sustain burning between clumps of plants.
Workforce Requirements	Depends on the age and density of the population. An approximate 10-person workforce would be required to pull or dig out a low-density seedling area of about 0.25-acre in an 8-hour day.	Approximately 2-5 persons would be required to place covers over treatment areas, depending on the size of the area. One person would be effective for periodic monitoring for tears or movement of covers.	A crew of 3-4 persons would be required to place, inflate and remove inflatable dikes. Crane required for sheetpile. One person would periodically monitor dike.	A crew of 3-4 persons and presence of fire department officials would be required.
Timing	This method can take place during any season, but is most frequently done in the spring. 1-2 visits per location per year are needed to prevent reestablishment or resprout.	Placing covers early in the growing season would eliminate the need for mowing. Covers must remain in place for two growing seasons to kill plants.	Sheetpile or Inflatable dike could be placed or removed during any season. However, removal should not occur during the fall or early winter when seed dispersal is greatest. Dikes could stay in place for as long as 2 years.	Most effective from the early fall-winter at warm and dry times of year when plants would dry more thoroughly between high tides. Burning would occur once per growing season on calm days with low or no wind.
Effectiveness	Depends on the diligence of the work crew. Any portion of rhizome left behind can potentially sprout and re-establish the clone. Complete removal results in eradication.	Covering has been successful in the S.F. Estuary on small patches up to 36 feet in diameter. Failure results from improper installation, or covering too large of an area. Improperly sealed seams allow plants to grow through the covers. Wind or tidal action may dislodge covers. Sediment may accumulate on top of the covering, hampering removal of fabric.	No information available.	Most appropriate for the prevention or reduction of seed set. Effects may be temporary. Burning does not kill *Spartina;* resprouted plants have greater stem density after burning and plants can resprout from rhizomes and buried roots. Colonies may be resistant to sustaining a burn due to daily wetting by the tide, and the presence of dried salt on the plant.

Alternatives: 1- Regional Eradication Using All Available Control Methods; 2- Regional Eradication Using Only Non-Chemical Control Methods; 3- No Action – Continued Limited, Regionally Uncoordinated Treatment

Table 2-1. Summary of Proposed Treatment Methods (continued)

	Pruning, Mowing & Flaming	Crushing & Mechanical Smothering	Mechanical Excavation & Dredging	Mechanical ripping/ flailing/maceration
Alter-native	**1, 2, and 3**	**1, 2, and 3**	**1, 2, and 3**	**1, 2, and 3**
Appropriate Setting	Small to medium area. To reduce biomass and facilitate other methods, or to remove seedheads to prevent cross-pollinating. Use repeatedly to stress and kill plants.	Meadows, large individual clones >25 feet in diameter or clusters of clones. May be used in conjunction with mowing.	Meadows, large individual clones >25 feet in diameter or clusters of clones in the mid to lower tidal zone where the site can be accessed by floating dredge, or in the upper marsh where accessible by excavator.	Meadows, large individual clones >25 feet in diameter or clusters of clones.
Removal Technique	Pruning- clip seedheads Mowing- cut plant at, near, or just below the soil surface for best results Flaming- use handtorch to burn seedhead.	Small amphibious vehicles with tracks trample new shoots and culms (stems) and covers them with a thin layer of sediment. This sediment smothers the plant, preventing the use of stems to transport oxygen to roots and rhizomes.	Cutterhead dredge (or other type) on floating barge or excavator removes entire plant and root mass to a depth of 1 foot, and disposes in upland disposal or approved tidal marsh restoration site.	Amphibious vehicles with tracks rip and shred root mass below the soil surface to a maximum depth of 1 foot.
Equipment Requirements	Clippers, weedeaters, small mechanical cutters, handtorches.	Small amphibious tracked vehicles. Trailer or barge for transport.	Dredge or excavator, trucks to remove material (if not slurried and piped to destination)	Amphibious track vehicle equipped for subsoil implements for ripping roots.
Workforce Requirements	Varies depending on method & height and density of vegetation. Approximately 2-3 persons required to treat a 0.25-acre area with weedeaters over 8 hours.	1-2 amphibious vehicles per site depending on infestation. One operator will be needed for each vehicle, and 1-2 persons needed for transporting the equipment.	One operator per vehicle, and 1-2 persons needed on site during operations.	One operator per vehicle, and 1-2 persons may be needed on site during operations.
Timing	Mowing can be done during any season. Biomass is less in late fall and winter, facilitating this method. Seedheads form in summer and fall. Eradication by mowing alone would require up to 4-6 treatments annually, for a minimum of 2 years.	Mechanical smothering is used during the fall and winter as close to the period of dormancy as possible. Culms from the previous growing season will have died back for the winter and be brittle and easily broken. Trampling would occur once per season.	Any time of year.	Ripping can take place any time of year. Ripping during the late fall and winter is facilitated by winter dieback which results in significantly less above ground biomass.
Effectiveness	Results of field tests are variable, and dependent on the frequency and the start date. Repeated application eventually weakens rhizomes and reduces energy reserves. One application may invigorate a plant. Therefore, multiple treatments are necessary.	No information available.	Large-scale demonstration work in Washington indicates a high level of efficacy.	Large-scale demonstration work in Washington indicates a high level of efficacy.

Alternatives: 1- Regional Eradication Using All Available Control Methods; 2- Regional Eradication Using Only Non-Chemical Control Methods; 3- No Action – Continued Limited, Regionally Uncoordinated Treatment

Table 2-1. Summary of Proposed Treatment Methods (continued)

	Herbicide, Ground or Boat Application	Herbicide, Aerial Application
Alter-native	**1 and 3**	**1 and 3**
Appropriate Setting	Small, medium, and large individual clones and mead-ows. Application of herbicide may be used in conjunction with seedhead clipping and mowing.	Large, heavily infested areas, meadows, or difficult to access sites.
Removal Technique	Glyphosate/surfactant/colorant solution is sprayed, wiped, or painted on foliage, or applied as a paste on cut stems.	Spray apparatus attached to a helicopter consists of a boom with multiple nozzles for broad-cast delivery, or a spray ball.
Equipment Requirements	Glyphosate, surfactants, col-orants, backpacks, hand spray apparatus, spray truck, air-boat, hovercraft.	Glyphosate, helicopter with boom or spray ball.
Workforce Requirements	1-2 persons needed for small infestations. Backpack crews in heavily infested areas with difficult access would range from 2-6 persons. Typical crews for large infestations would include 2-3 persons per ground application vehicle, or 1-3 persons per boat with support from 1-3 trucks.	Crew of approximately 2 per-sons.
Timing	Glyphosate is most effective when applied at flowering or soon thereafter.	Late summer through early fall.
Effectiveness	Optimal conditions and proper application techniques dictate the efficacy of glyphosate. The length of time from application to high tide, wind and weather conditions, application method, and timing of applica-tion in the plant's life cycle are all important factors. Efficacy can range from 0-100 percent.	See previous method.

Alternatives: 1- Regional Eradication Using All Available Control Methods 3- No Action – Continued Limited, Regionally Uncoordinated Treatment
2- Regional Eradication Using Only Non-Chemical Control Methods

the plant. Although it is highly toxic to plants, glyphosate has exceptionally low toxicity to mammals, birds, and fish[1].

Additives including surfactants and colorants, would be added to glyphosate to improve its performance in the aquatic environment. Surfactants, also known as sticker/spreaders, are similar to detergents in their action, reducing water surface tension to allow wetting and penetration of the plant tissues. The surfactants proposed for use by the Control Program – Agri-dex, R-11 Spreader Activator, and LI-700 – are approved by the U.S. Environmental Protection Agency (U.S. EPA) for use in aquatic habitats, and have been selected for the Control Program as among the least toxic of the available surfactants. It should be noted that R-11 would only be used if the other surfactants are ineffective. If R-11 is proposed for use in a specific treatment project, the ISP staff would first coordinate with NOAA Fisheries. Colorants would be added to the glyphosate/surfactant solutions to enable spray crews to see where they have sprayed after initial evaporation of the solution. "Blazon Blue Spray Pattern Indicator" is the commercial name for the colorant proposed for use by the Control Program. Sections 3.2, *Water Quality*, 3.3, *Biological Resources*, and 3.6, *Human Health and Safety*, evaluate the possible environmental effects of glyphosate, surfactants, and colorants.

<u>Application rates and methods</u>. To be effective, glyphosate must be applied to completely cover the plant surface. Glyphosate becomes inactive (physiologically ineffective, but chemically stable) when it contacts clay or fine silt particles, or organic films. It becomes tightly bound to chemically attractive surfaces of microscopic mineral particles, and cannot be absorbed by living tissues in this bound condition. In tidal marsh conditions, where fine silts and clay films are regularly deposited on plant surfaces, this can be a problem for efficacy of glyphosate. However, it also provides a buffer against impacts to non-target plants and organisms, which may be insulated from glyphosate in "dirty" environments, such as the sediment rich water column (see Section 3.3.2, *Analysis of Potential Effects on Biological Resources – Glyphosate Herbicide Application*).

Glyphosate mixtures may be applied as sprays to plant surfaces, pastes applied to cut stems, or solutions wiped or painted on foliage. Spray mixtures may be administered from manually transported tanks (backpack sprayers **[Figure 2-1g]**) or spray equipment mounted on trucks **[Figure 2-1h]**, track vehicles, boats, or helicopters (broadcast sprayers **[Figure 2-1i]**). California Department of Pesticide Regulations-certified applicators, or persons under their direct supervision, would perform all herbicide applications. Glyphosate solutions would be prepared and applied consistent with the commercial product labels. For treatment of cordgrass in aquatic environments, the product labels specify a 1 to 2 percent solution applied with hand-held equipment, or 2.2-3.7 quarts of product per acre as a broadcast spray. Surfactants and colorants are added halfway through the mixing process. Surfactants must be added at a rate of 2 or more quarts surfactant to 100 gallons solution (0.50 percent). The colorant, Blazon, is typically added at a rate of 3 quarts per 100 gallons of solution, or 16 to 24 ounces per acre broadcast sprayed **(Table 2-2)**. The exact solution concentration and application rates for each constituent are determined based on site-specific conditions.

High mortality to cordgrasses, especially Atlantic smooth cordgrass (because of its broad leaf area), often results from adequate spray coverage of glyphosate. Aerial application of glyphosate is most effective on large areas of cordgrass (cordgrass meadows), where access by terrestrial or aquatic

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[1] Glyphosate inhibits the activity of the enzyme 5-enolpyruvylshikimic acid-3-phosphate synthase (EPSP), which is necessary for the formation of the aromatic amino acids tyrosine, tryptophan, and phenylanine. These amino acids are important to the synthesis of proteins that link primary and secondary metabolism. EPSPs are present in the chloroplast of most plant species, but are not present in animals. Animals need these three amino acids, but obtain them by eating plants or other animals.

Table 2-2. Glyphosate Herbicide Mixture Component Concentrations and Application Rates for Treatment of Cordgrass in an Aquatic Environment

Application Method	Glyphosate Product[1]	Glyphosate Salt[2, 3]	Non-Ionic Surfactant[4]	Colorant[5]
Handheld sprayer	1-2% solution[6] (1-2 gal./ 100 gal. solution)	5.4-10.8 lbs. glyphosate salt/100 gal. solution	Minimum 2 qt./ 100 gal. solution	3 qt./ 100 gal. solution
Low volume directed spray	5-8% solution[7] (5-8 gal./ 100 gal. solution)	27-43.2 lbs. glyphosate salt/100 gal. solution	Minimum 2 qt./ 100 gal. solution	3 qt./ 100 gal. solution
Broadcast sprayer	2.2-3.7 qt./acre[5]	3-5 lbs. glyphosate salt/acre	Minimum 2 qt./ 100 gal. solution	0.5-1.5 qt./ acre

1. Rodeo and Aquamaster
2. N-(phosphonomethyl)glycine, isopropylamine salt, active ingredient in Rodeo and Aquamaster
3. Calculated from volume application rate at conversion ratio of 5.4 lbs. glyphosate salt per gallon of liquid Rodeo or Aquamaster
4. Agridex, R-11 Spreader Activator, or LI-700
5. Blazon Spray Pattern Indicator
6. Label-specified rate for "Perennial Weeds: Cordgrass"
7. Label-specified rate for low volume, directed spray using hand-held equipment for spot treatment for trees and brush. Applicable to perennial weeds and cordgrass per personal communication, November 25, 2002, Monsanto Company.

equipment is restricted. Glyphosate is least effective on cordgrass colonies on mudflats where foliage is covered with silt films at the time of application, and few hours elapse before the sprayed leaf surfaces are submerged by rising tides. Best results are achieved on "clean" foliage at the upper reaches of the low marsh and above, particularly during neap (weak) tides.

Glyphosate treatment typically would occur in late summer through mid-fall, while the plants are in peak flowering stage (or later), and still green. Where appropriate, spraying would be scheduled to accommodate the mating and nesting seasons of the California clapper rail, which begins in winter and extends through summer. Application of glyphosate also would be timed to provide sufficient drying time before inundation by the tides, and would not occur during periods of high winds (greater than 5 to 10 miles per hour), when winds are directed towards residential areas or other receptors, or if precipitation is expected within 5 to 6 hours of spraying.

For ground based and aerial applications, every effort will be made to control drift during treatment. Aerial applications will conform to the Specimen Label as well as the Supplemental Labeling for Aerial Application in California Only, following all included recommendations for Spray Drift Management and Aerial Drift Reduction Advisory Information. The most effective way to reduce drift potential is to apply larger droplets. Therefore, ISP Field supervisors will engage in careful management of droplet size, taking into account spray pressure, number of nozzles, nozzle orientation, nozzle type, boom length and application distance. Using lower pressure spray equipment also reduces potential for overspray and drift. Therefore applicators will be advised to reduce pressure in equipment or use low-pressure equipment whenever possible. Drift control agents also should be added to the tank mix when wind conditions are condusive to drift. If spraying is to be done near discrete sensitive receptors,and there is the potential for drift, those receptors will be shielded by physical structures.

Additionally, wind speeds will be observed during the treatment period and monitored for exceedences of the label-recommended 10 mph wind speed guidelines. Aerial applications will also avoid temperature inversions, and periods of low relative humidity to minimize evaporation potential. Application of glyphosate would frequently be preceded by pruning or mowing several weeks before to (1) reduce the surface area of vegetation, thus reducing the amount herbicide needed, and (2) stimulate the plants into accelerated growth, thus increasing the plant's metabolism of the glyphosate. Spraying may also be used as a "follow-up" treatment after repeated mowing or burning, or after mechanical removal.

Potential glyphosate herbicide treatment sites would be selected based on site conditions, the severity of infestation, evaluation of short- and long-term environmental impacts compared to other treatment methods, efficiency, and proximity of the treatment site to sensitive receptors.

Program Approach

The Control Program will use a modified "integrated vegetation management" (IVM) approach to prioritize and implement control efforts. Applying this approach, the Control Program will use all available scientific information regarding the Estuary, the invasive cordgrasses, and the likely economic, sociological, and ecological consequences of both the invasion and the treatment program, to develop a management strategy that is effective, economical, and protective of public and environmental health. IVM is typically premised on the assumption that a pest or weed can be managed rather than eradicated. Based on the preponderance of information available at this time, the Control Program is proceeding on the assumption that full eradication of the invasive cordgrasses, particularly Atlantic smooth cordgrass, will be necessary to accomplish control. This seemingly extreme approach is based on the apparent impossibility of controlling pollen flow and hybridization with native Pacific cordgrass. For the purpose of the Spartina Control Program, the practical criterion for eradication of the Spartina alterniflora hybrid swarm will be elimination of genotypes (genetic individuals) exhibiting, or capable of reproducing, the robust, invasive hybrid phenotypes with distinctive ecological traits of S. alterniflora. The ISP does not assumes that all genes originating in the S. alterniflora genome must be extirpated in the introgressant population to protect the genetic and ecological integrity of S. foliosa. This working hypothesis will be re-evaluated in during the SPC in coordination with scientific advisors. The IVM approach will be adapted to accommodate this more restrictive objective. However, if future research shows a reduced threat, or if eradication proves infeasible in the coming several years, the Control Program objective would revert to long-term management rather than eradication. For additional information regarding IVM, the reader may refer to Ebasco 1993b, Bottrell and Smith 1982, Hoglund *et al.* 1991, and Thill *et al.* 1991.

While current "best science" sets the initial course of the Control Program, new information regarding *Spartina* and its effect on the ecosystem—here and in other areas—is continually being screened. In addition, the ISP and others are conducting research to increase knowledge and improve decision-making. During the coming years, the Control Program will follow the developing scientific understanding of such critical issues as cordgrass hybridization and the resulting changes in plant biology; the effects of non-native cordgrass invasion on California clapper rail populations, song sparrows, and other species; the spread of Pacific smooth cordgrass onto mudflats; and the successional processes that will occur at locations invaded by non-native cordgrasses. Such information will be used to help guide future Control Program planning decisions.

Prioritization Strategy. Particularly during the initial months of the *Spartina* Control Program, it would be important to carefully select which sites would be treated and when. Consistent with the IVM approach, the first priority of the Control Program would be to prevent the establishment of new cordgrass populations in areas that they do not currently exist. This is particularly important in areas where it may then spread rapidly to other locations – such as near the Golden Gate, where it may spread to West Marin estuaries (**see Figure 1-5**) – or near a proposed tidal marsh restoration site where it would quickly infest the newly restored habitat. Maps of non-native cordgrass locations developed by the Invasive *Spartina* Project (see **Figure 1-4**) provide an accurate picture of the "edges" of the current infestation, and help to identify the sites or regions that should be targeted first. In addition, the Control Program receives reports from landowners and naturalists on a regular basis when new stands of non-native cordgrasses and hybrids are discovered.

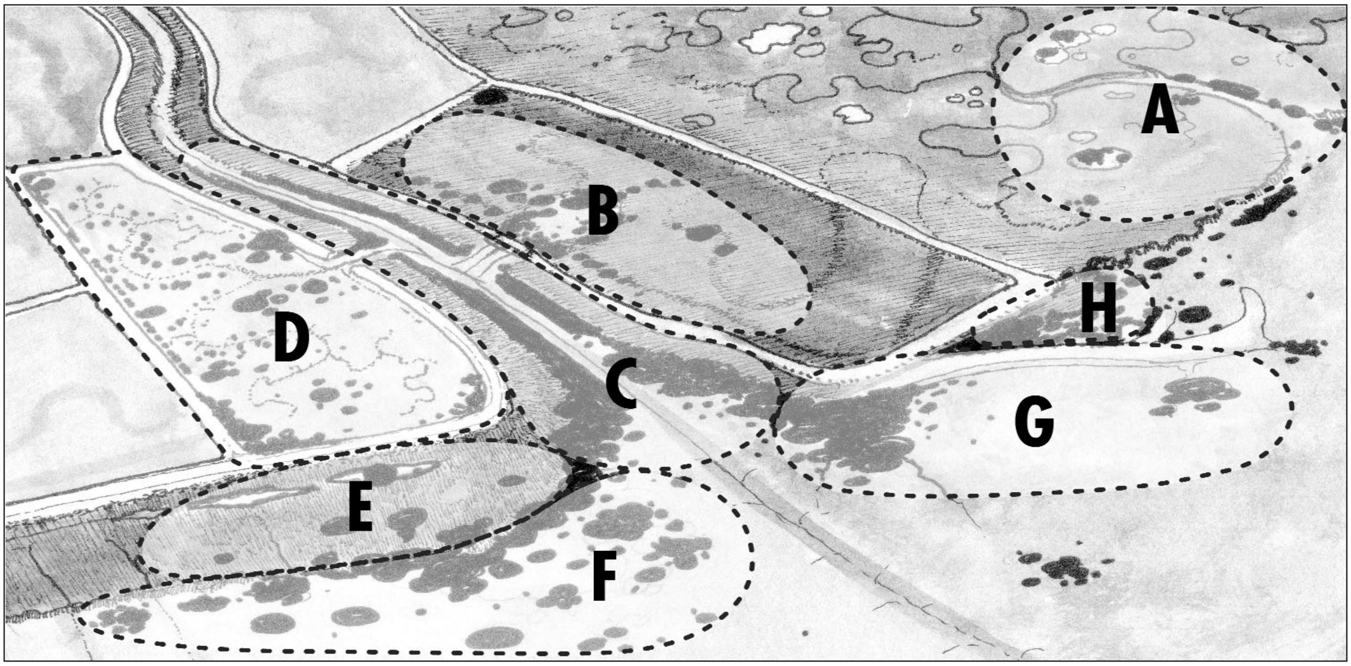
In addition to identifying and eradicating "outliers," the Control Program would target the control of pollen and seed spread from Atlantic smooth cordgrass and hybrid colonies. This may include mowing, clipping, burning, or spraying plants that threaten to disperse seed and pollen, but for which there is not ready budget for a more complete eradication effort. Control of pollen and seed production would be a priority for hybrid colonies that are identified as exceptionally productive of seed or fertile pollen. Once the spread of cordgrass to new areas is under control, the Control Program would begin to direct some resources towards treating sites that are already heavily infested. To help gain needed experience with the efficacy of the various treatment methods in the local environment and to investigate new treatment techniques, some heavily infested sites would be targeted early on as "pilot" studies.

A primary consideration for site prioritization is the presence of California clapper rail at many of the non-native cordgrass-infested sites. **Figure 3.3-1**, in the *Biological Resources* section of this report, shows the location of known clapper rail nesting sites relative to non-native cordgrass stands. This EIS/R includes several proposed mitigations and a stringent set of best management practices to reduce the Control Program's short-term impacts on the clapper rail. However, these measures require review by the U.S. FWS under Section 7 consultation. Once approved, it still may be necessary for projects at sites with clapper rail populations to undergo additional independent review before implementing control measures. In anticipation of delays implementing control at sites with clapper rails, the Control Program would initially focus funding and operations in other areas, while agreements and permits are being obtained.

Site-specific selection of control methods. After the priority sites are identified, a number of factors would be considered to determine what control methods would be implemented at each site. **Table 2-1** summarized many of the considerations. Control of noxious weeds from the perspective of IVM focuses on the harmonious use of several management methods to reduce the damage caused by the infestation. No single treatment technique is expected to be completely effective on its own; most frequently the methods are combined according to site-specific needs to achieve the desired control objective with minimized adverse impacts. **Figure 2-2** illustrates a number of ways in which methods might be combined to accomplish eradication in specific situations.

A site-specific plan would be developed for each treatment site based on specific site conditions, adjacent land uses, feasible treatment methods, costs, and budget. The plan would identify which methods would to be used, time schedules, and necessary phasing and coordination. Depending on the methods selected, the plan would identify and address such issues as sediment contamination, endangered species, adjacent land uses, sensitive receptors, site safety and access, spill prevention, and so on. In all cases, the Control Program would rely heavily on partnerships with the landowners and land managers to plan and complete the work.

In the first few years, the Control Program would necessarily rely most heavily on those methods for which equipment and supplies are readily available. It is expected that this may mean greater use of herbicides in the first years than would be used later, when specialized dredges, track vehicles, boats, etc. have been acquired.



AREA A: Tidal Marsh - Remote, discrete colonies (more than 10 ft. wide) within marsh plain or small tidal creeks, far from vehicle access on levees. Colonies are too large for efficient manual excavation, and too remote for efficient access across multiple tidal creeks by equipment.

Primary options: **(a)** smothering/covering by fabric, followed by herbicide treatment of survivors; **(b)** mowing followed by herbicide treatment of resprouts/survivors; **(c)** wicking or spraying of herbicide over intact colonies. ***Alternative options:*** burning (difficult ignition), trampling, both followed by herbicide treatment of survivors.

AREA B: Muted (Microtidal) Marsh - Locally extensive, coalescing colonies are shown within a "forebay" and channels of low marsh, backed by a higher marsh plain. Most colonies shown are beyond the reach of excavation equipment working from levees, but vehicle access along levees allows relatively efficient marsh vehicle use. Restricted tidal flows help limit potential spread of vegetative fragments (propagules). Colonies shown are too extensive for efficient manual excavation or smothering/covering.

Primary options: **(a)** mechanized removal by flail (maceration) or shredding/disking, followed by herbicide treatment of survivors; **(b)** wicking or spraying of herbicide over intact colonies. ***Alternative options:*** drowning (mowing in fall followed by persistent flooding, impoundment by closing tidegates during the growing season); wicking or spraying of herbicide over intact colonies; burning, smothering/covering, or trampling of isolated colonies, all followed by herbicide treatment of survivors.

AREA C: Major Tidal Slough or Flood Control Channel - Extensive, wide, continuous bands of Atlantic smooth cordgrass along sloping intertidal channel banks, some discrete colonies. Soft, sloping mud substrates make marsh vehicle use difficult, except where channels have accreted to gently sloping plains. Relatively little Atlantic smooth cordgrass lies within reach of excavation equipment working from levees.

Primary options: **(a)** dredging from barge in navigable channel, with disposal in suitable nontidal diked baylands; **(b)** mechanized removal by flail (maceration), or mowing followed by herbicide treatment of survivors. ***Alternative option:*** wicking or spraying of herbicide over intact colonies.

AREA D: Young Tidal Marsh Restoration, Former Diked Bayland - Widespread colonies on sheltered mudflats, but concentrated along marsh edge (near levee) and banks of developing tidal channels. Very soft, recent mud deposits below Mean High Water.

Primary options: **(a)** excavators working from levee, depositing excavated cordgrass/mud on levee top, within limited reach from levee; **(b)** mechanized removal by flail (maceration), or mowing followed by herbicide treatment of survivors. ***Alternative option:*** wicking or spraying of herbicide on intact colonies.

AREA E: Fringing Tidal Marsh - Relatively firm high marsh plains with few channels, depressions, or pans. Localized colonies in depressions, pans, and lower marsh plain elevations. Commonly old borrow ditches lie between levee and marsh; marshes generally lie close to levees, allowing potential marsh vehicle access.

Primary options: **(a)** smothering/covering by fabric, followed by herbicide treatment of survivors; **(b)** mowing followed by herbicide treatment of resprouts/survivors; **(c)** mechanized removal by flail, or mowing followed by herbicide treatment of survivors; **(d)** wicking or spraying of herbicide over intact colonies. ***Alternative options:*** burning (difficult ignition), trampling, both followed by herbicide treatment of survivors; temporary impoundments around larger colonies, followed by herbicide treatment of survivors.

AREA F: Mudflats - Both extensive coalesced colonies (young marsh) and widely spaced discrete colonies of variable size. Very soft muds.

Primary options: **(a)** mechanized removal by flail, or mowing, trampling followed by herbicide treatment of survivors; **(b)** wicking or spraying of herbicide over intact colonies. ***Alternative option:*** shallow dredging from shallow-draft barge at high tide, barge disposal, permanent disposal in non-tidal diked bayland.

AREA G: Estuarine Beaches - Generally firmer substrates with high sand or shell content; near levee access.

Primary options: **(a)** low-ground pressure excavators, shallow excavation/removal (within reach of firm substrates) with disposal on levees or nontidal diked baylands; **(b)** mechanized removal by flail, or mowing, trampling followed by herbicide treatment of survivors; **(c)** wicking or spraying of herbicide over intact colonies.

AREA H: Backbarrier Marsh - Semi-enclosed mudflat or marsh behind sand or shell spits, sheltered from bay waves. Generally near levees and beaches with firm substrates and vehicle access.

Primary options: **(a)** flooding/drowning (temporary impoundment, berm or inflatable dam across free end of spit); **(b)** low-ground pressure excavators, shallow excavation/removal (within reach of firm substrates) with disposal on levees or nontidal diked baylands; **(c)** mechanized removal by flail, or mowing, trampling followed by herbicide treatment of survivors. ***Alternative option:*** wicking or spraying of herbicide over intact colonies.

Figure 2-2. Examples of Options for Combining Treatment Methods in Various San Francisco Estuary Environments

Timing of treatment methods.

A number of factors influence the times during which certain treatment methods can be used. The two most significant factors for planning project implementation are diurnal fluctuation of the tides (for sites within the normal tidal spectrum), and the seasonal nesting and fledging of California clapper rails (for sites occupied by clapper rails). These two factors combined severely restrict the possible "treatment window" for many sites, and necessitate careful planning for efficient use of resources and effective treatment. As illustrated in **Figure 2-3**, during the 2003-year, most of the morning minus tide events (tide levels below 0.0 ft) occur during months that some level of California clapper rail nesting and fledging is expected to occur. Therefore, control work that must be implemented in the mornings during low tide (e.g., herbicide application) is restricted to a handful of days in the fall. A greater number of minus tide events occur in the afternoon in non-clapper rail "season," however afternoon conditions, such as high winds, are not conducive for many treatment methods. Conversely, high tide events may be targeted for implementation of methods that rely on boat access or dredging techniques.

Post-treatment monitoring and management. Treated cordgrass eradication sites would be monitored to verify that (a) surviving remnants of treated clones have not regenerated; and (b) the site is not reinvaded by dispersal from seed or vegetative fragment sources. Ultimately, eradication objectives must be integrated with local marsh management or restoration objectives. These may include: (a) restoration to pre-invasion mudflat or unvegetated channel conditions; (b) natural or accelerated succession to tidal marsh plain and creeks, such as in tidal marsh restoration sites; (c) restoration of pre-invasion native cordgrass-pickleweed dominated vegetation composition and structure. Each of these target conditions entails different approaches for monitoring and management following treatment, and different levels of effort and efficiency.

Where invasive cordgrass had caused sufficient sediment accretion to shift from cordgrass marsh to pickleweed-dominated marsh in treated areas, with rare and conspicuous establishment of cordgrass after treatment, or none, monitoring would be relatively simple. Post-treatment re-invasion would be easy to detect and reversed by low-level maintenance (manual removal, spot-spraying or cut-stump herbicide paste application). No other vegetation management would be required.

In relatively high-energy environments with rare establishment of any vegetation, such as open and exposed bay mudflats, post-treatment monitoring would also be relatively efficient and simple. No revegetation would be appropriate where the target condition is restoration of mudflat or unvegetated channel.

Minus Tide Events (Less than 0.0 ft)	***Jan***	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	***Nov***	***Dec***
Morning Low Tides (4 am to 11 am)	0	0	5	7	19	19	18	14	6	0	0	0
Afternoon Low Tides (11 am to 6 pm)	12	10	14	7	4	1	0	0	0	2	6	8

Key: Black Squares indicate peak California clapper rail nesting and fledging periods
Gray Squares indicate potential California clapper rail nesting and fledging periods
White Squares indicate periods considered unlikely for California clapper rail nesting and fledging

Figure 2-3. Number of Minus Tide Events (less than 0.0 ft) in 2003, with Peak and Potential California Clapper Rail Nesting and Fledging Periods (Source: *Goals Project* 2000 and *Tides and Currents Nautical Software* 1996)

Monitoring and post-treatment management would also be relatively simple near the range limits of invasive cordgrass species, where colonies are typically isolated, surrounded by native tidal marsh vegetation, and have very low or negligible rates of re-invasion because of long dispersal distances from seed sources. Local replanting with native Pacific cordgrass, pickleweed, or other appropriate local native vegetation may be appropriate in some cases, but spontaneous recruitment of native vegetation would normally be indicated.

More challenging would be eradication in tidal restoration sites or tidal channels with predominantly low marsh, or substrate elevations in the tidal range of low marsh. Most problematic would be this type of site surrounded by seed or fragment dispersal sources of invasive cordgrass, particularly Atlantic smooth cordgrass. If post-treatment vegetation management results in a new generation of non-native invasive cordgrass (by seedling establishment), then simply eradicating existing infestations would be pointless. It would be equally self-defeating to manage sites dedicated to tidal marsh restoration as non-tidal ponds or marshes indefinitely simply to preclude re-invasion. Planting treatment sites with native Pacific cordgrass would compound this problem rather than mitigate it, because plantings would interfere with detection of re-invading non-native cordgrass, and would probably generate significant proportions of hybrid invasive seed if surrounding infestations (smooth cordgrass pollen sources) are substantial. Spontaneous recruitment of hybrid cordgrass in treated areas is an important indicator of the effectiveness of regional control. For large treatment sites managed to be restored to native Pacific cordgrass while surrounding infestations persist, post-treatment monitoring and management should be coordinated with targeted reduction/eradication of key seed source populations, subregional suppression of invasive seed production, and scheduling of re-establishment of tidal marsh vegetation.

In practice, it would be difficult to separate tidal marsh management, restoration, monitoring, invasive cordgrass eradication, and post-eradication monitoring and management. It would be even more difficult to achieve success without closely integrating them beginning at early stages of implementation.

First Year (2003) Operations

The Control Program would implement a number of pilot and demonstration projects during the first control season, beginning approximately September 2003. The first year projects would be selected to be consistent with the Control Program's IVM strategy, focusing on preventing spread of non-native cordgrass to uninfested locations, removing cordgrass from newly infested locations, and reducing spread of pollen and seed. First-year projects would also be selected to accomplish a number of other important objectives, including:

1. Determining or demonstrating the effectiveness of specific control methods,
2. Providing assistance to local agencies currently dealing with cordgrass control for flood control or other public agency purposes,
3. Acquiring water quality and fate and transport data for herbicides, and
4. Coordinating with and supporting other important research and monitoring efforts (e.g., song sparrows and invertebrate monitoring).

Certain restoration projects may also be implemented in the first year to help develop a mitigation base for adverse impacts to California clapper rail habitat.

A preliminary list of possible first year project sites includes Pickleweed Park, Corte Madera Creek, and Blackie's Pasture, Marin County; India Basin, San Francisco County; Colma Creek-San Bruno

Marsh and Bayfront Park, San Mateo County; Bair Island, Ravenswood Slough, and Mowry Slough South, Santa Clara County; Alameda Flood Control Channel/Upper Coyote Hills Slough, Oro Loma Marsh, San Lorenzo Creek Mouth, and Emeryville Crescent, Alameda County; Point Pinole, Contra Costa County; and Southampton Marsh, Solano County. Some details regarding each of these sites, including the reasons they were selected, are provided in **Appendix I**. Consideration of most of these sites is in the very early stages, and site-specific plans have not been finalized.

If all potential first year projects were implemented, approximately 60 acres of non-native cord-grass would be treated. However, the Control Program anticipates that only six to ten of the four-teen identified projects may be implemented due to difficulty identifying and coordinating with landowners and partners. Approximately 40% of the first year projects would include manual and mechanical treatment methods, and up to 90% would include some level of herbicide treatment, either in the first year or as follow-up treatment in the next year. Projects not completed this year would be included in the program next year, pending availability of funding.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

This alternative is identical to Alternative 1, with the important exception that herbicides treatment methods would not be used. Without the use of herbicides, it would be necessary to rely entirely on mechanical and manual methods, including mowing, discing/shredding, excavation, and dredging.

Under Alternative 2, in the short term (first year), over 60% of the 60 acres of eradication pro-posed under Alternative 1 (see discussion above) would not occur, because mechanical mowers and dredges are not anticipated to be available in that period. Removal of small outlying patches of invasive cordgrass would still occur using manual techniques, such as digging and smothering.

In the longer term, once equipment is available to treat large expanses of invasives, mowing, disc-ing/shredding, excavation, and dredging would be used on those areas, some or all of which would otherwise be treated with chemicals. Identifying a precise number of acres that would be treated by mechanical methods rather than chemical methods is not possible, because under Alternative 1, the acreage proposed for chemical treatment may decline as newer and more effective mechanical equipment becomes available. In addition, as described under ***Site Specific Selection of Treat-ment Methods****,* on p. 2-15, above, treatment specific treatment methods cannot be determined un-til specific characteristics of each priority site are identified. However, ultimately, it can be as-sumed that, under this alternative, substantially larger areas would need to be treated with me-chanical methods. In addition, because combined treatment with mechanical and chemical meth-ods would not be possible, it would be far more difficult to assure the death of individual plants, resulting in the possible need for repeated mechanical treatment of areas as plants regenerate from roots and rhizomes.

It is unlikely that this alternative would meet all of the goals of the project. In some locations of moderate to heavy infestation the use of mechanical equipment would be infeasible, such as in ar-eas of soft substrate, especially along channel banks or inappropriate such as in areas that support special status species.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Under this alternative, the Conservancy and the Service would not implement a regionally coordinated treatment effort to control invasive cordgrass in the San Francisco Bay Estuary. Local agencies and landowners would continue to implement control measures on their properties. The scope, extent and persistence of these measures is not known, however, for the purposes of this analysis, it is assumed that approximately 100 acres of infested baylands would be treated annually. All treatment methods described in Alternative 1 would be used under this alternative. Mitigation measures are assumed to be similar to those described for Alternative 1 – mitigation measures for biological resources would continue to be required through Endangered Species Act permits. It also is assumed that, after about 10 to 15 years, most local landowners would cease treatment as infestations would become too widespread for control to be effective or worthwhile. The background for this conclusion is presented in Section 3.1.2, *Geomorphology and Hydrology*, under the discussion of the impacts of Alternative 3. At that point in time, the only treatment that would continue would be that necessary to maintain navigational and flood control channels.

Alternative 3 is the CEQA No-Project Alternative and NEPA No-Action Alternative. It is a reasonable scenario of the continuation of the existing policy extended into the future. As such, it forms the basis for comparison of the impacts of approving the proposed project with the impacts of not approving the project. This alternative would not implement a regionally coordinated treatment effort for any non-native cordgrass species at any scale. Local agencies and landowners may continue to implement control measures on their properties; however the scope, extent and persistence of these efforts is not known.

2.3 ALTERNATIVES AND TREATMENT METHODS CONSIDERED AND ELIMINATED FROM FURTHER EVALUATION

Pursuant to NEPA Section 1502.14(a) and CEQA Guidelines Section 15126.6(a) and (b), several alternatives and treatment methods were not carried forward for further analysis.

Treatment on Public Property Only

Under this approach, resources would be directed toward treating non-native cordgrass populations only on public properties that are designated for the protection of habitat and conservation of wetland species and communities. These properties would include the National Wildlife Refuge, wildlife preserves, restored marshes, bird sanctuaries, and some shoreline parklands. This alternative is not carried forward for further analysis in the EIS/R because responsible agencies likely would spend considerable funds and energy treating infestations, yet be unable to control the exponentially escalating input of seed, pollen, and vegetative propagules from neighboring infestations on private lands.

Eradication of Species with Limited Distribution

The goal of this approach would be to eradicate only three of the non-native cordgrass species: Chilean cordgrass, salt-meadow cordgrass, and English cordgrass. These species currently have small population sizes and limited distributions; therefore the likelihood of full eradication is high.

However, This approach would not address the existing and expanding problem of Atlantic smooth cordgrass invading low intertidal mudflat habitats.

Biological Control

The introduction of bio-control agents (e.g., insects or pathogens) to control weedy, non-native vegetation may, in some cases, offer permanent and self-perpetuating control of the invasive species, while minimizinge risk to human health and the environment. In order to be approved for use in natural environments by U.S. EPA, California Department of Fish and Game (CDFG), and United States Department of Agriculture (USDA), bio-control agents must pass rigorous host-specificity tests to determine that damage to non-target species would not occur. In Washington State, the plant-hopper, *Prokelisia marginata*, has been released for the purpose of controlling Atlantic smooth cordgrass populations in Willapa Bay. However, use of this insect species or other bio-control agents to reduced populations of non-native cordgrass have has not been approved for use, or for release in California. Bio-control is not considered by experts to be a practical treatment of non-native cordgrass species in California because it has the high potential to attack genetically similar populations of native Pacific cordgrass. The issues surrounding host-plant specificity are difficult to overcome and are not likely to be resolved in the near future. Therefore, the Control Program would not involve the use of bio-control methods, and these methods are not analyzed further in the EIS/R.

Chemical Methods Only

A chemical-only approach is too rigid to allow for opportunities to minimize environmental impacts in all situations, such as sites where rare or endangered plants, or essential vegetation cover for endangered wildlife, are present within or adjacent to stands of non-native cordgrass. The modified IVM approach allows for adaptive adjustment of treatment methods to site-specific needs of vegetation and plant community structure, wildlife conservation, and other receptors. The need for non-herbicide methods is also indicated for circumstances where treatment occurs directly adjacent to, or even within, residential areas where citizens may object to herbicide use. The potential benefits of herbicide use are fully exploited in the proposed alternative, and are not reduced compared with a "chemical-only" approach. Some potential herbicide impacts and limitations in specific circumstances (examples above) are eliminated with the proposed alternative.

Although chemical methods have been proven effective in controlling populations of non-native *Spartina,* there are substantial public concerns over potential ecological, public health, and safety effects of releasing herbicides and surfactants into the local environment. In addition, there are infestation locations where these chemical methods would not be feasible or appropriate. Therefore, this alternative is not carried forward in this EIS/R.

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3.0 ENVIRONMENTAL SETTING, IMPACTS, AND MITIGATION MEASURES

This chapter describes the environmental setting, analyzes the potential impacts to environmental resources that would occur from the implementation of the alternatives described in Chapter 2, *Program Alternatives*, and identifies feasible mitigation measures to reduce or eliminate impacts.

This is a program-level EIS/EIR intended to provide a general level of detail of the potential effects of regional approaches to invasive cordgrass control. It does not address site-specific control impacts. This document provides general mitigation measures that can be applied to specific treatment sites, as well as an overview of regional impacts and general site-impacts of each alternative. Additional CEQA and NEPA assessments may be required as site-specific invasive cordgrass treatment projects are proposed.

This chapter uses the term "Project" to indicate the "Spartina Control Program." Under CEQA, an EIR analyzes a project and alternatives to the project. Alternatives are intended to reduce one or more of the project's impacts. Under NEPA, "Alternatives" include the project. This EIS/R follows NEPA guidance and regulation, and addresses each alternative in equal depth. However, Alternative 1 constitutes the CEQA "Project", and the other alternatives are intended to reduce some significant impacts compared with Alternative 1.

CEQA and NEPA have different terminologies for setting and impacts. CEQA uses "Setting" to describe existing conditions, while NEPA uses "Affected Environment". CEQA uses "Impacts" to describe the project's adverse or beneficial effects on the environment, while the NEPA terminology is "Environmental Consequences" or "Environmental Effects". This document considers the CEQA and NEPA terms to be broadly synonymous. Therefore, this document considers "Setting" to have the same meaning as "Affected Environment" and "Impacts" to have the same meaning as "Effects" or "Consequences". The terms are used interchangeably in this document. Both CEQA and NEPA use the term "Mitigation" identically.

Analysis of impacts requires comparison of post-project conditions with a baseline condition. CEQA case law is clear that, in most cases, the Setting is the existing, on-the-ground conditions at the time that the draft EIR is prepared. NEPA allows the setting to be either existing on-the-ground conditions or some future baseline without the project. Because of CEQA's strict definition of the "Setting" conditions, this EIS/EIR uses the existing conditions as the baseline. Adverse effects compared to these existing conditions are considered project impacts. Beneficial effects of each alternative also are described to provide the public and decision-makers with information upon which to evaluate the alternatives; these effects are identified in this chapter as "Beneficial Effects."

Future no-project conditions are compared with existing conditions under the No-Action alternative (continuation of existing control efforts and no control efforts). Environmental changes that would result under the No-Action alternative are considered adverse or beneficial impacts.

Baseline and post-project conditions used in this chapter are summarized in **Table 3-1**, below:

Table 3-1: Baseline and Post-project Conditions

	Action Alternatives (Alternatives 1 and 2)	*No-Project Alternative (Alternative 3)*
Baseline	Now (2002 existing conditions)	Now (existing conditions)
Impacts	Change in the Future	Change in the Future
General Types of Impacts		
	Adverse Impacts of Treatment Methods	Adverse Impacts from Treatment Methods (for Alternative 3 only)
	No adverse impacts of Future Spread	Adverse Impacts of Future Spread
	Benefits of Removal of Existing Infestations	No Benefits or Adverse Impacts from Removal of Existing Infestations

3.1 GEOMORPHOLOGY AND HYDROLOGY

This section addresses the hydrologic and landform (geomorphic) conditions and processes that could be affected by the project. In the San Francisco Estuary, cordgrasses and their removal primarily affect the landforms and tidal waters of the intertidal zone and the marshes and flats that are regularly exposed and flooded by the reach of tides. Therefore, this section focuses on those areas. It describes existing and post-project drainage, erosion, sedimentation (accretion), flood control channels, and topography. Secondary effects of hydrologic and geomorphic impacts on biological resources and water quality are addressed in those respective sections of this document.

3.1.1 Environmental Setting

This section describes the tidal hydrology and dominant landforms that comprise the Estuary margins, as well as the primary hydrologic/geomorphic processes.

The Estuarine Intertidal Zone and Cordgrass

Established stands of cordgrass affect the patterns of sediment deposition and erosion, and local rates of sediment deposition, in intertidal environments. Cordgrass roots and below-ground stem networks bind and stabilize sediments, providing resistance to erosion and limiting the mobility of tidal sediment. Emergent tall stems and dense leaf canopies create shelter zones of reduced current velocities and wave energy, filtering and trapping both suspended fine sediment in the water column, and sands transported on the Estuary bottom.

Development of the modern intertidal estuarine environment. The modern San Francisco Estuary formed within a system of "drowned" river valleys – large ancient stream valleys that were flooded by rising sea levels after the last episode of major glaciation. The modern Estuary was preceded by more ancient estuaries in the same location, each deposited during post-glacial rises in sea level, partly overlapping older deposits. Nearly all the sediment near the surface of modern tidal marshes and mudflats was deposited during the last several thousand years, much of it derived from sediment transported by Sacramento-San Joaquin Delta outflows. The modern Estuary formed when the rate of sea level rise slowed enough for delta sediments to accumulate in the lower (downstream) reaches of the estuary in pace with rising sea level, allowing a large intertidal area to emerge as the drowned valley filled again with muds. Sea level has continued to rise slowly for several thousand years, and is currently accelerating.

During the last several thousand years the San Francisco Estuary accumulated large amounts of fine sediment from natural sources, and an additional surge of sediment during the Gold Rush, when vast amounts of hydraulic mining debris from the Sierras were deposited in the Sacramento-San Joaquin river systems, and eventually to the Estuary. Accumulation of sediments in the Estuary was further increased by widespread construction of dikes in the Estuary's marshes, which reduced the capacity of the estuary to flush out deposited sediment, and stimulated expansion of new marshes over former tidal flats. Marsh growth in the shallowest, upper intertidal zones also added much organic matter (peaty material) to sediments in the areas between tidal channels, assisting the marsh in keeping pace with rising sea level. Below the limit of native marsh vegetation, these recent sediment deposits combined to form the extensive unvegetated tidal mudflats that persist in San Francisco and San Pablo Bays.

Estuary sediments. Most of the Estuary's intertidal sediments are fine clays and silts. Sands tend to deposit more locally, such as in deep channels with fast-moving currents, near stream mouths that discharge local sand loads in deltas, or near ancient submerged beach and dune deposits. The prevalence of bay mud (the typical mix of estuarine silt and clay in the Estuary) and wide, open tidal mudflats creates naturally high turbidity in most of the Estuary. The unvegetated intertidal bay surface is mobile, easily eroded and redeposited. When the tidal mudflats are submerged at high tide, winds blowing over wide reaches generate waves, currents, and turbulence that erode the upper few centimeters of the mudflats, and place them in suspension. Much of the eroded sediment redeposits locally, but currents can readily transport fine sediment to quieter environments where it is trapped. Marsh sediments, in contrast, are tightly bound, and are slowly eroded by higher wave energy or tidal energy.

Sediment transport between marsh and mudflat. Vegetated marshes, especially low cordgrass marshes in sheltered areas, are efficient sediment traps. Marshes release their stored sediment back to the bay when they erode, particularly when wave energy from the Bay causes retreat of the marsh edge. Much of the bay edge of tidal marshes (and artificial levees that replaced many of them) are now retreating as low cliffs (scarps) in stiff peaty muds formed by the tidal marsh, returning stored sediment to the bay's tidal flats and subtidal bottom. Although local areas still may accrete marsh and mudflat, the modern estuary as a whole is exporting sediment, and despite its large reserves of mud, it is in a condition of net sediment deficit**.** Mudflats provide the most yielding and mobile reservoirs of mud.

The limit of tidal marsh development in the historic, natural condition of San Francisco Estuary was influenced by the inherent limitation of the native Pacific cordgrass to tolerate wave erosion, to trap sediment, and especially its limited ability to grow at lower elevations in the intertidal zone – roughly confined to elevations above mean sea level, and below mean higher high water. At higher intertidal elevations, pickleweed and associated perennial vegetation forms stiff peaty marsh soils. This characteristic vegetation and soil unit is an essential component of the typically complex, extensive, irregular networks of narrow, steep tidal creeks and pans (pond-like depressions) of the San Francisco Estuary's tidal marshes (Pestrong 1965). Changes in the structure of the vegetation, or the lower limit of its spread over tidal mudflats and channels, and its capacity to trap and bind sediment, therefore has the potential to alter the basic form of San Francisco Bay tidal marshes and tidal creeks.

Infilling of small existing tidal marsh channels. In wave-sheltered sites of the tidal marsh interior, Atlantic smooth cordgrass is likely to establish over most of the middle and upper middle intertidal zone within channels. This has occurred in both small and large tidal channels (sloughs, small tidal creeks, old ditches, dredge lock access channels, and flood control channels) of the Alameda shoreline, especially near the point of initial invasion near the mouth of the Alameda Flood Control Channel. Other examples of this phenomenon are found within Ideal Marsh and Whale's Tail Marsh, Hayward.

High densities of Atlantic smooth cordgrass significantly reduce tidal current and wave velocities, and increase sedimentation and sediment trapping (Gleason *et al.* 1979, Knutson *et al.* 1990). Atlantic smooth cordgrass exceeds Pacific cordgrass significantly in its potential to trap and stabilize sediment (Newcombe *et al.* 1979) and grow at lower intertidal elevations (Josselyn *et al.* 1993). These effects on sediment accretion and stabilization in low-energy tidal creeks are likely to infill them where invasions occur, as observed in older invaded sites. This would be particularly effective at the lowest-energy heads of invaded tidal creeks. Small invaded tidal creeks would gradually merge with the marsh plain, leaving shorter, simplified, less branched tidal creek systems. Upper channel segments that persist after invasion would probably also become narrower, and possibly steeper and deeper as well. Channel morphology in uncolonized portions of remaining larger channels may compensate for reduced capacity by eroding (widening or deepening), if tidal prism (volume of tidal water exchanged per unit area) is conserved. It is also possible that marshes may simply infill and exchange proportionally more tidal prism as sheetflow, or become poorly drained, as do many cordgrass meadows in the southeastern U.S. Overall, either pattern would result in less penetration of the marsh plain by the characteristic small, irregular, branched tidal creeks typical of San Francisco estuary tidal marshes. A more homogeneous topography would be expected. This may approximately replicate the typical tidal marsh topography of Atlantic coastal plain estuaries.

Partial damming or obstruction of tidal channels and water intake structures with cordgrass litter. Luxuriant above-ground biomass production from extensive cordgrass marshes would result in proportionally large seasonal deposition of cordgrass litter (dead stems and leaves floating or cast ashore in large rafts). Massive tidal litter deposits tend to accumulate at sheltered indentations in shorelines (coves, corners), and at the upper ends of tidal sloughs. Small canals leading to water intakes for man-made lagoons, managed diked marshes, or salt ponds would be at high risk for periodic obstruction with large volumes of litter (typical of productive cordgrass marshes of the Atlantic and Gulf U.S. coastlines).

Infilling and narrowing of larger sloughs and flood control channels. Colonization of the intertidal portions of wide tidal channels by Atlantic smooth cordgrass tends to trap abundant sediment and develop wide bands of low marsh in former channel side-slopes. This has occurred along the Alameda Flood Control Channel, a re-engineered tidal slough where the presence of Atlantic smooth cordgrass appears to have accelerated infilling of the channel.

Infilling of existing tidal marsh pans. Because Atlantic smooth cordgrass is able to colonize very poorly drained flats, marshes, and pans, short-form cordgrass stands will expand over the beds of most shallow submerged salt pans. The establishment of surface roughness in the pans will promote sedimentation and stabilization of deposited sediments, raising bed elevations of invaded pans. Pans would undergo gradual transformation to poorly drained short-form cordgrass marsh, or become significantly reduced in size. Some pans with moderate tidal drainage would become pure Atlantic smooth cordgrass marsh. Turbulence and water circulation within larger pans, driven by wind-stress currents and small waves, would be significantly reduced. Standing water within the pan would be essentially stilled except when the marsh surface is submerged by extreme high tides.

Establishment of typical homogeneous Atlantic cordgrass marsh topography in restored tidal marshes. Diked baylands restored to tidal flows initially develop drainage patterns on new mudflats. Drainage patterns of mudflats develop into tidal marsh creeks, and are modified by interactions with vegetation. The early establishment of initially dense, tall-form Atlantic smooth cordgrass would abort the development of complex creek networks, and promote the development of wide marsh plains with short, wide tidal sloughs with relatively few short branch creeks. Pans would be highly unlikely to develop in restored tidal marshes dominated by Atlantic smooth cordgrass. Instead, poorly drained short-form cordgrass plains would mature over decades.

Conversion of dynamic mudflat surfaces to stabilized or accreting cordgrass marsh. Mudflats that currently act as sources of sediment for marsh accretion or sediment nourishment of other mudflats would instead become sediment sinks (sites which trap sediment derived from erosion of other mudflats) once they are colonized by Atlantic smooth cordgrass.

Interference with tidal marsh restoration in designated diked bayland sites (sediment competition). The capacity of mudflats to act as sources of sediment to nourish developing restored tidal marshes in former diked baylands would be reduced. Limited sediments would be spread over larger marsh areas than intended by tidal marsh restoration projects, increasing the competition for sediment among these areas. Interactions of this effect with sea level rise could result in widespread delayed or arrested tidal marsh development at the low marsh (cordgrass) stage.

Conversion of open, dynamic estuarine beaches to vegetated, stabilized relict beach ridges and salt marsh. Estuarine beaches depend on sufficient wave energy to reach the foreshore (the intertidal zone in front of the beach) and the beach itself to maintain the beach. If wave energy is intercepted by dense cordgrass vegetation in the foreshore, sand that is naturally exported to the beach system cannot be resupplied, starving the beach. If sand above ordinary tides is not periodically eroded and redeposited in dynamic storm and calm cycles, it soon develops dense vegetation. Atlantic smooth cordgrass in the San Francisco Estuary has produced dense marshes in what were formerly open beach foreshores, and caused beaches to be engulfed by salt marsh. Marsh-engulfed beaches become immobile, relict beach ridges. This has occurred through the 1990s at several central San Francisco Bay beaches: Crown Beach, Alameda; Roberts Landing sand spit, San Leandro; and southeastern Hunters Point, San Francisco.

3.1.2 Analysis of Potential Effects

Potential effects and mitigation measures are summarized in **Table 3.1-1** and **Table 3.1-2**, respectively.

Significance Criteria

The thresholds for "significance" of impacts to geology and hydrology from implementation of the control alternatives of the San Francisco Estuary are based in part on specific regulatory standards from relevant environmental laws or regional plans, and on interpretation of the general physical context and intensity of changes in currents, waves, circulation, deposition, and erosion within the Estuary.

Other state laws, regulations, and policies and that apply to the geologic and hydrologic conditions in the San Francisco Estuary include the McAteer-Petris Act, San Francisco Bay Conservation and Development Commission's Bay Plan (BCDC Bay Plan), and the Porter-Cologne Act. These laws, regulations, codes, and plans identify the importance of the regional patterns of sediment deposition and erosion within sloughs, tidal flats, and marshes; the conservation or expansion of tidal prism (volume of tidewater exchanged within a given area), patterns of tidal currents, and large-scale fluctuations in gradients of salinity and nutrients within the Estuary, related to tidal currents, and transport of sediment and freshwater discharges. The principal environmental laws pertinent to evaluation of the level of significance to environmental impacts in the San Francisco Estuary are the California Environmental Quality Act (CEQA), which includes significance considerations in Appendix G of its Guidelines, and the federal Clean Water Act (CWA) as implemented via the San Francisco Regional Water Quality Control Board's Basin Plan for San Francisco Bay. The Clean Water Act's section 404(b)(1) guidelines for evaluation of discharges of dredged or fill materials (one incidental aspect of numerous proposed activities considered in this EIR/S) provide specific guidance for evaluating significant impacts to special aquatic sites, including wetlands in Subpart H. These include factors that cause or contribute to "significant degradation of the Waters of the United States," with emphasis on the persistence and permanence of effects. CEQA Guidelines Appendix G Environmental Checklist includes the following applicable criteria of significance:

- Resulting in substantial soil erosion;
- Substantially alter the existing drainage pattern of the site or area…in a manner which would result in substantial erosion or siltation on-or off-site;
- Substantially alter the existing drainage pattern of the site or area or substantially increase the amount of surface runoff in a manner which would result in flooding on- or off-site.

Based on these laws ,regulations, and policies, geomorphic and hydrologic effects are considered "significant" if they cause relatively high magnitude, persistent, or permanent changes in the following factors:

- Changes in the pattern or rate of sediment erosion or accretion;
- Changes in the reach or flow of twice-daily tides in the San Francisco Estuary;
- Changes in local wave climate (prevailing wave energy);
- Changes in prevailing current volumes or velocities, and associated capacity to transport nutrients, water, salts, and sediments; and/or
- Changes in the structure, distribution, or pattern of tidal channels and flats.

Geomorphic predictions (both qualitative and quantitative models) become less accurate and precise over long periods, when assumptions about key variables become uncertain estimates. A 1- to 2-year time frame is short-term, and within the direct experience (field observation and expertise) of most practicing engineers and geomorphologists working in the Estuary. A 10-year time frame is reasonably foreseeable, based on understanding of past changes recorded in bathymetric maps, aerial photographs, and sediment transport studies. This represents the near-term for qualitative, general estimates of ecological and geomorphic conditions in the Estuary. A 50-year time frame is a meaningful long-term point of reference for some of the most important physical and biological processes, which unfold only after many decades, such as sea-level rise and changes in sediment supply. There is, however, substantially greater uncertainty regarding long-term forecasts in physical processes dependent on basic unknown variables such as the future changes in the rate of sea level rise, and sediment fluxes in the Estuary.

The interactions of geomorphic and hydrologic factors with other environmental factors, such as biological resources, recreational uses, water quality, human health and safety, and aesthetics are addressed in those respective sections.

ALTERNATIVE 1: Proposed Action/Proposed Project. Regional Eradication

IMPACT GEO-1: Erosion or deposition of sediment at sites of cordgrass eradication

The degree to which invasive cordgrass removal methods would result in sediment erosion or deposition depends on (1) the general background conditions of sediment deposition and erosion related to the environmental setting; (2) the method of removal; and (3) subsequent interactions with new vegetation following removal.

Removal of invasive Atlantic smooth cordgrass from diked baylands restored to tidal action is unlikely to cause significant net erosion of new sediment if cordgrass and sediment are not mechanically removed (e.g. dredged or excavated). Residual cordgrass dead below-ground root/rhizome networks, left after colonies are killed by methods such as impoundment, repeat mowing, or herbicide treatment, probably would persist long enough to temporarily stabilize most accreted sediment while new (native) vegetation establishes and permanently stabilizes the marsh. This is most likely to occur where Atlantic smooth cordgrass caused enough marsh accretion to reach tidal elevations at which perennial pickleweed readily establishes.

Where sediments are loosened by ripping, discing, excavation, or dredging they would be subject to rapid erosion in chronically high-energy tidal flats, but would probably suffer minor erosion or net topographic changes in most depositional or stable mudflat settings. In no circumstances would invasive cordgrass removal result in chronic, progressive net erosional trends compared with adjacent, uninvaded tidal habitats. Changes in erosional rates and patterns of mudflats caused by removal operations would usually be less than significant, but could be significant in some exposed shores with relatively high wave energy or high background erosion rates.

The long-term reduction in sediment accretion due to treatment is considered a beneficial effect. Increased erosion in tidally restored diked baylands following removal of invasive Atlantic smooth cordgrass would be less than significant.

Tidal creeks invaded by Atlantic smooth cordgrass are naturally subject to relatively concentrated, high velocity tidal currents compared with open marsh surfaces. Tidal creek banks and bed surfaces released from live Atlantic smooth cordgrass cover are likely to scour and erode, but resistance caused by residual below-ground growth is likely to restrict full recovery of pre-invasion tidal creek dimensions. Slow erosion allows time for other native vegetation to stabilize accreted sediment. If tidal creeks are cleared of Atlantic smooth cordgrass by excavation or dredging below the root zone, tidal creek dimensions are more likely to be restored by erosion. If tidal channels are over-excavated (dug below original surfaces), they may instead become temporarily depositional environments until equilibrium dimensions and forms are regenerated in the tidal creek. Tidal creeks typically undergo rapid (one- to three-year) cycles of erosion and accretion during and after major storms, and similar rapid cycles are likely to develop where sediment and vegetation are removed artificially. Erosion and deposition induced in tidal creeks that are greater in magnitude or persistence than that associated with typical storm cycles would be significant. In tidal creeks currently experiencing invasion by Atlantic smooth cordgrass, erosional effects would be beneficial (consistent with environmental objectives of eradication).

Mudflats invaded by Atlantic smooth cordgrass in most cases are relatively exposed to the force of wind-generated waves in the open bay. Here, removal of invasive cordgrass colonies would likely release any sediment deposited above the elevation of adjacent mudflats. Residual dead belowground cordgrass roots and rhizomes would be less effective in resisting wave erosion than tidal currents of small creeks within tidal marsh settings. If invasive cordgrass colonies were removed from mudflats by excavation or dredging below the level of the root zone, broad, shallow depressions would be formed. These broad topographic depressions would likely fill with sediments to approach the elevation of adjacent mudflats in sediment-rich, net depositional settings under moderate to low wave energy conditions. In exceptional cases, where invasive cordgrass colonies established on erosional or chronically high-energy mudflats (e.g. southern Hayward bayfront), depressions left by over excavation would probably persist or enlarge. All mudflats released from cordgrass cover would be restored to near natural levels of sediment mobility within months or years.

High marsh plains (at elevations near Mean Higher High Water) invaded by Chilean or salt-meadow cordgrass are likely to be rapidly recolonized by native dominant plants capable of rapid lateral spread such as saltgrass, jaumea, or pickleweed, which also readily establish from seed. Potential erosional forces are weaker on the higher marsh surface because of relatively infrequent tidal inundation, and cohesive properties of marsh soils with dense, mature root systems or peat accumulation. Impacts in these locations would be less than significant.

MITIGATION GEO-1: In sites of cordgrass removal where unacceptable increases in erosion rates (significantly greater than background levels or threatening the stability of existing infrastructure such as access roads or utility structures) are likely, temporary physical erosion controls shall be established until sediments either consolidate or stabilize naturally. In mudflats, revegetation as a stabilization measure is precluded because it would be infeasible or defeat the purpose of eradication. In some situations natural lag armor materials such as shell fragments (too heavy to be eroded) may be spread over erosion-susceptible surfaces such as excavation scars to increase resistance to further scour. Other standard erosion control methods for terrestrial environments (such as jute netting, silt fences, coir fabric, etc.) would be ineffective and unstable (rapidly removed) in energetic tidal environments, and could cause nuisances or hazards where they are redeposited. For tidal creeks, monitor following removal for return of adequate channel dimensions. If tidal creek banks require revegetation after adequate dimensions are restored by erosion, they shall be replanted with sprigs of native Pacific cordgrass.

IMPACT GEO-2: Erosion or topographic change of marsh and mudflat by vehicles used in eradication

Heavy equipment or vehicles working on marsh or mudflat surfaces are very likely to cause ruts in relatively soft, unconsolidated spots on the marsh, and on nearly all mudflats. For some treatment methods, ruts and visible tracks would be intentional. Ruts and ridges (small mudwaves) are likely to cause a maximum of about 30 to 40 centimeters of topographic relief, creating persistent local depressions that impound water from rainfall or high tides on the marsh plain. Ruts and ridges left on unstable mudflats are likely to revert to adjacent elevations by rapid erosion and deposition. The more sheltered the mudflats, the more persistent changes are likely to be. Heavy equipment working on mats is unlikely to cause erosion or topographic changes in tidal marshes, unless operational failure causes lodging or miring of vehicles and equipment off the mats. If this were to occur, it could be a potentially significant impact.

MITIGATION GEO-2: Unless the treatment method specifically requires it, vehicle travel in the tidal marsh and mudflat shall be minimized. Mats shall be used to distribute the weight of vehicles on marsh surfaces wherever feasible. Sensitive sites, or sites surrounded by sensitive habitat that could be significantly impacted by erosion or sedimentation from overland vehicles shall be accessed by boat providing those access methods have less overall adverse environmental impact.

IMPACT GEO-3: Remobilization of sand in cordgrass-stabilized estuarine beaches

Where Atlantic smooth cordgrass and hybrids are removed from former sand or shell beaches, wave energy and wave-generated currents would rework previously deposited and stabilized sand in the beaches. Longshore transport of sand would resume, allowing erosion and accretion patterns to re-establish new shoreline configurations similar to pre-invasion conditions. During storms, previously stabilized, vegetated beach ridges would develop erosional scarps and washover deposits, as well as typical smooth, unvegetated sand shorelines. During calm periods, seasonal ephemeral beach ridges would redeposit on the shoreward faces of eroded beach ridges. Where only above-ground invasive cordgrass mass has been removed (e.g. herbicide or repeat-cropping methods such as mowing), residual erosion resistance of killed roots and rhizome mats would retard remobilization of beaches. Where invasive cordgrass growth has been removed, net sediment loss to the beach system would occur unless it were replaced by natural or artificial deposition.

In most cases, remobilization of estuarine beaches would be a beneficial effect. However, in some cases, it may be possible for resumed sediment transport to reactivate detrimental erosion that was halted by cordgrass invasion. This could occur along developed or artificially stabilized shorelines where there has been a natural reduction or failure of sediment supply, or excess wave energy.

MITIGATION GEO-3: Resumed erosion at sensitive locations shall be mitigated by one or both of the following shoreline stabilization measures:

- Sand nourishment (artificial placement of suitably textured sand [appropriate grain size for local wave climates]) may be appropriate along relatively low-energy estuarine shorelines. Sand nourishment may be suitable if cordgrass is removed by excavation, leaving extensive temporary erosional scars and deficits in local sand budgets. Excavated cordgrass-infested sand could be stockpiled at upland or non-sensitive diked baylands long enough to desiccate and kill cordgrass rhizomes. When inert, it could be replaced in the foreshore to be made again available for waves to rework.
- Repair or replacement of rock slope protection or other existing erosion protection structures. It should be noted that these measures may result in secondary impacts on biological and other resources that would need to be analyzed in project-specific environmental reviews.

IMPACT GEO-4: Increased demand for sediment disposal and potential spread of invasive cordgrass via sediment disposal

Treatment activities involving large-scale removal of accreted sediments (for example, dredging) will result in the secondary impact of increased demand for disposal of dredge spoils. If these spoils were to be disposed of in bay or ocean dredge material disposal sites, viable invasive cordgrass seeds could be spread throughout the Estuary and to other coastal estuaries. This would be a significant adverse impact of the project.

MITIGATION GEO-4: Sediments dredged or otherwise removed from treatment sites shall be disposed of as prioritized in the Corps of Engineers' 1998 Long Term Management Strategy (LTMS) for Bay dredged material. These sediments shall not be disposed of in dredge disposal sites in the Estuary or offshore where seeds may be dispersed elsewhere in the Estuary or to other coastal estuaries. They shall be disposed of in upland disposal sites or at depths in sites proposed for tidal marsh restoration. If the latter approach is selected, cordgrass-contaminated sediments shall be overlain by at least two feet of sediments that are free of invasive cordgrass seed or other invasive cordgrass matter. Regional strategic coordination between eradication and tidal marsh restoration projects may also allow a synergy among multiple projects involving sediment removal (flood control, eradication) and sediment deposition (tidal marsh restoration in salt ponds).

IMPACT GEO-5: Increased volume and velocity of tidal currents in channels due to the removal of invasive cordgrass

With the elimination of channel friction created by tall, dense stands of Atlantic smooth cordgrass, tidal flows in channels would increase to rates similar to or greater than those that prevailed prior to invasion. Increased flows would also increase the efficiency of tidal drainage from marsh plains adjacent to treated creeks. This impact generally would be beneficial.

Secondary impacts of increased tidal volumes and velocities (erosion) are addressed in Impact GEO-1, above.

Mitigation Measures

None required.

IMPACT GEO-6: Increased depth and turbulence of tidewaters impounded in salt marsh pans

Where Atlantic smooth cordgrass and hybrids are removed from salt marsh pans or similar ponded depressions, elimination of the shelter provided by the foliage and stem canopy would subject the water surface to wind-stress currents and waves. The hydrology of these treated wetland areas would function as shallow ponds rather than shallowly flooded marsh. Residual below-ground biomass and residual accreted sediment in the pan bottom would tend to stabilize the bed and reduce the effect of restored turbulence on turbidity. If pans were excavated to remove invasive cordgrass, they would probably become slightly deeper than in natural conditions or pre-invasion conditions, and would be slow to accrete. Restoration of typical pan conditions would be a beneficial effect on wetland hydrology.

Mitigation Measures

None required.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Impacts under the herbicide-free alternative would be similar to those described previously for Alternative 1, however additional repeated control activities would necessary under this alternative. In addition, this alternative would require a proportionally greater use of methods that would involve substrate disturbance (discing/shredding), excavation or dredging. Substrate disturbing methods would probably be required for eradication of tidal creek infestations in the absence of herbicide use. In some circumstances, methods that kill invasive cordgrass in place may substitute where herbicides would otherwise be most feasible or effective (e.g., smothering, impoundments within the marsh plain or tidally restored diked baylands, and repeat mowing or crushing). To the extent that dredging or other substrate-disturbing treatment methods are substituted for chemical applications, less dead below-ground cordgrass biomass would be left in place to bind sediments and resist or slow erosion rates, and erosion would be increased compared with Alternative 1.

For eradication work on mudflats and low marsh (which is the largest acreage category of the project, due to prevalence of *Spartina alterniflora* hybrids) the direct physical impacts of cordgrass removal are limited by the natural condition of unvegetated, unconsolidated bay mud of tidal flats. Even immediately after mechanical treatments such as tillage (discing) or excavation, substrate conditions would be consistent with the natural (though not pre-project) condition of unvegetated, unconsolidated mud. In context of naturally unvegetated conditions of mudflats, the intensity of this geomorphic impact would be insignificant. Most of the direct impacts would be biological (ecological) rather than physical. In the regulatory context of CEQA and NEPA, however, the reference condition is the existing invasion by non-native vegetation, not natural conditions. The most important indirect physical impacts of repeated mechanical treatment are likely to occur by access of equipment through the high and middle marsh zones. Here, too, ecological impacts (destruction of vegetation important to wildlife habitat) are relatively more important than purely physical effects. Even so, the incremental increase in damage to the marsh decreases after the first few passes of equipment, when most of the vegetation damage occurs. Prolonging the damage by repetition, rather than increasing its magnitude within an area, is a greater risk. Note also that some physical control methods, such as flooding/drowning, covering, and mowing, have minimal impacts to substrate, and long-term hydrologic impacts similar to any other method removing vegetation that provides bottom roughness (friction against water flow).

Mitigation Measures

Mitigations GEO-1 through GEO-4 would reduce this impact to less than significant levels.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Some of the ongoing and potential future effects of non-native cordgrass invasion are in early stages of development. Others are likely to develop only over many years or decades, and must be inferred by indirect evidence, comparison with analogous estuarine systems, and projected trends of current conditions.

The intertidal landforms of the San Francisco Estuary are currently being altered in areas where invasive cordgrasses have established. Most of the effects are due to Atlantic smooth cordgrass and its hybrids, which establish extensive colonies in the mudflats and channels (low marsh zone) of the Estuary. Atlantic smooth cordgrass is a potent geomorphic agent, and is widely used by coastal engineers to stabilize shorelines, increase local sedimentation, and other estuarine sediment deposits (Woodhouse 1979, Knutson and Inskeep 1982). Other invasive non-native cordgrasses of the low marsh, such as English cordgrass have potential to behave similarly. In contrast, invasive non-native cordgrasses of the higher marsh plain in the San Francisco Estuary, Chilean cordgrass and salt-meadow cordgrass, are likely to have more subtle effects on geomorphology and hydrology, because they have less direct exposure and interaction with tidal flows and sediments. Most of the following discussion focuses on the effects of the Atlantic smooth cordgrass hybrids.

Atlantic smooth cordgrass in its native salt marsh habitats can tolerate sediment accretion up to about 30 centimeters (one foot) per year (Zaremba 1982), and naturally establishes in estuarine “wave climates” (prevailing wave energy of a shoreline) far greater than those that support Pacific cordgrass (Newcombe *et al.* 1979). It is capable of stabilizing shorelines too exposed to support Pacific cordgrass (Knutson *et al.* 1982, Knutson and Woodhouse 1983). Its capacity to invade bare, poorly drained flats and pans (Bertness and Ellison 1987), and cover them with extensive stands of its mature “short form” is associated with the marked scarcity of the depressional tidal pools (salt pans) and lack of extensive, fine-scale tidal creek networks in the vast tidal marshes of the Atlantic coastal plain (Dame *et al.* 2000, Frey and Basan 1978). The relatively homogeneous salt marsh plains formed by Atlantic smooth cordgrass in most of its native range contrast with the complex tidal marsh topography (high density of sinuous creeks and pans) that is characteristic of San Francisco Estuary tidal marshes (Pestrong 1965).

In the Pacific Northwest (Willapa Bay), invasive Atlantic smooth cordgrass has progressively converted thousands of acres of tidal mudflat to single-species marsh plains, immobilizing underlying sediment, and increasing sedimentation rates within the areas it occupies. Rates of sedimentation under Atlantic smooth cordgrass depend in part on the local depositional environment (sediment supply, rates of transport), and cannot be generalized between regions, or even within tidal marsh systems. The capacity for a stand of Atlantic smooth cordgrass to increase sedimentation rate is also a function of stem density (number of stems per unit area) (Gleason, *et al.* 1979), which also corresponds with the density of the leaf canopy. The canopy height of Atlantic smooth cordgrass also is an important factor in damping wave energy and slowing currents, especially during higher tides.

On the basis of long-term development of Atlantic smooth cordgrass marshes in other estuaries, as described above, and actual observations of the early stages of the invasion in the San Francisco Estuary to date, the following geomorphic effects of this species' invasion are likely to increase as the invasion progresses.

Short-term impacts of this alternative would be similar to those described for the treatment methods for Alternative 1, however these impacts would be less widespread due to the anticipated smaller areas to be treated under this alternative.

This alternative assumes that the effectiveness of regionally uncoordinated, individual projects would be outpaced and overwhelmed by non-native cordgrass invasions within about a decade, allowing rates of spread to occur that do not effectively differ from a complete absence of eradication efforts in the region as a whole. In the short term, treatment impacts would be similar to those described above for Alternative 1. In the long term, about a decade, the invasion of non-native cordgrasses is expected to outpace control efforts to the extent that invasive cordgrass removal would be limited to that necessary to maintain essential flood control and navigational channels. Therefore, in the long-term, except for necessary flood control and navigational channel clearing, increased erosion at or near sites of cordgrass invasions would not occur as invasive cordgrass colonies coalesce to continuous marsh that resists erosion and promotes local deposition of sediment.

Evaluation of long-term effects of this alternative on tidal marshes requires long-range "forecasts" of marsh maturation. Reasonably reliable and realistic general, qualitative predictions about tidal marsh maturation can be made by geographic comparisons of observed long-term development of tidal marshes in other regions that have ecologically equivalent, or identical, major plant species as the San Francisco Estuary. Observations and scientific investigations of salt marshes influenced or dominated by the species of cordgrasses that are not native to the San Francisco Estuary provide guidance, but not certain knowledge, of the likely results of their spread in this region. Based on these observations and investigations, likely future scenarios of cordgrass invasion are variable and can best be viewed as alternative scenarios more or less likely to occur in the San Francisco Estuary.

The most optimistic scenario is one under which species that have been relatively slow to spread from established sites will continue to be poor long-distance invaders. Under this scenario, the most invasive species, such as Atlantic smooth cordgrass and its hybrids would become less "virulent" and aggressive over time as marshes mature, gradually dying out as marshes accrete, and becoming more intermediate with native cordgrass as the two species hybridize increasingly. This scenario is similar to the British salt marsh experience with English cordgrass where, after a century of invasion, dieback occurred spontaneously in some accreted marshes, and native salt marsh vegetation (but not the original mudflats) established.

There is little evidence that Atlantic smooth cordgrass is likely to behave in this way. In its native range, it is replaced in accreted northeastern Atlantic high salt marshes only by saltmeadow cordgrass, which itself is an invasive species in the San Francisco Estuary. In southeastern Atlantic salt marshes, smooth cordgrass dominates high marsh plains with its short form. Nowhere in its native range does perennial pickleweed (a minor associated species) replace it as dominant salt-marsh vegetation. Investigations of hybrid cordgrasses in San Francisco Bay do not support the hypothesis that natural selection is favoring the evolution of less invasive, slower-growing, native Pacific cordgrass-like hybrid intermediates. On the contrary, there appears to be a competitive advantage to more robust, smooth cordgrass--like hybrid forms. Thus, the optimistic scenario cannot be ruled out, but appears relatively unlikely.

Another relatively optimistic scenario would be that the invasive cordgrass species in this region can be confined to the San Francisco Estuary, and controlled by long-term maintenance (weeding) of existing infested marshes, short of regional eradication. Globally, there are no examples of benign naturalization of aggressively invasive cordgrasses, and no examples of stable long-term confinement. Efficient reproduction of cordgrasses in receptive habitats sustains a high potential for eruptive population spread.

A less optimistic, and more likely, scenario is that Atlantic smooth cordgrass progressively dominates the San Francisco estuary. Under this scenario, there is still much uncertainty about the likely future structure of intertidal habitats. If sea level rise continues to accelerate, while sediment supplies become more deficient, extensive low marsh cordgrass meadows with ample tidal drainage may form, and this would tend to favor tall forms of Atlantic smooth cordgrass. If sedimentation in the San Francisco Estuary is able to keep pace with sea level rise, there is a greater chance that higher marsh plains, with defined drainage patterns, may form. This would increase the risk that smooth cordgrass would behave as it does in the southeastern Atlantic salt marshes, where it forms extensive single-species stands of stunted, short-form cordgrass marsh, and limits the development of small tidal creeks and pans (features typical of Pacific and northeastern Atlantic high salt marsh).

Although all of the scenarios described above are possible, this last scenario is considered the most likely scenario and represents a "reasonable worst case". Under this scenario, it is reasonable to assume that pervasive or complete invasion would occur within a century, based on the history of other coastal non-native plant invasions in California and elsewhere (Cronk and Fuller 1995, Bossard *et al.* 2000). Overwhelming rates of spread by the hybrids would probably cause the extinction (or effective extinction) of *native* Pacific cordgrass in the San Francisco Estuary within a century after collapse of regional eradication. Individual eradication projects, such as selective removal of invasive cordgrass in individual marsh restoration sites or flood control channels, would have to accelerate maintenance schedules as invasion pressures (frequency of new colonies from dispersed seed) increase at an accelerating pace. Selective removal of non-native cordgrass at restoration sites would probably cease when monitoring confirms that no native cordgrass is recruited, and all spontaneous recruits are invasive species, even when natives are planted. Eradication for flood control purposes, however, may continue locally in perpetuity.

In the long term, increased sediment accretion, reduction in efficiency of tidal drainage, and reduced current velocities in channels would be likely, and would increase in magnitude and distribution over time. Shallow ponds would likely be converted to poorly drained marsh plain. Restored tidal marshes in formerly diked baylands would develop marsh topography similar to the salt marshes of the Atlantic coastal plain, forming relatively undifferentiated vegetated marsh plains. Rates of sediment supply to tidal marshes restored behind dikes may be constrained by the stabilization of mudflat sediment sources by invasive cordgrass, which would also intercept and trap significant volumes of potentially available tidal sediment. Most salt marsh pans would be assimilated into the marsh plain, and would not persist as distinct ponded features.

Mitigation Measures

Other than Alternatives 1 and 2, there are no feasible mitigation measures for these impacts of the spread of invasive cordgrasses.

Table 3.1-1: Summary of Potential Hydrologic and Geomorphic Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
GEO-1: Erosion or deposition of sediment at sites of cordgrass eradication.	All Alternatives: Minor erosion and sedimentation.	All Alternatives: Potentially significant erosion.	All Alternatives: Minor erosion potential.	All Alternatives: Potentially significant erosion from diking activities.	All Alternatives: Minimal erosion potential.	All Alternatives: Minor erosion potential.	Alternatives 1, 2: Beneficial effect on sediment transport in tidal creeks, mudflats, marshes, and channels.
GEO-2: Erosion or topographic change of marsh and mudflat by vehicles used in eradication.	All Alternatives: Minor impact from access.	All Alternatives: Potentially significant microtopographic changes and erosion from use of vehicles in marshes.	All Alternatives: Minor impact from access.	All Alternatives: Potentially significant topographic changes from diking activities.	All Alternatives: Minor impact from access.	All Alternatives: Minor impact from access.	N/A
GEO-3: Remobilization of sand in cordgrass-stabilized estuarine beaches.	All Alternatives: Minor increased beach erosion and sedimentation.	All Alternatives: Potentially significant erosion.	All Alternatives: No impact.	All Alternatives: Potentially significant beach erosion.	All Alternatives: Potentially significant beach erosion.	All Alternatives: Potentially significant beach erosion.	Alternatives 1,2: Long-term benefit of establishment of beaches. Alternative 3: Short-term benefit to beach restoration, no long-term benefit.

Table 3.1-1: Summary of Potential Hydrologic and Geomorphic Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
GEO-4: Increased demand for sediment disposal and potential spread of invasive cordgrass via sediment disposal.	All Alternatives: No impact.	All Alternatives: Potentially significant impacts related to disposal of dredged sediments and inadvertent dispersal of invasive cordgrass via disposed sediments.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.
GEO-5: Increased volume and velocity of tidal currents in channels due to the remoal of invasive cordgrass.	All Alternatives: Minor impact from localized clearing.	All Alternatives: Potential increase in erosion from increased tidal velocities/currents.	All Alternatives: No impact.	All Alternatives: Potential increase in erosion from increased tidal velocities/currents.	All Alternatives: Potential increase in erosion from increased tidal velocities/ currents.	All Alternatives: Potential increase in erosion from increased tidal velocities/currents.	All Alternatives: Beneficial effect on tidal channel and creek flows.
GEO-6: Increased depth and turbulence of tidewaters impounded in salt marsh pans.	All Alternatives: No adverse impacts. .	All Alternatives: No adverse impacts.	All Alternatives: No adverse impacts.	All Alternatives: No adverse impacts.	All Alternatives: No adverse impacts.	All Alternatives: No adverse impacts.	Alternatives 1, 2: Permanent beneficial effect. Alternative 3: Temporary beneficial effect.

Table 3.1-2: Summary of Mitigation Measures for Hydrology and Geomorphology

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
Mitigation GEO-1: Erosion or deposition of sediment. In sites of cordgrass removal where unacceptable increases in erosion rates (significantly greater than background levels or threatening the stability of existing infrastructure such as access roads or utility structures) are likely, temporary physical erosion controls shall be established until sediments either consolidate or stabilize naturally.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Mitigation GEO-2: Erosion or topographic change by vehicles used in eradication. Vehicle travel in the tidal marsh and mudflat shall be minimized. Mats shall be used to distribute the weight of vehicles on marsh surfaces wherever feasible. Sensitive sites that could be significantly impacted by erosion or sedimentation from overland vehicles shall be accessed by boat.	Not Applicable	Applicable	Not applicable	Not Applicable	Applicable	Applicable
Mitigation GEO-3: Remobilization of sand. Resumed erosion at sensitive locations shall be mitigated by sand nourishment or repair or replacement of existing rock slope protection or existing erosion control structure.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Mitigation GEO-4: Sediment disposal. Sediments dredged from treatment sites shall be disposed of as prioritized in the Long Term Management Strategy for Bay dredged material. These sediments shall not be disposed of in dredge disposal sites in the Estuary or offshore where seeds may be dispersed elsewhere in the Estuary or to other coastal estuaries. They shall be disposed of in upland disposal sites or at depths in sites proposed for tidal marsh restoration.	Not Applicable	Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Note: There may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

3.2 WATER QUALITY

Water quality of the San Francisco Estuary, including the Bay and the surrounding flats and tidal marsh may be affected directly and indirectly by implementation of the *Spartina* Control Program. This section describes potential impacts, and defines mitigation measures that will reduce the impacts to water quality to less than significant levels.

3.2.1 Environmental Setting

This section describes existing water quality in the San Francisco Estuary and processes affecting it, and outlines the regulatory framework under which water quality is protected. Potential effects of treatment methods on water quality are evaluated, and mitigation measures are identified for potentially significant effects. The region of influence for impacts to water quality includes the tidal flats and marshes where treatment will occur, and the shallow tidal waters immediately adjacent to these areas.

Natural Processes Affecting Water Quality

Water quality within the San Francisco Estuary is connected to and affected by complex regional and local natural processes. Hydrologic relationships between the Pacific Ocean, the Estuary, and the many freshwater tributaries (including the Sacramento-San Joaquin River system) govern salinity levels in different portions of the Estuary and along the Bay margins. Variable natural factors such as tidal cycles, local winds, basin bathymetry, and salinity gradients interact with river flows and affect the circulation of Estuary waters through channels, Estuary margins, and bays, distributing nutrients, salt concentrations, and pollutants. Major processes affecting water quality are described below.

Tidal Cycles. The Estuary has two low tides and two high tides every 24.8 hours. During each tidal cycle, an average of about 1.3 million acre-feet of water, or 24 percent of the Bay and Delta's volume, moves in and out of the Golden Gate. On the flood (incoming) tide, ocean water moves through the Golden Gate and into the Estuary's southern and northern reaches, raising the water level at the end of the South Bay by more than eight feet, and raising the height of the Sacramento River at the upstream edge of the Estuary by about three feet. It takes about two hours for the flood tide to reach the end of the South Bay and eight hours to reach Sacramento.

Subregional Conditions. Suisun and North Bay subregions (see **Figure 2-1**) receive the majority of freshwater input from the Sacramento and San Joaquin River system. In the open bays, density-driven currents show ebb dominance of the surface water and flood dominance of the bottom water. Waters in these embayments are well oxygenated, with low- to moderate-salinity and high-suspended solids concentrations. Water residence time affects the abundance and distribution of many estuarine organisms, the amount of primary production by phytoplankton, and some of the chemical and physical processes that influence the distribution and fate of pollutants. During low flow periods of the year (late summer), the residence time of freshwater moving from the Delta to the ocean can be relatively long (on the order of months) compared to periods when outflow is very high (winter), when freshwater can move from the Delta to the ocean in days.

The Central Bay subregion is influenced by ocean waters that are cold, saline, and lower in total suspended sediment. Water quality parameters fluctuate less than in other sectors of the Bay due to the predominance of ocean water. Net exchanges of ocean and Bay waters depend on freshwater flow in the Bay, tidal amplitude, and longshore coastal currents.

The southern part of San Francisco Bay receives less than 10 percent of the natural freshwater flow into the Bay, but the majority (>75 percent) of wastewater discharges. The largest flow is from San Jose, where approximately 120 million gallons per day (MGD) of treated wastewater are released into Artesian Slough, a tributary to Coyote Creek (**Figure 3.2-1**). This fresh water flow creates a local zone of brackish water in the otherwise saline tip if the South Bay. The rest of the South Bay, because it has so little freshwater input, is essentially a tidal lagoon with a relatively constant salinity (approximately the same as ocean water, 32 parts per thousand, ppt). South Bay waters are influenced by Delta outflow only during the winter months, when low-salinity water moves southward into the southern reach displacing the saline, denser water northward. In the summer months, however, South Bay currents are largely influenced by wind stress on the surface; northwest winds transport water in the direction of the wind, and the displaced water causes subsurface currents to flow in the opposite direction.

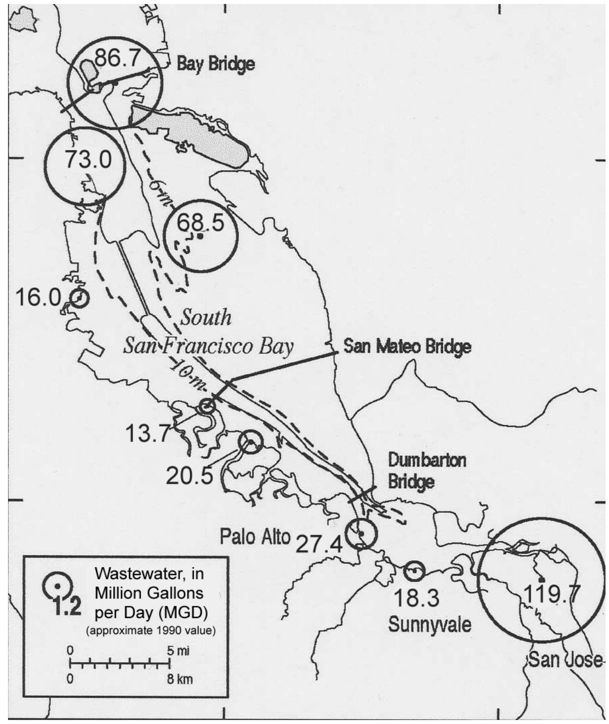

Figure 3.2-1. Locations and mean discharges for municipal wastewater treatment plants in South San Francisco Bay. Adapted from Schemel et al. 1999, based on Davis et al. 1991.

Currents and Circulation. Circulation patterns within the Bay are influenced by Delta inflows, gravitational currents, and tide- and wind-induced horizontal circulation. The cumulative effects of the latter three factors on net circulation within embayments tend to dominate over that of freshwater inflows except during short periods after large storm events (Smith 1987). Exchanges between embayments are influenced both by mixing patterns within embayments and by the magnitude of freshwater inflows (Smith 1987).

Currents created by tides, freshwater inflows, and winds cause erosion and transport of sediments. Tidal currents are usually the dominant form of observed currents in the Bay. Tidal currents are stronger in the channels and weaker in the shallows (Cheng and Gartner 1984). These processes enhance exchange between shallows and channels during the tidal cycle, and contribute significantly to landward mixing of ocean water and seaward mixing of river water. Also, the South Bay begins flooding while San Pablo Bay is still ebbing, making it possible for the South Bay to receive water from the northern reach (Smith 1987).

Tides have a significant influence on sediment resuspension during the more energetic spring tide when sediment concentrations naturally increase, and particularly during the ebbs preceding lower low water when the current speeds are highest (Cheng and McDonald 1994). Powell *et al.* (1989), however, observed no correlation between tidal cycle and suspended sediment loads or distribution in the South Bay. Their conclusion was that winds are the most important factor in resuspending sediments in the South Bay, and that sources of sediments are more important than transport of sediment resuspended from other parts of the Bay (Reilly *et al.* 1992).

Wind-induced currents have a significant effect on sediment transport by resuspending sediments in shallow waters (Krone 1979; Cloern *et al.* 1989). An estimated 100 to 286 million cubic yards of sediments are resuspended annually from shallow areas of the Bay by wind-generated waves (Krone 1974; SFEP 1992b).

Water Quality

Water quality in the San Francisco Estuary has improved significantly since the enactment of the California Water Quality Control Act (Porter-Cologne) in 1969 and the Clean Water Act in 1972. Nevertheless, the Estuary waters still carry significant loads of pollutants from human sources. Under Section 303(d) of the Clean Water Act, states were required to develop a list of water bodies that do not meet water quality standards; this list is referred to as the "303(d) list." This list defines low, medium, and high priority pollutants that require immediate attention by State and Federal agencies. Portions of the Estuary have high-priority 303(d) listings for a number of pollutants, including dioxin compounds, furan compounds, PCBs, mercury, copper, nickel, and exotic (plant and animal) species.

The most comprehensive information describing water quality in the Estuary comes from the Regional Monitoring Program managed by the San Francisco Estuary Institute (SFEI) and ongoing studies by the Interagency Ecological Program (IEP). In addition, numerous short-term studies that focus on specific sites, resources, or pollutants are conducted on a regular basis by researchers and entities conducting permit-specified monitoring of waste discharges. The primary water quality parameters discussed below are: temperature, salinity, dissolved oxygen (DO), pH, total suspended solids (TSS), turbidity, and pollutants.

Temperature. Water temperatures in the Estuary range from approximately 10°C to 22°C (50°F to 71.6°F). Temperatures are influenced by seasonal solar cycles and variable inputs of river and coastal ocean waters. Temperatures are typically at the higher end of this range along the Estuary margin during daylight hours as the influence of solar energy warms the water.

Salinity. The salinity of the Estuary varies spatially and temporally. Along the northern reach the salinity increases from the Delta to the Central Bay. At the mouth of the Sacramento River, for example, the mean annual salinity averages slightly less than 2 ppt; in Suisun Bay it averages about 7 ppt; and at the Presidio in Central Bay it averages about 30 ppt. In the South Bay, salinities remain at near-ocean concentrations (32 ppt) during much of the year, except in the vicinity of the San Jose wastewater outfall at Artesian Slough, where salinities are lessoned. During summer months in dry years, high evaporation rates may cause salinity in South Bay to exceed that of ocean water.

Seasonal changes in the salinity distribution within the Estuary are controlled mainly by the exchange of ocean and Estuary water, and by river inflow. River inflow has the greater influence on salinity distribution throughout most of the Estuary because inflow varies widely, while variations in ocean inputs are relatively small. In winter, high flows of freshwater from the Delta lower the salinity throughout the Estuary's northern reach. High Delta flows also intrude into South Bay, lowering salinity there for extended periods. In contrast, during the summer, when freshwater inflow is low, saline water from the Bay intrudes into the Delta. The inland limit of salinity intrusion varies greatly from year to year. In addition, channel dredging can increase gravitational circulation and enhance salinity intrusion (Nichols and Pamatmat 1988).

Dissolved Oxygen. Oxygen concentrations in estuarine waters are increased by the mixing action of wind, waves, and tides; photosynthesis of phytoplankton and other aquatic plants; and high DO in freshwater inflow. DO concentrations are lowered by plant and animal respiration, chemical oxidation, and bacterial decomposition of organic matter.

The Estuary's waters are generally well oxygenated, except during summer in the extreme southern end of the South Bay where concentrations are reduced by poor tidal mixing and high water temperature. Typical concentrations of DO range from 9 to 10 milligrams per liter (mg/l) throughout the Estuary during periods of high river flow, 7 to 9 mg/l during moderate river flow, and 6 to 9 mg/l during the late summer months when flows are the lowest. Unlike the 1950s and 1960s, when inadequately treated sewage and processing plant wastes depleted oxygen in parts of the Bay and Delta, today there are few reports of places in the Estuary where low oxygen concentrations adversely affect beneficial uses. Today, the lowest concentrations in the Estuary are typically observed in the extreme South Bay but, in some instances, DO levels in semi-enclosed embayments such as Richardson Bay can be much lower than in the main water body (SFEI 1994).

pH. The pH of the water in San Francisco Bay is relatively constant and typically ranges from 7.8 to 8.2[1].

Total Suspended Solids (TSS) and Turbidity. Turbidity and TSS are generally used as measures of the quantity of suspended particles. The distinction between the two terms lies mainly in the method of measurement. In general, higher TSS results in more turbid water.

Regions of maximum suspended solids occur in the North Bay in the null zone[2] (generally 50 to 200 mg/l, but as high as 600 mg/l TSS). The specific location of the null zone changes depending upon freshwater discharge from the Delta. TSS levels in the Estuary vary greatly depending on the season, ranging from 200 mg/l in the winter to 50 mg/l in the summer (Nichols and Pamatmat 1988; Buchanan and Schoellhamer 1995). TSS also varies with tidal stage and depth (Buchanan and Schoellhamer 1995). Shallow areas and channels adjacent to shallow areas have the highest suspended sediment concentrations. The Central Bay generally has the lowest TSS concentrations; however, wind-driven wave action and tidal currents, as well as dredged material disposal and sand mining operations cause elevations in suspended solids concentrations throughout the water column.

Pollutants. Pollutant loading to San Francisco Bay has long been recognized as one of many factors that has historically stressed aquatic resources. Pollutants enter the aquatic system through atmospheric deposition, runoff from agricultural and urbanized land, and direct discharge of waste to sewers and from industrial activity.

The Bay's sediment can be both a source and a sink for pollutants in the overlying water column. The overall influx of pollutants from the surrounding land and waste discharges can cause increases in sediment pollutant levels. Natural resuspension processes, biological processes, other mechanical disturbances, dredging, and sediment disposal can remobilize particulate-bound pollutants.

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[1] Water or solutions that are acidic have a pH of less than 7.0, and basic or alkaline water have a pH greater than 7.0. A pH of 7.0 is considered neutral.

[2] The null zone is area or region of an estuary where the bottom, high-density and surface, low-density currents have equal and opposite effects. It is defined as the zone where the mean near-bottom speed is zero. The actual location of the null zone migrates in response to changes in river discharge. It is important because it is typically characterized by high concentrations of suspended particulate matter and rapid sediment accumulation.

Table 3.2-1. Dissolved Concentrations of Trace Metals in Water Samples (SFEI 1998)

	Ag µg/L	As µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Hg µg/L	Ni µg/L	Pb µg/L	Se µg/L	Zn µg/L
Minimum	0.0002	0.83	0.003	0.09	0.37	0.0003	0.56	0.002	ND	0.07
Maximum	0.006	4.8	0.09	3.8	3.5	0.015	7.2	0.40	6.1	22.5
WQ Criteria 1-hour	1.9	69	42	1100	5		74	210		90
WQ Criteria 4-day		36	9.3	50	3.1		8.2	8.1		81

ND – Not detectable at laboratory limits

Metals. Ten trace metals in the aquatic system and in waste discharged to the Bay are monitored on a regular basis. Total and dissolved fractions are sampled three times a year at Regional Monitoring Program (RMP) stations throughout the Estuary. **Tables 3.2-1** and **3.2-2** present dissolved and total trace metal concentration ranges in Bay waters during 1998 (SFEI 1998).

Organic Pollutants. Three general types of trace organic contaminants, polycylic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides, are measured in San Francisco Bay water on a regular basis.

Water column concentrations of dissolved and total PAHs in 1998 ranged from 2.1 to 46 parts per trillion (pptr) and from 20 to 300 pptr, respectively (SFEI 1998). Total PCB concentrations in Bay waters during 1998 ranged from 70 to 7,000 parts per quadrillion (ppq), and were below the U.S. Environmental Protection Agency (U.S. EPA) 4-day (chronic toxicity) water quality criteria (30 pptr) (SFEI 1998). Dissolved PCB concentrations ranged from 12 to 930 ppq. Bay waters also contained measurable concentrations of chlorinated pesticides, including chlordanes and DDTs. Total chlordane concentrations ranged from 21 to 5,700 ppq, while total DDT concentrations ranged from 190 to 9,900 ppq (SFEI 1998).

A recent review of historical data from several sources found several previously unidentified organic contaminants in the San Francisco Estuary (SFEI 2002). In this study, p-nonylphenol, a common constituent in detergents and other household products, agricultural surfactants, and many industrial products, was identified in Sacramento and San Joaquin River water (at 19 ng/L and 5 ng/L, respectively), but it was not detected in Estuary water.

Sediment Quality

Sediment quality in the Estuary varies greatly according to the physical characteristics of the sediment, proximity to historical waste discharges, the physical and chemical condition of the sediment, and sediment dynamics that change with location and season. Generally, the level of sediment contamination at a given location will vary depending on the rate of sediment deposition, which varies with seasons and tides (Luoma *et al.* 1990). Chemical contaminant dynamics in an estuary are closely associated with the behavior of suspended and deposited sediments. The physical and chemical characteristics of sediments, and the bioavailability and toxicity of sediment-associated chemicals to aquatic organisms, are particularly important in determining their potential impact on environmental quality.

While pollutant loading to the Estuary from point and non-point sources has declined dramatically over the past two decades, and surface sediment contamination may be declining from historical highs, Bay sediments are still an important source and sink of pollutants. Much of the data documenting concentrations of trace metals and organics in Bay sediments are found in the historical summary of Long and Markel (1992) and in the more recent monitoring efforts by the State's Bay Protection and Toxic Cleanup Program (BPTCP) (SFBRWQCB 1994) and Regional Monitoring Program (SFEI 1994 and 1998).

Concentrations of Metals and Organic Pollutants in Sediments. Mean concentrations of trace metals and organics in sediments vary according to grain size, organic carbon content, and seasonal changes associated with riverine flow, flushing, sediment dynamics, and anthropogenic inputs. Anthropogenic inputs appear to have the greatest effect on sediment levels of copper, silver, cadmium, and zinc, as well as several chlorinated and petroleum hydrocarbons (SFBRWQCB 1994). Ranges in sediment metals and trace organic concentrations during 1998 are listed in **Table 3.2-3**. The table also compares measured concentrations to effects range-low (ER-L) and effects range-

Table 3.2-3. Ranges of Trace Pollutants in San Francisco Bay Sediments (SFEI 1998)

	Sediment Samples (mg/kg)		Effects Levels (mg/kg)	
	Minimum	*Maximum*	*ER-L*	*ER-M*
Arsenic	3.1	**19**	8.2	70
Cadmium	0.1	**2.1**	1.2	9.6
Chromium	63	**216**	81	370
Total Chlordanes	ND	**0.0099**	0.0005	0.006

Key: Concentrations bolded exceed the Lowest Observable Effects Level (ER-L)
Concentrations bolded and underlined exceed the Median Observable Effects Level (ER-M)
ND – Not detectable at laboratory limits

Table 3.2-2. Total Concentrations of Trace Metals in Water Samples (SFEI 1998)

	Ag µg/L	*As* µg/L	*Cd* µg/L	*Cr* µg/L	*Cu* µg/L	*Hg* µg/L	*Ni* µg/L	*Pb* µg/L	*Se* µg/L	*Zn* µg/L
Minimum	0.002	ND	0.009	0.29	0.42	0.0006	0.63	0.05	ND	0.77
Maximum	0.20	9.4	0.36	101	20	0.73	49.0	15.8	6.8	98.6
WQ Criteria 1-hour	2.3	69	43	1100		2.1		140		58
WQ Criteria 4-day		36	9.3	50		0.025	7.1	5.6		

ND – Not detectable at laboratory limits median (ER-M) values, which are levels that are rarely associated with adverse effects to benthic organisms from exposures to sediment-associated contaminants and levels that are frequently associated with adverse impacts, respectively (Long *et al.*, 1995). For most pollutants, ranges in measured concentrations exceed the respective ER-L values but are below the corresponding ER-M values. The exceptions are mercury, nickel, total PCBs, and total chlordanes, which exceed the ER-M values at one or more locations in the Bay. Some sites within San Francisco Bay, such as Lauritzen Canal, the Port of Oakland near San Leandro Bay, and Richmond Harbor, which have been greatly affected by historical contamination, contain sediment pollutant levels which are considerably higher than those measured by the Regional Monitoring Program.

3.2.3 Analysis of Potential Effects

Significance Criteria

The San Francisco Bay Area Regional Water Quality Control Board and the Central Valley Regional Water Quality Control Board (Water Boards) are the primary agencies responsible for protecting water quality in natural waters ("waters of the State"). The Water Boards' Basin Plans[3] designate beneficial uses for each water body (including wetlands and marshes) in the San Francisco Bay and Sacramento Regions (**Table 3.2-4**), and set water quality objectives to protect the present and potential beneficial uses. In addition, the Basin Plans identify a number of numerical and narrative objectives for surface waters that apply to all waters within the Regions. The surface water objectives include goals for a wide range of factors, including DO, pH, sediment, toxicity, and biota population and community ecology. The Basin Plan includes an implementation plan for achieving the water quality objectives for each of the Regions' water bodies. The designated bene-

Table 3.2-4. Beneficial Uses of Waters of the San Francisco Estuary as Defined by the San Francisco Bay Area Regional Water Quality Control Board

	Central San Francisco Bay	*Lower San Francisco Bay*	*South San Francisco Bay*	*San Pablo Bay*	*Suisun Bay*
Industrial Service Supply	E	E	E	E	E
Industrial Process Supply	E				
Navigation	E	E	E	E	E
Commercial and Sport Fishing	E	E	E	E	E
Shellfish Harvesting	E	E	E	E	
Contact Recreation	E	E	E	E	E
Non-contact Recreation	E	E	E	E	E
Fish Spawning	E		P		E
Fish Migration	E	E	E	E	E
Estuarine Habitat	E	E	E	E	E
Rare and Endangered Wildlife Habitat	E	E	E	E	E
Wildlife Habitat	E	E	E	E	E

Key: E = Existing, P = Potential

3 San Francisco Regional Water Quality Control Board (Region 2) Water Quality Control Plan (1995) and Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Region 5; 1998)

ficial uses, combined with the narrative and numerical water quality objectives and the implementation plan constitute water quality standards for the San Francisco Bay and Central Valley Regions. The Water Boards have also been designated as the State agencies responsible for implementing the Federal National Pollutant Discharge Elimination System (NPDES) under Section 401 of the Clean Water Act.

The California Toxics Rule (CTR). In May 2000, U.S. EPA promulgated water quality criteria for priority toxic pollutants for California's inland surface waters and enclosed bays and estuaries. Included are both human health and aquatic life protective criteria. The CTR criteria, along with the beneficial use designations in the Basin Plans, are directly applicable water quality standards for these toxic pollutants in these waters. Implementation provisions for these standards are provided in the Policy for *Implementation of Toxics Standards for Inland Surface Waters, Encloses Bays, and Estuaries of California* (SWRCB Resolution No. 2000-015). The CTR and other criteria for selected pollutants are listed in **Table 3.2-5**.

Table 3.2-5. Water Quality Criteria for Selected Constituents

Constituent	*California Toxics Rule Criteria*[a] *Saltwater*		*California Ocean Plan*[b] *Marine Aquatic Life*		*Drinking Water*[c] *State & US*
	CMC[e] µg/L	CCC[e] µg/L	Daily Maximum µg/L	Instantaneous Max µg/L	MCL µg/L
Copper[d]	4.8	3.1	12	30	1,300
Lead[d]	210	8.1	8	20	15
Mercury[d]	Reserved[f]	Reserved[f]	0.16	0.4	2
Selenium[d]	290	71	60	150	50
PCBs	NA	0.03	NA	NA	0.5
Glyphosate	NA	NA	NA	NA	700

a. Enclosed Bays and Estuaries criteria are the same as CTR criteria for all listed constituents.

b. California Ocean Plan criteria provided for comparison.

c. State and USEPA drinking water maximum contamination levels (MCLs) are provided for comparison only.

d. Criteria apply to California waters except for those waters subject to objectives in Tables III-2A and III-2B of the San Francisco Regional Water Quality Control Board's (SFRWQCB) 1986 Basin Plan, that were adopted by the SFRWQCB and the State Water Resources Control Board, approved by EPA, and which continue to apply.

e. Criteria Maximum Concentration (CMC) equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects. Criteria Continuous Concentration (CCC) equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. µg/L equals micrograms per liter.

f. U.S. EPA did not establish a standard at time of promulgation, but may do so at a future time.

NA – Criteria not available.

U.S. EPA also published recommended water quality criteria for nonylphenols for protection of saltwater aquatic life. The recommended criteria for continuous concentration (4-day) average and maximum concentration (1-hour average) are 1.6 µg/L and 6.2 µg/L, respectively.For the purposes of this evaluation, significant impacts to water quality would be determined to occur if the project would:

- Violate any Federal, State, regional, or local water quality standard, or any waste discharge requirement or NPDES permit condition;

- Discharge any toxic substances into the water in concentrations that are lethal to or that produce significant alterations in population or community ecology or receiving water biota;
- Degrade the existing high quality of water in any waters of the State; or
- Otherwise degrade water quality and adversely affect beneficial uses.

This section primarily evaluates possible impacts that would directly affect water quality and result in a violation of a numerical water quality standard or permit condition. Other, more subtle potential impacts, such as alteration of community ecology or adverse impact to a beneficial use of wetland or estuarine habitat, are evaluated in Section 3.3, *Biological Resources*.

The primary water quality impacts associated with the treatment of non-native cordgrass are summarized in **Table 3.2-7**. Each impact is described below, followed by an assessment of the significance of the impact. Mitigation measures that would be applied are identified in the text and summarized in **Table 3.2-8**.

Sediment Quality Criteria. There currently are no Basin Plan objectives or other regulatory criteria for sediment quality. However, there are sediment quality guidelines that may be used as screening tools. The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) has developed sediment screening and testing guidelines for determining the general suitability of dredged material for beneficial reuse (wetland restoration) projects (SFRWQCB 2000). The guidelines include sediment chemistry, acute toxicity, contaminant mobility, and elutriate chemistry and toxicity.

Chemistry. The guidelines for sediment chemistry are shown in Table 3.2-8. The sediment chemistry guidelines are divided into two levels, one for material that will be placed at or near the wetland surface ("surface material") and one for material that will be placed at a minimum specified distance below the wetland surface ("foundation material").

Toxicity. The recommended acute toxicity screening guideline for surface material is "no significant toxicity" for benthic bioassays. Benthic tests are to be interpreted following guidelines in SFBRWQCB Public Notice 93-3. For benthic bioassays, mortality in a test sediment that is statistically significant and 10 percentage points greater (20 percentage points for amphipods) than that in the reference is considered to be indicative of acute toxicity.

Contaminant Mobility. There are no screening levels for contaminant mobility for wetland surface material because toxicity and chemistry screening for this material will result in concentrations for which mobility is not considered of concern. The screening levels for wetland foundation material are based on Water Quality Objectives found in the Basin Plan. While the foundation material is not expected to be in direct contact with biological receptors, levels of contaminants in effluent discharged during placement of material or in leachate produced after placement of material must be below levels of concern.

Elutriate Chemistry and Toxicity. If dewatering will occur as part of material placement, discharge water must meet screening guidelines for both chemistry and toxicity. The screening guidelines for discharged water chemistry are the Water Quality Objectives listed in the Basin Plan. The screening guideline for toxicity is no significant toxicity. For the elutriate bioassay, this is met when the survival of organisms in effluent has a median value of not less than 90% and a 90^{th} percentile value of not less than 70% survival.

These guidelines will be used as screening criteria in situations where sediment will be dredged or excavated, to evaluate beneficial reuse options for dredged material and the potential adverse effects of these and other sediment disturbing activities. The guideline approach will also be used to evaluate effects of herbicide and surfactant residue in sediment. These criteria will be reviewed by the SFRWQCB as part of the NPDES Water Quality Monitoring Plan, and other criteria may be established by the SFRWQCB at that time. The SFRWQCB may also require different or additional criteria for specific sites as part of CWA Section 401 review.

Table 3.2-6. Sediment Chemistry Screening Guidelines (from Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines [SFBRWQCB 2000])

ANALYTE	Wetland Surface Material		Wetland Foundation Material	
	Concentration	**Decision Basis**	**Concentration**	**Decision Basis**
METALS (mg/kg)				
Arsenic	15.3	Ambient Values	70	ER-M
Cadmium	0.33	Ambient Values	9.6	ER-M
Chromium	112	Ambient Values	370	ER-M
Copper	68.1	Ambient Values	270	ER-M
Lead	43.2	Ambient Values	218	ER-M
Mercury	0.43	Ambient Values	0.7	ER-M
Nickel	112	Ambient Values	120	ER-M
Selenium	0.64	Ambient Values		
Silver	0.58	Ambient Values	3.7	ER-M
Zinc	158	Ambient Values	410	ER-M
ORGANOCHLORINE PESTICIDES/PCBS (mg/kg)				
DDTS, sum	7.0	Ambient Values	46.1	ER-M
Chlordanes, sum	2.3	TEL	4.8	PEL
Dieldrin	0.72	TEL	4.3	PEL
Hexachlorocyclohexane, sum	0.78	Ambient Values		
Hexachlorobenzene	0.485	Ambient Values		
PCBs, sum	22.7	ER-L	180	ER-M
POLYCYCLIC AROMATIC HYDROCARBONS (mg/kg)				
PAHs, total	3,390	Ambient Values	44,792	ER-M
Low molecular weight PAHs, sum	434	Ambient Values	3,160	ER-M
High molecular weight PAHs, sum	3,060	Ambient Values	9,600	ER-M
1-Methylnaphthalene	12.1	Ambient Values		
1-Methylphenanthrene	31.7	Ambient Values		
2,3,5-Trimethylnaphthalene	9.8	Ambient Values		
2,6-Dimethylnaphthalene	12.1	Ambient Values		
2-Methylnaphthalene	19.4	Ambient Values	670	ER-M
2-Methylphenanthrene		Ambient Values		
3-Methylphenanthrene		Ambient Values		
Acenaphthene	26.0	Ambient Values	500	ER-M
Acenaphthylene	88.0	Ambient Values	640	ER-M
Anthracene	88.0	Ambient Values	1,100	ER-M
Benz(a)anthracene	412	Ambient Values	1,600	ER-M
Benzo(a)pyrene	371	Ambient Values	1,600	ER-M
Benzo(e)pyrene	294	Ambient Values		
Benzo(b)fluoranthene	371	Ambient Values		
Benzo(g,h,i)perylene	310	Ambient Values		
Benzo(k)fluoranthene	258	Ambient Values		
Biphenyl	12.9	Ambient Values		
Chrysene	289	Ambient Values	2,800	ER-M
Dibenz(a,h)anthracene	32.7	Ambient Values	260	ER-M
Fluoranthene	514	Ambient Values	5,100	ER-M
Fluorene	25.3	Ambient Values	540	ER-M
Indeno(1,2,3-c,d)pyrene	382	Ambient Values		
Naphthalene	55.8	Ambient Values	2,100	ER-M
Perylene	145	Ambient Values		
Phenanthrene	237	Ambient Values	1,500	ER-M
Pyrene	665	Ambient Values	2,600	ER-M

Ambient Values – Ambient or "background" concentration statistically derived by the SFBRWQCB from data collected by the Regional Monitoring Program for Trace Substances (SFEI 1999) and the Bay Protection and Toxic Substances Cleanup Program Reference Study (SWRCB 1998)

TEL, PEL – Threshold Effects Level and Probable Effects Level - Sediment chemistry values developed by the Florida Department of Environmental Protection (FDEP 1994) as those below which biological effects are unlikely (TEL), and above which biological effects are likely (PEL).

ER-L, ER-M – Effects Range-Low and Effects Range-Median – Sediment chemistry values developed by Long et al. (1995) using the sediment chemistry and toxicity database of the National Oceanographic and Atmospheric Administration as those below which biological effects are unlikely (ER-L) and above which biological effects are likely (ER-M).

ALTERNATIVE 1: Proposed Action/Proposed Project – Regional Eradication Using All Available Control Methods

Impacts to water quality from physical and chemical treatment methods could be associated with application of herbicides, remobilization of sediment contaminants, spills of petroleum products (required for machinery, vehicles, and boats) or herbicides, and erosion of marsh sediments in the vicinity of structures.

IMPACT WQ-1: Degradation of Water Quality Due to Herbicide Application

Treatment methods involving the use of herbicides may degrade water quality and subsequently affect beneficial uses of waters of the Bay.

Only one herbicide, glyphosate, has been approved for use by the U.S. EPA in estuarine environments. The commercial glyphosate products that will be used by the Control Program are Rodeo and Aquamaster. Glyphosate must be combined with a suitable surfactant and colorant, as described in Chapter 2, *Program Alternatives*. The following presentation of empirical information on water quality impacts from herbicide applications is focused on Rodeo or Aquamaster, the active ingredient (glyphosate), its breakdown products, the surfactants R-11, LI 700, and Agri-dex, and the colorant, Blazon Blue.

There are four signal words ion US EPA registration labels describing the toxicity of the compounds: Caution, Warning, Danger, and Danger-Poison. Caution means the product is slightly toxic if eaten, absorbed through the skin, or inhaled, or it causes slight eye or skin irritation. Warning indicates that the product is moderately toxic if eaten, absorbed through the skin, or inhaled, or it may cause moderate eye or skin irritation. Danger means that the product is highly toxic, corrosive, or causes severe burning to the eyes or skin. Danger-Poison means that the pesticide product is highly toxic only if eaten, absorbed through the skin, or inhaled. These products have a "skull and crossbones" symbol on the label.

Glyphosate. Rodeo and Aquamaster are simple aqueous solutions of isopropylamine salt, and contain no inert ingredients other than water. The primary decomposition product of glyphosate is aminophosphoric acid (AMPA), and the commercial product contains an impurity, N-nitrosoglyphosate (NNG). The potential effects of AMPA and NNG are encompassed by the available toxicity data on glyphosate and glyphosate formulations (SERA 1996). Glyphosate is water-soluble and may be transported by surface waters. It is stable in water and sunlight, but is degraded rapidly by bacteria. Specific degradation rates in water depend on temperature and pH, and are usually within days to weeks. It is considered moderately persistent in soils with an estimated half-life of 47 days. Because glyphosate adheres strongly to particles, it does not readily leach to waters (Sprankle *et al.*, 1977 cited in Albertson, 1998), and potential movement of glyphosate to groundwater is unlikely. Information concerning the mobility, persistence, and toxicity of glyphosate in estuarine environments is compiled in **Appendix E-1**.

Surfactants. Pursuant to the U.S. EPA registration label for glyphosate, a non-ionic surfactant is required whenever glyphosate is used in aquatic systems. Several non-ionic surfactant formulations are registered by the U.S. EPA and the California Department of Pesticide Regulation for use in aquatic systems. Agridex, R-11, and LI-700 have been selected for use by the Control Program as among the least toxic of the approved surfactants. These three surfactants are described briefly below. Product labels and additional information are provided in **Appendix E-2**.

Agri-dex (Helena Chemical Company) is a non-ionic surfactant consisting of a paraffin base petroleum oil, polyol fatty acid esters, and polyethoxylated derivatives of the fatty acid esters. The pesticide label identifies a toxicity category of 3-4 (CAUTION)[4]. This surfactant improves pesticide application by modifying the wetting and deposition characteristics of the spray solution resulting in a more even and uniform coverage. The ingredients in this surfactant break down within several days.

R-11 Spreader Activator (Wilbur-Ellis Company) consists of a non-ionic alkylphenol ethoxylate. The pesticide label identifies a toxicity category of 3-4 (CAUTION). This surfactant increases the efficacy of herbicides by facilitating wetting and uniform coverage over the target surface.

Alkylphenol ethoxylates are widely used as detergents, emulsifiers, solubilizers, wetting agents, and dispersants, and are introduced into the aquatic environment primarily through industrial and municipal wastewater discharges (Heinis *et al.* 1999). Depending on the environment, alkylphenol ethoxylates may break down into a variety of metabolites, some of which may persist in the water column for several weeks and in sediments for many years (Ferguson *et al.* 2001). One of the break-down products, nonylphenol, has been found to bioaccumulate (Ferguson *et al.* 2001) and to have estrogenic effects on some organisms (Dreze et al. 2000, Meregalli et al. 2001).

Because the primary contributors of nonylphenol to the environment are wastewater sources, most of the available information on the persistence and effects of these substances is focused on wastewater processes. Several studies have concluded that nonylphenol does not tend to be persistant (i.e., it breaks down further to inert products) under aerobic conditions (J. Maguire 1999, Staples *et al.* 1998).

LI-700 Penetrating Surfactant (Loveland Industries), contains phosphatidylcholine (lecithin), which is a naturally occurring lipid that biodegrades readily. It also contains methylacetic acid and alkyl polyoxyethylene ether. The pesticide label identifies a toxicity category of 1 (DANGER). This surfactant facilitates uniform coverage of the spray solution and aids in penetration of the herbicide. The ingredients in this surfactant break down within several days.

Colorant. Blazon Spray Pattern Indicator (Milliken Chemical) is a water-soluble polymeric colorant. As with most colorant products, the active ingredients are proprietary; the Material Safety Data Sheet indicates that it is non-hazardous and non-toxic. The product information sheet reports that the product is non-staining to the skin or clothing. A literature survey on the toxicity of color indicators done for the U.S. Department of Agriculture reports "most commercial indicators are blue … and most often a form of Acid Blue 9…" (McClintock 1997 and Zullig 1997 cited in SERA 1997b). Acid Blue 9 is a disodium salt classed chemically as a triphenelmethane color (SERA 1997b). The Cosmetic, Toiletry, and Fragrance Association (CTFA) name for certified batches of Acid Blue 9 is FD&C blue No. 1. Product information for Blazon Spray Pattern Indicator is provided in **Appendix E-2**.

Herbicide mixtures. The glyphosate/surfactant/colorant mixture is a chemical formulation, and the toxicological characteristic may vary from that of its constituents. While information about the constituents may be instructive, it is desirable to consider the characteristics of the combined mixture to accurately assess possible toxicity. There is a wide range of possible interactions between the glyphosate mixture constituents, and the effects are difficult to predict based on structural, mechanistic, or theoretical considerations (SERA 1997b). The application of data from general

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[4] Toxicity categories are determined by the U.S. EPA for human health affects. See http://www.epa.gov/oppfead1/labeling/lrm/chap-08.htm for more information on pesticide label requirements.

aquatic studies to the estuarine environment is unreliable for determining possible effects. An important exception to the general lack of estuarine data is the recent research on glyphosate toxicity to Pacific estuarine organisms of Willapa Bay, cited in the EIR literature (Paveglio et al. 1996, Kilbride and Paveglio 2001, Killbride et al. 1995). These recent Pacific coast data and analyses are considered up to date, highly relevant, and scientifically reliable. They also are the closest and most similar estuarine systems to the San Francisco Estuary for comparative study of glyphosate impacts. Overall, they indicate that energetic, turbid conditions in tidal mudflats rapidly dissipate glyphosate between tides, resulting in rapid reduction to undetectible levels, and rapid inactivation (adsorption) by clay sediments, as well as low aquatic toxicity. The Control Program will perform studies, including bioassays, during the early phases of the Program to determine if there are additional toxic effects of the herbicide mixtures.

Herbicide application. Impacts to water quality from herbicide application depend on environmental fate, degradation rates of active agents and decomposition products of the herbicides. The primary route by which herbicide solution may contact water is by overspray directly onto the water surface, or by washing off from plants due to precipitation or tidal inundation. The proposed herbicide is formulated and approved for use in aquatic environments.

Glyphosate mixtures may be applied as sprays to plant surfaces, pastes applied to cut stems, or solutions wiped or painted on foliage. Spray mixtures may be administered from manually transported tanks (backpack sprayers) or spray equipment mounted on trucks, track vehicles, boats, or helicopters (broadcast sprayers; see Chapter 2, *Program Alternatives, Alternative 1* for a complete description of application methods and restrictions). Manual application would entail workers walking through the marsh and applying herbicide directly to target plants, with limited overspray to surrounding plants or water surfaces. Application from a boat would also result in direct application of herbicide to target plants, with limited overspray. Application from trucks and track vehicles would entail vehicles moving through the marsh, either on roadways and levees or tracking over marsh vegetation, respectively applying herbicide more broadly to vegetation in the immediate area. Aerial application would be by helicopter with either a boom sprayer (a horizontal pipe with spray nozzles along its length, mounted to the bottom of the helicopter) or a spray ball (a hollow ball with perforations suspended from the bottom of the helicopter). Aerial application would result in a wider dispersion of herbicides, with greater potential for overspray onto non-target areas or the water surface. Aerial application is would be used infrequently, and primarily at large areas of dense cordgrass infestations, particularly in locations where little native cordgrass and other non-target plants are nearby. The rate of application for each type of treatment was provided in **Table 2-2**.

Herbicide mixtures may be indirectly discharged to surface waters by tidal action or rainfall that rinses the herbicide solution from the plants. Rainfall is unlikely to occur during the planned application season (late summer), and herbicide applications would be postponed if rainfall were predicted, but tidal inundation is inevitable in many locations on a regular cycle.

Energetic tidal cycles and tidal currents effectively disperse bound (adsorbed) glyphosate and surfactants and dilute them in microbially active suspended sediment. Studies of the fate of glyphosate and surfactants applied in tidal marshes and mudflats have reported that concentrations of both substances dropped below detection levels as soon as two tidal cycles (one day) to seven days (Kroll 1991, Paveglio *et al.* 1996) after application. The initial tidal submergence of sprayed surfaces disperses a large fraction of applied glyphosate and surfactant.

Research in Willapa Bay, Washington, found that the highest average maximum concentrations of glyphosate and X-77 Spreader surfactant in water dispersed from sprayed estuarine mud with the first flooding tide were 26 µg/L and 16 µg/L, respectively. These conditions represent the highest expected concentrations for exposure for aquatic invertebrates or fish swimming into freshly sprayed sites. The solution of Rodeo (3.8 pts/acre) and X-77 Spreader (0.9 pts/acre) was applied aerially (Paveglia *et al.* 1996). This "worst case" concentration of glyphosate and surfactants is inherently short-lived in high-energy tidal environments, and would not be pertinent to potential chronic, low-level effects. The same study found that concentration of glyphosate and surfactants were below analytic detection limits (0.5 ppb) during the first high tide after treatment. Kroll (1991) found that glyphosate concentrations in seawater were below the detection limit of 5 ppb within 7 days after treatment by Rodeo (0.75% solution) and Arborchem Aquatic surfactant (0.5% solution) by a hand-held sprayer.

Research conducted for the California Department of Food and Agriculture (Trumbo 2002) studied the environmental fate and aquatic toxicity of Rodeo and R-11 in three locations, including a Sacramento-San Joaquin Delta slough, a riverine area, and a no-outlet pond. This study measured glyphosate, amino methyl phosphonic acid (AMPA; glyphosate's primary metabolite), nonylphenol ethoxylate, and nonylphenol at treated sites one hour, two days, and eight days after application. The study also tested for toxicity using 96-hour toxicity tests with the fish species fathead minnow *Pimephales promelas*. The study found that concentrations of the tested constituents at slough and river sites (with moving water) was below detectible levels for all tests, and that there was no significant mortality of test fishes. The pond site, however, showed detectable residues of glyphosate, nonylphenol ethoxylate, and nonylphenol at one hour and two days after treatment, but all constituents were below detection limits by day eight. The one-hour pond samples experienced 30% mortality of test fishes, which, because of the relatively low concentrations of glyphosate (which is known to be non-toxic at the detected level), was attributed to effects caused by nonylphenol ethoxylate and nonylphenol. The two- and eight-day tests showed no significant mortality to test fishes.

Kilbride *et al.* (2001) conducted another study in Willapa Bay to evaluate the fate of a more concentrated glyphosate mixture (5% Rodeo solution and 2% LI-700 solution) in sediments. This concentration is above that permitted for manual application to cordgrass. Both mudflat plots and cordgrass plots were treated. Sediment samples were collected at 1 and 21 days, and at one year after treatment, and geometric mean concentrations ranged from 0.090 mg/kg to 2.30 mg/kg.

Patten (2002) compiled data on the fate of glyphosate in water and sediment following applications in estuarine environments. Data are presented as geometric means for immediate maximum concentration (<3hrs after application) and short-term concentration (between24 hrs and 48 hrs after application). For use rates between 8 and 16 kg/ha (7-15 lbs/acre), the immediate maximum geometric mean glyphosate concentrations were 0.174 mg/L (174 µg/L) in water and 2 mg/kg in sediment. The short-term geometric mean glyphosate concentrations were 0.003 mg/L (3 µg/L) in water and 1.9 mg/kg in sediment.

These independent lines of research in the fate of glyphosate and surfactants in tidal (and other) habitats suggest that potential impacts to water quality and beneficial uses of waters of the State caused by spraying glyphosate mixtures in intertidal environments are likely to be small and temporary. Therefore, controlled applications (i.e., following label instructions) of registered herbicides are not expected to degrade water quality, except for limited temporal and spatial extent.

Herbicides adsorbed by soils also degrade rapidly in the environment. Glyphosate has little potential for affecting groundwater because of its strong affinity for soil particles, which results in low mobility in soils. Following herbicide application and eventual decay of affected plant roots, local soils may be somewhat destabilized and subject to erosion prior to recolonization, but this would not facilitate transfer of glyphosate adsorbed to soil particles to the underlying groundwater aquifer.

In summary, the use of glyphosate and surfactants to treat infestations of non-native cordgrass would result in less than significant impacts on water quality due to the rapid degradation rate and controlled application of herbicides only on target plants. Since application of herbicides would take place during low tide and low wind conditions, the herbicide would likely be absorbed by plants for a minimum of several hours (up to several weeks or months in high marsh) following application resulting in less than significant quantities of glyphosate or surfactants entering the water.

MITIGATION WQ-1: Herbicides shall be applied directly to plants and at low or receding tide to minimize the potential application of herbicide directly on the water surface. Herbicides shall be applied by a certified applicator and in accordance with application guidelines and the manufacturer label.

The Control Program shall obtain coverage under the State NPDES Permit for the Use of Aquatic Herbicides and any necessary local permits. A monitoring program shall be implemented as part of the NPDES permit, and shall include appropriate toxicological studies to determine toxicity levels of the herbicide solutions being used. The Control Program shall use adaptive management strategies to refine herbicide application methods to increase control effectiveness and reduce impacts. The Control Program shall continue to investigate improved herbicide formulations with lower ecological risk.

IMPACT WQ-2: Herbicide Spills

Large volumes of herbicide or surfactant, spilled or misapplied, could degrade water quality and cause temporary toxicity. As described for Impact WQ-1, above, controlled applications (i.e., following label instructions) of registered herbicides are not expected to degrade water quality because these materials degrade rapidly in the environment and do not represent high potentials for toxicity or bioaccumulation in marine or terrestrial organisms. However, if large volumes of herbicide or surfactant (adjuvant) are to be spilled near the treatment site in an undiluted (neat) form, or misapplied, these events would degrade water quality and cause temporary toxicity. Thus, impacts to water quality associated with large volume spills would be potentially significant.

MITIGATION WQ-2: Herbicides shall be applied by or under the direct supervision of trained, certified or licensed applicators. Storage of herbicides and adjuvants/surfactants on-site shall be allowed only in accordance with an approved spill prevention and containment plan; on-site mixing and filling operations shall be confined to areas appropriately bermed or otherwise protected to minimize spread or dispersion of spilled herbicide or surfactants into surface waters.

IMPACT WQ-3: Fuel or Petroleum Spills

Spills of gasoline or other petroleum products, required for operation of motorized equipment, into or near open water could degrade water quality, with potential for toxicity or contaminant bioaccumulation.

Gasoline or other petroleum products, such as oil and hydraulic fluids, required for operation of motorized equipment, could spill into or near open water. Large spill volumes could degrade water quality, with potentials for toxicity and contaminant bioaccumulation in marsh organisms. Water quality impacts also may occur if ignition fluids such as gasoline used for burning were inadvertently sprayed or spilled to surface waters. Gasoline, diesel, and other distilled petroleum products are more water-soluble than crude oils and heavier distillate fractions. However, they are also more volatile and therefore lost rapidly from water to the atmosphere. The lower molecular weight aromatic hydrocarbon compounds in petroleum products can be toxic to marine organisms at low exposure concentrations. Consequently, some toxicity to marine organisms could occur in the immediate vicinity of a spill, whereas environmental weathering processes reduce the toxicity of the spill with time.

This impact to water quality is potentially significant, but would be localized to the general vicinity of the spill and temporary. Impacts related to spills generally can be reduced to less-than-significant levels by implementing specific mitigation measures and best management practices.

MITIGATION WQ-3: Fueling operations or storage of petroleum products shall be maintained off-site, and a spill prevention and management plan shall be developed and implemented to contain and clean up spills. Transport vessels and vehicles, and other equipment (e.g., mowers, pumps, etc.) shall not be serviced or fueled in the field except under emergency conditions; hand-held gas-powered equipment shall be fueled in the field using precautions to minimize or avoid fuel spills within the marsh. Other, specific best management practices shall be specified as appropriate in project-specific Waste Discharge Requirements.

IMPACT WQ-4: Contaminant Remobilization

Treatment methods that include dredging or excavation of anaerobic bay mud may expose buried sediments with higher levels, or more biologically available forms of heavy metals (e.g., mercury, nickel, and zinc) or other contaminants such as polychlorinated biphenyls (PCBs). As shown in **Table 3.2-3**, heavy metals, including mercury, are present in bay muds from natural and artificial sources. Background levels in the San Francisco Bay are very high for some of these constituents compared to most estuaries nationally. If dredging or excavation is done in areas with high concentrations of metals or pollutants, it could degrade water quality and contribute to exposure of marsh organisms. Remobilization of contaminant would not be likely to occur from treatment methods that do not directly disturb sediments. Treatment methods that entail constructing levees or projects that require constructing roads for access could expose contaminants and create a minor risk to water quality.

MITIGATION WQ-4: For projects where dredging or excavation methods are used, a preliminary assessment shall be performed to determine the potential for contamination in sediments prior to initiating treatment. The preliminary assessment shall include (1) review of existing site data (e.g., from Regional Monitoring Program) and (2) evaluation of historical site use and/or proximity to possible contaminant sources. If the preliminary assessment finds a potential for historic sediment contamination, an appropriate sediment sampling and analysis plan shall be developed and implemented. If contaminants are present at levels of possible concern (but below levels that might trigger site cleanup), an alternative treatment method (that shall not disturb sediment) will be implemented, or the project shall apply to the Regional Water Board for site-specific Waste Discharge Requirements. If significant contamination that warrants site cleanup is found, sampling information shall be turned over to the U.S. Environmental Protection Agency or other appropriate authority.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Impacts to water quality from individual treatment methods and combinations of methods generally would be the same as those described for Alternative 1, with the exception that potential impacts associated with herbicide application and spills would be replaced by increased contaminant remobilization and erosion due to repeated application of physical or mechanical methods and ground disturbance. Overall, impacts to water quality are considered less than significant and subject to feasible mitigation.

Mitigation Measures

Mitigation measures WQ-3 and WQ-4 also apply to this alternative.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Under Alternative 3, all types of control methods would continue to be used in the Estuary as needed by individual landowners, without benefit of training and standardization provided by the *Spartina* Control Program. Water quality impacts from herbicide application and resuspension of contaminants would still occur. Water quality impacts from herbicide and fuel spills might occur with disproportional frequency as a result of a lack of training and application standards.

Mitigation Measures

Mitigation measures WQ1, WQ-2, WQ-3 and WQ-4 would apply to this alternative.

Impact WQ-5: Water Quality Effects Resulting from Sediment Accretion

Colonization by invasive cordgrass can directly and indirectly affect water quality by trapping marsh sediments (Daehler and Strong, 1996). This process filters suspended particles from marsh waters, thereby increasing water clarity and light penetration, and promoting further deposition and accumulation of sediment and possible changes in sediment texture (Daehler and Strong, 1996). Accretion rates vary but appear to be related to stem density and sediment supply, and inversely related to wind and wave action (Chung, 1985 cited in Ebasco 1997). Sediment accretion and stabilization may eventually alter local topography and habitats relative to tidal elevation, promote changes in tidal drainage channels, and change topography from gentle slope to steep slopes in tidal channels. Changes in marsh circulation can, in turn, decrease the frequency of tidal inundation or exchange, and lead to stagnation and localized degradation of water quality. *Spartina* colonization of flood control channels may also increase flooding potential of residential and commercial properties (see also Section 3.1-*Geomorphology and Hydrology*). These indirect effects would result in potentially significant impacts to water quality.

This alternative is not expected to affect water quality standards although some beneficial uses associated with fish and wildlife habitat may be adversely affected. Other, local control programs, independent of the proposed regional eradication program, could generate waste discharges and affect local water quality conditions; however evaluation of local control programs is outside the scope of this EIS/EIR.

MITIGATION WQ-5: No feasible mitigation has been identified to address this impact. Moreover, mitigation measures associated with treatment methods would not be implemented by the Conservancy or the Service or required under this alternative. Locally sponsored control programs may incorporate mitigation measures to reduce potential impacts on water quality and sediment accretion. Mitigation would not be needed or appropriate at marsh locations where sediment accretion is a beneficial or neutral impact.

Residual Impacts

Because no mitigation measures would be implemented, residual impacts would be as described above. These residual impacts are considered potentially significant.

Table 3.2-6: Summary of Potential Water Quality Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
WQ-1: Degradation of Water Quality due to Herbicide Application	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	Alternatives 1 & 3: Minor impact Alternative 2: No impact.	N/A
WQ-2: Degradation of Water Quality due to Herbicide Spills	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	Alternatives 1 & 3: Potentially significant and mitigable impact Alternative 2: No impact.	N/A
WQ-3: Degradation of Water Quality due to Fuel or Petroleum Spills	All Alternatives: No impact.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	All Alternatives: Small potential for spill.	N/A
WQ-4: Degradation of Water Quality due to Contaminant Remobilization	Alternative 1-2: Small potential Alternative 3: No significant impact.	Alternative 1: Small potential Alternative 2: Potentially significant Alternative 3: No significant effect	All Alternatives: No adverse impacts.	Alternative 1: Small potential Alternative 2: Potentially significant Alternative 3: No significant effect	All Alternatives: No adverse impacts.	All Alternatives: No adverse impacts.	N/A
WQ-5: Water Quality Effects Resulting from Sediment Accretion	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Alternatives 1 & 3: No effect Alternative 2: Insignificant effect	Clarification of the water column may benefit some species

Table 3.2-7: Summary of Mitigation Measures for Water Quality

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
Mitigation WQ-1: Degradation due to herbicide application. Herbicides shall be applied under NPDES Permit from the State. Herbicides shall be applied directly to plants and at low tide to minimize the potential application of herbicide directly on the water surface, and shall be applied in accordance with application guidelines and the manufacturer label. Best management practices shall be applied at all times. The SCP shall monitor and evaluate projects.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable
Mitigation WQ-2: Herbicide spills. Herbicides shall be applied under NPDES Permit from the State, and by or under the direct supervision of a trained, certified or licensed applicator. Spill prevention and containment plan shall be developed and implemented.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable
Mitigation WQ-3: Fuel or petroleum spills. Fueling and storage of fuels will be maintained offsite. A spill prevention and containment plan shall be developed and implemented.	Not Applicable	Applicable	Not Applicable	Applicable	Applicable	Applicable
Mitigation WQ-4: Contaminant remobilization. Site sediments will be researched and sampled (if needed) prior to initiating treatment of any site where there may be contamination. Waste Discharge Requirements shall be obtained for operations in a site where contamination is present.	Applicable	Applicable	Not Applicable	Usually Not Applicable	Not Applicable	Not Applicable

Note: There may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

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3.3 BIOLOGICAL RESOURCES

The biological resources that may be affected directly or indirectly by the *Spartina* Control Program include the intertidal habitats (mudflats, tidal creeks, sloughs, tidal marshes) of the San Francisco Estuary, shallow subtidal habitats near them (sloughs and nearshore bay habitats), and habitats immediately adjacent to the Estuary, particularly diked baylands where access and staging areas for eradication activities may occur, and the plants and animals that inhabit these places. This section focuses on those aspects of the Estuary's biological resources that may be affected by the proposed project and alternatives.

3.3.1 Environmental Setting

A recent comprehensive overview of the biological communities and species of the San Francisco Estuary is provided in the Baylands Ecosystem Habitat Goals Project (Goals Project 1999, 2000). The ecological communities (populations of interacting species in different tidal habitats) of the San Francisco Estuary are influenced by position along numerous physical gradients of the Estuary, and the variation in distribution of the species that compose them. An overview of relevant ecological communities, and key species of concern, is presented below. Descriptions of these habitats and species emphasize aspects likely to be most sensitive to changes caused by eradication measures or cordgrass invasions themselves.

Biological Communities

Biological (ecological) communities are the interacting populations of the species associated in particular habitats defined by physical, chemical, geographic, and topographic gradient boundaries. To understand individual environmental impacts to species, it is necessary to recognize their relationships within biological communities in potentially affected areas of the San Francisco Estuary. Many of these biological communities and features that comprise them were shown previously in **Figure 1-7**.

Tidal Marsh Communities. Tidal marsh essentially consists of herbaceous (non-woody) vegetation that is periodically flooded by tidal waters with varying degrees of salinity. Tidal marshes include areas that are normally waterlogged as well as areas that are infrequently or intermittently flooded. Low marsh cordgrass species (e.g. Atlantic smooth cordgrass, Pacific cordgrass, English cordgrass) typically grow in tidal marsh zones flooded by daily tides. High marsh cordgrasses like Chilean cordgrass and salt-meadow cordgrass typically grow in higher marsh elevations, which are tidally flooded less frequently, often only a few days per month. Tidal marsh can establish on terrestrial substrates (tidally flooded soils which originated in non-tidal lands, especially in high marsh), but most of the tidal marsh in the San Francisco Estuary is established on estuarine sediment mixed with varying proportions of decomposed vegetation (peaty or muck-like organic matter). Most tidal marsh is typically described in terms of the dominant plant species, appearance of the vegetation, and the landforms on which they occur.

<u>Tidal salt marsh vegetation</u>. Tidal salt marshes are prevalent in San Francisco Bay, where the salinity of tidal waters in the summer growing season often approach or even exceed ocean seawater. Tidal salt marsh along channel banks and areas which are submerged twice daily by tides (low marsh zone, below mean higher high water) historically were dominated by a single species, Pacific cordgrass (*Spartina foliosa*), a colonial marsh grass usually less than one meter tall. Relatively un-

common native annual pickleweed (*Salicornia europaea*) establishes at the upper portion of this zone in sheltered sites, but low salt marsh was essentially a pure stand of Pacific cordgrass prior to the introduction of non-native cordgrasses.

The upper salt marsh plain, which is flooded only by the higher tides of the month, not daily tides (near the elevation of mean higher high water; the middle or high marsh zone, depending on classification) is dominated in San Francisco Bay by patchy mosaics of perennial pickleweed (*Salicornia virginica*), saltgrass (*Distichlis spicata*), jaumea (*Jaumea carnosa*), and numerous less frequent low-growing salt-tolerant herbs. In young salt marshes, the marsh plain vegetation is sometimes nearly pure stands of pickleweed. The salt marsh plain vegetation in the Estuary is usually less than 30 to 40 centimeters (12 to 16 inches) tall. Pacific cordgrass is sparse or absent on the marsh plain, usually confined to its lowest elevations. In historic salt marsh conditions, grasses such as saltgrass dominated the salt marsh only in local zones (Cooper 1926).

California salt marsh vegetation is relatively diverse and species-rich compared with Atlantic salt marshes, which are generally dominated by either grasses (often pure stands of Atlantic smooth cordgrass) or grass-like plants throughout the marsh. Even higher plant species diversity and vegetation structure occurred in high salt marsh zones of San Francisco Bay, flooded only by the highest tides of the year. These occurred along natural levees at tidal creek banks, bay edges of alluvial fans, and contacts and transitions to other environments such as grasslands, freshwater riparian scrub or woodland near streams or seeps, freshwater marshes, beaches, salt pans, and lagoons (Baye *et al.* 2000, Holstein 2000). Natural high salt marsh communities are rare today, displaced by weedy flood control levees and shoreline stabilization. Gumplant (*Grindelia stricta* var. *angustifolia*), a tall, evergreen subshrub, dominates the narrow high marsh zone along the banks of mature tidal creeks, where it provides critically important high tide cover for marsh wildlife. It also often occurs in high marsh zones along upland edges."

<u>Tidal brackish marsh vegetation</u>. Where the salinity of tidal water is significantly diluted by stream or urban wastewater discharges, the physiological harshness of saline water that restricts the growth of many plant species is eased, and marsh community diversity increases. Marshes that vary between nearly freshwater conditions and salinities about half as strong as undiluted seawater are broadly described as *brackish marshes* (though many salinity classifications of marshes exist). Brackish marshes in the San Francisco Estuary vary in vegetation composition a great deal, and the relative abundance of dominant brackish marsh plants is highly sensitive to short-term climate changes that influence salinity, flooding, and sediment deposition. Most of northern San Pablo Bay and all of the Suisun Bay region (Suisun Marsh and the Contra Costa marshes) tidal marshes are brackish. Brackish marshes were historically also locally common along the edges of many portions of San Francisco Bay (Cooper 1926, Baye *et al.* 2000).

Pacific cordgrass thrives in diluted salinity of brackish tidal marshes, growing more productively than in full-strength seawater. Other, larger plants tolerant of lower salinities and even greater immersion in water, also thrive in brackish marshes. Although cordgrasses often establish colonies in brackish intertidal muds, alkali bulrush (*Scirpus maritimus* and intergrades with *S. robustus*), tules (*S. acutus*, *S. californica*), and cattails (*Typha* spp.) can invade and overtop lower-growing Pacific cordgrass vegetation in brackish marshes. These taller emergent brackish marsh plants often establish as the dominant pioneers on channel banks and upper mudflats in brackish reaches of the Estuary. The marsh plain in brackish tidal marshes is much richer in plant species and more variable and diverse in structure compared with tidal salt marshes in San Francisco Bay. Many of the rarer plants in the Estuary occur in brackish marsh plains or high brackish marsh.

Tidal marsh animal communities. Animal communities of tidal marshes of the San Francisco Estuary are relatively mobile, and are less often narrowly restricted to a single fixed marsh vegetation zone or patch. They may move according to tides, storm surges, or seasons. Insect communities of the San Francisco Estuary marshes are not well studied, and even basic descriptive information about insect species composition and trophic relationships (food webs) are limited (Maffei 2000). The terrestrial arthropod fauna of tidal marshes in the Estuary are dominated by brine flies, leafhoppers, plant hoppers, mites, and spiders (Resh and Balling 1979). Insects and spiders are abundant in the middle and upper high marsh zones, and crustaceans (including amphipods) are abundant in moist organic tidal litter wracks, and in frequently flooded marsh. Many are important consumers of detritus from decomposing plant litter, a critical link in the tidal marsh food web.

Vertebrate wildlife of tidal marshes is better studied than insects, particularly waterbirds (shorebirds, waterfowl, wading birds, terns and gulls). Short-legged shorebirds seldom roost or feed in thick salt marsh vegetation, but occasionally roost at high tides on smooth wracks (tidal litter mats) in the high marsh. Short-legged shorebirds instead frequent shallow or emergent flats lacking vegetation. Wading birds (egrets, herons) and long-legged shorebirds (e.g. willets, marbled godwits, long-billed curlews, whimbrels) do roost or forage on the marsh plain, along low marsh banks of tidal channels, and in the many shallow ponds and natural salt pans enclosed within the marsh plain. Long-legged shorebirds, however, generally prefer open flats when they emerge from tidal flooding. Rails (clapper rails, black rails, Virginia rails, and sora), in contrast, spend nearly all their time within vegetated areas of tidal marsh and small channels, where they forage on benthic invertebrates in the muddy substrate. Northern harriers ("marsh hawks") are frequent and characteristic avian predators of San Francisco Estuary tidal marshes. Black-shouldered kites and red-tail hawks also hunt in tidal marshes, as well as osprey. Songbirds (perching birds or passerines) which spend much or most of their lives in San Francisco Estuary tidal marshes include several endemic subspecies of song sparrow (each geographically restricted to part of the Estuary), and the salt marsh common yellowthroat. Many other songbirds are occasional or incidental visitors to tidal marsh habitats.

Emergent tidal marsh plains are often rich in small mammal populations, particularly higher marsh plains. Both non-native rodents (Norway rat, roof rat, house mouse) and native rodents (California vole, western harvest mouse, salt marsh harvest mouse, salt marsh wandering shrew, Suisun shrew, and ornate shrew) inhabit salt marshes seasonally or year-round, depending on the species and ecological conditions in adjacent habitats. They tend to occur mostly in the sub-shrubby perennial vegetation of the marsh plain, not in low cordgrass marsh. Abundant small mammals, in turn, attract raptor foraging in tidal marshes. Small mammals are temporarily displaced from tidal marshes during extreme tidal flooding events, and seek refuge in sheltering debris, tall vegetation, and local high ground with cover to shield them from birds of prey (Johnston 1957).

Large mammals also inhabit tidal marshes in the San Francisco Estuary. Resident bay colonies of harbor seals use some specific tidal marsh localities as "haul-outs". These are areas above frequent high tides to rest and bask, usually near feeding areas. Haul-outs are also used for pupping. Traditional seal haul-out sites in tidal marshes of San Pablo Bay and San Francisco Bay often are high marsh plains with close access to deeper tidal channels, adjacent to gently sloping unvegetated banks (actually devegetated in places by seal activity). Seals do not move through wide cordgrass marshes on very gentle intertidal gradients (Lidicker and Ainley 2000). Coyotes hunt in North Bay tidal marshes and diked baylands (P. Baye, pers. observ. 2001), and the non-native red fox, a significant predator of California clapper rails, is now widely established in San Francisco Bay and San Pablo Bay, particularly where access to marsh feeding areas is facilitated by artificial levees or uplands where they travel or build dens (Harding 2000). Raccoons and skunks also are widespread in modern tidal marshes. Feral cats frequently inhabit marsh areas at the urban interface adjacent to landfills, urban development, and other areas where food and shelter are available.

Estuarine Beach Communities. Central San Francisco Bay historically supported extensive sand beaches, and beaches made of shell fragments (mostly fossil oysters) are still widespread along the shores of the South Bay. Sand spits, some approaching the size of marine beaches, prevailed along the bay/marsh interface from what is now Richmond to Alameda, and were also common along the northern San Francisco peninsula. These areas were also the main centers of urban waterfront development, and were destroyed so early after settlement that little is known directly about them. Historic beaches in San Francisco Bay were generally restricted to shorelines where bay waves directly attack and re-work exposed, submerged deposits of sand or shell, or sandy deltas of tributary streams (see Section 3.1, *Geomorphology and Hydrology*).

Physically dynamic estuarine beaches provide naturally open, sparsely vegetated roosting habitats for shorebirds flooded off of preferred feeding areas, such as tidal mudflats. Some shorebirds and terns typically nest on sand beaches, especially sand spits, but there are no records of nesting in the vestigial urban-edge beaches of San Francisco Bay. Instead, the western snowy plover and California least tern exploit today's extensive artificial playa-like (beach plain and salt flat) habitats, such as emergent artificial salt pan beds and even derelict runways (Page *et al.* 2000, Feeney 2000).

Modern beaches have regenerated at some shoreline positions near those of their historic predecessors, derived from the same sediment sources. Some of these support vestiges of estuarine beach and dune communities. Some modern sand beaches of the bay, such as Crown Beach (Alameda) and Roberts Landing sand spit (San Leandro) are being converted to low-energy tidal salt marsh in the shelter of Atlantic smooth cordgrass and its hybrids.

One endangered plant, California sea-blite (*Suaeda californica*) probably was restricted largely to salt marsh edges of sand and shell beaches of San Francisco Bay, rather than typical salt marshes. Other rare plants are associated with sandy high salt marsh environments (Baye *et al.* 2000). Several rare species of tiger beetles native to San Francisco Bay occur primarily in beach or dry pan habitats (Maffei 2000). Drift-lines and organic debris on beaches provide refuges of high moisture and organic matter, and can produce abundant insect and amphipod populations.

Communities of Lagoons, Ponds, and Pans. Within tidal marsh ecosystems, marshes establish in relatively waterlogged soils, but subsurface water movement and drainage to nearby tidal creeks moderates waterlogged soil conditions, providing some gas exchange. Where tidal waters become impounded in poorly drained depressions, wide flats, or behind barrier beaches that act as natural dams for streams, extreme waterlogging or salt accumulation can cause toxic soil conditions. Salt accumulation and sulfide accumulation (indicated by "rotten egg" scent) in very poorly drained areas cause dieback of emergent marsh vegetation, or severely inhibit its establishment. These areas lacking extensive cover by emergent vegetation form distinct and important habitat types in the Estuary. Some types of marsh pans are subject to invasion and modification by at least one non-native cordgrass that can tolerate greater waterlogged soil conditions than native species.

Most of the original tidal marshes in the San Francisco Estuary were rich in small to moderate-sized (fractions of an acre to several acres) pans -- shallow tidal pools embedded in the marsh plain. Tidal marsh pans in the marsh plain lack drainage outlets and are infrequently flooded by tides that overtop the marsh plain. They are often rounded in outline, and have steep banks less than a foot high, with soft muck beds. This type of salt marsh pan is often shallowly flooded for most of the winter and spring, and is intermittently flooded in summer. In its flooded phase, it often supports extensive colonies of submerged aquatic vegetation, equivalent to eelgrass and other seagrass meadows. Wigeon-grass (*Ruppia maritima*, not a true grass) is the prevalent submerged vegetation of natural salt pans in San Francisco and San Pablo Bays. It tends to become covered by filamentous algae when stagnant pans warm in summer, and is often mistaken for pure algal mats. Wigeon-grass canopies in pans support rich invertebrate communities, providing important habitats for dabbling ducks, diving ducks, and geese. They die back when the pan evaporates in summer between peak high tides, forming saline or hypersaline mats of dried algae and fabrics of dead wigeon-grass foliage.

Some salt pans may be entirely barren of any vegetation. Even these produce rich aquatic invertebrate communities that provide important habitat for some shorebirds (avocets, black-necked stilts, and yellowlegs) which otherwise would find little foraging habitat in vegetated tidal marsh plains. Salt pans are relatively abundant in natural tidal marshes that formed pre-historically, but are usually scarce in recently formed marsh plains that lack complex, irregular tidal creek patterns. In Suisun Marsh, tidal marsh pans are brackish, and these are even scarcer today than natural salt pans. Brackish pans support a greater diversity of submerged aquatic plant species.

The smallest tidal marsh pans (less than 0.25 acre), and marsh pans encroached by emergent vegetation, can produce abundant salt marsh mosquitoes. Larger pans have turbulent open water surfaces (internal wind-generated waves), which discourage survival of mosquito larvae. When tidal marsh pans become invaded by emergent vegetation, they produce very poorly drained marsh and still, sheltered water surfaces that encourage successful mosquito breeding (Balling and Resh 1983, J. Collins, pers. comm.).

Extensive natural salt ponds (evaporation basins producing beds of crystalline salt) no longer exist in San Francisco Bay, but were locally characteristic features of the Hayward shoreline. Similarly, natural lagoons (brackish to saline ponds, infrequently and intermittently tidal) no longer exist in the Estuary. Equivalent habitats are provided by "intake" solar salt evaporation ponds – permanently flooded, shallow saline waters that support soft-bottom benthos, entrapped estuarine fish population, wigeon-grass beds (submerged aquatic vegetation), and large algae. The management of salt ponds depends on tidegates used as water intakes. Sediment accretion and cordgrass growth can obstruct intakes.

Brackish lagoons are also represented by a few permanently flooded waterfowl-managed ponds in Suisun Marsh. Waterfowl-managed ponds depend on operation of water intakes (tidegates) to flood and drain tidal waters, either on artificial seasonal schedules, or partially choked daily tidal flows. The surrogate lagoon habitat represented by early-stage solar salt evaporators is significant in that it excludes the growth of all cordgrasses, even invasive non-native cordgrasses established in adjacent populations. No cordgrass species in San Francisco Bay can tolerate extreme hypersaline soils or prolonged, deep flooding.

Mudflat Communities. Intertidal flats in the San Francisco Estuary are mostly soft, unconsolidated sediment habitats made of physically unstable bay mud (fine silt and clay; mudflats) on very gentle gradients. By definition "tidal flats" do not include steeply sloping, consolidated mud banks of tidal channels. A minority of intertidal flats are made of sandy sediments (especially in the Central Bay), or fossil shell deposits and lag surfaces of shell over softer muds.

The permanent bottom-dwelling residents (benthic infauna) of mudflats are invertebrates, such as clams, worms, snails, and crustaceans. These permanent residents of the mudflat are highly dynamic, however, and adjust to the physically unstable surface of the mudflat. Turnover of populations and species is also high following sequences of major pulses of salinity changes. The vast majority of total living mass of benthic infauna in the San Francisco Estuary are non-native species introduced through international shipping in San Francisco Bay ports. The principal ecological values of mudflats are not for the resident native biological diversity, but for the estuarine production, trophic (food web) support to fish and wildlife, and biogeochemical "processing" (transformation) of sediment and water provided by mudflats (Goals Project 1999). In contrast with the intertidal fauna of rocky shores, which includes many sessile (physically attached, fixed) invertebrates, the mudflat infauna is composed of mobile invertebrates adapted to the unstable surface of the mudflat, which is subject to daily erosion and redeposition by bay waves and tidal currents. Disturbed intertidal mudflats are rapidly recolonized by the prevalent infauna.

Mudflats are submerged twice daily and periodically become habitat for a diverse, mobile estuarine fish community. Fish in submerged mudflats feed on benthic infauna (invertebrates living under the mud) epibenthos (invertebrates living on the submerged mud surface), other fish, and drifting detritus or plankton. No eelgrass beds occur in intertidal mudflats in San Francisco Bay; they are restricted to shallow subtidal habitats in areas of relatively less turbid bay tidewaters, where they provide important habitat for benthic invertebrates and fish. Fish assemblages vary with geographic position in the Estuary, often in relation to large-scale and local salinity gradients, abundance of plankton (the foundation of the food web), and habitat structure.

Anadromous fish (species migrating upstream to freshwater rivers to spawn), estuarine fish, and marine fish occur in the submerged intertidal mudflats and tidal marsh channels. Juveniles of anadromous fish (such as salmon and steelhead) use vegetated edges of mudflats and marsh tidal channels as nursery and feeding habitats, providing both food and shelter from predators. Pacific herring and anchovy feed on drifting plankton in shallow or deep open waters. They provide a prey base for many larger fish. Flatfish species (flounder, sole, halibut, turbot), sculpin, and goby species are common bottom fish in both shallow and deepwater habitats. Cartilaginous fish (rays and sharks) are commonly found in shallow submerged mudflats, including leopard sharks, brown smoothhound, and bat rays. Rays are bottom feeders, taking benthic invertebrates by disturbing bottom sediments. Many non-native fish have also permanently established in the San Francisco Estuary.

Most of the San Francisco Estuary's tidal flats occur today in the South and North Bays; less mudflat area naturally occurs in Suisun Bay. The unvegetated surface of mudflats, combined with their very high productivity (infauna rich in calories and protein), makes their production available to migratory shorebirds and waterfowl of the Pacific Flyway. These waterbirds cannot feed, or feed only marginally, in consolidated (root-bound) emergent tidal marsh substrate and its vegetation. The bare soft bottom of mudflats submerged at high tide also provides rich feeding for diverse native fish populations (Goals Project 1999) and terns, including the endangered California least tern.

The essential unvegetated character of tidal flats in the San Francisco Estuary is due to an interaction between wave energy (forces of erosion and deposition from waves generated by winds blowing across the bay), intertidal slopes, and vegetation. Wave erosion during storms trims back the leading edge of cordgrass clones. Wave erosion also is responsible for maintaining mudflat area as sea level rises (converting the lower intertidal zone to subtidal habitat). The physical limitation of native marsh plants to resist wave-driven substrate dynamics is key to the maintenance of mudflat habitat and its proportions in the Estuary.

Subtidal and Intertidal Channels. A characteristic feature of historic San Francisco Estuary tidal marshes is the very high density of irregular, sinuous, branched tidal channels that extensively penetrate the marsh plain. This structure is related to the properties of native marsh plants, especially, the tidal elevations to which they are limited, and the effect their below-ground parts have on the cohesiveness of marsh substrate. Native wildlife, such as California clapper rails, and many native estuarine fish exploit the extensive channel networks in San Francisco Estuary tidal marshes, which provide close proximity of vegetative cover (predator refuge) and productive feeding in narrow channel beds and banks. Diving ducks and bay ducks, in contrast, congregate in larger tidal sloughs to feed or rest. Fish communities in channel habitats are essentially similar to those of mudflats submerged at high tide (see Mudflat Communities, above).

Salt marshes on coasts dominated by larger, robust cordgrass species, such as the Atlantic coastal plain, lack these complex and high densities of tidal channels, and instead develop simpler drainage systems and vast cordgrass meadows.

Eelgrass (*Zostera marina*) canopies provide important habitats for fish (foraging, shelter), and for geese where the vegetation grows intertidally or in very shallow subtidal zones. Establishment of eelgrass beds is also limited by current velocities: high tidal current energy can erode bottom sediments and uproot small colonies. Eelgrass is scarce in the turbid waters of San Francisco Bay and San Pablo Bay. In San Francisco Bay it is limited to subtidal areas, in contrast with low-turbidity, sandy marine estuaries, where it also grows intertidally (Phillips 1984). It is relatively more abundant in tidal channels and subtidal shallows in marine embayments with stabler sandy mud bottoms and clear water.

Special-Status Species

The San Francisco Estuary provides habitat for a large number of rare, threatened, and endangered species, and even more declining species of concern for conservation (Goals Project 1999, 2000). Those species that are subject to direct, indirect, or cumulative effects of cordgrass control are described in abbreviated, relevant detail here. Special-status species that occur in affected habitats are summarized in **Appendix F**, and species of particular relevance to this project are discussed in detail below.

California Clapper Rail (Rallus longirostris obsoletus). The endangered California clapper rail is one of the most important ecological issues related to invasive cordgrass eradication, because of complex and variable short-term and long-term impacts from the cordgrass invasion and the proposed eradication measures. The species, *Rallus longirostris,* is protected under the Migratory Bird Treaty Act, and this subspecies is Federally and State-listed as endangered.

The California clapper rail is one subspecies among many geographic "races" of the species in North America. Clapper rails resemble small chickens with long bills and legs, reflected in the common name, "marsh hen". California clapper rails specifically inhabit tidal salt and brackish marshes. Historically, California clapper rails ranged from Humboldt Bay to Morro Bay, with the core of the species' population in San Francisco Bay. Today, it is largely restricted to San Francisco Bay and San Pablo Bay, with occasional to regular vagrants reported from Tomales Bay (J. Evans, pers. comm.). Recent known clapper rail nesting locations are shown in **Figure 3.3-1**.

Clapper rails are opportunistic, omnivorous feeders. They feed mostly under or near stands of cordgrass, which shelter many of the food items clapper rails depend on, such as crustaceans, bivalves, insects, and even small mammals or birds. Within a tidal marsh, their "home ranges" and nest sites are usually keyed to small tidal creeks or channel edges. They generally avoid uniform marsh plains lacking tidal creeks, and seek channels or ditches with vegetation overhanging banks or covering the bank slopes.

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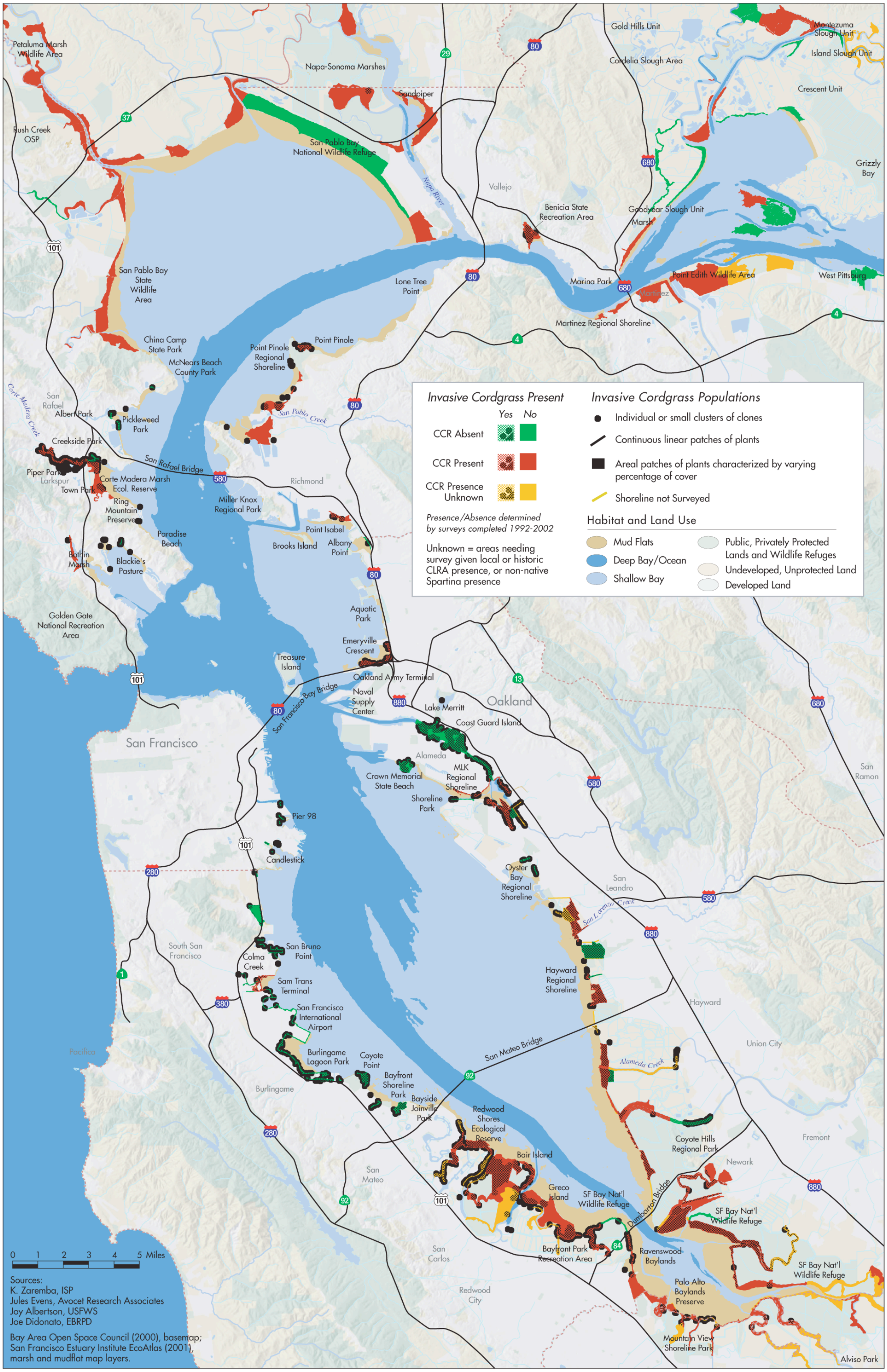

Figure 3.3-1. California Clapper Rail Presence/Absence Relative to Non-native Cordgrass

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California clapper rails generally avoid exposure outside of dense vegetation cover, where they are vulnerable to predation by hawks (especially northern harriers) or terrestrial predators (especially non-native red fox). The spread of the red fox in the South Bay during the 1980s destroyed many rail populations, and nearly caused the extinction of the species there. California clapper rail populations rebounded following red fox population control efforts, but red fox have since spread to the North Bay as well. Successful clapper rail breeding populations in the South Bay often depend on adequate access for red fox control operations (Harding 2000, Evens and Albertson 2000). Clapper rails are most vulnerable to predation during extreme high tides, when almost all emergent vegetation cover is submerged, exposing rails visually to predators. During these periods, clapper rails seek cover in almost anything that stands above the flooded marsh vegetation, including debris, tall semi-evergreen native vegetation (particularly gumplant, *Grindelia stricta* var. *angustifolia*), and even invasive tall-form Atlantic smooth cordgrass and its hybrids.

In the San Francisco Estuary, California clapper rails do not construct "floating" nests within Pacific cordgrass stands, as their southern California counterparts do (light-footed clapper rail, *R. longirostris levipes*). They naturally nest in tall, dense pickleweed or gumplant vegetation near small tidal creek banks in San Francisco and San Pablo Bays. However, they have recently been reported to nest locally within tall-form Atlantic smooth cordgrass vegetation in San Francisco Bay (J. Evans, K. Zaremba, pers. comm.).

California Black Rail (Laterallus jamaicensis coturniculus). The California black rail also is a relatively secretive tidal marsh resident, more often detected by its calls than actual sightings. The San Francisco Estuary supports the largest coastal population, mostly in northern San Pablo Bay and around Suisun Bay. They have been rare to locally extinct in San Francisco Bay in recent decades. It is now presumed extirpated in San Francisco Bay, but vagrants or new founders may occur. California black rails spend most of its time in dense cover of brackish tidal marshes, and prefer mixed pickleweed vegetation. They sometimes appear in freshwater or salt marshes along the coast. California black rails nest in tall grasses and grass-like vegetation as well as mixed pickleweed vegetation well above ordinary high tides. Like clapper rails and other resident marsh birds, the abundance of black rails corresponds with tidal creeks that dissect the marsh plain, and the availability of adequate, well-distributed high tide escape cover. Its distribution within the San Francisco Estuary suggests affinity for brackish tidal marsh vegetation (pickleweed, bulrush and tule), but it does occur in moderate densities where typical salt marsh dominant vegetation (pickleweed/cordgrass) prevails. Breeding birds do not utilize young cordgrass marshes, but may feed in cordgrass areas outside the breeding season. Black rails are declining in abundance within the Estuary (Trulio and Evens 2000, Evens et al. 1991). The species, *Laterallus jamaicensis,* is protected under the Migratory Bird Treaty Act, and this subspecies is currently listed as endangered in California, but not under Federal law.

California Least Tern (Sterna antillarum browni). California least terns are migratory, seasonal inhabitants of the San Francisco Estuary, where they breed in colonies. They arrive at California in April, and establish nests in May and June. Their natural coastal breeding habitats are sand spits and flats with minimal, sparse vegetation. In San Francisco Bay, natural habitats (suitable isolated, large beaches and flats) are now nearly absent, and California least terns have adapted to colonize man-made habitats with similar key features, such as barren levee crests or dry beds of salt ponds, and paved or other isolated areas with extensive, barren, flat artificial surfaces and little human activity. Their principal breeding colony in the region is at the former Alameda Naval Air Station on an abandoned runway, now managed for tern breeding (Feeney 2000). California least terns are ecologically similar to other, larger native terns, some of which (Forster's tern, Caspian tern) also breed in the San Francisco Estuary, and are themselves species of concern. Their nests all are vulnerable to terrestrial predators (rats, fox, skunks, raccoons), and avian predators (hawks, gulls). The species, *Sterna antillarum,* is protected under the Migratory Bird Treaty Act, and this subspecies is Federally and State-listed as endangered.

Like other terns in the San Francisco Estuary, California least terns forage in shallow bay waters for small, slender fish, particularly schools of northern anchovy and silversides. They commonly forage over productive tidal flats when they are submerged at high tide. The E.B. Roemer Marsh, Alameda and Roberts Landing area in San Leandro are established feeding areas: both have extensive sand flats, and both are being invaded by Atlantic smooth cordgrass. California least terns also feed in tidally connected man-made lagoons with low turbidity and abundant populations of small fish (e.g. salt intake ponds). Least terns teach their fledged young how to fish, and some roosts and feeding areas in San Francisco Bay are particularly used as post-fledging feeding sites for juveniles acquire feeding skills. Rich feeding in San Francisco Bay is important in building energy reserves needed for migration (Feeney 2000).

Western Snowy Plover, Pacific Coast Population (Charadrius alexandrinus nivosus). There are many subspecies (geographic races) of the small, pale shorebird in the species *Charadrius alexandrinus* (Kentish plover) worldwide (Hayman *et al.* 1986). The western U.S. subspecies, known as the western snowy plover (*C. alexandrinus nivosus*), inhabits playas (salt flats, dry beds of seasonal saline lakes) of the interior states, and beaches on the Pacific Coast. The population of the Pacific Coast constitutes a relatively distinct breeding unit. San Francisco Bay is one of the most productive breeding sites along the central California coast, while breeding success has often declined at natural beach breeding sites (U.S. Fish and Wildlife Service 2001). Like the California least tern, the western snowy plover has adapted to exploit the artificial playa-like habitats provided by dry beds of solar salt evaporation ponds and bare, linear levees. The natural analogues of these habitats in San Francisco Bay were extensive sand and shell spits, and natural salt ponds, primarily in the Berkeley-Oakland-Alameda shoreline. These were largely destroyed by urban and port development early in the State's history, (1850s to 1870s) prior to local breeding records for the species. Almost all of the Estuary's breeding colonies are in the South Bay. The San Francisco Bay population typically ranges around 200 to 300 adult birds. The subspecies is protected under the Migratory Birds Treaty Act and is Federally listed as threatened, but is not currently State-listed.

Western snowy plovers feed on insects and other small invertebrates found in sand or firm mud, edges of saline waters, decomposing algal mats or around moist, rich organic debris. In San Francisco Bay, they feed in salt ponds, levees, and sand flats at low tide. Brine flies are an important component of their diets in salt pond beds and levees. Like California least terns, they nest in small scrapes on relatively barren or very sparsely covered (debris, low vegetation) surfaces, preferring light-colored surfaces which mask their pale tan-gray backs. They are vulnerable to nest predators, including mammals (Norway rat, red fox, skunk, raccoon) and birds (ravens, falcons, hawks, gulls).

Salt Marsh Common Yellowthroat (Geothlypis trichis sinuosa). The common yellowthroat (*Geothlypis trichis*) is a small warbler with a complex of subspecies. The salt marsh subspecies (*G. t. sinuosa*) is recognized as a distinct breeding population, with geographic distribution, habitats, and morphological traits that subtly grade into some other subspecies. It inhabits tidal salt and brackish marshes in winter, but breeds in freshwater to brackish marshes and riparian woodlands during spring to early summer. Common yellowthroats feed on insects gleaned from vegetation or the ground. Salt marsh common yellowthroats occur in estuarine marshes along the coast from Tomales Bay to Santa Cruz, but the San Francisco Estuary represents the largest area of suitable tidal marsh habitat (Terrill 2000). Recent re-estimates of population size in the Estuary's tidal marshes (Nur *et al.* 1997) have been higher than those of the 1970s (Terrill 2000). The subspecies is a Federal and State "species of concern" due to major decline of both habitat and populations in the past decade, but is not currently listed as endangered or threatened. The common yellowthroat is protected under the Migratory Birds Treaty Act.

Tidal Marsh Subspecies of Song Sparrows (Melospiza melodia)

San Pablo Bay song sparrow (*M. m. samuelis*)

Suisun song sparrow (*M. m. maxillaris*)

Alameda song sparrow (*M. m. pusillula*)

Song sparrows are wide-ranging North American perching birds that inhabit a wide range of habitats. Local populations with distinct geographic and ecological affinities have evolved in the San Francisco Estuary, and are treated as subspecies. Each has undergone major declines in tidal marsh habitats, and proportionate declines in populations. The distribution of the region's three tidal marsh subspecies roughly correspond to San Pablo Bay, Suisun Bay area marshes, and San Francisco Bay. The tidal marsh song sparrow subspecies hold territories in tidal marshes all year, and breed in tidal marshes. They nest in areas of tall, emergent marsh vegetation above ordinary high tides especially in high marsh above tidal creek banks. They feed widely in the tidal marsh, gleaning insects off of vegetation. Within tidal marshes, San Pablo Bay song sparrows favor complex tidal marsh topography formed by marsh plains with dense networks of irregular tidal channels; they avoid homogeneous cordgrass. This habitat preference also applies to San Francisco song sparrows. Their territories follow configurations of tidal channels rather closely (Cogswell 2000). Suisun song sparrows nest in tall tules with local pickleweed. They also frequent tall vegetation along the edges of tidal marshes. Song sparrows are protected under the Migratory Birds Treaty Act. The subspecies are Federal and State "species" of concern, but are not currently listed as endangered or threatened.

Salt Marsh Harvest Mouse (Reithrodontomys raviventris)

Southern subspecies (*R. r. raviventris*)

Northern subspecies (*R. r. halicoetes*)

The salt marsh harvest mouse is a small mammal that inhabits salt marshes and brackish marshes only in the San Francisco Estuary. Its ecological distribution is closely (but not always exclusively) associated with vegetation including pickleweed, and its abundance often corresponds with the thickness, height, and continuity of pickleweed cover. It has two ecologically similar but distinct subspecies, one in the South Bay (the most critically endangered populations) and a more widespread and frequent subspecies in the North Bay and Suisun Bay marshes. Both subspecies are Federally and State-listed as endangered.

Though the salt marsh harvest mouse is adapted to tidal salt marshes, the young, small, isolated remnant tidal marshes of the South Bay are often deficient or lacking in salt marsh harvest mouse populations. This may be due to immature marsh topography and elevation, especially lack of well-distributed high marsh topography and vegetation cover, making the populations vulnerable to catastrophic flooding (drowning and excessive exposure to birds of prey) during extreme high tides that submerge the tidal marsh. Many of the largest South Bay populations occur in diked nontidal salt marsh, or diked marshes with limited tidal flows choked by tidegates. Salt marsh harvest mice are seldom if ever found in cordgrass marsh. They chiefly depend on pickleweed, plants associated with pickleweed, and green terrestrial grasses adjacent to tidal marshes, to which they disperse in spring. Environmental factors which constrict the development of tall, thick growth of salt marsh or brackish marsh above the cordgrass vegetation zone, or limit the development of high tide escape cover, are detrimental to conservation of the species. Prolonged, deep submergence of marsh vegetation at any time of the year is detrimental to the stability of their populations, particularly in smaller salt marsh patches (Shellhammer 2000a, U.S. Fish and Wildlife Service 1984).

Tidal Marsh Shrews (Sorex species). The salt marsh wandering shrew (*Sorex vagrans halicoetes*) and Suisun shrew (*Sorex ornatus sinuosis*) are small carnivorous mammals with high demand for abundant prey with high nutritional and energy value, including insects, amphipods (beachhoppers), isopods, and other small invertebrates. Unlike the salt marsh harvest mouse, they do not adapt well to diked non-tidal salt marshes, which are seasonally dry, or to upland grasslands. They tend to occur mostly in low, dense vegetation and under mats of tidal debris in tidal marsh plains. Like the salt marsh harvest mouse and other small mammals, they also depend on the availability of adequate cover during extreme high tides, which submerge vegetation cover and expose them to predators. Wandering shrews and ornate shrews are taxonomically difficult, and local distinct marsh populations or subspecies may intergrade with more widespread types within their species. Currently, the salt marsh wandering shrew is geographically limited to the South Bay. The Suisun ornate shrew occurs in the North Bay and Suisun Marsh (Shellhammer 2000b, MacKay 2000). Though rare and dependent on highly reduced habitat, they do not currently have protected status under State or Federal endangered species laws. The subspecies are Federal and State "species of concern."

California Red-Legged Frog (Rana aurora draytonii). California red-legged frogs are formerly widespread amphibians native to freshwater marsh habitats, subsaline coastal lagoons (stream-mouth estuaries periodically impounded by beach ridges), creeks and riparian habitats, and seasonal ponds. In modern landscapes, their habitats include man-made seasonal wetlands such as stock ponds and ditches. Their limited salt tolerance (around 4 parts per thousand salinity, lower than most of Suisun Marsh in summer) restricts them to wetlands landward and peripheral to tidal marshes in modern San Francisco Bay. They require standing water for breeding, but disperse widely in uplands during summer, remaining inactive in small mammal burrows. They periodically return to freshwater refuges to rehydrate, but they can remain inactive in upland burrows for many weeks. The subspecies is Federally listed as threatened, but is currently not State-listed.

San Francisco Garter Snake (Thanophilis sirtalis tetrataenia). Like the California red-legged frog, the San Francisco garter snake inhabits freshwater marshes, riparian habitats, and seasonally disperses to burrows in uplands. One of the largest remaining populations occurs in a freshwater to subsaline non-tidal marsh west of Highway 101, across from the San Francisco International Airport. It is not reported from tidal marsh habitats, but channelized freshwater drainages (flood control channels) along the northern San Francisco Peninsula could provide potential linkages between suitable habitat and tidal marshes, but it has not been detected in creeks discharging to the Bay (Jennings 2000). The subspecies is Federally and State-listed as endangered.

Harbor Seal (Phoca vitulina richardi), San Francisco Estuary Resident Populations. Harbor seals are permanent residents of San Francisco Bay and San Pablo Bay. Harbor seals, like all mammals, are protected by the Federal Marine Mammal Protection Act, but they are not listed as endangered or threatened under the Endangered Species Act. They feed on fish in deepwater habitats (channels, open bay), but use emergent shores as "haul-outs," where they come ashore to rest, and also to pup (give birth to offspring). Several haul-out sites in the Estuary occur on high tidal marshes, such as Tubbs Island/Midshipman's Point, and Dumbarton Point, and other areas of Newark Slough, Mowry Slough, and Calaveras Point. Haul-outs are necessarily directly connected to deepwater habitats, have gently sloping terrain, and must be free from human disturbances from boats or land (Lidicker and Ainley 2000, Allen *et al.* 1984). Seals trample and wallow vegetation to sparse, low mats. They do not access haul-outs through wide, dense, tall cordgrass marshes.

Southern Sea Otter (Enhydra lutris nereis). The historic range of the sea otter extended from Baja California to the Aleutian islands. The species has been fragmented to two isolated population segments by historic hunting, which nearly drove the species to extinction. Sea otters were formerly abundant in San Francisco Bay, which presumably provided rich feeding areas. They feed on bivalves, abalone, urchins, crustaceans, cephalapods (squid relatives) and fish. Along the central California coast, sea otters are established from Point Sur to Pacifica, San Mateo County. Vagrant sea otters are periodically reported in San Francisco Bay (Ainley and Jones 2000). The nearest estuary that supports sea otters is Elkhorn Slough, a historically brackish semi-tidal lagoon and marsh forced to full marine tidal influence by jetties at Moss Landing. Shallow intertidal habitats in San Francisco Bay, which could potentially support recovery and re-establishment of sea otters in San Francisco Bay are subject to invasion by Atlantic smooth cordgrass. Estuarine habitat of sea otters in Elkhorn Slough is also potentially vulnerable to spread of Atlantic smooth cordgrass from San Francisco Bay. The southern sea otter is Federally and State-listed as endangered.

Tiger beetles (Cicindela senilis senilis, C. oregona, C. haemorrhagica). Insects of San Francisco Estuary tidal habitats are very poorly understood in terms of both taxonomy (biological diversity of species) and their ecological interactions within estuarine communities. They also are sensitive to changes in tidal marsh habitats. Several species of tiger beetle (*Cicindela* spp.), large insects with large eyes and toothed, conspicuous mandibles, have become rare (or sub-regionally extinct) in the San Francisco Estuary. *C. haemorrhagica* and *C. oregona* are associated with maritime and estuarine beaches. *C. senilis senilis* is found on high channel banks, levees, and salt pond margins today, and were probably historically dependent on natural habitats between the edges of tidal marsh and large pans (Maffei 2000). Alluvial fans and sandy deltas, now largely eliminated from the urbanized edges of the Estuary, may have been potential habitat as well.

Winter- and Spring-Run Chinook Salmon (Onchorhyncus tschawytscha). Chinook salmon populations native to the Sacramento-San Joaquin river systems are segregated into distinct populations, reproductively isolated by different migration times. The winter-run and spring-run Chinook salmon migrate upstream from the sea to spawn in gravel beds of freshwater streams in winter and spring. The winter-run and spring-run populations have been Federally listed as endangered. Loss and degradation of spawning habitat, mass entrainment of young in water diversions, and reduced delta outflows (also due to water diversions) are among the leading threats to the survival and recovery of the species. Smolts (juvenile salmon spawned upstream) move through the Estuary to feed in shallow water habitats, including salt marsh channels and submerged tidal mudflats. Adults also pass through the Estuary during seasonal migrations upstream, and forage in both intertidal and subtidal habitats. They feed primarily on invertebrates and small fish. National Marine Fisheries Service has designated all tidal waters of the San Francisco Estuary as critical habitat for winter-run Chinook salmon. Tidal marsh and other estuarine habitats are reported to have an important role in Chinook salmon life-history. Tidal marshes are important habitats for small juveniles (fry), while older smolts tend to use deeper waters. Fry tend to occur near the shelter of submerged channel bank or marsh edge vegetation at high tide, and retreat with submerged habitat as the tide falls (Maragni 2000, U.S. Fish and Wildlife Service 1996)

Steelhead (Onchorhyncus mykiss irideus). Steelhead are trout species in the same genus as salmon, and they have life-histories essentially like those of Chinook salmon. Steelhead in the San Francisco Estuary are among the populations Federally listed as threatened. Adults and juveniles pass through the Estuary and feed in subtidal and intertidal habitats, including tidal marsh channels and submerged mudflats, as they migrate upstream to freshwater streams or downstream to marine habitats. Steelhead are drift-feeders, consuming a wide range of aquatic invertebrates and small fish. Adult steelhead migrating upstream seldom feed. Small steelhead runs occur in South Bay tributaries (e.g. San Francisquito Creek, Guadalupe River, Alameda Creek), and in many creeks and rivers of the North Bay and Suisun Bay areas. The importance of tidal creeks and other transient estuarine habitats for steelhead is not well understood (Maragni 2000).

Delta Smelt (Hypomesus transpacificus). Delta smelt are small, short-lived estuarine fish that migrate between shallow freshwater stream habitats in which they spawn, and brackish reaches of the San Francisco Estuary. Delta smelt also spawn at the terminal ends of tidal creeks in fresh-brackish tidal marshes. Downstream habitat is primarily limited to intertidal and subtidal habitats of Suisun Bay and its tidal marshes, but they occur also in San Pablo Bay, particularly during and after heavy freshwater flows. They may persist in tributaries of San Pablo Bay during periods of reduced salinity. They generally are limited to estuarine salinity below 10 to 14 parts per thousand, and are usually found in tidewater salinity 2 parts per thousand or less. Their abundance in the Estuary is variable, and appears to be related to both Delta outflows and food supplied by plankton production. The species is Federally and State-listed as threatened.

Sacramento Splittail (Pogonichthys macrolepidotus). Sacramento splittail is the only species in a unique genus of large, native minnows. It inhabits the Sacramento-San Joaquin river system and the Delta, including the brackish northern reaches of the San Francisco Estuary. The species has been collected in tidal waters as salty as 18 parts per thousand salinity, but splittail abundance is greatest in salinity lower than 10 parts per thousand. Within the Estuary, it occurs primarily in the Suisun Bay area, but reaches northern San Pablo Bay regularly in years of high river discharge. Sacramento splittail have been very rarely collected in San Francisco Bay. They spawn in fresh or nearly fresh, nonsaline shallow waters with submerged vegetation. Within the Estuary, they are reported to be most abundant in small tidal creeks, particularly those with freshwater discharges or partially submerged marsh vegetation (Sommer 2000). The species is Federally and State-listed as threatened.

Tidewater Goby (Eucyclogobius newberryi). Tidewater gobies are rare, small estuarine fish related to sculpin. The species is Federally listed as endangered. Tidewater gobies primarily inhabit coastal stream mouths, which become intermittent lagoons dammed by beach ridges, impounding brackish waters. The tidewater goby's historic geographic range is from Humboldt County to southern California, including San Francisco Bay. They also occur in subtidal brackish estuarine habitats, but little survey information is available from San Francisco Bay. The few historic records from San Francisco Bay are old; no populations have recently been confirmed. Former collection sites include Berkeley Aquatic Park (1950). Greater predation in large estuaries, compared with intermittent habitat of coastal lagoons, may limit them in San Francisco Bay (Swift *et al.* 1989, U.S. Fish and Wildlife Service 1994). The species is Federally listed as endangered, but northern and central coast populations have been proposed for delisting (U.S. Fish and Wildlife Service 1999).

California Sea-Blite (Suaeda californica). California sea-blite is a low, sprawling, fleshy gray-green shrub related to pickleweed. This Federally endangered plant was historically native only to San Francisco Bay and Morro Bay (San Luis Obispo Co.). Habitat of California sea-blite is restricted to the upper edges of tidal marshes or bay shorelines, generally in coarse, well-drained substrate such as sand, sandstone, or shell fragments. Historic records of California sea-blite in San Francisco Bay are known from Richmond, Berkeley, Oakland, Alameda, San Francisco, South San Francisco, and Palo Alto, all locations of historic sand or shell beaches with adjacent salt marsh. The original native San Francisco Bay population of California sea-blite became completely extinct some time around or after 1960. A pilot project to re-establish a colony propagated from Morro Bay stock was initiated at a constructed tidal marsh in the Presidio of San Francisco in 1999. The recovery of this species in San Francisco Bay would depend on maintenance and restoration of estuarine sand beaches with salt marsh transition zones, a habitat threatened by Atlantic smooth cordgrass invasion. Beach-salt marsh transition zones are also a prime habitat for *Spartina patens* in its native range. The species is Federally listed as endangered, but is not State-listed.

Suisun Thistle (Cirsium hydrophilum var. hydrophilum). Suisun thistle is among the rarest and most endangered plants in the San Francisco Estuary. Suisun thistle is a stout, tall short-lived perennial thistle, superficially resembling the weedy European bull thistle. It grows along tidal creek banks and high brackish marsh plains at very few locations in very old tidal marshes around upper Suisun Slough, near Rush Ranch and Peytonia Slough. It was historically reported only from Suisun Marsh, where it was formerly associated with Bolander's water-hemlock, once a common and conspicuous plant there. In addition to loss of nearly its entire original tidal marsh habitat, its survival is threatened by many biological and physical changes in Suisun Marsh, including an introduced weevil that feeds on its seedheads, an aggressive brackish marsh weed (*Lepidium latifolium*), and large-scale hydrologic manipulations aimed at salinity control for non-tidal waterfowl pond management (SEW 1998, Baye *et al.* 2000). The last remaining habitat for this species is within the potential invasion range of *Spartina patens* (well-established at Southhampton Marsh, the western extreme of Suisun Marsh), Chilean cordgrass and Atlantic smooth cordgrass. This variety is Federally and State-listed as endangered.

Soft Bird's-Beak (Cordylanthus mollis ssp. mollis). Soft bird's-beak is an annual herb with creamy-yellow flowers and glistening glandular hairs on its foliage that exude salt. It is native only to the tidal marshes around Suisun Bay and northern San Pablo Bay. Its historic range was very similar to its modern range, but its abundance has declined severely with the loss of its essential tidal marsh habitat. It occurs in both salt marsh and brackish marsh, but the vast majority of populations recorded are in brackish high marsh habitats, where it typically occurs in mixtures of pickleweed and other associated salt marsh herbs, including edges of pans, terrestrial ecotones, and tidal creek bank edges (Rugyt 1994). At Southhampton Marsh, Benicia, multiple colonies are_being encroached by *Spartina patens* and the highly invasive perennial pepperweed (*Lepidium latifolium*). At Point Pinole, the locations of former colonies have been colonized by *Spartina densiflora*. Most of the species' ecological and geographic range is within the potential range of the aggressive Atlantic smooth cordgrass hybrid swarm. The subspecies is both Federally and State-listed as endangered.

Northern Salt Marsh Bird's-Beak (Cordylanthus maritimus ssp. palustris). Northern (or Point Reyes) salt marsh bird's-beak is a low annual herb of the high salt marsh, typically in low or sparse vegetation or the edges of pans. In the San Francisco Estuary, it has showy rosy-pink flowers and purplish gray-green foliage bearing salt crystals, exuded from specialized glands. It occurs in tidal salt marshes from southern Oregon to San Francisco Bay. It has been locally extinct south of the Golden Gate in San Francisco Bay for many decades, where it was formerly widespread and abundant as far south as Alviso. A few populations remain only in salt marshes of the Estuary's Marin shores (northern Sausalito, Mill Valley, Greenbrae, Bucks Landing [Gallinas Creek], and the Petaluma Marsh). Marin County (Creekside Park, Corte Madera) is the center of spread of *Spartina densiflora*, and the point of introduction of English cordgrass. Large populations of northern salt marsh bird's-beak occur in west Marin's maritime salt marshes (Bolinas Lagoon, Point Reyes, and Tomales Bay), many appearing distinct from San Francisco Bay types. Most of the subspecies' ecological and geographic range is within the potential invasion range of all non-native cordgrasses of the San Francisco Estuary. It is closely related and difficult to distinguish in most respects from the Federally listed southern salt marsh bird's-beak (*C. maritimus* ssp. *maritimus*), which ranges from Morro Bay to Baja California. The northern subspecies is treated as a species of concern, but has no special legal status.

Pacific or California Cordgrass (Spartina foliosa). Pacific cordgrass is the Pacific Coast's ecological equivalent of Atlantic smooth cordgrass, and its close relative. It is the sole historic dominant low salt marsh species from Bodega Bay to Baja California. Though common, the recent discovery of strong and rapid genetic assimilation by Atlantic smooth cordgrass indicates a high risk that this species may become extinct in San Francisco Bay, and eventually throughout its range as the Atlantic smooth cordgrass hybrid swarm disperses and fills out its potential niche in the California coast. It was recently discovered that the overwhelming fertility and abundance of Atlantic smooth cordgrass pollen was causing Pacific cordgrass to reproduce only hybrids, rather than its own species, in the presence of Atlantic smooth cordgrass. Prior to this discovery, Pacific cordgrass was not considered a species of concern (Antilla *et al.* 1999, Ayres *et al.* 2001); now it is believed that the species is in danger of extinction. Previously, competition alone was the main threat to this species, which allowed for the possibility of persistent co-existence with Atlantic smooth cordgrass rather than a genetic "winner-take-all" outcome of hybridization between species (Strong and Daehler 1994). The species is not currently Federally or State-listed as endangered or threatened, but is under evaluation because of the rapidly changing genetic threat to the species.

Bolander's Spotted Water-Hemlock (Cicuta maculata var. bolanderi). Bolander's spotted water-hemlock is a very rare perennial herb resembling parsnips, closely related to the wider-ranging spotted water-hemlock (*C. maculata* var. *maculata*). Historically "conspicuous and abundant" in Suisun Marsh (Greene 1894), it occurs in small, rare populations there today, mostly along banks of tidal creeks (B. Grewell, unpubl. data). It was associated with the Suisun thistle (Greene 1894). Its extreme decline was only recently recognized. Most of the threats that affect Suisun thistle also affect this plant. The variety is not currently Federally or State-listed, but is under evaluation because of its apparent extreme rarity and habitat decline.

Mason's Lilaeopsis (Lilaeopsis masonii). Mason's lilaeopsis is a creeping, mat-forming perennial herb with a grass-like appearance. It grows among low, turfy vegetation along eroding marsh banks at the edges of tidal channels or bay-edge marshes, often in peaty marsh soil, or thin sediment deposits. It occurs in scattered populations in the San Francisco Estuary from lower Tubbs Island (Sonoma County) through Suisun Bay and the Delta. Wave-trimming and channel bank erosion are important factors that maintain its dynamic, unstable habitat in some locations. Chilean cordgrass aggressively colonized analogous habitat at Point Pinole, San Pablo Bay, and Atlantic smooth cordgrass has established below wave-cut marsh scarps and eroding channel banks, promoting stabilization and dense cover of vegetation. The species is classified as rare by the State, but is not Federally or State-listed as endangered or threatened.

Salt Marsh Owl's-Clover (Castilleja ambigua, affinity with ssp. ambigua). Salt marsh owl's-clover is an annual herb with showy tubular, pouched flowers, related to bird's-beak. Historically widespread in tidal marshes of the San Francisco Estuary, it is now restricted to salt marsh edges of Point Pinole, near an arrested invasion of *Spartina densiflora*, and at Southhampton Marsh, Benicia, near expanding *S. patens* colonies. Typical *C. ambigua* ssp. *ambigua*, or johnny-nip, is widespread in coastal grasslands of California and Oregon. The distinctive Point Pinole population contains mostly purple-tinged plants and flowers which do not match the diagnostic description for the subspecies *C. ambigua* ssp. *ambigua*, and appear distinct from typical yellow-white flowered upland grassland forms of that subspecies in the region. The San Francisco Bay population has no protective legal status.

Other Declining High Marsh Plant Species of Concern. A large number of tidal marsh plants which were historically widespread or at least locally abundant have become either regionally uncommon, rare or locally extinct. Most occur in the high marsh zone, which has been compressed by steep levee slopes in most of the San Francisco Estuary. Some are perennial species that may be mistaken for more widespread species with similar appearance, and others are ephemeral spring annuals that are readily identified during brief flowering periods. Examples include Suisun aster (*Aster lentus*), California saltbush (*Atriplex californica*), centaury (*Centaurium trichanthum*), downingia (*Downingia pulchella*), smooth goldfields (*Lasthenia glabrata* ssp. *glabrata*), maritime spikeweed (*Hemizonia pungens* ssp. *maritima*) and numerous others (Baye *et al.* 2000). The high marsh zone is subject to periodic storm deposition of tidal litter, which smothers vegetation and creates openings favorable to establishment of some species. Extreme drift-line deposits, however, can accumulate as persistent wracks along steep levees and destroy most high marsh vegetation. This occurs along segments of southern Hayward shoreline where Atlantic smooth cordgrass litter is produced in abundance.

3.3.2 Analysis of Potential Effects on Biological Resources

The impacts evaluation is divided into three parts: First, the criteria used to determine the significance of the project effects on biological resources are described. Then a general discussion of the impacts of the various treatment methods is presented; this discussion is followed by specific enumerated project impacts and mitigation measures. Potential effects and mitigation measures are summarized in **Table 3.3-1** and **Table 3.3-2**, respectively.

Significance Criteria

The thresholds for "significance" of impacts to biological resources are based in part on specific regulatory standards from relevant environmental laws or regional plans, and on interpretation of the general biological context and intensity of effects within the ecosystem.

The principal environmental laws pertinent to evaluation of the level of significance to environmental impacts in the San Francisco Estuary include the California Environmental Quality Act (CEQA), the Clean Water Act (CWA, including specific guidance on evaluation of impacts to wetlands and other special aquatic habitats), the California and Federal Endangered Species Acts (CESA, ESA), and Migratory Bird Treaty Act. Other State government agency plans and laws which apply to the quality of habitats in the San Francisco Estuary include the California Fish and Game Code, the McAteer-Petris Act and San Francisco Bay Conservation and Development Commission's Bay Plan (BCDC Bay Plan), the Suisun Marsh Preservation Act, the Porter-Cologne Act and the San Francisco Regional Water Quality Control Board's Basin Plan for San Francisco Bay. The endangered species recovery plans for the California clapper rail and salt marsh harvest mouse, and native fish of the Sacramento-San Joaquin Delta (U.S. Fish and Wildlife Service 1984, 1996) and the multi-agency Baylands Ecosystem Regional Habitat Goals Project (Goals Project 1999) are also important plans specific to habitats and species of the San Francisco Estuary. All of these laws, regulations, and plans recognize the ecological importance of intertidal mudflats, and estuarine salt and brackish marshes, and estuarine fish habitats.

CEQA includes the following mandatory findings of "significance" for biological resources if the project would:

- Substantially reduce the habitat of a fish or wildlife species;
- Cause a fish or wildlife species to drop below self-sustaining levels;

- Threaten to eliminate a plant or animal community; or
- Reduce the number or restrict the range of an endangered or threatened species.

CEQA also requires consideration of the project's compliance with local, State, or Federal policies or plans for the protection of sensitive species or habitats. These include Habitat Conservation Plans, Natural Community Conservation Plans, Section 404 of the Federal Clean Water Act, the Migratory Bird Treaty Act, the Bald Eagle Protection Act, and local regulations such as Creek Protection Ordinances.

The Clean Water Act's section 404(b)(1) guidelines for evaluation of discharges of dredged or fill materials (one incidental aspect of numerous proposed activities considered in this EIS/R) provide specific guidance for evaluating significant impacts to special aquatic sites, including wetlands in Subpart H. These include factors that cause or contribute to "significant degradation of the Waters of the United States," with emphasis on the persistence and permanence of effects. Determinations essential to determination of "significant degradation" must include:

- Recolonization of indigenous organisms;
- Wildlife and wildlife habitat (reproduction, food supply, cover, resting areas, nurseries, etc.)
- Threatened and endangered species, and their habitats (reproduction, food supply, cover, resting areas, nurseries, etc.)
- Proliferation of undesirable competitive species
- Wetlands and mudflats, and vegetated shallows

The baseline, for determination of a significant impact is the existing San Francisco Estuary ecosystem. The "existing conditions" of an ecosystem are not static, but involve dynamic changes in the status and trends that are reasonably foreseeable over an ecologically meaningful timeframe. As described earlier in this section, a 1-2 year period is the short-term timeframe, a 5-10 year period is the intermediate time frame, and a 50-year period is used as the long-term timeframe for ecological evaluations.

Therefore, for the purposes of the following evaluation, biological effects are considered "significant" within an appropriate time-frame and ecological context if they cause relatively high magnitude, persistent, or permanent changes in the following factors, compared with a dynamic environmental baseline rooted in existing conditions:

- Substantially reduce the population size, distribution, viability, or recovery potential of a rare, threatened, or endangered species, or species of concern;
- Changes in the population size, distribution, viability, or resilience of a native fish, wildlife, or plant species;
- Changes in the range, patterns, or fluctuation (dynamics) of physical or chemical attributes of physical estuarine habitats (tidal waters or substrates).
- Changes in stability or structure of estuarine habitats.
- Conflicts with local, State, or Federal biological resource protection plans, policies, and regulations.

Variables Affecting Biological Predictions and Analyses

Major variables affecting the long-term maturation of tidal marshes cannot be determined with high confidence. Future rates of sea-level rise, future sediment budgets, and complex interactions between new dominant invader plant species in new physical estuarine conditions are examples of such variables. The closest comparable cordgrass invasion, the more advanced spread of Atlantic smooth cordgrass in Willapa Bay, Washington, occurs in a different tidal marsh plant community and estuarine setting, one without any native cordgrass species or currently listed endangered resident marsh plants, fish, and wildlife. The future consequences of continued spread or eradication of invasive cordgrass in San Francisco Bay can be inferred by comparing San Francisco Estuary marshes with native marshes of the four introduced cordgrass species and with other estuaries that have already been colonized by these cordgrasses. Biological impacts of non-native cordgrass eradication efforts have been assessed in many other estuaries, and provide a range of analogous environments to help evaluate conditions in the San Francisco Estuary.

Another indeterminate aspect of predicting ecological outcomes of the Invasive Spartina Project is its nature as a regional coordination program, rather than a single site-specific project with specifically defined project logistics (time, methods, location, etc.). The following evaluation of biological impacts addresses the broader regional scope of potential effects and mitigation for adverse impacts to biological resources. Ecological evaluations consider various contingencies to cover the range of eradication methods that would be most applicable to a given type of impact. These address different types of local environments (mudflats, mature marshes with creek systems, simple young marsh strips, beaches, etc.) and different methods of removal (mechanical excavation or dredging; cropping methods such as repeated mowing or disking; methods which leave a matrix of killed roots and rhizomes physically in place, such as herbicides, drowning, or smothering; etc.). Evaluations emphasize biological resource issues that are likely to apply generally to many or most potential projects, as well as issues that can be addressed only at larger regional scales, beyond individual projects.

General Impacts of Proposed Treatment Methods

The following overview of cordgrass control methods and materials (the *Spartina* control "toolbox") emphasizes some of the operational, physical, and physiological aspects of eradication work that is particularly relevant to interpretation of biological impacts to species and communities affected.

Amphibious Vehicles and Equipment. Various eradication methods depend on use of vehicles designed to operate in semi-aquatic environments. Some support equipment or attachments for mowing vegetation, ripping and shredding vegetation and substrate, or excavation of marsh substrate. Amphibious vehicles are usually designed to operate with low ground pressure, distributing weight on specialized tracks or tires. All amphibious vehicles, however, crush and cause dieback of marsh vegetation, particularly sub-shrubby vegetation with brittle stems. The amount of vegetation dieback often depends on the number of vehicle passes, the shear strength of the substrate, and the season. Vehicles passing over brittle vegetation in summer tend to cause the most dieback. Soft sediment, which causes ruts or depressions, or shearing of sediment below tires or tracks, often magnifies the impact of vehicle passes on marsh vegetation. Insects, benthic invertebrates, and small mammals have a definite but unquantified risk of being crushed by vehicles. Marsh-nesting birds may be disturbed by vehicles, and abandon territories or home ranges to less suitable (and competitive) locations. Nests may be destroyed inadvertently by marsh vehicles. The insufficiently surveyed populations of rare plants, including dormant seed banks or bud banks, are also subject to destruction by mobilization of marsh vehicles.

The pattern of invasive vegetation colonies in the marsh or mudflat determines the potential for unavoidable track disturbance if vehicles are used. Also important is the location of potential entry points to the marsh. Marsh entry points that are close to both target colonies and to maintenance or access roads on the land or levee side help to avoid excess vehicle track formation. This is not always the case for larger marshes far from roads or levees.

Vehicles working in unpredictable patterns of soft marsh substrates with many small tidal creeks run the risk of becoming stuck or mired. This would necessitate the entry of additional equipment to remove stuck vehicles. Such operations cause substantial local marsh disturbance, and may require additional rehabilitation or marsh restoration.

Vehicles working in marshes are seldom if ever refueled in the marsh itself. Such refueling would result in risks of fuel spills. Floating barge-mounted equipment, in contrast, is more likely to require refueling while working in sloughs.

"Mats," large wooden blocks placed over tough geotextile fabric to distribute the weight of equipment and protect underlying marsh vegetation, are sometimes used in conjunction with heavy equipment in tidal marshes. Mats limit the mobility of equipment to work in a few areas. They reduce, but do not eliminate, damage to marsh vegetation.

Small vehicles are routinely used in tidal marshes of the San Francisco Estuary for monitoring and treating production of mosquitoes. They leave both temporary and persistent tracks, depending on frequency of use. Most vehicle access to tidal marshes in the region is limited to restoration or enhancement of tidal creeks or ditches (improvement of tidal circulation), debris removal, and eradication.

Mechanical Disturbance of Substrates. Some eradication methods involve destabilizing the surface substrates of tidal marshes and mudflats in the course of removing or damaging both above-ground and below-ground parts of invasive cordgrasses. In mudflats, removal of stabilizing root and rhizome systems re-exposes the mudflats to normal patterns of erosion and redeposition by waves and tidal currents. Exposure of deeper, coal-black anoxic (oxygen-starved) muds causes rapid oxidation of chemically reduced substances such as iron sulfide and hydrogen sulfide. In contrast with dredging that occurs in subtidal, deepwater environments, excavation, dredging or similar actions applied to cordgrass necessarily occur in intertidal environments, and generally while exposed to air. Plumes of turbid water or blackened, anoxic suspended sediments in the water column, associated with excavation disturbances under water, are not aspects of upper and middle intertidal disturbances during low tide. If dredging of cordgrass were conducted at high tide when the bottom is shallowly submerged, general immediate impacts would be intermediate between those typical of navigational dredging and intertidal excavation. Smooth cordgrass stems and foliage provide oxygen pathways to its roots and rhizomes, which "leak" oxygen to otherwise oxygen-starved (anoxic) sediments. Removal of above-ground growth of smooth cordgrass results in an acute increase in the severity of root-toxic, anoxic waterlogged sediment conditions.

Dredging or excavation of anaerobic bay mud may expose buried sediments with higher levels of mercury, or more biologically available forms of it. Mercury is a heavy metal present in bay muds from natural and artificial sources, and background levels in San Francisco Bay are very high compared with most estuaries nationally. Biological activity of mercury is dependent in part on microbial transformation of mineral forms of mercury to organic forms, principally methylmercury. Mercury in organic materials can be ingested by benthic organisms, which in turn, may be consumed by fish, birds, and mammals, and can thereby bioaccumulate in higher organisms in the food chain.

The irregular, rough topography left by mechanical disturbances to soft sediments is subject to brief increases in erosion until it is planed off by wave action. Both mudflats and prevailing benthic infauna are adapted to mobility of the upper few centimeters of the mudflat surface, and regularly move and resettle as sediment is lifted by wave erosion and redeposited. Depressions in exposed mudflats caused by natural bioturbation, such as foraging by bat rays, tend to be ephemeral. Any shallowly buried substances, whether natural biogeochemical products (like toxic sulfides) or artificial contaminants, would be remobilized and dispersed following excavation, digging, or other mechanical disturbance of the substrate.

Dislodged or cut plant material (stems, rhizomes, roots, live or dead foliage) from mechanically disturbed sites is likely to redeposit at more stable positions in the Estuary than open marsh or mudflats. They typically accumulate as drift-lines or debris patches near where the contemporary high tide level is intercepted by emergent vegetation downwind. Debris also collects where coves or angles occur in the shoreline. Much above-ground biomass of cordgrass is shed in winter rather than late summer or fall. Fragments of rhizomes may remain viable in cold Bay water and cold air temperatures, but quickly lose viability if exposed to air at mild or warm temperatures, or exposed to sun. Stem fragments with viable buds may regenerate clones if they are rapidly deposited in shallow mud.

Disturbed mudflat substrates are not more likely to be recolonized by marsh vegetation or non-native invaders after disturbance. Disturbed tidal marsh vegetation and substrate, in contrast, is highly vulnerable to invasion by numerous non-native plants, which take advantage of openings in the vegetation canopy and temporary freedom from interference from established vegetation. Disturbed substrates, such as ditch spoils or recently capped levees, often become nuclei for additional invasions by multiple salt marsh weeds.

Flooding and Draining. Impounding standing water in marshes can cause significant, but reversible, changes in marsh soils. The degree to which conditions are reversible depends on the duration of the impoundment. The extensive segments of the large "strip marsh" of pickleweed along the northern edge of San Pablo Bay impounds shallow water (up to 18" deep) for months in winters of high rainfall and high tides, killing hundreds of acres of pickleweed. The marsh vegetation regenerates in years of reduced marsh flooding. Long-term, persistent impoundment, however, allows marsh organic matter to slowly decompose under extreme oxygen-deficient conditions, causing depression of the marsh surface and accumulation of toxic sulfides, which acidify the soil after marsh drainage is restored (Portnoy 1997). If cordgrass stems are mowed in winter to prevent gas transport from live or dead stems to roots and rhizomes below ground, high mortality is likely to occur by the end of the growing season following flooding treatment. Therefore, marsh impoundments used for cordgrass eradication are likely to be in place for less than one year.

When tidal marshes are diked and drained, rather than flooded, they undergo rapid physical and chemical changes. Organic matter decomposes when microbes are exposed to air; clays shrink when dewatered; and sulfides formed in oxygen-free mud transform to sulfates forming strong acids (Portnoy, 1999). Therefore, diking and draining, although conceivably effective for killing cordgrass, would adversely impact marsh soils and restoration, and the longer salt marsh soils are diked and drained the more difficult these adverse soil changes are to reverse. For these reasons, diking and draining will only be used in critical situations where no other method is feasible, and only after careful evaluation and planned mitigation. Diked salt marsh soils that remain permanently flooded undergo relatively slower and less significant changes. Diked flooded salt marshes would eliminate existing standing vegetation, but are readily re-colonized by youthful salt marsh vegetation if the diking is brief.

Low berms can be constructed by excavation equipment or "inflatable dams" used for dewatering construction sites – tubes of geotextile fabric inflated by pumping water in them. Both methods involve mobilization of equipment in the tidal marsh, which is inherently disturbing to vegetation and wildlife. Earthen berm construction requires excavation of a borrow ditch, and multiple "lifts" (layers of piled mud) to raise elevations as drained mud shrinks. Destruction of berms by backfilling the borrow ditch leaves a depression because of the shrinkage in sediment volume in drained conditions. The drained and rewetted mud also tends to become somewhat to very acidic. Inflatable dams leave less persistent impacts to marsh vegetation and topography.

Burning. Burning tidal salt marsh vegetation is difficult. Most vegetation has high water content, salt that absorbs moisture, and some have succulent stems and leaves. Fuel generally has to be added to salt marsh vegetation to ignite it. Brackish marsh vegetation, which has a higher proportion of tall, grass-like plants, is easier to burn. Burning vegetation in the Bay Area can be difficult because of air quality controls. Dikes, salt ponds, and tidal channels typical of the south San Francisco Bay provide natural firebreaks.

Glyphosate Herbicide Application. The potential biological and ecological impacts of glyphosate (the active ingredient in the two proposed herbicides, Rodeo and Aquamaster), associated surfactants (detergent-like additives that allow herbicides to penetrate plant tissues to be effective) and inert ingredients resulting from the use of herbicides are addressed below.

Literature Review. Much of the general information about physiological effects of glyphosate mixtures on animals has been assembled and reviewed by EXTOXNET (Extension Toxicology Network). EXTOXNET is an independent collaborative information project about pesticides, established by the Cooperative Extension Offices of Cornell University, Oregon State University, the University of Idaho, the University of California at Davis, and the institute for Environmental Toxicology, Michigan State University. EXTOXNET literature review and synthesis regarding biological effects of glyphosate usage is presented in **Appendix E-3**. EXTOXNET does not produce original research, recommendations, or conclusions about pesticides.

Disagreements occur over interpretation of scientifically peer-reviewed experimental results and field studies dealing with glyphosate and surfactants. Different results from different experimental methods and circumstances, a normal aspect of repeated scientific experimental work, also have occurred over several decades of research on glyphosate. It is possible that future research may further change prevailing scientific opinion about the toxicology and environmental fate of glyphosate mixes. To provide context for interpretation of prevailing scientific views, this EIS/R includes a critical review of the scientific literature by a pesticide reform advocacy group, NCAP (Northwest Coalition for Alternatives to Pesticides), a response to the review by the pesticide manufacturer, and a related article by a toxicologist (**Appendix E-1**). Like EXTOXNET, NCAP synthesizes literature rather than produce original research, but in contrast to EXTOXNET, NCAP asserts opinions about published scientifically peer-reviewed research. Neither EXTOXNET nor NCAP information and views are specifically endorsed or followed in this EIS/R. This EIS/R summarizes contemporary and comprehensive peer-reviewed scientific literature about the biological toxicity of glyphosate and surfactants approved for aquatic application.

Terminology. Direct toxicity refers to both acute and chronic toxicity that occur as a result of direct contact, or dermal exposure, with contaminated media such as water or sediment (as opposed to indirect contact, which occurs through ingestion of contaminated prey or other media). Acute toxicity refers to death of the subject organism (lethality) during short-term exposure (generally up to 96 hours). Chronic toxicity refers to sublethal adverse effects (such as disease, reduced growth, or reproduction) during long-term exposure.

Acute toxicity data are often presented in terms of an LC50, which represents the concentration of the toxin that has been found to result in lethal effects to 50% of the test organisms, or EC50, which represents the concentration that has been found to result in sub-lethal effects to 50% of the test organisms. Data can also be presented in terms of a no-observable-effect concentration (NOEC), the concentration for which no effects were observed, or lowest observable effect concentration (LOEC), the lowest concentration for which effects were observed.

Bioaccumulation is the process by which living organisms can retain and concentrate chemicals directly from their surrounding aquatic environment (i.e., from water, bioconcentration) and indirectly from sediments, soil, and food. Biomagnification is a form of bioaccumulation in which the concentration of a chemical in a higher-trophic-level organism is higher than that in the food that the organism consumes.

Conceptual Exposure Model. The known properties of the herbicides, potential methods of application, and the ecological characteristics of the Estuary were evaluated to develop a conceptual model (**Figure 3.3-2**) and identify likely receptors and exposure pathways. This model includes identification of primary and secondary herbicide sources, release mechanisms, exposure media, exposure routes, and potential ecological receptors.

For effects to occur, a receptor and a complete exposure pathway must be present. An exposure pathway is only considered complete when all four of the following elements are present: project-related source of a chemical, a mechanism of release of the chemical from the source to the environment, a mechanism of transport of the chemical to the ecological receptor, and a route by which the receptor is exposed to the chemical.

The exposure routes associated with the complete pathways include direct contact with the herbicide mixture during and immediately after application, ingestion of contaminated surface water and sediments, direct contact with contaminated surface water and sediments, and food-web exposure. The conceptual model (**Figure 3.3-2**) illustrates the links between sources, release and transport mechanisms, affected media, exposure routes, and potentially exposed ecological receptors. Although several complete exposure pathways may exist, not all pathways are comparable in magnitude or significance. The significance of a pathway as a mode of exposure depends on the identity and nature of the chemicals involved and the magnitude of the likely exposure dose. For birds and mammals, ingestion, is generally the most significant exposure pathway.

Dermal contact is expected to be insignificant and unquantifiable due to the nature of the site and frequent movement, ranging habits, and furry or feathery outer skin of most wildlife species. Inhalation may be significant during herbicide application, but is difficult to quantify for ecological receptors, and little toxicity data exists for organisms other than mammals.

Because Project applications of herbicides would occur only once or twice a year and compounds in the herbicide mixture are not expected to persist in significant concentrations for more than several hours, chronic exposure is not likely. Therefore, this evaluation focuses on acute toxicity, which would occur when the compounds are present at relatively high concentrations during and immediately following application.

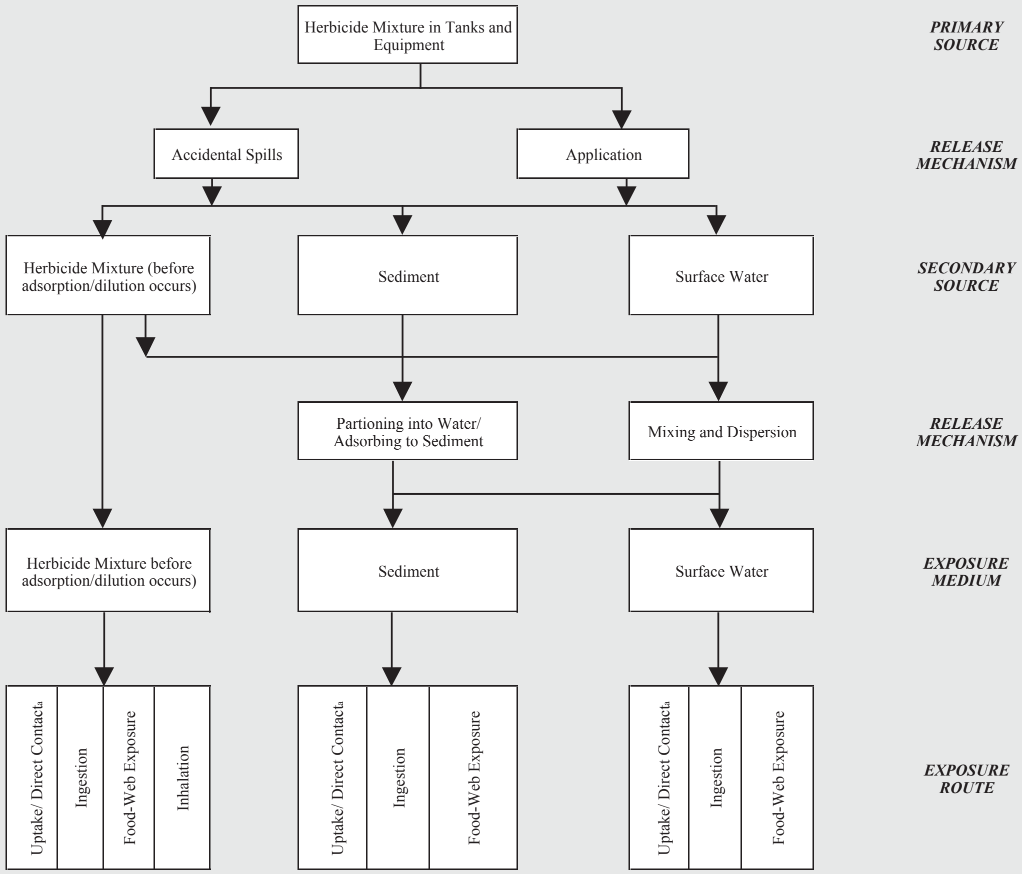
Food-web exposures become significant only if chemicals with a tendency to bioaccumulate or biomagnify are present. The adverse effects associated with bioaccumulative chemicals relate to their propensity to transfer through the food web and accumulate preferentially in adipose or organ tissue. Basic routes for exposure to bioaccumulative compounds by organisms are the trans port of dissolved contaminants in water across biological membranes, and ingestion of contaminated food or sediment particles with subsequent transport across the gut. For upper-trophic-level species, ingestion of contaminated prey is the predominant route of exposure, especially for hydrophobic chemicals.

U.S. EPA's Hazardous Waste Identification Rule (USEPA 1999) identifies compounds that are recognized as having a low, medium or high potential for bioaccumulation. For bioaccumulation in aquatic systems, rankings were determined using bioaccumulation factors in fish, which are indicated in laboratory tests as having low octanol-water partitioning coefficient (or log $K_{ow)}$) values for organic compounds. Bioaccumulation potential is defined as follows:

Bioaccumulation potential	*Bioaccumulation Factor (BAF)*	*log K_{ow}*
High	BAF >= 10,000	log K_{ow} >= 4.0
Medium	10,000 > BAF >= 100	4.0 > log K_{ow} >= 2.0
Low	BAF < 100	log K_{ow} < 2.0

All reported bioaccumulation factor values for glyphosate in aquatic organisms are well below 100 (Ebasco 1993; Heyden 1991; Wang *et al.* 1994). The highest bioaccumulation factor of 65.5 was reported for tilapia (a species of fish) in fresh water (Wang *et al.* 1994). Other studies report much lower bioaccumulation factors in the range of 0.03 to 1.6 for fish (Ebasco 1993). Most studies report rapid elimination and depuration from aquatic organisms after exposure stops (Ebasco 1993). Therefore, bioaccumulation of glyphosate is considered to be low and food-web transfer is not considered to be a significant exposure route.

Chemicals of Concern. Chemicals of potential ecological concern that may be used in the herbicide mixture include glyphosate and its breakdown products; the surfactants R-11, Agri-dex, and LI 700; and the colorant Blazon. The effects of these chemicals on the biota of tidal wetlands depend on the composition of the solution and the physical, chemical, and biological fate in the environment. The chemical properties of glyphosate, surfactants, and colorants are described in Section 3.2, *Water Quality*. The ecotoxicological aspects are discussed in this section. *Glyphosate*. Glyphosate is a non-selective herbicide (it kills all vascular plants regardless of species). Plants vary in their sensitivity to glyphosate exposure mostly by how readily it is absorbed and internally transported by plant tissues. Its action is systemic, meaning that it is transported within plant tissues from surfaces it contacts to affect remote parts of the plant, such as roots and rhizomes. Despite its high toxicity to plants, it is relatively low in toxicity to animals. This is due to its chemical nature and the physiological basis for its activity. Glyphosate is chemically similar to certain types of amino acids (components of proteins) found in plants, but not in animals. When glyphosate interacts with the physiological processes of manufacturing proteins in plants, it disrupts protein synthesis. Proteins are essential to all physiological processes in plants, and thus glyphosate exposure



Potential Ecological Receptors	Herbicide Mixture: Uptake/ Direct Contact[a]	Herbicide Mixture: Ingestion	Herbicide Mixture: Food-Web Exposure	Herbicide Mixture: Inhalation	Sediment: Uptake/ Direct Contact[a]	Sediment: Ingestion	Sediment: Food-Web Exposure	Surface Water: Uptake/ Direct Contact[a]	Surface Water: Ingestion	Surface Water: Food-Web Exposure
Non-Target Aquatic Plants and Algae	C	IC	IC	IC	C	IC	IC	C	IC	IC
Aquatic and Benthic Invertebrates	IC	IC	IC	IC	C	C	M	C	C	M
Fish	IC	IC	IC	IC	M	C	M	C	C	M
Birds	M	C	M	N	M	C	M	M	M	M
Mammals	M	C	M	N	M	M	M	M	M	M
Humans (Applicators)	M	M	IC	M	M	IC	IC	M	IC	IC

Legend:
C Potentially complete pathway (evaluated in a quantitative way)
N Not quantified because insufficient data available
M Minor or insignificant pathway
IC Incomplete pathway

[a] Direct contact refers to dermal exposure.

Figure 3.3-2. Conceptual Model of Possible Exposure of Biological Organisms to Herbicide Mixture Used by the Spartina Control Program is generally highly lethal to plants. Glyphosate does not poison protein synthesis in animals, because it does not act as an analogue of amino acids metabolized in animals. Glyphosate has other effects on animals, however, as do many of its spray mix additives.

One ecologically significant feature of glyphosate is that it is strongly adsorbed by organic matter and fine sediment, such as clay or silt. Sediment films on plant surfaces strongly interfere with uptake and activity of glyphosate. In its chemically bound, adsorbed state, glyphosate is chemically intact, but physiologically inactive. Actual decomposition of glyphosate in the soil or sediment is distinct from its inactivation by adsorption. Glyphosate also desorbs (releases) from soil particles, but its strong affinity for fine mineral and organic particles maintains the predominantly bound, inactivated form (EXTOXNET, Ebasco 1993, Giesy 2000).

The primary breakdown product of glyphosate is aminophosphoric acid (AMPA), which is generally reported to be nontoxic to animals (EXTOXNET, Ebasco 1993). Glyphosate is decomposed by microbial activity in the soil. The reported rates of glyphosate decomposition and persistence in soil vary a great deal: most studies suggest rapid decomposition, while others detect persistence in the soil for more than a year (Ebasco 1993). Rates of decomposition by soil microbes vary with factors such as temperature, oxygen, and pH. Glyphosate may be used as a food substrate by bacteria, and can stimulate bacterial activity. It has been found to kill or inhibit the growth of some soil fungi in pure cultures, however. Little is known about how glyphosate affects the microflora in realistic soil environments, where important interactions such as soil adsorption can occur (Ebasco 1993).

Laboratory tests of glyphosate generally indicate it to be nontoxic or low in toxicity to mammals and birds, particularly at the concentrations or doses that occur in field conditions (EXTOXNET). Most information about glyphosate toxicity to mammals comes from experiments on rats, mice and rabbits, and some on dogs. Little information is available on toxicity of glyphosate or its breakdown products on most wildlife species. Toxic effects of glyphosate are usually achieved in laboratory animals at very high doses (hundreds or many thousands of times the exposure expected from concentrations and doses applied in field conditions) comparable to portions of animal diets, are often required to generate acute effects (EXTOXNET, Ebasco 1993, Giesy 2000).

Surfactants and Colorants. Three surfactants are approved for use with glyphosate in aquatic environments, and have been used to treat invasive cordgrass. They are known by trade names LI-700, Agri-dex, and R-11. Toxic effects of spray mixes of glyphosate are due primarily to surfactants rather than the active herbicide. These surfactants are non-ionic, meaning they do not dissociate into electrically charged particles in water, as salts do. They contain nonylphenol polyethoxylate (NPE) ingredients.

As described in Section 3.2, *Water Quality*, the Material Safety Data Sheet indicates that Blazon is non-toxic. Some additional information on surfactants and colorants is included in Section 3.2, *Water Quality*, and **Appendix E-1** and **E-2**.

<u>Toxicological Effects on Ecological Receptors</u>. Herbicide solutions have the potential to affect organisms that live in the water column, including algae, non-target plants, fish and aquatic invertebrates. While some other receptors such as mammals and birds may spend a considerable portion of their time in the water, they are generally more likely to be affected by other exposure routes, primarily dermal contact during application and incidental ingestion of contaminated sediment during foraging.

Non-Target Aquatic Plants and Algae. Glyphosate is ineffective for treating submerged aquatic vegetation. It is likely that factors in the aquatic environment, such as suspended organic matter or sediment, interfere with glyphosate uptake by submerged plant tissues. Glyphosate also is slightly toxic or practically nontoxic to freshwater and marine algae and phytoplankton tested in both laboratory and field studies. Species of algae vary in their sensitivity to glyphosate in terms of population growth (EXTOXNET, Giesy 2000). Field studies indicate the least toxicity to phytoplankton (microscopic floating algae), possibly because of dilution and adsorption in open water and flooded marshes.

Few data are available on effects to marine algae, as most toxicity tests have been performed on freshwater species. Giesy *et al.* (2000) reviewed the data available on glyphosate toxicity to microorganisms, and found that acute toxicity EC50 values ranged from 2.1 to 189 mg/L. NOECs ranged from 0.73 to 33.6 mg/L. Giesy *et al.* (2000) also reviewed the data available on glyphosate toxicity to aquatic macrophytes, and found that acute toxicity EC_{50} values ranged from 3.9 to 15.1 mg/L. It should be noted that these studies included tests on the (non-aquatic) Roundup formulation as well as other forms of glyphosate. The formulated product known as Roundup (glyphosate plus specific surfactants) is known to be more toxic than the (aquatic) Rodeo formulation (now called Aquamaster). For studies conducted on microorganisms using glyphosate tested as isopropylamine salt, EC_{50} values ranged from 72.9 to 412 mg/L, and NOEC values ranged from 7.9 to 26.5 mg/L (Giesy *et al.* 2000). The lowest of these NOEC values (0.73 mg/L) is well above the maximum concentration of 0.026 mg/L reported by Paveglio *et al.* (1996) (see Section 3.2) and the immediate maximum geometric mean glyphosate concentration of 0.174 mg/L reported by Patten (2002). Therefore, these data indicate that impacts to non-target submerged aquatic plants or algae are not likely. Impacts in estuarine conditions with high concentrations of suspended sediment, which interfere with glyphosate activity, would be even less likely.

The NEPA Environmental Assessment conducted for Willapa Bay (Washington State 1997) included a review of field toxicity studies for non-target marine plants, which indicated that Rodeo tank mixes have had variable effects on non-target plants. Japanese eelgrass was adversely affected in one of two plots aerially treated with Rodeo and X-77 Spreader in Willapa Bay. Rodeo and X-77 Spreader applied by hand-held sprayer to eelgrass did not affect biomass in an eight-week study conducted in Padilla Bay.

Some adverse effects to non-target plants that are not completely submerged are likely to occur. However, these effects can be mitigated using the methods described in this section.

Aquatic and Benthic Invertebrates. Giesy *et al.* (2000) reviewed the data available on glyphosate toxicity to aquatic invertebrates. Few data were available for marine species, and those studies that did use marine species were conducted with glyphosate acid, not salt. Acute toxicity EC50 values for five marine species ranged from 281 mg/L to greater than 1000 mg/L, and NOEC values ranged from 10 to 1000 mg/L. Data compiled by Ebasco (1993) include mortality tests on two marine species, for which EC_{50} values were found to be 281 mg/L and greater than 1,000 mg/L.

Grue *et al.* (2002) conducted laboratory studies to evaluate reproductive effects of exposure to Rodeo mixed with four different surfactants, including R-11, LI 700, and Agri-dex, on Pacific oysters. The EC50 for glyphosate alone was 68.1 mg/L, the EC_{50} for the tank mix including Rodeo and R-11 surfactant was 29.9 mg/L, and the EC_{50} for the R-11 surfactant alone was 1.0 mg/L.

The lowest of these NOEC and LC_{50} values (10 mg/L) for glyphosate or glyphosate/surfactant mixtures is well above the maximum glyphosate concentration of 0.026 mg/L reported by Paveglio *et al.* (1996) and the immediate maximum geometric mean glyphosate concentration of 0.174 mg/L reported by Patten (2002) (see Section 3.2). Therefore, these data indicate that impacts to aquatic invertebrates due to post-application water concentrations of glyphosate are unlikely in experimental conditions. Impacts in estuarine conditions with high concentrations of suspended sediment, which interfere with glyphosate activity, would be even less likely.

Kubena *et al.* (1997) conducted sediment and water toxicity studies on marine invertebrates (oysters and amphipods). The LC_{50} values for Rodeo and surfactant in water ranged from 200 to 400 mg/L, and the LC_{50} values in sediment ranged from 1000 to 6000 mg/kg. These LC_{50} values are well above the highest measured geometric mean sediment concentrations of 2.3 mg/L reported by Kilbride *et al.* (2001) and Patten (2002), as described in Section 3.2.

Field studies of glyphosate/surfactant applications to tidal mudflat invertebrate communities in Willapa Bay, Washington, agree with laboratory tests, which indicate low potential for adverse impacts to benthic invertebrates. Sampling of benthic invertebrates in mudflats up to 199 days after glyphosate/surfactant (X-77) applications revealed no short-term or long-term effects. Short-term laboratory tests of amphipods exposed to glyphosate and surfactants did not affect survival even at high concentrations relative to post-spray field conditions (Kubena 1996).

Fish. Giesy *et al.* (2000) reviewed the data available on glyphosate toxicity to fish. Although some data were available for anadromous species, it appears that all tests were conducted using freshwater test methods. Acute toxicity LC_{50} values for glyphosate tested as isopropylamine salt ranged from 97 to greater than 1,000 mg/L and NOEC values ranged from <97 to 1,000 mg/L. Data compiled by Ebasco (1993) on one-day acute toxicity tests indicate EC_{50} values ranging from 12.8 mg/L to 240 mg/L.

The lowest of these NOEC and LC_{50} values (12.8 mg/L) for glyphosate or glyphosate/surfactant mixtures is well above the maximum glyphosate concentration of 0.026 mg/L reported by Paveglio *et al.* (1996) and the immediate maximum geometric mean glyphosate concentration of 0.174 mg/L reported by Patten (2002) (see Section 3.2). Therefore, these data indicate that impacts to fish due to maximum post-application water concentrations of glyphosate are unlikely in experimental conditions. Impacts in estuarine conditions with high concentrations of suspended sediment, which interfere with glyphosate activity, would be even less likely.

Acute toxicity of X-77, R-11, ad LI-700 to fish can be moderate. Threshold LC_{50} for an anadromous salmonid fish tested (Atlantic salmon, *Salmo salar*) was as low as 0.13 parts per million, and young fish or eggs are generally found to be more sensitive than adults. Despite the low threshold for concentrations of surfactant causing significant mortality, actual concentrations to which fish are likely to be exposed in actual estuarine environments are orders of magnitude lower. Research in Willapa Bay found that the highest average maximum concentrations of surfactant in water dispersed from sprayed estuarine mud with the first flooding tide – the highest concentration for exposure, a "worst case scenario" for fish swimming into freshly sprayed sites – was 16 parts per billion (Paveglio *et al.* 1996).

Birds. Effects of glyphosate on birds have been tested on mallard ducks (dabbling ducks which ingest wetland sediment along with seeds, insects, and vegetation) and bobwhite quail. As with mammals, very high dietary concentrations of glyphosate (a 4,640 mg/kg dietary concentration) resulted in no adverse reactions such as weight loss or mortality (Ebasco 1993). Little or no data are available on toxicity of surfactants to birds.

Mammals. Ebasco (1993) compiled data on glyphosate toxicity to mammals commonly used in laboratory tests, and reported that LD 50 values (the dose resulting in lethal effects to 50% of test organisms) ranged between 3,800 mg per kg body weight. Glyphosate is considered to be practically non-toxic to mammals.

The toxicity of the aquatic-approved surfactants to mammals is reported to be very low: greater than 5 grams per kilogram body weight oral dosage of Agri-dex and LI-700 is the threshold for LC_{50}, the level at which 50% mortality occurs in laboratory rat tests. The corresponding LC_{50} for R-11 is reported to be 2 to 4 grams per kilogram body weight (**Appendix E**; USDA and USFS fact sheets). Nonylphenol has been raised as a concern as a potential breakdown product because it exhibits weak estrogen-like hormonal activity, which could alter reproductive physiology of animals exposed at low concentrations (NCAP 2002). There is little evidence that estrogenic effects occur in field conditions, but such activity is possible.

Little is known about potential interactive effects between applied glyphosate/surfactant solutions and cumulative loads of herbicides, insecticides, detergents, perfume agents, and many other organic contaminants in the San Francisco Estuary. It is reasonable to assume that cumulative, interactive effects occur in organisms of the Estuary, but the complexity of multiple interactions in uncontrolled field conditions makes definitive research difficult.

In practice, total dosages of glyphosate/surfactant solutions applied in field conditions (amount of solution applied, and concentration, and the number of re-applications to eradicate survivors) depends on many factors which are independent of the physiology of glyphosate and surfactants themselves. The physiological activity and health of the plant, interference with spray coverage by persistent dead leaves or sediment films, all affect the percent kill of vegetation, and the ability of regenerative buds to survive and re-establish the population. Regeneration requires re-application of herbicide or other eradication methods. Total dosages of glyphosate needed to achieve complete mortality of target vegetation can be minimized by combining its use with prior "knock-down" treatments that reduce vegetation density, mass, attached leaf litter, and regenerative capacity, prior to spray application. Mass-defoliation followed by partial regeneration of sufficient receptive new leaf surface area can make vegetation more exposed and sensitive to glyphosate applications. This can reduce total requirement of spray needed to completely cover foliage and achieve high mortality, and it can minimize the need for follow-up sprays for survivors.

Modes of glyphosate application (other than spraying) include "wicking" (painting wiping solutions with fabric or sponge-like applicators), and application of glyphosate pastes (in carriers such as lanolin) on cut stumps. Wicking often results in both reduced coverage (and effectiveness), and reduced non-target vegetation damage. Cut-stump application is usually used for woody plants, but may be used at a small scale for non-woody species where precise and labor-intensive methods may be used.

Specific Impacts to Biological Resources

This section provides a comprehensive evaluation of the impacts to biological resources of each of the project alternatives and describes mitigation measures that will be implemented to reduce impacts to a less than significant level (where feasible). The effects are summarized in **Table 3.3-1** and the mitigation measures for each impact are summarized in **Table 3.3-2**.

ALTERNATIVE 1: Proposed Action/Proposed Project - Regional Eradication Using All Available Control Methods

IMPACT BIO-1: Effects of treatment on tidal marsh plant communities.

Effects of the project on tidal marsh plant communities are evaluated below.

IMPACT BIO-1.1: Effects of treatment on tidal marsh plant communities affected by salt-meadow cordgrass and English cordgrass.

Salt-meadow cordgrass, which has small, slowly spreading populations to date, would be eliminated and prevented from potential increases in their rates of spread after reaching a critical population size. This would prevent conversion of high tidal marsh plains of brackish and salt marshes from being converted to low-diversity or monotypic stands of salt-meadow cordgrass throughout the Estuary. The small population of English cordgrass would also be rapidly eradicated.

Short-term effects of salt-meadow cordgrass removal at the single confirmed population (multiple colonies) at Southhampton Marsh, Benicia, would probably be limited to localized disturbance of vegetation. Mechanical removal and burning are unlikely to be used in this setting; smothering and glyphosate spraying are probably most suited to the patch size, distribution, and terrain at this location. Potential impacts of eradication method failure may involve movement of geotextile/black plastic covers by wind or tides, smothering non-target vegetation; or spray drift to non-target adjacent vegetation. Dispersal of salt-meadow cordgrass seed or fragments by eradication operations is unlikely, but possible. These impacts, though locally important, are overall less than significant, and are further mitigable.

Long-term biological effects of removal would most likely result in recolonization of cleared patches by native brackish marsh vegetation. It is possible that cleared patches could become invaded by perennial pepperweed (*Lepidium latifolium*), particularly where seed and rhizome sources are adjacent or close to cleared patches.

MITIGATION BIO-1.1: Vehicle and foot access pathways in marsh invaded by salt-meadow and English cordgrasses, including marsh access to invaded mudflats shall be minimized. Seasonal timing of glyphosate treatment of *S. patens* shall be adjusted to minimize impacts to non-target native marsh vegetation. When treating small, discrete colonies of salt-meadow cordgrass or English cordgrass, adjacent vegetation shall be buffered against spray drift by temporarily placing geotextile fabric segments (aprons or fence-like fabric barriers) adjacent to colonies at the time of spraying. Adjacent vegetation also could be buffered against spray drift by pre-application of bay mud suspensions to coat leaf surfaces. Oversprayed non-target vegetation could be irrigated with muddy bay water applied by portable pumps or truck tanks. Geotextile covers shall be stabilized by stakes and weights, and monitored after high tides or high wind events. Standard best management practices for herbicide application in wildlands (e.g. field crew training, clear marking of spray boundaries in the field, expert ecological supervision during field operations, restricting operation to optimal low-wind times, nontoxic spray markers, etc.) shall be used to minimize incidental overspray and drift. Cleared patches shall be monitored for recruitment of invasive perennial pepperweed until native vegetation has become dominant. In patches highly vulnerable to spread of contiguous perennial pepperweed, treated areas shall be replanted with saltgrass and pickleweed in the following spring to discourage seedling microhabitats for perennial pepperweed. Salt-meadow cordgrass and English cordgrass mown, cut, or shredded shall be prevented from dispersal by mounding cut debris and on-site composting under heat-retaining geotextile fabric or black plastic in warm weather. Optimal combinations of treatment shall be used to minimize repeat entry to marsh and re-treatment (e.g. mowing or burning followed by spot-application of herbicide to low densities of survivors). Where Atlantic smooth cordgrass is removed from high marshes where native species other than cordgrass are dominant, native vegetation may be replanted.

IMPACT BIO-1.2: Effects of treatment on tidal marsh plant communities affected by Atlantic smooth cordgrass and its hybrids.

Eradication work aimed at Atlantic smooth cordgrass colonies may have adverse indirect short-term effects on adjacent, non-target tidal marsh plant communities, where colonies occur within marsh rather than mudflat. The most common incidental effect would be localized destruction of vegetation at the margins of eradication treatments, such as herbicide (glyphosate) spray drift resulting from aerial applications, herbicide overspray resulting from ground-based accidental discharge beyond targeted plants, mechanical damage from vehicles, and locally escaped controlled burns in the marsh. This would be proportionally greater for eradication work aimed at Atlantic smooth cordgrass because of its more extensive coverage and distribution in the Estuary. Indirect short-term impacts to adjacent vegetation are likely to be significant only in large-scale operations.

Mechanical removal techniques which result in severing fragments of rhizomes or buds in viable units capable of regenerating after dispersal could increase invasion of established plant communities and defeat the purpose of eradication. Excavation, dredging, disking, and shredding methods all carry this risk. Equipment that finely shreds all biomass is least likely to cause dispersal of viable fragments. Fragment viability is reduced when air is warm, as in summer months; warm, dry air results in rapid desiccation and loss of viability, especially for fragments that are deposited in high-tide lines. Mechanical removal methods also may generate large volumes of wrack (tidal litter) that is likely to be deposited in high marsh or marsh plain vegetation. Mechanical removal also may promote seed dispersal if ripe seed have matured at the time work is done. This impact would be significant but mitigable. Critically important tall native high marsh vegetation cover (especially gumplant) could be trampled and destroyed by vehicle operations.

An effect on existing infested tidal marsh plant communities would be the release of accreted marsh sediment from dominant, exclusive Atlantic smooth cordgrass cover, allowing succession to native tidal marsh plant communities. This would be a beneficial impact.

MITIGATION BIO-1.2: Vehicle and foot access pathways in marsh invaded by Atlantic smooth cordgrass, including marsh access to invaded mudflats shall be minimized. Equipment working in marsh plains shall be restricted to mats and geotextile fabric covers. Non-viable excavated non-native cordgrass and excavated sediment shall be stockpiled and removed from marsh. Non-target vegetation shall be covered with fabric adjacent to areas sprayed with herbicide, or non-target vegetation shall be pre-treated with protective films of silt-clay. Smothering geotextile mats shall be stabilized with stakes and weights, and inspected frequently. Optimal combinations of treatment shall be used to minimize repeat entry to marsh and re-treatment (e.g. mowing or burning followed by spot-application of herbicide to low densities of survivors). Herbicide spray dose requirements for effective treatment shall be minimized by pre-treatments (mowing, crushing, or burning) that reduce live cordgrass density and increase exposure of receptive young growth following pre-treatment. Removal methods other than helicopter applications of herbicide shall be used whenever feasible and less environmentally damaging. If new technology is available and feasible, non-spray application techniques (e.g., modified cut-stump herbicide application or wicking techniques) shall be used to reduce herbicide dose and minimize non-target contact. Dispersal of viable seed shall be minimized by performing removal prior to seed set or maturation, or if natural or artificial conditions constrain seed set prior to eradication.

IMPACT BIO-1.3: Effects of treatment on tidal marsh plant communities affected by Chilean cordgrass.

Impacts to adjacent plant communities caused by eradication projects aimed at Chilean cordgrass would be similar to those of salt-meadow cordgrass, which also grows in the middle and high salt marsh zone. The clumped growth habit of Chilean cordgrass would allow for higher feasibility of effective manual excavation with only shovels rather than mechanical equipment. Similarly, spot-spraying with herbicide (possibly cut-stump paste methods, too) may be feasible for eradication of some stands. This may reduce impacts to adjacent vegetation compared with salt-meadow cordgrass in some conditions. The greater interspersion of Chilean cordgrass clumps among native salt marsh vegetation may distribute impacts more widely in some dense stands, however. These impacts are considered significant but mitigable.

MITIGATION BIO-1.3: Mitigation BIO-1.1 also would apply to Chilean cordgrass.

IMPACT BIO-1.4: Effects of treatment on submerged aquatic plant communities

Impacts to eelgrass beds are highly unlikely to occur from invasive cordgrass eradication in the San Francisco Estuary. All eelgrass beds, both large permanent colonies and small intermittent colonies establish in subtidal waters of the Estuary, and do not occur in mudflats or marshes where cordgrass eradication would occur. Submerged eelgrass would not be affected by tidal dispersion of glyphosate, because overwhelming dilution and adsorption effects of suspended sediment in tidal waters. Epiphytic algae on eelgrass stems and leaves would further intercept potential exposure. Submerged aquatic vegetation within salt marsh pans is almost entirely wigeon-grass (*Ruppia maritima*). Wigeon-grass is also covered in epiphytic algae during most of its growth and decline, and flooded salt marsh pans are rich in dissolved organic matter rather than suspended mineral sediment. These factors also minimize potential incidental glyphosate impacts, consistent with laboratory test of submerged aquatic plant insensitivity to applied glyphosate. Pondweeds (*Potamogeton* species) in brackish marsh pans found in Suisun Marsh and parts of northern San Pablo Bay would be similarly insensitive to incidental glyphosate exposure. Minor impacts to submerged aquatic vegetation could result from local deposition of cut (mown) cordgrass debris after tidal rafting from marsh to pans. This impact is unlikely because most pans naturally tend to draw down and die back to algal mats in summer. Only accidental direct spillage of bulk herbicide solution would pose a potential substantial risk to submerged aquatic vegetation. No other impacts are expected for submerged aquatic plants.

MITIGATION BIO-1.4: Large deposits of mown cordgrass shall be raked and removed during the growing season if tidal marsh pans supporting submerged aquatic vegetation occur in the vicinity; or temporary water-permeable debris barriers (i.e. silt fences) shall be installed around vulnerable pans. Transporting tanks of spray solution near pans shall be avoided to prevent contact by accidental spills.

IMPACT BIO-2: Effects of treatment on special-status plants in tidal marshes.

Most effects of regional cordgrass eradication on special-status plants would be indirect and long-term consequences of preventing future cordgrass invasion impacts to occupied and potential habitat (altered tidal hydrology, altered sedimentation, competition, massive wracks, etc.). This is because most of the cordgrass invasion currently occurs in subregions of the Bay where special status plants have already become locally extinct (esp. San Francisco Bay), so eradication efforts in the near-term would be focused away from sensitive populations. In the long term, the eradication program would have significant benefits for the long-term chances of survival and recovery of endangered tidal marsh plants. Short-term effects of cordgrass eradication operations on special-status plant species could be adverse, however, particularly for the endangered soft bird's-beak populations at Southhampton Marsh, Benicia (where salt-meadow cordgrass is locally abundant) and Point Pinole (where Chilean cordgrass has been largely eradicated, but regenerates at low levels).

Soft bird's-beak at Southhampton Marsh grows closely adjacent to one colony of salt-meadow cordgrass. Removal operations may result in trampling of undetected seedlings, since this annual species has a distribution that changes from year to year. Herbicide spray drift may destroy seedlings or reproductive plants. Dislodged geotextile fabric may smother adjacent soft bird's-beak. Repeated marsh re-entry at Point Pinole near the Whittell Marsh population of soft bird's-beak to remove regenerated Chilean cordgrass may trample seedlings. Conversely, small-scale trampling disturbances may provide local gaps in salt marsh vegetation suitable for establishment of new subcolonies of soft bird's-beak in subsequent years.

Incidental impacts to other plant species of concern could result from mobilizing equipment and marsh vehicles in tidal marshes where invasive cordgrass eradication projects are implemented. In San Francisco Bay, where the largest proportion of the non-native cordgrass invasion occurs, this is least likely to occur because most rare plants and all endangered plants are either extirpated or do not occur in affected marshes. Eradication operations are unlikely to adversely affect any of these species because their natural distribution is remote from sites where non-native cordgrass invasion is in progress. North Bay and Suisun marshes have richer tidal marsh floras, and eradication work there is more likely to impact rare plants. This is a potentially significant but mitigable impact.

MITIGATION BIO-2: Pre-project spring surveys for sensitive plants shall be conducted the same year as eradication work at treatment sites (for annual species), or at least the prior year (for perennial species). GPS data and stake locations of sensitive plant populations shall be recorded, and field crews on foot or in vehicles shall be instructed to avoid and protect sensitive populations. Qualified, experienced on-site botanical supervision shall be required if sensitive plants occur in the vicinity of eradication work. If sensitive plant populations occur near the high tide line, rake and large deposits of mown cordgrass shall be removed during the growing season. Burning in marshes supporting sensitive plant species shall be prohibited. Smothering geotextile mats shall be stabilized with stakes and weights, and inspected frequently. Non-target vegetation shall be covered with fabric adjacent to areas sprayed with herbicide, or spray-drift barriers made of plastic or geotextile (aprons or tall silt fences) shall be installed. If accidental exposure to spray drift occurs, affected plants shall be thoroughly irrigated with silt-clay suspensions.

Refrain from rapid replanting Pacific cordgrass (native *Spartina foliosa*) in both new restoration sites or invasive cordgrass-eradicated sites, until pollen flow and seed rain from hybrid Atlantic smooth cordgrass to the site is confirmed to be minimal for purposes of subsequent detection and control. Use natural cordgrass seedling recruitment rates to monitor "invasion pressure" (ratio of non-native to native cordgrass seedlings) to determine both eradication effectiveness for a tidal marsh subregion, and the earliest date for active replanting with native clones, if needed. In patches highly vulnerable to spread of contiguous perennial pepperweed, treated areas shall be replanted with saltgrass and pickleweed in the following spring to discourage seedling microhabitats for perennial pepperweed.

IMPACT BIO-3: General effects of treatment on shorebirds, waterfowl, and marshland birds

Short-term impacts of cordgrass eradication operations are likely to be disturbance of shorebirds present within about 500 to 1,000 feet from operations of field crews. Shorebird flocks are likely to relocate to other mudflat areas at low tide, or alternate high tide roosts. Relocation sites may provide inferior food resources or roost capacity. Waterfowl are less likely to be disturbed by crews working at low tide, since they are most likely to occupy shallow water. This impact would usually be less than significant, but could become significant for exceptionally large eradication projects with operations that last for many days over a wide area of mudflat.

If dredging or excavation is used to remove non-native cordgrass in mudflats foraged by shorebirds, exposure to elevated levels of mercury is a potential issue. Shorebirds may be exposed to mercury through foods they consume. Most shorebirds forage over a wide area of the Bay, or further, in the case of migratory birds. For these birds, it is unlikely that any potential exposure from a dredged or excavated treatment site would cause a significant increase in mercury ingestion. An exception would be rails, which forage almost exclusively near their nesting locations. Mitigation measures for possible exposure to California clapper rails are discussed below.

If large swards of Atlantic smooth cordgrass hybrids are removed from large flood control channels or major sloughs by operation of a floating dredge (barge and crane), waterfowl in the vicinity of dredging operations would be disturbed. The typical attraction to gulls and terns provided by subtidal dredging for navigation purposes would probably not occur with dredging in the cordgrass zone (near mean sea level elevation), since it would not generate turbidity plumes in the channel water column that force fish to the surface.

Field crews working on marsh plains would probably disturb wading birds and long-legged shorebirds in pans and small tidal channels (egrets and herons, avocets, stilts, yellowlegs, willets, marbled godwits) and long-legged shorebirds on the marsh plain roosting at high tide. Following mechanical disturbance at cordgrass removal sites, feeding by these species would be increased, because disturbances increase exposure of invertebrates. Repeat-cropping methods such as mowing or disking would increase the incidence of shorebird disturbances, and spread them over longer periods of time. Only in cases of large-scale, recurrent disturbances from repeated marsh operations would shorebird disturbance be a significant impact, because it would be likely to alter routine bird behavior and selection of feeding and roost areas. Single or infrequent disturbance events would generally not be significant impacts.

Glyphosate sprays on low marsh colonies of Atlantic smooth cordgrass on mudflats or channels probably would not have direct contact with shorebirds, even if drift occurs, since field crew activity would cause shorebird flocks to flee from active spray areas. Aerial (helicopter) applications of spray (potential method for very large, isolated cordgrass stands) would increase potential amount and distance of drift, but this potential would be partially offset by the increased hazing of shorebirds by helicopters. Dispersal of spray by subsequent tidal flooding, dilution, and inactivation of glyphosate in bay sediment would render sprayed areas and adjacent areas effectively harmless to shorebirds.

Accidental spray spills could be temporarily hazardous to shorebirds and waterfowl. Hazards would be mainly due to locally high concentration of surfactants, which could be ingested as shorebirds probe mud. This would be a very localized and short-term impact, and due to the very low toxicity of the herbicide solution to shorebirds, any impacts are expected to be less than significant.

MITIGATION BIO-3: treatment activities occuring within 1,000 feet of mudflats shall be scheduled to avoid peak fall and spring Pacific Flyway stopovers. Optimal combinations of treatments shall be used to minimize repeated entry to sites near sensaitive shorebird roosts or preferred foraging areas, and to minimize the need for re-treatment. Field crews shall be mobilized to project sites soon after high tide, before mudflats emerge. Field crews shall haze shorebird flocks downwind of spray sites to minimize potential of direct contact with drifted glyphosate spray mixes. Hazing shall be maintained in buffer areas until flood tide to minimize potential indirect contact with shorebirds returning to sprayed or drift-exposed areas. Spilled herbicide, surfactant, or solution on marsh or mudflats shall be immediately remediated by application and removal of adsorbent materials, suction using portable wet vacuum or pumping equipment, or by other suitable method. Shorebirds will be kept away from the spill area by hazing until the spill is remediated. Broadcast spraying by helicopters shall be restricted to meadows and large stands of cordgrass, or where there is no other reasonable access. Targeted helicopter application of herbicide by "spray ball" will be a preferred treatment option to reduce all negative treatment impacts to shorebirds. Helicopters will not be operated within 1,000 feet of active major roosting or foraging sites

IMPACT BIO-4: Effects of treatment on special status mammals

IMPACT BIO-4.1: Effects of treatment on the salt marsh harvest mouse and tidal marsh shrew species.

Because small mammals do not generally inhabit cordgrass stands, direct effects of eradication on small mammals would be minimal or lacking. Indirect effects to the salt marsh harvest mouse and tidal marsh shrew species could occur through marsh vehicle disturbance of vegetation (habitat degradation), crushing of mice or shrews beneath tracked vehicles while accessing infested marsh areas, destruction of high tide flood refugia (debris or tall broadleaf vegetation), and exposure of mice and shrews to glyphosate/surfactant solutions drifted from cordgrass to adjacent mixed pickleweed vegetation. Trampling of marsh plain vegetation by field crews is unlikely to crush small mammals or significantly degrade habitat quality.

The risk of these potential impacts is low for the salt marsh harvest mouse in the vast majority of potential eradication project sites in San Francisco Bay: trapping (detection) studies of the species have repeatedly confirmed that their populations are usually very low and intermittent in tidal marsh plains in San Francisco Bay subject to prolonged, deep flooding during high tides. This is the typical condition of the majority of potential eradication sites. Furthermore, the salt marsh harvest mouse is presumably extirpated from most tidal marshes in central San Francisco Bay. But because of the severe endangerment of the southern subspecies, any potential substantial risk of "take" of this species is significant.

High densities of salt marsh harvest mice are found in some North Bay marshes with relatively high elevations and heavy cover of tall pickleweed. Cordgrass-infested marsh plains in the North Bay are limited to Whittell Marsh, Point Pinole (historically lacking the salt marsh harvest mouse), Creekside Park, Corte Madera (possible occurrence in treatment areas of *Spartina densiflora*), and Southhampton Marsh, Benicia (probable occurrence in or around treatment areas of salt-meadow cordgrass). At Creekside Park and Southhampton Marsh, the risk of adverse indirect impacts to the salt marsh harvest mouse is greater. This is a significant but mitigable impact.

Because the distribution and abundance of tidal marsh shrews is poorly known, it is reasonable to presume that undetected shrew populations may occur in any treatment sites, including relatively lower elevation pickleweed-dominated tidal marsh. This is consistent with their high demand for invertebrate food items, which are abundant in moist intertidal marsh zones. High rates of food consumption may also mean relatively greater potential exposure to moderate toxicity of surfactants drifted to marsh adjacent to sprayed areas. This is a significant but mitigable impact.

Marsh wildlife, including salt marsh harvest mice, are unlikely to come into contact with colorants in spray mixes. Spray crew operations would generally disturb wetland birds and cause them to disperse away from areas being sprayed. Salt marsh harvest mice and other small mammals generally remain under dense vegetation cover at ground level except during extreme tides (when no spraying would occur) and would not be exposed to sprays applied to vegetation surfaces. Even if wildlife were exposed to colorants, risk of predation would not increase if background vegetation were also exposed to colorants.

The effect of eradication of existing non-native cordgrass from high marsh sites would be beneficial in terms of restoring pickleweed tidal marsh (essential to the recovery of the salt marsh harvest mouse).

MITIGATION BIO-4.1: Even where environmental conditions indicate low probability of presence, and low potential abundance of the salt marsh harvest mouse, the species shall be presumed to be present in project areas containing mixed pickleweed vegetation. This presumption is a precaution against avoidable "take" of this endangered species. Use of vehicles in potential tidal marsh habitat of the salt marsh harvest mouse and tidal marsh shrew species shall be minimized. Shortest possible access paths shall be determined prior to marsh entry, and shall be flagged to limit travel patterns of vehicles to areas with mats or geotextile covers. Use of optimal combinations of treatment shall be implemented to minimize repeat entry to marsh and re-treatment (e.g. mowing or burning followed by spot-application of herbicide to low densities of survivors)**.** When possible, work shall be scheduled in suitable small-mammal habitat soon after natural mass-mortality events caused by extreme high tides.

If site-specific evaluations indicate that potential take of salt marsh harvest mouse individuals is excessive, or degradation of habitat is unacceptable despite avoidance and minimization measures, then compensatory mitigation shall be planned and implemented. Appropriate compensatory mitigation may include construction of pickleweed marshes (acreage and location to be determined) at or slightly above the plane of contemporary mean higher high water, to increase the resilience of resident salt marsh harvest mouse populations to natural extreme tidal flooding and sea level rise. Providing tidegates to choke tidal circulation to optimal levels needed to maintain optimal salt marsh harvest mouse habitat quality (with reduced risk of tidal flooding mortality) is an additional mitigation option, depending on mitigation site conditions. These and/or other options shall be proposed as mitigation in consultation with the U.S. Fish and Wildlife Service and California Department of Fish and Game.

IMPACT BIO-4.2: Effects on resident harbor seal colonies of San Francisco Bay

Short-term effects of eradication methods on harbor seals due to repeated disturbance could be significant near haul-out sites with substantial infestations of Atlantic smooth cordgrass in the vicinity, such as Dumbarton Marsh, Mowry Slough, and Newark Slough. Methods that require repeated entry of field crews in the marsh would have the most significant impact, and could potentially cause or contribute to mortality of pups or abandonment of a haul-out site. Mechanical removal methods would also have significant impacts because of noise and duration of operations. Disturbances from helicopter or ground applications of herbicides would be briefer, but still would be significant, especially for pups.

Indirect contamination of waters or fish by glyphosate/surfactant solutions applied to cordgrass probably would not have acute or chronic adverse toxic effects on seals, since reported mammalian toxicity of glyphosate is generally very low, and dispersal of spray would require transport by turbid bay water, which inactivates glyphosate. Concentrations of surfactants diluted by transport in tidal water from marsh to sloughs would probably be well below levels that could cause sensitive reactions to seals. Atlantic smooth cordgrass infestations near the Mowry/Dumbarton marshes are discrete colonies, and would not involve mass loading of the intertidal zone with spray. Accidental tank spills of solution from boats or barges transporting spray mixes to field crews could cause significant acute skin and eye irritation from surfactant concentrations, affecting seals following boats, a common behavior.

As described in the General Impacts of proposed treatment methods, harbor seals also could be exposed to elevated levels of mercury from project dredging. This impact is less than significant because concentration in fish prey would not exceed background levels. These impacts are significant and mitigable.

MITIGATION BIO-4.2: Vehicle and foot access pathways in marsh within 1,000 feet of seal haul-outs shall be minimized, and approaching haul-outs within 2,000 feet, or any distance that elicits vigilance behavior when pups are present shall be avoided. Marine mammal experts shall be consulted to determine seasonal variation in sensitivity to disturbance. Equipment working in marsh shall be restricted to prescribed paths. Optimal combinations of treatment shall be used to minimize repeat entry to marsh and re-treatment (e.g. mowing or burning followed by spot-application of herbicide to low densities of survivors). Treatment combinations that minimize the need for re-entry of the vicinity of the haul-out shall be used. Low-flying aerial spray helicopters shall be prohibited within 2,000 feet of seal haul-outs. Spray tanks containing pre-mixed solutions of herbicide shall be transported in impact-resistant sealed containers to prevent accidental tank rupture during transport or loading/unloading. In case of herbicide/surfactant solution spill, small volumes of spilled solutions on mudflats shall be remediated to the greatest extent feasible by suction of surface muds, using portable wet vacuum, or pumping equipment.

IMPACT BIO-4.3: Effects on the southern sea otter

Invasive cordgrass eradication operations would be highly unlikely to have any direct effect on sea otters, which are vagrants, not residents, of San Francisco Bay, and remain largely in subtidal waters.

Mitigation Measures: None required.

IMPACT BIO-5: Effects on special-status bird species

IMPACT BIO-5.1: Effects on the California clapper rail

In addition to possible impacts described in Impact BIO-3, above, eradication of invasive non-native cordgrass would have unavoidable significant short-term adverse effects on California clapper rails, and potential long-term beneficial effects.

Clapper rails have been reported to nest in young, tall, vigorous stands of Atlantic smooth cordgrass and its hybrids, and at relatively high nest densities in some areas. When Atlantic smooth cordgrass stands are taller than adjacent cordgrass and other vegetation, they are likely to attract clapper rails seeking cover during high tides, when shorter vegetation (including native cordgrass and other species) provide less cover. Where Atlantic smooth cordgrass and hybrids dominate whole marshes or large tracts, such as Cogswell Marsh, Alameda Flood Control Channel or the Whale's Tail marsh mitigation site (Hayward shoreline), eradication would result in significant adverse impacts to individual rails and the viability of their local populations. Even in marshes where smaller Atlantic smooth cordgrass colonies occur, eradication operations ranging from manual work by field crews to mechanized removal would disturb rails, risk nest destruction or abandonment, or abandonment of home ranges. Clapper rails may also nest in isolated, discrete colonies of Atlantic smooth cordgrass and hybrids. All eradication methods that result in destruction of rail-occupied stands of Atlantic smooth cordgrass would ultimately suffer the same significant impact.

This impact cannot readily be mitigated by incremental, phased projects within an infested marsh, because such phasing would defeat the basic objective of non-native cordgrass eradication: phasing (piecemeal eradication) would be equally ineffective at preventing re-invasion by locally dominant non-native cordgrass.

If eradication caused complete local extinction of any clapper rail sub-population, this would be a significant long-term adverse effect as well. Local sub-population extinction distributes the risk of species extinction more heavily on remaining populations, which have independent risks of population failure at different sites. Therefore, invasive cordgrass eradication operations would result in unavoidable adverse impacts to California clapper rails.

Direct toxicity of herbicide and surfactant applications is unlikely to have significant adverse impacts to clapper rails inhabiting stands treated by field crews on the ground. Clapper rails would likely be displaced from areas disturbed by field crew activities, and would flee treatment sites before or during operations, thus avoiding exposure to spray. Helicopter applications of glyphosate/surfactant solutions may result in drift and coverage where clapper rails are present, however toxicity of the drift is low. Rails fleeing treatment sites may be subject to increased predation risks, and surviving rails that disperse would risk significant reduction in reproductive success for the current year.

As discussed in *General Impacts of Proposed Treatment Methods*, dredging or excavating to remove cordgrass could expose buried sediments with higher levels or more biologically available forms of mercury (methylmercury). Mercury contamination is a concern for clapper rail reproduction, and elevated levels of mercury are related to embryo mortality of clapper rail eggs in the San Francisco Bay (USFWS, unpub. data). Clapper rails, like other animals, are exposed to mercury through foods they consume. Clapper rails feed within and at the edges of cordgrass stands in tidal creeks or marsh edges, and do not stray far into open mudflats, where they would be vulnerable to predators. The risk of clapper rail exposure to possible mercury-contaminated sediments due to dredging or excavating cordgrass colonies on mudflats would be extremely minimal, because the activity would remove suitable rail foraging habitat, and thus prevent exposure from feeding. Dredged/excavated areas restored to pickleweed, open mudflat, or unvegetated channel bank would be unlikely to affect mercury exposure to clapper rails, since these are not areas where these birds typically forage. Excavated areas restored to native Pacific cordgrass would accrete new sediment from ambient (background) sources, and would then not be a risk for foraging birds.

MITIGATION BIO-5.1: Although some project impacts on clapper rails cannot be reduced to less than significant levels, the following measures shall be implemented to reduce project impacts as much as possible. This EIS/R includes Best Management Practices for reducing project impacts to California clapper rails in **Appendix G**. These clapper rail mitigation requirements may be modified by the US Fish and Wildlife Service in its Biological Opinion.

Treatment projects shall be planned to avoid disturbance outside of treatment areas. Access routes for personnel and equipment shall conform to avoidance protocols. Treatment in occupied clapper rail habitat shall be conducted outside of the clapper rail breeding season. Avoidance measures shall be based on current survey and map data.

For unavoidable significant impacts to clapper rails, compensatory mitigation shall address loss of individuals, population reproductive potential, and population viability (resilience or probability of persistence following perturbations) at both local and regional scales. Compensatory mitigation is based on enhancing or restoring habitat, populations, or reproductive success in the larger regional population.

One method for increasing breeding success in California clapper rail populations offsite (outside of eradication project areas) is to apply rigorous predator population controls to areas invaded by non-native predators such as red fox and Norway rats. Habitat modifications that enhance shelter from predators during high tides, such as replacing annual weeds with tall, native perennial salt marsh edge vegetation, and increasing adult survivorship has a large, positive effect on breeding success: clapper rails are prolific breeders when adult survival is high.

Where tidal marsh can be restored near occupied proposed treatment sites without becoming significantly invaded by additional non-native cordgrass (i.e. where invasion pressures and seed sources are minimal), alternative rail habitat shall be enhanced or restored in advance of eradication operations. Rails affected by eradication operations may be allowed to disperse into newly provided habitat, or if necessary they could be experimentally translocated to suitable alternative habitat, if required by the U.S. Fish and Wildlife Service and California Department of Fish and Game. Where large blocks of habitat are proposed for eradication work, compensatory mitigation for clapper rails must be planned and implemented at larger regional scales. A potentially feasible regional compensation strategy would be to establish accelerated, large-scale clapper rail habitat restoration in the nearest subregion of the Estuary that is subject to minimal invasion pressure from non-native cordgrass. High-impact, large-scale eradication projects would be phased to coincide with or follow successful establishment of viable clapper rail populations of sufficient size in new "rail refuges." All compensation strategies would be at the discretion of the U.S. Fish and Wildlife Service and California Department of Fish and Game, to be determined by formal consultation.

All dredging proposals would require individual authorization and review by the Dredge Materials Management Office, a multi-agency panel of regulatory agencies (Corps of Engineers, Regional Water Quality Control Board, BCDC, EPA). Sediment screening criteria for contaminants of sediments placed in wetlands, and more recent criteria from the California Toxics Rule, would be used to evaluate sediment samples from proposed cordgrass dredge sites. In addition, the U.S. Fish and Wildlife Service would review and regulate dredging in clapper rail habitat through formal endangered species consultation. These stringent reviews and subsequent authorizations would prevent dredging in areas of excessive contaminant mobilization risk, and reduce the risk of mercury and other contaminant impacts to clapper rails to less than significant levels.

IMPACT BIO-5.2: Effects on the California black rail

California black rails would be much less likely to be affected by invasive cordgrass eradication operations because of their geographic and habitat distribution in relation to the current and predicted distribution of invasive cordgrass populations. Black rails are effectively extirpated in San Francisco Bay, and are most frequent in Suisun Marsh and brackish northern San Pablo Bay. Black rails are likely to occur in Southhampton Marsh, Benicia, where salt-meadow cordgrass is proposed for eradication. Eradication of salt-meadow cordgrass would not likely displace black rail habitat, since black rails utilize mixed pickleweed vegetation and tall emergent channel vegetation, not dense matted turfs formed by this species. Eradication operations may disturb black rails, and devegetated patches may temporarily degrade habitat quality for black rails where treatment areas occur near tidal creek banks. Any further spread of invasive cordgrasses into black rail habitat is likely to be limited to new detections of small, pioneer colonies. Eradication of small pioneer cordgrass plants or colonies would have minor, localized impacts to black rails. Some unavoidable incidental impacts to black rails may occur as a result of field crews entering black rail home ranges. Therefore, impacts to black rails are considered significant and unavoidable.

MITIGATION BIO-5.2: Protocols for minimization and avoidance of California clapper rails (Appendix G) for work in infested marshes known to support populations of California black rails (currently one: Southhampton Marsh, Benicia) shall be adopted, emphasizing pre-project surveys (call detection), minimization of marsh disturbance (Mitigation BIO-1.2), and occupied habitat shall be avoided during the breeding season. In treatment areas within 15 feet of tidal creek banks at Southhampton Marsh, treated areas shall be replanted with local gumplant, saltgrass, and pickleweed in the following spring to hasten growth of improved cover for black rails.

IMPACT BIO-5.3: Effects on tidal marsh song sparrow subspecies and the salt marsh common yellowthroat

Resident song sparrow subspecies, particularly the Alameda song sparrow of San Francisco Bay, may suffer short-term adverse impacts by invasive cordgrass eradication operations. Impacts would result from general marsh disturbances by field crews, vehicles and equipment in nesting and feeding areas, as for clapper rails and black rails. Inadvertent nest destruction by vehicles and crews is also a risk. Cordgrass removal also would directly eliminate sources of insects on which song sparrows feed, although cordgrass vegetation is not generally primary foraging habitat for song sparrows. Song sparrows and salt marsh common yellowthroats may be exposed to glyphosate and surfactants by feeding on insects exposed directly to sprays. However, this exposure is not likely to result in significant impacts due to the low toxicity of glyphosate herbicide solutions to birds. Overall impacts to this species are significant and mitigable.

MITIGATION BIO-5.3: Adapt protocols for minimization and avoidance of California clapper rails (**Appendix G**) for work in infested marshes known to support populations of Alameda song sparrows, San Pablo song sparrows, Suisun song sparrow, and the salt marsh common yellowthroat, emphasizing pre-project surveys, minimization of marsh disturbance (Mitigation BIO-1.2), and avoidance of occupied habitat during the breeding season.

IMPACT BIO-5.4: Effects on western snowy plovers and California least terns

Habitats of western snowy plovers usually would not be directly affected by invasive cordgrass eradication operations, since the species is largely confined to emergent salt pond beds behind dikes in this region. If eradication project sites are accessed by levees that pass through snowy plover nest sites, nests on levee tops could be destroyed.

Most eradication operations applied to Atlantic smooth cordgrass in mudflats would occur during low tides, and would not affect nesting, roosting, or feeding habitats of Californian least terns. Upon re-submergence at high tide, mudflat eradication sites may resume as foraging habitat for least terns. Mechanical excavation or surface-disturbing eradication methods may locally increase surface sediment mobility and local turbidity during rising tides, and could reduce visibility of prey fish of least terns. This would be a localized, temporary, moderate impact. Incidental exposure of California least terns to glyphosate herbicide solution spray residues through fish is unlikely because of strong dilution and dispersion in high-energy tidal mudflat environments, rapid inactivation degradation, and low bioaccumulation potential.

If large stands of Atlantic smooth cordgrass were eradicated by temporary impoundments, shallow saline ponds formed would provide possible minor foraging habitat for least terns, but this is less likely than habitat benefits for dabbling ducks, wading birds, and bay ducks.

If large stands of Atlantic smooth cordgrass were eradicated by dredging adjacent to navigable channels, turbidity impacts could affect feeding of least terns. This would depend on tidal stage:

dredging very shallow intertidal areas would have less turbidity impact than dredging subtidal bottoms. Turbidity increases can attract terns by forcing small fish to the surface, or they can interfere with feeding by reducing water clarity and prey fish visibility. In any case, potential turbidity effects from cordgrass dredging or excavation would have moderate impacts on least terns. Overall project impacts on California least terns and western snowy plovers are significant but mitigable.

MITIGATION BIO-5.4: Prior to levee access in areas where snowy plovers may breed, levee routes shall be surveyed for potential nests, including nests in salt pond beds near levee roads. Dredging and excavation of cordgrass shall be conducted either after least terns have migrated out of San Francisco Bay, or during middle to lower tidal stages that allow navigation of barge and crane operations, while exposing the maximum extent of cordgrass above standing tides.

IMPACT BIO-5.5: Effects of regional invasive cordgrass eradication on raptors (birds of prey)

Some eradication operations may affect raptors, including northern harriers, short-eared owls, white-tailed kites, and black-shouldered kites. Low-flying helicopters used in aerial spray application of glyphosate herbicide solutions may interfere with raptor foraging or nesting. This impact would be less likely for operations on tidal mudflats or low marshes, because raptors forage in tidal marshes mainly over higher marsh plains that support small mammals. Helicopter disruption of foraging would be very short-term (only up to a few hours) and not significant (Granholm, pers. com.) Raptors may ingest small mammals or birds that have been sprayed with herbicide solutions. This is not expected to be a significant impact due to the limited occurrences of spraying and low toxicity of the solutions to birds. Disruption of nesting, however, may be significant if adults are scared away and unable to tend eggs and young. Harriers, owls, and kites frequently nest in or adjacent to the upper marsh edge.

MITIGATION BIO-5.5: Use of helicopters to apply glyphosate herbicide solution in mid- and upper-marsh plains shall be minimized during raptor nesting season. If helicopters are used at there locations during the nesting season, a survey for raptors shall be performed by a qualified biologist, and any identified nests shall be provided a buffer of at least 500 feet from spray helicopters.

IMPACT BIO-6: Effects on estuarine fish species

IMPACT BIO-6.1: Effects on anadromous salmonids (winter-run and spring-run Chinook salmon, steelhead)

Chinook salmon and steelhead juveniles and adults may pass through low marsh, channel bank, and mudflat sites where invasive cordgrass eradication is performed. Most eradication methods occur at low tide, and would indirectly affect salmon and steelhead during later flood tidal stages when contact is possible. Only dredging methods performed at higher tidal stages could have direct impacts to passing salmon and steelhead through exposure to elevated turbidity, depressed dissolved oxygen levels, and mobilization of toxic sulfides. Dredging or excavation of target cordgrass stands when they are emergent (mid to low tide) would have minimal indirect effects on salmonids. These effects would be related to suspension of anoxic subsurface muds from intertidal dredge sites to tidal channels, which would involve less exposure than subtidal dredging used in navigational dredging projects. Excavation of small channels in the marsh plain would occur at low tide, and would have minor impacts to fish. Dredging impacts in larger channels could occur in few locations infested with Atlantic smooth cordgrass, but could be significant for listed salmonids.

Eradication methods based on impoundment and chronic flooding (drowning) of cordgrass would carry risks of entrapment of Chinook salmon and steelhead. This method would potentially apply mainly to Atlantic smooth cordgrass in San Francisco Bay. Entrapment impacts could be similar to those routinely practiced for salt pond intakes, without fish screens, for the last century. Entrapment impacts of this type would occur in the case of large tidally restored diked salt marshes refitted with new tidegates and intake invert elevations near mean low water. The cumulative impact of such intakes would be minimized by the proposed reduction in salt production by the region's sole industrial salt producer. Entrapment impacts would lower for small, shallow impoundments that are flooded by a combination of extreme high tides that overtop both the marsh plain and berm or dam crest, and rainfall. Total entrapment impacts caused by impoundments used for cordgrass eradication, even if used commonly (which is not likely because of cost and feasibility constraints), would be minor compared with the large number of unscreened intakes in Suisun Marsh (over 100 in this subregion alone), and the Napa-Sonoma Marshes, where Chinook salmon are likely to be more frequent than in San Francisco Bay.

Applications of glyphosate/surfactant solutions to marsh and mudflat surfaces may result in low-level exposure of Chinook salmon and steelhead to toxic effects during subsequent tidal reflooding. Spray solution concentrations of glyphosate and surfactants may be moderately toxic to salmonids, but effective exposure would dilute spray solution with bay water. Exposure even in "worst case", maximum exposure conditions during the first tidal reflooding following application is unlikely to have toxic effects because of rapid, strong dilution in turbulent tidal currents, rapid and thorough inactivation of glyphosate in high concentrations of suspended fine sediment, low inherent toxicity of glyphosate to fish, and the likelihood of very brief exposure times. Steelhead and Chinook salmon are not bottom feeders, so their feeding behavior would minimize rather than magnify their potential exposure to residual spray-contaminated sediment concentrated on the submerged mudflat surface. Accidental spills of glyphosate/surfactant solutions on mudflats would cause greater local concentration and higher levels of exposure. Overall project impacts on anadromous salmonids are considered significant but mitigable.

MITIGATION BIO-6.1: Dredging of infested intertidal channels shall be limited to: (1) tidal stages when target areas are emerged above water level, and (2) during seasons when winter- and spring-run Chinook salmon and steelhead migration times minimize their risk of exposure at project sites, particularly juveniles. Water intakes for impoundments shall have intake elevations limited to tides above mean high water (extreme tides overtopping marsh plain) to minimize entrainment and trapping. Alternatively, fish screens shall be installed on any new tidegates used to impound and drown large cordgrass-infested marshes in former diked baylands. Herbicide methods shall be minimized or avoided near channels and mudflats during migration periods of winter-run and spring-run Chinook salmon and steelhead. Glyphosate/surfactant spray application requirements shall be minimized by pre-treating target cordgrass stands with mechanical methods that reduce cordgrass biomass and density, increase receptivity and coverage of spray, and increase mortality response to glyphosate. In case of herbicide/surfactant solution spill, small volumes of spilled solutions on mudflats shall be remediated to the greatest extent feasible by suction of surface muds, using portable wet vacuum or pumping equipment.

IMPACT BIO-6.2: Effects on delta smelt and Sacramento splittail

Delta smelt and Sacramento splittail occur in the San Francisco Estuary mostly in the Suisun Bay area and northern reaches of San Pablo Bay, where cordgrass eradication operations are likely to be few and small in scope for the foreseeable future. Splittail are known to have inhabited Coyote

Creek, a tributary to San Francisco Bay, in the late 1800s, but were thought to be extirpated in the early 20th century (Aceituno, et. al. 1976). However, in 1983, splittail again were captured in Coyote Creek (Kinetic Labs, Inc., and L.W. Associates, 1987). These fish may have migrated to Coyote Creek during the high flows of Winter 1983 that created low salinity conditions in shallow waters throughout San Francisco Bay. The winters of 1995, 1997, and 1998 produced similar low-salinity conditions. No other records of splittail from Coyote Creek are known No significant impacts for these species are expected. Minor, temporary impacts could occur at Southhampton Marsh, in the Carquinez Strait. Salt-meadow cordgrass here occurs only in the high marsh plain, so direct and indirect effects of cordgrass eradication work would have minimal contact with these species. Potential indirect effects of glyphosate/surfactant solutions would be negligible in high marsh, which is not submerged during September-October tides, when clapper rail non-breeding season would most likely allow such work to be performed.

MITIGATION BIO-6.2: For work in infested North Bay marshes where delta smelt or Sacramento splittail may occur (currently only Southhampton Marsh, Benicia), impoundment techniques shall be eliminated and spray drift near tidal creeks shall be minimized (Mitigations BIO-1.1, 1.2). Any intertidal excavation or dredging in tidal creeks shall be restricted to tidal stages when target areas are emerged above water level.

IMPACT BIO-6.3: Effects on the tidewater goby

No impacts are expected to occur to tidewater gobies in San Francisco Bay because they are not known to occur in intertidal mudflats or marsh tidal creeks in San Francisco Bay. All records of this species in the Estuary are old, and limited to the Central Bay. Even if they were present, impacts would be improbable for most of the same reasons pertinent to steelhead and Chinook salmon (see BIO-6.1).

Mitigation Measures: None required.

IMPACT BIO-6.4: Effects on estuarine fish populations of shallow submerged intertidal mudflats and channels.

Many estuarine fish feed in intertidal mudflats that may be exposed to glyphosate/surfactant solutions that may be moderately toxic to fish at applied concentrations. Bottom-feeding fish, which contact sediments to capture invertebrates on or below the mud surface, have relatively greater risk of exposure to glyphosate and surfactants in sediments. Exposure risks are offset by physiological inactivation of glyphosate upon contact (adsorption) with clay, silt, and organic matter, strong dilution effects in energetic, turbulent conditions of rising tides and wind-generated waves, and rapid resuspension of surface sediment in contact with spray. Mechanical disturbance of mudflat or channel surfaces may expose fish populations to elevated levels of mercury in the water column and in prey species. Although elevated, these levels would still be below those likely to adversely affect fish because of the limited and infrequent treatment occurrences, and low organic content (hance limited methylization potential) of exposed sediments.

Only dredging methods performed on target cordgrass stands at higher tidal stages could have direct impacts to estuarine fish by exposure to elevated turbidity, depressed dissolved oxygen levels, and mobilization of toxic sulfides. Dredging or excavation of target cordgrass stands when they are emergent (mid to low tide) would have minimal indirect effects on fish. These effects would be related to suspension of anoxic subsurface muds from intertidal dredge sites to tidal channels, which would involve less exposure than subtidal dredging used in navigational dredging projects. Excavation of small channels in the marsh plain would occur at low tide, and would have minor direct impacts to fish. Dredging impacts in larger channels could occur in few locations infested with Atlantic smooth cordgrass, but could be significant for estuarine fish.

Impacts of eradication methods based on impoundment and chronic flooding (drowning) of cordgrass to estuarine fish would be similar to those described above for anadromous salmonids. Total entrapment impacts caused by impoundments used for cordgrass eradication, even if used commonly (which is not likely because of cost and feasibility constraints), would be minor.

MITIGATION BIO-6.4: Dredging of infested intertidal channels shall be limited to tidal stages when target areas are emerged above water level, or appropriate measures shall be taken to isolate the dredged area from adjacent Bay or channel waters. Herbicide methods shall be minimized near channels. Glyphosate/surfactant spray application requirements shall be minimized by pre-treating target cordgrass stands with mechanical methods that reduce cordgrass biomass and density, increase receptivity and coverage of spray, and increase mortality response to glyphosate. In case of herbicide/surfactant solution spill, small volumes of spilled solutions on mudflats shall be remediated to the greatest extent feasible by suction of surface muds, using portable wet vacuum or pumping equipment.

IMPACT BIO-7: Effects on California red-legged frog and San Francisco garter snake

No impacts are expected to occur to California red-legged frogs or San Francisco garter snakes from equipment staging, equipment mobilization, eradication operations, or indirect effects of eradication. No suitable habitat (freshwater to fresh-brackish seasonal ponds, stream channels, woody riparian vegetation with scour pools, or freshwater marshes) occur in tidal habitats where eradication operations would occur, and adjacent areas used for access, staging, equipment mobilization, etc. are typically dry saline levees, salt pods, urban developed lands, and flood control levees far from suitable habitat. Terrestrial habitats in these areas also are unsuitable as aestivation (summer dormant state) habitat. Potential habitat areas are remote from potential sources of spray drift in tidal habitats, and are sheltered by urban landscapes bordering the bay.

Mitigation Measures: None required.

IMPACT BIO-8: Effects on mosquito production

Control operations within mudflats and low marsh environments would have no effect on mosquito production, since these turbulent, dynamic environments do not support mosquito breeding. Access to low marsh and creek sites of control work may require vehicles leaving tracks and ruts in the marsh plain, like the "Argo" vehicles routinely used by mosquito abatement district personnel. Local undrained marsh depressions in tracks can cause local increases in mosquito breeding habitat and larval production. This would be a minor adverse impact. Conversely, the spread of Atlantic smooth cordgrass in tidal marsh pans, or over wide marsh plains with poor drainage (see Geomorphology and Hydrology), would also be likely to produce mosquito breeding habitat at a larger scale.

MITIGATION BIO-8: Access routes in marshes shall be monitored to detect formation of undrained depressions in tire ruts or foot trails. Access-related shallow marsh depressions shall be backfilled or incised with narrow drainages so they do not impound small, sheltered areas of standing water. Where impoundments are used, impoundments shall be of sufficient size and depth to minimize mosquito breeding habitat.

IMPACT BIO-9: Effects on tiger beetles species of estuarine habitats

Eradication of existing Atlantic smooth cordgrass at sites of estuarine beaches and intertidal sand flats (mostly in the Central Bay) would restore sediment mobility, sparse vegetation, and beach dynamics. This would increase potential habitat for tiger beetle species with affinity for sand.

Mitigation Measures: None required.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Alternative 2 would involve proportionally greater extent and frequency of treatment methods that involve mechanical disturbance, use of vehicles in tidal marshes, disturbance of marsh wildlife by repeated re-entry for repeat-cropping methods, and impacts of dredging and excavation compared with Alternative 1. Potential effects of herbicide applications, including disturbance from helicopters, toxicity of surfactants, spray drift impacts to non-target vegetation, fish, and wildlife, would not occur. The time required to achieve a given unit of cordgrass reduction or eradication (acreage, population reduction, geographic area covered) would be substantially greater than with integrated, combined treatments that may include use of glyphosate. In particular, the duration of total treatment time and the number of repeat treatments needed to achieve complete mortality for any given target colony would increase, possibly over multiple years for large stands. Prolonged disturbance, and delayed recovery/restoration of marsh at treated sites, would extend impact duration and intensity, particularly for sensitive wildlife around project sites.

The overall slower pace of regional eradication would significantly increase the risk that the rapid and accelerating spread of Atlantic smooth cordgrass and its hybrid swarm would overwhelm the eradication program. The relatively small, slower-spreading populations of other invasive cordgrass species, however, could probably be eradicated by individual projects (though with some doubt about Chilean cordgrass). It is uncertain whether a regional eradication program for invasive cordgrasses in the San Francisco Estuary can avoid being overwhelmed by rates of invasion without integrating at least minimal use of glyphosate methods in local and regional eradication strategies. No successful regional invasive cordgrass programs in Britain, New Zealand, or the Pacific Northwest have excluded all use of herbicides. If population growth of Atlantic smooth cordgrass' hybrids overtakes the rate of eradication, Alternative 2 would converge towards the same ecological endpoint as the no-action alternative.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Short-term impacts of this alternative would be similar to those described for the treatment methods for Alternative 1, above, however these impacts would be less widespread due to the anticipated smaller areas to be treated under this alternative.

As described in Section 3.1, Geomorphology and Hydrology likely future scenarios of cordgrass invasion are variable and can best be viewed as alternative scenarios more or less likely to occur in the San Francisco Estuary. The most optimistic scenario is one under which species that have been relatively slow to spread from established sites will continue to be poor long-distance invaders. As described in Section 3.1, the optimistic scenario cannot be ruled out, but appears relatively unlikely. Another relatively optimistic scenario would be that the invasive cordgrass species in this region can be confined to the San Francisco Estuary, and controlled by long-term maintenance (weeding) of existing infested marshes, short of regional eradication. As described in Section 3.1, this scenario also is unlikely. A less optimistic, and more likely, scenario is that Atlantic smooth cordgrass progressively dominates the San Francisco estuary. As described in Section 3.1, under this scenario, there is still much uncertainty about the likely future structure of intertidal habitats. If sea level rise continues to accelerate, while sediment supplies become more deficient, extensive low marsh cordgrass meadows with ample tidal drainage may form, and this would tend to favor tall forms of Atlantic smooth cordgrass. If sedimentation in the San Francisco Estuary is able to keep pace with sea level rise, there is a greater chance that higher marsh plains, with defined drainage patterns, may form. This would increase the risk that smooth cordgrass would behave as it does in the southeastern Atlantic salt marshes, where it forms extensive single-species stands of stunted, short-form cordgrass marsh, and limits the development of small tidal creeks and pans (features typical of Pacific and northeastern Atlantic high salt marsh).

Although all of the scenarios described above are possible, this last scenario is considered the most likely scenario and represents a "reasonable worst case". As described in Section 2.2.3, Alternatives Description, Alternative 3, selective removal of non-native cordgrass at restoration sites would probably cease when monitoring confirms that no native cordgrass is recruited, and all spontaneous recruits are invasive species, even when natives are planted. Eradication for flood control purposes, however, may continue locally in perpetuity.

If "short-form" Atlantic smooth cordgrass salt marsh establish and spread over time, significant habitat and species population changes would occur.

The most important ecological effect of regional invasive cordgrass eradication on shorebirds and waterfowl would be long-term. This would result from protection and restoration of prime mudflat feeding areas for the Pacific Flyway, which are invaded by Atlantic smooth cordgrass and its hybrids and converted to habitat types that shorebirds and waterfowl cannot use for feeding. A less obvious but important indirect long-term effect would be avoidance of massive cordgrass wrack (tidal litter) production, which would routinely affect tidegate (water intake) operations for managed wetlands, choking them with debris, reducing efficiency, increasing maintenance costs, and elevating risks of recurrent short-term problems with species-sensitive water level management, and water quality. Eradication methods based on impoundment of shallow water (drowning cordgrass) would have short-term, moderately beneficial impacts on dabbling ducks, bay ducks, herons, and larger egrets, by providing shallow, low-turbidity ponds similar to salt intake ponds. These would support feeding habitat and high tide roosts. Shorebirds may roost on temporary berms or inflatable dams that impound water, but water depths would exclude shorebirds.

The density and distribution of California clapper rails would be radically altered compared with both natural and modern tidal marsh conditions. Large new or restored marshes formed under the influence of Atlantic smooth cordgrass in future decades may have significantly less habitat value for California clapper rails than native marshes. Atlantic subspecies of clapper rails scarcely occupy the vast plains of short-form Atlantic smooth cordgrass and nest almost exclusively in tall-form cordgrass along tidal creek banks and marsh edges (Meanley 1985). This suggests that clapper rails in the San Francisco Estuary may be "marginalized" in typical Atlantic marsh structure. Future marsh structure and vegetation structure are critical issues for predicting the future status of California clapper rails in alternative cordgrass scenarios for San Francisco Bay, and these issues are speculative. In natural conditions of San Francisco Bay, clapper rails typically construct nests in pickleweed or gumplant vegetation, not cordgrass. It is uncertain whether Atlantic smooth cordgrass-dominated marshes which accrete to the elevation of Mean Higher High water will "release" marsh plains to pickleweed-mixture vegetation. The typical nesting behavior of California clapper rails may be affected by widespread persistence of cordgrass marsh in what would otherwise be tidal pickleweed marsh. Another long-term effect of invasive cordgrass would be the loss of suitable tidal marsh plain and creek habitats for California black rails.

Long-term adverse effects of spread of Atlantic smooth cordgrass infestations on snowy plovers include the loss of sand and shell beaches in San Francisco Bay. Beaches and sandy foreshores that provide transient roost or feeding habitats for snowy plovers moving between other Pacific coast locations would be lost. The potential for restored estuarine beaches that could potentially support breeding also would be lost.

Invasive cordgrass would adversely affect California least terns in the long term by eliminating intertidal mudflat habitat that is used for feeding at high tide.

Invasive cordgrass spread also would result in the loss of existing marsh plain habitat (most suitable habitat for small mammal prey of raptors).

The recovery of the endangered salt marsh harvest mouse in tidal marsh habitats, and California sea-blite in estuarine beach-marsh edges, would be either precluded or strongly constrained. Harbor seals could not access existing high marsh haul-out sites because they require access with close proximity to subtidal water, and established major seal haul-outs would be isolated and made inaccessible by wide, tall, cordgrass marsh.

An important general cumulative effect of invasive cordgrass spread, is the population growth interaction with region-wide tidal marsh restoration in the San Francisco Estuary, particularly San Francisco Bay. The location and timing of large-scale tidal marsh restoration projects can have an overwhelming effect on population growth of non-native cordgrass by combining source populations with large acreages of new habitat to invade.

All tidal salt marsh restoration in the San Francisco Estuary currently proposed would be either wholly dominated by Atlantic smooth cordgrass hybrids as they reach the low marsh stage of succession, or they would progressively become dominated by them. Extensive conversion of open mudflat to tidal marsh would occur in San Francisco Bay and San Pablo Bay, and gradients in remaining mudflats would steepen. Shorebird habitat in former mudflats would be reduced by displacement to cordgrass marsh (acreage not known, possibly over one-fourth of existing mudflats), and the quality of diked managed shorebird and waterfowl habitat may decline due to indirect effects of cordgrass dominance on water management (debris obstruction of intakes, infilling of intake channels). The recovery of special-status plant species would be impaired by significant increases the frequency, area, and mass of wrack deposition in the high marsh, and altered marsh hydrology. The elimination of Chilean cordgrass and salt-meadow cordgrass in the North Bay and Suisun Marsh would contribute to the recovery of endangered Suisun thistle and soft bird's beak, and the conservation of northern salt marsh bird's-beak, salt marsh owl's-clover, Bolander's spotted water-hemlock, and Mason's lilaeopsis, and other species in regional decline. Reduction in the extent and size of highly branched, irregular tidal channels within tidal marsh plains would significantly reduce important nursery and feeding habitat for fish, including endangered delta smelt, California splittail, and Chinook salmon runs, as well as other fish species using the Estuary.

Massive, matted cordgrass litter in the high marsh zone could be detrimental to tiger beetle habitat quality.

Mosquito production and subsequent required abatement activities would likely increase significantly.

As an indirect impact beyond the San Francisco Estuary, the expanded population of hybrid Atlantic smooth cordgrass would annually export large quantities of seed beyond the Golden Gate, and increase the rate of recruitment in highly vulnerable sandy estuaries of west Marin County, where the last refuge of "pure" Pacific cordgrass remains north of Point Conception (see **Figure**

1-5). Similar impacts of invasion would occur there, but with greater significance for marine mammals, mariculture (oyster farms), and shorebirds. Sea otter habitat in Elkhorn Slough, Monterey County may indirectly affected by cordgrass spread. Net conversion of intertidal channels or mudflats to cordgrass marsh would adversely affect habitat availability for the sea otter in Elkhorn Slough.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-1.1: Effects on tidal marsh plant communities affected by salt-meadow cordgrass and English cordgrass.	All Alternatives: Local, short-term minor adverse effects would be possible because of incidental trampling by crews.	All Alternatives: Minor to moderate adverse impacts could occur because of damage from vehicles on mats, trampling.	All Alternatives: Minor adverse effects may occur if geotextile fabric is displaced and damages non-target vegetation. Repeat mowing or smothering treatments would result in local but persistent trampling damage.	All Alternatives: Not applicable: method not feasible for existing infestation, generally infeasible for potential small infestations in the high salt marsh zone.	All Alternatives: Not applicable: method not feasible for existing infestation, probably generally infeasible for potential small infestations of this species; no adverse impact.	Alternatives 1, 3: Potential local, persistent (to 2-3 year), adverse impact due to spray drift effect on non-target emergent marsh vegetation. Alternative 2: No impact.	Alternatives 1 & 2: Eradication of the existing small regional infestation is likely, resulting in early arrest of spread to regional tidal marshes. Significant long-term benefit. Alternative 3: Short-term benefits of continued uncoordinated contyrol efforts; no long-term benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-1.2: Effects on tidal marsh plant communities affected by Atlantic smooth cordgrass and its hybrids.	Alternative 1: Minor to moderate short-term local adverse impacts due to incidental trampling by crews. Alternative 2: Proportionally more use of this method than in Alternative 1, greater impact, but not significant. Alternative 3: Less regional use and impact than Alternatives 1 & 2.	Alternative 1: Minor to moderate adverse impacts if limited to isolated mudflat colonies: potentially significant adverse impacts if applied to extensive colonies within existing tidal marsh. Alternative 2: Proportionally more regional use of this method than Alternative 1, greater impact, potentially significant. Alternative 3: Less impact than Alternatives 1& 2.	Alternative 1: Minor adverse effects may occur if geotextile fabric is displaced and damages non-target vegetation. Repeat mowing or smothering treatments would result in local but persistent trampling damage. Alternative 2: Proportionally more use of this method than Alternative 1, greater impact, but not significant. Alternative 3: Less regional use of and impact of this method than Alternatives 1 & 2.	Alternative 1: Potentially significant short-term (1-3 year) large-scale impacts due to non-selective eradication caused by impoundment of existing salt marsh vegetation. Alternative 2: Proportionally more use of this method than Alternative 1, greater impact. Alternative 3: Low or no impact if used.	Alternatives 1-3A: Local, short-term adverse impacts to tidal marsh vegetation marginal to burned areas; low potential for inadvertent spread of fire to in tidal marsh vegetation adjacent to smooth cordgrass. Limited potential for use. Alternative 3: No impact.	Alternatives 1, 3A: Local, moderately persistent adverse impacts of herbicide spray drift on tidal marsh vegetation adjacent to treated areas could occur from manual and normal helicopter application. Minimal non-target impacts to vegetation could occur from wick/ brush applications. Significant adverse impacts could occur from worst-case helicopter spray drift. Alternative 2,	Alternatives 1: Long-term benefit to regional tidal marsh communities due to arrest of invasion. Alternatives 2-3: Temporary local benefits from individual eradication projects; no long-term or significant benefits. Alternative 3: Short-term benefits of continued uncoordinated contyrol efforts; no long-term benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-1.3: Effects on tidal marsh plant communities affected by Chilean cordgrass.	Alternative 1: Minor to moderate adverse impacts due to incidental trampling by crews. Alternative 2: Proportionally greater use and impact of this method than Alternative 1, but not significant. Alternative 3A: Less trampling impact than Alternatives 1 & 2.	All Alternatives: Unlikely methods for known infestations of this high salt marsh species. Local, short-term minor to moderate adverse impacts could occur because of damage from vehicles on mats, trampling.	Alternatives 1, 3A: Local, short-term minor adverse effects may occur if geotextile fabric is displaced and damages non-target vegetation. Repeat mowing or smothering treatments would result in local but persistent trampling damage. Alternative 2: Greater impact of this method than Alternative 1, but not significant.	All Alternatives : Not applicable: method not feasible for existing infestation, generally infeasible for potential small infestations of this species in the high salt marsh zone.	All Alternatives: Minor to moderate local and short-term adverse impacts due to marginal impacts to non-target salt marsh vegetation. Limited applicability of this method for known infestations.	Alternative 1: Minor to moderate short-term adverse impact due to spray drift from manual applications. Helicopter spray probably infeasible for known infestations of this species. Alternative 2: No impact.	Alternative 1: Probably fastest regional eradication, lowest risk of regional spread. Greatest significant long-term benefit. Alternatives 2, 3 Possibly slower but feasible regional eradication and arrested spread. Significant long-term benefit.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-1.4: Effects on submerged aquatic plant communities.	Alternative 1: No adverse impact. Alternatives 2& 3: No impact.	Alternative 1: No adverse impact. Alternatives 2 & 3: No impact.	All Alternatives: minimal adverse impact. Leaf litter from mowing could raft on high tides and deposit in pans, causing one growing season of local wigeongrass dieback. Moderate to minor impact. Alternative 2: No impact.	All Alternatives: No adverse impact.	All Alternatives: No adverse impact.	All Alternatives: No adverse impact.	Alternatives 1-2: Short-term increases in habitat due to flooding (impoundment) methods in some cases, potentially significant benefits over life of regional program due to prevention of invasion by smooth cordgrass. Alternative 3: No long-term benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-2: Effects on special-status plants in tidal marshes.	Alternative 1: Local, short-term potentially significant impacts to soft-birdês beak due to incidental trampling or disturbance, only with removal of known saltmeadow and Chilean cordgrass infestations. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1 but still significant.	Alternative 1: Local, short-term potentially saignificant impacts to soft-birdês beak due to incidental trampling or disturbance, only with removal of known saltmeadow and Chilean cordgrass infestations. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: Local, short-term minor adverse effects may occur if geotextile fabric (smothering) is displaced and damages soft birdês-beak populations. Repeat mowing treatments would result in local but persistent trampling damage; only with removal of known saltmeadow and Chilean cordgrass infestations. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1 but still significant.	All Alternatives: This method is unlikely to be applied to any habitats supporting special-status plants (smooth cordgrass only); no impact.	All Alternatives: This method is unlikely to be applied to any habitats supporting special-status plants (smooth cordgrass only); no impact.	Alternative 1: Potentially significant adverse impacts to soft birdês-beak, only with removal of known saltmeadow and Chilean cordgrass infestations. (less than significant with mitigation). Alternative 2: No impact. Alternative 3: Less impact than Alternative 1.	Alternative 1: Pacific cordgrass likely to avoid regional extinction; California sea-blite recovery feasibility increased; threats reduced for other rare species; all significant long-term benefits. Alternatives 2, 3: short- to moderate-term benefits, probably no long-term benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	Manual Removal (Hand pulling and manual excavation)	Mechanical Removal (Excavation, dredging, and shredding)	Pruning, Hand-mowing, and Smothering	Flooding (Diking, drowning, and salinity variation)	Burning	Herbicide Application	Beneficial Effects
BIO-3: Effects on shorebirds and waterfowl.	Alternative 1: Short-term, local potentially significant disturbance of shorebirds and waterfowl in vicinity of access and treatment areas (slough and mudflat). Alternative 2: Greater impact than Alternative 1. Alternative 3. Less impact than Alternative 1.	Alternative 1: Short-term, local potentially significant disturbance of shorebirds and waterfowl in vicinity of access and treatment areas (slough and mudflat). Moderate adverse impact. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: Short-term, local disturbance of shorebirds and waterfowl in vicinity of access and treatment areas (slough and mudflat). Moderate adverse impact. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: If impoundment requires construction of berms or inflatable dams, short-term, local disturbance waterfowl of shorebirds Alternative 2: Greater impact than Alternative 1. Alternative 3: Low or no adverse impact if used.	Alternative 1: Short-term, local disturbance of shorebirds and waterfowl in vicinity of access and treatment areas (slough and mudflat). Moderate adverse impact. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: Short-term, local disturbance of shorebirds and waterfowl in vicinity of access and treatment areas (slough and mudflat). Moderate adverse impact. Potentially significant impacts if helicopters are used for repeat treatment of large mudflat colonies. Alternative 2: No impact. Alternative 3: Less impact than Alternative 1.	Alternative 1: Long-term region-wide increase or stabilization and protection of primary foraging and roosting habitats in tidal mudflats at key stopover in Pacific flyway. Highly significant benefit. Alternatives 2, 3: Relatively short-term (ca. 10 yr) increase of primary foraging and roosting habitat. Moderate benefit.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-4.1: Effects on the salt marsh harvest mouse and tidal marsh shrew species.	Alternative 1: Eradication of non-native cordgrass in high marsh may have significant short-term adverse impacts in few locations, but usually minor or none. Local, short-term minor to moderate adverse impacts due to incidental trampling or disturbance. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: Eradication of non-native cordgrass in high marsh may have significant short-term adverse impacts in few locations, but usually minor or none. Local, short-term minor to moderate adverse impacts due to incidental trampling or disturbance. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: Eradication of non-native cordgrass in high marsh may have significant short-term adverse impacts in few locations, but usually minor or none. Local, short-term minor to moderate adverse impacts due to incidental trampling or disturbance. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: Method probably not applicable to high marsh habitat of small tidal marsh mammal species; minor impacts of feasible applications. Alternative 2: Proportionally greater, but not significant impacts than Alternative 1. Alternative 3: Method probably infeasible without regionally coordinated mitigation for scale of wildlife impacts; low or no adverse impact if used.	Alternative 1: Eradication of non-native cordgrass in high marsh may have significant short-term adverse impacts in few locations, but usually minor or none. Local, short-term minor to moderate adverse impacts due to incidental trampling or disturbance. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1.	Alternative 1: Eradication of non-native cordgrass in high marsh may have significant short-term adverse impacts in few locations, but usually minor or none. Local, short-term minor to moderate adverse impacts due to incidental trampling or disturbance. Alternative 2: No impact. Alternative 3: Less impact than Alternative 1.	Alternative 1: Probable long-term, widespread cumulative benefit due to arrest of invasions by non-native cordgrass, protection of habitat. Significant long-term benefit. Alternatives 2, 3: Temporary local benefits from individual eradication projects, not long-term or significant (invasion likely to overtake eradication).

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-4.2: Effects on resident harbor seal colonies of San Francisco Bay.	Alternative 1: Short-term, local disturbance of harbor seals in vicinity of a few access and treatment areas. Potentially significant adverse impacts at a few potential project sites, minor or no impacts at most project sites. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1, potentially significant.	Alternative 1: Short-term, local disturbance of harbor seals in vicinity of a few access and treatment areas. Potentially significant adverse impacts at a few potential project sites, minor or no impacts at most project sites. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1, potentially significant.	Alternative 1: Short-term, local disturbance of harbor seals in vicinity of a few access and treatment areas. Potentially significant adverse impacts at a few potential project sites, minor or no impacts at most project sites. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1, potentially significant.	Alternative 1: Short-term, local disturbance of harbor seals in vicinity of a few access and treatment areas. Potentially significant adverse impact. Minor or no impacts at most project sites. Alternative 2: Greater impact than Alternative 1. Alternative 3: If used, impacts may be significant at a few potential project sites, but minor or no impacts at most sites.	Alternative 1: Short-term, local disturbance of harbor seals in vicinity of a few access and treatment areas. Potentially significant adverse impacts at a few potential project sites, minor or no impacts at most project sites. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1, potentially significant.	Alternative 1: Short-term, local disturbance of harbor seals in vicinity of a few access and treatment areas. Potentially significant adverse impacts at a few potential project sites, minor or no impacts at most project sites. Alternative 2: No impact. Alternative 3: Less impact than Alternative 1, potentially significant.	Alternative 1: Long-term stabilization of existing haul-out habitats by preventing isolation from encroaching smooth cordgrass. Significant benefit, especially for Mowry Slough and other south San Francisco Bay colonies. Alternatives 2 & 3: Some short-term benefits, no long-term benefits likely.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-4.3: Effects on the southern sea otter.	All alternatives: Negligible or no impact.	All alternatives: Negligible or no impact.	All alternatives: Negligible or no impact.	All alternatives: Negligible or no impact.	All alternatives: Negligible or no impact.	All alternatives: Negligible or no impact.	Long-term reduction of risk that important habitat in Elkhorn Slough will be invaded by pioneers of smooth cordgrass from San Francisco Bay.
BIO-5.1: Effects on California clapper rail.	All Alternatives. Potentially significant disturbance of clapper rail foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to rail habitats. Local loss of breeding; risk of mortality. Order of severity: 2 (greatest), 1, 3.	All Alternatives. Potentially significant disturbance of clapper rail foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to rail habitats. Local loss of breeding; risk of mortality. Order of severity: 2 (greatest), 1, 3.	All Alternatives. Potentially significant disturbance of clapper rail foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to rail habitats. Local loss of breeding; risk of mortality. Order of severity: 2 (greatest), 1, 3.	All Alternatives. Potentially significant disturbance of clapper rail foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to rail habitats. Local loss of breeding; risk of mortality. Greater severity for Alternative 2.	All Alternatives. Potentially significant disturbance of clapper rail foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to rail habitats. Local loss of breeding; risk of mortality. Greater severity for Alternatives 1 & 2.	Alternatives 1, 3. Potentially significant disturbance of clapper rail foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to rail habitats. Local loss of breeding; risk of mortality. Greater severity for Alternative 1. Alternative 2: No impact.	Alternative 1: Long- term protection and restoration of typical tidal creek and marsh habitat structure to which the subspecies is adapted. Alternatives 2, 3: Delayed loss of typical habitat structure, eventual significant net expansion of suitable habitat of uncertain long-term stability.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-5.2: Effects on the California black rail.	All Alternatives: Potentially significant impact foreseeable only at one site; no impacts in San Francisco Bay.	All Alternatives: Potentially significant impact foreseeable only at one site; no impacts in San Francisco Bay.	All Alternatives: Potentially significant impact foreseeable only at one site; no impacts in San Francisco Bay.	All Alternatives: Method probably inapplicable to existing or foreseeable San Pablo Bay infestations; no impacts in San Francisco Bay.	All Alternatives: Method probably inapplicable to existing or foreseeable San Pablo Bay infestations; no impacts in San Francisco Bay.	All Alternatives: Potentially significant impact foreseeable only at one site; no impacts in San Francisco Bay.	Alternative 1: Probable long-term, widespread cumulative benefit due to arrest of invasions by non-native cordgrass, protection of habitat. Significant long-term benefit. Alternatives 2-3: No long-term benefits (invasion likely to overtake eradication).

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-5.3: Effects on tidal marsh song sparrow subspecies and the salt marsh common yellowthroat.	All Alternatives: Potentially significant disturbance of foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to habitats. Local loss of breeding; risk of mortality. Order of severity: 2 (greatest), 1, 3.	All Alternatives: Potentially significant disturbance of foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to habitats. Local loss of breeding; risk of mortality. Order of severity: 2 (greatest), 1, 3.	All Alternatives: Potentially significant disturbance of foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to habitats. Local loss of breeding; risk of mortality. Order of severity: 2 (greatest), 1, 3A.	Alternatives 1-2. Potentially significant disturbance of foraging, mating, nesting, due to treatment activity, resulting in habitat destruction, and crew access to rail habitats. Local loss of breeding; risk of mortality. Greater severity for Alternative 2. Alternative 3A: Potentially significant adverse impact if used.	All Alternatives: Potentially significant disturbance of foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to habitats. Local loss of breeding; risk of mortality. Order of severity: 2 (greatest), 1, 3A.	Alternatives 1 & 3: Potentially significant disturbance of foraging, mating, nesting, due to treatment activity, resulting habitat destruction, and crew access to habitats. Local loss of breeding; risk of mortality. Greater severity for Alternative 1 than for Alternative 3. Alternative 2: No impact.	Alternative 1: Long- term protection and restoration of typical tidal creek edge and marsh plain-habitat structure to which these subspecies are adapted. Alternatives 2, 3: delayed loss of typical habitat structure, no long-term benefit.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-5.4: Effects on California least terns and western snowy plovers.	Alternative 1: Potentially significant local adverse impacts to levee nest sites due to vehicle access. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1, but still potentially significant.	Alternative 1: Potentially significant local adverse impacts to levee nest sites due to vehicle access. Potential minor to moderate turbidity impacts on tern foraging due to intertidal dredging, excavation. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1, potentially significant.	Alternative 1: Potentially significant local adverse impacts to levee nest sites due to vehicle access. Alternative 2: Greater impact than Alternative 1. Alternative 3: Less impact than Alternative 1, potentially significant.	Alternative 1: Potentially significant local adverse impacts to levee nest sites due to vehicle access. Alternative 2: Greater impact than Alternative 1. Alternative 3: If used, impacts minor or no impacts at most sites.	Alternative 1: Potentially significant local adverse impacts to levee nest sites due to vehicle access. Alternative 2: Greater impact than Alternative 1. Alternative 3: If used, impacts may be significant at a few potential project sites, but minor or no impacts at most sites.	Alternative 1: Potentially significant local adverse impacts to levee nest sites due to vehicle access. Alternative 2: No impacts Alternative 3: Less impact than Alternative 1, potentially significant.	Alternatives 1, 2: Long-term moderate potential benefits for additional restored estuarine beach habitats, avoidance of salt pond intake obstruction by massive cordgrass wracks. Alternative 3: Short-term benefits, no long-term benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-5.5: Effects on raptors (birds of prey).	All alternatives: minor short-term or no impact.	All alternatives: minor short-term or no impact.	All alternatives: minor short-term or no impact.	All alternatives: minor short-term or no impact.	All alternatives: minor short-term or no impact.	Alternatives 1, 3: Potential moderate adverse impacts if helicopters are used, otherwise minor short-term impacts. Alternative 2: No impact.	Alternative 1: Long- term protection and restoration of typical tidal creek edge and marsh plain-habitat structure to which these subspecies are adapted. Moderate to significant benefit of stabilizing pickleweed-dominated marsh plains. Alternatives 2, 3: Delayed loss of typical habitat structure, no long-term benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-6.1: Effects on anadromous salmonids (winter-run and spring-run Chinook salmon, steelhead).	All Alternatives: minor short-term impact or none.	Alternative 1: Potential minor to moderate adverse impacts of dredging in tidal creeks or channels at low tide, due to elevated turbidity, dissolved sulfides, reduced dissolved oxygen; South Bay only. Alternative 2: Impacts greater than Alternative 1, but less than significant. Alternative 3: Similar to Alternative 1, less impact.	All Alternatives: minor short-term impact or none.	Alternative 1: Minor to moderate potential entrainment and trapping impact within impounded areas, less than ongoing salt pond operations in region; South Bay only. Alternative 2: Impacts greater than Alternative 1, but less than significant.	All Alternatives: minor short-term impact or none.	Alternative 1: Minor to moderate impact due to potential exposure of fish to tidally remobilized herbicide spray solution containing surfactants. Alternative 2: No impact. Alternative 3: Less impact than Alternative 1.	Alternative 1: Long-term stabilization and restoration of natural tidal creek structure and high density of small tidal creeks due to arrested spread of smooth cordgrass, protection of favorable habitat. Alternatives 2, 3: Delayed degradation of tidal creek habitat quality and abundance, no long-term benefit.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-6.2: Effects on delta smelt and Sacramento splittail.	All Alternatives: Minor short-term impact or none.	All Alternatives: Minor short-term impact or none.	All Alternatives: Minor short-term impact or none.	All Alternatives: Method probably inapplicable to North Bay geographic range of these species.	All Alternatives: Minor short-term impact or none.	Alternative 1: Long-term stabilization and restoration of natural tidal creek structure and high density of small tidal creeks due to arrested spread of smooth cordgrass, protection of favorable habitat. Alternatives 2, 3: Delayed degradation of tidal creek habitat quality and abundance, no long-term benefit.	All alternatives: No benefits.
BIO-6.3: Effects on the tidewater goby.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All alternatives: No benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-6.4: Effects on estuarine fish populations of shallow submerged intertidal mudflats and channels.	All Alternatives: Minor short-term impact or none.	Alternative 1: Potential minor to moderate adverse impacts of dredging in tidal creeks or channels at low tide, due to elevated turbidity, dissolved sulfides, reduced dissolved oxygen; South Bay only. Alternative 2: Impacts greater than Alternative 1, but less than significant. Alternative 3: Similar to Alternative 1, less impact.	All Alternatives: Minor short-term impact or none.	Alternative 1: Minor to moderate potential entrainment and trapping impact within impounded areas, less than ongoing salt pond operations in region; South Bay only. Alternative 2: Impacts greater than Alternative 1, but less than significant. Alternative 3: similar to Alternative 1, less impact.	All Alternatives: Minor short-term impact or none.	Alternative 1: Minor to moderate impact due to potential exposure of fish to tidally remobilized herbicide spray solution containing surfactants. Alternative 2: Impacts greater than Alternative 1, but less than significant. Alternative 3: similar to Alternative 1, less impact.	Alternative 1: Long-term stabilization and restoration of natural tidal creek structure and high density of small tidal creeks due to arrested spread of smooth cordgrass, protection of favorable habitat. Alternatives 2, 3: Delayed degradation of tidal creek habitat quality and abundance, no long-term benefit.
BIO-7: Effects on California red-legged frog and San Francisco garter snake.	All alternatives: No impacts.	All alternatives: No impacts.	All alternatives: No impacts.	All alternatives: No impacts.	All alternatives: No impacts.	All alternatives: No impacts.	All alternatives: No benefits.

Table 3.3-1: Summary of Potential Biological Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
BIO-8: Effects of regional invasive cordgrass eradication on mosquito production.	All Alternatives: Minor to moderate production of additional mosquito breeding habitat in topographic depressions in marsh plain left by vehicles, excavation pits.	All Alternatives: Minor to moderate production of additional mosquito breeding habitat in topographic depressions in marsh plain left by vehicles, excavation pits.	All Alternatives: Minor to moderate production of additional mosquito breeding habitat in topographic depressions in marsh plain left by vehicles, excavation pits.	Alternative 1: No impact from large impounded or deeply flooded areas; moderate potential for additional new breeding habitat in small, shallow hypersaline impoundments. Alternative 2: Similar to Alternative 1, greater impact. Alternative 3: Similar to Alternative 1, ess impact.	All Alternatives: Minor to moderate production of additional mosquito breeding habitat in topographic depressions in marsh plain left by vehicles, excavation pits.	All Alternatives: Minor to moderate production of additional mosquito breeding habitat in topographic depressions in marsh plain left by vehicles, excavation pits.	Alternative 1: Long-term avoidance of risk that poorly drained çshort formé smooth cordgrass plains would increase mosquito production, comparable to Atlantic coastal marshes. Potential significant benefit. Alternatives 2, 3: Delay in risk of habitat modification favoring mosquito production, no long-term benefit.
BIO-9: Effects on tiger beetle species.	All alternatives: No impact.	All alternatives: No impact.	All alternatives: No impact.	All alternatives: No impact.	All alternatives: No impact.	All alternatives: No impact.	Alternatives 1, 2: Beneficial impact because potential habitat for tiger beetle species would increase.

Table 3.3-2: Summary of Mitigation Measures for Biological Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
BIO-1.1: Saltmeadow and English cordgrass. Minimize vehicle and foot access pathways. Restrict equipment working in marsh to mats and geotextile fabric covers. Stockpile non-viable excavated non-native cordgrass and excavated sediment and remove from marsh. Stabilize smothering geotextile mats. Cover non-target vegetation, or pre-treat non-target vegetation with protective films. Use optimal combinations of treatment to minimize repeat entry to marsh.	Applicable	Applicable	Applicable	Not Applicable	Applicable	Applicable
BIO-1.2: Atlantic Smooth cordgrass. Minimize vehicle and foot access pathways. Restrict equipment in working in marsh plains to mats and geotextile fabric covers. Stockpile non-viable excavated non-native cordgrass and excavated sediment and remove from marsh. Cover non-target vegetation with fabric adjacent to areas sprayed with herbicide, or pre-treat with protective films of silt-clay. Stabilize smothering geotextile mats. Use optimal combinations of treatment to minimize repeat entry to marsh and re-treatment. Minimize herbicide spray dose requirements by pre-treatments. Use removal methods rather than helicopter applications of herbicide whenever feasible and less environmentally damaging. Use non-spray application techniques to reduce herbicide dose and minimize non-target contact.	Applicable	Applicable	Applicable	Applicable	Not Applicable	Applicable
BIO-1.3: Chilean cordgrass. Identical with Mitigation BIO-1.1.	Applicable	Applicable	Applicable	Not Applicable	Not Applicable	Applicable

Table 3.3-2: Summary of Mitigation Measures for Biological Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
BIO-1.4: Submerged aquatic plant communities. Remove large deposits of mown cordgrass during the growing season; or install temporary water-permeable debris barriers around vulnerable pans. Avoid transporting tanks of spray solution near pans.	Not Applicable	Not Applicable	Applicable	Not Applicable	Not Applicable	Applicable
BIO-2: Special-status plant species. Conduct pre-project spring surveys for sensitive plants and instruct field crews to avoid and protect sensitive populations. Require qualified, experienced on-site botanical supervision if sensitive plants occur in the vicinity. If sensitive plant populations occur near the high tide line, rake and remove large deposits of mown cordgrass during the growing season. Refrain from burning in marshes supporting sensitive plant species. Stabilize smothering geotextile mats. Cover non-target vegetation, or install spray-drift barriers. If accidental exposure to spray drift occurs, thoroughly irrigate affected plants with silt-clay suspensions. Refrain from rapid replanting of Pacific cordgrass until Atlantic smooth corgrass pollen and see rain is minimal.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
BIO-3: Shorebirds and waterfowl. For work within 1,000 feet of mudflats, schedule eradication activities to avoid peak fall and spring Pacific Flyway stopovers. Mobilize crews to project sites before mudflats emerge. Use optimal combinations of treatment to minimize repeat entry. Avoid helicopter applications of herbicide to mudflat colonies within 1,000 feet of major habitual roosting or foraging sites. As a last resort, haze shorebirds and waterfowl within 1000 feet of spray operations. Remediate small volumes of spilled solutions on mudflats.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
BIO-4.1: Salt marsh harvest mouse and tidal marsh shrew subspecies. Minimize vehicle and foot access pathways in potential tidal marsh habitat. Restrict equipment working in marsh to areas with mats and geotextile fabric covers. Use optimal combinations of treatment to minimize repeat entry re-treatment. Schedule work in suitable habitat soon after natural mass-mortality events caused by extreme high tides. Compensatory measures for incidental take include restoration of optimal habitat within large tidal marsh restoration projects.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable

Table 3.3-2: Summary of Mitigation Measures for Biological Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
BIO-4.2: Resident San Francisco Bay harbor seals. Minimize vehicle and foot access pathways in marsh within 1,000 feet of seal haul-outs, and avoid approaching haul-outs within 2,000 feet, or any distance that elicits vigilance behavior when pups are present. Consult with marine mammal experts to determine seasonal variation in sensitivity to disturbance. Restrict equipment working in marsh to prescribed paths. Use optimal combinations of treatment to minimize repeat entry to marsh and re-treatment. Refrain from use of low-flying helicopters within 2,000 feet of seal haul-outs. Transport any pre-mixed solutions of herbicide in double-lined containers. Remediate spilled solutions on mudflats to the greatest extent feasible.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
BIO-5.1: California clapper rail. To minimize or avoid indirect impacts of eradication operations on clapper rails, follow çbest management practicesé in EIS/R Appendix G, as modified by the US Fish and Wildlife Serviceês Biological Opinion. These protocols are based on (1) current survey and map data to determine distribution and abundance of rails in relation to project sites, and local behavior of rails in occupied habitats; (2) training and expert biological supervision of field crews to detect clapper rails and identify habitat; (3) modification of timing and within-site location of operations to minimize or avoid disturbances to clapper rails. In addition, the mitigation measures generally used to minimize disturbances in MITIGATION BIO-1.2 and BIO-4.1 also apply. For unavoidable significant impacts due to eradication of Atlantic smooth cordgrass and hybrids which provide habitat currently occupied by clapper rails, proportional compensatory mitigation is necessary. Primary components of compensatory mitigation include: (1) large-scale, rapid restoration of suitable tidal salt marsh habitat (including all essential habitat components for colonization by clapper rails) in advance of large-scale habitat destruction, and within the same subregion as impacts, but at locations with low invasion pressure from non-native cordgrasses; (2) significantly increasing reproductive success of clapper rails within the same subregion as impacts, through management which reduces predation from non-native red fox, and enhances flood refugia (cover for rails during extreme high tides).	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable

Table 3.3-2: Summary of Mitigation Measures for Biological Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
BIO-5.2: California black rail. Adapt protocols for minimization and avoidance of California clapper rails (Appendix G) for work in infested marshes known to support populations of California black rails (currently one: Southhampton Marsh, Benicia), emphasizing pre-project surveys (call detection), minimization of marsh disturbance (MITIGATION BIO-1.2), and avoidance of occupied habitat during the breeding season.	Applicable	Potentially Applicable	Applicable	Not Applicable	Not Applicable	Applicable
BIO-5.3: Tidal marsh song sparrow subspecies and salt marsh common yellowthroats. Adapt protocols for minimization and avoidance of California clapper rails (Appendix G) for work in infested marshes known to support populations of Alameda song sparrows, San Pablo song sparrows, Suisun song sparrow, and the salt marsh common yellowthroat, emphasizing pre-project surveys, minimization of marsh disturbance (MITIGATION BIO-1.2), and avoidance of occupied habitat during the breeding season.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
BIO-5.4: Western snowy plovers and California least terns. Prior to levee access in areas where snowy plovers and least terns may breed, levee routes should be surveyed for potential nests, including nests in salt pond beds near levee roads. Dredging and excavation of cordgrass should be conducted either after least terns have migrated out of San Francisco Bay, or during middle to lower tidal stages that allow navigation of barge and crane operations, while exposing the maximum extent of cordgrass above standing tides.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
BIO-5.5: Birds of prey in tidal marshes. Minimize use of helicopters to apply herbicides over marshplains where raptors forage.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable

Table 3.3-2: Summary of Mitigation Measures for Biological Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
BIO-6.1: Chinook salmon and steelhead (anadromnous salmonids). Dredging of infested intertidal channels should be limited to: (1) tidal stages when target areas are emerged above water level, and (2) during seasons when winter- and spring-run Chinook salmon and steelhead migration times minimize their risk of exposure at project sites, particularly juveniles. Intakes for impoundments should be limited to tides above mean high water to minimize entrainment and trapping. Alternatively, fish screens could be installed on new tidegates used to impound and drown large cordgrass-infested marshes in former diked baylands. Herbicide methods should be minimized or avoided near channels and mudflats during migration periods of winter-run and spring-run Chinook salmon and steelhead. Minimize glyphosate/surfactant spray application requirements by pre-treating target cordgrass stands with mechanical methods that reduce cordgrass biomass and density, increase receptivity and coverage of spray, and increase mortality response to glyphosate. In case of herbicide/surfactant solution spill, remediate small volumes of spilled solutions on mudflats to the greatest extent feasible by suction of surface muds, using portable wet vacuum or pumping equipment.	Not Applicable	Applicable	Not Applicable	Applicable	Not Applicable	Applicable
BIO-6.2: Delta smelt and Sacramento splittail. For work in infested North Bay marshes where delta smelt or Sacramento splittail may occur (currently one: Southhampton Marsh, Benicia), eliminate impoundment techniques and minimize spray drift near tidal creeks (MITIGATION BIO-1.1, 1.2). Restrict any intertidal excavation or dredging in tidal creeks to tidal stages when target areas are emerged above water level.	Not Applicable	Applicable	Not Applicable	Applicable	Not Applicable	Applicable

Table 3.3-2: Summary of Mitigation Measures for Biological Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
BIO-6.4: Shallow-water estuarine fish. Dredging of infested intertidal channels should be limited to tidal stages when target areas are emerged above water level. Water intakes for impoundments should have invert elevations limited to tides above mean high water to minimize entrainment and trapping. Alternatively, fish screens could be installed on new tidegates used to impound and drown large cordgrass-infested marshes in former diked baylands. Herbicide methods should be minimized near channels. Minimize glyphosate/surfactant spray application requirements by pre-treating target cordgrass stands with mechanical methods that reduce cordgrass biomass and density, increase receptivity and coverage of spray, and increase mortality response to glyphosate. In case of herbicide/surfactant solution spill, remediate small volumes of spilled solutions on mudflats to the greatest extent feasible by suction of surface muds, using portable wet vacuum or pumping equipment.	Not Applicable	Applicable	Not Applicable	Applicable	Not Applicable	Applicable
BIO-8: Mosquito production in tidal marshes. Monitor access routes in marshes to detect formation of undrained depressions in tire ruts or foot trails. Backfill access-related shallow marsh depressions or incise narrow drainages so they do not impound small, sheltered areas of standing water. Where impoundments are used, design impoundments of sufficient size and depth to minimize mosquito breeding habitat.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable

Note: Due to summarization, there may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

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3.4 AIR QUALITY

This section describes existing air quality in the Bay Area Air Basin, processes affecting air quality, and the regulatory framework under which air pollutant emissions are controlled. Potential effects of treatment methods on local and regional air quality and odors are evaluated, and mitigation measures are identified for potentially significant impacts.

3.4.1 Environmental Setting

Regional Air Quality

The Bay Area has relatively good air quality despite its extensive urbanized area, vehicles, and industrial sources. The Bay Area's coastal location and favorable meteorology help to keep its pollution levels low most of the time (California Air Resources Board [CARB] 2001). The climate in the Bay Area varies, ranging from mild year-round temperatures along the coast, to warmer temperatures with greater seasonal fluctuation in the inland counties. The coastal and Estuary shoreline areas, which experience steady ocean breezes, tend to have the best air quality. The highest ozone levels and concentrations of other pollutants typically are recorded in inland areas, such as Livermore, Concord, Los Gatos, and Gilroy. However, when there are no ocean breezes and temperatures are hot, the levels of ozone and other pollutants along the Estuary shoreline can exceed the standards. According to the CARB, air quality has been improving steadily over the past decade, with steadily declining total volatile organic compounds (VOC) and nitrogen oxides (NOx) emissions over time (CARB 2001). However, these reductions have not been enough to prevent exceedances of State and Federal air quality standards under all meteorological conditions. In addition, the Bay Area serves as a significant source of emissions that are carried out of the area when the onshore winds blow. These emissions and resulting pollution can spread far downwind of the Bay Area: to the San Joaquin and Sacramento Valleys, the Monterey Bay area, northern Sonoma County, and even as far away as San Luis Obispo County and the Sierra foothills.

The ambient air quality in a given area depends on the quantities of pollutants emitted within the area, transport of pollutants to and from surrounding areas, local and regional meteorological conditions, as well as the surrounding topography of the air basin. Air quality is described by the concentration of various pollutants in the atmosphere. Units of concentration are generally expressed in parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$).

The Bay Area Air Quality Management District (BAAQMD) identifies seven categories of air pollutants that are of concern in the Bay Area. These include particulate matter (monitored as small diameter particles called $PM_{10)}$, organic compounds, nitrogen oxides (NOx), sulfur dioxide/oxides (SO_2/SOx), carbon monoxide (CO), hydrogen sulfide (H_2S), and photochemical smog (ground level ozone – O_3). These are referred to as "criteria pollutants".

The BAAQMD monitors criteria pollutants continuously at stations located throughout the Bay Area. A summary of air pollutant levels measured in the Bay Area over the past five years is shown in **Table 3.4-1**. Federal and State health-based ambient air quality standards are also in the table.

The Federal Clean Air Act establishes National Ambient Air Quality Standards (NAAQS) for each of these contaminants. If an area does not meet the NAAQS over a set period of time (three years), the United States Environmental Protection Agency (EPA) designates it as a "nonattainment" area for that particular pollutant.

Table 3.4-1. State and National Standards for Selected Criteria Pollutants, and Measured Air Pollutant Concentrations in the San Francisco Bay Area

Pollutant (unit of measure)	***Average Time***	***State Standard***	***National Standard***	***Maximum Levels Measured and Days Exceeding Standards**** ***(State/National Standards)***				
				1995	***1996***	***1997***	***1998***	***1999***
Ozone (O_3) (ppm)	1-Hour	0.09	0.12	**0.15** 28 / 11	**0.14** 34 / 8	**0.11** 8 / 0	**0.15** 29 / 8	**0.16** 20 / 3
	8-Hour	--	0.08	**0.12** -- / 18	**0.11** -- / 14	**0.08** -- / 0	**0.11** -- / 16	**0.12** -- / 9
Carbon Monoxide (CO) (ppm)	8-Hour	9.0	9	5.4 0 / 0	6.5 0 / 0	5.8 0 / 0	6.0 0 / 0	5.9 0 / 0
Nitrogen Dioxide (NO_2) (ppm)	1-Hour	0.25	?	0.12 0 / --	0.11 0 / --	0.12 0 / --	0.10 0 / --	0.13 0 / --
	Annual	--	0.053	N/A	N/A	N/A	N/A	0.026
Small Particulate Matter (PM_{10}) ($\mu g/m^3$)	24-Hour	50	150	N/A 42 / 0	N/A 18 / 0	N/A 24 / 0	N/A 30 / 0	**114** 72 / 0
	Annual	30	50	22	22	24	23	25
Fine Particulate Matter ($PM_{2.5}$) ($\mu g/m^3$)	24-Hour	50 $\mu g/m^3$	65 $\mu g/m^3$	N/A	N/A	N/A	N/A	N/A
	Annual	50 $\mu g/m^3$	15 $\mu g/m^3$	N/A	N/A	N/A	N/A	N/A

Notes: ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
* Values reported in bold exceed ambient air quality standard
N/A = Not Applicable
Source: CARB, 2000

The San Francisco Bay Area Air Basin had been designated as a Federal "nonattainment" area for ozone due to violations of the Federal standard (See **Table 3.4-1**). Ground-level ozone, which is not emitted directly into the atmosphere, is the principal component of smog. It is caused by the photochemical reaction of ozone precursors (reactive organic gases and nitrogen oxides). Ozone levels are highest in the San Francisco Bay Area during days in late spring through summer when meteorological conditions are favorable for the photochemical reactions to occur (clear warm days and light winds). The Bay Area co-lead agencies (BAAQMD, Metropolitan Transportation Commission, and Association of Bay Area Governments) prepared and submitted the 1999 San Francisco Bay Area Ozone Attainment Plan or ozone State Implementation Plan (SIP) to the CARB. This plan was submitted to EPA in 1999 and revised in 2001, but final approval of the plan has not been made.

As can be seen in **Table 3.4-1**, The Bay Area Air Basin is in Federal attainment for all other "criteria pollutants," but is a "maintenance" area for carbon monoxide (requiring controls on emissions of CO – see Applicable Federal Air Quality Regulations, below).

The California Clean Air Act of 1988, amended, outlines a program for areas in the State to attain the CAAQS by the earliest practical date. The California Clean Air Act set more stringent air quality standards, California Ambient Air Quality Standards (CAAS), for all of the pollutants covered under national standards, and additionally regulates levels of vinyl chloride, hydrogen sulfide, sulfates, and visibility-reducing particulates. If an area does not meet the CAAQS, it is designated as a State nonattainment area.

As shown in **Table 3.4-1**, the Bay Area is a serious nonattainment area for ozone (since the area cannot forecast attainment of the State ozone standard in the foreseeable future). It is also a State nonattainment area for PM_{10}. Inhalable particulates or PM_{10} refers to a wide variety of solid or liquid particulates in the atmosphere that have a diameter of 10 micrometers (µm) or less. These include dust and smoke, the two sources of air pollution most applicable to the *Spartina* Control Project. PM_{10} is both a local and regional air quality problem. The Bay Area has met the CAAQS for all other air pollutants.

The CARB requires regions that do not meet the CAAQS for ozone to submit clean air plans that describe plans to attain the standard. The BAAQMD has prepared the Bay Area Clean Air Plan to address the California Clean Air Act. This plan includes a comprehensive strategy to reduce emissions from stationary, area, and mobile sources to achieve a region-wide reduction of ozone precursor pollutants. Air quality plans are developed on a triennial basis, with the latest plan developed in 2000 (i.e., 2000 CAP). The primary objective of the 2000 CAP is to reduce ozone precursor pollutants through the implementation of all feasible control measures.

Federal Air Quality Conformity Requirements

Under Section 176(c) of the 1990 Clean Air Act Amendments, the "conformity" provisions for Federal projects are outlined. Federal actions are required to conform to the requirements of a SIP and must not jeopardize efforts for a region to achieve the NAAQS. Section 176 (c) also assigns primary oversight responsibility for conformity assurance to the Federal agency undertaking the project, not the EPA, State, or local agency. For there to be conformity, federally supported or funded activities must not (1) cause or contribute to any new air quality standard violation, (2) increase the frequency or severity of any existing standard violation, or (3) delay the timely attainment of any standard, interim emission reduction, or other SIP milestone aimed at bringing the region into attainment.

In 1993, the U.S. EPA issued conformity regulations that addressed all non-transportation Federal actions (General Conformity). These regulations apply to a wide range of Federal actions or approvals that would cause emissions of criteria air pollutants above specified levels to occur in locations designated as nonattainment or maintenance areas. Specifically since the Bay Area is nonattainment (moderate) for ozone and is a CO maintenance area, projects with Federal involvement are subject to the General Conformity regulations if they generate emissions of ozone precursor pollutants (i.e., reactive organic compounds and nitrogen oxides) or carbon monoxide in excess of 100 tons per year or the emissions are more than 10 percent of the nonattainment or maintenance area's emission inventory for the pollutant(s) of concern. Projects that are subject to the General Conformity regulations are required to mitigate or fully offset the emissions caused by the action, including both direct and indirect (e.g., traffic) emissions that the Federal agency has some control over. The BAAQMD adopted and incorporated the Transportation and General Conformity regulations into its SIP in 1994.

3.4.2 Analysis of Potential Effects

The primary air quality issues associated with the presence, spread, and treatment of non-native cordgrasses are the potential for dust and smoke emissions from ground treatment methods and the potential for chemical drift from aerial application of herbicide. Impacts on air quality are summarized in **Table 3.4-2** and mitigation measures are summarized in **Table 3.4-3**.

Significance Criteria

The significance of a pollutant emission is determined by comparing the resulting pollutant concentration to an appropriate State or Federal ambient air quality standard. The standards represent the allowable pollutant concentrations designed to ensure that the public health and welfare are protected, while including a reasonable margin of safety to protect the more sensitive individuals in the population. The BAAQMD has also developed CEQA guidelines that establish significance thresholds for evaluating new projects and plans and provide guidance for evaluating air quality impacts of projects and plans (BAAQMD 1999).

Projects impacts would be considered significant if the would:

- Violate any air quality standard or contribute substantially to an existing or projected air quality violation;
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable Federal or State ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors). A significant impact on regional air quality is defined in this analysis as an increase in emissions of an ozone precursor or PM_{10} exceeding the BAAQMD recommended thresholds of significance. The latest guidelines issued by the BAAQMD for the evaluation of project air quality impacts consider emission increases significant if they exceed 80 pounds per day (or 15 tons/year) for ozone precursors or PM_{10}. Any proposed project that would individually have a significant air quality impact would also be considered to have a significant cumulative air quality impact.
- Expose sensitive receptors to substantial pollutant concentrations;
- Expose the public to significant levels of toxic air contaminants, defined as follows: (1) the probability of contracting cancer for the Maximally Exposed Individual (MEI) exceeds 10 in one million or (2) ground-level concentrations of non-carcinogenic toxic air contaminants would result in a hazard Index greater than 1 for the MEI; and/or
- Create objectionable odors affecting a substantial number of people.

ALTERNATIVE 1: Proposed Action/Proposed Project - Regional Eradication Using All Available Control Methods

All methods would involve relatively small emissions of criteria air pollutants through either direct or indirect sources. Direct sources may include emissions from equipment such as mowers, boats, or helicopters. Emissions from indirect sources would include vehicles used for transporting materials and workers and worker vehicle trips to the work sites.

IMPACT AQ-1: Dust Emissions

Dust contains small particulate matter (PM_{10}), for which the BAAQMD has established significance thresholds of 80 pounds per day. Treatment of infested sites using manual or mechanical and ground-based chemical methods will require accessing the sites on foot or by vehicles. This is expected to cause disturbance to soils during access to the treatment sites. However, the majority of the work would be done in wet or moist soil or mud, thereby minimizing the likelihood of dust generation. The primary source of airborne dust generated by the project would be travel on unpaved access roads to the treatment sites. Dust generation is expected to be localized, and not result in emissions that affect off-site receptors, or exceed the BAAQMD significance thresholds. Therefore, the impact would be less than significant. Mitigation AQ-1 will be implemented at treatment sites to further reduce this impact.

MITIGATION AQ-1: Apply dust control measures where treatment methods may produce visible dust clouds and where sensitive receptors (i.e., houses, schools, hospitals) are located within 500 feet of the treatment site. The following dust control measures should be included in the site-specific work plans:

- Suspend activities when winds are too great to prevent visible dust clouds from affecting sensitive receptors.
- Limit traffic speeds on any dirt access roads to 15 miles per hour.

IMPACT AQ-2: Smoke and Ash Emissions

Treatment methods and activities using burning are a potential source of PM_{10} emissions involving smoke and ash from prescribed burns. The emissions would vary depending on the amount and type of activity, target plant and soil conditions, and meteorological conditions. This impact would be potentially significant. However, burning is subject to BAAQMD Regulation 5 – *Open Burning,* and approval of the County Agricultural Commissioner to minimize the impact to both local and regional air quality. Under this regulation, prescribed burns are allowable under Section 5-401.1 on permissive burn days. The fire must be set or allowed by the Agricultural Commissioner of the County. Prior notification to the BAAQMD is required. Prescribed burns conducted in accordance with this regulation would result in less than significant impacts to air quality. Mitigation AQ-2 would reduce this impact to less than significant. Temporary incidences of odors from prescribed burns may be detected and would be less than significant.

MITIGATION AQ-2: For prescribed burns, notify the BAAQMD and the Agriculture Commissioner prior to initiating the burn, and/or obtain a burn permit.

IMPACT AQ-3: Herbicide Effects on Air Quality

Aerial application of herbicides and surfactants could result in chemical drift to populated areas. The potential for chemical drift is highly dependent on the proximity to populated areas, wind flow, equipment used, and height application is conducted above ground. Chemical drift to areas within one-half mile of a treatment site would be a potentially significant impact. Ground–based application of herbicide is not expected to result in air quality impacts since the application would occur only within the targeted areas, and because glyphosate and the proposed surfactants have very low volatility.

While there are no established BAAQMD significance thresholds for herbicides that would be sprayed during implementation of the Control Program, aerial application of herbicides has the potential to cause chemical drift that could expose the public to the herbicide downwind from application areas. Populated areas may detect slight odors and proximity to populated areas, droplet size, and wind conditions are the primary factors that affect drift of herbicide, and detection or exposure of the public. Although there is no evidence that glyphosate could cause human health risks (see Section 3.6, *Human Health and Safety*), impacts such as skin or eye irritation or respiratory problems (similar to those that result from smog) could occur if drift affected populated areas. For these reasons, the impact would be potentially significant.

Although aerial application of herbicide would not involve use of workers or equipment on the ground, emissions of criteria air pollutants would occur from the uses of helicopters that burn fuel. These emissions would be well below significance thresholds established by the BAAQMD, and therefore have a less than significant impact on air quality because the helicopters would be used for a short period of time and in a manner consistent with its intended use.

MITIGATION AQ-3: For areas targeted for aerial application of herbicides that are within 0.5 mile of sensitive receptors (i.e., houses, schools, hospitals), prepare and implement an herbicide drift management plan to reduce the possibility of chemical drift into populated areas. The plan shall include the following elements:

1. **Coordination.** Coordinate aerial applications with the County Agricultural Commissioner.
2. **Sensitive Receptors.** Identify nearby sensitive areas (e.g., houses, schools, hospitals) or areas that have non-target vegetation that could be affected by the herbicide and provide advanced notification.
3. **Equipment Use.** Identify the type of equipment (e.g., nozzle types) and application techniques (i.e., nozzle angle and airspeed) to be used in order to reduce the amount of small droplets that could drift into adjacent areas (smaller droplets are subject to greater drift). Consult with herbicide manufacturer for proper application instructions and warnings.
4. **Meteorological Conditions.** Avoid spraying when winds exceed 10 miles per hour, consistent with California supplemental labeling. Herbicide applications should not be conducted when surface-based inversions are present (usually in fall and winter early mornings or late evenings). The site-specific work plan should identify how meteorological conditions would be obtained (e.g., National Weather Service).
5. **Buffer Zones.** Establish buffer zones to avoid affecting sensitive receptors. The buffer zones are established based on wind conditions, droplet size, application height above ground, as well as proximity to sensitive receptors.
6. **Restriction on Public Access.** Ensure that the public will not be present in the treatment area during treatment activities, and for a period (of up to 12 hours) after application of the herbicide. The re-entry period should be identified in the site-specific work plan.
7. **Alternate Spray Method.** Consider ground application near buffer zones and areas adjacent to sensitive receptors when prevailing conditions would increase potential for drift. Application of herbicide shall be temporarily terminated if conditions change and present drift potential at sensitive receptor sites.

Mitigation Measures

Implementation of the mitigation measures identified above would reduce air quality impacts of Alternative 1 to a less than significant level.

IMPACT AQ-4: Ozone Precursor Emissions

Treatment methods involving internal combustion engines are a potential source of ozone emissions. The BAAQMD has established significance thresholds for emissions of ozone precursor pollutants (reactive organic gases and nitrogen oxides) of 80 pounds per day for each pollutant. The BAAQMD CEQA Guidelines indicate that projects with potential to exceed the established thresholds are traffic associated with subdivision developments of 320 homes, shopping centers of 44,000 square feet, or office parks of 210,000 square feet. Therefore, the combination of direct and indirect vehicular or equipment-related emissions associated with implementation of the Control Program would result in emissions less than the BAAQMD thresholds for ozone precursor pollutants. Vehicle and equipment emissions would be less than significant. Therefore, no mitigation is required for this impact.

IMPACT AQ-5: Carbon Monoxide Emissions

Treatment methods involving internal combustion engines are a potential source of CO emissions. The BAAQMD CEQA Guidelines indicate that exceedances of the CO air quality standard are not anticipated from projects that generate less than 550 pounds per day of CO, do not cause congestion at intersections, or do not increase traffic substantially (by 10 percent or more) at congested intersections. Traffic generated by implementation of any of the treatment methods would not lead to exceedances of CO air quality standards. Therefore, no mitigation is required for this impact.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Alternative 2 is identical to Alternative 1, with the exception that chemical methods would not be used, and manual or mechanical treatment methods would be applied more frequently.

Impacts associated with this alternative would be similar to Alternative 1 except impacts associated with herbicide and surfactant application would be eliminated and replaced by increased dust and smoke from repeated mechanical treatment.

Mitigation Measures

Mitigation measures AQ-1 and 2, above, would apply to this alternative. Implementation of these Mitigation Measures would reduce residual impacts of Alternative 2 to less than significant.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Under this alternative, the proposed project would not be implemented and treatment efforts that local jurisdictions conduct would not be regionally coordinated.

The extent of localized treatment and the methods to be used are not specified, however it is likely that the localized treatment would be less widespread than with Alternative 1. Therefore, potential air quality impacts would be similar to, but generally, less than those described for Alternative 1.

Mitigation Measures

Mitigation Measures for Alternative 3 would be the same as for Alternative 1. No significant residual impacts to air quality would occur under this alternative.

Table 3.4-2: Summary of Potential Air Quality Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
AQ-1: Dust Emissions.	All Alternatives: Dust generation is expected to be localized, and not affect off-site receptors, or exceed BAAQMD significance thresholds.	All Alternatives: Dust generation is expected to be localized, and not affect off-site receptors, or exceed BAAQMD significance thresholds.	All Alternatives: Minor erosion and dust generation potential.	All Alternatives: Dust generation is expected to be localized during construction, and not affect off-site receptors, or exceed BAAQMD thresholds.	All Alternatives: Minor dust generation is possible during burning activities.	Alternatives 1, 3: On-ground treatment would generate minor amounts of dust. Alternative 2: No impact.	N/A
AQ-2: Smoke Emissions.	All Alternatives: No smoke emissions.	All Alternatives: No smoke emissions.	All Alternatives: No smoke emissions.	All Alternatives: No smoke emissions.	All Alternatives: Potentially significant smoke emissions.	All Alternatives: No smoke emissions.	N/A
AQ-3: Herbicide Effects on Air Quality.	All Alternatives: No herbicide impacts.	All Alternatives: No herbicide impacts.	All Alternatives: No herbicide impacts.	All Alternatives: No herbicide impacts.	All Alternatives: No herbicide impacts.	Alternatives 1 & 3: Chemical drift to areas within 0.5 mile of a treatment site would be a potentially significant impact. Alternative 2: No impact.	N/A

Table 3.4-2: Summary of Potential Air Quality Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
AQ-4: Ozone Precursor Emissions.	All Alternatives: No ozone precursor emissions.	All Alternatives: Direct and indirect vehicular or equipment-related emissions would be less than BAAQMD thresholds for ozone precursor pollutants.	All Alternativess: Direct and indirect vehicular or equipment-related emissions would be less than BAAQMD thresholds for ozone precursor pollutants.	All Alternatives: Direct and indirect vehicular or equipment-related emissions would be less than BAAQMD thresholds for ozone precursor pollutants.	All Alternatives: Direct and indirect vehicular or equipment-related emissions would be less than BAAQMD thresholds for ozone precursor pollutants.	All Alternatives 1, 3: Direct and indirect vehicular or equipment-related emissions would be less than BAAQMD thresholds for ozone precursor pollutants. Alternative 2: No impact.	N/A
AQ-5: Carbon Monoxide (CO) Emissions.	All Alternatives: Traffic generated by implementation of any of the treatment methods would not lead to exceedances of CO air quality standards.	All Alternatives: Traffic generated by implementation of any of the treatment methods would not lead to exceedances of CO air quality standards.	All Alternatives: Traffic generated by implementation of any of the treatment methods would not lead to exceedances of CO air quality standards.	All Alternatives: Traffic generated by implementation of any of the treatment methods would not lead to exceedances of CO air quality standards.	All Alternatives: Traffic generated by implementation of any of the treatment methods would not lead to exceedances of CO air quality standards.	All Alternatives: Traffic generated by implementation of any of the treatment methods would not lead to exceedances of CO air quality standards.	N/A

Table 3.4-3: Summary of Mitigation Measures for Air Quality

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
Mitigation AQ-1: Dust emissions. Apply dust control measures where treatment methods may produce visible dust clouds and where sensitive receptors (i.e., houses, schools, hospitals) are located within 500 feet of the treatment site. The following dust control measures should be included in the site-specific work plans: Suspend activities when winds are too great to prevent visible dust clouds from affecting sensitive receptors. Limit traffic speeds on any dirt access roads to 15 miles per hour.	Not Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Mitigation AQ-2: Smoke and ash emissions. For prescribed burns, notify the BAAQMD and the Agriculture Commissioner prior to initiating the burn, and/or obtain a burn permit.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable	Not Applicable
Mitigation AQ-3: Herbicide effects on air quality. For areas targeted for aerial application of herbicides that are within 0.5 mile of sensitive receptors (i.e., houses, schools, hospitals), prepare and implement an herbicide drift management plan to reduce the possibility of chemical drift into populated areas. The plan shall include the following elements: coordination, sensitive receptors, equipment use, meteorological conditions, buffer zones, restriction on public access, and alternative spray method.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable

Note: There may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

3.5 NOISE

This section describes the existing noise setting in the areas along the Estuary margin where treatment may occur, and identifies potential sensitive receptors. It then evaluates the effects of the various treatment methods on sensitive human noise receptors, and identifies mitigation measures to minimize these impacts. Noise impacts to wildlife are addressed in Section 3.3, Biological Resources.

3.5.1 Environmental Setting

Terminology

Noise is defined as unwanted sound. Noise usually is objectionable because it is disturbing or annoying due to its pitch or loudness. Pitch is the height or depth of a tone or sound. Higher pitched signals sound louder to humans than sounds with a lower pitch. Loudness is intensity of sound waves combined with the reception characteristics of the ear.

A decibel (dB) is a unit of measurement that is used to indicate the relative amplitude of a sound. Sound levels in decibels are calculated on a logarithmic scale. Subjectively, each 10-decibel increase in sound level is generally perceived as approximately a doubling of loudness. Technical terms are defined in **Table 3.5-1**.

There are several methods of characterizing sound. The most common in California is the *A*-weighted sound level or dBA. This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in **Table 3.5-2**. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

Since the sensitivity to noise increases during the evening and at night – because excessive noise interferes with the ability to sleep – 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The Community Noise Equivalent Level (CNEL) is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 p.m. to 10:00 p.m.) and a 10 dB addition to nocturnal (10:00 p.m. to 7:00 a.m.) noise levels. The Day/Night Average Sound Level, L_{dn}, is essentially the same as CNEL, with the exception that the evening period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Effects of Noise

Hearing Loss. While physical damage to the ear from an intense noise impulse is rare, hearing loss can occur due to chronic exposure to excessive noise, but may be due to a single event such as an explosion. Natural hearing loss associated with aging may also be accelerated from chronic exposure to loud noise. The Occupational Safety and Health Administration (OSHA) has a noise exposure standard that is set at the noise threshold where hearing loss may occur from long-term exposures. The maximum allowable level is 90 dBA averaged over eight hours. If the noise is above 90 dBA, the allowable exposure time is correspondingly shorter.

1 Table 3.5-1. Technical Terms for Noise

Term	Definitions
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1, 10, 50, and 90 percent of the time during the measurement period.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 p.m. to 10:00 p.m. and after addition of 10 decibels to sound levels measured in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

2 *Source:* Illingworth & Rodkin, Inc., 2002

Table 3.5-2. Representative Outdoor and Indoor Noise Levels (in Units of dBA)

At a Given Distance from Noise Source	***A-Weighted Sound Level in Decibels***	***Noise Environments***	***Subjective Impression***
	140		
Civil Defense Siren (100')	130		
	120		Pain Threshold
Jet Takeoff (200')			
	110	Rock Music Concert	
	100		Very Loud
Diesel Pile Driver (100')			
	90	Boiler Room Printing Press Plant	
Freight Cars (50')	80		
Pneumatic Drill (50')			
Freeway (100')	70	In Kitchen With Garbage Disposal Running	Moderately Loud
Vacuum Cleaner (10')			
	60	Data Processing Center	
	50	Department Store	
Light Traffic (100')			
Large Transformer (200')	40	Private Business Office	Quiet
	30	Quiet Bedroom	
Soft Whisper (5')			
	20	Recording Studio	
	10		Threshold of Hearing
	0		

Source: Illingworth & Rodkin, Inc., 2002

Sleep and Speech Interference. The thresholds for speech interference indoors are about 45 dBA if the noise is steady and above 55 dBA if the noise is fluctuating. Outdoors the thresholds are about 15 dBA higher. Steady noise of sufficient intensity (above 35 dBA) and fluctuating noise levels above about 45 dBA affect sleep.

Annoyance. Attitude surveys determined that the causes for annoyance include interference with speech, radio and television, house vibrations, and interference with sleep and rest. People appear to respond relatively adversely to aircraft noise. When the L_{dn} is 60 dBA, approximately 10 percent of the population is believed to be highly annoyed. Each decibel increase to 70 dBA adds about two percentage points to the number of people highly annoyed. Above 70 dBA, each decibel increase results in about a three percent increase in the percentage of the population highly annoyed.

Existing Noise Levels

The ambient noise levels near potential cordgrass treatment sites varies depending on the adjacent land uses. Vehicular traffic is the predominant source of noise throughout the San Francisco Bay Area. Aircraft traffic over the Bay from San Francisco, Oakland, and San Jose International Airports, as well as smaller airports, also contributes to the noise exposure. Railroad train traffic along the railroad corridors on either side of the Bay is an intermittent source of noise. The ambient noise level at a particular location depends upon proximity to major or minor noise sources. Typical daytime noise levels in the areas surrounding the Estuary vary from about 45 dBA up to about 75 dBA in close proximity to the freeways or airports.

Noise Monitoring Survey. A noise monitoring survey was conducted to provide examples of different noise exposures in the study area. Four sites were selected for the noise monitoring survey.

Creekside Park, Marin County. The noise environment at Creekside Park is created primarily from vehicular traffic on the local street network. The park is surrounded on three sides by residential land uses. Marin General Hospital is to the east across Bon Air Avenue from the park. Noise levels were monitored during the morning of May 21, 2001 for a 10-minute interval beginning at 10:35 a.m. The L_{eq} during the measurement was 48 dBA. Noise levels ranged from a low of 44 dBA to a high of 59 dBA.

Bair Island, San Mateo County. Bair Island is across a channel from the Redwood Shores residential area. Noise sources affecting the environment in the area include regular aircraft activity, distant traffic on the Bayshore Freeway and local traffic. Ambient noise levels were monitored on the levee near Waterside Circle in the Redwood Shores Development during the same morning between 11:50 a.m. and noon. The L_{eq} during the measurement was 55 dBA. Noise levels during the monitoring survey ranged from a low of 50 dBA in the absence of all identifiable noise sources to a high of 61 dBA during an aircraft over-flight. Distant traffic generated a steady noise level of 50 to 54 dBA.

Alameda Creek Flood Control Channel, Hayward. Noise levels were not monitored at this site due to high winds. Residential receptors are in new subdivisions located along Whipple Road and Seaport Drive. Ambient noise levels at this location would be expected to be similar to the Bair Island Area with noise from aircraft and distant traffic and local traffic all contributing to ambient noise levels in the area.

Crown Beach, Alameda. The noise environment at this shoreline park in Alameda results from vehicular traffic on the street network and jet aircraft departing Oakland International Airport. Noise levels were monitored on Monday, May 21, 2001 for a 10-minute period beginning at 4:00 p.m. The average noise level during the measurement was an L_{eq} of 55 dBA. Noise levels during the monitoring survey ranged from a minimum level of 47 dBA to a maximum level of 71 dBA resulting from a jet aircraft departing Oakland International Airport.

3.5.2 Analysis of Potential Effects

The key potential noise impact associated with the eradication of non-native cordgrass is the disturbance resulting from noise generated by equipment and machinery used in the eradication process. Because of the wide variability in ambient noise levels at sensitive receptors (e.g., residences, schools, hospitals, etc.), and distances between potential treatment sites and sensitive receptors, it is not possible to quantitatively predict and evaluate the effects of noise at specific locations. Guidelines are presented in the impact assessment to evaluate the appropriateness of treatment control methods in certain settings. Potential impacts and mitigation measures are summarized in **Table 3.5-3** and **Table 3.5-4**, respectively.

Significance Criteria

Noise impacts would be considered significant if the project would:

- Expose persons to or generate noise levels in excess of standards established in a local general plan, noise ordinance, or applicable standards of other agencies;
- Expose persons to or generate excessive ground-borne vibration or ground-borne noise levels;
- Cause a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project; and/or
- Cause a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

ALTERNATIVE 1: Proposed Action/Proposed Project. Regional Eradication Using All Available Control Methods

Impacts

Treatment methods that would involve the use of clippers, knives, shovels, trowels, bags, wheelbarrows, hand carts, sleds, and trucks for transport of removed material are not expected to generate noise over ambient levels at any location. The only source of noise associated with these activities would be from the trucks that would support the work crew. The noise generated by the occasional movement of trucks would be less than significant anywhere in the Bay Area.

The use of crews and application of fuel, such as propane, to ignite stems and leaves is not expected to generate noise. Although fire department personnel and equipment would be present at the treatment site during this method, fire suppression activities are also not expected to generate noise above ambient levels. It is not anticipated that the use of sirens or fire department equipment would be necessary unless there were an accident. This treatment method would result in less than significant noise increases at any sensitive receptors regardless of their proximity to the eradication site.

Physically covering cut plants or small clones would require transporting approximately two to five persons by truck to place the covers. This activity would not generate significant noise and the limited scale and duration of this work would result in less than significant impacts.

Other potential noise impacts are described below.

IMPACT N-1: Disturbance of Sensitive Receptors

Use of gas-powered or other mechanized equipment may generate noise and affect residences or other sensitive receptors. However, these impacts would be temporary and less than significant with mitigation due to the limited scale and duration of periodic treatment at sites.

The use of water-filled dams or temporary dikes to enclose stands of non-native cordgrass and prevent tidal action would require construction equipment such as trucks, cranes, generators, and pumps. The engines and motors associated with the trucks, crane, generators, and pumps would temporarily elevate noise levels in close proximity to the site where the dam was being inflated. Such construction equipment typically generates maximum A-weighted noise levels of 80 to 85 dBA at a distance of 50 feet. Assuming compliance with local noise ordinance restrictions (including timing of construction activities) the noise generated by this activity would not cause a significant impact because of the limited duration necessary to install or remove the dam.

Mowing infestations with mechanical hand-held weed eaters has the capacity to generate noise. Noise generation would be similar to a residential gas-powered lawn mower, and noise levels would be elevated in close proximity to the work for the several hours or days necessary to treat infested sites. This treatment method would not cause a significant noise impact in excess of established standards on sensitive receptors, regardless of their proximity to the eradication area if the activity occurs during the daytime (7:00 a.m. to 7:00 p.m.), as typically required by local noise ordinances.

Mechanical smothering, ripping, and shredding machines are small, amphibious vehicles with tracks. It is anticipated that one to two amphibious vehicles per site would be used, depending on the size of the infestation. Noise data is not available for the small amphibious tracked vehicles. However, it is anticipated that the noise from these types of equipment would be similar to a small tractor or bulldozer. Such equipment generates a maximum noise level of about 80 dBA at a distance of 50 feet. Noise levels could be temporarily elevated at a sensitive receptor depending upon the ambient noise environment and proximity to the treatment site where the equipment is being operated. This eradication method would be appropriate in any setting regardless of the proximity of the noise-sensitive receptors, if the activity occurs only during daytime hours (7:00 a.m. to 7:00 p.m.) as typically required by local noise ordinances. The impact of this method would be less than significant because of the short duration (approximately one to two weeks to treat a large site) of the activity at any particular sensitive receptor location.

Ground-based application of herbicide by crews on foot, from trucks or other land-based vehicles or from boats would also be used to eradicate non-native cordgrass infestations. Typically, from one to three trucks or combination of trucks and boats for a large infestation would be expected. Noise resulting from crews, vehicles, air boats, or hover crafts could disturb adjacent residents located within approximately 500 feet of the activity. Because of the short duration (one to two weeks to treat a large site) of the noise exposure, the noise impact would be less than significant with mitigation.

Aerial application of herbicide would include the use of a helicopter fitted with a boom or spray ball. Helicopter noise is common in the Bay regions. If helicopters are maintained at a distance of at least 1,500 feet from residences, helicopter noise would not cause a substantial increase in noise levels or cause a significant disturbance because of the short duration (less than one day to treat a large site) expected to be necessary at any particular eradication area. Normally, helicopters do not operate within approximately 1,500 feet of residences, however if operations are closer than this distance, significant helicopter noise impacts may occur.

Mitigation N-1: Disturbance of Sensitive Receptors. The following measures shall be implemented to reduce project noise impacts:

N1-A. The use of equipment and machinery shall comply with all applicable local noise ordinances and policies. At a minimum, use of equipment and machinery in cordgrass removal shall be limited to weekdays (Monday to Friday) between the hours of 7:00 a.m. to 7:00 p.m. within 500 feet of sensitive receptors.

N1-B. Helicopters shall not be used within 1,500 feet of sensitive receptors.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Alternative 2 would result in manual or mechanical methods being applied more frequently to compensate for those areas that might otherwise have been treated chemically. Short-term mechanical/vehicular noise impacts could result on a more frequent basis than described above under Alternative 1. However, there would not be any helicopter noise associated with this alternative. Impacts would be temporary and less than significant with mitigation due to the limited scale and duration of periodic treatment at sites.

Mitigation Measures

Mitigation N-1A would apply under this alternative. Mitigation N-1B would not apply because this alternative does not include aerial spraying.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Under Alternative 3, there would be an uncoordinated effort to eradicate non-native cordgrass throughout the Bay. Continued limited uncoordinated treatment could incorporate the use of any or all of the treatment methods included in Alternative 1, but the area of treatment could be reduced. Impacts would be temporary and less than significant with mitigation due to the limited scale and duration of periodic treatment at sites.

Mitigation Measures

Same as for Alternative 1.

Table 3.5-3: Summary of Potential Noise Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
N-1: Disturbance of Sensitive Receptors.	All Alternatives: Minor noise during treatment activities.	All Alternatives: Potentially significant equipment noise during treatment activities.	All Alternatives: Minor noise during treatment activities.	All Alternatives: Potentially significant equipment noise during treatment activities.	All Alternatives: Minor noise during treatment activities.	Alternatives 1, 3: Minor noise during hand, all-terrain vehicle, or boat application activities. Potentially significant helicopter noise during aerial spraying. Alternative 2: No impact.	N/A

Table 3.5-4: Summary of Mitigation Measures for Noise

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
Mitigation N-1: Disturbance of sensitive receptors. N-1A. The use of equipment and machinery shall comply with all applicable local noise ordinances and policies. At a minimum, the use of equipment and machinery in cordgrass removal shall be limited to weekdays (Monday-Friday) between the hours of 7:00 a.m. to 7:00 p.m. within 500 feet of sensitive receptors. N-1B. Helicopters shall not be used within 1,500 feet of sensitive receptors.	Not Applicable	Applicable (N-1A only)	Applicable (N-1A only)	Applicable (N-1A only)	Not Applicable	Applicable (Alts 1 & 3 only)

Note: Due to summarization, there may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

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3.6 HUMAN HEALTH AND SAFETY

This section addresses the potential effects of implementing treatment methods on human health and safety. Ecological health and safety issues are addressed in Section 3.2, Biological Resources; water quality issues are addressed in Section 3.1, Water Quality. This section focuses on potential health issues associated with herbicide use, as well as other possible health and safety concerns to project workers, nearby residents, and others using the Bay margins for various activities. The Region of Influence considered in this section is the potential treatment area (the intertidal margins of the San Francisco Estuary) and nearby areas (within 0.25 mile) that could be affected by drift of herbicides.

3.6.1 Environmental Setting

This section includes a general description of human activities in the treatment area, and identifies human receptor populations potentially affected by the proposed project and alternatives.

Potentially Exposed Populations

The Control Project encompasses numerous potential sites around San Francisco Bay, some of which include populations or land uses that would be sensitive to health risks that may be posed by the project. In the North Bay, non-native invasive cordgrass grows adjacent to residential and open space areas in Corte Madera and at the head of Richardson Bay and San Pablo Bay. Non-native invasive cordgrass is more widespread in the Central and South Bays, and grows adjacent to a variety of land uses. It is found along the East Bay near the heavily industrialized Port of Oakland and the island of Alameda. Further south, it is primarily adjacent to salt evaporator ponds, which are open space areas with minimal development. A large portion of this area also falls within the San Francisco Bay National Wildlife Refuge. On the western shore of the Bay, non-native cordgrass is adjacent to industrialized areas, including the Port of Redwood City and San Francisco Airport. Residential areas, including the neighborhood north of 3Com Park, are also along the Bay shoreline where non-native cordgrass is found.

Sensitive Receptors

Sensitive receptors include hospitals, schools, and residences near the bay margin that are in close proximity (e.g., within 0.25 mile) to areas infested with non-native cordgrass. These residential areas include neighborhoods in Corte Madera in Marin County, and along the Alameda County shorelines of Alameda, Hayward and San Leandro.

Birders, bicyclists, joggers, pedestrians, and users of recreational facilities (including parks, marinas, launch ramps, fishing piers, and beaches) that surround the Bay also could be sensitive receptors. For example, several possible treatment sites are located within the East Bay Regional Parks District, including Crown Beach, Martin Luther King Jr., Oyster Bay, Hayward Shoreline, and Coyote Hills parks. Other parks and open space areas with non-native cordgrass in the south, west, and north areas of the Bay also are used for recreational purposes.

Existing Hazardous Waste Sites Near Potential Invasive Cordgrass Control Sites

Some potential non-native cordgrass control sites may be located at or near various known hazardous waste sites, including the Treasure Island Naval Station--Hunters Point Annex and the former Alameda Naval Air Station (both National Priorities List [NPL] hazardous waste sites), United Heckathorn Company in the Richmond Inner Harbor (also an NPL site), Cooley Landing Salt Pond restoration site near East Palo Alto, and various sites in and adjacent to San Leandro Bay and the South Bay area.

3.6.2 Analysis of Potential Effects

Three primary types of health and safety impacts are associated with the treatment of non-native cordgrass infestations:

- Safety impacts to workers associated with manual labor and the use of potentially dangerous equipment during treatment activities
- Health effects to workers and the public associated with the routine application of glyphosate herbicide (including surfactants and dyes) and
- Health effects associated with accidents involving release of herbicide or other hazardous materials into the environment

Each impact is described and followed by an assessment of the significance of the impact. These impacts are summarized in **Table 3.6-1**. Mitigation measures are summarized in **Table 3.6-2**.

Significance Criteria

Significant impacts to public health and safety would occur if the project:

- Creates a significant health or safety hazard to workers associated with the implementation of manual, mechanical, or chemical treatment measures
- Creates a significant health hazard to the public or sensitive subpopulations (e.g., schools, hospitals) through the routine use of herbicides/surfactants/dyes and/or
- Creates a significant hazard to workers or the public through reasonably foreseeable upset and accident conditions involving the release of herbicide/surfactant into the environment

ALTERNATIVE 1: Proposed Action/Proposed Project-Regional Eradication Using All Available Control Methods

IMPACT HS-1: Worker Injury from Accidents Associated with Manual and Mechanical Aspects of Invasive Cordgrass Treatment.

Implementation of manual or mechanical methods to treat non-native cordgrass may result in injuries to workers during treatment activities. The impact would depend on the specific methods and equipment used and the size of the area to be treated.

Workers involved in digging and pulling, pruning, mowing, mechanical smothering, mechanical ripping and shredding, prescribed burning, temporary diking, and covering would be exposed to the risk of cuts, bruises, or sprains associated with working in the mud, from manual labor and use of mechanized equipment. Workers involved in manual spraying of herbicides could be subject to similar types of injuries.

Accidents involving machinery could cause serious injury and falls might occur when traversing uneven terrain or upon contact with slippery soils.

During prescribed burning, a worker would use a propane flamer to create a line of fire. Use of this burner could result in injuries to workers. The potential for the generation of by-products from burning of treated vegetation would be less than significant because the project would not burn vegetation already treated with herbicides.

The Federal and California Occupational Safety and Health Administrations are responsible for developing and enforcing regulations necessary to provide a safe and healthy work environment. These regulations include measures to minimize exposure to toxic air contaminants, educate employees on potential hazards associated with their work environment, provide respiratory protection, provide head, eye, and hearing protection, minimize exposure to noise, and require training to prevent and minimize the impacts of emergencies.

MITIGATION HS-1: Worker Injury from Accidents Associated with Manual and Mechanical Non-native Cordgrass Treatment. Appropriate safety procedures and equipment, including hearing protection, shall be used by workers to minimize risks associated with manual and mechanical treatment methods. Workers shall receive safety training appropriate to their responsibilities prior to engaging in any treatment activities.

IMPACT HS-2: Worker Health Effects from Herbicide Application.

Workers involved in herbicide application would be routinely exposed to hazardous chemicals (glyphosate, surfactants, and dyes) via dermal (skin) contact and inhalation. This may result in health effects to workers. Symptoms following unintentional exposure to glyphosate herbicides include eye irritation, burning sensation on eyes or skin, other skin irritations and rashes, rapid heartbeat, elevated blood pressure, chest pain, congestion, coughing, headache, and nausea. Studies of long-term exposure to glyphosate herbicides indicate that they may also result in reproductive problems including miscarriages and reduced sperm counts (NCAP 2002). The impact would depend on the specific herbicide application methods to be used, the level and duration of contact or inhalation, and the sensitivity of the worker. Glyphosate and surfactant toxicity are summarized below and discussed in detail in **Appendix E**.

Toxicity of Glyphosate to Humans

Glyphosate has relatively low oral and dermal acute (short-term) toxicity (USEPA 1993). It has been placed by U.S. EPA's Office of Prevention, Pesticides and Toxic Substances in Toxicity Category III (Caution) for these effects (Toxicity Category I indicates the highest degree of acute toxicity, Category IV the lowest). Potential health effects associated with human exposure to glyphosate have been extrapolated from laboratory mammalian toxicity studies. Acute toxic effects of glyphosate in rats, rabbits, mice, and dogs include nasal irritation, slight dermal irritation, decreased body weight gains, and decrease in pituitary weight. Maternal and development toxicity were noted in pregnant rats and maternal toxicity was noted in pregnant rabbits (USEPA 1993).

Eye effects from human exposures to herbicides containing glyphosate based on 1,513 calls to poison treatment centers in the United States (Acquavella et al. 1999) included transient minor symptoms (70 percent), no injury (21 percent), and temporary injury (2 percent). Glyphosate, in the form of Rodeo®, is slightly toxic via the inhalation pathway (Monsanto 2001 and 1998; see Appendix E for the Material Safety Data Sheet). Toxicological information provided by Monsanto and Dow Agri-Sciences indicates that acute inhalation toxicity (LC_{50} – level where 50% of the test organisms die) of aerosol formulations of the product Rodeo® for the test species (rats) over a four-hour period is greater than 1.3 milligrams per liter (mg/L); this resulted in a Category III (Caution) rating by the USEPA. Additional tests of inhalation toxicity using the isopropylamine salt of glyphosate resulted in lower potential for acute inhalation toxicity (>4.24 mg/L) and no mortality of the test species (rats). These tests resulted in a Category IV (practically non-toxic) rating.

Knowledge regarding the acute toxicity of glyphosate ingestion to humans comes from a study conducted by Japanese physicians who investigated 56 poisoning cases, most of which were suicides or attempted suicides, involving Roundup®. This project does not propose to use Roundup® since this herbicide is not approved by the USEPA for use in estuarine environments. However, for the nine cases in which the suicide attempts were successful, the mean amount of herbicide ingested was 200 milliliters (mL) (equals 6.8 ounces). Moreover, the polyethoxylated tallowamines surfactant in Roundup® (but not in Rodeo®) likely caused the herbicide toxicity (Sawada et al. 1988). A similar study of 97 glyphosate-surfactant herbicide poisonings found an average of 263 mL was ingested by non-survivors (Tominack et al. 1991). Irritation of the oral mucous membrane and gastrointestinal tract was the most frequently reported effect. Other effects recorded were pulmonary dysfunction, oliguria, metabolic acidosis, hypotension, leukocytosis, and fever.

Several chronic (long-term) toxicity and carcinogenicity studies using rats, mice, and beagle dogs resulted in no effects based on the parameters examined, or resulted in findings that glyphosate was not carcinogenic. The USEPA has classified glyphosate as a Group D oncogen – not classifiable as to human carcinogenicity, based on inadequate evidence for carcinogenicity in animals (USEPA 2001). A reference dose (RfD), or estimate of daily exposure that would not cause adverse effects throughout a lifetime, of 0.1 milligrams per kilogram per day (mg/kg-day) has been proposed for glyphosate, based on kidney effects in rats (USEPA 2001). However, an updated (2002) literature review prepared by the Northwest Coalition for Alternatives to Pesticides (NCAP) noted that a recent Swedish study of hairy cell leukemia found that people who were occupationally exposed to glyphosate herbicides had a threefold higher risk of contracting that disease. The NCAP report also noted that a similar study of people with non-Hodgkins lymphoma found exposure to glyphosate herbicides was associated with an increased risk of about the same size (NCAP 2002). The NCAP report also summarizes other studies where some increased risk of carcinogenisis may result from exposure to glyphosate herbicides. Those conclusions are disputed by the US Environmental Protection Agency (NCAP 2002).

Glyphosate and surfactants dissipate rapidly from the water column from adsorption to sediment particles. However, glyphosate can also de-adsorb from the sediments (NCAP 2002). Half-lives of glyphosate have been measured to range from three to 141 days (NCAP 2002). The half-life in water is a few days (USEPA 2001; Kilbride 1999). After spraying, glyphosate and surfactant levels in sediment rise and then decline to low levels within a few months. Glyphosate and surfactants do not volatilize from water or soil (USEPA 2001).

Toxicity of Surfactants, Impurities, and Mixtures

Impacts to human health could also result from exposure to surfactants that are used with glyphosate, trace impurities in glyphosate or its surfactants, and application of glyphosate to areas where other herbicides are sprayed. Information on the toxicity of surfactants, impurities, and chemical mixtures is limited. Mammalian studies indicate that the surfactants Agridex®, R-11®, and LI-700® are practically nontoxic to rats and rabbits, but are rated as corrosive, based on eye irritation in rabbits. LI-700® is also rated corrosive based on dermal irritation in rabbits. However, the concentrations of surfactant required to elicit these responses, while sometimes lower than that of glyphosate itself, are substantially greater than the concentrations that would be applied to treat non-native cordgrass.

Trace impurities in glyphosate at levels less than or equal to 0.1 parts per million (ppm) include N-nitroso-glyphosate (NNG) (USFS 1995). Monsanto Agricultural Company has evaluated NNG for mutagenicity, carcinogenicity, and teratogenicity, and found that this chemical does not elicit negative effects and is excreted unchanged (Washington State 1993).

Project Worker Exposure Effects

The potential for human health effects from the application of glyphosate depends on the potential human exposure routes, and the toxicity of the herbicide and associated surfactants and impurities. An exposure route describes the ways in which people can be exposed to contaminants in a particular area. Workers could be exposed to glyphosate and other substances if they inhale glyphosate spray droplets or windblown soil particles; if they touch the liquid herbicide during mixing and loading (dermal contact); or by ingesting small amounts of soil or sediment containing glyphosate residues (e.g., for example, sediment clinging to hands or face). Based on the information summarized above, it is highly unlikely that workers applying glyphosate and surfactants with hand-held sprayers or from vehicles or boats would willfully inhale or ingest the quantities that would cause mortality.

The greatest potential for worker exposure is associated with wicking or wiping activities and use of injection devices. These activities are more labor-intensive than spraying and involve greater direct contact with the herbicide. Backpack spraying is more rapid than wicking or wiping, and reduces the potential for the worker to contact the herbicide. However, some spray drift may occur during spraying.

Application of herbicide using boats, trucks, and all-terrain vehicles (ATVs) mounted with a boom sprayer or spot spraying with a hose from these vehicles may also be conducted; these methods allow for more specific application than aerial spraying. Aerial spraying allows quick application to a large area, but has the potential for drift and therefore inhalation of glyphosate spray droplets.

All herbicide application methods involve the potential for dermal (skin) contact from splashes during mixing and loading. As noted above, primary health effects include eye and skin irritation. In California, glyphosate ranks high among pesticides causing illness or injury to workers, who report numerous incidents of eye and skin irritation from splashes during mixing and loading. Use of personal protective equipment (PPE), including protective eyewear, as specified on the product label would minimize this risk. Proper handling of glyphosate and the surfactants in accordance with the labeling requirements would reduce the potential for eye and dermal irritation in workers.

Mitigation HS-2: Worker Health Effects from Herbicide Application. Appropriate health and safety procedures and equipment, as described on the herbicide or surfactant label, including PPE as required, shall be used by workers to minimize risks associated with chemical treatment methods. Only certified or licensed herbicide applicators shall mix and apply herbicide.

Impact HS-3: Health Effects to the Public from Herbicide Application. Routine application of glyphosate herbicide and surfactants to treat non-native cordgrass may result in adverse health effects to the public, including area residents, recreational visitors, and sensitive subpopulations including children and the elderly. The impact would depend on the herbicide application method, the specific site location, potential receptors in the area, and the size of the area to be treated.

Drift of chemical spray could potentially affect residents living in close proximity to the affected areas, or recreational visitors to the area. Drift from ground application can extend up to about 250 feet, with pesticide concentrations diminishing as the drift gets farther from the source. Drift of herbicides from aerial application has been measured up to 2600 feet (approximately half a mile) from the source (NCAP 2002), however concentrations are substantially diluted with distance from the source. In addition, glyphosate and surfactants are only slightly toxic via the inhalation pathway

(Monsanto 2001 and 1998; USEPA 1993). (See information in Impact HS-1, above on the inhalation toxicity of glyphosate.)

Once glyphosate is released into the environment by spraying, it can enter various environmental media including air, surface water, soil, and sediments. The public could be exposed to glyphosate if they contact these media. Potential exposure routes include:

- Inhalation of fine glyphosate spray droplets or windblown soil particles to which glyphosate is adsorbed
- Dermal (skin) contact with airborne glyphosate or glyphosate residues on vegetation, soil, sediments, or surface water
- Incidental ingestion of glyphosate in soil or sediments by inadvertently swallowing soil or sediment (e.g., by touching dirty hands to mouth or by placing dirty objects, such as toys, into the mouth); this exposure route is of greatest importance for children, who tend to engage in activities that can result in soil or sediment ingestion and
- Ingestion of glyphosate by eating food containing glyphosate residues, such as berries, garden vegetables, fish, or shellfish

People who use treated areas for recreation could come into direct contact with vegetation that has recently been sprayed, thus posing a minor risk of skin irritation. Individuals could be exposed to glyphosate and surfactants while playing, walking, swimming, or fishing at or near treatment sites. Glyphosate and surfactants are poorly absorbed through the skin (USEPA 1993), therefore dermal contact is not likely to cause significant health effects.

People who consume plants or wildlife (including fish and shellfish) harvested near the spray area could be exposed to glyphosate and surfactants if present in the plant or animal. However, glyphosate is minimally retained and rapidly eliminated in fish, birds, and mammals (USEPA 2001). Based on these characteristics, and the water solubility and rapid degradation of glyphosate, it is not expected to bioconcentrate in aquatic organisms; therefore glyphosate poses minimal risk to humans via consumption of aquatic organisms.

A quantitative human health risk assessment was conducted during preparation of the EIS for noxious emergent plant management in Washington State to evaluate the potential for adverse human health effects resulting from exposure to glyphosate (product name: Rodeo®, Washington State 1993). In that risk assessment, conservative estimates of non-cancer and cancer toxicity were compared with a conservative estimate of the amount of glyphosate to which the public could be exposed. The routes of exposure evaluated included: inhalation of spray; dermal exposure from vegetation and water; and ingestion of surface water, soil, sediment, wild game, fish, shellfish, garden vegetables, and berries. Potential concentrations in the environment were estimated by assuming that no glyphosate degradation occurred. Potential human intake rates were calculated using reasonable maximum exposure assumptions developed by USEPA (Washington State 1993). Results of the human health risk assessment indicated little potential for adverse non-cancer or cancer health effects from potential exposures related to noxious vegetation treatment. Short-term (acute) and long-term (chronic) cancer and non-cancer health effects for adults and children were all below levels of potential concern (Washington State 1993).

The Washington study included several scenarios that evaluated all receptor pathways and between one and six spray exposures per a receptor's lifetime. This is conservatively applicable to the Control Program, given the Control Program's goal of spraying each site annually for either one or two years. It also assumed use of Rodeo at an application rate of 3 pounds of active ingredient per acre; this is within the range of glyphosate expected to be used in the San Francisco Estuary, and between the highest concentrations permitted on the label (5.1 pounds/acre) and the mean application rate (2.7 pounds/acre). As noted in the Washington State study, "the over- or underestimation [of active ingredient in spray applications] is expected to be normal, because the differences in exposure point concentrations based on application rates would be minimal (less than an order of magnitude)." Overall, the Washington State study is applicable to the proposed *Spartina* Control Program because the projects involve similar exposure parameters; therefore, potential health hazards associated with the use of glyphosate and surfactants would be less than significant.

However, the following mitigation measures are suggested to further reduce health risks from exposure to chemical treatment.

MITIGATION HS-3: Health Effects to the Public from Herbicide Application. To minimize risks to the public, mitigation measures for chemical treatment methods related to timing of herbicide use, area of treatment, and public notification, shall be implemented by entities engaging in treatment activities as identified below:

- Herbicide application shall be managed to minimize potential for herbicide drift, particularly in areas where the public could be affected. Herbicide shall not be applied when winds are in excess of 10 miles per hour or when inversion conditions exist (per Supplemental Labeling for Aquamaster for Aerial Application in California Only), or when wind could carry spray drift into inhabited areas. This condition shall be strictly enforced by the implementing entity.
- Colored signs shall be posted at and/or near any public trails, boat launches, or other potential points of access to herbicide application sites a minimum of 24 hours prior to treatment. These signs shall inform the public that the area is to be sprayed with glyphosate herbicide for weed control, and that the spray is harmful if inhaled. They will advise "no entry" for humans and animals until a minimum of eight (8) hours after treatment, and that date and time will be stated. A 24-hour ISP contact number shall be provided.
- Application of herbicides shall be avoided near areas where the public is likely to contact water or vegetation as follows:
    - A. Application of herbicides in or adjacent to high use areas shall not be allowed within 24 hours prior to weekends and public holidays.
    - B. If a situation arises (due to weather or other variables) that makes it necessary to treat high-use areas on weekends or holidays, the areas shall be closed to the public for 24 hours before and after treatment.
- At least one week prior to application, signs informing the public of impending herbicide treatment shall be posted at prominent locations within a 500-foot radius of treatment sites where homes, schools, hospitals, or businesses could be affected. Schools and hospitals within 500 feet of any treatment site shall be separately noticed at least one week prior to the application.
- No aerial spraying shall be conducted within 0.25 mile of a school, hospital, or other sensitive receptor location.

IMPACT HS-4: Health Effects to Workers or the Public from Accidents Associated with Chemical Treatment.

Application of glyphosate and surfactants to treat non-native cordgrass may result in adverse health effects to workers or the public from reasonably foreseeable upset or accident conditions. Accidents during burning activities may also result in adverse health effects. The impact would depend on the specific site location, potential receptors in the area, and weather conditions at the time of the accident.

MITIGATION HS-4: Health Effects to Workers or the Public due to Accidents Associated with Non-native Cordgrass Treatment. Appropriate health and safety procedures and equipment shall be used to minimize risks associated with non-native cordgrass treatment methods, including exposure or spills of fuels, petroleum products, and herbicides. These shall include:

- Preparation of a contingency plan including a Spill Prevention, Control and Countermeasures (SPCC) plan (see also the mitigation measures in Section 3.2 *Water Quality*) and
- Participation of the local fire department during prescribed burning activities

Short-term, acute exposure to hazardous chemicals could occur during accident or upset conditions. Exposures could result from accidental spills or improper disposal of chemicals. The risk of health effects is highest for workers during non-native cordgrass treatment. With appropriate mitigation measures, health and safety impacts due to upset conditions would be less than significant.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Under this alternative, health and safety impacts associated with the potential for exposure of workers or the public to herbicides would not occur. Increased reliance on manual or mechanical treatment methods, and possible need for repeated treatment under this alternative could result in higher worker safety impacts due to the increased use of manual labor and potentially dangerous cutting equipment.

Mitigation Measures

Mitigation measures HS-1 and HS-4 would apply to this alternative. Mitigations HS-2 and HS-3 would not apply because they address herbicide-related hazards.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Under Alternative 3, Limited uncoordinated cordgrass control efforts would have impacts similar to those associated with Alternative 1, except that treatment efforts and resultant impacts would likely be less widespread.

Mitigation Measures

Mitigation measures identified for Alternative 1 would also be applicable to this alternative and would be required for this alternative.

Table 3.6-1: Summary of Potential Human Health and Safety Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
HS-1: Worker Injury from Accidents Associated with Manual and Mechanical Cordgrass Treatment.	All Alternatives: Minor worker injuries are possible during treatment activities.	All Alternatives: Minor worker injuries are possible during treatment activities.	All Alternatives: Minor worker injuries are possible during treatment activities.	All Alternatives: Minor worker injuries are possible during treatment activities.	All Alternatives: Minor worker burns are possible during treatment activities.	Alternatives 1 & 3: Minor worker injuries are possible during manual spraying activities.	N/A
HS-2: Worker Health Effects from Herbicide Application.	No impact.	No impact.	No impact.	No impact.	No impact.	Alternatives 1 & 3: Significant but mitigable worker health effects are possible from worker inhalation and contact with herbicides during treatment activities.	N/A
HS-3: Health Effects to the Public from Herbicide Application.	No impact.	No impact.	No impact.	No impact.	No impact.	Alternatives 1 & 3: Significant but mitigable public health effects are possible from worker inhalation and contact with herbicides during treatment activities. Alternative 2: No impact.	N/A

Table 3.6-1: Summary of Potential Human Health and Safety Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
HS-4: Health Effects to Workers or the Public from Accidents Associated with Treatment.	No impact.	All Alternatives: Minor public health effects are possible from accidental releases of fuels during treatment activities.	All Alternatives: Minor public health effects are possible from accidental releases of fuels during treatment activities.	All Alternatives: Minor public health effects are possible from accidental fires and releases of fuels during treatment activities.	All Alternatives: Minor public health effects are possible from accidental fires and releases of fuels during treatment activities.	Alternatives 1 & 3: Significant but mitigable public health effects are possible from accidental spills of herbicides during treatment activities. Alternative 2: No impact.	N/A

Table 3.6-2: Summary of Mitigation Measures for Human Health and Safety

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
Mitigation HS-1: Worker injury from accidents associated with non-native cordgrass treatment. Appropriate safety procedures and equipment shall be used by treatment workers.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable
Mitigation HS-2: Worker health effects from herbicide application. Appropriate health and safety procedures and equipment, as described on the herbicide or surfactant label, including personal protective equipment, shall be used by workers to minimize risks associated with chemical treatment methods. Only certified or licensed herbicide applicators shall mix and apply herbicide.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable
Mitigation HS-3: Health effects to the public from herbicide application. To minimize risks to the public, mitigation measures for chemical treatment methods are related to timing of herbicide use, area of treatment, and public notification.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable
Mitigation HS-4: Health effects to workers or the public from accidents associated with non-native cordgrass treatment. Appropriate health and safety procedures and equipment shall be used to minimize risks associated with non-native cordgrass treatment methods, including exposure to fuel spills or other petroleum products, and herbicides.	Not Applicable	Applicable	Applicable	Applicable	Applicable	Applicable

Note: Due to summarization, there may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

3.7 VISUAL RESOURCES

This section assesses the effects of the treatment techniques on views from public viewpoints. The Region of Influence is the potential treatment areas surrounding the San Francisco Estuary, including the intertidal areas, nearby trails and open space, roadways, and residential areas. Local laws and policies regarding visual resources will be applicable for each treatment location, and compliance with these laws will be addressed in subsequent environmental analyses.

3.7.1 Environmental Setting

Urbanization and industrial uses characterize the San Francisco Estuary margins, although major portions of the area around San Francisco Bay remain undeveloped. Many recreational users of the waterfront -- including bird watchers, bicyclists, joggers, anglers, and pedestrians -- value the aesthetic views of the Bay's edge. Open space views of tidal flats and salt marshes in many areas around the Bay afford spectacular views of wildlife and long distance views otherwise unavailable in an urban setting.

Views of the margin of the San Francisco Estuary from the water are characterized by unvegetated areas (mudflats) that transition into vegetated areas (intertidal marshes and transitional vegetation) and then into uplands that are developed. Views from upland areas also are characterized by vegetated marshes of various heights, channels, and mudflats.

The mudflats are typically brown when exposed but are frequently flooded by tides and are then viewed as extensions of the bay waters. Visually, the marshes range from having a low shrubby vegetated appearance (pickleweed marshes) to clumps of taller grasses and reed and grassy prairies (cordgrass marshes). Large flocks of shorebirds are also a characteristic visual feature of tidal mudflats. These marshes are typically bisected by open channels bounded by taller marsh vegetation.

Intertidal marshes that are comprised of native vegetation (e.g., *Salicornia virginica*, *Spartina foliosa*, *Jaumea carnosa*) are typically green in the spring and summer months. In the fall and winter months, some of these plants enter a dormant phase and turn reddish brown. This cyclic change in color and visual character of the vegetated marshes is also typical of areas infested with non-native cordgrass. Transitional plants on the banks typically remain green throughout the year, but only flower in the spring or summer months.

The vegetation in native marshes is shorter than areas with non-native cordgrass. The native cordgrass is approximately two to three feet tall compared to Atlantic smooth cordgrass and hybrids, which can reach five to six feet. English cordgrass has a growth form and seasonal color change similar to Atlantic smooth cordgrass. Chilean cordgrass and salt-meadow cordgrass are about the same height and color as native marsh vegetation. However, Chilean cordgrass grows in dense clumps, and colonies of salt-meadow cordgrass resemble a pile of hay or straw. These two species also undergo seasonal color changes. Even though non-native and native vegetation are visually different, a marsh of non-native vegetation may rank as visually pleasing as a native one to the unknowing observer. Tidal marshes dominated by non-native cordgrasses, however, are highly homogeneous, and lack the varied texture, pattern and color provided by the mature mosaic of native tidal marsh vegetation between complex tidal creek networks. This is evident even to casual observation. The primary visual contrast between native tidal wetlands and invasive cordgrass-dominated marsh is between landscapes of homogenous cordgrass meadows, and complex drainage-patterned and diverse tidal marsh vegetation.

3.7.2 Analysis of Potential Effects

Impacts on visual resources are summarized in **Table 3.7.1**.

Significance Criteria

In accordance with the California Environmental Quality Act (CEQA) Guidelines, the impacts described below for each of the alternatives will be considered significant if they:

- Noticeably increase visual contrast and substantially reduce scenic quality, as seen from any high sensitivity foreground or middle-ground viewpoint;
- Block or disrupt existing views or reduce public opportunities to view scenic resources; and/or
- Would conflict with policies and regulations governing aesthetics.

ALTERNATIVE 1: Proposed Action/Proposed Project - Regional Eradication Using All Available Control Methods

IMPACT VIS-1: Alteration of Views from Removal of Non-native Cordgrass Infestations.

Methods that require removal of large and densely vegetated areas would result in a change in visual character and loss of scenic quality. Impacts associated with non-native cordgrass removal would vary slightly depending on the size of the area being eradicated and the treatment method used. Manual removal of non-native cordgrass would have a short-term impact on small, isolated infestations. Pruning and hand-mowing would cause an immediate change from vegetative cover to dead vegetation, and focus on infestations that are 1 to 10 acres. Views of cut vegetation would be comparable to views of natural dieback. Flooding would change a treatment site's appearance from vegetated to water-covered for the duration of the flooding, then would appear as dead vegetation until revegetated (up to two years).

Some of the visual impacts of removal methods are shown in **Figure 3.7-1**, **3.7-2** and **3.7-3**. **Figure 3.7-1** shows changes in views associated with herbicide use. Use of herbicides would include use of a colorant. Sprayed areas would appear blue-tinted. However, these visual effects would be temporary and less than significant because the colorant would be slowly rinsed from the plants by tidal action and rainfall events. The herbicide treatments would result in vegetation turning orange-brown then brown, as the vegetation dies and decomposes. This browning would be similar to that which occurs seasonally as cordgrass enters winter dormancy, but would persist until the plant decomposes or is removed.

Figure 3.7-2 shows an area treated with herbicides and an area treated with a tracked mower. The mowing example was taken from an invasive cordgrass control project in Willapa Bay, Washington, and it shows that for methods involving the removal of above- and below-ground biomass, mudflat habitat would be immediately restored. This photo also shows the scale over which tracked vehicles could be used. There would be a temporary impact on large stands (greater than 10 acres). Views of dense vegetation would be temporarily replaced with unvegetated mudflats until revegetation. Of all the treatment methods proposed, large-scale mechanized

Spartina alterniflora - orange-brown (background) area was treated the previous year with herbicide, pickleweed (foreground)

Comparison of clones of *Spartina alterniflora* treated with herbicide (foreground) and untreated clones (background), San Francisco Bay

Figure 3.7-1. Changes in Views Associated with Herbicide Use

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Example of area treated with herbicides (foreground)

Mechanical mowing of *Spartina alterniflora*, Willapa Bay, Washington

Figure 3.7-2 Changes in Views Associated with Herbicide Use and Mechanical Mowing

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Spartina alterniflora - treatment area is covered with black plastic

Example of recovery of native pickleweed following removal of non-native *Spartina*

Figure 3.7-3 Changes in Views Associated with Covering and Native Plant Recovery

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removal of invasive cordgrass, and removal by the use of herbicides, would result in the greatest visual alteration as seen from onshore or offshore viewpoints around San Francisco Estuary. These treatment methods would result in a temporary significant impact to the existing visual environment. An example of a covering treatment on a small area is shown in **Figure 3.7-3**. The covering treatment would not contrast substantially with the mudflats since sediment would settle on the plastic. **Figure 3.7-3** also shows an area where native pickleweed recovered over a short period. The photo of the recovered site shows that native vegetation, where nearby seed and vegetative sources exist, readily re-colonizes treated areas in about a year. In areas to be restored as mudflats or beaches that occurred prior to infestation by invasive cordgrass, the visual change would be permanent, but not adverse. This small-scale treatment would result in minor, localized effects to the visual environment.

The most substantial change in the visual character of the treatment site under Alternative 1 would occur during the first treatment. Subsequent treatments, if necessary, would have less impact since the majority of the vegetation and biomass would be removed in the initial treatment. Following treatment, the treatment areas would have significant impacts on visual resources because there would be vast areas of decaying and dead vegetation. The areas would contain expanses of blackened vegetation if it were burned, fallen vegetation in mowed and sprayed areas, and other evidence of dead vegetation. This impact would be temporary because the treatment areas would return to low-vegetation native marshes and mudflats. However, as noted above, temporary (under two years) impacts at large-scale treatment sites could be perceived as visually significant impacts.

Mitigation Measures

MITIGATION VIS-1: The ISP will integrate signage into all treatment areas that are adjacent or within areas accessible or visible to the general public, whenever the treatment of nonnative Spartina will result in a substantial change in the visual character of the area. Signage will vary depending upon the site-specific components of treatment methods, availability and nature of public access and visibility, extent of the infestation, and other factors. Signage will therefore range from simple signs providing a brief description of the nature and reason for the change (e.g. where there is little public visibility or the extent of infestation is small) to more detailed interpretive signs highlighting the ecological effects of Spartina and the need for control (e.g. where there is significant public access and high visibility, and infestation is broad).

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Alternative 2 would be similar to Alternative 1, except that chemical methods would not be used and visual quality impacts from a colorant would not occur. The visual impacts associated with manual or mechanical methods would occur more frequently if repeated treatment is required. As with Alternative 1, potential impacts on visual resources for areas of large-scale treatment would be temporarily significant.

Mitigation Measures

Mitigation VIS-1 also applies to this alternative.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

IMPACT VIS-2: Change in Views from Native Marsh, Mudflat, and Open Water to Non-native Cordgrass Meadows and Monocultures.

For the first five to ten years, visual quality impacts would be similar to those under Alternative 1. Although limited treatment would continue in navigational waterways, after this period, assuming that the uncoordinated treatment does not halt the invasive cordgrass infestations in the Estuary, viewers would see a substantial increase in vegetative cover from new infestations and the spread of existing colonies of non-native cordgrass. Changes in the visual character (from low stature native marsh and mudflats to tall meadow-like areas) would continue and potentially cover a large portion of native marshes, mudflats, and shallow subtidal areas.

Views of shallow open water, mudflats, and low-vegetation marshes would be altered to large expanses of taller non-native cordgrass. This would dramatically alter the visual character of the shoreline throughout the Estuary. The current variety of visual elements in the intertidal areas along the shoreline would be replaced with a single dominant monotonous element - large expanses of cordgrass meadows. This potential change in scenic quality of the San Francisco Estuary shoreline from the continued spread of non-native cordgrass would be a significant impact. One of the most conspicuous consequences of this alternative would be reduced visibility of shorebirds in mudflats from viewing points within the San Francisco Bay National Wildlife Refuge, East Bay Regional Parks, and other fixed viewing locations closely adjacent to tidal mudflats. Growth of Atlantic smooth cordgrass from marsh edges towards the Bay would obstruct views from low-lying levees, and would increase viewing distances by displacing tidal mudflats farther from existing levees and platforms. This would significantly reduce scenic values of public access areas along the Bay edge.

Mitigation Measures

Under this alternative, no feasible mitigation has been identified to reduce the impact of spreading infestations on the scenic qualities of the San Francisco Estuary shoreline. Under this alternative, potential impacts on visual quality would be significant since there is no feasible mitigation to reduce the impact.

Table 3.7-1: Summary of Potential Visual Resource Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
VIS-1: Alteration of Views from Removal of Non-native Cordgrass Infestations.	All Alternatives: Short-term impact on small, isolated infestations.	All Alternatives: Temporary impact on large stands (>10 acres). Views of dense vegetation would be temporarily replaced with unvegetated mudflats until revegetation.	All Alternatives: Immediate increase in visual contrast between vegetative cover (before) and treated areas (after), and focus on infestations that are 1 to 10 acres. Views of the abandoned cut material would be comparable to views of natural dieback.	All Alternatives: Short-term impact for up to two years. Areas would be similar to existing intertidal views (flooded or dry).	All Alternatives: Short-term impact from green to brown or blackened vegetation. Views would change from dense vegetation to dead plant material.	All Alternatives: Views of green vegetation would be replaced with blue-tinted plants that decompose over time. The color of treated plants would be bluish-brown and the blue colorant would rinse off. Alternative 2: No impact.	N/A
VIS-2: Change in Views from Native Marsh, Mudflat, and Open Water to Non-native Cordgrass Meadows and Monocultures.	Alternatives 1 & 2: No impact. Alternative 3: Potentially significant impact from the spread of non-native cordgrass to uninfested areas and spread of existing colonies of non-native cordgrass.	Alternatives 1 & 2: No impact. Alternative 3: Potentially significant impact from the spread of non-native cordgrass to uninfested areas and spread of existing colonies of non-native cordgrass.	Alternatives 1 & 2: No impact. Alternatives 3: Potentially significant impact from the spread of non-native cordgrass to uninfested areas and spread of existing colonies of non-native cordgrass.	Alternatives 1 & 2: No impact. Alternative 3: Potentially significant impact from the spread of non-native cordgrass to uninfested areas and spread of existing colonies of non-native cordgrass.	Alternatives 1 & 2: No impact. Alternative 3: Potentially significant impact from the spread of non-native cordgrass to uninfested areas and spread of existing colonies of non-native cordgrass.	Alternatives 1& 2: No impact. Alternative 3: Potentially significant impact from the spread of non-native cordgrass to uninfested areas and spread of existing colonies of non-native cordgrass.	N/A

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3.8 LAND USE

This section assesses the effects of the proposed action on land uses at the treatment areas and in the project vicinity. The compatibility of the proposed action with regional land use policies and goals is evaluated. The Region of Influence is the intertidal areas where non-native cordgrass occurs and may infest, and adjacent areas within one-half mile in the nine Bay Area counties and Sacramento County.

3.8.1 Environmental Setting

The project area includes the San Francisco Estuary and, in particular, the tidelands located between developed areas and water. The project area is within Alameda, Contra Costa, Solano, Napa, Sonoma, Marin, San Francisco, San Mateo, Santa Clara, and Sacramento Counties. The land uses surrounding areas where invasive non-native cordgrass grows within the San Francisco Estuary vary and include residential, open space, agricultural, and industrial areas. Non-native cordgrass in the North Bay grows adjacent to residential and open space areas in Corte Madera and at the head of Richardson Bay, and San Pablo Bay. Non-native cordgrass is more widespread in the Central and South Bay subregions (see **Figure 1-1**) and grows adjacent to a variety of land uses. It is found along the East Bay near the heavily industrialized Port of Oakland and Alameda Island. Further south, it is primarily located adjacent to salt evaporator ponds, which are open space areas with minimal development. A large portion of this area also falls within the San Francisco Bay National Wildlife Refuge. On the western shore of the Bay, non-native cordgrass is found adjacent to industrialized areas, including the Port of Redwood City and San Francisco Airport. Residential areas, including the neighborhood north of 3Com Park (Candlestick Point), are also located along the Bay shoreline where non-native cordgrass is found. Some of the areas around San Francisco Bay provide sensitive habitats that are subject to Habitat Conservation Plans.

Ranging from urban to rural, land uses within the project area vary. Contra Costa and San Mateo Counties remain relatively undeveloped with agriculture, recreation and general open space areas. Santa Clara County's northwestern areas contain nearly 18,000 acres of diked baylands, which consist mostly of salt evaporation ponds with areas of remnant salt marsh and wetlands. Solano County contains a number of significant marsh and wetland habitat areas including the Suisun and Napa Marshes. The Suisun Marsh is an 85,000-acre tidal marsh containing wildlife habitat of national importance.

Land uses surrounding the Bay are governed by a variety of Federal, State, and local laws, policies, and regulations. For the purpose of this analysis, land uses that are governed by regional plans and policies are the focus since regional plans and policies often are more protective of the environment, and reflect the content of a variety of other Federal and State laws, policies, and requirements. Local laws and policies will be applicable for each treatment location, and compliance with these laws will be addressed in subsequent environmental analyses. Provided below are summaries of applicable regional plan policies that would apply to the proposed project.

Regional plans and policies are discussed in Chapter 5.0, *Environmental Compliance*. These include the San Francisco Bay Plan, Baylands Ecosystem Habitat Goals, and Comprehensive Conservation and Management Plan. The San Francisco Bay Plan was prepared following development of the McAteer-Petris Act of 1965, which established the Bay Conservation and Development

Commission (BCDC) as the agency to prepare an enforceable plan to guide protection and use of the San Francisco Bay and its shoreline. The San Francisco Bay Area Wetlands Ecosystem Goals Project began in 1995. It was a cooperative effort among nine State and Federal agencies, and nearly 100 scientists. The principal objective of the Baylands Ecosystem Habitat Goals Project was to develop a concept for the types, quantities/acres, distribution of wetlands and related habitats needed to restore and sustain a healthy baylands ecosystem (Goals Project 1999). The Comprehensive Conservation and Management Plan was prepared as part of the San Francisco Estuary Project and presented strategies to protect and restore the health of the San Francisco Estuary.

3.8.2 Analysis of Potential Effects

Significance Criteria

In accordance with the California Environmental Quality Act (CEQA) Guidelines, the impacts described below for each of the alternatives will be considered significant if they:

- Fundamentally conflict with established residential, recreational, educational, or scientific uses of an area;
- Disrupt or divide established land use configurations;
- Result in substantial alteration of present or planned land uses; and/or
- Substantially conflict with adopted environmental plans, policies or regulations established by an agency with jurisdiction over the project.

ALTERNATIVE 1: Proposed Action/Proposed Project - Regional Eradication Using All Available Control Methods

The project would be conducted in close coordination with relevant Federal, State, and local agencies. The nature of the proposed action is such that the particular method for non-native cordgrass removal (i.e., mechanical, manual, spraying, etc.) in a given area would be selected or rejected based on particular restrictions presented by relevant regional or local plans, policies, or regulations. Although there may be short-term impacts on habitats and beneficial uses along the Bay shoreline, the proposed project would be largely consistent with the long-term goals of the principal habitat protection and wildlife recovery policies in key regional plans.

It is not anticipated that the proposed project would conflict with any applicable habitat conservation plan or natural community conservation plan because the proposed project is intended to implement goals presented in habitat conservation and natural community conservation plans developed by several agencies with jurisdiction in the region.

No permanent land use changes would occur from the proposed project although effects from various methods could conflict with land use policies protecting the Bay Area. The manual and mechanical treatment methods including digging, pruning, mowing, prescribed burns, temporary diking, and covering would not lead to land use changes. Due to the nature of the proposed project, no agricultural land would be converted to urban uses, and no existing or planned residential, commercial, or industrial structures would be moved or relocated. Indirect effects such as soil erosion, compaction, and non-target plant and animal mortality could conflict with policies designed to enhance and preserve the Bay. However, these potential impacts are expected to be temporary and affect only the treatment site and the immediate vicinity.

IMPACT LU-1: Land Use Conflicts Between Herbicides and Sensitive Receptors

Aerial application of herbicide could result in chemical drift to populated areas and thus conflict with established residential, recreational, institutional, or scientific uses. Refer to Section 3.6, *Human Health and Safety*. Glyphosate applied by helicopter has been monitored 2,600 feet from a treatment area. Short-term chemical drift to areas of sensitive receptors within approximately one-half mile of applications would be a potentially significant and mitigable impact.

The use of herbicides would potentially affect sensitive receptors and could affect sensitive species and research areas in treated habitats. Refer to Section 3.3, *Biological Resources*, Section 3.4, *Air Quality*, and Section 3.6, *Human Health and Safety*.

Mitigation Measures

Air quality mitigation measures in Section 3.4, *Air Quality* would reduce Impact LU-1 to less than significant. Air quality mitigation measure AQ-3, requires preparation of an herbicide drift management plan, which includes elements such as coordination with the County Agricultural Commissioner, application by certified or licensed applicators, notification of the public, proper equipment use, spraying with ideal meteorological conditions, and buffer zones. Residual impacts of aerial spraying would be less than significant within areas surrounded by residential, recreational, or educational facilities. In addition, mitigation measures in Section 3.6, *Human Health and Safety* would reduce Impact LU-1 to less than significant.

IMPACT LU-2: Land Use Conflicts from Mechanical and Burning Treatment Methods

The use of mechanical or burn treatment methods would lead to dust and smoke emissions, and potentially conflict with residential, recreational, educational, or scientific land uses. Because most of the treatment activities would occur in wetlands, dust generation would be limited to access roads, resulting in a less than significant impact. See Impact AQ-1. The land use conflict would be a potentially significant and mitigable impact.

Mitigation Measures

Implementation of Air Quality mitigation measures would reduce impacts associated with dust and smoke emissions. Refer to Section 3.4, *Air Quality*, for a detailed description of each mitigation measure. Residual impacts would be less than significant.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts on land use associated with Alternative 2 would be less than impacts for Alternative 1 because land use conflicts associated with aerial application of herbicide would not occur. However, potential land use conflicts associated with increased/repeated use of alternative methods without chemicals would increase. The increased use of manual and mechanical treatment methods including digging and mowing would lead to increased dust to nearby sensitive receptors. In addition, smoke from prescribed burns could affect sensitive land uses, although these impacts are expected to be of short duration, and, with mitigation identified in Section 3.4, *Air Quality*, would be less than significant.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Potential short-term impacts on existing land uses within the project site or surrounding land uses would be less than under Alternative 1. The potential for short-term chemical drift from aerial applications to areas of sensitive receptors within one-half mile of applications could be significant. Manual, mechanical, or burn treatment methods would lead to dust and smoke emissions, and could conflict with residential, recreational, educational, or scientific land uses. More frequent treatments could be required under this alternative compared to Alternative 1. Therefore, long-term land use conflicts could be greater under this alternative. In addition, the gradual loss of existing mudflats and native cordgrass habitats likely would continue to occur, and the long-term goal of restoring habitats and improving wildlife recovery in the Bay would not likely be achieved.

Mitigation Measures

Mitigation measures in Section 3.4, *Air Quality* would reduce the potential land use impact of herbicides on sensitive receptors and dust and smoke emissions to less than significant. Residual impacts would remain less than significant, however, the gradual loss of existing mudflats and native cordgrass habitats likely would continue to occur, and the long-term goal of restoring habitats and improving wildlife recovery in the Bay would not likely be achieved.

Table 3.8-1: Summary of Potential Land Use Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
LU-1: Land Use Conflicts Between Herbicide Use and Sensitive Receptors	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	All Alternatives: No impact.	Alternatives 1 & 3: Potentially significant impacts to sensitive receptors. These would be mitigated to less than significant by Air Quality and Human Health and Safety mitigations. Alternative 2: No impact.	N/A
LU-2: Land Use Conflicts from Mechanical and Burning Treatment Methods	All Alternatives: No impact.	All Alternatives: Minor dust impact on access roads.	All Alternatives: No impact.	All Alternatives: Minor impact.	All Alternatives: Possible smoke impacts to nearby residents. Mitigated by Air Quality mitigations.	Same as impact LU-1, above.	N/A

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3.9 CULTURAL RESOURCES

This section assesses the effects of the proposed action on cultural resources. The analysis considers the historic and prehistoric cultural resources of the potential treatment areas and vicinity. The Region of Influence considered in this section is the intertidal area of the San Francisco Estuary.

3.9.1 Environmental Setting

The earliest archaeological sites in the Bay region are from about 7,000 to 4,000 years before present (BP), a time when sparse populations of hunter-gatherers began to exploit a wider range of habitats. The presence of large projectile points, milling stones, and a lack of high density shell deposits typical of later time periods suggests that these early inhabitants relied heavily on the hunting and gathering of terrestrial foods (Moratto 1984:277).

By 4,000 years BP, populations established numerous villages throughout the San Francisco Bay Area. Village sites were commonly situated near a stream adjacent to resource-rich bayshore and marsh habitats (Moratto 1984:277) and often had deep, stratified deposits of shellfish and other remains from repeated occupations over time.

Beginning around 1,700 BP there was an increasing complexity in artifact assemblages that seems to reflect an intensified hunting, gathering, and fishing adaptation. The introduction of the bow and arrow, harpoon, and the use of clam disk beads as currency for trade are just a few indications that populations were larger and more densely settled.

The prehistoric inhabitants of the San Francisco Bay area were collectively known as the Costanoans, which is a linguistic designation that covered approximately 50 separate and politically autonomous nations or tribelets (Levy 1978). They hunted large and small game, collected berries and acorns, and fished the local waters. Native American groups are known to have heavily utilized marshlands for a wide variety of natural resources, and prehistoric habitation sites have been recorded in or adjacent to marshland settings.

The Spanish explored northern California as early as 1769, beginning with the expedition of Gaspar de Portola. As part of their expansion into the area, the Spanish established a fort, Castillo de San Joaquin, and presidio in the Golden Gate area between 1776 and 1794. The U.S. Army took over this Spanish settlement in 1846.

San Francisco Bay has a long history of maritime activities that undoubtedly left material remains along the water's edge. The California Gold Rush of 1849 greatly stimulated San Francisco's development as the primary port on the West Coast. Thousands of vessels took advantage of the Bay's calm waters and the rivers that provided easy access to the Sierra foothills where gold fever was rampant. Hundreds of vessels anchored in the Bay. The importance of maritime shipping continued throughout all succeeding historic periods and areas near major watercourses, estuaries, and nearby mudflats. Early population centers could be expected to have historic remains associated with these maritime activities.

The integrity and visibility of historic and prehistoric cultural resources along the perimeter of the Bay have been greatly affected over the last 150 years. Nearly all of the prehistoric tidal marsh in the San Francisco Estuary was diked between 1853 and the 1950s. Dikes were constructed along the edges of the prehistoric salt marshes, following the edges of tidal sloughs too large to dam, and enclosing all small sloughs (Ver Planck 1958). Thus, almost all prehistoric marsh surfaces in the Estuary are located in the interior side of dikes. Nearly all existing tidal marshes formed in sediments deposited after dikes were constructed. These tidal "fringing" or "strip" marshes outboard of dikes established in the positions of previously unvegetated historic tidal channel beds or mudflats (Atwater *et al.* 1979). These modern marshes have been, or will likely be, invaded by Atlantic smooth cordgrass.

Within the modern San Francisco Estuary, prehistoric tidal marsh surface with the potential for shallow-buried cultural resources are restricted to locations within (a) diked bayland interiors, and (b) rare, locally preserved, undiked, prehistoric tidal marshes (e.g., upper Newark Slough, inner Dumbarton Marsh). Because non-native cordgrasses do not establish in the diked bayland interiors (where there is no tidal flow), these areas are not of concern for Control Program treatment activities. Areas of greatest concern are those areas where non-native cordgrass has invaded, or threatens to invade, preserved, prehistoric, tidal marshes.

Some tidal marshes that re-emerged after brief, failed periods of diking, such as Greco Island, may have near-surface archaeological resources, even though they are not pristine prehistoric tidal marshes. Tidal marshes that re-emerged in the 20th Century after many decades of diking and salt pond management, such as Ideal Marsh and Whale's Tail marsh, probably have prehistoric marsh surfaces buried at depths greater than one foot below contemporary surfaces. Burial of these prehistoric marsh surfaces is due to subsidence during past diked conditions, followed by vertical accretion of sediment with rising sea level since the mid-19th Century. Both Ideal Marsh and Whale's Tail Marsh are heavily invaded by Atlantic smooth cordgrass today. No site-specific sediment core data are currently available to determine the depth of prehistoric marsh surfaces in relation to modern marsh surfaces invaded by nonnative cordgrass.

Arrowhead Marsh in San Leandro Bay (Oakland) is a naturally formed tidal marsh. Although Arrowhead Marsh developed in historic times, it has the appearance of a prehistoric tidal marsh. Roberts Landing (San Leandro) salt marshes occur within a highly altered diked bayland that has been restored to restricted tidal circulation. These may also have some prehistoric marsh surfaces at an unknown depth below the modern surface where Atlantic smooth cordgrass colonies occur. Triangle Marsh on Coyote Creek was not diked historically, but the marsh today is essentially a modern deposit built over the original (prehistoric) one. Strong subsidence due to groundwater withdrawal in the Santa Clara Valley converted the original marsh to mudflat and low marsh, which rebounded to modern high tide elevation range after groundwater pumping and subsidence ceased. The tidal marshes of outer Bair Island have also rebounded after less extreme subsidence due to salt pond management and subsequent drainage. Bair Island currently has limited infestations of Atlantic smooth cordgrass, mostly near the adjacent sloughs.

In the North Bay and Suisun Subregions are also a few ancient tidal marshes that have infestations of non-native cordgrasses. The interior portions of Southhampton Marsh, Benicia, are prehistoric tidal marsh, and these have become invaded by saltmeadow cordgrass. Whittell Marsh, Point Pinole, is a prehistoric tidal marsh, now rapidly eroding. It has remnants of an invasion by Chilean cordgrass, which was previously treated. Heerdt (Greenbrae) Marsh has limited infestations near its edges. Other known prehistoric tidal marshes of San Pablo and Suisun Bays (i.e., China Camp Marsh, Petaluma Marsh, Fagan Marsh, Rush Ranch) have not yet been invaded by non-native cordgrasses.

Historic remains associated with maritime or fishery activities could be located where mudflat harbors and anchorages once existed, although the likelihood of discovering such remains has been reduced by infilling, diking, land reclamation, and other large-scale modifications of the bayshore landscape. Moreover, subsidence and sea-level rises have continued to accrete sediments in the project area, and areas infested with non-native cordgrass are likely to experience high rates of sedimentation (see Section 3.1, *Hydrology and Geomorphology*) that could bury historic resources.

3.9.2 Analysis of Potential Effects

Project activities have the potential to directly affect cultural resources from ground disturbance during treatment and implementation of erosion control measures. Indirect impacts may occur as a result of increased compaction and erosion of landforms that may contain archaeological deposits.

Descriptions of the specific setting, removal techniques, equipment and workforce requirements, timing and effectiveness of individual treatment methods are provided in Chapter 2, *Program Alternatives*. Project impacts are summarized in **Table 3.9-1**. A more detailed discussion of impacts and their potential significance is presented below.

Significance Criteria

Implementation of the proposed action or an alternative would require compliance with Section 106 of the National Historic Preservation Act (NHPA) and CEQA. The significance of project impacts on cultural resources is related to the following factors: the presence, nature, and importance of any cultural resources that may be present in the treatment area; the location, size, and access requirements of the treatment areas; and need for heavy equipment.

CEQA Guidelines Section 15064.5 indicate a project may have a significant environmental effect if it causes "substantial adverse change" in the significance of an "historical resource" or a "unique archaeological resource," as defined or referenced in CEQA Guidelines Section 15064.5[b, c] (1998). Such changes include "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of a historical resource would be materially impaired" (CEQA Guidelines 1998 Section 15064.5 [b]). This EIS/R uses these general criteria for both CEQA and NEPA impact assessment.

ALTERNATIVE 1: Proposed Action/Proposed Project - Regional Eradication Using All Available Control Methods

IMPACT CUL-1: Disturbance or Destruction of Cultural Resources from Access and Treatment

Any treatment method that involves excavation, dredging, or disturbance of marsh sediments has the potential to destroy, damage, or otherwise disturb undetected prehistoric or historic cultural resources. The potential for project impacts depends on the presence of invasive nonnative cordgrass in contemporary tidal marsh locations where prehistoric marsh sediments (or other prehistoric sediments) are present at or within approximately a foot below the current marsh surface. Comparison of early historic (1850s) and modern tidal marsh locations (Nichols and Wright 1971; Goals Project 1999) indicates that this potential is highly restricted in the San Francisco Estuary because diking has isolated nearly all early historic tidal marsh surfaces from modern tidal settings. Potential for disturbance of cultural resources in marshes with current non-native invasive cordgrass colonies is greatest in: Southhampton Marsh, Heerdt (Greenbrae) Marsh, Arrowhead Marsh, Roberts Landing (inside dikes), Whales Tail Marsh, Ideal Marsh, Dumbarton

Marsh, outer Bair Island, and Greco Island. Potential for disturbance of these resources in other possible treatment areas is unlikely, but not impossible.

Sea-level rise since the mid-19^{th} Century has caused marsh sedimentation (peat accumulation, deposition of bay mud) to bury prehistoric marsh surfaces with variable depths of historic substrate. This lessens the potential for disturbance. Burial is greatest where prehistoric marshes were subject to diking or groundwater withdrawal that caused subsidence of the marsh prior to renewed tidal sedimentation and marsh growth after dikes failed. The stratigraphic "signature" of tidal marsh renewal after dike failure is detectible in marsh core samples, which allows estimation of the depth of ancient marsh surface burial. Rare near-"pristine" prehistoric tidal marshes are likely to have the shallowest burial of early historic or prehistoric surfaces, and the greatest potential for impact, but few such tidal marshes (upper Southhampton Marsh, outer Heerdt Marsh) so far have become invaded by nonnative cordgrasses. The most disturbing potential impact, dredging or excavation of cordgrass, is generally not suitable for treatment of ancient tidal marsh sites; it is most applicable to large tidal channels or outboard of dikes. The deepest dredging or excavation would be 18 inches below the current marsh surface.

Individual treatment methods differ in the potential magnitude of their impacts. Treatment methods using manual or mechanical methods could potentially disturb the ground. Chemical treatment itself would not affect cultural resources, but use of ground-disturbing vehicles during application of chemicals could disturb the ground surface and impact subsurface deposits.

Landforms such as mudflats and intertidal marshes could contain deeply buried archaeological deposits, but they have a relatively low potential to contain intact cultural remains at or near the present ground surface where most ground disturbance during access and treatment would occur. However, it is possible that remnants of maritime-related historic structures or, less likely, Native American archaeological sites could still occur in some areas. If present, such resources could be disturbed during access and treatment. For example, ground-based treatment may require accessing and traversing treatment sites with tracked-vehicles, or by boat or hovercraft. Use of tracked vehicles could compact and otherwise disturb the ground surface because soils colonized by non-native cordgrass are soft silts, muds, and clays. Any surface or near-surface archaeological materials in such soft soils could be damaged or disturbed, particularly by tracked vehicles. Such impacts could be significant at Heerdt (Greenbrae) Marsh, Roberts Landing, Whittell Marsh, or Southhampton Marsh.

In addition, accessing some treatment sites may involve vehicle travel along diked bayland interiors. These areas may contain historic or prehistoric sites that could be disturbed or destroyed by traffic if vehicle travel routes exceeded established levee roads or paths.

Any treatment that involves removal of root masses in prehistoric sediments could affect historic or prehistoric cultural resources, and methods that utilize heavy machinery to mow, cut, rip, or shred root masses also have potential to affect these resources. However, as noted above, few intact cultural resources are expected at or near the ground surface in most areas of treatment, because the vast majority of infested modern mudflats, intertidal marshes, and tidal channels are recent (20^{th} Century) in origin. In addition, in places such as restored marshes, cultural resources may already have been removed, recorded, or covered. In such locales, it is unlikely that the project would further affect those resources.

MITIGATION CUL-1:

a. For all sites proposed for ground-disturbing control methods and ground-disturbing accsss (other than manual removal and smothering) a qualified archaeologist shall conduct a Phase I prehistoric and historical resource site record and literature search to assess the site's cultural resource sensitivity and the potential for project-related impacts. The literature search shall include a review of historic maps to determine whether the site is located on construction fill and whether historic buildings or structures are or were located within its boundaries. The record search shall identify all recorded prehistoric and historic sites in the site and identify previous cultural resource studies conducted in or adjacent to the site. The Phase 1 report shall assess potential impacts and, if needed, recommend site-specific measures to avoid or reduce potential impacts to less than significant levels. If evaluation requires excavations at any prehistoric or historic cultural resource sites, then excavations will be monitored by local Native American representatives identified by the Native American Heritage Commission. If the Phase 1 report finds that there are significant cultural resources, then an alternative treatment method that does not disturb the cultural resources (i.e. herbicide treatment) must be used. Otherwise, if the resource is determined significant and impacts cannot be avoided, then the lead Federal agency shall consult with the California Office of Historic Preservation (OHP) to identify appropriate mitigation measures (e.g. data recovery, recordation) to reduce impacts to less than significant levels.

b. For sites involving manual removal or smothering of invasive cordgrass and not requiring ground-disturbing access, if prehistoric or historic cultural resources are discovered during digging, the project sponsor will suspend all work in the immediate vicinity of the find pending site investigation by a qualified archaeologist or historic resources consultant to assess the materials and determine their significance. If the qualified archaeologist/historic resource consultant determines that the find is an important resource, the project sponsor will provide funding and time to allow recovering an archaeological sample or to implement avoidance measures. Work could continue at other locations while archaeological mitigation takes place.

IMPACT CUL-2: Loss of Cultural Resources from Erosion

Project-generated erosion, as described in Section 3.1, *Hydrology and Geomorphology*, could indirectly disturb or destroy cultural resources sites. This condition would be limited to a few sites within the Estuary (see impact CUL-1, above). Use of mechanical smothering, ripping, cutting, and shredding at the base of steep creek banks at such locations could induce erosion that could disturb or destroy archaeological resources. Methods that leave root masses in-place would slow erosional processes and result in a lower potential for impacts when compared to manual and mechanical treatment methods. Implementation of erosion control measures in Section 3.1, *Hydrology and Geomorphology,* would reduce the potential for erosion-related impacts. However, installation of some erosion control treatments using vehicles or heavy equipment has a potential to directly disturb or destroy archaeological deposits if applied to sensitive sites within remnant prehistoric marshes. Circumstances for such impacts would be very rare, but may be potentially significant.

MITIGATION CUL-2: The potential for erosion impacts to archaeological sites may be minimized by implementing the following:

Project implementation and erosion control measures shall be designed to avoid damaging potentially significant cultural resource sites. Priority shall be placed on (1) early screening to detect the locations of sensitive prehistoric marsh remnants or near-surface buried prehistoric marsh surfaces (see mitigation measure CUL-1); (2) selecting non-native cordgrass control methods that minimize and avoid the potential for damage to such sites. If this is not feasible, then relevant portions of mitigation measure CUL-1 shall be implemented to reduce impacts to less than significant levels.

Implementation of mitigation measures CUL-1 and CUL-2 in combination with mitigation measures in Section 3.1, *Hydrology and Geomorphology* would reduce residual impacts to cultural resources from project-generated ground disturbance and erosion to less than significant levels. Collectively, these measures would ensure that archaeologically sensitive areas are identified and surveyed prior to ground disturbance. They also would ensure that any cultural resource located within the area of potential effect is recorded and avoided if feasible.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

The exclusion of herbicide treatment from Alternative 2 would require a proportional increase in ground-disturbing eradication methods, such as manual or mechanical excavation, disking or maceration, dredging, temporary diking, etc. This would reduce opportunities to avoid or minimize impacts to prehistoric and historic cultural resources s. In the absence of combined mechanical/herbicide treatment methods, the need for repeated mechanical treatment also would increase. This would increase the risk of disturbance of cultural resources compared with Alternative 1.

Mitigation Measures

Mitigation measures recommended for Alternative 1 would be implemented under Alternative 2. The measures would reduce potential impacts to less than significant levels.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Under this alternative, there would be a continued limited uncoordinated program to eradicate non-native cordgrass. Therefore, less cultural impact would occur than under Alternative 1. Local control programs would likely use similar treatment measures described under Alternative 1, with similar potential impacts and feasible mitigation measures.

Mitigation Measures

Mitigation measures recommended for Alternative 1 would be implemented under Alternative 3. The measures would reduce potential impacts to less than significant levels. Residual impacts would be the same as described under Alternative 1 (i.e. less than significant).

Table 3.9-1: Summary of Potential Cultural Resources Effects

Impact	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, salinity variation)*	*Burning*	*Herbicide Application*	*Beneficial Effects*
CUL-1: Disturbance or Destruction of Cultural Resources from Access and Treatment.	All Alternatives: Potentially significant impact from access and ground disturbance.	All Alternatives: Potentially significant impact from access and ground disturbance.	All Alternatives: Potentially significant impact from access.	All Alternatives: Potentially significant impact from access and ground disturbance.	All Alternatives: Potentially significant impact from access and burning.	Alternatives 1, 3: Potentially significant impact from access. Alternative 2: No impact.	N/A
CUL-2: Loss of Cultural Resources from Erosion.	All Alternatives: Less than significant impact from erosion and erosion control.	All Alternatives: Potentially significant impact from erosion and erosion control..	All Alternatives: Less than significant impact from access and ground disturbance. Root masses would be retained.	All Alternatives: Less than significant impact from erosion and erosion control.	All Alternatives: Less than significant impact from access and ground disturbance.	Alternatives 1 & 3: Less than significant impact from access and ground disturbance. Alternative 2: No impact.	N/A

Table 3.9-2: Summary of Mitigation Measures for Cultural Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
Mitigation CUL-1: a. For all sites proposed for ground-disturbing cortnol methods and ground-disturbing accsss (other than manual removal and smothering) a qualified archaeologist shall conduct a Phase I prehistoric and historical resource site record and literature search to assess the siteês cultural resource sensitivity and the potential for project-related impacts. The literature search shall include a review of historic maps to determine whether the site is located on construction fill and whether historic buildings or structures are or were located within its boundaries. The record search shall identify all recorded prehistoric and historic sites in the site and identify previous cultural resource studies conducted in or adjacent to the site. The Phase 1 report shall assess potential impacts and, if needed, recommend site-specific measures to avoid or reduce potential impacts to less than significant levels. If evaluation requires excavations at any prehistoric or historic cultural resource sites, then excavations will be monitored by local Native American representatives identified by the Native American Heritage Commission. If the Phase 1 report finds that there are significant cultural resources, then an alternative treatment method that does not disturb the cultural resources (i.e. herbicide treatment) must be used. Otherwise, if the resource is determined significant and impacts cannot be avoided, then the lead Federal agency shall consult with the California Office of Historic Preservation (OHP) to identify appropriate mitigation measures (e.g. data recovery, recordation) to reduce impacts to less than significant levels. b. For sites involving manual removal or smothering of invasive cordgrass and not requiring ground-disturbing access, if prehistoric or historic cultural resources are discovered during digging, the project sponsor will suspend all work in the immediate vicinity of the find pending site investigation by a qualified archaeologist or historic resources consultant to assess the materials and determine their significance. If the qualified archaeologist/historic resource consultant determines that the find is an important resource, the project sponsor will provide funding and time to allow recovering an archaeological sample or to implement avoidance measures. Work could continue at other locations while archaeological mitigation takes place.	**Applicable**	Applicable	Applicable	Applicable	Applicable	Applicable (ground access only)

Table 3.9-2: Summary of Mitigation Measures for Cultural Resources

Mitigation	*Manual Removal (Hand pulling and manual excavation)*	*Mechanical Removal (Excavation, dredging, and shredding)*	*Pruning, Hand-mowing, and Smothering*	*Flooding (Diking, drowning, and salinity variation)*	*Burning*	*Herbicide Application*
Mitigation CUL-2: Loss of Cultural Resources from Erosion. Project implementation and erosion control measures shall be designed to avoid damaging potentially significant cultural resource sites, as specified in Mitigation CUL-1, above.	Not Applicable	Applicable	Not Applicable	Applicable	Applicable	Not Applicable

Note: There may be textual differences between the measures in this summary table and the text in the section. The actual mitigation measure is in the text.

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3.10 SOCIOECONOMICS

This section assesses the effects of the proposed action on socioeconomics in the vicinity of the treatment areas, and addresses employment, population, and impacts of the project on housing. The Region of Influence for socioeconomics is Sacramento County and the nine-county Bay Area (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties).

3.10.1 Environmental Setting

The Bay Area, with a regional population of approximately 6.8 million people, is one of California's major urban and economic centers. By 2020, the regional population is projected to grow to approximately 8.1 million, representing a 17 percent increase (Association of Bay Area Governments [ABAG] 2000). Population refers to the number of persons residing within the Region of Influence, the incorporated communities and sub-county areas.

ABAG (2000) estimated that the Bay Area economy supported 3.7 million jobs during 2000. The distribution of the jobs within the nine Bay Area counties is shown in **Table 3.10-1**. During 2000, approximately 49 percent of the jobs in the Bay Area were located in Santa Clara and Alameda Counties. These counties support the largest populations of the Bay Area counties (ABAG 2000), and the most jobs. The majority of jobs in the nine-county Bay Area, about 37 percent, were in the services industry, which includes business services. Retail trade and manufacturing (includes the high technology industry) industries accounted for 15 percent each of regional jobs in 2000. The remaining 33 percent of the region's jobs were distributed among the following industry categories: agriculture, forestry, fisheries, mining, construction, transportation, wholesale trade, finance, insurance, real estate, and government. Employment refers to the number of full- and part-time jobs by category or sector for the Bay.

Table 3.10-1. Distribution of Jobs in San Francisco Bay Area Counties

County	*Number of Jobs in 1990*	*Number of Jobs in 2000*	*Percent Share of the Job Market in 2000*
Alameda	617,320	655,090	19
Contra Costa	305,140	342,160	10
Marin	102,240	111,390	3
Napa	47,590	57,610	2
San Francisco	582,010	595,370	18
San Mateo	319,120	367,180	11
Santa Clara	864,110	899,450	27
Solano	119,300	140,480	4
Sonoma	153,600	190,160	6
Region	3,110,430	3,358,990	100%

Source: ABAG, 2000

3.10.2 Analysis of Potential Effects

For the impact analysis, the major differences between the alternatives are the amount of land, the intensity of disturbance, and the potential for use of chemicals associated with the various treatment methods.

Significance Criteria

There are no generally accepted significance criteria for socioeconomic impacts under the National Environmental Policy Act (NEPA). CEQA does not require socioeconomic analysis except in cases of secondary physical impacts to the environment. Therefore, economic or social changes resulting from a project are considered to produce significant impacts if they result in a substantial adverse physical change in the environment (i.e., urban blight).

ALTERNATIVE 1: Proposed Action/Proposed Project - Regional Eradication Using All Available Control Methods

Impacts

Population. Changes in population in the project area during implementation of this alternative would likely be unrelated to the project. The project does not include a housing component. Long-term changes in employment associated with the project would be minor, such as the use of crews that would be used to treat non-native cordgrass and for monitoring new infestations. It is expected that workers already residing in the Bay Area could fill project-related jobs. The project's impact on existing populations would be minimal and less than significant.

Employment**.** The project is expected to create part-time jobs. Employment associated with the Control Program is expected to last for up to ten years. Employment would vary depending upon the treatment method being performed and the size of the site being treated. The estimated labor force associated with each method will vary from a few to tens of workers per day during the treatment period, which may last several days or weeks. Monitoring treated sites would require fewer workers, such as team of two to four workers trained to recognize non-native cordgrass. There would be a minor beneficial impact on employment, since trained workers would likely be retained on-call for work around the Bay. Potential impacts would be less than significant.

Housing. No new housing demand or construction of new housing units would be created by the proposed project. Therefore, potential impacts on housing would be negligible and less than significant.

Mitigation Measures

No significant impacts to socioeconomics have been identified and no mitigation measures are required.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Under this alternative, the impacts on socioeconomics of the region would be similar to Alternative 1. Impacts would be less than significant.

Mitigation Measures

No significant impacts to socioeconomics have been identified for any treatment method or project alternative. Therefore, no mitigation measures are proposed.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Under this alternative, the impacts on socioeconomics of the region would be similar to Alternative 1. Impacts would be minimal and less than significant.

Mitigation Measures

No significant impacts to socioeconomics have been identified for any treatment method or project alternative. Therefore, no mitigation measures are proposed.

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3.11 ENVIRONMENTAL JUSTICE

This section assesses the effects of the non-native cordgrass treatment on environmental justice near the treatment areas. The Region of Influence for environmental justice consists of communities near the treatment areas in the nine-county Bay Area (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties) and Sacramento County. Anglers who fish for recreation and subsistence, and others who use the intertidal area for recreation were also considered in this analysis.

3.11.1 Environmental Setting

The objectives of Executive Order (EO) 12898, Environmental Justice, include identification of disproportionately high and adverse health and environmental effects on minority populations and low-income populations that could be caused by a proposed Federal action. Accompanying EO 12898 was a Presidential Transmittal Memorandum that referenced existing Federal statutes and regulations, including the National Environmental Policy Act (NEPA), to be used in conjunction with the EO. The Council on Environmental Quality (CEQ) issued *Guidance Under NEPA* in December 1997 (CEQ 1997). Minority populations include all persons identified by the U.S. Census of Population and Housing to be of Hispanic origin, regardless of race, and all persons not of Hispanic origin other than White (i.e., Black, American Indian, Eskimo or Aleut, Asian or Pacific Islander, or other race). Income levels vary widely in neighborhoods near treatment areas.

The treatment areas would occur in communities with low-, middle-, and high-income residents. The treatment areas would be in both minority dominated, and non-minority communities. Recreationalists using potential treatment areas also come from all income levels and ethnicities.

However, according to the California Office of Environmental Health Hazard Assessment, the environmental organization, Save the Bay, conducted a survey in 1995 of 228 anglers at fishing piers in the Central and North Bays. (*Fishing for Food in San Francisco Bay, Part II)*, and found that most anglers were male and over 70 percent non-Caucasian. Asians were the predominant ethnic group of anglers, comprising about 36 percent of those interviewed.

3.1.2 Analysis of Potential Effects

Resource impacts identified in this EIS/R were considered to determine the potential for high and adverse health and environmental impacts to human populations. If impacts were identified, an analysis of the potential for disproportionately high and adverse impacts to minority and low-income populations was conducted.

Significance Criteria

No formal, commonly accepted significance criteria have been adopted for Environmental Justice impacts. However, the Presidential Memorandum accompanying the EO directs Federal agencies to include measures to mitigate disproportionately high and adverse environmental effects of proposed Federal actions on minority and low-income populations. Federal agencies also are required to give affected communities opportunities to provide input into the NEPA process, including identification of mitigation measures. No specific significance thresholds have been developed.

Application of EO 12898 to NEPA documentation suggests two questions should be examined:

- Is a Federal project with significant adverse environmental impacts being proposed in a community comprised largely of minority or low-income persons?
- Would any significant adverse human health or environmental effects of the project disproportionately affect minority or low-income persons?

ALTERNATIVE 1: Proposed Action/Proposed Project. Regional Eradication Using All Available Control Methods

Impacts

The treatment areas would occur in communities with low-, middle-, and high-income residents that are composed of minorities and non-minorities; no disproportionate impacts to minority or low-income populations would result from Alternative 1. In addition, as described elsewhere in Chapter 3, *Environmental Setting, Impacts, and Mitigation Measures*, health risks and other long-term impacts to visitors of the treatment areas and residents would be less than significant after implementation of mitigation measures identified in this EIS/R. Glyphosate and surfactants have not been shown to bioaccumulate, and therefore, impacts to low-income and minority fishermen would not be significant.

Mitigation Measures

No mitigation measures are required.

ALTERNATIVE 2: Regional Eradication Using Only Non-Chemical Control Methods

Impacts

Environmental Justice impacts for Alternative 2 would be similar to those described above for Alternative 1, except that human health and safety impacts associated with herbicide applications would not occur. As with Alternative 1, Alternative 2 would not result in any disproportionately high or adverse impacts to minority or low-income populations.

Mitigation Measures

None required.

ALTERNATIVE 3: No Action – Continued Limited, Regionally Uncoordinated Treatment

Impacts

Under Alternative 3, localized treatment would occur but invasive cordgrasses would continue to spread. As with Alternative 1, there would not be disproportionately high or adverse impacts on minority or low-income populations from treatment under Alternative 3. Continued spread of invasive cordgrasses would not disproportionately affect any specific income level or ethnic groups.

Mitigation Measures

None required.

3.12. CUMULATIVE IMPACTS

Cumulative impacts are the result of the additive and synergistic impacts combined with other past, present, and reasonably foreseeable future actions. This discussion summarizes the potential cumulative impacts associated with the proposed project. Potential cumulative impacts are primarily discussed on a regional programmatic basis since the impacts of site-specific projects would not be known unless case-by-case, project specific analyses are performed.

Cumulative effects of the various cordgrass control efforts that comprise the *Spartina* Control Program (Control Program) are discussed in sections 3.1 through 3.11. This section analyzes the potential cumulative effects of regional non-native cordgrass control efforts, combined with proposed or reasonably foreseeable tidal restoration projects, mosquito abatement activities, and other weed control projects.

3.12.1 Projects Considered for Cumulative Impacts Analysis

Three types of projects potentially have significant cumulative interactions with the Control Program: (1) other aquatic weed control programs in the Bay-Delta (Sacramento Delta) region; (2) mosquito abatement activities in tidal marshes of the Bay region; and (3) restoration and management projects affecting tidal marshes of the San Francisco Estuary.

Tidal Marsh Restoration Projects

Regional wetland planning efforts among government resource agencies and research institutions have recommended large-scale restoration of non-tidal diked baylands to a regionally balanced mosaic of tidal marsh, unvegetated shallow-water habitat, and pans (Goals Project 1999). Large-scale regional mitigation plans, such as the San Francisco International Airport expansion proposal, and large-scale public acquisitions of salt ponds (in negotiation), indicate the likelihood of significant increases in the size of individual tidal restoration projects (compared with the past 20 years), and the cumulative area subject to mudflat-salt marsh succession within the next 20 years. Sheltered mudflats and immature tidally restored baylands are highly susceptible to invasion and early dominance by Atlantic smooth cordgrass and its hybrid swarm. Major seed and pollen source populations of Atlantic smooth cordgrass hybrids surround the diked baylands (mostly salt ponds) along the East Bay to the vicinity of Mowry Slough. Recent monitoring data indicate that all recent (1990s) tidal restoration sites from the Central Bay south to Newark Slough are either heavily invaded, or completely dominated by Atlantic smooth cordgrass and its hybrids. For example, tidal marsh vegetation at Cogswell Marsh and Whale's Tail mitigation marsh, are dominated by invasive Atlantic smooth cordgrass hybrids. At Oro Loma Marsh, Atlantic smooth cordgrass hybrids also are dominant over Pacific cordgrass. There are no known examples of recently restored tidal marshes in the East Bay that have not become dominated by Atlantic smooth cordgrass, and there is no evidence that selective planting or weeding of restored marshes is effective at screening out Atlantic smooth cordgrass when its seed rain from adjacent sources is abundant and uncontrolled.

These expanding newly restored tidal marsh populations of invasive non-native cordgrass, in turn, increase the seed rain and pollen load to adjacent marshes and other newly restored tidal marshes. The cumulative interaction between tidal marsh restoration and non-native invasive cordgrasses (particularly Atlantic smooth cordgrass) indicates a potential for exponential increase in invasion rates. The cumulative impact of the Control Program with tidal marsh restoration would depend primarily on the sequencing of tidal restoration and eradication of invasive cordgrasses. If tidal marsh restoration at a large, regional scale proceeds in advance of effective suppression of invasive non-native cordgrass (primarily Atlantic smooth cordgrass, the only significant invader of early-succession, low tidal marsh), demand for cordgrass control would increase exponentially in proportion with dominance of non-native vegetation over thousands of acres of former salt ponds. If large-scale tidal restoration precede effective control and eradication work, the impacts of that eradication work would be far greater because the areas to be treated would be increased substantially. In addition, it is likely that the invasion would proceed irreversibly if thousands (or tens of thousands) of acres of additional tidal marsh became productive seed sources of hybrid Atlantic smooth cordgrass, and particularly if youthful tall stands became colonized by endangered California clapper rails.

If tidal marsh restoration were planned to be contingent on effective suppression of non-native cordgrass invasion rates (reduction of seed and pollen rain to insignificant local levels), the feasibility of the Control Program would be relatively high, and the cumulative impacts of wetland restoration and invasive cordgrass eradication would be limited.

The potential for uncoordinated tidal restoration to generate irreversibly large populations (and uncontrollably large seed output) could occur within a decade after tidal restoration. This estimate is roughly consistent with observed changes in the spread and dominance of Atlantic smooth cordgrass in San Francisco Bay from 1990 when focused scientific studies of the invasion were first published (Callaway 1990) to 2002, and quantitatively estimated rates of smooth cordgrass invasions in Willapa Bay (Feist and Simenstad 2000), and assessments of San Francisco Bay's vulnerability to invasion by non-native cordgrasses (Daehler and Strong 1996).

The geographic distribution of tidal marsh restoration would have cumulative effects with the Control Program equal to sequencing. If tidal marsh restoration is geographically concentrated around the centers of distribution of the Estuary's invasive cordgrasses (e.g. San Bruno, Hayward Shoreline, Corte Madera) prior to adequate control, the feasibility of subsequent control would be low, and impacts of control would be high. If tidal marsh restoration is initially geographically concentrated in areas of low contemporary invasion rates (e.g. south of Mowry Slough and Palo Alto, nearly all of San Pablo Bay), feasibility of control would be high, and impact would be relatively low. The high degree of subsidence (low initial elevation for tidal restoration) in the Santa Clara Valley also constrains the "window" for efficient and successful tidal restoration in the South Bay (Siegel and Bachand 2002).

IMPACT CUM-1: Effects of Wetland Restoration Projects on Spread of Non-native Cordgrass

Proposed wetland restoration projects could accelerate the spread of non-native cordgrass, which, in turn, could interfere with the effectiveness of the Control Program. This would result in significant and adverse effects on Estuary biological resources, hydrology, and geomorphology.

MITIGATION CUM-1: The potential for cumulative impacts may be reduced by implementing the following: The Coastal Conservancy and US Fish and Wildlife Service shall internally review each proposed wetland restoration project other than control to assure that they are properly sequenced with cordgrass treatment and do not contribute to the increased spread of invasive cordgrass to newly restored wetlands. In addition the ISP/Coastal Conservancy and USF&WS shall encourage all agencies with permitting authority to utilize their discretion to assure proper sequencing of restoration projects with the Control Program.

Aquatic and Wetland Weed Control

There are no other systematic or resource agency-sponsored control or eradication programs for any of the other invasive non-native plants of the San Francisco Estuary. The most serious invader of brackish tidal marshes, broadleaf (perennial) pepperweed is not yet subject to systematic, regional control efforts, as it is in some interior agricultural/rangeland areas in western states. Local, independent control efforts for this species are limited to volunteer manual removal, and attempts at using salinity variation to limit its seed set or growth. A regional control program for this species could be possible in the future because of the severity of its impacts to brackish marshes and endangered species (Goals Project 1999, Baye et al. 2000), but none has yet been proposed, and none is currently foreseeable.

The aquatic weed control projects of the Delta are primarily freshwater weeds with relatively weak hydrologic or ecological linkage to the tidal marshes of San Francisco Bay and the few North Bay sites where cordgrass eradication projects could occur. Egeria (*Egeria densa*) and water-hyacinth (*Eichhornia crassipes*) infestations (submerged and floating freshwater weeds, respectively) are also treated with glyphosate and physical removal methods. The impacts of their control projects occur in freshwater river, pond, riparian, and perennial marsh habitats of the Delta (east of Antioch), not intertidal marsh and mudflats of the San Francisco Estuary. The foreseeable extent of aquatic weed control is on the order of 1,000-2,000 acres in the Delta region. Unless aquatic weed control was to spread into Suisun Marsh, it would not likely have significant cumulative interactions with the Control Program. As sea level rises, estuarine salinity gradients would extend east, making this impact increasingly unlikely. The short- and long-term prospects for significant cumulative impacts between interior freshwater weed eradication programs, and the Control Program, would be minimal.

Mosquito Abatement Activities in Tidal Marshes and Diked Baylands

Mosquito Abatement Districts conduct survey and mosquito control operations in all nine Bay Area counties, and in practically all tidal marshes. Many survey and ground-level control operations are aimed at detecting and mitigating mosquito production in poorly drained portions of tidal marshes. This occurs year-round. Most ground-level actions depend on the use of amphibious or all-terrain vehicles (primarily the Argo) to travel across tidal marsh plains. The impacts of marsh vehicle tracks and ditching due to mosquito abatement work are likely to overlap with similar cordgrass eradication impacts.

The geographic distribution of mosquito abatement activities covers the entire Estuary, which is far more extensive than that of the Control Program. Mosquito abatement vehicle use and trampling damage is unevenly distributed in tidal marshes. Well-drained tidal marshes (marshes with extensive channel networks, or low-elevation cordgrass marshes) produce few or no mosquitoes, and are seldom or never subject to mosquito abatement vehicles. Relatively high-elevation tidal marshes with locally obstructed drainage (such as pickleweed plains with small salt pans or waterlogged, incipient pans) are subject to frequent vehicle access. Atlantic smooth cordgrass invasions occur most frequently in sheltered mudflats, low-elevation salt marsh, and channel banks, which are well-drained and poor mosquito habitat. However, the two may coincide. All invasive cordgrass species in San Francisco Estuary can also occur in the vicinity of poorly drained high marsh, which may be needed for access by vehicles used in eradication operations. Therefore, there could be a small potential for compound vehicle trampling damage to occur to marsh plain vegetation where both mosquito abatement and cordgrass eradications coincide. These would most likely occur along the East Bay salt marshes, from San Leandro to Newark.

Almost all mosquito abatement operations in tidal marshes of the San Francisco Estuary rely on biological or physical control methods; chemical pesticide spraying in tidal marshes generally is prohibited. Ditching, insect pathogens (bacterial strains such as *Bacillus thuringiensis israeliensis*), and insect "hormones" (growth regulators; such as Altosid, that prevent sexual maturation) are the methods used to control salt marsh and diked wetland mosquitoes in the Bay region. Because mosquito abatement districts spray non-insecticide agents in tidal marshes instead of synthetic chemical pesticides, the risk of compound, cumulative impacts among insecticide and herbicide (glyphosate) applications would be very low or non-existent.

IMPACT CUM-2: Cumulative Damage to Marsh Plain Vegetation

The risk of significant damage to marsh plain vegetation from cumulative vehicle damage would be relatively low, but could occur in rare cases.

MITIGATION CUM-2: Mosquito abatement operations in tidal marshes of the San Francisco Estuary generally rely upon biological or physical vector control methods where practicable. Synthetic chemical pesticide applications (such as resmethrin) in tidal marshes are limited, and used only as appropriate on a site-specific basis. Ditching, insect pathogens (bacterial strains such as *Bacillus thuringiensis israeliensis*), naturally-derived pesticides (such as pyrethrin), and insect "hormones" (growth regulators; such as Altosid, that prevent sexual maturation) are the main methods used to control salt marsh and diked wetland mosquitoes in the Bay region. Because the bulk of vector control operations undertaken by mosquito abatement districts rely upon non-insecticidal agents in tidal marshes or limited amounts of naturally-derived or synthetic chemical pesticides, the risk of compound, cumulative, synergistic impacts among insecticide and herbicide (glyphosate) applications would be very low or non-existent.

4.0 EVALUATION OF PROJECT ALTERNATIVES

4.1. COMPARISON OF ALTERNATIVES

There is a strong contrast in the comparisons of alternatives from the perspectives of long-term versus short-term environmental consequences. Normally, with private development or public works projects, the "no action" alternative is associated with more environmentally benign protection or conservation of existing natural resources. In this case, the existing natural resources are undergoing long-term degradation because of "biological pollution" caused by non-native invasive cordgrass species.

Alternatives 1 and 2 (Regional Eradication Using All Available Control Methods and Regional Eradication Using Only Non-chemical Control Methods, respectively; **Table 4-1**) clearly cause significantly more adverse short-term, acute, direct, and indirect environmental impacts than the no-action Alternative 3 (Continued Uncoordinated Treatment), which would have lesser, but still potentially significant treatment impacts. The short-term impacts of Alternatives 1, 2, and 3 are the inevitable consequences of eradication methods that devegetate tidal wetlands invaded by non-native cordgrass. Alternatives 1 and 2, and to a lesser extent Alternative 3 eliminate or displace the wildlife that inhabit them, and cause significant short-term side effects from operation of vehicles and equipment. Alternatives 2 and 3 may have less short-term, acute, direct, and indirect impact than Alternative 1 because it excludes impacts related to application of aquatic herbicides, such as operation of helicopters and vehicles, and risk of spray drift, overspray and accidental spillage. However, if chemical eradication methods are selected and used in accordance with the Program Approach described in Alternative 1(mostly as a secondary treatment following mechanical treatment), the potential impacts from Alternative 1 would be reduced from compared with impacts from repeated physical eradication methods that may be necessary under Alternative 2. Thus, Alternative 2 could prolong wetland degradation and ultimately exceed the net impact of combined use of manual, mechanical, and chemical methods proposed in Alternative 1. Alternative 3's lack of coordination would exacerbate this impact, compared with Alternative 2.

Alternative 2 also has a higher risk of failure to control and eventually eradicate invasive cordgrasses compared to Alternative 1. If Alternative 2 failed to control these invasives, it eventually would result in the same long-term environmental consequence as described below for Alternative 3. Alternative 3's lack of regional coordination would allow the continued and increasing spread of Atlantic smooth cordgrass. This would result in diminishing local control effectiveness and increasing local costs for non-native cordgrass "maintenance" control over time. Probably within one to two decades, only flood control and navigation interests would have incentives and resources to combat overwhelming invasion rates of Atlantic smooth cordgrass hybrids, especially if

Table 4-1. Description of Project Alternatives Considered in This EIS/R

Alternative	*Description*
1	Regional Eradication Using All Available Control Methods
2	Regional Eradication Using Only Non-Chemical Control Methods
3	No Action – Continued Limited, Regionally Uncoordinated Treatment

tidally restored salt ponds generate vast new hybrid populations and seed sources. Alternative 3A, therefore, would result in the same long-term regional wetland quality degradation as Alternative 3B, but would have the added short-term treatment impacts.

Assuming that both Alternatives 1 and 2 could achieve the project objectives, the following is a comparison of environmental consequences of the project alternatives as they relate to several pivotal issues.

4.1.1 Tidal Marsh Restoration

Under Alternative 1, and possibly under Alternative 2, the original restoration objective of native tidal marsh vegetation structure and composition would be supported, and probably could be achieved within 50 to 100 years in many locations. Under Alternatives 3A and 3B, all San Francisco Bay salt ponds restored to tidal marsh eventually would be dominated exclusively by hybrid Atlantic smooth cordgrass, at least for several hundred years. After that time, there might be a possibility that a habitat similar to the Estuary's native upper marsh habitat could evolve.

4.1.2 California Clapper Rails

Under Alternatives 1 and 2, assuming that successful strategies were implemented to integrate clapper rail conservation and invasive cordgrass eradication, clapper rails would endure short-term impacts, and would gain the long-term benefits of native habitat structure and composition from tidal marsh restoration. Under Alternatives 3A and 3B, as large acreages of tall cordgrass habitat increase, California clapper rail populations would likely benefit in the short term and be significantly adversely impacted in the long-term (next 50 to 75 years). However, the integrity of the distinctive California subspecies' behavioral adaptations likely would be lost as rails evolved and adapted to the new Atlantic-type marsh environment. Also, the Atlantic marsh habitat type, as it matured within the limited size of Pacific estuaries, would likely become only marginally supportive of clapper rails.

4.1.3 Other Endangered Wildlife and Plants

The conservation or recovery of a number of plant and wildlife species of concern would probably be feasible under successful implementation of Alternatives 1 and 2. Under Alternatives 3A and 3B, the tidal habitats of the salt marsh harvest mouse would be variously degraded or eliminated by invasive non-native cordgrass, particularly Atlantic smooth cordgrass. Native Pacific cordgrass would become jeopardized, and eventually extinct. The recovery of California sea-blite in San Francisco Bay would be precluded, and many plant and wildlife species of concern would probably become jeopardized.

4.1.4 Shorebirds and Waterfowl

Permanent and interim tidal flat habitats of migratory waterbirds would be protected under successful implementation of Alternatives 1 and 2. Under Alternatives 3A and 3B, migratory shorebirds and waterfowl of the Pacific Flyway would be impacted by long-term reduction in tidal flat habitat in San Francisco Bay, and eventually in other critical stopovers in the Pacific Flyway in this region, such as Tomales Bay and Drakes Estero. Interim benefits of the mudflat phase of tidal marsh succession in restored salt ponds would be quickly lost.

4.2. NEPA ENVIRONMENTALLY PREFERRED ALTERNATIVE

The agencies understand Alternative 1 to include impacts of the efficient use of the variety of physical removal methods and judicious and minimized use of herbicides within a coordinated regional strategy. The Federal lead agencies conclude that Alternative 1 is most likely to achieve long-term protective benefits for California's estuarine environments, and the most favorable ratio of environmental costs to benefits. Therefore, Alternative 1 is identified as the NEPA environmentally preferable alternative. Alternative 1 is most likely to result in the greatest overall (net) environmental benefits in the long-term, despite greater short-term impacts compared with Alternative 3, and more likely to achieve the project objectives than Alternative 2, with little additional environmental risk. These short-term impacts can be further reduced by implementation of mitigation measures identified in this EIS/R. If only short-term impacts of the project itself were evaluated, or if they were attributed much greater weight in evaluating the public interest compared with long-term benefits, then Alternative 3 (no action) would be environmentally superior.

4.3. CEQA ENVIRONMENTALLY SUPERIOR ALTERNATIVE

CEQA Guidelines (Section 15126.6(a) and (e)(2)) require that an EIR's analysis of alternatives identify the "environmentally superior alternative" among all of those considered. In addition, if the No Project Alternative is identified as environmentally superior, then the EIR also must identify the environmentally superior alternative among the other alternatives. As described above, because the project is, in effect, an environmental restoration and protection project, its primary adverse impacts are short-term, during the treatment process. The No Project Alternatives (3A and 3B) would eliminate these short-term impacts, but would also forego the longer-term environmental benefits of the project. As described in Section 4.1.2, above, Alternative 2 could have somewhat less environmental impacts than Alternative 1 because it would exclude impacts related to application of aquatic herbicides.. However, these reduced impacts could be offset by the need for additional mechanical treatment if chemicals are not used, and by the potential impacts resulting from repeated treatment under Alternative 2. In addition, Alternative 2 also has a lower probability of achieving the project's ultimate environmental benefits than Alternative 1. Therefore this EIR considers the CEQA Environmentally Superior Alternative to be a modified version of Alternative 1 in which all mitigations in this EIS/R have been incorporated into the program. This is identified as the Mitigated Project Alternative. It should be noted, however, that despite mitigation, some significant adverse impacts would remain under this Alternative, as with Alternatives 1 and 2.

Under CEQA, the goal of identifying the environmentally superior alternative is to assist decision-makers in considering project approval. CEQA does not, however, require an agency to select the environmentally superior alternative (CEQA Guidelines Sections 15042-15043).

4.4. UNAVOIDABLE SIGNIFICANT ADVERSE IMPACTS

Biological Resources

Alternatives 1 and 2 would result in significant unavoidable short-term impacts to the salt-marsh harvest mouse, tidal shrew, California clapper rail, California black rail, (Impacts BIO-4.1, BIO-5.1, and BIO-5.2). Alternative 3 would reduce the short-term unavoidable impacts on these species, but would result in long-term unavoidable adverse impacts on them.

Visual Resources

Alternatives 1 and 2 would result in significant unavoidable short-term impacts to visual quality of treated marshes (VIS-1). Alternative 3 would reduce the short-term unavoidable impacts on visual quality, but would result in long-term unavoidable adverse impacts on this resource.

5.0 ENVIRONMENTAL COMPLIANCE

The following environmental laws and regulations are applicable to implementation of the proposed action.

5.1 APPLICABLE FEDERAL LAWS, REGULATIONS, EXECUTIVE ORDERS, AND APPROVALS

5.1.1 National Environmental Policy Act (42 U.S.C. 4321 *et seq.*)

This programmatic Environmental Impact Statement/Report (EIS/R) was prepared pursuant to regulations implementing the National Environmental Policy Act (NEPA). NEPA affects federally authorized projects. It was established to ensure that Federal projects or decisions incorporate considerations of environmental consequences into the decision-making process. NEPA establishes a process for input by affected parties through public noticing and scoping. This input is considered when analyzing a reasonable range of alternatives in an Environmental Assessment (EA) or EIS. The Notice of Intent (NOI) is included in **Appendix A**. When all key permits are obtained and the final EIS/R is released, a Record of Decision (ROD) will be filed.

5.1.2 Clean Water Act (33 U.S.C. 1252 *et seq.*)

The Clean Water Act (CWA) was enacted to restore and maintain the chemical, physical, and biological integrity of U.S. waters through the elimination of discharges of pollutants. Among other things, the CWA provided that continuing (point-source) pollutant discharges could not occur unless specifically authorized by permit, and it established permit programs for various forms of discharges, including the discharge of dredged materials. The main sections of the CWA that apply to dredging and dredged material disposal are Sections 401 and 404.

CWA Section 401

The Act requires Section 401 Certification that the permitted discharges of dredged or fill material comply with State water quality standards for actions within State waters or Federal water quality criteria for offshore waters. The State is required to establish water quality standards for all State waters including the territorial sea under Section 301 of the CWA. Compliance with Section 401 is provided by approval of a Water Quality Certification or waiver from the State Water Resources Control Board (SWRCB) or Regional Water Quality Control Board (RWQCB), and is a condition for issuance of a Section 404 permit, discussed below.

CWA Section 402

This section of the Act requires that the permitted project comply with National Pollutant Elimination Discharge System (NPDES) requirements. The State is required to establish waste discharge standards for all State waters, including the territorial sea under Section 301 of the CWA. Compliance with Section 402 is provided by approval of a NPDES permit from the SWRCB and RWQCB.

CWA Section 404

Section 404 of the Clean Water Act (33 U.S.C. §1344) generally requires a Corps of Engineers permit for the discharge of dredged or fill material into waters of the United States, including adjacent wetlands. The Corps' decision whether to issue a CWA Section 404 permit is based on an evaluation of the probable impacts on the public interest as stated below for Section 10 of the Rivers and Harbors Act as well as on application of the guidelines promulgated by EPA, otherwise referred to as the Section 404(b)(1) guidelines (40 CFR, Part 230). These guidelines require that the following four conditions be met before a Section 404 permit may be issued:

(1) There is no other practicable alternative that would have less adverse impact on the aquatic environment;

(2) The disposal, after consideration of dispersion and dilution, will not cause or contribute to violations of applicable water quality standards; will not violate any applicable toxic effluent standards; nor will it jeopardize the continued existence of threatened or endangered species; nor will it violate any requirement to protect marine sanctuaries;

(3) The disposal will not cause or contribute to significant degradation of waters of the United States; and

(4) All appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic environment (Reference 40 CFR 230.10).

The Corps can authorize regulated activities in its jurisdiction by individual or general permits. Individual (standard) Corps permits are specific to particular projects; general Corps permits apply to classes of activities Regional permits and Nationwide permits are types of general permits, and have the same basic restrictions. General permits can apply only to actions that have minimal cumulative and individual environmental impacts, as determined by the Corps. Once a Regional permit is issued, actions that fully comply with all of its conditions are authorized for up to 5 years. The Corps retains discretion to override general permits and require standard individual permits for some regionally authorized activities on a case-by-case basis. This usually occurs only if there is a reasonable indication that a particular regionally permitted action may have impacts that are substantially greater than minimal.

General permits require full environmental evaluation and public notice for the permit itself, but not for individual actions within its scope. Some Regional and Nationwide permits have "reporting requirements", which involve some pre-project notification and review by the Corps (and/or natural resource agencies) to allow fine-tuning of conditions to ensure reduction of overall impacts to a minimum. To avoid "piecemealing" of regulated activities in permit review, the Corps normally requires that portions of an overall project that are reasonably related be included in the same permit application. Some Nationwide permits that have "independent utility" can be combined with other permits, but full environmental review of the whole scope of a regional permit program is required prior to authorization.

The ISP treatment methods include many actions that would be regulated by the Corps under the Clean Water Act, Section 404 (mechanical removal techniques that involve excavation and backfill of sediment in tidal areas) and Rivers and Harbors Act, Section 10 (impounding tidal waters locally, placing stakes in tidal areas below Mean High Water). Even activities that may not be regulated by the Corps (such as crushing vegetation by driving tracked amphibious vehicles over it, mowing, herbicide treatment, or covering with fabric) would be considered by the Corps in its evaluation of overall cumulative impacts of the project

The ISP will apply to the Corps for a Regional Permit to cover all categories of Corps regulated Spartina treatment activities documented in the EIS/R to have minimal impacts in a complete, programmatic way. Developing and finalizing such a permit may take several months to greater than a year. For control projects initiated prior to issuance of a regional permit, the ISP will provide site-specific plans to the Corps for these projects, and request that they be authorized under appropriate Nationwide permits (e.g., NWPs 27 "Stream and Wetland Restoration Activities," 5 "Scientific Measurement Devices," 33 "Temporary Construction, Access and Dewatering," 31 "Maintenance of Existing Flood Control Facilities," and 6 "Survey Activities") or other mechanism.

5.1.3 Rivers and Harbors Act (33 U.S.C. 403, Section 10)

Section 10 of the Rivers and Harbors Act of 1899, authorizes the USACE to regulate virtually all structures or work within navigable waters of the United States (see 33 CFR Part 328.3 for definition of navigable waters). Virtually all projects in navigable waters must comply with Section 10, however the USACE does not issue Section 10 permits to itself for federally authorized projects. This programmatic EIS/R describes potential effects of the proposed action on wetlands and other waters.

5.1.4 Endangered Species Act (16 U.S.C. 1531 *et seq.*)

The Endangered Species Act of 1973, as amended (ESA) establishes a national program for the conservation of threatened and endangered species and the preservation of the ecosystems upon which they depend. Consultation with and an opinion statement from the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) are required under Section 7 of this Act. Section 7(a) of the ESA further prohibits Federal agencies from jeopardizing the continued existence of listed and proposed species, and it requires Federal agencies to implement conservation programs for listed species. Section 9 of the Act prohibits the taking of listed species without authorization from the USFWS or NMFS. This EIS/R describes the potential programmatic effects of the proposed action on special status species. Consultation with the USFWS will evaluate measures to bring adverse effects to a level of "not likely to adversely affect." The USFWS will forward a concurrence determination on applicable special status species to NMFS.

5.1.5 Migratory Bird Treaty Act (16 U.S.C. 703 *et seq.*) and Executive Order 13186

The Migratory Bird Treaty Act (MBTA) governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent overutilization. Further, the MBTA prohibits the take, possession, import, export, transport, selling, purchase, barter, or offering for sale, purchase or barter, any migratory bird, their eggs, parts, and nests, except as authorized under a valid permit (50 CFR 21.11). Certain exceptions apply to employees of the Department of the Interior to enforce the MBTA and to employees of Federal agencies, State game departments, municipal game farms or parks, public museums, public zoological parks, accredited institutional members of the American Association of Zoological Parks and Aquariums (now called the American Zoo and Aquarium Association) and public scientific or educational institutions.

Executive Order (EO) 13186 (effective January 10, 2001), outlines the responsibilities of Federal agencies to protect migratory birds, in furtherance of the MBTA, the Bald and Golden Eagle Protection Acts, the Fish and Wildlife Coordination Act, ESA, and NEPA. This EO specifies the following:

- The USFWS as the lead for coordinating and implementing EO 13186;
- Requires Federal agencies to incorporate migratory bird protection measures into their activities;
- Requires Federal agencies to obtain permits from the USFWS before any "take" occurs, even when the agency intent is not to kill or injure migratory birds;
- Requires a Memorandum of Understanding (MOU) between the Federal agencies within two years from the inception of EO 13186 (January 10, 2003);
- Outlines migratory bird protection specifications that are to be included in MOUs;
- Encourages Federal agencies to immediately begin implementation of the elements required by the USFWS to be included in MOUs;
- Requires the USFWS to develop a schedule for completion of the MOUs within 180 days from the signing of EO 13186; and
- Requires Federal agencies to notify the public of the availability of its MOU in the *Federal Register*.

5.1.6 Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*)

This Act prohibits taking or harassment of any marine mammals except incidental take during commercial fishing, capture under scientific research and public display permits, harvest by Native Americans for subsistence purposes, and any other take authorized on a case-by-case basis as set forth in the Act. The Department of the Interior, USFWS, is responsible for the polar bear, sea otter, marine otter, walrus, manatees, and dugong, while the Department of Commerce, NMFS, is responsible for all other marine mammals.

5.1.7 Federal Clean Air Act (42 U.S.C. Section 7401 *et seq.*, as amended)

The Clean Air Act (CAA) is intended to protect air quality by regulating emissions of air pollutants. The CAA requires compliance with State and local requirements and prohibits Federal agencies from engaging in non-conforming activities.

5.1.8 Coastal Zone Management Act (16 U.S.C. 1456 *et seq.*, as amended)

The Coastal Zone Management Act (CZMA) provides for the development and implementation of coastal management programs by the states. The Bay Conservation and Development Commission's (BCDC) coastal management program for the Bay, which was approved in 1977, is based on the provisions and policies of the McAteer-Petris Act, the Suisun Marsh Preservation Act of 1977, the San Francisco Bay Plan, the Suisun Marsh Protection Plan, and its administrative regulations. Under the CZMA, Federal agencies are required to carry out their activities and programs in a manner consistent with BCDC's coastal management program. To implement this provision, Federal agencies make *consistency determinations* regarding proposed Federal activities while applicants for Federal permits or licenses, or Federal financial assistance make *consistency certifications*. BCDC reviews these determinations and certifications, and concurs or objects based on a proposal's consistency with its laws and policies.

5.1.9 Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*)

The Fish and Wildlife Coordination Act (FWCA) provides a procedural framework for the consideration of fish and wildlife conservation measure in Federal and federally permitted or licensed water development projects. When a water body is proposed to be controlled or modified by a Federal agency or by any public or private entity under Federal permit or license, the Federal lead agency must consult with and consider the recommendations of the USFWS, the California Department of Fish and Game (CDFG) (in California) and, for projects affecting marine fisheries, NMFS. The FWCA is applicable to ACOE and EPA evaluation of CWA Section 404 and the Marine Protection, Research, and Sanctuaries Act (MPRSA) Section 103 permits. However, because the USFWS is the Federal lead agency for this EIS/R, they will coordinate pursuant to this Act.

5.1.10 Magnuson-Stevenson Fishery Conservation and Management Act

Prior to completion of the project, the USFWS has a statutory requirement under Section 305(b)(4)(B) of the Magnuson-Stevenson Fishery Conservation and Management Act (MSFCMA) to consult with NMFS with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect essential fish habitat (EFH).

5.1.11 National Historic Preservation Act (16 U.S.C. 470 *et seq.*)

The National Historic Preservation Act (NHPA) protects historic and prehistoric resources from impacts by Federal projects and requires consultation (under Section 106) with the State Historic Preservation Officer (SHPO). Compliance with the NHPA would be necessary for any undertaking. The USFWS, the Advisory Council on Historic Preservation, and SHPO, pursuant to Section 800.13 of the regulations (36 CFR 800.13) implementing Section 106 of the NHPA, entered into a Programmatic Agreement (PA) to streamline the cultural resource compliance process for low-impact projects. Applicability of this PA to project activities would be determined depending on project specifics, and the PA would apply only to activities for which the USFWS is the federal lead agency. For the proposed action, a request for cultural resource compliance will be submitted to the Regional Archaeologist, Region 1, in Portland, Oregon.

5.1.12 The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (US Code: Title 7, Chapter 6, Subchapter II),

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) defines the requirements for Federal registration and use of pesticides nationwide. The heart of FIFRA is the regulation of pesticide registration. The role of regulating use falls to individual states when they have developed an EPA Administrator authorized program. FIFRA requires that all applicators follow pesticide label instructions when applying pesticides within the United States.

5.1.13 Executive Order 11990 – Protection of Wetlands

EO 11990 requires Federal agencies to follow avoidance, mitigation, and preservation procedures with public input before proposing new construction in wetlands. This EO directs Federal agencies to avoid to the extent possible long and short-term effects associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Specifically, Federal agencies are directed to:

- Provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities when acquiring, managing, and disposing of Federal lands and facilities; and providing federally sponsored, financed, or assisted construction and improvements, or conducting Federal activities and programs affecting land use.

This EO does not apply to the issuance of permits (by Federal agencies), licenses, or allocations to private parties for activities involving wetlands on non- Federal property.

5.1.14 Executive Order 11988 – Floodplain Management

This EO directs Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. Specifically, Federal agencies are directed to:

- Provide leadership and take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for acquiring, managing, and disposing of Federal lands and facilities, providing federally sponsored, financed, or assisted construction and improvements and conducting Federal activities and programs affecting land use.

This EIS/R describes the potential effects of the proposed actions on floodplains.

5.1.15 Executive Order 13112 – Invasive Species

The National Invasive Species Management Plan was developed in response to EO 13112 in 1997. This EO established the National Invasive Species Council (Council) as the leaders in development of the plan. It directs the Council to provide leadership and oversight on invasive species issues to ensure that Federal activities are coordinated and effective. In addition, the Council has specific responsibilities including: promoting action at local, State, tribal, and ecosystem levels; identifying recommendations for international cooperation; facilitating a coordinated network to document, evaluate, and monitor invasive species' effects; developing a web-based information network on invasive species; and developing guidance on invasive species for Federal agencies to use in implementing NEPA. The Council is comprised of the Secretaries of Agriculture, Commerce, Interior, Treasure, Defense, Transportation, State, and the Administrator of the EPA, and they have developed nine plan priorities, that provide direction for Federal agencies. The plan priorities are as follows:

- Leadership, coordination, and development of State and Federal partnerships

- Prevention (a risk-based approach)
- Early detection and rapid response
- Control and Management
- Restoration
- International Cooperation
- Research
- Information Management
- Education and Public Awareness

The proposed project would implement the San Francisco Estuary Invasive *Spartina* Project (ISP), which is a regionally coordinated approach to controlling, or eradicating, populations of non-native *Spartina* in San Francisco Bay. Although there is no formal international cooperation taking place on this issue, the Federal and State lead agencies have shown that the proposed project is consistent with the plan by:

- Providing effective leadership in development of the ISP,
- Determining prevention measures to curtail further spread,
- Coordinating with researchers at the San Francisco Estuary Institute, UC Davis, and Bodega Marine Lab, to develop early detection methods and rapid response techniques,
- Conducting experiments to determine effective control and management techniques,
- Developing a preliminary approach to restoration following control,
- Establishing working relationships with researchers to further understand the biology and ecology of the target species,
- Creating an archive of data and reports, and serving as a clearinghouse for information regarding *Spartina* biology and ecology and the efficacy of control efforts in California and elsewhere, and
- Developing and implementing a public education and public awareness program.

Additional details regarding this plan can be found at the following Internet address: http://www.invasivespecies.gov/council/.

5.1.16 Executive Order 12898 – Environmental Justice in Minority and Low Income Populations

The objectives of EO 12898 include identification of disproportionately high and adverse health and environmental effects on minority and low-income populations that could be caused by a proposed Federal action. Accompanying EO 12898 was a Presidential Transmittal Memorandum that referenced existing Federal statutes and regulations, including NEPA, to be used in conjunction with the EO. The EIS/R analyzes the environmental, social, and economic impacts on minority and low-income populations and complies with this EO.

5.1.17 Indian Trust Assets, Indian Sacred Sites on Federal Land – Executive Order 13007, and American Indian Religious Freedom Act of 1978

These laws protect Indian Trust Assets; accommodate access and ceremonial use of Indian sacred sites by Indian religious practitioners, and avoid adversely affecting the physical integrity of such sacred sites; and protect and preserve the observance of traditional Native American religions, respectively. Compliance with these laws, regulations, and Executive Orders is the responsibility of the federal land manager. The USFWS' Regional Cultural Resources Office would be available to provide assistance in the review the proposed action for potential effects on cultural resources of Native Americans.

5.2 APPLICABLE STATE LAWS, REGULATIONS, AND POLICIES

5.2.1 California Environmental Quality Act (P.R.C. 21000-21177)

The California Environmental Quality Act (CEQA) contains requirements similar to NEPA and requires the preparation of an EIR prior to implementation of applicable projects. CEQA requires significant impacts to be mitigated to a level of insignificance or to the maximum extent feasible, and that less damaging alternatives be considered. The State or local lead agency is responsible for CEQA compliance.

5.2.2 Porter-Cologne Water Quality Control Act (C.W.C. Section 13000 *et seq.*; C.C.R. Title 23, Chapter 3, Chapter 15)

This Act is the primary State regulation addressing water quality and waste discharges (including dredged material) on land. The Act's requirements are implemented by the SWRCB at the State level, by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) in the Bay Area, and by the Central Valley Regional Water Quality Control Board (CVRWQCB) in the Delta. The dividing line between the SFBRWQCB and the CVRWQCB is in the vicinity of Chipps Island in Suisun Bay. Additionally, the SWRCB requires a Permit to Appropriate Water for actions including diversion of surface waters to non-riparian land or for seasonal storage of unappropriated surface waters.

5.2.3 California Endangered Species Act (Fish and Game Code Section 2050 *et seq.)*

This Act provides for recognition and protection of rare, threatened, and endangered plants and animal species. The Act requires State agencies to coordinate with the CDFG to ensure that State authorized/funded projects do not jeopardize a listed species. The Act prohibits the taking of a listed species without authorization from the CDFG.

5.2.4 McAteer-Petris Act

The McAteer-Petris Act, first enacted in 1965, created BCDC to prepare a plan to protect the Bay and shoreline and provide for appropriate development and public access. The McAteer-Petris Act directs BCDC to issue or deny permit applications for placing fill and extracting materials, or changing the use of any land, water, or structure within its jurisdiction, which includes the Bay, shoreline band, saltponds, managed wetlands, and certain waterways. Such permits are issued or denied in accordance with the provisions of the McAteer-Petris Act and Suisun Marsh Preservation Act, and the policies of the San Francisco Bay Plan (Bay Plan) and the Suisun Marsh Protection Plan. The shoreline development aspect of the McAteer-Petris Act ensures that prime shoreline sites are reserved for priority uses, such as ports, water-related industry, airports, wildlife refuges, and water-related recreation. The Act also ensures that public access to the Bay is provided to the maximum extent feasible for each development project, and that shoreline development projects are designed in an attractive and safe manner. Under the CZMA, Federal agencies are required to carry out their activities and programs in a manner consistent with BCDC's coastal management program.

The Bay Plan was adopted in 1968, signed by the California Legislature in 1969, and has been implemented with several amendments by BCDC. The Bay Plan established the framework for a permit program that provides for protection of the Bay and its natural resources, as well as development of the Bay and shoreline while minimizing the amount of fill. Several relevant Bay Plan policies are summarized below.

Dredging Policies of the Bay Plan

Dredging and dredged material disposal should be conducted in an environmentally and economically sound manner. Dredging should be authorized when the Commission can find that the dredging is needed to serve a water-oriented use or other important public purpose; the materials meet the water quality requirements of the San Francisco Bay Regional Water Quality Control Board; natural resources would be protected; the project will result in the minimum dredging volume necessary; and dredged materials are disposed of properly. Dredging projects should be carefully designed so as not to undermine the stability of any adjacent dikes, fills or fish and wildlife habitats.

Fish and Wildlife Policies of the Bay Plan

The benefits of fish and wildlife in the Bay should be insured for present and future generations of Californians. To this end, remaining marshes and mudflats around the Bay, including water volume, surface area, and freshwater inputs of the Bay should be maintained.

Specific habitats that would prevent the extinction of species, or maintain or increase species populations that would provide substantial public benefits should be protected, whether in the Bay or on the shoreline behind dikes.

Water Quality Policies of the Bay Plan

Bay marshes, mudflats, water surface area. and volume should be maintained and increased wherever possible. Freshwater inputs should also be maintained at a level sufficient to protect Bay resources and beneficial uses. Water pollution should be avoided.

Water quality in the Bay should be maintained at a level that will support and promote beneficial uses of the Bay, as identified in SFBRWQCB's Basin Plan.

Tidal Marshes and Tidal Flats Policies of the Bay Plan

Marshes and mudflats should be maintained to the fullest extent possible, to conserve fish and wildlife, and abate air and water pollution. Activities that eliminate marshes and mudflats should be allowed only for purposes providing substantial public benefits and only if there is no reasonable alternative. These areas should be protected in the same manner as open water areas.

Proposed activities (fills, dikes, piers) should be thoroughly evaluated to determine their effects on marshes and mudflats so as to minimize harmful effects.

Former marshes should be restored, existing marshes should be augmented, new marshes created where appropriate (by selective placement of dredged material), and the quality of existing marshes should be improved whenever possible.

The proposed project would take place in salt marsh and mudflat habitats that are subject to policies of the Bay Plan. Although the proposed project does not involve the import or discharge of fill, some control methods, such as mechanical ripping/shredding would result in a redeposition of sediment due to the ground disturbances associated with equipment. The primary goal of the proposed project is to restore infested marshes to a more natural [native] condition for the benefit of marsh and mudflat-dependent species that prefer or require native marsh habitat. To the extent that the project would restore these habitats over the long-term, the project is consistent with Bay Plan policies.

Findings and Policies 5, 6, and 7 concerning tidal marshes and tidal flats around the Bay were amended in April 2002:

- 5. Any tidal restoration project should include clear and specific long-term and short-term biological and physical goals, and success criteria and a monitoring program to assess the sustainability of the project. Design and evaluation of the project should include an analysis of: (a) the effects of relative sea level rise; (b) the impact of the project on the Bay's sediment budget; (c) localized sediment erosion and accretion; (d) the role of tidal flows; (e) potential invasive species introduction, spread, and their control; (f) rates of colonization by vegetation; (g) the expected use of the site by fish, other aquatic organisms and wildlife; and (h) site characterization. If success criteria are not met, appropriate corrective measures should be taken.
- 6. Non-native species should not be used in habitat restoration projects. Any habitat restoration project approved by BCDC should include a program for the periodic monitoring of the site for non-native species and a program for control and, if appropriate and feasible, eradication should an introduction occur. The use of non-native plant species in public access landscape improvements should be avoided where a potential exists for non-native plants to spread into the Bay, other waterways, or transition zones between tidal and upland habitats.
- 7. BCDC should continue to support and encourage the expansion of scientific information on the arrival and spread of invasive plants and animals, and when feasible, support the establishment of a regional effort for Bay-wide eradication of specific invasive species, such as non-native cordgrasses.

5.2.5 California Pesticide Regulations

The California Department of Pesticide Regulation (CDPR) regulates pesticides though the California Food & Agriculture Code (CFAC), Divisions 6,7 & 13 (Pest Control Operations; Agricultural Chemicals, Livestock Remedies and Commercial Feeds; and Bee Management and Honey Production, respectively). These regulations are at least commensurate with, and generally more stringent than, those described in FIFRA. The California Code of Regulations (CCR) Title 3, Division 6, Chapters 1-4 (Pesticide Regulatory Program, Pesticides, Pest Control Operations & Environmental Protection, respectively), define the specific requirements of pesticide application within the State of California. The State Water Quality Management Agency Agreement (MAA) is an agreement between the State Water Resources Control Board and the State Department of Pesticide Regulation to coordinate the two agencies' efforts to monitor and control herbicide use.

5.2.6 Executive Order W-59-93 - California Wetlands Conservation Policy

In August 1993, the Governor announced the California Wetlands Conservation Policy. The goals of the policy are to establish a framework and strategy that:

- Ensures no overall net loss and achieve a long-term net gain in the quantity, quality, and permanence of wetlands acreage and values in California in a manner that fosters creativity, stewardship, and respect for private property.
- Reduces procedural complexity in the administration of State and Federal wetlands conservation programs.
- Encourages partnerships to make landowner incentive programs and cooperative planning efforts the primary focus of wetlands conservation and restoration.

The EO also directed the California Resources Agency to establish an Interagency Task Force to direct and coordinate administration and implementation of the policy.

The Resources Agency and the departments within that agency generally do not authorize or approve projects that fill or harm wetlands. Exceptions may be granted for projects meeting all the following conditions: the project is water-dependent; there is no other feasible alternative; the public trust is not adversely affected; and the project adequately compensates the loss.

5.2.7 State Lands Commission Policies

California became a State on September 9, 1850, and thereby acquired nearly 4 million acres of land underlying the State's navigable and tidal waterways. Known as "sovereign lands," these lands included the beds of rivers, streams, and sloughs; non-tidal lakes; tidal navigable bays and lagoons; and tidal and submerged lands adjacent to the entire coast and offshore islands of the State from mean high tide line to 3 nautical miles offshore. These lands are managed by the California State Lands Commission (SLC). The State's interest in these lands consists of sovereign fee ownership, or a Public Trust easement implicitly retained by the State over sovereign lands sold into private ownership. They can only be used for public purposes consistent with the provisions of the Public Trust, such as fishing, water-dependent commerce and navigation, ecological preservation, and scientific study. Use of these lands for dredging and dredged material disposal activities, may require written authorization from the SLC. Some of the alternative project components under consideration in this EIS/R may be subject to the jurisdiction of the SLC. Therefore, coordination with the SLC will be fulfilled when required for a specific project. Public and private entities may apply to the SLC for leases or permits on State lands for many purposes. Therefore, coordination with the SLC would be necessary.

5.2.8 California Clean Air Act

The California Air Resources Board (CARB) and local air districts are responsible for developing clean air plans to demonstrate how and when California will attain air quality standards established under both the Federal and California Clean Air Acts. For the areas within California that have not attained air quality standards, CARB works with local air districts to develop and implement State and local attainment plans. The local air quality districts in the Bay Area will review the EIS/R and coordinate with the California Coastal Conservancy or the USFWS as the proposed project and specific treatment methods are implemented.

5.3 REGIONAL PLANS AND POLICIES

5.3.1 Baylands Ecosystem Habitat Goals

The San Francisco Bay Area Wetlands Ecosystem Goals Project began in 1995. It was a cooperative effort among nine State and Federal agencies, the EPA, USFWS, NMFS, California Resources Agency, California Coastal Conservancy, CDFG, SFBRWQCB, SWRCB, and BCDC, and nearly 100 scientists. The Project's vision was presented to the public in the Goals Project's final report, the Baylands Ecosystem Habitat Goals Project (Goals Project 1999). The Baylands Ecosystem Habitat Goals were adopted into the Bay Plan. SFBRWQCB uses the goals to evaluate projects that are proposed for permitting and some cities adopted the goals into their local plans. The goals are implemented through cooperative efforts of the agencies and stakeholders.

The principal objective of the Goals Project was to develop a concept for the types, quantities/acres, distribution of wetlands and related habitats needed to restore and sustain a healthy baylands ecosystem. The timeframe for achieving these goals is several decades, and it provides a habitat approach, rather than a species-based approach, although the authors recognize the importance of monitoring individual species that are indicators of ecosystem health. Regional and subregional goals are described in the Goals Project. The regional (Bay-wide) goals are summarized below because the proposed project is expected to occur Bay-wide. Regionally, the goals for restoration are as follows:

- Develop a diverse mosaic of habitats. The mosaic should include large patches of tidal marsh connected by corridors to enable movement of wildlife and birds; complexes of salt ponds managed for resident and migratory shorebirds and waterfowl; extensive areas of managed seasonal ponds, large expanses of managed marsh; continuous corridors of riparian vegetation along tributary streams and rivers; restored beaches, natural salt ponds and other unique habitats; and undisturbed patches of transitional habitats including grasslands, seasonal wetlands, and forested areas (Goals Project 1999).

More specifically, the goals include:

- Restoration of large areas (1,000± acres) of tidal marsh or connected patches centered around existing populations of special status species such as California clapper rail or salt marsh harvest mouse. These areas would encompass salinity gradients that permit movement to alternate areas in response to freshwater flows. Priority sites for this type of restoration would include the Bay margin and specifically, areas adjacent to tributaries where freshwater enters the Bay that provides a diversity of microhabitats such as pans and large channels.
- Re-establish natural transitions from mudflat to marsh, and marsh to uplands, and establish buffers from developed areas to transitional zones.
- Manage former salt ponds (as well as diked agricultural lands no longer in production) for waterfowl and shorebirds. Managed ponds adjacent to important shorebird foraging areas would provide the most benefit to a large number and diversity of species.

The primary goal of the proposed project is to restore infested marshes to a more natural (native) condition for the benefit of marsh- and mudflat-dependent species that prefer or require native marsh habitat. While it is recognized that the proposed project would impact habitats and species within the Bay, large areas of mudflat and intertidal marsh habitat are substantially degraded by the presence of non-native cordgrass, and the decline of these habitats may contribute to the regional decline of several special status and mudflat/marsh-dependent species over time. To the extent that the project would restore these habitats over the long-term, the project is consistent with the Habitat Goals as described in the Goals Project.

5.3.2 Comprehensive Conservation and Management Plan

The Comprehensive Conservation and Management Plan (CCMP) plan was prepared in 1993 as part of the San Francisco Estuary Project. The plan establishes wetland ecosystem goals, a regional wetlands management plan, and geographically focused cooperative efforts to protect wetlands. The CCMP presented strategies to protect and restore the health of the San Francisco Estuary. The plan found that the region's wetlands were subject to uneven protection efforts and called for a coordinated intergovernmental system to ensure maximum protection, restoration, and management of wetlands. BCDC is the lead agency to assist in developing and implementing local wetland protection programs to minimize impacts of urbanization on wetland and agricultural resources. The CCMP presents a blueprint of 145 specific actions to restore and maintain the chemical, physical, and biological integrity of the Bay and Delta.

CCMP Priorities

In August 2001, the priorities of the CCMP were reorganized and refined. The #2 priority is: "Reduce the impact of invasive species on the San Francisco Estuary through prevention, control, eradication and education."

5.3.3 Bay Area Air Quality Management District

Air quality permits are required by State law in the San Francisco Bay Area: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara and the southern portion of Solano and Sonoma counties. Air quality permits are issued by the Bay Area Air Quality Management District (BAAQMD), a regional government agency responsible for controlling air pollution. Situations for which a permit application must be submitted include:

- Construction or installation of new equipment that may cause air pollution;
- Existing equipment operations without a valid Permit to Operate;
- Modification of existing permitted equipment;
- When equipment is transferred from one location to another;
- Installation of abatement equipment used to control emissions.

By granting a permit, BAAQMD indicates that a project or the proposed equipment would meet air quality standards. Both large and small businesses and their activities are covered by BAAQMD rules and regulations. Typical large businesses requiring permits include bulk petroleum operations, refineries, and power plants. Typical small businesses include dry cleaners, gasoline service stations, auto body shops, coating operations and printers. Permits for new or modified facilities must be obtained before construction or use of equipment is initiated.

5.4 LOCAL LAWS, REGULATIONS, AND PERMITS

The lead agencies recognize that counties and cities around the Bay have local policies, ordinances, zoning designations and restrictions, permit requirements, and special districts (i.e., East Bay Regional Park District, mosquito abatement districts, flood control districts, etc.) within their jurisdictional boundaries. While the analyses contained herein are intended to provide sufficient information for most Federal and State permits and approvals, additional information or details regarding the application of treatment methods may be needed by cities, counties, or special districts before *Spartina* control efforts may be implemented at a particular site.

5.5 AGENCY JURISDICTION AND PROJECT APPROVALS

Table 5.5-1 summarizes the agencies with jurisdiction over the proposed project, applicable laws and authorizations or permit approvals needed to implement the proposed project.

Table 5.5-1 Agency Jurisdiction and Project Approvals.

Agency	*Applicable Law or Regulation*	*Authority or Permit Action*
	FEDERAL	
U.S. Environmental Protection Agency	NEPA Clean Water Act (CWA) Clean Air Act (CAA)	NEPA compliance CWA Section 404(b)(1) guidelines compliance CAA Section 309 compliance
U.S. Army Corps of Engineers	Clean Water Act (CWA) Rivers and Harbors Act (RHA)	CWA Section 404 permit and Section 404(b)(1) guidelines compliance RHA Section 10 permit
U.S. Fish and Wildlife Service	Endangered Species Act (ESA) Fish and Wildlife Coordination Act	ESA Section 7 Biological Opinion and Incidental Take Statement
National Oceanic and Atmospheric Aadministration Fisheries (formerly National Marine Fisheries Service)	ESA Marine Mammal Protection Act (MMPA) Magnuson-Stevenson Fishery Conservation and Management Act	ESA and MMPA Section 7 Biological Opinion and Incidental Take Statement
	STATE	
California Coastal Conservancy	California Environmental Quality Act (CEQA)	CEQA compliance and funding approvals
Department of Fish and Game	California Endangered Species Act (CESA) California Public Resources Code (CPRC)	CESA Section 2081 permit CPRC Section 1601 Streambed Alteration Agreement

Agency	*Applicable Law or Regulation*	*Authority or Permit Action*
State Lands Commission	California Public Resources Code (CPRC)	Permits for work on State lands
Air Resources Board	California Clean Air Act	Review EIS/R for compliance with local attainment plans
	REGIONAL	
San Francisco Regional Water Quality Control Board	CWA San Francisco Bay Area Basin Plan	CWA Section 401 certification or waiver CWA Section 402 National Pollutant Discharge Elimination System (NPDES) Permit
San Francisco Bay Conservation and Development Commission	(Federal) Coastal Zone Management Act McAteer-Petris Act	Coastal Development Permit(s)
California Department of Pesticide Regulation (CDPR)	***California Food & Agriculture Code, Divisions 6,7 & 13*** ***California Code of Regulations (CCR) Title 3, Division 6, Chapters 1-4***	***Controls use of pesticides***
	LOCAL	
Air Pollution Control or Mosquito Abatement Districts	Local policies	Permits to use chemical methods or conduct controlled burns
Agricultural Commissioners	Local policies ***and CDPR regulations (see above)***	Authorization or permits for conducting prescribed burns ***Implement Calif. Department of Pesticide Regulations requirements within their respective counties***

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6.0 PUBLIC INVOLVEMENT

In compliance with the National Environmental Policy Act (NEPA), a Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) was published in the *Federal Register* on April 20, 2001 (**Appendix A**). A Notice of Preparation (NOP) for an Environmental Impact Report (EIR) was issued on April 9, 2001 (**Appendix B**). In accordance with the California Environmental Quality Act (CEQA), the NOP was forwarded with the Initial Study (**Appendix C**) to the State Clearinghouse, noticed in regional newspapers, and provided to various agencies, organizations, and interested citizens.

These were the first steps in the environmental scoping process that took place to elicit public input regarding the range of the issues to be addressed in the EIS/R. A formal scoping hearing, designed to solicit public comment on the proposed scope and content of the EIS/R, was held on April 24, 2001 at 7:00 p.m., in the Association of Bay Area Governments' auditorium in Oakland, California.

Future public involvement will include public review of the Draft EIS/R, several public meetings or hearings on the draft document, distribution of the Final EIS/R, and certification hearings before the California State Coastal Conservancy, and possible future hearings or meetings with the approving-bodies of the responsible and trustee agencies with permit authority. Project-specific CEQA review for site-specific invasive cordgrass treatment projects also will afford opportunities for public input and participation via the CEQA process.

6.1 PUBLIC CONCERNS

Several written comments were received in response to the NOP, NOI, and at the EIS/R public scoping meeting. Copies of comment letters are provided in **Appendix D**, and the issues raised in these letters are addressed in the EIS/R. A summary of the verbal and written comments *(in italics)* is provided below, followed by a brief statement of the manner in which these issues are addressed in this document.

6.1.1 Comments Received at the Scoping Hearing

CEQA/NEPA Process

Describe this environmental review process in the context of the previously prepared and certified Program EIS for invasive cordgrass control efforts in Washington State.

The Washington State efforts were carefully reviewed in the development of alternatives and impacts analysis in this document. Environmental analyses prepared for those efforts were reviewed and are referenced in this EIS/R where appropriate.

Wetland Restoration Goals

Discuss the relationship between restoration of diked areas in which mosquito control activities take place and the potential for spread of non-native cordgrasses.

The proposed project would remove non-native cordgrass from wetlands and mudflats in San Francisco Bay. Within creek channels, infestations of non-native cordgrass result in sediment accretion and channel blockage. Ponding of water and stilling of water in existing ponds also would exacerbate these infestations during seasonal low flow periods. Blocked channels and ponded water may enhance conditions for mosquito breeding, which may result in the need for increased mosquito control activities. Restoration of tidal action to diked lands (not a project component) may, over the long-term, reduce the frequency of mosquito abatement activities in some areas since water would not remain ponded following breaching of dikes, and these areas would likely support populations of breeding mosquitoes.

Alternatives

Describe the difference between the Alternatives and the treatment methods or "tools" that will be used to treat populations of non-native cordgrasses.

Alternatives (including treatment methods included and rejected) are described in Chapter 2, *Program Alternatives*, of this EIS/R.

Public Utilities and Facilities

Reducing infestations of non-native cordgrasses is expected to reduce the potential for flooding and flood hazards since infestations of non-native cordgrasses generally results in sediment accumulation and blockage of flood control channels.

This is discussed in Section 3.1, *Hydrology and Geomorphology*, of this EIS/R.

6.1.2 Written Comments Received in Response to the NOP/NOI

U.S. Environmental Protection Agency (EPA), Region IX (letter dated June 4, 2001)

The EPA indicates that it strongly supports the effort to control invasive cordgrass, which it considers to be a threat to the San Francisco Bay Estuary, and that the proposed project appears to be consistent with the goals of the Invasive Species Management Plan (dated January 18, 2001) by the National Invasive Species Council. The EPA also had several specific comments. These are summarized below followed by a brief statement indicating the section of the EIS/R that addresses the comment.

Chemical Control

All pesticides used must be registered with the U.S. EPA.

The project proposes only to use registered chemical products.

Impacts of glyphosate and surfactants must be included in the document.

These impacts are addressed in several sections based on the subject. Section 3.2, *Water Quality*, addresses the impact of these chemicals on water quality, Section 3.3, *Biological Resources*, addresses the toxicity of these chemicals on wildlife and plant species, and Section 3.6, *Human Health and Safety*, addresses the toxicity of these chemicals on humans.

Due to National Marine Fisheries Service (NMFS) concerns over glyphosate use in Washington State, the EPA recommends coordination with NMFS to ensure their concurrence.

NMFS is being consulted and will evaluate the EIS/R during consultation with the US Fish and Wildlife Service (USFWS).

Due to recent court decisions regarding use of pesticides to control aquatic pest species, the EPA recommends that a National Pollutant Discharge Elimination System (NPDES) permit be obtained from the San Francisco Regional Water Quality Control Board.

A NPDES permit will be obtained for the proposed project. Beneficial uses and waste discharge requirements are discussed in Section 3.2, *Water Quality*.

The EIS/R should include a discussion of impacts on non-target species.

These issues are addressed in Section 3.3, *Biological Resources*.

The Conservancy and the USFWS should implement a public outreach program as soon as possible to address public concerns with herbicide use.

This issue is not addressed specifically in the EIS/R, however, the Conservancy has had, and continues to have, an active public education program that includes presentations to local jurisdictions, flood control departments, and others.

Experimental use of non-registered herbicides must be permitted by the U.S. EPA.

No experimentation with non-registered herbicides is proposed as part of the *Spartina* Control Program.

The impact of herbicides on phytoplankton should be discussed in the EIS/R.

This issue is addressed in Section 3.3, *Biological Resources*.

General Comments

The Conservancy and the USFWS should review the Invasive Species Management Plan to ensure the proposed project is consistent with this plan.

Plan consistency is addressed in Chapter 5, *Environmental Compliance*, as well as the various sections of Chapter 3.

Discuss invasive cordgrass control projects from Washington State.

The Washington State efforts were carefully reviewed in the development of alternatives and impacts analysis in this document. Environmental analyses prepared for those efforts were reviewed and are referenced in this EIS/R where appropriate.

Include EPA as an approval agency

The EPA's role is described in Chapter 5, *Environmental Compliance*. While EPA does not have specific permit responsibility for the proposed project activities, it has responsibility for determining NEPA adequacy, the projects' compliance with the Clean Water Act Section 404(b)(1) Guidelines, and Section 309 of the Clean Air Act.

Describe the timeframe for the proposed project.

The timeframe of the proposed project, as described in this document is 10 to 50 years, as described in Chapter 2, *Program Alternatives*, and Section 3.3, *Biological Resources*.

Water Resources

Discuss compliance with water quality management plans and water quality standards.

These issues are addressed in Section 3.2, *Water Quality*.

Discuss beneficial and adverse impacts to water quality, wetlands, and the aquatic ecosystem including impacts on fisheries, and threatened and endangered species.

These issues are addressed in Section 3.2, *Water Quality*, and Section 3.3, *Biological Resources*.

Discuss monitoring programs to be implemented before and after treatment activities to determine impacts on water quality and beneficial uses.

Mitigation measures to protect water quality are discussed in Section 3.2, *Water Quality*.

Discuss impacts to wetlands in the context of Section 404 of the Clean Water Act.

Impacts to wetland biological resources are discussed in Section 3.3 *Biological Resources*. Impacts to wetland hydrology and geomorphology are addressed in Section 3.1, *Hydrology and Geomorphology*. Impacts to wetland water quality are addressed in Section 3.2, *Water Quality*.

Air Quality

Discuss air quality standards, ambient conditions, and impacts to air quality from the proposed project if prescribed burns are proposed.

This issue is addressed in Section 3.4, *Air Quality*.

The EIS/R may need to demonstrate that the proposed project complies with the Clean Air Act, Section 176(c).

Federal Clean Air Act air conformity requirements are addressed in Section 3.4, *Air Quality*.

Species Viability

Evaluate the proposed project in the context of the potential for habitat restoration, habitat fragmentation, habitat connectivity, and cumulative effects on species viability, and include potential impacts on species other than endangered species and species of concern.

Impacts to sensitive and more common species and their habitats, as well as mitigation measures proposed to protect them, are addressed in detail by species in Section 3.3, *Biological Resources*. The issue of species viability and whether the project would threaten the continued existence of listed threatened or endangered species will be determined by the USFWS and NMFS during the Section 7 consultation process.

National Environmental Policy Act

Include a clear description of the project purpose and need, alternatives, impacts, and mitigation measures.

Project purpose and need are described in Chapter 1, *Introduction*. The project description and alternatives are described in Chapter 2, *Program Alternatives*. Impacts and mitigations that would occur under each alternative and with the various treatment methods are discussed in Chapter 3.

Discuss each alternative and the rationale for eliminating alternatives from further consideration.

Alternatives carried forward in the analysis and those eliminated from further review are described in Chapter 2, *Program Alternatives*.

Funding and Administration

Summarize the funding, implementation, and monitoring commitments of the proposed project.

This issue is addressed in Chapter 2, *Program Alternatives*.

Native American Heritage Commission (letter dated April 16, 2001)

The Commission recommends three actions for potential impacts that may result from site-specific projects. These are: conduct a records search, prepare and submit a records search report or Phase I field survey report to the applicable Information Center, and contact the Commission if a Sacred Lands File Check or Native American consultant is needed to assist in implementing mitigation measures or monitoring.

These issues are addressed in Section 3.9, *Cultural Resources*.

City of Alameda, California (letter dated May 10, 2001)

Air Quality

The City identifies a variety of sensitive receptor populations such as residences, schools, and the like within one-quarter mile from San Francisco Bay and San Leandro Bay, and recommends including a discussion of impacts in the EIS/R.

A specific analysis of these sensitive receptors is beyond the scope of the program-level EIS/R. However, general impacts to sensitive receptors are addressed in Sections 3.4, *Air Quality* and 3.6, *Human Health and Safety*.

Biological Resources

Discuss impacts on Bay waters, vegetation, nursery habitats, and spawning grounds for aquatic species, including fisheries species. Discuss impacts to endangered least terns, eelgrass beds, the endangered California clapper rail and its habitat. Discuss impacts on common marine fish, crustacean, and bird species.

These issues are addressed in Section 3.3, *Biological Resources*.

Discuss impacts to wetlands and lagoons.

These issues are addressed in Sections 3.1 *Hydrology and Geomorphology*, 3.2 *Water Quality*, and 3.3 *Biological Resources*.

Include a Biological Assessment of the treatment sites around the City of Alameda.

A detailed discussion of specific treatment sites is beyond the scope of this program-level EIS/R. However, general impacts on biological resources of various possible treatment methods on various habitat types, including those present in Alameda, are addressed in Section 3.3, *Biological Resources*.

Evaluate impacts of chemical treatments on the former Alameda Naval Air Station, a designated National Priorities List site.

A detailed discussion of specific treatment sites is beyond the scope of this program-level EIS/R. However, general impacts of chemical methods are discussed in Sections 3.2, *Water Quality*, 3.3 *Biological Resources*, and 3.6 *Human Health and Safety*.

Contra Costa Water District (letter dated May 15, 2001)

The District requests review of Section 401 and Section 402 permits once issued for the project.

Any such permits will be a matter of public record, once issued, and the District may obtain copies from the Conservancy or the Regional Water Quality Control Board.

Save the Bay (letter dated May 10, 2001)

Include a discussion of the adverse and beneficial impacts of the proposed project on current wetland restoration projects, fish and wildlife, water quality, and human health.

These issues are addressed in Sections 3.1, *Hydrology and Geomorphology*, Sections 3.2, *Water Quality*, 3.3 *Biological Resources*, and 3.6, *Human Health and Safety* of the EIS/R.

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8.0 DEFINITIONS

Acre: An acre is a unit of land measurement equal to 43,560 square feet.

Acute Exposure: Either a single or short-term exposure to a compound.

Adjuvant: A substance added to a solution to aid its action. Surfactants and colorants are adjuvants added to herbicides.

Adsorption: Adhesion of a gas, liquid, or dissolved substance to a surface, such as the surface of a soil particle.

Archaeological Resource: means any material remains of past human life or activities including (but not limited to): pottery, basketry, bottles, weapons, weapon projectiles, arrowheads, tools, structures or portions of structures, pit houses, rock paintings, rock carvings, intaglios, graves, human skeletal materials, or any portion of the foregoing items at least 100 years of age. Defined by Section 4(a) of the Archaeological Resources Protection Act and 43 CFR Part 7.3.

Atlantic cordgrass: Refers to *Spartina alterniflora* (Lois). In this report, Atlantic smooth cordgrass is used.

Atlantic smooth cordgrass: Common name use within this report for *Spartina alterniflora* (Lois). Other names include Atlantic cordgrass, smooth cordgrass, salt-water cordgrass, and saltmarsh cordgrass.

Beneficial Impact: An impact that has beneficial consequences.

Bioaccumulation: an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment.

Bioconcentration: The degree to which a chemical can be concentrated in the tissues of organisms.

Biodegradation: Capable of being decomposed by biological agents, especially bacteria or other microorganisms.

Brackish: Marine or estuarine water salinity between 0.5 and 30 parts per thousand, due to ocean-derived salts.

California cordgrass: Refers to *Spartina foliosa* Trin. In this report, Pacific cordgrass is used.

Chilean cordgrass: Common name use within this report for *Spartina densiflora* Brongn. Other names include dense-flowered cordgrass and denseflower cordgrass.

Chronic Exposure: A long-term exposure to a chemical, either continuously or periodically through that period.

Common cordgrass: Refers to *Spartina anglica* C..E. Hubbard. In this report, English cordgrass is used.

Contain: To prevent from spreading to new sites.

Control: Reduce infestations to manageable levels.

Cultural Resources: The physical remains, objects, historic records, and traditional lifeways that connect us to our nation's past.

Cumulative Impact: A cumulative impact refers to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. The individual effects may be changes resulting from a single project or a number of separate projects. The cumulative impact from several projects is the change in the environment, which results from incremental impacts of the project when added to other closely related past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period.

Dense-flowered cordgrass: Refers to *Spartina densiflora* Brongn. In this report, Chilean cordgrass is used.

Denseflower cordgrass: Refers to *Spartina densiflora* Brongn. In this report, Chilean cordgrass is used.

Direct Impact: Environmental effects that are caused by a project and occur at the same time and place.

Endangered [species]: A species of animal or plant that is in danger of becoming extinct.

English cordgrass: Common name use within this report for *Spartina anglica* C.E. Hubbard. Another name is common cordgrass.

Epifauna: Animals that live on the surface of marine or freshwater sediment or mud.

Eradication: To destroy; to remove by the roots; exterminate.

Estuary: An inlet or arm of the sea.

Exotic [species]: A species of animal or plant that is not indigenous to the region.

Half-life: Half-life is the length of time required after application for a chemical to decrease to one-half of its original concentration.

Hectare: A hectare is a metric unit of land measurement equal to 10,000 square meters or approximately 2.5 acres.

Herbicide: A chemical substance used to destroy plants, especially weeds.

Historic Property: The term used to describe any prehistoric or historic district, site, building structure, or object included in, or eligible for inclusion in, the National Register. The term includes artifacts, records, and remains that are related to such properties. As a general guideline, and cultural resource should be at least 50 years old to be considered as a historic property.

Hybrid: The offspring produced by crossing two individuals of unlike genetic constitution; specifically the offspring of two animals or plants.

Identification Inventory or Field Survey (Cultural Resources): This involves background research and in-field inspection of the area of potential effects (APE) to seek and record historic properties.

Impact: To have an effect on.

Indirect Impact: Effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Infauna: Animals that burrow into marine or freshwater sediment and live beneath the mud surface.

Inflorescence: The arrangement of flowers on a stem or axis.

Intertidal: The shore zone between the highest and lowest tides.

Introduced [species]: Species of animals or plants intentionally or unintentionally released into an area or region where it is not indigenous. Introduced species may or may not become invasive once established.

Invasive [species]: Typically an exotic species of animal or plant that establishes and spreads over time, ultimately forming a population.

Lipid: Any of a group of organic compounds consisting of the fats and other substances of similar properties: they are insoluble in water, soluble in fat solvents and alcohol, greasy to the touch, and are important constituents of living cells.

Marsh: A saturated, poorly drained area, intermittently or permanently covered with water; having aquatic and grass-like vegetation.

Mesic: Moderately moist.

Microorganism: An organism of microscopic or submicroscopic size, especially a bacterium or protozoan.

Mitigation Measure: An action or change in a project designed to avoid, minimize, rectify, reduce, or compensate for a significant environmental impact.

Mudflat: An extensive flat tract of land alternatively covered and uncovered by the tide, and comprised mostly of unconsolidated mud and sand (i.e., tidal flat).

National Register Eligible: A property that meets the National Register Criteria. for Section 106 purposes, an eligible property is treated as if it were already listed.

No Effect (Cultural Resources): When no effect is determined, the agency finds that the undertaking will have no effect on historic properties and notifies the State Historic Preservation Officer (SHPO) and interested persons of the findings. Unless the SHPO objects within 15 days of receiving such notice, the agency official is not required to take any further steps in the Section106 process.

Non-native: Plants or animals originating in a part of the world other than where they are growing.

Pacific cordgrass: Common name use within this report for *Spartina foliosa* Trin. Another name is California cordgrass.

Pacific Flyway: An avian migratory corridor along the eastern Pacific Basin and western coast of North America where seasonal migrations of waterfowl and shorebirds take place.

Persistence: Persistence is the length of time required for a chemical to degrade to the point where it can no longer be detected.

pH: The degree of acidity or alkalinity of a solution. Values from 0 to 7 indicate acidity, values from 7 to 14 indicate alkalinity.

Poison: A substance causing illness or death when eaten, drunk, or absorbed.

Population: Any group of organisms capable of interbreeding and coexisting at the same time and in the same place.

Propagule: Any of various usually vegetative portions of a plant, such as a bud or other offshoot, that aid in dispersal of the species and from which a new individual may develop.

Residual Impact: An impact that would still occur after applying mitigation at a treatment site.

Rhizome: An underground stem (as opposed to root) that runs horizontal beneath the ground.

Salinity: The total amount of solid material, in grams, contained in one kilogram of water when all the carbonate has been converted to oxide, the bromine and iodine replaced by chlorine, and all the organic matter completely oxidized.

Salt-meadow cordgrass: Common name use within this report for *Spartina patens* Aiton.

Salt-water cordgrass: Refers to *Spartina alterniflora* Lois. In this report, Atlantic smooth cordgrass is used.

Saltmarsh cordgrass: Refers to *Spartina alterniflora* Lois. In this report, Atlantic smooth cordgrass is used.

Sessile: Permanently attached; not moving.

Shoaling: The process of sediment accumulation that results in a shallow place in an aquatic system that may threaten navigation (such as a sandbar).

Significance: The importance of the impact on the resource. Significance is judged from the standpoint of the impacted resources. Council on Environmental Quality (CEQ) regulations specify several tests to determine whether an action will significantly affect the quality of the human environment. While these tests apply to the entire action, they can also be used in amended form to judge impact significance for individual resources. Significance is an either/or determination: the level of impact either is significant or is not significant. As specified in CEQ regulations, significance needs to be determined for each of three geographic areas: local, regional, and national. This places the impact into context. Significance is also determined in the terms of intensity. Archaeological sites are also described as significant or insignificant. Significant sites require protection (which can include mitigation excavations) while protection is not required for insignificant sites.

Smooth cordgrass: Refers to *Spartina alterniflora* Lois. In this report, Atlantic smooth cordgrass is used.

Special Status [species]: Species that are listed as threatened or endangered by the U.S. Fish and Wildlife Service, NOAA Fisheries, or the California Department of Fish and Game.

Species: A fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding.

Surfactant: A substance added to a solution to aid its action (see Adjuvent). For the *Spartina* Control Program, surfactants will be added to glyphosate and water formulations to help solubilize the active ingredient in water and to help "spread" the spray droplets across a leaf surface for better coverage. Surfactants have various chemistries but all have several properties in common. For example, they all reduce the surface tension of water and they can disrupt the lipid layer of biological membranes. Everyday surfactants include soaps for hand washing, hair shampooing, and cleaning dirty dishes.

Threatened [species]: A species of animal or plant that is rare and may become an endangered species in the near future.

Treatment Method: A method used to treat infestations of non-native *Spartina* in the San Francisco Bay and Delta.

Toxicity: The degree to which a substance is toxic; poisonous.

Turbidity: Having sediment or foreign particles stirred up or suspended; muddy, turbid water.

Undertaking (Cultural Resources): Any project, activity, or program that can result in changes in the character of use of historic properties, if any such properties are located in the area of potential effect. The project, activity, or program must be under the direct or indirect jurisdiction of a federal agency or licensed or assisted by a federal agency. Undertakings include new and continuing projects, activities, or programs.

Wrack: Seaweed or other marine life cast upon the shore.

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9.0 REFERENCES

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10. COMMENTS AND RESPONSES ON THE EIS/R

10.1 INTRODUCTION

The U.S. Fish and Wildlife Service (Service) and the State Coastal Conservancy (Conservancy) circulated the Draft Programmatic Environmental Impact Statement/ Environmental Impact Report (DEIS/R) for the San Francisco Estuary Invasive Spartina Project, Spartina Control Program (SCH # 2001042058) for a 47-day public review period ending on June 4, 2003. Copies of the DEIS/R were distributed to state, regional, and local agencies, as well as to any requesting individuals and organizations, for their review and comment. The Conservancy held four public meetings in May and June 2003 to explain the project and DEIS/R, and to solicit public input on the document and the project.

This chapter contains written comments on the DEIS/R received during that period, the Lead Agencies' responses to those comments, and a section containing technical and editorial corrections initiated by Conservancy and Service staff.

Pursuant to the requirements of the California Environmental Quality Act (CEQA), the Conservancy, as the CEQA lead agency, is required to evaluate the comments received on the DEIS/R and prepare written responses to the comments received. The US Fish and Wildlife service has similar responsibilities under NEPA. Responses are provided in this chapter for each of the significant environmental points raised in the review, comment and consultation process.

Each response in this chapter is preceded by a brief summary of the comment to which it relates. All of the comment summaries have been created by the preparers of the EIS/R and not by the author of the comment. The comment summaries are intended solely to provide context to the response and are not intended to replace the comment to which the response refers. Care has been taken to accurately summarize each comment. However, as is true with any summary, the summary may be incomplete, not wholly accurate, or fail to fully explain the comment. For complete clarity and accuracy, the reader is directed to the full comment itself. All changes to the DEIS/R referred to in this Comments and Responses chapter have been incorporated into the DEIS/R text, resulting in this Final EIS/R. Revisions to the DEIS/R text are shown in strike through (deleted text) and italics (new text).

Under CEQA, before approving the ISP Control Program or any Conservancy actions under the Control Program, the Conservancy will need to certify that the Final EIS/R is complete and adequate in order to make the necessary findings for project approval. The Conservancy may require the mitigation measures identified in this Final EIS/R as conditions of project approval. In connection with approval of the Control Program, the Conservancy must also adopt a separate document, prepared pursuant to CEQA Guidelines Section 15091 and 15093, containing a set of required CEQA "Findings" with respect to each significant environmental effect, and a "Statement of Overriding Considerations" for any effects that are unavoidable or infeasible to mitigate. Also included in the Findings document is a Mitigation Monitoring Program that must be adopted in accordance with California Public Resources Code Section 21081.6.

Pursuant to NEPA, the Service will prepare a Record of Decision (ROD), a summary of the decisions made by the Service on the project. In brief, under NEPA, the ROD describes the decision and reasoning of the federal agency, identifies all alternatives, including the environmentally preferable alternative, that were considered by the agency, discusses whether or not all practical means to avoid or minimize environmental harm have been adopted and, if not, why they were not, and includes a summary of the monitoring and enforcement program that the agency has adopted. 40 C.F.R §1505.2 The ROD must be published in the Federal Register.

10.2. COMMENTS AND RESPONSES

Comments received, and the responses to them, are identified by the page number below.

Commenter	Comment Date	Comment Page	Response Page
Federal Government Agencies			
A. US Environmental Protection Agency	6/2/03	10-5	10-12
B. US Department of the Army	6/3/03	10-18	10-20
State Government Agencies			
C. California State Lands Commission	5/30/03	10-21	10-25
D. San Francisco Bay Conservation and Development Commission	6/2/03	10-31	10-33
E. California Department of Food and Agriculture, Integrated Pest Management	6/4/03	10-37	10-38
F. State of California Governor's Office of Planning and Research	6/3/03	10-39	10-41
Regional and Local Agencies			
G. East Bay Regional Park District	5/4/03	10-42	10-45
H. Port of Oakland	5/19/03	10-49	10-51
I. Santa Clara Valley Water District	6/2/03	10-52	10-60

Individuals and Organizations

A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

June 2, 2003

Mr. Wayne White
Field Supervisor
US Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, CA. 95825

Subject: Draft Programmatic Environmental Impact Statement for the San Francisco Estuary Invasive Spartina Project: Spartina Control Program, California (CEQ # 030163)

Rating: Environmental Concerns - Insufficient Information (EC-2)

Dear Mr. White:

The Environmental Protection Agency (EPA) has reviewed the above-referenced document pursuant to the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and Section 309 of the Clean Air Act. Our detailed comments are enclosed.

The Spartina Control Program would implement a region-wide program to control the spread of invasive, non-native cordgrass species in the San Francisco Estuary to preserve and restore the ecological integrity of its intertidal habitats and estuarine ecosystem. Treatment methods range from mowing, pulling, or smothering plants to spraying with herbicides. The preferred alternative is use of all available control methods including herbicides. 1

EPA provided scoping comments on June 4, 2001. Our scoping comments requested information on chemical control methods, the Spartina Control Program approach and priorities, and the potential effects on water quality, wetlands, air quality, and species viability. The majority of our comments have been addressed.

We commend the US Fish and Wildlife Service and California State Coastal Conservancy for taking a leadership role in the effort to control invasive non-native Spartina species. We support the regional, estuary-wide approach. The urgent need for a regional control program is clearly demonstrated in the Draft Programmatic Environmental Impact Statement (PDEIS).

Given the scope and ecological importance of the Spartina Control Program, it is important to ensure the program approach, mitigation measures, and potential impacts are fully considered and disclosed. We recommend the Final Programmatic Environmental Impact Statement (PFEIS) include additional evaluation and disclosure of Clean Water Act Section 404 requirements; mitigation measures for biological resources and visual effects; the program approach for managing dredged material reuse, outside seed sources of Spartina, peer reviews, and funding; cumulative impacts; and Endangered Species Act Section 7 consultation. 1 (cont.)

Because of the importance of the above additional information, we have rated the preferred alternative and PDEIS as Environmental Concerns-Insufficient Information (EC-2). EPA's rating and a summary of our comments will be published in the *Federal Register*. Please see the enclosed Rating Factors for a description of EPA's rating system.

We appreciate the opportunity to review this PDEIS. When the Final Programmatic EIS is released for public review, please send two copies to the address above (mail code: CMD-2). If you have any questions, please contact me or Laura Fujii, the lead reviewer for this project. Laura can be reached at (415) 972-3852 or fujii.laura@epa.gov.

Sincerely,

Lisa B. Hanf, Manager
Federal Activities Office
Cross Media Division

cc: √Ms. Maxene Spellman, California State Coastal Conservancy
Perry Herrgesell, Central Valley-Bay Delta Branch, California Dept. of Fish and Game
Dick Whitsel, Region 2, Regional Water Quality Control Board
US Corps of Engineers, San Francisco Regional Office

SUMMARY OF EPA RATING DEFINITIONS

This rating system was developed as a means to summarize EPA's level of concern with a proposed action. The ratings are a combination of alphabetical categories for evaluation of the environmental impacts of the proposal and numerical categories for evaluation of the adequacy of the EIS.

ENVIRONMENTAL IMPACT OF THE ACTION

"LO" (Lack of Objections)

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

"EC" (Environmental Concerns)

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

"EO" (Environmental Objections)

The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

"EU" (Environmentally Unsatisfactory)

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potentially unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

ADEQUACY OF THE IMPACT STATEMENT

Category 1" (Adequate)

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

"Category 2" (Insufficient Information)

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analysed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

"Category 3" (Inadequate)

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analysed in the draft EIS, which should be analysed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From EPA Manual 1640, "Policy and Procedures for the Review of Federal Actions Impacting the Environment."

Section 404 of the Clean Water Act

While the Draft Programmatic Environmental Impact Statement (PDEIS) describes potential impacts to wetlands and the regulatory requirements of Clean Water Act Section 404, it does not appear to evaluate or describe the Section 404 permit requirements of the Spartina Control Program or how the program will comply with the 404(b)(1) Guidelines.

Recommendation:

The Programmatic Final Environmental Impact Statement (PFEIS) should include a specific section that describes and evaluates compliance with the Federal Guidelines for Specification of Disposal Sites for Dredged or Fill Materials (40 CFR 230) [hereafter referred to as the Guidelines], promulgated pursuant to Section 404(b)(1) of the Clean Water Act (CWA). To comply with the Guidelines, the proposed actions must meet all of the following criteria: 2

- There is no practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem (40 CFR 230.10(a)).

- The proposed action does not violate State water quality standards, toxic effluent standards, or jeopardize the continued existence of federally listed species or their critical habitat (40 CFR 230.10(b)).

- The proposed action will not cause or contribute to significant degradation of waters of the United States, including wetlands (40 CFR 230.10(c)). Significant degradation includes loss of fish and wildlife habitat, including cumulative losses.

- All appropriate and practicable steps are taken to minimize adverse impacts on the aquatic ecosystem (i.e., mitigation) (40 CFR 230.10(d)). This includes incorporation of all appropriate and practicable compensation measures for unavoidable losses to waters of the United States, including wetlands.

Mitigation Measures

1. Mitigation measures for potential impacts to biological resources include different restrictions on the type, timing, season, and daily schedule of treatments. For example, no herbicide treatments will occur within 24 hours prior to weekends or public holidays (p. 3.6-7), 3
no burning will occur in locations with sensitive plant species (p. 3.3-35), and treatments will

avoid the peak fall and spring Pacific Flyway stopovers if the work is within 1000 feet of mudflats (p. 3.3-36).

Recommendation:

We recommend the PFEIS include a calendar or chart that shows the temporal and location restrictions for each treatment method. Include information on specific use prohibitions for each treatment method; daily and seasonal schedule restrictions (e.g., only at very low tide or after the snowy plover breeding season), and other pertinent application information (e.g., wind speed restrictions on herbicide applications). The goal is to provide in one chart an overview of when, where, and how each treatment method should be used which shows the application windows for the different treatment methods. 3 (cont.)

2. The PDEIS states that significant temporary visual effects will occur which cannot be mitigated. While mitigation measures to reduce or eliminate temporary visual impacts caused by Spartina treatments may not be feasible, public perception of the adverse visual effects could be alleviated through an educational program regarding the Spartina Control Program.

Recommendation: 4

We recommend an educational and signage program be implemented as a means to alleviate negative public perception of visual effects of treatment. For example, include educational signs overlooking large and long-lasting treatment areas describing the work being done and its benefits to the estuarine ecosystem.

Program Approach

1. The Spartina Control Program proposes to reuse excavated and dredged material to facilitate restoration of diked baylands (p. 2-10). Reused material would be disposed on uplands and only in places where seeds and rhizomes cannot disperse or would be covered by two feet of clean sediments (p. 3.1-8).

Recommendation: 5

It is clear from the PDEIS that non-native Spartina species, especially Atlantic smooth cordgrass, are aggressive invaders with a wide range of ecological tolerances. Thus, despite the restricted reuse of excavated material containing Spartina material, EPA remains concerned with the risk of spreading invasive exotic species to new sites. We urge caution in reuse of sediment containing Spartina material. We recommend small scale pilot projects to determine the risk of Spartina introductions from the reuse of material from Spartina control projects. 5 (cont.)

2. The PDEIS describes other areas along the Pacific Coast that are fighting or have already failed to control invasive Spartina populations (e.g., Willapa Bay, p. 3.1-10).

Recommendation: 6

The PFEIS should describe how the Spartina Control Program will address continual introduction of exotic Spartina species from outside seed and rhizome sources. For instance, describe the risk of future introductions from shipping or ballast water and potential control measures, if any, to address these sources.

3. The Spartina Control Program approach includes pilot and demonstration projects (p. 2-21) and scientific research (p. 1-1).

Recommendation: 7

The PFEIS should describe the peer review and public participation process for proposed research and demonstration and pilot studies.

4. Adequate and steady funding will be an important component of an effective Spartina Control Program.

Recommendation: 8

We recommend the PFEIS outline the proposed funding mechanism for the Spartina Control Program. Describe possible funding sources, cost share policies, and matching funding opportunities.

<u>Cumulative Impacts</u>

The PDEIS evaluates the cumulative impacts of the Spartina Control Program in conjunction with other tidal restoration projects, mosquito abatement activities and other weed control projects. However, there appears to be no description of specific projects or an estimate of existing weed control activity and the historical or current use of herbicides. 9

Recommendation:

If feasible, the PFEIS should include a description and estimate of the level of regional herbicide use and weed control activities. Include an evaluation of whether the regional Spartina Control Program will increase, decrease, or be at the same level of historical herbicide use and weed control activity. 9 (cont.)

Endangered Species Act Section 7 Consultation

Species viability and whether the project would threaten the continued existence of listed threatened or endanger species will be determined by the US Fish and Wildlife Service and National Marine Fisheries Service during the Section 7 consultation process.

10

Recommendation:

The status of the Section 7 consultation process should be described in the PFEIS. We recommend the Biological Assessment and Biological Opinion, if available, be included as appendices in the PFEIS.

A. U.S. ENVIRONMENTAL PROTECTION AGENCY

Comment A 1:

Comment noted. Specific comments are addressed below.

Comment A 2: ISP does not evaluate or describe Section 404 Permit requirements of the *Spartina* Control Program or how the program will comply with the 404(b)(1) Guidelines.

In response to this comment, the text on lines 2-13, p. 5-2 has been deleted, and the following text inserted in its place:

> *Section 404 of the Clean Water Act (33 U.S.C. §1344) generally requires a Corps of Engineers permit for the discharge of dredged or fill material into waters of the United States, including adjacent wetlands. The Corps' decision whether to issue a CWA Section 404 permit is based on an evaluation of the probable impacts on the public interest as stated below for Section 10 of the <u>Rivers and Harbors Act</u>as well as on application of the guidelines promulgated by EPA, otherwise referred to as the Section 404(b)(1) guidelines (40 CFR, Part 230). These guidelines require that the following four conditions be met before a Section 404 permit may be issued:*
>
> *(1) There is no other practicable alternative that would have less adverse impact on the aquatic environment;*
>
> *(2) The disposal, after consideration of dispersion and dilution, will not cause or contribute to violations of applicable water quality standards; will not violate any applicable toxic effluent standards; nor will it jeopardize the continued existence of threatened or endangered species; nor will it violate any requirement to protect marine sanctuaries;*
>
> *(3) The disposal will not cause or contribute to significant degradation of waters of the United States; and*
>
> *(4) All appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic environment (Reference 40 CFR 230.10).*
>
> *The Corps can authorize regulated activities in its jurisdiction by individual or general permits. Individual (standard) Corps permits are specific to particular projects; general Corps permits apply to classes of activities Regional permits and Nationwide permits are types of general permits, and have the same basic restrictions. General permits can apply only to actions that have minimal cumulative and individual environmental impacts, as determined by the Corps. Once a Regional permit is issued, actions that fully comply with all of its conditions are authorized for up to 5 years. The Corps retains discretion to override general permits and require standard individual permits for some regionally authorized activities on a case-by-case basis. This usually occurs only if there is a reason-*

able indication that a particular regionally permitted action may have impacts that are substantially greater than minimal.

General permits require full environmental evaluation and public notice for the permit itself, but not for individual actions within its scope. Some Regional and Nationwide permits have "reporting requirements", which involve some pre-project notification and review by the Corps (and/or natural resource agencies) to allow fine-tuning of conditions to ensure reduction of overall impacts to a minimum. To avoid "piecemealing" of regulated activities in permit review, the Corps normally requires that portions of an overall project that are reasonably related be included in the same permit application. Some Nationwide permits that have "independent utility" can be combined with other permits, but full environmental review of the whole scope of a regional permit program is required prior to authorization.

The ISP treatment methods include many actions that would be regulated by the Corps under the Clean Water Act, Section 404 (mechanical removal techniques that involve excavation and backfill of sediment in tidal areas) and Rivers and Harbors Act, Section 10 (impounding tidal waters locally, placing stakes in tidal areas below Mean High Water). Even activities that may not be regulated by the Corps (such as crushing vegetation by driving tracked amphibious vehicles over it, mowing, herbicide treatment, or covering with fabric) would be considered by the Corps in its evaluation of overall cumulative impacts of the project

The ISP will apply to the Corps for a Regional Permit to cover all categories of Corps regulated Spartina treatment activities documented in the EIS/R to have minimal impacts in a complete, programmatic way. Developing and finalizing such a permit may take several months to greater than a year. For control projects initiated prior to issuance of a regional permit, the ISP will provide site-specific plans to the Corps for these projects, and request that they be authorized under appropriate Nationwide permits (e.g., NWPs 27 "Stream and Wetland Restoration Activities," 5 "Scientific Measurement Devices," 33 "Temporary Construction, Access and Dewatering," 31 "Maintenance of Existing Flood Control Facilities," and 6 "Survey Activities") or other mechanism.

Comment A 3: Recommend a calendar or chart that shows restrictions for each method.

Table 2-1 (page 2-13) includes details regarding appropriate timing (seasonal and daily) for each treatment method. The two most critical factors for timing of control methods are clapper rail nesting season and tidal cycle, as described on page 2-20. A calendar showing the effects of these factors on the "treatment window" was presented in Figure 2-3, page 2-20.

Comment A 4: EPA recommends an educational and signage program to be implemented as a means to alleviate negative public perception of the visual effects of treatment.

The ISP agrees on the importance of public education, including signage, as a way to help alleviate negative public perception of *Spartina* treatment, and plans to implement a signage program as part of public outreach and education. In response to this comment, the following replaces the existing text under the heading "Mitigation Measures" for both Alternative 1 and Alternative 2, found on p. 3.7-9 of the DEIS/R:

> *MITIGATION VIS-1: The ISP will integrate signage into all treatment areas that are adjacent or within areas accessible or visible to the general public, whenever the treatment of nonnative Spartina will result in a substantial change in the visual character of the area. Signage will vary depending upon the site-specific components of treatment methods, availability and nature of public access and visibility, extent of the infestation, and other factors. Signage will therefore range from simple signs providing a brief description of the nature and reason for the change (e.g. where there is little public visibility or the extent of infestation is small) to more detailed interpretive signs highlighting the ecological effects of Spartina and the need for control (e.g. where there is significant public access and high visibility, and infestation is broad).*

Comment A 5: EPA remains concerned about spread of invasive exotic species to new sites, and urges caution in reuse of sediment containing *Spartina* material.

The ISP shares the commenter's concern about inadvertent spread of invasive cordgrass in dredging, excavation, and other mechanical removal methods. Please refer to Impact BIO 1.2 and Mitigation BIO 1.2, pp. 3.3-31 to 32, and p. 2-10, lines 9-10. There is ample scientific evidence that Spartina alterniflora is unable to survive in hypersaline environments and the use of this method would be limited to diked, hypersaline, non-tidal environments. See Portnoy (1999) and Portnoy and Valiela (1997) in the EIS/R references, and additional references within these publications. There are no reports of any native or non-native Spartina species in diked, hypersaline, non-tidal wetlands of San Francisco Bay. Limited cordgrass (native and non-native) occurs in diked salt marshes and lagoons with strongly damped tidal range and salinity lower than marine concentration. There is also ample scientific evidence from Portnoy (1999) and Portnoy and Valiela (1997) that altered soil chemistry of diked salt marsh alone, even without desiccation and hypersalinity, severely inhibits growth and causes significant mortality of Spartina alterniflora. Tidal restoration of diked "disposal"/reuse sites would occur after confirmed inviability of translocated rhizome and stem fragments, presumably a year after one year of diked "fallow" treatment. The Project will implement pilot projects to test this disposal/reuse method prior to large-scale application.

Comment A 6: Show how continual introduction of exotic .. from outside sources will be addressed.

With the exception of the Spartina patens population in Suisun, the original introduction of all of the existing non-native Spartina populations has been traced to intentional introduction by humans for restoration, landscaping, or stabilization purposes. These introductions all happened at a time when our collective understanding regarding invasive plants in the Estuary was far less than it is now; continued public education should considerably reduce the potential for such introductions to be repeated today. It is suspected that Spartina densiflora was introduced to Willapa Bay, Washington, and Humboldt Bay and Bolinas Lagoon, California, in packing material for the commercial oyster industry. The San Francisco Bay region has not supported an oyster industry since 1960, so there would be little chance of this method of introduction. Finally, it is unlikely that Spartina seed or propagules could be transported in ship ballast water, as ballast water is usually obtained from subsurface, offshore sources. It is also improbable that viable seeds or propagules could withstand the stresses of transport in ballast water.

Most re-infestation of treated sites occurs within the San Francisco Estuary as a result of dispersal of seed from other local populations. A small, but potentially significant form of re-infestation may occur from dispersal of seed originating in remote estuaries, such as Humboldt Bay and Willapa Bay. Transport of seed from very remote estuaries is most likely to occur inadvertently via vessels traveling between ports. These two modes of re-introduction require different strategies to counter them.

Consistent with the Integrated Vegetation Management (IVM) program, the ISP includes three mechanisms to reduce the possibility of re-introduction of non-native *Spartina* into the Estuary: public outreach and education, monitoring, and a rapid response protocol.

As part of public outreach and education, the ISP conducts and will conduct field trips with creek groups, landowners, and environmental interests to teach them to identify Spartina and assist them in controlling Spartina and planning restoration projects. In 2002 and 2003, over 1,000 staff hours were spent in this area. The ISP has developed and distributed several informational brochures, and is developing guidance for plant nurseries, restoration consultants, and regulatory agencies. Since these components have no adverse environmental impacts, they were not included in the Draft Programmatic EIS/R evaluations. The ISP and its affiliates conduct regular field monitoring for invasive *Spartina* species.

The ISP will continue to monitor the Bay for new infestations of *Spartina*. A Rapid Response Protocol has been developed for responding to new sightings of non-native Spartina in currently uninvaded areas (e.g., outer coast estuaries). The approach in these situations is to quickly contact all landowners and potentially interested stakeholders, acquire needed access, permits, and authorizations, and then to work with the landowners to quickly implement focused manual control methods (typically digging or covering). The potential impacts of these methods have been evaluated in the Draft Programmatic EIS/R.

Comment A 7: PDEIS should describe the peer review and public participation process for research and demonstration and pilot studies.

The ISP includes the formation of several public and technical support groups that will help develop the process for peer review of data from research, demonstration, and pilot projects. The groups include a Science Advisory Panel, Monitoring Technical Advisory Team, and Field Operations Review Group. In addition, the ISP includes a Steering Committee made up of public agency, landowner, and environmental interests to help develop and guide the Project's overall decision-making processes.

Comment A 8: Outline proposed funding.

The ISP anticipates that adequate funding will be available through future appropriations to the Conservancy and its San Francisco Bay Area Conservancy Program (SFBACP) from the "Water Security, Clean Drinking Water, Coastal and Beach Protection Fund of 2002" (Proposition 50). Proposition 50 authorizes up to 120 million dollars to be appropriated from this fund to the Conservancy and up to 20 million dollars to the SFBACP for projects that serve to protect coastal watersheds. Because Proposition 50 funds are derived from the issuance of state bonds, it is not expected that the viability of this fund will be severely impacted by the current State General Fund deficit. The Coastal Conservancy Strategic Plan concerning the San Francisco Bay Area Conservancy Program, Goal 10, Objective A states among other things, "…restore…approximately 30,000 acres of wetlands…" for which Proposition 50 is identified as the funding source. ISP is a high priority wetland restoration project for the Conservancy. As such, Conservancy staff has targeted $2.5 million of future Proposition 50 funds towards invasive Spartina control. Those funds will first need to be appropriated and subsequently authorized by the Conservancy Board. This is expected to occur in 2003-04.

The Conservancy is also currently meeting with Calfed to explore additional funding for ISP. The Conservancy understands that the Invasive Spartina Control is also a high priority for Calfed. The Service also fully expects that it will continue to fund ongoing Spartina control efforts on its Don Edwards San Francisco Bay National Wildlife Refuge lands. Finally, the ISP plan for the future includes a fund raising element, which requires that the ISP staff diligently identify, pursue and take advantage of all available federal, state, local and private funding sources.In addition to sources of financial assistance, the ISP Control Program will rely on in-kind contributions by its partner agencies in connection with specific control projects. It is expected that partner agencies will provide control services, equipment and other related services and supplies, that will further the Control Program. For example, , some of the ISP's larger partners, such as East Bay Regional Parks District, Alameda County Flood Control District, and Don Edwards San Francisco Bay National Wildlife Refuge are providing staff time for planning and treatment and equipment such as backpack sprayers, hose and real trucks, argos, hydrotracks, and airboats. Smaller groups and non-profits, such as Golden Gate and Marin Audubon societies, Literacy for Environmental Justice, Marin Rowing Association, and Friends of Corte Madera Creek are providing volunteer labor for manual treatment. In Pointe Reyes, Avocet Research Associates, Point Reyes Bird Observatory, Point Reyes National Seashore, Audubon Canyon Ranch, and Cypress Grove Preserve have provided volunteer support for surveys and manual removal of plants in West Marin. As examples of contributions from private interests, the Sunset Scavenger Company has donated plant debris removal for a manual removal project, the Tomales Bay and Hog Island Oyster Companies provided volunteer labor, and Hansen Aggregate, Inc. provided refreshments for volunteer laborers.

If the ISP unable to acquire adequate funding for a coordinated control program, impacts would be essentially similar to those described in the EIS/R for Alternative 3: No Action. In the absence of an effective coordinating program for the Bay region, non-native cordgrass eradication is likely to consist of individual, perpetual maintenance projects with recurrent impacts. Please refer to impacts of the "no-action" alternative.

Comment A 9: There is no account of existing weed control activities or regional herbicide use in the project area. Will SCP increase, decrease, or match historic herbicide use?

In the long term, the SCP should reduce historic herbicide use if the ISP objective of eradication is achieved, compared with the No Action Alternative.

The Don Edwards San Francisco Bay NWR has recently focused control efforts on approximately 250 acres of marshlands in Fremont and Newark. In 2001, the refuge and their contractors sprayed a total of 1,231 gallons of spray solution, composed of 61 gallons of Rodeo, 6 gallons of R-11 surfactant and 6 gallons of Blazon Blue dye in water. A total of 8 net acres of Spartina alterniflora were sprayed. In 2002, a total of 3,800 gallons of spray solution was used, composed of 152 gallons of Aquamaster, 19 gallons of R-11 surfactant, and 19 gallons of Blazon Blue dye in water. A total of 30 net acres of Spartina alterniflora were treated. Some pepperweed in certain tidal marshes and in grassland areas was also treated (Albertson 2003).

The Santa Clara Valley Water District has not performed any *Spartina alterniflora* control. They are anticipating control activities for *Spartina alterniflora* to begin in 2004 (Porcella 2003). The District has controlled peppergrass within brackish marsh habitats and within diked tidal areas using mowing and aquatic herbicide techniques. They also have selectively removed non-native species such as poison hemlock, wild celery, pampas grass, and rabbit's foot grass using mechanical methods or herbicide application in freshwater and brackish areas.

The East Bay Regional Park District is not currently treating *Spartina alterniflora*. They are planning to apply for an NPDES permit so they will be able to spray (Brownfield 2003).

In 2001 and 2002, the Alameda County Agriculture Department assisted the Don Edwards San Francisco Bay NWR in treating Spartina alterniflora on refuge marshes. The data for Alameda County's herbicide use is included in the refuge data in the second paragraph of this response. The County previously sprayed in San Leandro marshes until NPDES permits were required (Manchestoer 2003).

Comment A 10: Status of Section 7 consultation should be described. BA and BO included as appendices.

The Coastal Conservancy and the Fish and Wildlife Service have submitted the Draft EIS as the biological assessment. It contains all the information required for a biological assessment pursuant to the Endangered Species Act of 1973 as amended. The Fish and Wildlife Service has initiated Section 7 consultation with the National Oceanographic and Atmospheric Administration, Fisheries (NOAA Fisheries) and has also initiated an internal Section 7 consultation within the Fish and Wildlife Service. This consultation will be completed before the Record of Decision is signed.

B

DEPARTMENT OF THE ARMY

SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
333 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94105-2197

JUN 9 2003

Regulatory Branch

SUBJECT: File Number 27819S – Invasive Spartina Control Program

Mr. Wayne White
U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825
Attn: Mark Littlefield

Dear Mr. White:

This letter is in response to a request for comments on the "San Francisco Estuary Invasive Spartina Project: Spartina Control Program, Draft Programmatic Environmental Impact Statement/Environmental Impact Report," dated April 2003, concerning your project to conduct an invasive Spartina control program in San Francisco Bay that was received on April 24, 2003, by a notice from U.S. Fish and Wildlife Service dated April 2003. Your project is located within the San Francisco Bay Estuary, California. Since this activity may involve vegetation control activities such as mowing, maceration, dredging, spraying, et al., within and/or over a water of the U.S., the Corps of Engineers will need to review those portions of your project.

All proposed work and/or structures extending bayward or seaward of the line on shore reached by: (1) mean high water (MHW) in tidal waters, or (2) ordinary high water in non-tidal waters designated as navigable waters of the United States, must be authorized by the Corps of Engineers pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). Additionally, all work and structures proposed in unfilled portions of the interior of diked areas below former MHW must be authorized under Section 10 of the same statute. 1

All proposed discharges of dredged or fill material into waters of the United States must be authorized by the Corps of Engineers pursuant to Section 404 of the Clean Water Act (CWA) (33 U.S.C. 1344). Waters of the United States generally include tidal waters, lakes, ponds, rivers, streams (including intermittent streams), and wetlands.

Your proposed work appears to be within our jurisdiction and a permit may be required. We believe a programmatic permit may be the most appropriate approach for this project. Application for Corps authorization should be made to this office using the application form in the enclosed pamphlet. To avoid delays it is essential that you enter the File Number at the top of this letter into Item No. 1.

Should you have any questions regarding this matter, please call Molly Martindale of our Regulatory Branch at 415-977-8448. Please address all correspondence to the Regulatory Branch and refer to the File Number at the head of this letter.

Sincerely,

ORIGINAL SIGNED
BY
CHIEF, SOUTH SECTION
FOR
Edward A. Wylie
Chief, South Section

Enclosures

Copy Furnished (w/o enclosure):

Maxene Spellman
California Coastal Conservancy
Oakland, CA

RECEIVED
JUN 05 2003
COASTAL CONSERVANCY
OAKLAND, CALIF.

B. DEPARTMENT OF ARMY

Comment B 1: Need to apply for ACOE authorization – programmatic permit.

Please see response to USEPA Comment A-2. All specific implementation projects under this program will be reviewed to identify the need for further permits, including those required under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act.

C

GRAY DAVIS, *Governor*

ATE OF CALIFORNIA

ALIFORNIA STATE LANDS COMMISSION
0 Howe Avenue, Suite 100-South
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May 30, 2003

File Ref: SCH# 2001042058

Ms. Nadell Gayou
The Resources Agency
901 P Street
Sacramento, CA 95814

Ms. Maxene Spellman
California Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612

Dear Ms. Gayou and Ms. Spellman:

SUBJECT: Draft Programmatic Environmental Impact Statement/Report (DEIR/S) for the San Francisco Estuary Invasive Spartina Project: Spartina Control Program

Staff of the California State Lands Commission (CSLC or Commission) has reviewed the above document. Under the California Environmental Quality Act (CEQA), the CSLC is a Responsible and/or Trustee Agency for any and all projects which could directly or indirectly affect sovereign lands, their accompanying Public Trust resources or uses, and the public easement in navigable waters.

<u>Jurisdiction</u>

The State of California acquired sovereign ownership of all tidelands and submerged lands and beds of navigable waterways upon its admission to the United State in 1850. The State holds these lands for the benefit of all people of the State for statewide Public Trust purposes, which include waterborne commerce, navigation, fisheries, water-related recreation, habitat preservation and open space. The landward boundaries of the State's sovereign interests are often based upon the ordinary high watermarks of these waterways, as they existed prior to fill or accretions caused by human activities. Thus, such boundaries may not be readily apparent from present day site inspections. The State's sovereign interests are under the jurisdiction of the Commission. 1

The Public Trust is a sovereign property right held by the State or its delegated trustee for the benefit of all the people. This right limits the uses of these lands to waterborne commerce, navigation, fisheries, open space, recreation, or other recognized Public Trust purposes. A lease from the Commission is required for any those portions the project extending onto State-owned lands which are under its exclusive jurisdiction. Please contact Ms. Nanci Smith, Public Land Management Specialist at (916) 574-1862 for any questions regarding the CSLC's leasing requirements. 1 (cont.)

Environmental Comments

CSLC staff review of the DEIS/DEIR for the Spartina Control Program offers the following comments as noted below.

Section 2 (Program Alternatives)

1. Page 2-12 line 30 This statement is incorrect. Glyphosate is not the only herbicide currently approved by USEPA for use in aquatic or estuarine environments. EPA and CalEPA have registered several herbicides for aquatic use. 2

Section 3 (Environmental Setting, Impacts and Mitigation Measures)

2. Page 3.2-9 line15 What is the source of this information? Other active ingredients such as diquat, 2,4-D, or triclopyr, have aquatic registration in wetland environments.

   Actually, as an effective contact and dessicant, diquat should be considered as another possible chemical tool. Diquat, although it has a different mode of action, may be more effective, and is comparable (to glyphosate) in aquatic toxicity (refer to EcoToxNet). Combinations may be synergistic. Applied to relatively small clumps, it could enhance spring burning to augment control potential with minimal disturbance to the hydrosoil. California Department of Pesticide Regulation has allowed registration for both above water and in-water use. The relatively low mammalian, fish and invertebrate toxicity allows several modes and sites of application. Please see the California Department of Boating and Waterways 2000 EIR for the *Egeria densa* Control Program in the Sacramento-San Joaquin Delta, in which diquat was analyzed in application for efficacy and toxicity, and found to be an approved herbicide for that program. Imazapyr should also be mentioned for field assessment of efficacy and toxicity under an Experimental Use Permit in the Research Authorization Program. USFWS Portland has been aware of this active ingredient from Extension work conducted in 1998 in Willapa Bay, Washington, and its efficacy may be significantly greater. 3

3. Page 3.4-6 Impact AQ-3 Mitigation 4 line 20 Change "and" to "or". In an aerial
application, a wind exceedance of 15 mph by itself (no direction necessary)
should be sufficient cause to cease spray operations. Include the following wind
monitoring provision: if the winds exceed 7 mph, wind measurements, the
applicator shall record wind speed every 15 minutes, noting direction and 4
whether steady or in gusts. Consider adding a provision for use of dye cards for
300' downwind at 50' intervals before and during treatment (sensitive receptors
noted or County Ag Commissioner staff recommendation or if other
circumstances warrant).

4. Page 3.2-13 Mitigation WQ-1 line10 The measure specifically mentions the
investigation of improved herbicide formulations. Would this scope include other 5
active ingredients, e.g., diquat, 2,4-D, imazapyr (imazapyr/glyphosate monitored
in 1998 in Willapa Bay)?

5. Page 3.2-13 Mitigation WQ-2 line 21
   - California regulations (CCRs) already require herbicide applications (non-
private) to be under direct supervision of trained, certified, licensed
applicators. For this mitigation measure, we recommend that every 6
applicator be CDPR-licensed in the aquatic pest control category. Some of
the proposed adjuvants are category II and I materials.
   - Aerial applications require large amounts of herbicide in a single site and,
hence, present the greatest spill hazard, for which a commercial applicator is
responsible. We recommend that for all other applications, impose a limit of 7
no more than 10 gallons (or 5) of herbicide be transported in a single vehicle
at any one time, and that in practice, 2½ gallon and service (diluted)
containers be used.

6. Page 3.12-4 line 2 The statement is poorly worded. All registered pesticides
contain chemicals, even the *Bacillus thurigiensis* formulation for the insecticide 8
registered to kill insect larvae. The growth regulators such as methoprene may
be chemically synthesized.

Section 5 (Environmental Compliance)

7. Section 5.1 Applicable Federal Laws Page 5.1 The EIS/EIR should refer to the
Fungicide, Rodenticide and Insecticide Act (FIFRA), administered by the
Environmental Protection Agency (EPA), which regulates the registration,
manufacture, transportation and use as well as the marketing of pesticides.
FIFRA also requires that all pesticides, whether for commercial or private use, be 9
applied in accordance with product labeling and that containers are properly
disposed. The EIS/EIR should list FIFRA especially as it relates to pesticide use
on federal or mixed public trust lands.

8. Section 5.2 Environmental Compliance - Applicable State Laws Page 5.7 The 10
EIS/EIR should specifically mention the California state pesticide laws of the

California Agricultural Code (more stringent than FIFRA),their matching pesticide regulations (CCRs), the State Water Quality Management Agency Agreement (MAA) and the specific Regional Water Board restrictions regulating use of and tracking pesticides, including near and in water. 10 (cont.)

9. Section 5.5 Agency Jurisdiction Table 5.5-1 The table should add a row to list the responsible state regulator (registration, use tracking and enforcement), the California Department of Pesticide Regulation (CDPR). FIFRA allows individual state registrations to be more restrictive than federal registrations, but not less. 11

10. Table 5.5-1 The table should also list responsibilities of the County Agricultural Commissioners (CACs) in ensuring commercial applicators (especially if aerial) are properly licensed, use written recommendations, file Notices of Intent, use proper techniques, and report pesticide usage. Often a recommendation will stipulate provisions that must apply before a spray can receive a go-ahead. The CAC would be responsible for the investigation of any complaint. If a sensitive receptor is nearby, the Commissioner may also require a Notice of Intent before a specific application, even of glyphosate, supervise the treatment, or require other specific tasks in a given treatment. 12

11. Appendix E215 Isn't the aquatic toxicity of LI-700 relatively high? If it were used as a 5% solution (instead of the adjuvant ⅛ to ½%), it would probably act as an effective herbicide by itself. And if Monsanto had to remove the X-77 from the Roundup formulation to obtain EPA registration for aquatic use of glyphosate (as Rodeo formulation), why does USFWS approve this adjuvant for aquatic use? 13

Please contact Ms. Valerie Van Way, Staff Environmental Scientist, at (916) 574-2274 should you have questions regarding the environmental comments.

Sincerely,

Stephen L. Jenkins

Stephen L. Jenkins, Asst. Chief
Division of Environmental
Planning and Management

cc: N. Smith
V. Van Way
E. Gillies
S. York
S. Jenkins

RECEIVED
JUN 03 2003
COASTAL CONSERVANCY
OAKLAND, CALIF.

C. CALIFORNIA STATE LANDS COMMISSION

Comment C 1:

The State Lands Commission's public trust jurisdiction over tidelands and submerged lands is noted and is discussed in section 5.2.6 on p. 5-10 of the EIS/R.

Comment C 2: Glyphosate is not the only herbicide currently approved by USEPA for use in aquatic and estuarine environments. EPA and CalEPA have registered several herbicides for aquatic use.

Although there are several herbicides registered for aquatic use by EPA and CalEPA, glyphosate is the only herbicide registered for estuarine environments. See also response to Comment I-4.

Comment C 3: Other herbicides should be considered in addition to glyphosate.

The ISP will consider using other herbicides only if (1) the herbicide is at least as effective as glyphosate, and (2) adequate research shows that its use would result in lower risk of potential toxic effects on fish and wildlife *specific to shallow intertidal and subtidal estuarine environments*. The most rigorous studies of herbicides applied to tidal marsh and mudflat environments most similar to those of San Francisco Bay are from Willapa Bay. These studies have focused primarily on glyphosate (Paveglio et al. 1996, Kilbride and Paveglio 2001, Killbride et al. 1995), and only more recently on imazapyr (Patton 2002, 2003). Imazapyr shows promise, in that it appears to have very low toxicity to estuarine species, however U.S. EPA does not yet register imazapyr for use on *Spartina*. Fusilade has been used with great efficacy to control *Spartina* in Tasmania, however tests have shown notably higher toxicity to some organisms in marine environments (Hedge et al. 1999, Palmer et al. 1995; we are not aware of peer-reviewed research on fusilade in estuarine environments), and U.S. EPA also does not yet register it for this use. Less information is available on impacts of other herbicides in estuarine environments. As sufficient information on alternative herbicides is developed through ISP research or research by others around the world, the ISP will entertain their use by the Control Program. The ISP is currently supporting experimental research on imazapyr effectiveness on *Spartina alterniflora* hybrids, and indirect impacts to non-target organisms in San Francisco Bay in cooperation with ARS-USDA and University of California, Davis. The ISP has no information (and is aware of no such information) on the effectiveness or toxicity of Diquat use in estuarine environments and therefore is not currently proposing using Diquat for *Spartina* control.

Comment C 4: Page 3.4-6 Impact AQ-3 Mitigation 4 line 20. Change "and" to "or" – an aerial application in wind exceeding 15 mph by itself (no direction necessary) should be sufficient cause to cease spray operations. Include the following wind monitoring provision: if the winds exceed 7 mph, the applicator shall record wind speed every 15 minutes, noting direction and whether steady or in gusts. Consider adding a provision for the use of dye cards for 300' downwind at 50' foot intervals before and during treatment.

The ISP agrees that monitoring winds is an important aspect of any herbicide application. To that end, wind speed will be taken into account during the planning as well as the implementation phases of each site-specific plan. Applicators on each site will record wind speed, direction, and whether steady or gusts before, during and after applications at appropriate intervals. In addition, herbicide treatments will generally be conducted during the mornings preceding typical afternoon winds on the Bay.

Consistent with the product label, the first sentence of Mitigation AQ-3, paragraph 4, "Meteorological Conditions", p. 3.4-6 of the DEIS/R, has been amended to read:

> *"Avoid spraying when winds exceed 10 miles per hour, consistent with California supplemental labeling."*

The next mitigation measure described in Mitigation AQ-3 - paragraph 5, "Buffer Zones" - already directs that wind conditions be considered when establishing buffers to protect sensitive receptors.

The use of dye cards to monitor herbicide drift may be tried on a test plot or adjacent to sensitive receptors to determine the value of this technique, but not adopted on a program-wide scale. Pre-treatment planning, oversight by CADPR-licensed applicators, and site-specific treatment protocols will effectively preclude the need for program-wide adoption of this technique. See also response to SCVWD comment I 35.

Comment C 5: Would the investigation of improved herbicide formulations include diquat, 2,4-D or imazapyr?

Please see response to C 3, above.

Comment C 6: CSLC recommends that *every* applicator should be CDPR-licensed in the aquatic pest control category.

Although the ISP does not plan to require all applicators to be CDPR-licensed, as noted by CSLC in the original comment, the California Code of Regulations (CCR) requires herbicide applicators to be under the direct supervision of a trained, licensed applicator. Most, if not all of the land managers who will be involved in *Spartina* control around the Bay already have such licenses, as do many of the staff who work under them. Where necessary, additional licenses would be obtained for CCR compliance. .

Comment C 7: CSLC recommends that for non-aerial applications, a 10 gallon limit (or 5) be imposed on the transport of herbicide in one vehicle at one time.

A 10 gallon limit on herbicide volume transported per vehicle trip may be reasonable in many marsh locations where resupply from access roads is feasible. The ISP will fully consider this recommendation as an objective for such situations. For some remote marsh locations lacking access, an objective of limiting transport to less than 10 gallons of herbicide may be infeasible because of tide schedule constraints and the size of areas to be treated. It should be noted that the standard container for all of these herbicides is a 2.5-gallon plastic jug; it is highly unlikely that over 4 of these containers would be damaged or destroyed in any given accident.

Comment C 8: Page 3.12-4 line 2. The statement is poorly worded. All registered pesticides contain chemicals, even the *Bacillus thurigiensis* formulation for the insecticide registered to kill insect larvae. The growth regulators such as methoprene may be chemically synthesized.

In response to this comment, the text on page 3.12-4 lines 2-9, is replaced with:

> *Mosquito abatement operations in tidal marshes of the San Francisco Estuary generally rely upon biological or physical vector control methods where practicable. Synthetic chemical pesticide applications (such as resmethrin) in tidal marshes are limited, and used only as appropriate on a site-specific basis. Ditching, insect pathogens (bacterial strains such as Bacillus thuringiensis israeliensis), naturally-derived pesticides (such as* pyrethrin*), and insect "hormones" (growth regulators; such as Altosid, that prevent sexual maturation) are the main methods used to control salt marsh and diked wetland mosquitoes in the Bay region. Because the bulk of vector control operations undertaken by mosquito abatement districts rely upon non-insecticidal agents in tidal marshes or limited amounts of naturally-derived or synthetic chemical pesticides, the risk of compound, cumulative, synergistic impacts among insecticide and herbicide (glyphosate) applications would be very low or non-existent.*

Comment C 9: <u>Section 5.1 Applicable Federal Laws Page 5.1</u>. The EIS/EIR should refer to the Fungicide, Rodenticide and Insecticide Act (FIFRA), administered by the Environmental Protection Agency (EPA), which regulates the registration, manufacture, transportation and use as well as the marketing of pesticides. FIFRA also requires that all pesticides, whether for commercial or private use, be applied in accordance with product labeling and that containers are properly disposed. The EIS/EIR should list FIFRA especially as it relates to pesticide use on federal or mixed public trust lands.

For completeness, the following has been added as Section 5.1.12 on p. 5-4 of the EIS/R. All subsequent subsections are renumbered accordingly.

> ***5.1.12 The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) (US Code: Title 7, Chapter 6, Subchapter II),***
>
> *The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) defines the requirements for Federal registration and use of pesticides nationwide. The heart of FIFRA is the regulation of pesticide registration. The role of regulating use falls to individual states when they have developed an EPA Administrator authorized program. FIFRA requires that all applicators follow pesticide label instructions when applying pesticides within the United States.*

Comment C 10: <u>Section 5.2 Applicable State Laws Page 5.7</u>. The EIS/EIR should specifically mention the California state pesticide laws of the California Agricultural Code (more stringent than FIFRA), their matching pesticide regulations (CCRs), the State Water Quality Management Agency Agreement (MAA) and the specific Regional Water Board restrictions regulating use of and tracking pesticides, including near and in water.

For completeness, the following has been added as Section 5.2.5 on p. 5-9 of the EIS/R. All subsequent subsections are renumbered accordingly.

5.2.5 California Pesticide Regulations

The California Department of Pesticide Regulation (CDPR) regulates pesticides though the California Food & Agriculture Code (CFAC), Divisions 6,7 & 13 (Pest Control Operations; Agricultural Chemicals, Livestock Remedies and Commercial Feeds; and Bee Management and Honey Production, respectively). These regulations are at least commensurate with, and generally more stringent than, those described in FIFRA. The California Code of Regulations (CCR) Title 3, Division 6, Chapters 1-4 (Pesticide Regulatory Program, Pesticides, Pest Control Operations & Environmental Protection, respectively), define the specific requirements of pesticide application within the State of California. The State Water Quality Management Agency Agreement (MAA) is an agreement between the State Water Resources Control Board and the State Department of Pesticide Regulation to coordinate the two agencies' efforts to monitor and control herbicide use.

Comment C 11: Section 5.5 Agency Jurisdiction Table 5.5-1. The table should add a row to list the responsible state regulator (registration, use tracking, and enforcement), the California Department of Pesticide Regulation (CDPR). FIFRA allows individual state registrations to be more restrictive than federal registrations, but not less.

Table 5.5-1 has been modified as shown below (additions are indicated in bold italics).

Table 5.5-1 Agency Jurisdiction and Project Approvals

Agency	*Applicable Law or Regulation*	*Authority or Permit Action*
	FEDERAL	
U.S. Environmental Protection Agency	NEPA Clean Water Act (CWA) Clean Air Act (CAA)	NEPA compliance CWA Section 404(b)(1) guidelines compliance CAA Section 309 compliance
U.S. Army Corps of Engineers	Clean Water Act (CWA) Rivers and Harbors Act (RHA)	CWA Section 404 permit and Section 404(b)(1) guidelines compliance RHA Section 10 permit
U.S. Fish and Wildlife Service	Endangered Species Act (ESA) Fish and Wildlife Coordination Act	ESA Section 7 Biological Opinion and Incidental Take Statement
National Oceanic and Atmospheric Administration Fisheries (formerly National Marine Fisheries Service)	ESA Marine Mammal Protection Act (MMPA) Magnuson-Stevenson Fishery Conservation and Management Act	ESA and MMPA Section 7 Biological Opinion and Incidental Take Statement
	STATE	
California Coastal Conservancy	California Environmental Quality Act (CEQA)	CEQA compliance and funding approvals

Agency	*Applicable Law or Regulation*	*Authority or Permit Action*
Department of Fish and Game	California Endangered Species Act (CESA) California Public Resources Code (CPRC)	CESA Section 2081 permit CPRC Section 1601 Streambed Alteration Agreement
State Lands Commission	California Public Resources Code (CPRC)	Permits for work on State lands
Air Resources Board	California Clean Air Act	Review EIS/R for compliance with local attainment plans
REGIONAL		
San Francisco Regional Water Quality Control Board	CWA San Francisco Bay Area Basin Plan	CWA Section 401 certification or waiver CWA Section 402 National Pollutant Discharge Elimination System (NPDES) Permit
San Francisco Bay Conservation and Development Commission	(Federal) Coastal Zone Management Act McAteer-Petris Act	Coastal Development Permit(s)
California Department of Pesticide Regulation (CDPR)	***California Food & Agriculture Code, Divisions 6,7 & 13*** ***California Code of Regulations (CCR) Title 3, Division 6, Chapters 1-4***	***Controls use of pesticides***
LOCAL		
Air Pollution Control or Mosquito Abatement Districts	Local policies	Permits to use chemical methods or conduct controlled burns
Agricultural Commissioners	Local policies ***and CDPR regulations (see above)***	Authorization or permits for conducting prescribed burns; ***Implement Calif. Department of Pesticide Regulations requirements within their respective counties***.

Comment C 12: <u>Table 5.5-1</u>. The table should also list responsibilities of (CACs) in ensuring commercial applicators (especially if aerial) are properly licensed, use written recommendations, file Notices of Intent, use proper techniques, and report pesticide usage. Often a recommendation will stipulate provisions that must apply before a spray can receive a go-ahead. The CAC would be responsible for the investigation of any complaint. If a sensitive receptor is nearby, the Commissioner may also require a Notice of Intent before a specific application, even of glyphosate, supervise the treatment, or require other specific tasks in a given treatment.

The County Agricultural Commissioners (CAC) implement the laws and regulations for the California Department of Pesticide Regulation (DPR) within their respective counties. Table 5.5-1 has been revised to add this responsibility in response to comment C 11, above.

Comment C 13: <u>Appendix E215</u>. Isn't the aquatic toxicity of LI-700 relatively high? If it were used as a 5% solution (instead of the adjuvant 1/8 to _%), it would probably act as an ef-

fective herbicide by itself. And if Monsanto had to remove the X-77 from the Roundup formulation to obtain EPA registration for aquatic use of glyphosate (as Rodeo formulation), why does USFWS approve this adjuvant for aquatic use?

As explained on page 2-16, the ISP selected the proposed surfactants (including LI-700) because they are among the least toxic of the available surfactants. The referenced product label (Appendix E-215) provides the aquatic acute toxicity for three freshwater species, including rainbow trout, bluegill sunfish, and daphnia magna. The 24-hour lethal 50% concentrations for LI-700 for these species are 140 mg/L, 220 mg/L, and 450 mg/L, respectively – an order of magnitude higher than the worst-case, undiluted concentration to be applied by the ISP. Additional discussion on the potential effects of surfactants on biota in the estuarine environment is included on pages 3.3-24 through 3.3-31.

LI-700 is an acidifier and its hazardous component is propionic acid. Although it may be possible that LI-700 at a high enough concentration could be an herbicide, the ISP does not propose the use of LI-700 alone as an herbicide and does not plan to investigate such a use at this time. The ISP technical staff is not aware of a published USFWS "approval" of LI-700 for aquatic use. The ISP will continue to evaluate surfactant toxicity as part of the Monitoring Program, and will incorporate the use of less toxic surfactants as they are identified.

The USFWS does not provide approval of the use of any chemcial; the USFWS reviews and evaluates the use and effects on wildlife**;** and provides regulatory guidance, suggestions, measures and recommendations to lessen exposure and effects.

(D)

Making San Francisco Bay Better

June 2, 2003

Maxene Spellman
Project Manager
State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612

SUBJECT: San Francisco Estuary Invasive Spartina Project: Spartina Control Program Draft Programmatic EIR/EIS

Dear Maxene:

Thank you for the opportunity to comment on the above referenced Programmatic EIR/EIS. Although our Commission has not had the opportunity to review the document, and therefore these are staff comments, they are based on the Commission's law, the McAteer-Petris Act, and the provisions of its *San Francisco Bay Plan*.

As stated in the Programmatic EIR/EIS for the Spartina Control Program, the character of San Francisco Bay's estuarine ecosystem is defined by its expansive tidal flats and tidal marshes. Characteristic aspects of the Bay's tidal habitats include tidal sloughs and channels, salt marsh pans, mudflats, the mix of native plant species such as Pacific cordgrass, pickleweed and saltgrass, and the wildlife reliant on these tidal marshes and tidal flats, including California clapper rails, migrating shorebirds, and salt marsh harvest mice. However, due to the Bay's invasion by four species of non-native cordgrass, the unique nature of the Bay's habitats appears at risk of being redefined. 1

Based upon the international significance of the San Francisco Bay ecosystem and the potential for harm which could occur with the uncontrolled spread of non-native cordgrass species, it appears there is merit with moving forward with an invasive spartina control program, as proposed in the Programmatic EIR/EIS. However, we believe the program should incorporate a number of precautionary approaches which account for the disparity between potential tremendous short-term damage to tidal habitats associated with the proposed program and long-term benefits that may be associated with the control of non-native cordgrass species in San Francisco Bay. 2 Thus, the primary focus of the program for the foreseeable future should be, we believe, to ensure the success and public understanding and acceptance of the proposed pilot studies. These pilot studies should: (1) demonstrate the efficacy of the program's treatment methods; (2) illustrate the recovery of impacted habitats post control treatment; (3) incorporate the best available scientific expertise; (4) utilize adaptive management in a manner which informs approaches that may be used later on a larger scale; (5) demonstrate successes in order to lend legitimacy to the program, thereby improving the potential for greater public agency support, including funding; and (6) serve as a foundation for educating the public about the program in an effort to build long-term public support. 3

Any person or government agency wishing to place fill, extract materials or make any sub-
stantial change in use of any water, land or structure within the area of the Commission's juris-
diction requires a Commission permit or federal consistency determination. The Commission's
jurisdiction includes San Francisco Bay, including tidal flats and subtidal areas, and marshlands
lying between mean high tide and five feet above mean sea level, and a 100 foot shoreline band
measured inland from the Bay shoreline, as well as certain waterways, such as Coyote Creek, as 4
defined by Section 66610 of the McAteer-Petris Act. Thus, before a variety of activities specified
in the EIR/EIS may proceed, such as flooding and draining or mechanical excavation and
dredging of tidal marshes, the Coastal Conservancy and the United States Fish and Wildlife
Service must obtain either a Commission permit or concurrence with a federal consistency de-
termination.

We recommend that the design of the Spartina Control Program include: (1) coordinating
the eradication of non-native cordgrass with an assessment of the most effective way of re- 5
vegetating test plots with native vegetation (e.g. evaluating whether native vegetation colonizes
an area more quickly when planted and testing different planting approaches); (2) creating a 6
well-defined schedule describing where and when specific pilot project activities will occur; (3)
continuing to consider the need for compensatory mitigation associated with impacts to Cali- 7
fornia clapper rails; (4) continuing to recognize the need for work windows in areas where sen- 8
sitive species are located, including sensitive aquatic species; (5) defining sources and amounts 9
of available funding; (6) monitoring the results of pilot projects and disseminating that infor- 10
mation to agencies, non-governmental organizations and the public; and (7) incorporating in-
terpretive signage into pilot project design in order to educate the public about what they may 11
be seeing at their neighborhood marsh.

In addition, Section 5.2.4 in the EIR/EIS should include a discussion of the *San Francisco Bay
Plan* policies pertaining to dredging and should also be updated to reflect the most recent
amendment to the Fish, Other Aquatic Organisms and Wildlife and Tidal Marshes and Tidal 12
Flats Bay Plan policies (see the Commission's website at www.bcdc.ca.gov).

Should you have any questions or concerns regarding the comments mentioned above please do not hesitate to contact me at 415/352-3642 or (katew@bcdc.ca.gov). I look forward to working with you on this important effort.

Sincerely,

KATHERINE WOOD
Coastal Planner

D. Bay Conservation and Development Commission

Comment D 1:
Comment noted.

Comment D 2: The program should incorporate a number of precautionary approaches which account for the disparity between potential tremendous short-term damage to tidal habitats....

The ISP agrees that great care must be taken in the planning and implementing of control projects within the estuary in order to minimize adverse effects, but we do not anticipate "tremendous" short-term damage as a tradeoff for the long-term benefit of eradicating invasive *Spartina*. The EIS/R documents the environmental impacts that would occur as a result of implementation of the program. Many of the ISP projects are unlikely to involve more than minor to moderate short-term damage in very localized areas. And some projects would result in fairly immediate benefit, with little adverse effect. For example, removing discrete colonies of Spartina alterniflora hybrids on mudflats, away from tidal sloughs and established native vegetation, would restore mudflats with relatively low impact; in such cases, de-vegetation would not be damage, but restoration.

Comment D 3: Primary focus of program for the foreseeable future should be, we believe, to ensure the success and public understanding and acceptance of the proposed pilot studies. These pilot studies should: (1) demonstrate efficacy of the program's treatment methods; (2) illustrate the recovery of impacted habitats post control treatment; (3) incorporate the best available scientific expertise; (4) utilize adaptive management in a matter which informs approaches that may be used later on a larger scale; (5) demonstrates success in order to lend legitimacy to the program, thereby improving the potential for greater public agency support, including funding; and (6) serve as a foundation for educating the public about the program in an effort to build long-term support.

The ISP concurs with the commenter's goals for the pilot studies. These are already incorporated into the program strategy and the ISP Implementation Plan. The ISP's priority on demonstrating efficacy of treatment methods is reflected in the project description and program approach (see EIS/R, Section 2.2). It is further reflected in the current development of pilot projects.

The ISP will implement a program of Integrated Vegetation Management and adaptively manage the project to incorporate new data and findings into its objectives and strategies. To accomplish this goal, it will be necessary to evaluate, on an ongoing basis, a wide variety of scientific, technical, and socio-political information, and to strategically integrate the conclusions into the ISP. As the ISP will not have sufficient scientific and technical experts on staff to adequately consider and address all such issues, it will rely on the input and expertise of outside experts. The ISP is in the process of forming four special support groups for this purpose, including a Science Advisory Panel, a Monitoring Technical Review Team, a Field Operations Group, and a Steering Committee. A brief description of each group follows:

- The Science Advisory Panel will be comprised of local and regional scientists with expertise in wetlands, restoration, ecosystem science, weed control, ecosystem dynamics, and so on. They will advise on the ISP's objectives (e.g., eradication vs. control) and strategy, identify research needs, and act as a conduit to national and/or international scientific opinion. The Science Advisory Panel is expected to meet for the first time in August – a list of preliminary invitees and a draft agenda is available on the ISP website (www.spartina.org). After initial formulation, briefing, and review, the group will meet at least annually.
- The Monitoring Review Team will be comprised of local biologists and regulatory agency staff with expertise in data collection and analysis. The Monitoring Review Team will review and revise protocols for collecting, reporting, and evaluating a range of data, including the spread of non-native *Spartina*, treatment impacts (including water quality), and treatment efficacy. The Monitoring Review Team has not yet met, but the ISP has been consulting individually with local experts while developing the various monitoring plans. We are currently considering ways to coordinate our Monitoring Review Team with existing monitoring efforts, such as the San Francisco Estuary Institute's Aquatic Pesticide Monitoring Program and the San Francisco Bay Area Wetlands Recovery Program's Monitoring Group. The Monitoring Review Team will review this season's monitoring results in the late winter to early spring, to begin developing recommendations for next year.
- The Field Operations Group will be comprised of individuals with current hands-on experience applying *Spartina* treatment methods. They will provide feedback and guidance before and after each treatment season regarding the problems and advantages, including efficacy and cost, of each treatment method, and help to prioritize treatment projects. The Field Operations Group has met twice, most recently in February of this year (see the ISP website, www.spartina.org, for participants and meeting records). It will meet again at the end of this treatment season to discuss the season's efforts and develop strategies for next year.
- The Steering Committee will be comprised of landowners and managers, regulatory agencies, and environmental interests. It will keep the ISP apprised of individual and community interests, and will assist ISP management in balancing the many overlapping and sometimes conflicting values. A list of potential Steering Committee participants has been developed and is being contacted. Again, we want to coordinate this group with existing efforts, such as the San Francisco Bay Area Joint Venture, and the South Bay Salt Pond Restoration Project Stakeholders Assessment. It is expected that the Steering Committee, once formulated, will meet quarterly.

In specific response to the question of timeline for reassessing goals and methods, it is a continual process, with a focused assessment in the winter following each treatment season. At the current time, the ISP expects that enough data will be available in 5-6 years to reassess the overarching goal of eradication of non-native Spartina. The criteria by which this objective might be evaluated were discussed on page 2-17 of the EIS/R.

Comment D 4: Required BCDC Permits

Comment noted. Local lead agencies of specific control projects will coordinate closely with BCDC staff and obtain all required BCDC permits and CZMA concurrences.

Comment D 5: We recommend the design of the *Spartina* Control Program include (1) coordinating the eradication of non-native cordgrass with an assessment of the most effective way of revegetating test plots with native vegetation.

Regarding comment item (1), please refer to page 2-21, lines 12-37, EIS/R and mitigation measure BIO-2 (p. 3.3-34). Revegetation would be appropriate in limited circumstances, depending on objectives for restoration of mudflat or marsh, and the species affected. For most *S. alterniflora* hybrid eradication on intertidal flats and estuarine beaches, no revegetation would be justified because the objective would be to restore unvegetated substrate. For most *S. alterniflora* hybrid eradication in low marshes adjacent to sources of hybrid cordgrass seed or pollen, rapid replanting with native cordgrass (*S. foliosa*) would interfere with detection of re-invasion, and may facilitate hybrid seedling nurseries. Revegetation with native cordgrass is recommended only where re-invasion rates have been confirmed by monitoring to be insignificant; otherwise, it would undermine the effectiveness and purpose of non-native cordgrass eradication. Where *S. alterniflora* hybrids have caused sediment accretion above Mean High Water, pickleweed is likely to colonize treatment areas spontaneously and rapidly, as results in Cogswell Marsh have indicated. If natural revegetation by pickleweed at suitable elevations is insufficient, it may be supplemented by planting, but this is not expected to occur often. In contrast, removal of *S. densiflora* and *S. patens* in large patches would involve some native revegetation to prevent excessive invasion by other marsh weeds (such as perennial pepperweed, *Lepidium latifolium*) and to replace habitat structure in the high marsh. These are examples rather than rules: revegetation plans would be considered for each individual project based on evaluation of overall vegetation (or de-vegetation) objectives, local wildlife habitat needs, natural revegetation rates and processes, and potential interactions with other wetland weeds.

Comment D 6: We recommend….(2) creating a well defined schedule describing where and when specific pilot project activities will occur;

The ISP is currently developing site-specific plans for the pilot projects, which will include project schedules.

Comment D 7: We recommend…(3) continuing to consider the need for compensatory mitigation associated with impacts to California clapper rails;

Compensatory mitigation for clapper rails will be part of the programmatic Section 7 (internal) consultation with U.S. Fish and Wildlife Service. Individual projects and federal lead agencies will also consult with USFWS regarding adequacy of compensatory mitigation for control projects which may cause substantial net local short-term reduction of rail populations and habitats. The ISP will also coordinate internally with large-scale tidal marsh restoration projects to ensure that the viability of the south bay clapper rail population overall is enhanced rather than diminished during the course of the ISP.

Comment D 8: We recommend…(4) continuing to recognize the need for work windows in areas where sensitive species are located…

Comment noted. Work windows will be observed as described in the EIS/R.

Comment D 9: We recommend…(5) defining sources and amounts of available funding;

Please refer to Response to Comment A 8.

Comment D 10: We recommend…(6) monitoring the results of pilot projects and disseminating that information to agencies, non-governmental organizations, and the public;

The ISP is working with San Francisco Estuary Institute (SFEI) Aquatic Pesticide Monitoring Program, the Regional Water Quality Control Board, and regional experts to develop a comprehensive monitoring program that will investigate treatment efficacy, spread/presence of non-native *Spartina,* water quality, invertebrates, and other factors. Please see Response to Comments A 7 for additional information on process. The results of all monitoring efforts will be made available on our project website and/or through SFEI.

Comment D 11: We recommend… (7) incorporating interpretive signage into pilot project design in order to educate the public…

Please see Response to Comment A 4.

Comment D 12: Section 5.2.4 should include a discussion of the San Francisco Bay Plan policies pertaining to dredging and should also be updated to reflect the most recent amendment to the Fish, Other Aquatic Organisms and Wildlife and Tidal marshes and Tidal Flats Bay Plan policies (see the Commissions website at www.bcdc.ca.gov)
]

The most recent Bay Plan policies for Fish, Other Aquatic Organisms and Wildlife and Tidal marshes and Tidal Flats Bay Plan, adopted in April 2002, were used in the EIS/R. The EIS/R provides a summary of the policies. Readers should refer to the Bay Plan for details.

The following has been added to Section 5.2.4 on p. 5-9 of the EIS/R.

> *Dredging Policies of the Bay Plan*
>
> *Dredging and dredged material disposal should be conducted in an environmentally and economically sound manner. Dredging should be authorized when the Commission can find that the dredging is needed to serve a water-oriented use or other important public purpose; the materials meet the water quality requirements of the San Francisco Bay Regional Water Quality Control Board; natural resources would be protected; the project will result in the minimum dredging volume necessary; and dredged materials are disposed of properly. Dredging projects should be carefully designed so as not to undermine the stability of any adjacent dikes, fills or fish and wildlife habitats.*

E

-----Original Message-----
From: Steve Schoenig [mailto:SSchoenig@cdfa.ca.gov]
Sent: Wednesday, June 04, 2003 12:07 PM
To: prolofson2@earthlink.net
Subject: EIR Comments

The Integrated Pest Control Branch of the California Department of Food and Agriculture would like to register support for the Spartina Control Program. The threat of the invasive Spartinas to the bay ecosystem is enormous and endangers the success all other restoration efforts which are being conducted. The potential economic costs of failed restoration is, at least, in the tens of millions of dollars. 1

We feel the draft EIR has fully addressed all important environmental concerns and the only viable Project Alternative is Number 1 - Regional Eradication Using All Available Control Methods. Alternatives 2 and 3 will lead to continued spread of invasive spartina and resulting ecological degradation.

=-=
Steve Schoenig -- Senior Environmental Research Scientist
Integrated Pest Control Branch -- Calif. Dept. of Food & Ag
1220 N St, Room A357, Sacramento CA 95814 (916)-654-0768
=-=

E. California Department of Food and Agriculture – Integrated Pest Control Branch

Comment E 1:

Comment noted.

(F)

STATE OF CALIFORNIA
Governor's Office of Planning and Research
State Clearinghouse

Gray Davis
Governor

Tal Finney
Interim Director

June 3, 2003

Maxene Spellman
California State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612

Subject: The San Francisco Estuary Invasive Spartina Project
SCH#: 2001042058

Dear Maxene Spellman:

The State Clearinghouse submitted the above named Joint Document to selected state agencies for review. The review period closed on June 2, 2003, and no state agencies submitted comments by that date. This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act. 1

Please call the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process. If you have a question about the above-named project, please refer to the ten-digit State Clearinghouse number when contacting this office.

Sincerely,

Terry Roberts

Terry Roberts
Director, State Clearinghouse

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OAKLAND, CALIF.

Document Details Report
State Clearinghouse Data Base

SCH# 2001042058
Project Title The San Francisco Estuary Invasive Spartina Project
Lead Agency State Coastal Conservancy

Type JD Joint Document

Description The Spartina Control Program (SCP) proposes to implement a number of treatment techniques (tools) to eradicate the four invasive non-native cordgrass species. These include a range of manual, mechanical, and chemical techniques including hand digging, smothering, use of herbicides, dredging, mowing, maceration, burning, and flooding. The geographic focus includes the nearly 40,000 acres of tidal marsh and 29,000 acres of tidal flats that comprise the shoreline areas of the nine Bay Area counties, including Alameda, Contra, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties. Currently, about 5,000 gross acres of marshland are infested with about 500 net acres of invasive cordgrasses.

Lead Agency Contact

Name Maxene Spellman
Agency California State Coastal Conservancy
Phone 510-286-1015 **Fax** 510-286-0470
email
Address 1330 Broadway, 11th Floor
City Oakland **State** CA **Zip** 94612

Project Location

County Alameda, Contra Costa, Santa Clara, San Mateo, ...
City
Region
Cross Streets
Parcel No.
Township **Range** **Section** **Base**

Proximity to:

Highways
Airports SFO, Oakland Int'l
Railways
Waterways San Francisco Bay/Estuary and tributary channels
Schools
Land Use Numerous land use and zoning designations throughout the San Francisco Estuary region.

Project Issues Aesthetic/Visual; Air Quality; Archaeologic-Historic; Coastal Zone; Drainage/Absorption; Economics/Jobs; Flood Plain/Flooding; Noise; Public Services; Recreation/Parks; Soil Erosion/Compaction/Grading; Toxic/Hazardous; Vegetation; Water Quality; Wetland/Riparian; Wildlife; Landuse; Cumulative Effects

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Reviewing Agencies Resources Agency; Department of Boating and Waterways; Department of Fish and Game, Headquarters; Department of Parks and Recreation; San Francisco Bay Conservation and Development Commission; Department of Water Resources; Caltrans, District 4; State Water Resources Control Board, Division of Water Quality; Regional Water Quality Control Board, Region 2; Native American Heritage Commission

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Date Received 04/17/2003 **Start of Review** 04/17/2003 **End of Review** 06/02/2003

F. State Clearinghouse

Comment F 1: State Clearinghouse receipt of EIR.

Comment noted.

EAST BAY REGIONAL PARKS FOR THE FUTURE PARK DISTRICT (G)

May 4, 2003

Ms. Maxene Spellman
Invasive Spartina Project Manager
State Coastal Conservancy
1330 Broadway, Suite 1100
Oakland, Ca 94612

Subject: Comments on Draft EIS/EIR for San Francisco Estuary Invasive Spartina Project: Spartina Control Program

Dear Ms. Spellman:

Thank you for the opportunity to comment on the subject draft EIR/EIS. Since the East Bay Regional Park District has been and will continue to cooperate as a regional partner in the proposed Spartina control program, we are especially appreciative of the excellent work effort reflected in the draft EIR/EIS. Our comments are, therefore, relatively brief and in two categories: 1. Areas of discussion that would benefit from expansion, and, 2. Areas of discussion that require some corrections or additions.

1. Areas of discussion that would benefit from expansion:
   a. potential effects of non-native cordgrass expansion on benthic (food chain) organisms and its consequences to fish and bird species that utilize wetlands and tidal mudflats; 1
   b. general impacts of proposed physical treatment methods including amphibious or track vehicles on aquatic and benthic communities; 2
   c. potential use of other more effective chemical control agents (other than glyphosate) such as Arsenal that have been used experimentally in Washington. 3
2. Areas of discussion that require some corrections or additions:
   a. pg.2-16 suggests glyphosate application to cut stems might be in the form of a "paste", however, the manufactures' label does not describe this technique as an alternative; 4
   b. there is no mention as part of the control alternatives that a site specific pest control recommendation is required as per CDFA and Cal-EPA for mitigation to apply an herbicide in a non-residential, non-commercial site; 5

c. X-77 (Loveland) surfactant is referred to in several sections of the document but information on and evaluation of this material is lacking (label and MSDS should be included in Appendix E). 6

We look forward to finalization of this document and implementation of the control program for this invasive species in the near future.

Sincerely,

Kenneth R. Burger

Kenneth R. Burger
Stewardship Manager

EAST BAY REGIONAL PARK DISTRICT

July 14, 2003

Ms. Maxene Spellman
Invasive Spartina Project Manager
State Coastal Conservancy
1330 Broadway, Suite 1100
Oakland, Ca 94612

Subject: Addendum to Comments on the Invasive *Spartina* Project Draft Programmatic Environmental Impact Statement/Environmental Impact Report (EIS/EIR)

Dear Ms. Spellman:

Pursuant to my conversations with Peggy Olofson, please append the following comments to those provided in the District letter dated May 4, 2003. We appreciate your accommodation of this addition.

Comment:

The Draft Programmatic EIS/EIR appears not to incorporate significant studies and findings possibly relevant to the implementation of the *Spartina* Control Program. Specifically, in 1999 the District performed a study on the status of the California clapper rail in the East Bay Regional Park District (Bobzien and DiDonato, 1999). A nesting study performed at Cogswell Marsh, Hayward, a restored marsh site dominated by *S. alterniflora* hybrids, found the following:

- There is a high rate of nest establishment by California clapper rails in this marsh (27 nests within 98.9 acres, with 22 of those within 34.6 acres of the site). 7
- No California clapper rail nests were found in native vegetation at the site.
- Other factors being equal (e.g., predator control and proper siting of public access), the data suggests a positive correlation between the presence of *S. alterniflora* and establishment of California clapper rail nests.

Reference:

Bobzien, S. and J. DiDonato. 1999. "Status of the California Clapper Rail (*Rallus longirostris obsoletus*) in the East Bay Regional Park District, California." Annual report of activities conducted under USFWS Permit PRT-817400 for the take of California clapper rail. East Bay Regional Park District, 2950 Peralta Oaks Court, Oakland, CA 94605.

We recommend these findings be included in the final EIS/EIR, and that additional research be done into the ability and potential preference of California clapper rail to use *S. alterniflora* habitat, and its implications for recovery of the species.

Sincerely,

Joseph DiDonato
Stewardship Manager

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G. EAST BAY REGIONAL PARK DISTRICT

Comment G 1: Discuss further potential effects of non-native cordgrass expansion on benthic organisms providing trophic (food chain) support. Discuss further general impacts of physical treatment methods on aquatic and benthic communities.

Atlantic smooth cordgrass develops a network of fiber-rich rhizomes and roots which accumulate as a peaty mesh. Cordgrass peat generally does not support the same soft-bottom benthos as unconsolidated bay mud (such as bivalve mollusks), and those invertebrates that to inhabit the substrate under cordgrass canopies and within young peat may be largely unavailable to bottom-feeding fish that forage over mudflats, such as bat rays. Invertebrate production may be substantial within cordgrass canopies, including prey items of clapper rails, such as crabs, insects (adults and larvae) and polychaete worms. There are very limited data on invertebrate abundance comparisons among native and non-native cordgrasses and mudflats in San Francisco Bay. Interpretation of such data may be complicated by seasonal movements or naturally high seasonal variation in some species. Polychaete worm abundance was greater under native Pacific cordgrass than under Atlantic smooth cordgrass or bare mudflat in one San Francisco Bay study (Josselyn et al. 1993), but crustacean abundance was significantly higher under Atlantic smooth cordgrass at one site, but not another. Bivalve abundance. Introduction of Atlantic smooth cordgrass to mudflats of China resulted in increased production of crabs and nereid worms.

Based on available data, significance of non-native cordgrass expansion on the availability of invertebrates to different classes of consumers, and the types of invertebrate prey items, may be more significant than effects on invertebrate production itself. We propose that the most significant effect of non-native cordgrass expansion on trophic support would be between soft-bottom benthic invertebrates and shorebirds. Shorebirds generally do not forage in dense, tall, continuous canopies of cordgrass, and invertebrate production within them would be unavailable to shorebirds. Atlantic smooth cordgrass is most likely to colonize the uppermost intertidal mudflats that remain exposed relatively longest during rising tides, reducing shorebird foraging time during the tidal cycle.

As described in the EIS/R, mechanical removal based on substrate disturbance with no sediment discharge (maceration, discing) would cause increased short-term availability of benthic infauna to predators at low tide, and may attract shorebirds. In open mudflats subject to daily wave-induced resuspension and redeposition of surface sediments during tidal submergence, benthic organisms capable of rapid dispersal would recolonize the substrate in one to several tidal cycles. In this respect, recently disturbed substrate would behave superficially in a manner similar to undisturbed mudflats. In contrast, sedentary infauna, such as bivalves, would recover biomass within a period of months: populations would have to regenerate through slower recolonization and growth in place. This type of invertebrate recolonization would be similar to annual cycles of erosion and deposition (between erosional winter and depositional summer mudflat profiles) near channels of major sloughs and flood control channels. It would occur at relatively smaller scales in most cases of *Spartina alterniflora* removal. Most of the invertebrate infaunal biomass would probably be non-native, as in most of San Francisco Bay.

Where dredging or excavation is used to remove low marsh infested with non-native *Spartina alterniflora* hybrids, substrate removal is proposed to occur at low tide. In this case, more rapid sedimentation is expected to occur in many cases where the profiles of channels and flats are depressed below equilibrium elevations. Backfill of excavated sediments during dredging would cause local and temporary increases in availability invertebrate prey to shorebird and gull predators. Exposure of deeper bay mud would initially result in minimal local benthic invertebrate biomass, but rapidly deposited (and oxygen-exposed) suspended muds would become rapidly recolonized when submerged, as in dredging sites. Extremely rapid sediment accretion may temporarily reduce the accumulation of invertebrate biomass at the rising mud surface. When surface sediment elevations begin to stabilize, the new mudflat/channel bank surface would then build up benthic invertebrate biomass. The species composition of the benthic invertebrate community may change following disturbance, depending on the relative abundance of dispersing larval species during recolonization, season, and salinity. In any case, most of the benthic invertebrate community would likely be non-native. Dredging and excavation would result in moderate short-term decline in invertebrate production, but would probably recover within months as intertidal elevations rebound. This would be analogous with navigational dredging of shallow marinas.

Comment G 2:

See response to Comment G 1, above.

Comment G 3: Discuss further other more effective chemical control agents than glyphosate.

See response to Comment C 3. The ISP would consider other herbicides that are at least as effective as glyphosate only if their use would result in lower risk of potential toxic effects on fish and wildlife specific to shallow intertidal and subtidal estuarine environments, based on the best available peer-reviewed scientific research.

Comment G 4. Cut-stump application of glyphosate in paste carrier is not covered on manufacturer's label (EIR/S p. 2-16).

The ISP technical staff agrees with the comment. This modification of glyphosate application (to reduce total dose and minimize non-target contact with herbicide) is similar to direct contact wiping/wicking of solution, but the use of a paste carrier (such as lanolin) would be experimental and require research permits from the RWQCB. Cut-stump herbicide treatments are widely used in wildland weed control.

Comment G 5: There is no mention as part of the control alternatives that a specific pest control recommendation is required, as per CDFA and CalEPA for mitigation to apply an herbicide in a non-residential, non-commercial site.

Comment noted. Under the control program, prior to the use of an herbicide, each proposed treatment site will have a site-specific pest control recommendation provided by a "Pest Control Adviser" who is licensed pursuant to the California statute regulating the application of pesticides (Food and Agriculture Code §§11401 et seq,). There is considerable ambiguity under this statute as to whether an official recommendation by a licensed "Pest Control Adviser" is required for the use of an herbicide on publicly owned lands not easily accessible to the public but preserved for wildlife habitat, such as the marshlands and mudflats within which the ISP proposes to do chemical control work. Historically, CDFA has found these types of public areas exempt from these regulations. (V. Guise, Contra Costa County Deputy Ag. Commissioner, pers. comm.)

Nonetheless, individual County Agricultural Commissions may require such recommendations for spray work within the marshlands as proposed by the ISP, even if CDFA typically has a more lenient interpretation of the statute. Accordingly, the ISP, in an effort to follow the intent and spirit of the statute, will require a written recommendation by a California licensed "Pest Control Adviser for each site-specific plan which includes the use of herbicide.

Comment G 6: X-77 (Loveland) surfactant is referred to in several sections of the document, but information on and evaluation of this material is lacking. Label and MSDS should be included in Appendix E).

The ISP does not intend to use X-77. On page 3.6-4, line 38, "X-77®" has been deleted in the sentence as follows:

> *Mammalian studies indicate that the surfactants Agridex®, ~~X-77®,~~ R-11®, and LI-700® are practically nontoxic to rats and rabbits, but Agridex®, R-11® and LI-700® are rated as corrosive, based on eye irritation in rabbits.*

Comment G 7: EIS/EIR omits reference to relevant California clapper rail research.

The ISP is aware of the referenced study and generally referred to its findings in the DEIS/R (e.g., see page 1-27, lines 17-20 and page 3.3-11, lines 16-18). However, in an effort to be consistent with the intent of CEQA and NEPA, the EIS/EIR authors chose to provide a limited number of representative technical references rather than comprehensive selection. This principle was generally applied to discussion of biological resources and impacts, except for herbicide ecotoxicity issues. The reasons for limiting technical discussion to what is as readable for the general public are grounded in NEPA and CEQA regulations. NEPA regulations require EIS documents, which are not "encyclopaedic" and reduce emphasis on background material (40 CFR 1502.16, 1502.2(a)), but analytic, focusing on major issues and alternatives (40 CFR 1500.2(b)). Similar principles and language are found in CEQA regulations (CEQA Guidelines Section 15006)."

Also we note that, while the commenter and other local observations have shown that California clapper rails can use, and sometimes seemingly prefer, *Spartina alterniflora*, the ISP has concluded that additional research is warranted before broader, long-term projections can reasonably be made. See EIR/S text at 3.3-47, lines 4-5 and 19-34 for discussion of the uncertainty about long-term habitat suitability of large salt marshes dominated by variable height-forms of Atlantic smooth cordgrass."

In the interest of completeness and in response to this comment, the following text is inserted on page 1-27, line 20, following "tall cordgrass stands", and on page 3.3-11, line 18, following "(pers. comm.):

> *"(Bobzein and DiDonato 1999)".*

In addition, the following reference is added to Chapter 9.0 References, following "Bert-nes, M.D. and A.M. Ellison":

> *Bobzein and DiDonato. 1999. "Status of the California Clapper Rail (Rallus obsoletus longirostris) in the east Bay Regional Park District, California." Annual report of activities conducted under USFWS Permit PRT-817400 for the take of California clapper rail.*

PORT OF OAKLAND

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May 19, 2003

(H)

Ms. Maxene Spellman
Project Manager
State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612

Dear Ms. Spellman:

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT/REPORT ON THE SAN FRANCISCO ESTUARY INVASIVE SPARTINA PROJECT CONTROL PROGRAM

Thank you for the opportunity to review the document referenced above. The actions that are taken, or not taken, to control or eradicate invasive *Spartina* species will have a great impact upon the Bay, so it is important that we carefully evaluate them. Our comments on the document concern policy and implementation issues that will affect the effectiveness of the project.

As described in the document, uncoordinated and incomplete actions for controlling and eradicating invasive *Spartina* species (alternative number 3) are unlikely to lead to successful eradication, and therefore are likely to lead to long-term adverse impacts to the ecology of the Bay. However, there are several impediments to successful implementation of the preferred alternative that may ultimately lead to those same effects, as described below. 1

Our current understanding is that there is a shortfall in the funding available to implement the proposed alternative, "Regional eradication using all available control methods." The funding shortfall may cause the eradication efforts to be incomplete either in geographic scope or time, and thus be ineffective, given the capacity of some of the invasive species to spread aggressively to new locations and habitats and outcompete native species. Thus, some of the so-called "short-term" impacts from eradication actions may become long-term if repeated application becomes necessary, or in the worst case, the short-term impacts will not be offset by the long-term benefits of eradication.

The programmatic document is not explicit about what parties will be implementing the program. Although some property owners (e.g., flood control districts, etc.) may have the resources and incentives to control invasive species on their 2 property, other owners may not. Property owners may not grant right-of-entry to public agencies to all affected properties. If pockets of invasive species remain on some properties, these plants may be sufficient to repopulate areas where control measures have been implemented. The final document should address how control/eradication measures can be comprehensive given the patchwork of ownership on the bay margins. 2 (cont.)

Finally, the documents should address the probability of successful eradication/control for each of the alternatives. Given the large-scale nature of the invasions, the impacts of eradication/control measures, and the significant resources required to implement either of the control alternatives, policy makers should know the chances of success of the endeavor. 3

Thank you for your consideration of our comments.

Sincerely,

Joseph K. Wong
Director of Engineering

JZ: JKW

EP Project File: 2003048

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OAKLAND, CALIF.

H. PORT OF OAKLAND

Comment H 1: Our current understanding is that there is a shortfall in the funding available to implement the proposed alternative, "Regional eradication using all available control methods." The funding shortfall may cause the eradication efforts to be incomplete either in geographic scope or time, and thus be ineffective. .. Thus, some of the so-called "short-term" impacts from eradication actions may become long-term if repeated application becomes necessary, or in the worst case, the short-term impacts will not be offset by the long-term benefits of eradication.

Please see Response to Comment A 8.

Comment H 2: Property owners may not grant right-of-entry to public agencies to all affected properties. If pockets of invasive species remain on some properties, these plants may be sufficient to repopulate areas where control measures have been implemented.

The majority of intertidal lands in SF Bay are owned and managed by the State Lands Commission, U.S. Fish and Wildlife Service, East Bay Regional Park District, and other agencies that have expressed willingness to cooperate with the program. The ISP has no evidence of, or comment from, any private or public property owner of intertidal lands infested with non-native cordgrass who has indicated unwillingess to cooperate. Alternative approaches for sites where access is an issue may include access by boat or helicopter,. It appears unlikely that access would or could impair the feasibility of the ISP. The ISP also has an extensive public outreach program, as well as the addition of a signage program as described in D-3, above. Although unlikely, it is possible that there could be some resistance to treatment by some landowners. In those cases that the ISP would work with the landowners to develop an approach acceptable to them.

Comment H 3: Address probability of successful eradication/control for each alternative.

The relative potential success of each alternative is described in Section 4.1 of the EIS/EIR, Comparison of Alternatives.

nta Clara Valley
ater District

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June 2, 2003

I

Ms. Maxene Spellman
State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612
Fax (510) 286-0470

SUBJECT: Comments on Draft Programmatic Environmental Impact Statement/ Environmental Impact Report for the San Francisco Estuary Invasive Spartina Project: Spartina Control Program

Dear Ms. Spellman:

Thank you for the opportunity to review and comment on your April 18, 2003 Draft Programmatic Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the San Francisco Estuary Invasive Spartina Project (ISP). The Santa Clara Valley Water District (District) is eager to begin a coordinated approach in control of this invasive threat to our tidal wetlands and commends your efforts in preparing this comprehensive document.

District staff have reviewed the Draft EIS/EIR with particular attention to the threat of *Spartina alterniflora* invasion, and our program for its control in Santa Clara County. The District would like to adopt this document and utilize it for our own "Smooth Cordgrass Control Program" (District Cordgrass Program). The District's Cordgrass Program is a U.S. Army Corp of Engineers and California Department of Fish and Game, required permit condition of the 10-year Stream Maintenance Program Permits which were acquired this past year in July 2002. The purpose of the District's Cordgrass Program is to control existing and limit future infestations of invasive smooth cordgrass (*Spartina alterniflora*) in Santa Clara County tidal marshlands. Under the District's cordgrass program we will monitor the tidal, non-diked, areas within Santa Clara County, incorporating a portion of the adjacent Alameda County shoreline, for the presence of *Spartina alterniflora* and its hybrids. This monitoring will be conducted based on the guidelines provided by the Coastal Conservancy's Invasive Spartina Program (ISP). The monitoring will take place within the first two years of the program (2003 = year one). Concurrent with the on-going monitoring effort in year two, will be the initiation of the District's control component of the Cordgrass Program. Over a five year period, under this program, up to 10 acres of *Spartina alterniflora* or its hybrids will be eradicated within Santa Clara County.

Because the District plans to adopt this EIS/EIR for its Cordgrass Program in Santa Clara County, it is a 'Responsible Agency' (see comment on section 1.0 of the document for reference to this). In light of the District's Responsible Agency status and its own Cordgrass Program, which is a subset of the 10-year Stream Maintenance Program, we offer the following comments on your Draft EIS/EIR: 1
The District's comments are arranged with respect to the progression of the EIS/EIR.

Executive Summary
Page S-2, line 24: This sentence discusses four project alternatives that were selected for full
evaluation. The remainder of the document only discusses three alternatives. Suggest a simple 2
change to 3 rather than 4 alternatives in this text to be consistent throughout the document.

1.0 Introduction
Page 1-30 lines 27-37: This section addresses the use of this EIS/EIR by various local agencies and
specifies that an initial study checklist will be prepared for site-specific projects. The statement of
process provided here is correct, however Responsible Agencies, such as the District, have a specific
process to follow, found in CEQA Guidelines, Section 15096. Specifically, Section 15096 of the
CEQA guidelines allows the District (or other Responsible Agencies) to comply with CEQA by
reaching its own conclusions about how the portion of the program that it plans to carry out should
be approved. During the public process for the EIS/EIR, our obligation is to identify potential new
environmental impacts and recommend measures needed to eliminate the new significant effects. 3
After Certification of a Final EIS/EIR for the Coastal Conservancy's Invasive Spartina Program, the
District plans to adopt Findings and file a Notice of Decision for its Cordgrass Program. This means
that depending on the specifics of our project, the District may or may not need to prepare an initial
study check list. The District requests that the process for Responsible Agencies found in Section
15096 be incorporated in the "Use of the Document" section so District options on how to utilize this
program document for our CEQA compliance are not unnecessarily limited.

2.0 Program Alternatives
Page 2-12, line 30-31: This line needs clarification as it states that "Glyphosate…is the only
herbicide currently approved by the U.S. EPA for use in aquatic environments." There are several
other herbicides registered for use in aquatic environments. Did you mean that glyphosate is the only 4
U.S. EPA approved herbicide for estuarine environments? Can you please further clarify this point.

Table 2-1, Page 2-15 Row entitled 'Timing' with respect to the 'Herbicide Application' column: We
recommend that you further clarify the relationship between the plant lifecycle and the seasonality of 5
herbicide application, to reflect the fact that for the best systemic results, herbicides are most
effective when applied just prior to plant dormancy.

Page 2-16, lines 1-11: The District would like to note that our preferred surfactant is R-11. The
District regularly uses this surfactant as part of its vegetation management program and it is approved
as part of the Districts Pesticide Use Policy. The District would recommend R-11as the preferred 6
surfactant for this program based on personal experience and the research performed by Joel Trumbo
which showed low toxicity to exposed organisms.

Page 2-16, lines 38-41: The text mentions that herbicide is less effective on vegetation that has silt
residue from tidal action. The District can confirm this statement based on control efforts for
Lepidium latifolium in tidal areas. The District has found the technique of 'washing down' target
vegetation with fresh water to remove silt deposits, prior to herbicide application, improves herbicide 7
efficacy so the material is not bound up by the silt deposits on the foliage. This methodology,
however, should only be used in areas where tidal silt deposition on foliage is directly linked to
reduced herbicide efficacy as this technique is very costly and labor intensive.

Page 2-17, after line 2: Include a brief section here with regard to herbicide application techniques 8
and controlling 'spray drift'.

Page 2-18, lines 31-38: The District is concerned about the eminent delays for projects within California clapper rail territory. Santa Clara County is a 'hotspot' for clapper rails, yet it is also seen as a priority treatment location based on ISP's prioritization strategy of eradicating outliers to prevent further or new establishment of invasive cordgrass. The impending South Bay salt pond restoration projects would also deem the South Bay a priority candidate for cordgrass control. The District is concerned that current *Spartina alterniflora* infestation sites within the Santa Clara County could expand in size and thereby increase the impacts of cordgrass control treatments on clapper rails while awaiting independent consultation by the USFWS. Is there a way to streamline this process so that each project site will not require a separate consultation? The District would like to request a program-wide consultation for the District's Cordgrass Program. Additional comments on the clapper rail BMP's will be listed below in review of Appendix G. 9

Page 2-22, lines 11-12: Bair Island, Ravenswood Slough, and Mowry Slough are not in Santa Clara County. 10

Page 2-22, Alternative 2: You may want to further develop this alternative section to discuss the potential successes of using this alternative. Would alternative 2 fulfill the project goals by slowing or stopping the spread of Spartina spp.? 11

Page 2-24, lines 26-31: This section seems to be a quick dismissal of chemical only control methods with a lack of supporting evidence for the ecological, public health, and safety issues. There is no data or evidence presented here to support the underlying message that chemicals are of greater risk than other control methods such as mechanical controls. Alternative 1 as proposed in the program could be equally or more damaging than a chemical only method. The District does not disagree that the chemical only alternative is undesirable. However, without further clarification on why this alternative was not considered, this section could open up the document to future challenges. Providing some data to support the statements in this section may be beneficial. 12

<u>3.1 Geomorphology and Hydrology</u>

Page 3.1-9, Alternative 2, impacts: This section lacks the detail which may be necessary to convince people that alternative one is the superior alternative. Need to incorporate more detail on the increased mechanical impacts to the marsh by repetitive mechanical treatments. It may be useful to provide detail impact by impact for each mechanical method. 13

Page 3.1-9, line 34: Shouldn't this section say that more mitigation will be necessary due to repeated mechanical treatment than that of alternative 1? 14

<u>3.2 Water Quality</u>

Page 3.2-9, line 37: Line should read that "...a non-ionic surfactant is <u>recommended</u> whenever glyphosate is used in aquatic systems." The herbicide label does not 'require' the use of a surfactant. Use of a surfactant however, does significantly increase the efficacy of the herbicide in most applications. The label however, is the legal guiding document on how a herbicide is to be used. 15

Page 3.2-10, line 6: The sentence uses the word 'Caution.' This is a signal word in terms of herbicide use and has a specific legal and technical definition. If the document is going to use signal words as part of the narrative, you will need to provide a definition of what a signal word is, what they mean, and what relevance they have in terms of safety and use restrictions as they apply to the material. Include the terms 'signal word' and 'Caution' with definitions in the glossary of the document. 16

Page 3.2-10, line 22: Similar to statement above for line 6, why does this surfactant warrant a 'Danger' signal word? The document needs to provide this information to the reader. 17

Page 3.2-10, line 41: The document states that "data are unreliable" but offers no explanation for this statement. Can you please clarify this statement by adding a reference to another portion of the document or adding more information here? 18

Page 3.2-11, lines 3-28: The text needs to remind the reader that the proposed herbicide is formulated and approved for use in water (aquatic environments). While extensive contact with water is not the intent of the application technique, it is not necessarily an adverse impact due to the choice of materials being used. 19

<u>3.3 Biological Resources</u>

Page 3.3-27, lines 24-27: Need to mention here that glyphosate works well systemically in circumstances where the plant's vascular system translocates the chemical (i.e. when the plant is growing or as the plant is preparing for dormancy). 20

Page 3.3-32, line 41-42: In the context provided here, herbicide 'spray drift' and herbicide 'overspray' are essentially equal terms and it is redundant. Either delete one of the two terms or further clarify in the text what is meant by each (i.e., spray drift due to wind conditions and herbicide overspray due to operator error, etc.) 21

Page 3.3-33, lines 20-22: Non-target plant protection seems excessive, cumbersome and overly expensive. Proper selection of application equipment, trained licensed applicators coupled with management of equipment, pressure and wind conditions can significantly reduce drift off target so that none of these additional measures would be necessary. 22

Page 3.3-35, lines 9-26: Need to further qualify in this section whether or not pre-project surveys for sensitive plants need to be performed at all treatment sites regardless of location in the San Francisco Estuary, or just those mentioned in the preceding text on impacts (i.e., Southhampton Marsh, Point Pinole, Whittell Marsh, North Bay and Suisun Marshes). Requiring surveys at all treatment locations, regardless of the minimal potential for those species to occur, may cause delays in treatment work and would be cost prohibitive. 23

Page 3.3-37 line 18-19: The text states that "because of severe endangerment of the southern subspecies (salt marsh harvest mouse), any potential substantial risk of "take" of this species is significant." Does this mean compensatory mitigation will be necessary throughout the southern subspecies range at all treatment sites, or is this a mitigable impact at some sites? This point needs further clarification in the Mitigation section Bio 4-1.

Page 3.3-37-38, Mitigation Bio-4.1 (paragraph 1): The presumption in this section is that the salt marsh harvest mouse (SMHM) is present in areas with pickleweed. However, there is no mention of surveying to determine the presence of SMHM, there are no buffer areas proposed for vehicular storage or work, there is no mention of an on-site biological monitor in known locations of SMHM, and there is no suggested alterations, other than minimizing vehicle entry, to cordgrass control methods in these areas. The mitigation measures proposed in this section seem to be a bit short with respect to the potential impacts to the SMHM. You may want to suggest preferred control methods for projects in SMHM habitat. For example, it would seem that herbicide usage with backpack application in these areas could be the least impact method as long as drift is managed to avoid pickleweed. It would also appear that burning in these areas should be prohibited. This section of the 24 document could be challenged and may need further development of avoidance measures or best management practices to reduce effects on the SMHM.

Page 3.3-38, lines 10-20: This section needs further clarification of what is deemed as 'excessive' take or degradation of habitat with respect to the SMHM. Given that all of the District's jurisdiction falls within the range of the sensitive southern subspecies of SMHM, the District would like further clarification as to what mitigation measures can be implemented to minimize impacts to the SMHM and avoid compensatory mitigation. 24 (cont.)

Page 3.3-39, Mitigation Bio- 4.2: Might want to list the specific seal haul-out locations directly here in this section for future clarity sake. 25

Page 3.3-40, lines 34-38: This section needs further clarification of what is deemed as 'unavoidable significant impacts' and under what conditions compensatory mitigation will be required. Does this mean that following the BMP's listed in Appendix G will account for avoidance of significant impacts and the need for compensatory mitigation? Will each and every site with suitable clapper rail habitat require a separate section 7 consultation? Additionally, it is important to note here that other portions of this document argue, with merit, that the eradication of *Spartina alterniflora* could be considered a form of mitigation for potential impacts to the California clapper rail. The document should clearly state that the goals of the program itself are intended to significantly enhance the long term recovery of the California clapper rail. Additionally, should there be a specified distinction in this section with respect to clapper rail foraging habitat versus breeding habitat? Other comments on the clapper rail BMP's are listed below in review of Appendix G. 26

Page 3.3-42 lines 11-15: Lots of questions can be raised in this section of the document. Simply adopting mitigation measures based on an endangered species and applying them to other species which are designated as "species" of concern is not appropriate. These two classifications are very different and the guidelines for working around such organisms should be very different as well. For example, does this mean that surveys for each of these species will have to be performed at each and every treatment site if any of these species were found there within the past 10 years? Does this also mean that if they are found to be on-site a separate consultation will need to be conducted? You will want to clarify a few things here to avoid future misinterpretations. 27

Page 3.3-45, lines 10-11: Text says "...impacts would be improbable for most of the same reasons pertinent to steelhead and Chinook Salmon." You may need to further clarify which impacts would be pertinent amongst these species as the ecology of the salmonids and the tidewater goby are quite different. The tidewater goby impacts should be more similar to those of the section Bio-6.4 entitled "Effects on estuarine fish populations of shallow submerged intertidal mudflats and channels." You may want to revise this section to better reflect the ecology and life history of the tidewater goby rather than simply comparing it to salmonids. 28

<u>3.4 Air Quality</u>

Page 3.4-6, Mitigation AQ-3: Most of the measures proposed are either regulatory requirements or label requirements, which are legally binding. These requirements will normally be called out in a Pest Control Recommendation provided by a California Licensed Pest Control Advisor. The District requests that you add to this section the requirement that all herbicide work will be performed based on the label requirements and with a current recommendation by a licensed Pest Control Advisor. 29

Page 3.4-6, line 30: The text uses the term 're-entry period' which is a legal term found on the
herbicide label. Make sure that any specified 're-entry period' is consistent with the label
requirements. If this mitigation is proposing anything other than the specified period on the label for 30
the specific herbicide, please use another term. Also, please include the term 're-entry period' in the
glossary section of the document.

3.6 Human Health and Safety

Page 3.6-5, line 14-16: No rationale or data is offered here to substantiate that 'wicking or wiping
activities' poses a greater risk of herbicide contact to the herbicide applicator. Provide information to 31
support this statement.

Page 3.6-5, line 40: The claim regarding herbicide drift from ground application extending up to 250
feet seems excessive. No ground application, properly managed, would allow drift this far. Drift this 32
far off target would likely be a gross miss-application of herbicide. We suggest that you reduce this
number to 25 feet.

Page 3.6-7, line 16-18: The District feels this statement is incorrect and needs to be changed as it creates a limiting mitigation measure based on a label requirement misinterpretation. USEPA label requirements do not prohibit application of Rodeo when wind speed is greater than 5 MPH. The label states that there is a greater potential for damage to non-target vegetation from drift when wind speed is greater than 5 MPH. This is technical guidance rather than prohibition. The label directs the applicator not to allow drift to non-target vegetation (or areas) but does not call out a particular wind speed. The mitigation should require the applicator to manage drift through equipment selection, application technique, pressure management, shields, etc. In many of these areas, if you prohibit application in wind above 5 MPH, you will effectively prohibit all herbicide useage.

Page 3.6-7, lines 19-24: This mitigation measure seems excessive restricting access to treatment
areas for a 24 hour period. Restricted Entry Interval (REI) according to the Rodeo label is 4 hours.
Since there is no rationale offered for the 24 hour number, the District recommends doubling the time 33
on the label to an 8 hour period to create a more than adequate exclusion period.

Page 3.6-7, lines 22-24: The text states that a "letter of concurrence shall be obtained from the applicable city or county health department." We recommend a change in text here since you will not likely be able to acquire a letter of concurrence from any health department because they are not the entity that regulates herbicide useage. Any clearance or limitation for herbicide application must be obtained from the County Agricultural Commissioner. In all likelihood, the health department will not know how to address this type of request.

Page 3.6-7, lines 30-37: The text here is conflicting: one sentence states that signs must be placed within 24 hours of herbicide applications; another sentence states that signs should be posted within one week of chemical application. We recommend that you reconcile this text.

Page 3.6-7, lines 27-43: The District recommends that you remove all reference to the term 'Posting,' as this is, again, a legal term used on a herbicide label and has a very specific meaning from the Department of Pesticide Regulation. The herbicides proposed in this program have no 'Posting' requirements called out on the label. Therefore, the term in the text is confusing and should be replaced with something else.

4.0 Evaluation of Project Alternatives
Page 4-2, lines 2-4: What are alternatives 3A vs. 3B? This is the first time in the document that two sub-alternatives for number 3 are mentioned. 34

8.0 Definitions
General Comment: The District requests that you incorporate the definitions called out in the specific comments above with respect to herbicide usage. 35

Appendix E:
General Comment: Appendix E seems very complete and adequate for the purposes of this document. We recommend that you also include Joel Trumbo's research on glyphosate and surfactants in aquatic environments as cited in the comments above, page 2-16. 36

Appendix G:
Page G-1, paragraph 1: In general, does following the BMP's listed in this appendix negate the need for compensatory mitigation with the one noted exception: "where extensive stands have become opportunistically colonized by clapper rails," or is every case left to the discretion of the USFWS? 37

Page G-1, paragraph 2: The South Bay is seen as a priority treatment location based on ISP's prioritization strategy of eradicating outliers to prevent further or new establishment of invasive cordgrass. The impending South Bay salt pond restoration projects would also deem the South Bay a priority candidate for cordgrass control. The District is concerned that current *Spartina alterniflora* infestation sites within the Santa Clara County could expand in size and thereby increase the potential impacts of control treatments on clapper rails while awaiting independent USFWS consultation on a project by project basis. Since Santa Clara County is already a known 'hotspot' for clapper rails, the District would like to request a program-wide consultation for the District's Cordgrass Program. Additionally, will this consultation process need to be a formal section 7 consultation or can it be an informal consultation process? 38

Page G-2, Survey Protocols: You will need to define here what a "qualified biologist with expertise in clapper rail field biology" means. If this means that they will need a 10A permit to conduct clapper rail surveys, this could delay cordgrass control programs indefinitely in the South Bay as scientists with clapper rail 10A permits are few and far between. Further clarify necessary training for this job function. The District is concerned that the extensive survey effort and on-site monitoring may cause further delays during the narrow window for which control is possible in Santa Clara County (i.e., outside clapper rail breeding season) potentially making our Cordgrass Program cost prohibitive. The District would like to request further clarity on when each of these activities is necessary given that most of Santa Clara Counties tidal areas is considered clapper rail habitat. 39

Page G-4, On-Site Supervision: Same comment as above: will this on-site monitor need to have a 10A permit for clapper rails?

The District would, once again, like to commend your efforts in proposing this comprehensive approach for control of invasive cordgrass. We look forward to becoming a Responsible Agency under this program. We appreciate the opportunity to comment on this Draft EIS/EIR and would also appreciate the opportunity to participate in the permitting process to ensure that our needs for the District's Cordgrass Program will also be met. 40

If you have any questions about any of our comments or recommendations, please contact Lisa Porcella at (408) 265-2607 x 2741.

Sincerely,

Lisa Porcella
Biologist
Ecological Services Unit

I. SANTA CLARA VALLEY WATER DISTRICT

Comment I 1: Because the District plans to adopt this EIS/EIR for its Cordgrass Program in Santa Clara County, it is a "Responsible Agency" [under CEQA].

The District's role as a CEQA Responsible Agency is noted.

Comment I 2: Page S-2, line 24. This sentence discusses four project alternatives that were selected for full evaluation. The remainder of the document only discusses three alternatives.

The word *"four"* on p. S-2, line 24, of the DEIS/R has been corrected to read *"three"*.

Comment I 3: Page 1-30 lines 27-37. The statement of process provided here is correct, however Responsible Agencies, such as the District, have specific process to follow, found in CEQA Guidelines Section 15096. […] The District Requests that the process for Responsible Agencies found in section 15096 be incorporated in the "Use of the Document" section so District options on how to utilize this program document for our CEQA compliance are not unnecessarily limited.

In order to clarify responsible agencies' future uses of this document, the following paragraph is added after line 37 on p. 1-30:

> *Responsible Agencies under CEQA must consider the EIR prior to reaching their own conclusions on whether and how to approve a project. Those agencies may, at their discretion, follow the responsible agency requirements found in Section 15096 by considering the document (15096(f)), mitigating or avoiding only the direct or indirect environmental effects of those parts of the project which it decides to carry out, finance, or approve (15096(g)), adopting findings (15096(h)), and filing a Notice of Determination (15096(t)). Responsible agencies also may prepare a subsequent or supplemental EIR as provided for in CEQA Guidelines Sections 15162 and 15163, respectively. Since this EIS/R is a programmatic document, in addition to adoption of the EIS/R, the Responsible Agency will also have to determine whether further tiered environmental documentation, such as a mitigated negative declaration, is required for the site-specific project. See CEQA Guidelines section 15168(c) and (d).*

Comment I 4: Page 2-12 line 30-31. Clarify statement that glyphosate is the only herbicide approved for aquatic use.

The statement on p. 2-12, lines 30-31 of the EIS/R that glyphosate is the only herbicide approved for aquatic use is in error and has been corrected to read as follows:

> *Glyphosate, the herbicide proposed for use in the Control Program, is the only herbicide currently approved by the US Environmental Protection Agency for use in estuarine aquatic habitats.*

Although the ISP is evaluating experimental data on estuarine applications of other herbicides with potentially higher efficacy and even lower toxicity to fish, wildlife, and humans, these are not currently available.

Comment I 5: <u>Table 2-1, page 2-15</u>, row entitled 'timing' with respect to the 'Herbicide Application' column: We recommend that you further clarify the relationship between plant life-cycle and seasonality of herbicide application. Herbicides are most effective when applied just prior to dormancy.

Glyphosate efficacy (mortality) in tidal San Francisco Bay environments is influenced by many factors, including phenological stage (seasonally variable developmental and physiological state) of non-native cordgrass. Glyphosate can be highly effective long before the approach of dormancy in perennial plants when physiologically active foliar tissues are well-covered with solution, provided that solution is not washed off soon after application (by tidal inundation or rain), and glyphosate is not significantly inactivated by adsorption on silt or clay films. Coverage of glyphosate spray solution, exposure of clean, green leaf surface to solution, and the duration of contact before tidal immersion, appear to be the key factors for glyphosate efficacy on cordgrass. Glyphosate's systemic action does not depend on seasonal variation in carbohydrate physiology (fall translocation by mass loading of sugars in phloem, or peak rates of basipetal (toward the base, or physiologically downward) translocation of photosynthates to rhizomes). Root and rhizome respiration requires continual transport of carbohydrates to below-ground tissues. Late summer/early fall is coincidentally the time when relatively weak tides, clapper rail non-breeding regulatory "windows", and peak basipetal translocation times occur together. This is a potential optimal time for herbicide treatment, but it is not the only time when effective herbicide work can be accomplished.

Comment I 6: <u>Page 2-16, lines 1-11</u>. The District would like to note that our preferred surfactant is R-11.

The commenter's surfactant preference is noted.

Comment I 7: <u>Page 2-16, lines 38-41</u>. The District has found a technique of 'washing down' target vegetation with fresh water to remove silt deposits prior to herbicide application, improves herbicide efficacy… This methodology, however, should only be used in areas where tidal silt deposition on foliage is directly linked to reduced herbicide efficacy as the technique is very costly and labor intensive.

Comment noted. The commenter's experience will be incorporated into the ISP knowledge base.

Comment I 8: <u>Page 2-17, after line 2</u>. Include a brief section here with regard to herbicide application techniques and the control of spray drift.

For clarity, the following text is added after line 3 on p. 2-18 of the Final EIS/R:

> *For ground based and aerial applications, every effort will be made to control drift during treatment. Aerial applications will conform to the Specimen Label as well as the Supplemental Labeling for Aerial Application in California Only, following all included recommendations for Spray Drift Management and Aerial Drift Reduction Advisory Information. The most effective way to reduce drift potential is to apply larger droplets. Therefore, ISP Field supervisors will engage in*

careful management of droplet size, taking into account spray pressure, number of nozzles, nozzle orientation, nozzle type, boom length and application distance. Using lower pressure spray equipment also reduces potential for overspray and drift. Therefore applicators will be advised to reduce pressure in equipment or use low-pressure equipment whenever possible. Drift control agents also should be added to the tank mix when wind conditions are condusive to drift. If spraying is to be done near discrete sensitive receptors,and there is the potential for drift, those receptors will be shielded by physical structures. Additionally, wind speeds will be observed during the treatment period and monitored for exceedences of the label-recommended 10 mph wind speed guidelines. Aerial applications will also avoid temperature inversions, and periods of low relative humidity to minimize evaporation potential.

Comment I 9: Page 2-18. lines 31-38. Is there a way to streamline the permit process so that each project will not require a separate consultation with USFWS?

Please refer to section 1.3, Purpose and Use of this EIR/S. The ISP, with U.S. Fish and Wildlife Service as the lead federal agency, will complete a programmatic formal consultation on endangered species with National Marine Fisheries Service (NOAA Fisheries), and an equivalent process internal to USFWS for wildlife species federally listed under the Endangered Species Act (ESA). We expect that the precedents set by many regional permits for compliance with ESA will broadly apply to the ISP. These typically involve annual reporting of proposed activities within a regional program or permit, preliminary review by USFWS and NMFS, agency determinations of “no effect” or “not likely to adversely affect” in some cases, and subsequent review or additional mitigation or planning for other actions. The specific process depends on what is required by the terms and conditions of the “incidental take statement” of the biological opinion, the culmination of the ESA formal consultation process. This is “streamlined” compared with individual, ad hoc requirements for individual consultations for each action, because much of the impact assessment, mitigation, and protocols (e.g. Appendix G) have been pre-established by the program.

Comment I 10: Page 2-22, lines 11-12. Bair Island, Ravenswood Slough, and Mowry Slough are not in Santa Clara County.

Comment noted. The text on p. 2-22, lines 11-12 includes the sites first, then the county. Thus the referenced text indicates that the sites listed in the comment are in San Mateo County.

Comment I 11: Page 2-22, Alternative 2: You may want to further develop this alternative section to discuss the potential successes of using this alternative. Would Alternative 2 fulfill the project goals by slowing or stopping the spread of *Spartina* spp.?

See response to comment M-8. The goal of the ISP is not merely to slow and stop the spread after decades of extensive spread and establishment of non-native cordgrass, but also reverse the spread. Merely slowing or containing the spread of highly invasive non-native species and hybrid swarms within areas of permanently vulnerable habitat is not sustainable ecologically

Comment I 12: The rejection of a chemical-only approach to control was not adequately supported by evidence, and was dismissed without sufficient reason.

The following text is added to page 2-26 to further explain the rejection of a "chemical-only" alternative:

> *A chemical-only approach is too rigid to allow for opportunities to minimize environmental impacts in all situations, such as sites where rare or endangered plants, or essential vegetation cover for endangered wildlife, are present within or adjacent to stands of non-native cordgrass. The modified IVM approach allows for adaptive adjustment of treatment methods to site-specific needs of vegetation and plant community structure, wildlife conservation, and other receptors. The need for non-herbicide methods is also indicated for circumstances where treatment occurs directly adjacent to, or even within, residential areas where citizens may object to herbicide use. The potential benefits of herbicide use are fully exploited in the proposed alternative, and are not reduced compared with a "chemical-only" approach. Some potential herbicide impacts and limitations in specific circumstances (examples above) are eliminated with the proposed alternative.*

In addition, for clarity, the first sentence of the DEIS/R discussion under Chemical Methods Only (FEIS/R, p. 2-26) is revised to read as follows:

> *Although chemical methods have been proven effective in controlling populations of non-native Spartina, there are substantial public concerns over potential ecological, public health, and safety effects of releasing herbicides and surfactants into the local environment.*

Comment I 13: Discussion of Alternative 2 impacts on geomorphology and hydrology requires more detail, particularly impacts of repetitive mechanical treatments.

In order to further explain the geomorphic and hydrologic effects of Alternative 2, the following is added after line 36 on p. 3.1-9 of the EIS/R:

> *For eradication work on mudflats and low marsh (which is the largest acreage category of the project, due to prevalence of Spartina alterniflora hybrids) the direct physical impacts of cordgrass removal are limited by the natural condition of unvegetated, unconsolidated bay mud of tidal flats. Even immediately after mechanical treatments such as tillage (discing) or excavation, substrate conditions would be consistent with the natural (though not pre-project) condition of unvegetated, unconsolidated mud. In context of naturally unvegetated conditions of mudflats, the intensity of this geomorphic impact would be insignificant. Most of the direct impacts would be biological (ecological) rather than physical. In the regulatory context of CEQA and NEPA, however, the reference condition is the existing invasion by non-native vegetation, not natural conditions. The most important indirect physical impacts of repeated mechanical treatment are likely to occur by access of equipment through the high and middle marsh zones. Here, too, ecological impacts (destruction of vegetation important to wildlife habitat) are relatively more important than purely physical effects. Even so, the incremental increase in damage to the marsh decreases after the first few passes of equipment, when most of the vegetation damage occurs. Prolonging the damage*

by repetition, rather than increasing its magnitude within an area, is a greater risk. Note also that some physical control methods, such as flooding/drowning, covering, and mowing, have minimal impacts to substrate, and long-term hydrologic impacts similar to any other method removing vegetation that provides bottom roughness (friction against water flow).

Comment I 14: Shouldn't the mitigation for Alternative 2 (non-chemical eradication program) state that more mitigation will be necessary due to repeated mechanical treatment, compared with Alternative 1 (proposed program)?

The key CEQA/NEPA threshold is whether mitigation can reduce the impact to a less-than-significant level. At a programmatic level, it would be difficult to quantitatively compare less-than-significant impacts below this threshold. We agree, however, that the relative magnitude and duration of physical impacts would be greater if all herbicide use were excluded from the ISP, and corresponding increases in mitigation would be necessary. No changes are required to the text, as the actual mitigation measures do not change.

Comment I 15: <u>Page 3.2-9, line 37</u> should read "…a non-ionic surfactant is <u>recommended</u> whenever glyphosate is used in aquatic systems." The herbicide label does not '<u>require</u>' the use of a surfactant.

There is only one line within the Aquamaster label that refers to surfactant requirements or recommendations (6.1, Mixing with Water and Surfactant). The label's language is somewhat ambiguous, stating, "Fill the mixing or spray tank with the required amount of water. Add the recommended amount of this product and the required surfactant near the end of the filling process and mix well." The language of this section would not seem to indicate a legally binding condition of glyphosate application. Nevertheless, the label does use the word "require."

Comment I 16: <u>Page 3.2-10, line 6</u>: The sentence uses the word 'Caution." This is a signal word in terms of herbicide use that has a specific legal and technical definition. If the document is going to use signal words as pat of the narrative, you will need to prove a definition of what a signal word is, what they mean, and what relevance they have in terms of safety and use restrictions as they apply to the material.

Four of the five products proposed for use by the ISP, including the herbicide Aquamaster/Rodeo, the surfactants Agri-dex and R-11, and the colorant Blazon, have signal words 'Caution,' indicating that they are of the lowest of these toxicity rankings. One surfactant, LI 700, is very acidic in concentrated form (pH 3.0; note that vinegar is even more acidic with a pH of 2.0) and therefore very corrosive. This corrosiveness earns it a rating of 'Danger.' LI 700 is the only one of the chemicals proposed for use by the ISP that requires the use of personal protective equipment (gloves and goggles) for product handling.

The terms 'Caution,' and 'Danger' are 'signal words,' words that describe the acute (short-term) toxicity to humans of a formulated pesticide product. For clarity, the following is added after line 39 on page 3.2-8 of the Final EIS/R:

There are four signal words ion US EPA registration labels describing the toxicity of the compounds: Caution, Warning, Danger, and Danger-Poison. Caution means the product is slightly toxic if eaten, absorbed through the skin, or inhaled, or it causes slight eye or skin irritation. Warning indicates that the product is moderately toxic if eaten, absorbed through the skin, or inhaled, or it may cause moderate eye or skin irritation. Danger means that the product is highly toxic, corrosive, or causes severe burning to the eyes or skin. Danger-Poison means that the pesticide product is highly toxic only if eaten, absorbed through the skin, or inhaled. These products have a "skull and crossbones" symbol on the label.

Comment I 17: Page 3.2-10, line 22: Similar to comment above, why does this surfactant warrant a 'Danger' signal word? The document needs to provide this information to the reader.

See response to comment I 16, above.

Comment I 18: The document states that 'data are unreliable' [in connection with estuarine toxicity and water quality impacts of glyphosate], but offers no explanation for this.

Please see response to comments M 2.

The statement in the EIR/S was incomplete. The following text is added to the EIS/R in place of the last complete sentence on lines 40 and 41 on p. 3.2-10 of the DEIS/EIR:

The application of data from general aquatic studies to the estuarine environment is unreliable for determining possible effects. An important exception to the general lack of estuarine data is the recent research on glyphosate toxicity to Pacific estuarine organisms of Willapa Bay, cited in the EIR literature (Paveglio et al. 1996, Kilbride and Paveglio 2001, Killbride et al. 1995). These recent Pacific coast data and analyses are considered up to date, highly relevant, and scientifically reliable. They also are the closest and most similar estuarine systems to the San Francisco Estuary for comparative study of glyphosate impacts. Overall, they indicate that energetic, turbid conditions in tidal mudflats rapidly dissipate glyphosate between tides, resulting in rapid reduction to undetectible levels, and rapid inactivation (adsorption) by clay sediments, as well as low aquatic toxicity.

Comment I 19: Page 3.2-11, lines 3-28. The text needs to remind the reader that the proposed herbicide is formulated and approved for use in aquatic environments. While extensive contact with water is not the intent of the application technique, it is not necessarily an adverse impact due to the choice of material being used.

The following text is added to the end of the first paragraph on p. 3.2-11of the DEIS/R:

The proposed herbicide is formulated and approved for use in aquatic environments.

Comment I 20: Mention that glyphosate works well systemically where the plant's vascular system translocates the chemical, when the plant is growing or preparing for dormancy.

See response to comment I 5, above.

Comment I 21: Herbicide 'spray drift' and 'overspray' are redundant within the context of the indicated lines.

There is a significant difference between the terms 'spray drift' and 'overspray', and the text of the document mostly indicates this. Lines 41-42 on page 3.3-32 of the Draft EIS/R, are not redundant but are revised as follows for clarity:

> *"….eradication treatments, such as herbicide (glyphosate) spray drift resulting from aerial applications, herbicide overspray resulting from ground-based accidental discharge beyond targeted plants, mechanical…"*

Comment I 22: Non-target plant protection seems excessive, cumbersome, expensive. Proper application is sufficiently protective to ensure that these measures would not be necessary.

In south San Francisco Bay (the region of commenter jurisdiction), rare plants are usually absent in or near cordgrass habitat, because of recent marsh subsidence and rebound history, dike maintenance, extreme scarcity of natural marsh remnants, and influence of non-saline wastewater discharges. It is unlikely that non-target plant protection measures would be necessary to protect plants in the South Bay region. In exceptional cases, the high conservation importance of tidal refugia in the high marsh zone (essential flood escape cover for endangered wildlife) may warrant this mitigation. These protections are more often appropriate and needed in the North Bay, where multiple species of non-native cordgrass occur in a wider range of tidal marsh plant associations (see p. 3.3-33, lines 34-37, for example).

Comment I 23: Clarify whether pre-project sensitive plant surveys will need to be performed for all treatment sites.

The ISP presumes that the need for sensitive plant surveys would be determined on a subregional or case-by-case basis. The indirect impacts of cordgrass eradication were classified by high marsh and low marsh species (Impact BIO 1.1, 1.2). The invasive high marsh species of cordgrasses (S. patens, S. densiflora) occur in relatively species-rich plant associations, and their eradication may warrant surveys for plant species of concern. This would be determined in site-specific reviews. In the low marsh (S. alterniflora hybrids, S. anglica), there are no known native plant species of concern, other than native S. foliosa. Adequate plant surveys as a best management practice prior to herbicide treatment are not usually expensive or cumbersome if planned for the proper season, and if performed by regionally experienced botanists.

Comments I 24 : Will compensatory mitigation for the federally endangered salt marsh harvest mouse be required at all sites? Mitigation measures listed seem "a bit short". "Excessive" take of this species needs clarification. Will surveys be needed in potential habitat?

Compensatory mitigation requirements for the southern salt marsh harvest mouse subspecies, if any, would be required at the discretion of the U.S. Fish and Wildlife Service, in connection with formal consultation. The threshold for "excessive" or "unacceptable" take, or jeopardy, for this species is similarly a project-specific matter of USFWS consultation. The ISP prioritizes programmatic avoidance of impacts to salt marsh harvest mouse populations and habitats, above compensation. Most impacts to potential salt marsh harvest mouse habitat would be limited to access by equipment, not eradication work itself: the salt marsh harvest mouse generally does not occupy cordgrass marsh zones, and is seldom detected in the frequently flooded, relatively low-elevation tidal pickleweed marshes of the extreme South Bay (rebounding by sedimentation following historic subsidence). It is possible that mitigation for this species may be required in some circumstances (as indicated in Mitigation BIO-4.1); this would depend on the specific impacts of individual projects.

The ISP does not propose surveys for this species because of the difficulty of detection at low population densities, mobility of the species within habitat patches, and the risk of false negative surveys. Survey requirements, if any, would be determined for individual sites at the discretion of the U.S. Fish and Wildlife Service in the course of either informal or formal consultation. We agree that pedestrian access to cordgrass treatment sites, using backpack sprayers, would minimize access impacts to salt marsh harvest mouse habitat. Burning is not likely to be used as a control method, and if it were used in the geographic range of the southern salt marsh harvest mouse, it would be in the cordgrass (low marsh) zone, not the pickleweed zone (potential habitat for small mammals).

Comment I 25: Consider listing the known seal haul-out sites for clarity.

Updated information about seal haul-outs would be reviewed upon planning of individual projects, in cooperation with wildlife resource agencies and marine mammal experts. This would provide more reliable information than past lists of haul-out sites available in the scientific literature.

Comment I 26: [refers to p. 3.3-40, lines 34-38, which is black rails; subject in comment in clapper rails...p. 3.3-39?] Clarify " unavoidable significant impacts" to clapper rails. Would compliance with Appendix G imply less than significant impacts? Will each site's project require a separate endangered species consultation? Could eradication of *Spartina alterniflora* be a form of mitigation for clapper rails, and a contribution to their recovery? Should clapper rail breeding habitat be distinguished from foraging habitat?

Unavoidable significant impacts to clapper rails would include eradication of stands of hybrid *Spartina alterniflora* during the non-breeding season, that have been occupied by clapper rails during the nesting season (p. 3.3-38, lines 35-36). This significant impact would be particularly acute where alternative habitat is either unavailable, or already occupied by other nesting clapper rails. The degree of significance would depend on the size of the stand eradicated (number of nesting pairs displaced), and the regional importance of the local population to the region's population viability, which depends on geographic variation in relative breeding success. The EIR/S acknowledges (Impact BIO-5.1) that eradication would require temporary destruction of large, fully invaded marshes such as Cogswell Marsh; it further recognizes the impossibility of phasing eradication work to mitigate impacts to clapper rails, since this would result in rapid recolonization by hybrid *S. alterniflora*. Appendix G is suggested as a preliminary protocol for avoiding <u>indirect</u> incidental impacts of eradication work in marshes; it does not cover significant direct impacts that are subject to compensatory mitigation requirements. For endangered species consultation requirements, please refer to response to comment I 9, above. Eradication of *Spartina alterniflora* may contribute to the recovery of the California clapper rail in its native ecosystem in the long term, but it cannot in itself count as mitigation for clapper rails, because it may cause short-term reduction in local population viability, size, and functional habitat – an impact that itself requires mitigation. Impacts to breeding and foraging habitat would be evaluated specifically for each site, but in the case of tall, young stands of hybrid *Spartina alterniflora*, they may not be readily distinguishable.

Comment I 27: [refers to p. 3.3-32 lines 11-15, which is about raptors; doesn't match comment; probably refers to p. 31, song sparrows] Adopting mitigation measures based on endangered species for non-endangered species of concern is inappropriate for these very different classifications. Will site-specific surveys have to be performed at each site if species have been found in the past 10 years? Will each require a separate consultation?

Mitigation measure BIO 5.3 is intended to recommend adapting *the basic approach of* Appendix G clapper rail protocols for tidal marsh song sparrow subspecies and salt marsh common yellowthroats. The basic principles of detection, avoidance, and impact minimization still apply to the conservation of resident and seasonal bird populations in tidal marshes, regardless of their legal status. The distinction between endangered species and species of concern is not a biological one, but a legal one. Some non-endangered species are nonetheless protected legally under the state Fish and Game code. For endangered species consultation requirements, please refer to response to comment 9. The ISP does not address a 10-year period of past occupancy by a sensitive species as a threshold for requiring surveys. It would be appropriate to consult informally with resource agencies, such as the California Department of Fish and Game and the U.S. Fish and Wildlife Service, to minimize project-specific impacts to species of concern. This does not imply a formal process.

Comment I 28: The ecology of salmonids and goby species are quite different, and the impacts to these species would differ.

The EIS/R concludes that no impacts would be expected to occur to tidewater gobies (Impact BIO 6.3, p. 3.3-44), a species that has not been detected in San Francisco Bay (marginal habitat) for many decades. The potential biological impacts to gobies, other estuarine fish, and salmonids, are related by their turbid aquatic habitat in San Francisco Bay, not the species' very distinct life-histories and ecology. The physical environmental effects of cordgrass eradication on channel and submerged mudflat would be similar for each species. Physical removal would occur at low tide, when fish are not directly affected by intertidal treatment of non-native cordgrasses. Glyphosate/surfactant exposure risks would be minimized by high turbidity (adsorption, inactivation) and the high magnitude of dispersion and dilution due to tidal currents, wind-wave turbulence, and complete turnover of water over treated intertidal areas with each tidal cycle. Their exposure to these physical effects would vary with each fish species' behavior and ecology, but the types of effects would be the same.

Comment I-29: The district requests that the requirement be added to this section that all herbicide work will be performed based on the label requirements and with a current Pest Control Recommendation by a licensed Pest Control Adviser.

All herbicide work will be performed based on the label requirements, and with a current Pest Control Recommendation prepared by a licensed Pest Control Adviser. (See also response to comment G 5 above).

Comment I 30: Page 3.4-6, line 30. "Re-entry period" is a legal term, make sure its use here is consistent with the label requirements

The label-specific re-entry period, in the case of Rodeo/Aquamaster, 4 hours, will be identified in site-specific control plans. The re-entry period applies to properly attired and trained applicators and field workers, not necessarily the general public. The term has been added to the glossary.

Comment I 31: Page 3.6-5, line 14-16. Provide rationale to substantiate statement that 'wicking or wiping activities' pose a greater risk of herbicide contact to the herbicide applicator.

Please refer to Lines 15-17 on page 3.6-5 of the EIS/R for the reason for the statement.

Comment I 32: Page 3.6-5, line 40. The claim regarding herbicide drift from ground application extending up to 250 feet seems excessive. No ground application, properly managed, would allow drift this far. … We suggest that you reduce this number to 25 feet.

The distances cited were from a Journal of Pesticide Reform article by the Northwest Coalition for Alternatives to Pesticides (Appendix E, page 137). Their referenced sources included Breeze et al. 1992, Yates et al. 1978, and Marrs et al. 1993. As we did not review the original sources, we do not know site-specific conditions or whether applications were in compliance with label requirements.

Comment I 33: Mitigation HS-3 is erroneous and unreasonably restrictive.

It is acknowledged that Mitigation HS-3, commencing at p. 3.6-7 of the DEIS/R is very general in nature, and is not specific to glyphosate and the surfactants proposed for use by the ISP. Therefore, it has been revised to read as follows:

- *Herbicide application shall be managed to minimize potential for herbicide drift, particularly in areas where the public could be affected. Herbicide shall not be applied when winds are in excess of 10 miles per hour or when inversion conditions exist (per Supplemental Labeling for Aquamaster for Aerial Application in California Only), or when wind could carry spray drift into inhabited areas. This condition shall be strictly enforced by the implementing entity.*
- *Colored signs shall be posted at and/or near any public trails, boat launches, or other potential points of access to herbicide application sites a minimum of 24 hours prior to treatment. These signs shall inform the public that the area is to be sprayed with glyphosate herbicide for weed control, and that the spray is harmful if inhaled. They will advise "no entry" for humans and animals until a minimum of eight (8) hours after treatment, and that date and time will be stated. A 24-hour ISP contact number shall be provided.*
- *Application of herbicides shall be avoided near areas where the public is likely to contact water or vegetation as follows:*

    A. *Application of herbicides in or adjacent to high use areas shall not be allowed within 24 hours prior to weekends and public holidays.*

> B. *If a situation arises (due to weather or other variables) that makes it necessary to treat high-use areas on weekends or holidays, the areas shall be closed to the public for 24 hours before and after treatment.*

- *At least one week prior to application, signs informing the public of impending herbicide treatment shall be posted at prominent locations within a 500-foot radius of treatment sites where homes, schools, hospitals, or businesses could be affected. Schools and hospitals within 500 feet of any treatment site shall be separately noticed at least one week prior to the application.*
- *No aerial spraying shall be conducted within 0.25 mile of a school, hospital, or other sensitive receptor location.*

Comment I 34: Page 4-2, lines 2-4. What are alternatives 3A vs. 3B?

These were references to old alternatives that were replaced by Alternative 3. This erroneous reference to Alternatives 3A and 3B has been deleted.

Comment I 35: Incorporate the definitions from above.

See responses to above comments with respect to herbicide use.

Comment I 36: Include Joel Trumbo's research in the Appendix.

Comment noted. Mr. Trumbo's research was cited in the text, and the reference included in Chapter 9, References. This level of research is generally more detailed than what was included in Appendix E. The ISP will make it, and other published and unpublished studies, available on our website in the near future.

Comment I 37: Does following the BMPs generally eliminate the need for compensatory mitigation for clapper rails?

Appendix G is suggested as a preliminary protocol for avoiding indirect impacts eradication work in marshes, and focuses on avoidance of impacts; it does not cover significant direct impacts that are subject to compensatory mitigation requirements. For endangered species consultation requirements, please refer to response to comment I 9, above. Appendix G does not affect the regulatory authority of the U.S. Fish and Wildlife Service in requiring take minimization measures (including mitigation) for endangered wildlife.

Comment I 38: South Bay is a priority for ISP strategy, and is a "hotspot" for clapper rails. The formal endangered species consultation procedure may cause delays in eradication work that could allow undue expansion of the *S. alterniflora* hybrid invasion. Would informal or formal endangered species consultation be available for this region, to reduce this risk?

See response to comment I 9, above. Endangered species consultation is proposed to be implemented in the same manner as in most general permits for activities in endangered tidal marsh species habitat.

Comment I 39: What is a "qualified biologist with expertise in clapper rail field biology"? Does it require a Section 10A (endangered species recovery research) permit for "take"?

The DEIS/R does not include a biological opinion of the U.S. Fish and Wildlife Service for the program. That opinion will be finalized prior to the Service's signing of the ROD.

It will be included in the FEIS if completed prior to the issuance of that document. The descriptive language for qualifications of experts is general. The Service has discretion over the qualifications for clapper rail biological expertise, and carefully reviews their qualifications prior to issuing research take permits. Certain surveys may require section 10A permits. 10A permits are required only for survey actions that involve "take", such as playback tape calls to elicit rail vocalization, or entry into occupied rail habitat during the breeding season. Passive listening surveys from levees or boats may not involve "take" if rails are not disturbed.

J

CALIFORNIA EXOTIC PEST PLANT COUNCIL

A nonprofit organization protecting California's wildlands from invasive plants through restoration, research, and education

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June 4, 2003

Peggy Olofson, Director
Invasive Spartina Project
605 Addison St., Suite B
Berkeley, CA 94110

Dear Ms. Olofson,

I am writing to express my support for the recent Draft Programmatic EIS/EIR for work controlling invasive *Spartina* species in San Francisco Bay.

CalEPPC is extremely concerned about the ecological damage caused by invasive *Spartina* species in the Bay. The program described in the Draft EIS/EIR does a thorough job of examining the options for control of these species based on experience to date. The factors used to select pilot project sites are effective, and we look forward to learning from control work performed at each of the sites selected. 1

This is a regional problem, and will require a collaborative regional approach. Please keep us informed as you proceed—we plan to be an active partner in supporting this project in whatever ways we can.

Sincerely,

Doug Johnson, Executive Director

J. CALIFORNIA EXOTIC PEST PLANTS COUNCIL

Comment J 1: Supports EIS/EIR and ISP program.

The commenter's opinion and support for the project are noted.

K

CATs Californians for Alternatives to Toxics

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June 2, 2003

Wayne White
Field Supervisor
U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, CA 95825

Re: Draft Programmatic Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the San Francisco Estuary Invasive Spartina Project: Spartina Control Program

Dear Sir,

Californians for Alternatives to Toxics (CATs) is a public interest, non-profit organization that is concerned about the use of and alternatives to pesticides in California. Many CATs members live in the vicinity of or otherwise use and enjoy San Francisco Bay. The activities that are planned for the Spartina Control Program are of particular concern to our members.

The California State Coastal Conservancy and the U.S. Fish and Wildlife Service (the Agencies) have chosen to use an Integrated Vegetation Management (IVM) approach to deal with invasive species. However, the Program does not reflect the principles of IVM.

<u>The Elements that Make up Integrated Vegetation Management</u>
One cannot call a program IVM if it does not include all the elements that make up IVM. It is insufficient to focus on one single portion of IVM. That is clear from the name and definition of the concept: <u>Integrated</u> Vegetation Management (emphasis added). The program focuses only on the eradiction aspect, whereas under the definition of IVM it should integrate all the elements (pest monitoring, tolerance assessment, prevention and control) into a single proposal. As it stands, this project proposal ignores the basic premises on which IVM is based, and consequently piecemeals the program into individual measures, which combined have significant impacts. 1

Both in order to achieve the purpose of IVM and to comply with the mandates of the National Environmental Policy Act (NEPA) andthe California Environmental Quality Act (CEQA), the EIS/EIR will need to consider, analyze and disclose all of the elements of IVM, including but not limited to pest prevention vector identification and elimination, and replanting with native species, instead of focusing solely on one element, pest control. 1 (cont.)

For example, if cleared areas are to remain free from reinfestation, they must be replanted with native species that have a good chance of survival. The Agencies have failed to incorporate such cultural practices into the EIS/EIR. 2

Control v. Eradication

On page 2-17, the EIS/EIR contains a description of the "modified "integrated vegetation management" (IVM) approach" that will be used to guide control efforts. Even though the Agencies recognize that IVM focuses on pest control rather than eradication, the Agencies choose to ignore this most basic premise of IVM.

Species that have already colonized large parts of the country should not be treated with the goal of eradication because of their potential for recolonization. The high cost of eradication efforts year after year will exceed the long-term costs of control. 3

Furthermore, with a focus on eradication rather than on control, the need for the use of toxic chemicals and its associated impacts would be much greater than if a long-term control plan without the use of pesticides were employed.

Herbicide Resistance

The EIS/EIR fails to consider the impacts of the continuous use of one pesticide, glyphosate, on the development of resistance. As indicated by Dr. Jerry Doll, extension weed scientist at the University of Wisconsin, the repeated use of glyphosate will lead to resistance. 4

Cumulative Effects

The EIS/EIR fails to consider the cumulative impacts of the recurring treatment for up to 50 years, the lifespan of this program as indicated in the EIS/EIR. It fails to consider such long-term, and cumulative impacts on water quality, endangered species, habitat degradation, human health and other resources. 5

Glyphosate

The Agencies have failed to adequately analyze the potential impacts associated with the use of glyphosate. The herbicide and surfactant information provided in Appendix E is insufficient to fulfill the analysis requirements imposed by NEPA and CEQA. It would be simply unacceptable to approve a project involving such extensive herbicide use with the 'analysis' consisting only of the mentioning of existing scientific controversy. 6

Among other impacts, the EIS/EIR has failed to analyze the significant environmental impact on soil organisms. As indicated by Robert J. Kremer, microbiologist USDA-ARS and Professor of Soil Science at the University of Missouri, glyphosate has significant impacts on soil organisms. Glyphosate causes plant roots to become infected by soil fungi, leading to diseases that contribute to plant death. Such effects are not limited to the target plant, and can affect non-target species. Furthermore, elevated levels of soil fungi cause the natural equillibrium of microbial communities in the soil to become unbalanced, which may impact biological processes in the soil. Glyphosate stimulates fungi in the genus Fusarium and influences potential disease development. ("Herbicide Impact on Fusarium spp. and Soybean Cyst Nematode in Glyphosate-Tolerant Soybean" R.J. Kremer, USDA-ARS, P.A. Donald, A.J. Keaster, H.C. Minor, Univ. of Missouri. American Society of Agronomy Title Summary Number: S03-104-P) 7

In conclusion, the Spartina Control Program needs to develop an alternative which employs a true Integrated Vegetation Management Program, with a focus on control, as suggested in the title, not on eradication, and which does not permit the use of toxic chemicals on an already besieged and disrupted environment. 8

Sincerely,

/s/ Patricia M. Clary

Patricia M. Clary
Executive Director

/s/ Petra Taylor-Vandormael

Petra Taylor-Vandormael
Program Associate

K. CALIFORNIANS FOR ALTERNATIVES TO TOXICS

Comment K 1: The ISP does not reflect the principles of Integrated Vegetation Management (IVM) and cannot be called IVM unless it embraces all its principles.

The other aspects of IVM referenced in the comment, including pest monitoring, tolerance assessment, prevention of re-infestation, public education, and evaluation of the likely economic, sociological, and ecological consequences of both the invasion and the treatment program, are addressed by other components of the ISP, as explained on pages 1-4 and 1-5. These components were not included in the EIS/R because they would not result in any environmental impacts that required assessment.

The EIS/R states (p. 2-17) that it will employ a *modified* IVM approach, not a conventional one, because of the specific nature of the hybridization problem associated with *Spartina alterniflora* invasion of *S. foliosa* populations. The best available scientific research from the University of California at Davis on the San Francisco Bay populations of these species concludes that the native *S. foliosa* is overwhelmed by hybrid pollen, and can neither reproduce itself by seed or compete with *S. alterniflora* hybrids where mixed populations occur. Invaded *S. foliosa* populations, indeed, produce further hybrids. IVM presumes that weed species are discrete taxa, and that native plants interact with them only through competition and environment, not gene flow. IVM by its nature is adaptive, not orthodox, and so a restrictive definition of IVM requiring narrow adherence to all of its tenets in all cases is inconsistent with the nature of IVM.

Neither NEPA nor CEQA have specific requirements for consideration, analysis, and disclosure of IVM. Both CEQA and NEPA require rigorous analysis of a reasonable range of alternatives that minimize harm to the environment, and all necessary and appropriate mitigation measures to minimize or avoid significant adverse impacts to the environment. The EIS/R considered a non-chemical program approach alternative and concluded that it would be infeasible to eradicate the *S. alterniflora* hybrid population with complete exclusion of chemical controls, and that the compensatory increase in repeated physical removal methods would increase impacts of attempts, and prolong their duration.

Comment K 2: If cleared areas are to remain free of infestation, they must be replanted with native species that have a good chance of survival.

While the principle of revegetation has broad applications in most terrestrial vegetation, it does not apply to restoration of tidal mudflats invaded by non-native cordgrass, and it is inconsistent with program needs to monitor and detect re-invasion of hybrid *S. alterniflora*. This is explained on page 2-21, lines 12-37 of the DEIR/S, and in mitigation measure BIO-2 (p. 3.3-34). For most *S. alterniflora* hybrid eradication on intertidal flats and estuarine beaches, no revegetation would be justified because the objective would be to restore naturally <u>unvegetated</u> substrate (mud flats). For most *S. alterniflora* hybrid eradication within low marshes adjacent to sources of hybrid cordgrass seed or pollen, rapid replanting with native cordgrass (*S. foliosa*) would interfere with detection of re-invasion, and may facilitate hybrid seedling nurseries. This would defeat the purpose and efficacy of control. Revegetation with native cordgrass is recommended only where re-invasion rates have been confirmed by monitoring to be insignificant. Where *S. alterniflora* hybrids have caused sediment accretion above Mean High Water, pickleweed is likely to colonize treatment areas spontaneously and rapidly, as results in Cogswell Marsh have indicated. If natural revegetation by pickleweed at suitable elevations is insufficient, it may be supplemented by planting, but this is not expected to occur often. In contrast, removal of *S. densiflora* and *S. patens* in large patches would involve some native revegetation to prevent excessive invasion by other marsh weeds (such as perennial pepperweed, *Lepidium latifolium*) and to replace habitat structure in the high marsh. These are examples rather than rules: revegetation plans would be considered for each individual project based on evaluation of overall vegetation (or devegetation) objectives, local wildlife habitat needs, natural revegetation rates and processes, and potential interactions with other wetland weeds.

Comment K 3: Species that have already colonized large parts of the country should not be treated with the goal of eradication because of their potential for recolonization. The high cost of annual eradication efforts will exceed the long-term costs of control. A control plan without eradication effort would have less need for chemicals.

With respect to the comment that DEIS/R willfully ignores IVM focus on pest control rather than eradication, please see response to comment K 1.

With respect to species that have already colonized large parts of the country, the invasive non-native cordgrass populations of San Francisco Bay have limited regional distribution, and most are only a few decades old. The major estuaries of the Pacific coast are widely separated by steep, rocky coastlines, and each estuary appears to have its own independent invasion of cordgrasses at current population sizes. Long-distance dispersal of non-native cordgrasses between estuaries is infrequent (or lacking, in some species), and is probably related to transport by humans in most cases. Even within the San Francisco Estuary, non-native cordgrass invasions are subregional or localized. The “no project” alternative (no coordinated program, not “no control”) would probably result in greater, not less, long-term application of herbicide to control hybrid *S. alterniflora* in perpetuity in flood control channels, marinas, etc., because invasion rates would increase with overall population size and seed rain. Independent agencies with institutional need to control *S. alterniflora* hybrids within their jurisdiction would perpetually maintain their tidelands with the most practical available cost-effective method, which has been glyphosate application. This is the case now, and would increase over time in the absence of eradication.

Comment K 4: The EIR/S fails to consider the impacts of herbicide resistance.

The referenced research (Doll) is not applicable to the conclusions suggested by the commenter. The species studied by Dr. Doll for glyphosate resistance, goose grass (*Eleusine indica)* and rigid rye grass (*Lolium rigidum)*, were both annual grasses, which die out and regrow from seed each year. Salt marsh cordgrasses are long-lived clonal perennial plants. The turnover of their populations (multiple generations of clone extinction and establishment) necessary for natural selection and evolution of herbicide resistance would be very slow, much longer than the duration of the ISP. No cordgrass genes for glyphosate resistance are known to exist in nature, and we are aware of no plans to breed glyphosate-resistant cordgrasses or cordgrass relatives than could confer the trait to wild populations by gene flow. There is no field evidence reported for heritable resistance to glyphosate in cordgrass species, although it is possible that some genetic variation in glyphosate sensitivity exists. Glyphosate resistance is a concern with annual plant species capable of rapid natural selection (high population turnover), particularly where resistance genes may occur in the species' population or that of close genetic relatives. The ISP technical staff knows of no research or theory to indicate glyphosate resistance may be a substantial (non-speculative) issue for cordgrass eradication.

Comment K 5: The EIR/S fails to consider the cumulative impacts of treatment for up to 50 years on water quality, endangered species, habitat degradation, etc.

The EIS/R considers cumulative impacts expressly in section 3.12. It also discusses cumulative impacts in the comparison of program alternatives in section 4.1, and in the context of interaction with other projects such as salt pond restoration in the "no action" alternative (p. 3.1-9 to 3.1-12, 3.3-46), which focuses on habitat degradation. The main analytical text of the EIS/R (Chapters 3.1 through 3.11) addresses the full lifespan of the project to the degree possible without being unduly speculative, consistent with CEQA and NEPA requirements.

Comment K 6: The EIR/S fails to consider adequately to potential impacts of glyphosate; information provided in Appendix E is insufficient for assessment under NEPA and CEQA.

The potential impacts of glyphosate were evaluated in the discussion of individual fish and wildlife species, as well as guilds (groups) of species in related habitats (EIS/R Section 3.3 *Biological Resources).* The potential transport, deposition, environmental, and physiological fate of glyphosate were evaluated also in discussion of water quality (EIS/R Section 3.2 *Water Quality*).

Appendix E is not intended or represented as an alternative or even supplement for assessment of potential substantive, environmental impacts of glyphosate application. Appendix E serves to disclose and identify the existence of scientific and policy controversy regarding glyphosate (see, for example, page E-135), representing a full spectrum of information from both critics and manufacturers.

Comment K 7: The EIR/S fails to analyze the significant environmental impact of glyphosate application on soil organisms, such as fungi and nematodes.

The referenced research (Kremer et al.), and similar research on cereal crops, cannot appropriately be used to infer effects of glyphosate on marsh organisms. The Kremer study analyzed the effect of glyphosate on soil organisms associated with soybean crops, which grow in an aerobic terrestrial environment. Glyphosate will not be applied to terrestrial soils as a part of the ISP. The substrates that would be affected by glyphosate treatment are intertidal bay muds (hypoxic, saturated, saline clay-silt sediments) and salt marsh soils composed of mixtures of peat, muck (finely decomposed organic matter), and bay mud. As discussed in context of the physiology of glyphosate action (p. 3.2-9, p. 3.3-24 to 3.3-30), glyphosate strongly adsorbs to fine organic material, silt, and clay. Since San Francisco Bay is highly turbid (wind-wave turbulence over mudflats causes strong daily resuspension of muds), and the substrate is saturated (not readily leached) below Mean High Water, the majority of the actions proposed in the ISP have negligible or no potential to penetrate to the substrate of the root zone. Nematodes and fungi are not known to have comparable presence or ecological importance in mudflats as they have in terrestrial soils.

Comment K 8: The Spartina Control Program needs to develop a true IVM alternative focused on control without chemicals rather than eradication.

Please refer to responses to comments M 8 and K 1. The EIS/R evaluated Alternative 2, which is essentially the same program as proposed, but without the use of herbicides. Please see the last paragraph on p. 2-17 of the EOS/EIR for a discussion of why eradication, and not control, is the program goal.

L

Comments on
Draft Programmatic
Environmental Impact Statement/Environmental Impact Report
San Francisco Estuary Invasive Spartina Project: Spartina Control Program
Prepared for the California State Coastal Conservancy and the
U.S. Fish and Wildlife Service
Dated April 2003

Comments Submitted by
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June 2, 2003

At the request of the BayKeeper/DeltaKeeper, I have reviewed the Draft Programmatic Environmental Impact Statement/Environmental Impact Report; San Francisco Estuary Invasive *Spartina* Project: *Spartina* Control Program dated April 2003, and the associated California State Coastal Conservancy Invasive *Spartina* Project Monitoring and Reporting Plan (undated) and Appendix G: Mitigation Monitoring and Reporting Program: Invasive *Spartina* Project, *Spartina* Control Program dated June 2003. The comments presented herein focus on the potential water quality impacts of the use of the herbicide glyphosate for *Spartina* control, as well as the deficiencies in the proposed water quality monitoring program associated with the *Spartina* control project. 1

My qualifications to undertake this review are summarized in an appendix to this report. They include over 40 years of work on the transport, fate and impacts of chemicals, including herbicides and other pesticides, in various types of aquatic systems.

Overall

I find that the draft EIS/EIR for the proposed San Francisco Estuary *Spartina* Control Program covers many of the issues that need to be covered in evaluating the potential for the use of herbicides to control *Spartina* in San Francisco Bay and coastal waters to have a significant adverse impact on the environment. One of the major deficiencies in this draft EIS/EIR is the failure to adequately discuss the potential impacts of mixtures of chemicals that can occur associated with the *Spartina* control project. While briefly mentioned as an issue in the draft EIS/EIR, additional discussion needs to be provided on the potential for the glyphosate-based herbicide and its associated chemicals as well as other chemicals in the Bay waters to interact to cause aquatic life toxicity in the sediments of the areas where treatment occurs. Further, because of this and other unknowns, a key component of the *Spartina* Control Program must be a comprehensive monitoring program to assess, to the extent possible, the potential adverse effects in the water column and in the sediments of herbicide treatment to control *Spartina*. The draft *Spartina* control monitoring program is significantly deficient in several aspects in evaluating 2 potential impacts of the use of glyphosate and its associated chemicals in the proposed *Spartina* control project. 2 (cont.)

Specific Comments on the Draft EIS/EIR

Page 3.2-6, Table 3.2-3 compares the concentrations of various potential pollutants in San Francisco Bay sediments to the ER-L and ER-M developed by Long, *et al.* Such a comparison can readily prove to be highly unreliable. It has been found from a review of independent datasets that the ER-L and ER-M approach originally developed by Long and Morgan is less reliable in predicting sediment toxicity than flipping a coin. This issue has been discussed in detail by Lee and Jones-Lee (2002) and by Lee (2003).

On page 3.2-12, last paragraph, the draft EIS/EIR states, beginning on line 40,

"In summary, the use of glyphosate and surfactants to treat infestations of non-native cordgrass would result in less than significant impacts on water quality due to the rapid degradation rate and controlled application of herbicides only on target plants." 3

On the same page, beginning on line 30, it is stated,

"These independent lines of research in the fate of glyphosate and surfactants in tidal (and other) habitats suggest that potential impacts to water quality and beneficial uses of waters of the State caused by spraying glyphosate mixtures in intertidal environments are likely to be small and temporary. Therefore, controlled applications (i.e., following label instructions) of registered herbicides are not expected to degrade water quality, except for limited temporal and spatial extent."

However, on page 3.2-10, beginning on line 35, it is stated,

"**Herbicide mixtures.** *The glyphosate/surfactant/colorant mixture is a chemical formulation, and the toxicological characteristic may vary from that of its constituents. While information about the constituents may be instructive, it is desirable to consider the characteristics of the combined mixture to accurately assess possible toxicity. There is a wide range of possible interactions between the glyphosate mixture constituents, and the effects are difficult to predict based on structural, mechanistic, or theoretical considerations (SERA 1997b).* ***Studies of toxicity of glyphosate mixtures in saline or estuarine environments are few, and data are unreliable.*** *The Control Program will perform studies, including bioassays, during the early phases of the Program to determine if there are additional toxic effects of the herbicide mixtures."* [Emphasis added.] 4

The reference to SERA 1997b is not included in the reference list. 5

Further, page 3.3-31, second paragraph, beginning on line 4, states, 6

"Little is known about potential interactive effects between applied glyphosate/surfactant solutions and cumulative loads of herbicides, insecticides, detergents, perfume agents, and many other organic contaminants in the San Francisco Estuary. It is reasonable to assume that cumulative, interactive effects occur in organisms of the Estuary, but the complexity of multiple interactions in uncontrolled field conditions makes definitive research difficult." 6 (cont.)

Both of the above statements mandate that a comprehensive monitoring program be developed as part of monitoring the impacts of the use of herbicides and other chemicals for *Spartina* control. Further, the control program should be conducted in phases, so that an evaluation can be made of potential impacts discerned by the monitoring program during the early phases, and appropriate adjustments can be made in further control efforts. One of the major problems with attempting to review this draft EIS/EIR is that the proposed monitoring program is significantly deficient in providing the information needed to evaluate potential impacts.

As quoted above, and throughout the draft EIS/EIR, mention is made that the herbicide will be used in accord with the US EPA OPP label restrictions. Those who understand the US EPA Office of Pesticide Program registration process know that this process does not necessarily result in protection of aquatic life from toxicity due to the registered pesticide. US EPA OPP's standard for aquatic life protection in registering pesticides allows destruction of aquatic life. Further, it fails to evaluate the potential impacts of mixtures, such as in the herbicide formulation, or with other chemicals that are present in the systems being tested and treated. In addition, it does not consider fate/transport of the pesticide and its impacts "downstream" from the point of application. 7

The US EPA OPP allows a significantly different degree of protection of aquatic life than the Clean Water Act. The Clean Water Act dictates that there shall be no toxicity, while the US EPA OPP allows toxicity if it is not "significant," and the evaluation of significance can include economic considerations and other factors.

Page 3.2-13, line 1 states,

*"**MITIGATION WQ-1:** Herbicides shall be applied directly to plants and at low or receding tide to minimize the potential application of herbicide directly on the water surface. Herbicides shall be applied by a certified applicator and in accordance with application guidelines and the manufacturer label.*

The Control Program shall obtain coverage under the State NPDES Permit for the Use of Aquatic Herbicides and any necessary local permits. A monitoring program shall be implemented as part of the NPDES permit, and shall include appropriate toxicological studies to determine toxicity levels of the herbicide solutions being used. The Control Program shall use adaptive management strategies to refine herbicide application methods to increase control effectiveness and reduce impacts. The Control Program shall continue to investigate improved herbicide formulations with lower ecological risk." 8

Because of the importance of controlling *Spartina* spread and eliminating it to the maximum extent practicable where invasive species already exist, and because there are situations where the use of herbicides appears to be an appropriate approach, it is essential that a highly comprehensive monitoring program be conducted. 8 (cont.)

Since mechanical and other means of controlling *Spartina* also will have adverse impacts, it will be important to monitor their impacts, as well.

Page 3.3-25, line 31 states,

> *"Because Project applications of herbicides would occur only once or twice a year and compounds in the herbicide mixture are not expected to persist in significant concentrations for more than several hours, chronic exposure is not likely. Therefore, this evaluation focuses on acute toxicity, which would occur when the compounds are present at relatively high concentrations during and immediately following application."* 9

While that approach may be appropriate to some extent for water column effects, there is a potential for the herbicide mixture and interactions with other chemicals to lead to chronic toxicity in the sediments. This needs to be evaluated.

Page 3.3-27, line 35 states,

> *"One ecologically significant feature of glyphosate is that it is strongly adsorbed by organic matter and fine sediment, such as clay or silt. Sediment films on plant surfaces strongly interfere with uptake and activity of glyphosate. In its chemically bound, adsorbed state, glyphosate is chemically intact, but physiologically inactive."*

That statement may be unreliable with respect to uptake in the intestinal tract by benthic organisms. Pesticides that have been characterized as being strongly adsorbed to particles are being found to be absorbed by benthic organisms into their tissues through their intestinal tract (see Weston, 2002). The toxicological effects of this absorption are not understood at this time. 10

An issue of particular concern with respect to the potential for sediment toxicity is mentioned on page 3.3-28, line 5:

> *"The reported rates of glyphosate decomposition and persistence in soil vary a great deal: most studies suggest rapid decomposition, while others detect persistence in the soil for more than a year (Ebasco 1993)."*

Page 9-1 begins a listing of the references. Since one of the references (SERA 1997b) that was reviewed in these comments was not present in the reference list, someone should check to be certain that every reference cited in the text is listed properly in the reference list, in sufficient detail so that someone else could obtain a copy of that reference. 11

As part of this review I examined the US EPA OPP Ecotoxicity Database for information on glyphosate toxicity to various types of aquatic organisms. The information in this Database is derived from registrants as part of conducting the required testing for registration of the pesticide. It has been reviewed by an expert in the field. The Database contains about 90 entries for glyphosate. It shows that there are zooplankton and some fish that have 48-hour or 96-hour LC_{50}s on the order of a few milligrams per liter. No information is provided in the US EPA OPP Ecotoxicity Database on the toxicity of glyphosate in combination with other chemicals. 12

One of the issues that should be addressed in the final EIS/EIR is a plausible worst-case scenario evaluation of the concentration of glyphosate that could occur when applied in accordance with label instructions, and when the applied chemical is assumed to be dispersed evenly in the water column during the initial low-tide runoff from the area to which the chemical is applied. My preliminary calculations indicate that there is at least a hundred-fold margin of safety between worst-case concentrations under normal application rates, and acute toxicity in the water column. This needs to be evaluated for the potential situations where treatment could occur. 13

Overall, it is concluded that glyphosate-based herbicides have low toxicity to aquatic life, compared to many other pesticides. Further, it appears that the properties of glyphosate herbicides are such that their aqueous environmental chemistry would tend to lead to rapid detoxification and eventual degradation. An issue of particular concern is whether the combination of chemicals used in the herbicide mixture, as well as other chemicals in Bay waters and/or sediments, could lead to aquatic life toxicity which would be adverse to the beneficial uses of the waterbody. One of the issues of concern is whether the *Spartina* beds are a habitat for larval fish or desirable forms of other aquatic life. This issue will need to be carefully evaluated in the monitoring program to determine if the chemicals used in the *Spartina* control program are significantly adverse to resident aquatic life in the area of treatment, as well as any downstream areas. 14

There is a potential for aquatic life toxicity, especially associated with the sediments, that needs to be evaluated. This should be done during the initial pilot studies on the application of the glyphosate herbicide, through comprehensive field studies. The results of these studies should be reviewed by an independent panel of experts, and a decision should be made as to what modifications in the monitoring program should be made during the second phase, should the initial pilot studies show that no detectable problems were encountered.

Comments on the Monitoring and Reporting Plan

Overall, the information provided on the monitoring program for the use of glyphosate and its associated chemicals to control *Spartina* in the San Francisco Bay area and coast is insufficient to evaluate it. Issues of particular concern are presented below. 15

Specific Comments

Page 2, last paragraph states,

"Monitoring for surfactants or colorants used with herbicides is not required under the Statewide General Permit. Therefore, the Project will not monitor for the non-ionic surfactants or colorant used in conjunction with glyphosate, except for R-11 as described below."

All constituents that are used in the chemical treatment for control of *Spartina* should be monitored, independent of whether it is required by the Statewide General Permit. While the other surfactants appear to be less toxic than R-11, it is possible that in combination with other chemicals they could be adverse to the beneficial uses of the waters in the area of treatment.

Monitoring Parameters

Page 3 presents an unnumbered table of the water quality parameters that will be monitored as part of the evaluation of the water quality impacts of the application of glyphosate 16
and its associated chemicals. Dissolved oxygen and pH are chemical parameters and should not be listed under physical parameters. Under toxicity testing in this table, I do not understand the difference between "96-Hour LC50 Bio-Toxicity" and "96-Hour Acute Toxicity." Also, information is needed on the species that will be tested. Both sensitive fish larvae and zooplankton should be tested.

I have discussed this with Dr. Scott Ogle of Pacific EcoRisk, who is familiar with San 17
Francisco Bay toxicity testing and with whom I have worked on a number of projects. Further, he is working with SFEI in their aquatic weed control program toxicity testing efforts. For the zooplankton, he recommends *Americamysis bahia* (Opossum shrimp, formerly *Mysidopsis bahia*). For the fish larvae test, he recommends *Atherinops affinis* (topsmelt) or *Menidia beryllina* (Inland Silversides). Standard US EPA (1994a) testing procedures using these organisms should be used.

No mention is made in the Monitoring Plan of toxicity testing of the sediments. If there is toxicity, it is likely to be associated with the sediments. There is need to test the sediments for toxicity to sensitive species. The ten-day US EPA (1994b) standard test should be used. Dr. Ogle has recommended the amphipods *Eohaustorius estuarius* and *Ampelisca abdita*. According 18
to Scott, *Eohaustorius estuarius* is not resident in San Francisco Bay, but it is the main amphipod used in Regional Board projects. It has wide grain size/salinity tolerance. *Ampelisca abdita* is resident, but does not do well in coarse sediments.

On page 4, "total nitrogen" is listed as a parameter. What constituents are to be included in total nitrogen measurements? How will these analyses be conducted? Measurement of ammonia and Kjeldahl nitrogen should be conducted. It will be important to examine whether 19
there is sufficient buildup of ammonia in the area of decaying vegetation to be toxic to aquatic life. This will require measurement of ammonia concentrations over several weeks in the treatment area during low or near-low tide.

The total concentration of the herbicide in the sediments should be measured, and the DO concentrations should be monitored in the waters in the treated area over several weeks to 20
determine if the DO is decreased to critical levels due to the decay of aquatic vegetation.

The transport/fate of the killed *Spartina* and non-target vegetation should be determined. If the killed species are carried by the tide/current to an area where they are deposited on the sediments, monitoring should also be conducted in this area for all the parameters to be certain that the dead *Spartina* and other vegetation do not transport the hazardous chemicals from the 21
point of application to another location where the chemicals and vegetation decay products (including elevated ammonia and low DO) are adverse to aquatic-life-related beneficial uses in the water column or sediments.

Another test that should be done is to examine whether the treatment chemicals in the sediments cause problems for germination of non-target species. Dr. Ogle has recommended the use of *Typha latifolia* (cattail) seed germination tests. 22

The analytical methods that will be used should be specified, as well as their detection/ quantitation limits.

Other Characteristics of the Monitoring Program

On page 7, under item 5 Sampling Frequency and Locations, additional information is needed on the proposed monitoring program with respect to collecting the two samples after treatment at "representative sites." How will the "representative sites" be selected? The first sampling should be done in an attempt to collect what would likely be worst-case conditions – 23
i.e., the highest concentration of glyphosate in the water column. If screening for worst-case conditions shows that there is no obvious problem, then the likelihood of other problems occurring will be small. The proposed six hours post-treatment sample collection may not be appropriate, since by then there could be appreciable dilution by the tide of worst-case conditions.

If potentially toxic concentrations of glyphosate and/or toxicity is found under worst-case conditions, then studies should be conducted to track the movement/fate of the waters that first leave the treated area, using drogues (such as oranges), where measurements are made along the drogue path. This information will give an indication of the potential duration of exposure experienced by planktonic organisms associated with the worst-case waters. Also, samples 24
should be collected just downstream of the treatment area on the next tidal cycle at the same stage of the tidal cycle as occurred during and immediately following treatment.

One or more untreated reference areas should be included for similar measurements.

Data Review and Management

When will the data be reviewed and by whom – i.e., as soon as possible after collection? What is the shortest timeframe in which this could occur and thereby be used to guide monitoring at other treatment sites? The approach that will be used to determine whether there is a potential adverse impact should be specified. 25

What method of data storage and retrieval will be used? When will a draft report be prepared and available for public review?

Provisions and funding for follow-up and/or special studies should be included in the Monitoring Plan, in the event that the data indicate that there is need for such studies. 25 (cont.)

Overall, the studies should be conducted in accordance with the nonpoint source water quality monitoring guidance provided by

> Lee, G. F. and Jones-Lee, A., "Issues in Developing a Water Quality Monitoring Program for Evaluation of the Water Quality - Beneficial Use Impacts of Stormwater Runoff and Irrigation Water Discharges from Irrigated Agriculture in the Central Valley, CA," California Water Institute Report TP 02-07 to the California Water Resources Control Board/ Central Valley Regional Water Quality Control Board, 157 pp, California State University Fresno, Fresno, CA, December (2002). 26
> http://www.gfredlee.com/Agwaivermonitoring-dec.pdf

When the details of the sampling program have been more fully defined, it will be appropriate to re-review this material.

References

Lee, G. F. and Jones-Lee, A., "Organochlorine Pesticide, PCB and Dioxin/Furan Excessive Bioaccumulation Management Guidance," California Water Institute Report TP 02-06 to the California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 170 pp, California State University Fresno, Fresno, CA, December (2002).

Lee, G. F., "Comments on the Unreliability of the SWRCB Workplan for Developing Sediment Quality Objectives," Submitted to Arthur G. Baggett, Jr., Chairman, State Water Resources Control Board by G. Fred Lee & Associates, El Macero, CA, May 20 (2003).

US EPA, "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Second Edition," EPA-600-4-91-003, US Environmental Protection Agency, Cincinnati, OH (1994a).

US EPA, "Methods for Measuring the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods," EPA-600/R-94/025, US Environmental Protection Agency, Env. Research Laboratory, Narragansett, RI (1994b).

Weston, D. P., "Toxicological Implications of Changing Pesticide Use in the Central Valley, *Norcal SETAC News* 13(1):15-16, March (2002).

Experience of G. Fred Lee, PhD, PE, DEE in Aquatic Plant Management

Dr. G. Fred Lee became involved in the control of excessive growths of aquatic plants in 1960, while he held a university professorship in water chemistry at the University of Wisconsin, Madison. In this position he developed, and then directed for a period of 13 years, a graduate-level degree program which focused on investigating and managing water quality problems in surface and ground waters. One of his primary areas of research was on the excessive fertilization of waterbodies, focusing on factors influencing and management of algae and other aquatic plants.

In the 1960s Dr. Lee was involved in a number of projects on the control of excessive growths of aquatic plants, including a project sponsored by the Wisconsin Department of Conservation (equivalent to the California Department of Fish and Game) devoted to evaluating the potential impacts of various types of herbicides for control of aquatic plants. The project included adding herbicides to fish hatchery ponds and examining the effects of the herbicides on fish, including their reproduction, growth, etc.

Dr. Lee's work on excessive fertilization management included mechanical harvesting of aquatic plants, where he served as an advisor to the predecessor of the US EPA (Federal Water Pollution Control Association) National Eutrophication Research Program on the benefits of mechanical harvesting of aquatic plants on water quality in Lake Sallie in Minnesota. Dr. Lee has been a long-term member of the Aquatic Plant Management Society, and continues to follow closely work that is done on aquatic plant management in various parts of the US.

Dr. Lee received a bachelors degree in environmental health sciences from San Jose State College in 1955, a Master of Science in Public Health degree focusing on water quality issues from University of North Carolina, Chapel Hill, in 1957, and a PhD degree from Harvard, University, Cambridge, Massachusetts, in 1960, in environmental engineering.

During the 30 years that he held university graduate-level teaching and research positions, Dr. Lee conducted over $5 million in research and published over 500 papers and reports on this work. In addition to holding professorial positions at the University of Wisconsin, Madison, he also held similar positions in the University of Texas system and at Colorado State University.

In 1989, he completed his university teaching and research career as a Distinguished Professor at the New Jersey Institute of Technology. At that time Dr. Anne Jones-Lee, with whom he has worked since the 1970s, and he expanded the part-time consulting that Dr. Lee had been doing while a university professor into a full-time activity, under the name of G. Fred Lee & Associates. Drs. Lee and Jones-Lee are the two principals in the firm.

Dr. Anne Jones-Lee has a bachelors degree in biology from Southern Methodist University, and masters and PhD degrees in environmental sciences, focusing on water quality, from the University of Texas at Dallas. She held university professorial positions for 11 years.

Drs. Lee and Jones-Lee worked on excessive fertilization problems as consultants to a number of countries, including South Africa, Israel, Jordan, Norway, the Netherlands, France, Spain, Japan, Canada, the USSR, Tunisia, Egypt and several of the US states. Their work included completion of a contract for the US EPA devoted to the US part of the Organization for Economic Cooperation and Development (OECD) eutrophication studies that were conducted in the 1970s. In that activity they developed a synthesis report on nutrient load eutrophication response relationships for about 100 waterbodies located throughout the US. The OECD eutrophication study was a five-year, $50-million, 22-country nutrient load eutrophication response investigation which involved the study of 200 waterbodies located in western Europe, North America, Japan and Australia. Subsequent to the completion of this work, Drs. Anne Jones-Lee and G. Fred Lee have expanded the database to over 750 waterbodies located throughout the world.

In 1989, when Dr. Lee completed his teaching and research career, he and Dr. Anne Jones-Lee moved to the Sacramento area to service new clients that had developed in California. This work involved examining eutrophication-related water quality issues in the Sacramento-San Joaquin River Delta, as a consultant to Delta Wetlands, Inc. Drs. Lee and Jones-Lee have been active in Central Valley water quality issues since 1989, including most recently serving as the coordinating PI for a $2-million, one-year CALFED project devoted to the low-DO problem in the San Joaquin River Deep Water Ship Channel located near Stockton, California. They have recently completed a 280-page Synthesis Report covering three years of work that has been done on the low-DO problem in the Deep Water Ship Channel. This problem is related to excessive growths of algae in the San Joaquin River watershed. This report is available on their website, as

> Lee, G. F. and Jones-Lee, A., "Synthesis and Discussion of Findings on the Causes and Factors Influencing Low DO in the San Joaquin River Deep Water Ship Channel Near Stockton, CA: Including 2002 Data," Report Submitted to SJR DO TMDL Steering Committee and CALFED Bay-Delta Program, G. Fred Lee & Associates, El Macero, CA, March (2003). http://www.gfredlee.com/SynthesisRpt3-21-03.pdf

During the mid- to late 1990s, Dr. Lee was responsible for conducting about $500,000 of 205(j) and 319(h) research on behalf of Orange County, California, and the Santa Ana Regional Water Quality Control Board, concerned with water quality problems (pesticide-caused toxicity) in the Upper Newport Bay watershed. As part of this effort he became familiar with the excessive fertilization problems of Upper Newport Bay and the approaches that need to be taken to control these problems.

During 2002 Drs. Lee and Jones-Lee completed reports for the Central Valley Regional Water Quality Control Board concerned primarily with nonpoint source water quality management issues in the Central Valley. These reports,

> Lee, G. F. and Jones-Lee, A., "Review of Management Practices for Controlling the Water Quality Impacts of Potential Pollutants in Irrigated Agriculture Stormwater Runoff and Tailwater Discharges," California Water Institute Report TP 02-05 to California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 128 pp, California State University Fresno, Fresno, CA, December (2002). http://www.gfredlee.com/BMP_Rpt.pdf

Lee, G. F. and Jones-Lee, A., "Organochlorine Pesticide, PCB and Dioxin/Furan Excessive Bioaccumulation Management Guidance," California Water Institute Report TP 02-06 to the California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 170 pp, California State University Fresno, Fresno, CA, December (2002). http://www.gfredlee.com/OClTMDLRpt12-11-02.pdf

Lee, G. F. and Jones-Lee, A., "Issues in Developing a Water Quality Monitoring Program for Evaluation of the Water Quality - Beneficial Use Impacts of Stormwater Runoff and Irrigation Water Discharges from Irrigated Agriculture in the Central Valley, CA," California Water Institute Report TP 02-07 to the California Water Resources Control Board/ Central Valley Regional Water Quality Control Board, 157 pp, California State University Fresno, Fresno, CA, December (2002). http://www.gfredlee.com/Agwaivermonitoring-dec.pdf

Lee, G. F. and Jones-Lee, A., "City of Stockton Mosher Slough and Five Mile Slough Diazinon and Chlorpyrifos Aquatic Life Toxicity Management Report," California Water Institute Report TP 02-08 to the California State Water Resources Control Board/Central Valley Regional Water Quality Control Board, 44 pp, California State University Fresno, Fresno, CA, December (2002). http://www.gfredlee.com/StockDiaTMDL12-14-02.pdf

were funded in part by the US EPA through the State Water Resources Control Board on behalf of the Central Valley Regional Water Quality Control Board. Drs. Lee and Jones-Lee developed these reports as employees of the California Water Institute at California State University, Fresno. One of the key issues that is emphasized in these reports is the development of appropriate nutrient monitoring and management programs to control excessive fertilization of Central Valley waterbodies.

Additional information on Drs. Lee and Jones-Lee's expertise and experience pertinent to conducting studies on the control of aquatic weeds is available on their website, www.gfredlee.com, or from Dr. Lee at gfredlee@aol.com.

L. DR. G. FRED LEE, Ph.D.

Comment L 1:

Responses to specific comments are provided below.

Comment L 2: Draft EIS/EIR fails to adequately discuss the potential impacts of chemical mixtures and interaction with chemicals in bay waters and sediments. Need a comprehensive monitoring program to assess potential adverse effects in water and sediment.

Please see response to comment M 2.

Comment L 3(: Comparison of concentrations of pollutants to ER-L and ER-M values is unreliable.

The table referenced is from a 1998 Annual Report of the San Francisco Estuary Regional Monitoring Program for Trace Substances (SFEI 1998). This program was originated by the San Francisco Bay Regional Water Quality Control Board, and is managed by the San Francisco Estuary Institute. There are currently no Basin Plan objectives or other regulatory criteria for sediment contaminant concentrations in the Estuary. However, there are sediment quality guidelines that may be used as informal screening tools for sediment contaminant concentrations, but hold no regulatory status. The ER-L and ER-M values, though imperfect, are still commonly used as a preliminary screening tool by the Regional Water Quality Control Board and others.

Comment L 4: EIR language, "studies of toxicity of glyphosate mixtures in saline or estuarine environments are few, and data are unreliable..."; inadequate information.

See response to M 13. Note also that toxicity issues may be moot if the concentrations in the environment are rapidly reduced by dilution and dissipation (diffusion) to non-detectible levels.

Comment L 5: Reference to SERA 1997B is missing from reference list.

The following missing reference is added to the references section of the EIS/R, p. 9-15:

> *SERA (Syracuse Environmental Research Associates, Inc.) 1997. Effects of Surfactants on the Toxicity of Glyphosate, with Specific Reference to Rodeo. Prepared for USDA Animal and Plant Health Inspection Services. SERA, Fayetteville, NY*

Comment L 6: EIR statements indicating uncertainty regarding environmental effects of mixtures mandates a comprehensive monitoring program. The control program should be conducted in phases to allow evaluation of monitoring results. Proposed monitoring program is deficient in providing information needed to evaluate potential impacts.

See responses to comments M 2, M 3, and M 4.

Comment L 7: The US EPA OPP registration process does not result in protection of aquatic life from toxicity due to the registered pesticides, as the standard allows destruction of life. It also does not evaluate mixtures, or consider fate and transport and downstream impacts. US EPA OPP is inconsistent with the Clean Water Act, as CWA dictates that there shall be no toxicity, and US EPA OPP allows toxicity if it is not "significant."

Comment noted. The ISP will be assessing toxicity of sediment and the water column, and has established "no toxicity" as the objective, consistent with Basin Plan requirements.

Comment L 8: Because of the importance of controlling *Spartina* spread and eliminating it to the maximum extent practicable, and because there are situations where the use of herbicides appears to be an appropriate approach, it is essential that a highly comprehensive monitoring program be conducted. Mechanical and other means of control will have impacts also and must be monitored.

Comment noted. A comprehensive monitoring plan is proposed as part of the project.

Comment L 9: There is a potential for herbicide mixture and interactions to lead to chronic toxicity in the sediments, and this should be evaluated.

Comment noted. See response to comments M2, M14, and M26.

Comment L 10: Comment on 'statement may be unreliable with respect to uptake in the intestinal tract by benthic organisms....'

See response to comment M 16.

Comment L 11: Since the reference to SERA 1997b is missing from the reference list, the list should be checked for completeness.

Comment noted. See response to comment L 5, above.

Comment L 12: The US EPA OPP Ecotoxicity Database shows that zooplankton and some fish have 48-hour or 96-hour LC50s on the order of a few milligrams per liter. No information is provided on toxicity of glyphosate mixtures.

Comment noted. See response to comments M2, M14, and M26.

Comment L 13: EIS/R should include a plausible worst-case scenario evaluation of the concentration of glyphosate that could occur when applied in accordance with the label, assuming even dispersal in the water column during the initial low-tide runoff. My calculations indicate at least a hundred-fold margin of safety between worst-case concentrations and acute toxicity. This needs to be evaluated for the potential situations where treatment could occur.

The EIS/R provided a general assessment of exposure and risk of herbicide application to human and ecological receptors in Chapter 3.3 (Biological Resources). As shown in Figure 3.3-2, this assessment considered potential worst-case conditions, i.e., both intentional application and accidental releases. Risk assessment methods are generally applied to impact analysis when environmental effects are unclear or unknown. Risk assessment considers the sensitivity and importance of receptors potentially affected, magnitude of impacts from improbable events, and the most likely pathways, types and magnitudes of impacts. This risk assessment indicated a very low risk of significant exposure of human and ecological receptors from the ISP's limited potential herbicide use. Therefore, no quantitative risk analysis was conducted. However, the ISP technical staff generally concurs with the commenter's rough calculation of a "worst case" scenario with respect to acute toxicity.

Comment L 14: [Comment on 'particular concern whether combinations of chemicals used in the herbicide mixture....as well as other chemicals in Bay water....could lead to toxicity...]

Please see responses to comments M 2, and M26. There is really no practical difference between evaluating particular combinations of chemicals and overall toxicity, since the assays will all be conducted in local sediments anyway. The "control" sample is not distilled/buffered pure solution, but ambient water and sediment, so interactions are built in to monitoring.

Comment L 15: The information provided on the monitoring program is insufficient to evaluate it.

Comments L 15-L 23 pertain to a preliminary draft water quality monitoring plan that was provided to Bay Keeper staff for discussion at a meeting on May 22, 2003. The water quality monitoring plan is being prepared in compliance with the Statewide NPDES Permit for Discharge of Aquatic Pesticides to Surface Waters of the United States (General Permit No. CAG990003). It is not a part of the EIS/R. The Water Quality Monitoring Plan, and accompanying Quality Assurance Plan, is being developed in coordination with the Aquatic Pesticide Monitoring Program (APMP) at the San Francisco Estuary Institute, and will be thoroughly peer-reviewed by external experts on the APMP Technical Review Teams. The Water Quality Monitoring Plan and Quality Assurance Plan must be reviewed and approved by the San Francisco Bay Regional Water Quality Control Board Aquatic Pesticide Program Manager before the ISP can be granted coverage under the Statewide NPDES Permit.

Please see response to comment M 2. The preliminary draft of the Water Quality Monitoring Plan was provided during a meeting with Bay Keeper staff for discussion purposes, it was not intended for evaluation. However, we appreciate your helpful comments and have incorporated many of them into the Plan.

Comment L 16: DO and pH are chemical parameters not physical.

Comment noted. Please see response to comment L 15. The requested correction will be made to the final Monitoring Plan.

Comment L 17: Do not understand difference between 96-hour LC50 Bio-Toxicity Test and 96-Hour Acute Toxicity. Information is needed on the species to be tested, both fish larvae and zooplankton should be tested. Suggest *Americamysis bahia*, *Atherinops affinis*, and *Menidia beryllina*.

Please see response to comments L 15 and M 2.As indicated, the table was extremely preliminary and the authors had been listing various tests found in similar monitoring plans for cross-reference purposes. The suggested test species will be proposed to the review panel for consideration..

Comment L 18: Mitigation Plan requirements if there is toxicity it is likely to be associated with the sediments.

The ISP technical staff agrees with this suggestion. The monitoring program will include sediment sampling and bioassays for glyphosate/adjuvant mix toxicity at multiple pilot project sites, representative of the full range of environments in which treatment is likely to occur over the program life. If rigorous bioassays of sediment indicate undetectible or insignificant toxicity in sediments within 1 to 3 tidal cycles after treatment with glyphosate mix treatments, this would indicate a reduced need for sediment monitoring, and a presumption of low toxicity. These results would be reviewed by an independent panel (see response to comment M 4). Please see response to comment L 15.

Comment L 19: What nitrogen constituents are to be measured and how will analyses be conducted? Ammonia and Kjeldahl nitrogen should be measured. It will be important to see whether ammonia buildup in areas of decaying vegetation is sufficient to be toxic to aquatic life.

Please see response to comment L 15. The ISP will propose a full range of Nitrogen compounds to the review panel, and discuss your suggestion regarding monitoring for ammonia buildup. See also response to comment L 20, below: decaying *Spartina* herbage generated by treatments is expected to accumulate near the high tide line (drift-line), not in energetic channel beds. The transport and deposition of leaf litter in tidal marshes is different from killed aquatic vegetation in nontidal ponds and slow-moving stream environments.

Comment L 20: Total concentration of herbicide in the sediments should be measured, and the DO (dissolved oxygen) concentrations should be monitored in the waters in the treated areas over several weeks to determine if DO is decreased to critical levels due to the decay of aquatic vegetation.

Please see response to comment L 15. Chemical concentration of herbicide in sediments would be measured in a few pilot studies, but would not be routinely monitored because (a) it would be useful only if bioassays indicate toxic effects; (b) costs of chemical analysis would be prohibitively expensive as a routine measure. The model of increased DO in the water column, based on lentic (pond/lake) or fluvial (nontidal river) environments with aquatic vegetation, does not apply to tidal salt marsh and mudflat environments. All cordgrass vegetation is intertidal, and thus is fully drained and reflooded twice a day by tides: there is generally full turnover of water within treated stands, and generally no standing water (with the rare exception of infested tidal marsh pans, which are naturally hypoxic or anoxic at the substrate surface when flooded). Cordgrass foliage and stems tissues are rich in aerenchyma (air-filled tissues), making them buoyant and subject to transport and deposition at the most recent high tide line, where they collect as wracks (drift-line deposits of debris) in the pickleweed marsh zone to the upper high tide lines. This has been observed directly by marsh managers and field botanists in SF Bay for over a decade in association with both natural seasonal senescence and herbicide treatment; see also DEIR/S, p. 1-27 at line 42, p. 3.3-33 at lines 1-24. Deposition of massive Spartina alterniflora wracks on marsh plains is a natural feature of Atlantic tidal marshes. These upper marsh habitats are subject to infrequent and transient flooding, more terrestrial than aquatic. Drifted leaf litter has impacts due to persistent smothering of vegetation rather than low DO in the ephemeral water column there.

Comment L 21: The transport/fate of the killed *Spartina* and non-target vegetation should be determined.

Please see response to comments L 15 and L 16, above.

Comment L 22: Tests should be performed to determine whether treatment chemicals cause problems for germination of non-target species; Cattail (*Typha latifolia*) is recommended as a seed germination test species.

Please see response to comment L 15. Seed germination in salt marshes generally occurs in winter and spring when surface sediment salinities are depressed by rainfall or increased dilution of freshwater discharges. In San Francisco Bay, annual maximum marsh substrate salinities occur in summer and fall, causing maximum enforced dormancy of seed. Summer and fall is also the time for herbicide treatment proposed in the ISP, coinciding with the non-germination period. Most herbicide treatment of *S. alterniflora* hybrids occurs in low marsh and mudflat, where the vegetation is composed of clonal cordgrass stands (native or non-native); if any seedlings are present, they are restricted to cordgrass. Other species' seedlings occur in the middle and high marsh zones. Low marsh usually establishes by clonal spread from upper intertidal points of colonization. For the upper intertidal *Spartina* invaders (*S. densiflora, S. patens*), potential indirect impacts on post-treatment seed germination between growing seasons would be limited by high fine sediment mobility and turnover, and immobilization and degradation of glyphosate, and dilution and dissipation of glyphosate. A more significant indirect impact would be the <u>promotion</u> (not reduction) of seedling establishment of undesirable non-native plants in other genera, such as *Lepidium latifolium* (see DEIR/S, p. 3.3-31, lines 12-15 and 27-29.

Cattails are not salt-tolerant plants, and their seedlings are extremely sensitive to even low salinity, which inhibits their germination. Cattails establish in brackish marshes only during intermittent fresh phases, and they are generally excluded from salt marshes. Therefore they are wholly unsuitable surrogates for testing germination of native marsh halophytes (plants that are specially adapted to completing their life-cycles in saline environments). Pickleweed, a rapidly germinating and naturally dominant native plant of salt and brackish marshes of the Bay Area, consistently produces abundant seed, and would be a leading candidate for testing residual soil effects of glyphosate on seed germination. Native cordgrass produces highly variable annual crops of seed with typically low or erratic germination.

Comment L 23: How would "representative sites" be selected? The first sample should attempt to collect the worst-case condition/highest concentrations of glyphosate in the water column. If screening of worst-case conditions shows not obvious problem, then the likelihood of other problems occurring will be small. The proposed six hours post-treatment sample collection may not be appropriate, since by then there could be appreciable dilution.

Please see response to comment L 15. The monitoring program has been constructed in such a way as to assure selection of sites representative of the range of treatment site types. The site types are shown in Figure 2.2 of the EIS/R. The exact sites will be selected in consultation with the scientific advisory panel/technical review team. The six hours post-treatment sample is expected to be the highest concentration because the tide will have reached the higher, more heavily sprayed vegetation and it will have had the opportunity to dissolve the herbicide on the plants. This assumption will be tested and monitoring strategy adjusted as appropriate.

Comment L 24: If potentially toxic concentrations of glyphosate and/or toxicity is found under worst-case conditions, then studies should be conducted to track the movement/fate of water that first leaves the treated area…

Please see response to comment L 15. The ISP concurs with this suggestion, and would conduct appropriate studies as necessary.

Comment L 25: When will the data be reviewed and by whom. Specify the approach that will be used to determine whether there is a potential adverse impact.

Please see response to comment L 15. The preliminary procedure for data review is as follows: The data from the laboratory will be reviewed first by the ISP Director, a Water Quality Engineer with 10 years experience in water analysis and impact determination (as staff for the Regional Water Quality Control Board), and the Field Operations Supervisor to determine whether there is any indication of a problem that needs to be acted on immediately. Any laboratory results that indicate an exceedance of Water Quality Objectives will be reported to the Regional Water Quality Control Board and the situation will be evaluated to determine whether modification of field practices and/or additional investigation is called for. Data will be kept in hard-copy and electronic format, to facilitate data management and interpretation. Monitoring reports will periodically be placed on the ISP website for public viewing. Monitoring data and the Monitoring Program will be evaluated at the end of each season by the Monitoring Review Team, and their findings summarized in an annual report.

Part or all of this procedure may be modified based on recommendations from the Monitoring Review Team and the Regional Water Quality Control Board.

Comment L 26: Studies should be conducted in accordance with the nonpoint source water quality monitoring guidance provided by Lee and Jones (2002).

Please see response to comment L 15. The ISP technical staff will review the referenced document and consider the comment's recommendation.

(M)

WaterKeepers

Submitted Via Electronic Mail: peggy@spartina.org, mspellman@scc.ca.gov

June 4, 2003

Ms. Peggy R. Olofson
Director, Invasive Spartina Project
Ms. Maxene Spellman
Project Manager
California Coastal Conservancy
1330 Broadway, Floor 11
Oakland, CA 94612

Re: Comments on the Proposed EIR for the San Francisco Estuary Invasive Spartina Project: Spartina Control Program

Dear Ms. Olofson, Ms. Spellman and Members of the Spartina Control Program:

On behalf of San Francisco BayKeeper, a project of WaterKeepers Northern California ("BayKeeper"), we offer, for your consideration, the following comments on the proposed EIR. We commend you for preemptively drafting a fairly thorough proposal. We reiterate, however, that the comments provided herein are brief due to limited resources for BayKeeper involvement and thus do not preclude any future objections that BayKeeper may have regarding the final monitoring plan, the final EIR, implementation of either proposal, and unforeseen consequences. BayKeeper has incorporated some comments made by Dr. G. Fred Lee into our assessment, but Dr. Lee will also be providing his complete scientific evaluation of the proposed EIR and draft monitoring plan under separate cover. 1

General Comments

Overall, the draft EIR for the proposed San Francisco Estuary Spartina Control Program covers most of the environmentally significant issues that may arise when evaluating the potential use of herbicides and mechanical techniques to control invasive *Spartina* species in the San Francisco Bay. However, because of the many chemical unknowns involved the application of glyphosate and its associated components (surfactants and colorants) to marsh and mudflat environments, it is essential that a comprehensive monitoring plan, similar to the one presented in draft form to BayKeeper, be included in the text of the EIR. The California Environmental Quality Act ("CEQA") requires an agency to identify a project's potential significant impacts on the environment, to identify alternatives to the project, and to indicate the manner in which those significant impacts can be mitigated or avoided. The agency must mitigate harmful environmental impacts whenever feasible. (CEQA § 21002.1(a) and (b)). The monitoring plan 2 is essential to the mitigation requirements. The plan should also consider the herbicide mixture's impact on the water column, sediment, and aquatic life, including the impact on benthic organisms. Little information is available regarding the toxicity of glyphosate in combination with other chemicals, and this gap in knowledge must be addressed as a central issue in the monitoring plan. The monitoring plan also must adequately address the impacts of mechanical removal technology at the time of removal and at a later time after removal. It must further address post application effects of the proposed non-chemical alternatives. 2 (cont.)

BayKeeper understands the agencies' urgent need to contain and reduce Spartina in these Bay watersheds, however, we greatly urge caution when turning to chemicals of unknown toxicity and other less-studied alternatives. The Bay ecosystem does not need to be faced with an even greater environmental hazard as a result of present haste. According to BayKeeper's current understanding of the Spartina problem and program, we believe the following comments will help improve the Spartina Control Program and reduce future unforeseen, unwanted consequences. 3

Specific Comments

Need To Clarify Timeline

The EIR does not include a clear timeline for monitoring the impacts of removal operations or reassessing the project's goal. There should be a definite short term and long term timeline that is consistent for all monitoring. There should also be a clear indication of when the project will cease to aim for eradication and move into a more management, control-based approach, and the EIR should indicate what factors could trigger this switch. The timeline should include a specific timeframe during which the program will be re-evaluated and control measures will be re-assessed. Especially since the EIR states that "the acreage proposed for chemical treatment may decline as newer and more effective mechanical [and we would hope other non-chemical technology] becomes available." (Page 2-22). 4

Disposal Methods After Removal May Be Inappropriate

CEQA requires a full analysis of all potentially adverse environmental impacts and any feasible mitigation measures. (§ 21002.1(a) and (b)). The EIR must contain specific, identified environmental risks, and specific mitigation measures. The language of the EIR does not provide enough specific context to assure that the disposal of dredged materials will not adversely effect the marsh environment. 5

In order to provide a full analysis of the impacts and mitigation the EIR should contain a specific reference to the feasible operations mentioned in the EIR: "Disposal of dredged material from navigational and flood control projects to diked bayland restoration projects has proven both feasible and cost effective. Based on the similarity of the operations, Control Program planners are optimistic that disposal of materials from eradication projects to assist wetland restoration may also be feasible." (Page 2-10). It should also provide a more detailed description of methods that aim to "beneficially re-use excavated or dredged materials from cordgrass eradication sites to facilitate restoration of dikes baylands." (Page 2-10). The EIR should contain references to the specific projects where the disposal technique has been, and will be, used, so that the effectiveness of the disposal method can be better understood. 5 (cont.)

CEQA also requires that an EIR contain a description of all mitigation measures, which should include all proposed monitoring and evaluation techniques. (§ 21002.1(a)). While the stated objective seems to fit this requirement, "the Control Program would carefully monitor and evaluate the efficacy of any such pilot effort [referring to the pilot disposal program described above], more monitoring detail should be provided for dealing with the future impacts on the environment from disposal of dredged materials, preferably as part of a comprehensive monitoring plan for the potential impacts of mechanical removal and other alternatives, including the long-term potential adverse impacts of frequent mowing, burning, pruning, flaming and flooding. As the EIR mentions, Spartina may sprout from tiny fragments. Thus any disposal method must be clearly described to better understand the environmental impacts and to ensure no further spreading. 6

Suggested Alternatives Are Inadequately Described And Should Not Be Entirely Rejected

CEQA requires an agency to consider all the alternatives to a proposed action that may impact the environment. (§ 21002.1(a)). CEQA also requires that all feasible mitigation measures be considered. Only if economic, social or other conditions make it infeasible to mitigate one or more of the significant effects on the environment of a project may the alternative or mitigation measure be rejected. (§ 21002.1(a) and (c)). The proposed EIR insufficiently rejects one of the action alternatives and the four alternatives presented in favor of an action that will include herbicidal applications and could lead to the most harmful impacts to the aquatic environment. 7

There are very few reasons, most of which are unconvincing, for not pursuing the non-chemical action alternative. For instance, Alternative 2 states that without chemical treatment, it would be "difficult to assure the death of individual plants, resulting in the possible need for repeated mechanical treatment of areas as plants regenerate." (Page 2-23). However, a repeated application of herbicides will probably have to occur to guarantee eradication and to prevent re-growth from parts. Additionally, the fact that mechanical equipment may be infeasible in certain areas does not rule this method out for optimal conditions. And no rationale is provided for why a combination of non-chemical alternatives, such as mechanical, hand excavation, and covering, cannot be used instead of toxic herbicides. 8

One of the rejected alternatives is the eradication of species with limited distribution. The draft EIR states the goal of the limited distribution approach "would be to eradicate only three of the non-native cordgrass species: Chilean cordgrass, salt-meadow cordgrass, and English cordgrass. These species currently have small population sizes and limited distributions, therefore the likelihood of full eradication is high. However, this approach would not address the existing and expanding problem of Atlantic smooth cordgrass invading low intertidal 9 habitats." (Page 2-24). The EIR presents inadequate reasons to reject this alternative. From the descriptions, the non-chemical alternatives could be used in combination with an alternative that focuses on Atlantic smooth cordgrass, such as the biological control method used in Washington, which utilizes the plant-hopper to eliminate this species. As the only alternative or mitigation measure it may be inadequate to prevent the spread of invasive Spartina, however, this alternative is likely to succeed as a part of a larger, non-chemical removal effort. This rejected alternative should be re-evaluated and more sufficiently included as part of the overall EIR. 9 (cont.)

The EIR must more fully address the potential to use biological controls to manage invasive Spartina populations. The EIR uses only one paragraph to describe the potential use of the plant-hopper to control the hybrid Spartina species. (Page 2-24). More analysis of the feasibility of this biological control should be addressed. It should not be rejected simply because it has a "high potential" to attack native species of cordgrass – if this rationale is used in this instance, then BayKeeper would like to suggest that glyphosate should not be used because it has a "high potential" to pollute the entire marsh ecosystem. Further, if the plant-hopper is already native to San Francisco Bay, then the difficulties in obtaining a permit should be less of an issue than they are said to be in the EIR. More information about permitting problems should be provided. Additionally, the success of biological control mechanisms in Washington and other sites should be described. In addition to the plant hopper, the EIR should also address any other potential organism that could act as a biological control. And the possibility of biological control should be addressed in combination with other methods. 10

Furthermore, since the EIR states that "the Control Program shall continue to investigate improved herbicide formulations with lower ecological risks," (Page 3.2-13) consideration of other potentially less toxic new herbicides, such as imazapyr (Arsenal), which is being tested in Washington state, should be considered and implemented into the Control Plan. In addition to the potential alternative imazapyr, other non-chemical alternatives being used by Washington authorities should be further analyzed and assessed for use in the San Francisco Bay. 11

<u>Vehicle Impacts On Geomorphology and Hydrology Should Be Further Described</u>

The EIR states that "unless the treatment method specifically requires it, vehicle travel in the tidal marsh and mudflat shall be minimized. Mats shall be used to distribute the weight of vehicles on marsh surfaces *wherever feasible*." Sensitive sites, or sites surrounded by sensitive habitat that could be significantly impacted by erosion or sedimentation from overland vehicles shall be accessed by boat providing those access methods have less overall adverse environmental impact." (Page 3.1-7, emphasis added).

The EIR should contain details about mitigation measures for using vehicles in the marsh where mats are not feasible, so that all the potential impacts of the vehicles are clear. Further, the EIR should contain an analysis of the environmental impacts of boat access on the wetland as part of their impact assessment. The above statement mentions that boat access will be used "providing those access methods have less overall adverse environmental impact." A comparison of the environmental impacts of vehicle and boat access for removal operations 12 should be included, as well as compared to alternatives requiring manual access. 12

Need to Address Cumulative Impacts from Herbicide Mixtures

The EIR does not adequately address the impacts of the herbicide and other chemicals for Spartina control, as required by CEQA. Additionally, as the EIR states, "a monitoring program shall…include appropriate toxicological studies to determine toxicity levels of the herbicide solutions being used. The Control Program shall use adaptive management strategies to refine herbicide application methods to increase control effectiveness and reduce impacts." (Page 3.2-13).

One of the major problems with attempting to review this EIR is the fact that there is no monitoring program within the EIR available for review. The monitoring program must be included in the EIR and must specifically address the overall toxicity that results from the combination of glyphosate, the surfactants and colorants, and the results from mixing these with other chemicals that already exist in the sediment and water column. If "studies of toxicity of glyphosate mixtures" in estuarine environments are "few and the data unreliable," and if the "tidal marsh conditions…can be a problem for efficacy of glyphosate," then why does the EIR propose to use glyphosate? More research and data collection on the toxic and cumulative impacts of glyphosate must be done before the known toxin can be applied to the environment for an unpredictable number of years. Precaution should prevail when there is a gap in the knowledge of a synthetic chemical's impacts and efficacy. 13

Additionally, in the Summary of Mitigation Measures for Water Quality, the mitigation measures for WQ-2, and WQ-3 state that a plan will be developed and implemented. A monitoring plan for the measurement and recording of any future impacts from the described herbicide activities should be included in the final EIR as part of the mitigation plan. Another row could be added to the table with a monitoring schedule for each procedure and its potential impacts. If the long-term effects of the alternatives and mitigation measures are unknown, then there is little justification to chose one alternative over another.

Chronic Toxicity Must Be Assessed

The EIR states that "because Project applications of herbicides would occur only one or twice a year and compounds in the herbicide mixture are not expected to persist in significant concentrations for more than several hours, chronic exposure is not likely. Therefore, this evaluation focuses on acute toxicity, which would occur the compounds are present at relatively high concentrations during and immediately following application." (Page 3.3-25). 14

This approach may be effective in a limited capacity for water column effects, but the herbicide mixture may interact with other chemicals in the sediment and lead to chronic toxicity. The EIR needs to more fully evaluate the potential for toxic spots in low tidal areas after application as a result of the mixing of the herbicide and other chemicals. The monitoring plan must also consider the potential for chronic toxicity and monitor the overall toxicity carefully.

CEQA requires adequate review of the cumulative impacts of any proposed action (see § 21083(b)), and thus includes monitoring for the total toxicity in the water and soil as part of any mitigation plan, particularly in areas that may become chronically over-toxic. 15

Potential Absorption By Benthic Organisms Must Be Analyzed

The EIR states that "one ecologically significant feature of glyphosate is that it is strongly adsorbed by organic matter and fine sediment, such as clay or silt. Sediment films on plant surfaces strongly interfere with uptake and activity of glyphosate. In its chemically bound, adsorbed state, glyphosate is chemically intact, but physiologically inactive." (Page 3.3-27).

The above statement may be unreliable with respect to the uptake in the intestinal tract by benthic organisms. Pesticides that have been characterized as strongly adsorbed to particles are being found to be absorbed into the tissues of benthic organisms through the intestinal tract. The toxicological effects of this absorption have been insufficiently studied. This unknown toxicological impact should be considered more carefully and monitored. 16

More Studies Need To Be Assessed Regarding The Impact Of Herbicides On Biological Resources

R-11, an adjuvant to be used in the proposed project, has been shown have an adverse impact on amphibian populations as an endocrine-blocking agent. Even at very low concentrations, serious effects of R-11 are seen in frogs in the field and in lab rats. Findings have indicated that exposures at 25 ppm produced significant disruption to the species' endocrine systems. Because R-11, and other adjuvants, have the potential to disrupt endocrine systems in amphibians at low concentrations, the application of herbicides on the habitats of these populations must be considered and mitigated. 17

On page 3.3-46, the proposed EIR analyzes the impacts of removal on the California red-legged frog (IMPACT BIO-7). While no impacts are foreseen because the proposed EIR assumes that the habitat for this species will not overlap with areas where eradication operations would occur, the possibility of these populations being impacted in the future must be addressed as part of any mitigation plan for biological resources. Additionally, the EIR must assess the impacts of herbicidal drift on these populations and their habitats. 18

Finally, there is documentation that glyphosate causes mutations in genetic structures of lab species. The EIR must address this potential impact of glyphosate, especially in light of the lack of sufficient research, in order to prevent long-term harm to both aquatic species and human applicators and communities. 19

Human Health Impacts Need To Be More Fully Mitigated

The EIR states under MITIGATION WQ-1 that "Herbicides shall be applied directly to 20 plants and at low or receding tide to minimize the potential application of herbicide directly on the water surface. Herbicides shall be applied by a certified applicator and in accordance with application guidelines and the manufacturer label." (Page 3.2-13). BayKeeper expects that certified applicators will be trained to take adequate precautions, however, the EIR should further mitigate potential impacts on human health by going beyond labeling requirements to keep applicators from accidental exposure to the toxin. It should also recommend measures such as change of clothes and showers before coming into contact with other people, especially children. 20 (cont.)

On page 3.6-1 the EIR describes the Potentially Exposed Populations that may be exposed to health risks associated with the herbicide. This paragraph and the follow-up impact and mitigation assessment should include mitigation for future unknown potentially exposed populations that may occur later in the project. The potential for accidental exposure during spray is great due to the open and public nature of the Bay. Measures should be taken to ensure that no boats and bystanders are close to the spray area during the appropriate window of dissipation. Additionally, since sediment toxicity could be a potential hazard for an unknown period of time, measures must be taken to ensure that people do not come into contact with contaminated patches of land. 21

Furthermore, the mitigation proposal for health effects to the public from herbicide application says that no spraying will be conducted within 0.25 miles of a school, hospital or other sensitive receptor location. The EIR should delineate why the 0.25 mile zone is a sufficient buffer for the spray zone. 22

Private Land Removal Requires Further Description

A monitoring plan for the application of herbicides is required by the NPDES permit. The EIR should more fully address this process in terms of getting permission of the private land owners. The EIR should also address the possibility of any unforeseen contact with the herbicide that may arise on private lands as a result of various land uses in the area. 23

Potential Drift Must Be More Adequately Addressed

The potential for herbicide drift should also be addressed in the context of private landowners and also as it impacts neighboring communities. The buffer zone, currently set at 0.25, must account for the possibility of drift both during the application period and for the time period that herbicide particles could again become airborne due to strong coastal winds. The monitoring plan must make sure it addresses the overall water and sediment quality in spray areas and surrounding communities for the full term of the project, not just during the time of application. 24

Worst Case Scenario Should be Addressed

The final EIR should contain a worst-case scenario evaluation of the concentration of 25 glyphosate that could occur when applied in accordance with label instructions. This scenario should assume the chemical is dispersed evenly in the water column during the initial low tide runoff from the area to which the chemical is applied. Dr. G. Fred Lee's preliminary calculations indicated that there is at least a hundred-fold margin of safety between worst-case concentrations under normal application rates and acute toxicity in the water column. 25

It is generally concluded that glyphosate-based herbicides have low toxicity to aquatic life as compared to many other pesticides. The properties of glyphosate herbicides are such that their aqueous environmental chemistry would tend to lead to rapid detoxification and eventual degradation. If this is proven to be true, then the issue becomes whether the combination of chemicals used in the herbicide mixture, as well as other chemicals in Bay water and/or sediments, could lead to aquatic life toxicity, which would be adverse to the beneficial uses of the waterbody. The EIR should address whether the Spartina beds are a habitat for larval fish or other forms of aquatic life and whether repetitive application of glyphosate and the destruction of habitat will result in any adverse impacts to these species. 26

Sediment toxicity is also highly probable, and this potential impact must be monitored for and evaluated. 27

The EIR must take all potential impacts on the community into account, this may include, as mentioned above, monitoring for specific impacts to the water and sediment caused by mixing of herbicide and other chemicals. 28 It should also include an analysis of the probable drift of application and its impact on surrounding communities. If in fact the final EIR determines that glyphosate is the appropriate approach to controlling the invasive spread of Spartina and eliminating it to the extent practicable, it is essential that a highly comprehensive monitoring program be conducted. 29

Proposed Monitoring and Reporting Plan (to meet requirements of Statewide General NPDES Permit for Discharges of Aquatic Pesticides to Waters of the United States).

The final comprehensive monitoring and reporting plan should be included in the final EIR because that is the only way to assess whether the assumptions made by the EIR are in fact realistic. The application of glyphosate is the EIR's chosen method because its harm on the environment is unknown. But just because the harm is unknown does not mean that it is mitigated, as required by CEQA. Short-term and long term impacts of glyphosate, its cumulative effects on both aquatic life and sediment quality, and the impacts of potential alternatives must be outlined in the EIR's monitoring plan and studied before the agency can justify its decision to use glyphosate for the duration of the Control Program. 30

Water Quality Parameters

Page 2 of the proposed monitoring and recording plan states, "Monitoring for surfactants or colorants used with herbicides is not required under the Statewide General Permit. Therefore, the Project will not monitor for the non-ionic surfactants or colorant used in conjunction with 31 glyphosate, except for R-11..." Colorants are not regulated as pesticides by state or federal agencies but contain a complex mix of chemicals. Because of their complexity and potential for toxicity, colorants should be analyzed as thoroughly as the active ingredients of both glyphosate and the surfactants R-11. 31 (cont.)

Aquatic Toxicity

The chart on page 3 does not specify a water quality objective in the 96-hour LC50 Bio-Toxicity larvae and juvenile test. More specific goals for future and long-term monitoring of water toxicity should be included in the final EIR. 32

Bioaccumulation

The chart on page 3 does not lay out specific parameters for measuring the bioaccumulation of toxicity over time. The monitoring plan should include more specific monitoring techniques for the long-term potential of chronic toxicity and bioaccumulation. 33

Sediment Quality

The proposed monitoring plan for sediment does not include any specific sediment quality goals in the table on page 4. The final EIR should outline specific sediment quality objectives as well as a comprehensive monitoring plan to evaluate contamination of the sediment. 34

Sampling Frequency and Locations

The EIR should more fully explain the reasoning behind collecting at high tide. Would concentrations be turn out to be higher when collected at low tides? If so, the monitoring would lead to skewed results that may not accurately reflect low tide concentration toxicity to aquatic species. 35

Page 7 of the proposed monitoring plan, under the Section labeled "Sampling Frequency and Locations" states in the first paragraph that "water quality samples will be evaluated for glphyosate, R-11, and nonylphenol residue." The samples should also evaluate any other chemicals, surfactants, and colorants applied in the herbicide process and other chemicals that are already present in the water to ensure that there are no negative impacts from the combination of all the chemicals. 36

Proposed Monitoring of Mechanical Techniques

All of the impacts of mechanical technology should be analyzed and mitigated. The EIR does include mitigation strategies for all mechanical and manual technology for removal of Spartina, however, the proposed monitoring plan only includes monitoring either prior to or at the time of removal. The Table on page 1, of the May 20, 2003 draft Monitoring and Reporting 37

Plan indicates no future monitoring or mitigation for any impacts on the area from mechanical or manual removal that may occur after actual removal. The EIR should include another column to address the future impacts of non-herbicide removal techniques. This monitoring should include any incidental takes of species that occur as a result of mechanical or hand removal operations. 37 (cont.)

BayKeeper hopes these comments on the draft EIR and monitoring plan help to improve the final Spartina Control Program. If you have any questions, please contact Sejal Choksi at 415-856-0444 x107.

Sincerely,

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Pesticide Program Attorney

Joanna Woolman
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M. WATERKEEPERS

Comment M 1:

Comment noted. Comments that overlap those addressed in responses to G.Fred Lee's comments (Letter L) are referred back to those responses.

Comment M 2: The Water Quality Monitoring Plan should be included in the EIR as it is essential to the mitigation requirements. The monitoring plan should address the "gap in knowledge" on the affects of glyphosate in combination with other chemicals. It should also address the impacts of mechanical removal.

The Water Quality Monitoring Plan, a preliminary draft of which was provided to Bay Keeper staff at a meeting on May 20, 2003, is being prepared in compliance with the Statewide NPDES Permit for Discharge of Aquatic Pesticides to Surface Waters of the United States (General Permit No. CAG990003). It is not a part of the EIS/R. The Water Quality Monitoring Plan, and accompanying Quality Assurance Plan, are being developed in coordination with the Aquatic Pesticide Monitoring Program (APMP) at the San Francisco Estuary Institute, and will be thoroughly peer-reviewed by external experts on the APMP Technical Review Teams. The Water Quality Monitoring Plan and Quality Assurance Plan must be reviewed and approved by the San Francisco Bay Regional Water Quality Control Board Aquatic Pesticide Program Manager before the ISP can be granted coverage under the Statewide NPDES Permit.

Rodeo and Aquamaster, the proposed herbicide products, are U.S. EPA-approved for application directly to water. ISP project implementers using chemical methods will be applying these products primarily to vegetation in absence of water, and allowing 4-8 hours of drying time prior to inundation of the sprayed vegetation by tidal water. Based on monitoring results in Willapa, Washington and other similar environments, as described in the EIS/R, there is no indication that the use of glyphosate herbicides will have any significant impacts on the environment. The Water Quality Management Plan would not alter any of the analysis or conclusions in the EIS/R. Therefore there is no requirement to include the Water Quality Monitoring Program in the EIS/R.

The Water Quality Monitoring Plan is designed to test the ISP's assumptions regarding the fate and transport of aquatic herbicide mixtures used for *Spartina* control, and to evaluate whether the herbicides adversely effect water quality or beneficial uses of waters of the State. The Water Quality Monitoring Plan is not a proposal for experimental research on synergistic ecotoxicity of glyphosate, and such research is far beyond the capability or scope of the ISP; the range of potential interactions between glyphosate and individual chemical contaminants detectible in bay water is limitless, and a meaningful evaluation would be impractical, if not infeasible. The Water Quality Monitoring Plan will include standard toxicity tests using bay sediments and waters to evaluate any potential toxicity of glyphosate mixtures in the environment. These will reflect any interactive, synergistic toxic effects that may occur with background (ambient) contaminants. We expect, based on previous research (cited in the EIS/R), that the fine clay, silt, and organic matter in bay water would adsorb glyphosate and render it physiologically unavailable to test organisms within assay tests. Similar toxicity tests have shown show no toxicity due to the use of the glyphosate herbicide mixtures, and the water column and sediment chemical analyses to show extremely low to non-detectable concentrations of herbicide and surfactant.

A monitoring program is also being developed to evaluate the effects to water quality and the environment caused by mechanical control methods, and the costs and impacts of these methods will be compared to the costs and impacts of herbicide control. Again, we are working with the APMP at the San Francisco Estuary Institute do develop the monitoring and evaluation protocols. Mechanical control methods will be regulated by the U.S. Army Corps of Engineers under Sections 10 and 404 of the Clean Water Act, and by the San Francisco Bay Regional Water Quality Control Board under Section 401 of the Clean Water Act and/or the State Water Code.

Comment M 3: Bay Keeper urges caution when turning to chemicals of unknown toxicity and other less-studied alternatives.

The ISP agrees that caution and prudence are critical to minimize the potential for adverse impacts on the environment. That is why the ISP is proposing to use only glyphosate; perhaps the most studied aquatic herbicide and the only aquatic herbicide approved for use in an estuarine environment. As noted in Response to Comment M 2, above, the ISP is not proposing any new or untested herbicides or surfactants, and it will be carefully monitoring to test assumptions regarding impacts to water quality.

Comment M 4: There should be a short-term and long-term timeline for monitoring and reassessing the project's goals and the control methods.

The ISP will implement a program of Integrated Vegetation Management and adaptively manage the project to incorporate new data and findings into its objectives and strategies. To accomplish this goal, it will be necessary to evaluate, on an ongoing basis, a wide variety of scientific, technical, and socio-political information, and to strategically integrate the conclusions into the ISP. As the ISP will not have sufficient scientific and technical experts on staff to adequately consider and address all such issues, it will rely on the input and expertise of outside experts. The ISP is in the process of forming four special support groups for this purpose, including a Science Advisory Panel, a Monitoring Technical Review Team, a Field Operations Group, and a Steering Committee. A brief description of each group follows:

- The Science Advisory Panel will be comprised of local and regional scientists with expertise in wetlands, restoration, ecosystem science, weed control, ecosystem dynamics, and so on. They will advise on the ISP's objectives (e.g., eradication vs. control) and strategy, identify research needs, and act as a conduit to national and/or international scientific opinion. The Science Advisory Panel is expected to meet for the first time in July or early August – a list of preliminary invitees and a draft agenda is available on the ISP website (www.spartina.org). After initial formulation, briefing, and review, the group will meet at least annually.
- The Monitoring Review Team will be comprised of local biologists and regulatory agency staff with expertise in data collection and analysis. The Monitoring Review Team will review and revise protocols for collecting, reporting, and

evaluating a range of data, including the spread of non-native *Spartina*, treatment impacts (including water quality), and treatment efficacy. The Monitoring Review Team has not yet met, but the ISP has been consulting individually with local experts while developing the various monitoring plans. We are currently considering ways to coordinate our Monitoring Review Team with existing monitoring efforts, such as the San Francisco Estuary Institute's Aquatic Pesticide Monitoring Program and the San Francisco Bay Area Wetlands Recovery Program's Monitoring Group. The Monitoring Review Team will review this season's monitoring results in the late winter to early spring, to begin developing recommendations for next year.

- The Field Operations Group will be comprised of individuals with current hands-on experience applying *Spartina* treatment methods. They will provide feedback and guidance before and after each treatment season regarding the problems and advantages, including efficacy and cost, of each treatment method, and help to prioritize treatment projects. The Field Operations Group has met twice, most recently in February of this year (see the ISP website, www.spartina.org, for participants and meeting records). It will meet again at the end of this treatment season to discuss the season's efforts and develop strategies for next year.
- The Steering Committee will be comprised of landowners and managers, regulatory agencies, and environmental interests. It will keep the ISP apprised of individual and community interests, and will assist ISP management in balancing the many overlapping and sometimes conflicting values. A list of potential Steering Committee participants has been developed and is being contacted. Again, we want to coordinate this group with existing efforts, such as the San Francisco Bay Area Joint Venture, and the South Bay Salt Pond Restoration Project Stakeholders Assessment. It is expected that the Steering Committee, once formulated, will meet quarterly.

In specific response to the question of timeline for reassessing goals and methods, it is a continual process, with a focused assessment in the winter following each treatment season. At the current time, the ISP expects that enough data will be available in 5-6 years to reassess the overarching goal of eradication of non-native *Spartina*. The criteria by which this objective might be evaluated were discussed on page 2-17 of the EIS/R.

Comment M 5: The EIR/S should provide specific support to the claim that diked bayland restoration projects have been feasible and cost-effective.

EPA's policy guidance on "Habitat development and restoration of Water Bodies" (preamble to the 404(b)(1) guidelines, Federal Register Vol. 45. No. 249, December 44, 1980, p. 85344) recognizes the potential benefits of re-using dredged materials to restore or create appropriate and well-planned aquatic habitats. EPA considers "obviously degraded " aquatic habitats to be prime candidates for use of dredge materials to create or restore habitats. This policy guidance will be reviewed for projects proposing to excavate tidal habitats infested with *Spartina* alterniflora hybrids, and reuse the excavated material for restoring non-tidal diked baylands to tidal marsh habitats. The selection and use of excavated disposal sites must be in accordance with guidelines developed by the Environmental Protection Agency (EPA) in conjunction with the Secretary of the Army, and with the San Francisco Bay Area Long Term Management Strategy for Disposal of Dredged Materials (LTMS).

With respect to specific projects where dredged material has been beneficially re-used in tideland restoration projects, the Faber Tract salt marsh in Palo Alto has long supported some of the highest breeding success of the endangered California clapper rail, a widely acknowledged indicator of habitat quality. The Faber Tract was formed by deposition of dredged material and natural sedimentation, beginning in the mid-1970s (See: http://www.southbayrestoration.org). In the North Bay, Muzzi Marsh in Corte Madera was constructed from dredged materials. It also supports a persistent population of clapper rails. Not all dredged material marshes are as successful as these; many develop more slowly because of site constraints or engineering difficulties. Not all dredged materials are suitable as "wetland cover" sediment. The ISP proposed to use suitable dredged materials placed in diked baylands, such as salt ponds to be restored to tidal marsh. See responses to comments A 2 and A 5. For regionally specific review of the feasibility and constraints of salt marsh restoration with and without using dredged materials, please refer to the San Francisco Bay Area Wetlands Habitat Goals Project report (Goals Project 1999).

If dredged materials generated by dredge/excavation removal of cordgrass were determined to be unsuitable as wetland cover material, disposal options would include use for construction of foundations for upland transition zones of restored tidal wetlands (while still in diked construction phases), wetland non-cover material (capped with at least three feet of "wetland cover"-class sediment, or upland disposal.

Comment M 6: Since *Spartina* may sprout from tiny fragments, any disposal method must be clearly described to ensure no further spreading, and understand impacts.

Locations where seed or rhizome-laden dredged material is disposed with the intent of beneficially reusing the material for wetlands restoration will be visually monitored for signs of vegetation re-growth in the spring and summer of the year following disposal. As explained on page 2-10, the issue of fragment regeneration applies principally to *S. alterniflora* hybrids and *S. anglica* (not *S. densiflora* or *S. patens*). All disposal of seed or rhizome-laden sediments of these plants are proposed for disposal in either diked non-tidal baylands or uplands, which are lethal environments due to desiccation, hypersalinity, and other soil factors, given sufficient time for full mortality. Even under ideal circumstances, *Spartina* seed is not typically viable for more than one year. In the unlikely event that re-growth is found, a mitigation plan will be developed and implemented to remove or kill the plants. See response to comment A 5.

Comment M 7: The EIR insufficiently rejects one of the action alternatives and the four alternatives presented [?] in favor of an action that will include herbicidal applications and could lead to the most harmful impacts to the aquatic environment.

The commenter's opinion is noted. Please see Section 2.1, "Development of Alternatives for Evaluation," and Chapter 4.0, "Evaluation of Project Alternatives" for rationale for rejecting alternatives and selecting Alternative 1, "Regional Eradication Using All Available Control Methods," as the Environmentally Preferred/Superior Alternative. Refer to response to comment M8 below

Comment M 8: The rationale for eliminating the non-herbicide alternative 2 is insufficient. Repeated herbicide treatment is likely, just as repeated mechanical treatment is likely. The

assessment does not consider whether combinations of non-herbicide methods could substitute for herbicides.

See EIR/S Chapter 4.0, "Evaluation of Project Alternatives", for a discussion of the rationale for the ISP's preferring Alternative 1 to the other alternatives. The EIS/R did not conclude that combinations of non-herbicide methods would be technically infeasible. Rather, it concluded that this universal substitution would: 1) significantly prolong the need for re-treatment, and cause the program to fall rapidly behind the aggressive rate of spread of the hybrid swarm of Spartina alterniflora, and; 2) would have significant short-term environmental effects, quite possibly greater than herbicide application, considering problems of access for mechanical control and the large acres of ripping, shredding, mowing, burning that would be required, all immediately disruptive of the marsh and its ecosystem.

Vigorous regeneration of physiologically intact remnants of hybrid *Spartina alterniflora* rhizomes is a serious problem for many mechanical removal methods. The role of herbicides in preventing regeneration after initial removal is distinct from physical control methods because it affects viability (vigor) of regenerating plants. Glyphosate's systemic action (poisoning organs of regeneration below-ground) is particularly efficient for minimizing regeneration from regenerating rhizome fragments, reducing the number of iterations of follow-up treatment.

The EIR/S concluded that excluding all herbicide use could result in situations in which the rate of reproduction and spread of the hybrid swarm of *Spartina* a*lterniflora* exceeds the maximum potential rate of removal by exclusively non-herbicide methods. This conclusion is based on both local experience during the last 10 years, and experience of estuary managers in Willapa Bay. The EIR/S also concluded that reliance on herbicides may be minimized when it is feasible to use broad physical controls to destroy the bulk of the cordgrass population, and treat survivors/regenerating plants efficiently with localized herbicide application.

There are many infested areas within the remote marshes of the estuary where conditions make frequent re-entry for multiple re-treatment of sites with physical methods infeasible. For example, in many marshes of the San Francisco Bay National Wildlife Refuge, there is no levee road access for equipment to reach multiple treatment sites, and no available travel routes for equipment or vehicles between sites within the marsh, due to impassable channels and high-shear, saturated muds.

Comment M 9: The EIR/S must more fully address the potential to use biological controls to manage invasive *Spartina* populations.

Definitive, authoritative scientific research on the prospects for biological control of Spartina alterniflora hybrids in San Francisco Bay, conducted by Prof. Don Strong and associates at the University of California, Davis, has concluded that biological controls are infeasible because: (a) the impact of biological control agents is insufficient; (b) the "pure" species are too closely related to avoid risks to the native non-target species; (c) the overwhelming majority of the invasion is composed of hybrid intermediates, making selective control of non-native species versus the native impossible. Planthoppers and other cordgrass herbivores have been tested thoroughly, and were determined to be ineffective at inhibiting growth and reproduction of *Spartina alterniflora*: reduction in herbivore densities by 70% had minimal effect on growth, and plants subject to highest possible densities of herbivores grew vigorously under experimental conditions. The researchers concluded that insect herbivores have little impact and were unlikely to limit spread of this extremely vigorous invasive species in San Francisco Bay. (Daehler, C.C. and D.R. Strong. 1995. Impact of high herbivore densities on introduced smooth cordgrass (*Spartina alterniflora*) invading San Francisco Bay. Estuaries 18: 409-417). The ISP has relied on the expert opinion and analytic research from UC Davis to form its policy on biological control. No scientific evidence, analysis or opinions from scientific authorities in this field have challenged these conclusions. The long lead time for research and development and approval of biological controls would make this approach infeasible for the explosive spread of the hybrid S. alterniflora population even if the approach were feasible. Please refer to: Daehler, C.C. and D.R. Strong, (1995) Impact of high herbivore densities on introduced smooth cordgrass, Spartina alterniflora, invading San Francisco Bay, California. Estuaries 18: 51-58.

Comment M 10:

See response to comment M 9, above.

Comment M 11: Imazipyr and other non-chemical alternatives being used by Washington authorities should be further analyzed for use in San Francisco Bay.

The ISP is coordinating closely with Kim Patton, Charles Stenvall, Terri Butler, and others involved in the Washington (Willapa Bay) *Spartina* control effort, and is evaluating all treatment methods proved successful or promising there. Regarding Imazipyr, please see response to comment C 3.

Comment M 12: The EIR should contain details about mitigation measures for using vehicles in marsh where mats are not feasible, and should analyze the impacts of boat access on the wetland.

The mitigation for marsh access impacts where mats are not feasible is to have an appropriately trained biologist advise on a route of least possible impact to salt marsh harvest mouse and other mammals, to mark the route, and to minimize the trips taken. Site access by boat causes no impact to the wetland. In some situations it is the preferred access, however, the access route by boat is frequently prohibitively time consuming.

Comment M 13: If studies of toxicity of glyphosate mixtures" in estuarine environments are "few and data are unreliable", then why does the EIR propose to use glyphosate: Precaution should prevail in the absence of reliable information about glyphosate.

Please see response to comment M 2. The statement in the DEIR/S was incomplete; it referred to general aquatic studies. An important exception is the recent research on glyphosate toxicity to Pacific estuarine organisms of Willapa Bay, cited in the EIR literature (Paveglio *et al*. 1996, Kilbride and Paveglio 2001, Killbride *et al*. 1995). These recent Pacific coast data and analyses are considered up to date, highly relevant, and scientifically reliable. They also are the closest and most similar estuarine systems to the San Francisco Estuary for comparative study of glyphosate impacts. Overall, they indicate that energetic, turbid conditions in tidal mudflats rapidly dissipate glyphosate between tides, resulting in rapid reduction to undetectible levels, and rapid inactivation (adsorption) by clay sediments, as well as low aquatic toxicity.

Comment M 14: The herbicide mixture may interact with other chemicals in the sediment and lead to chronic toxicity.

Chronic toxicity due to synergistic effects of glyphosate and other compounds would require: (a) persistence of glyphosate at physiologically effective concentrations, or frequent recurrent applications at a rate exceeding its rate of decomposition; (b) desorption of glyphosate to react with a reactive unknown contaminant; (c) physiological availability of the speculative glyphosate/unknown complex, in sufficient concentrations and quantities to result in toxic effects. None of these requirements are supported by the available background data on glyphosate. Glyphosate is strongly adsorbed by mineral and organic colloids; though it may dissociate from colloid complexes (desorb), it has higher affinity for fine sediment than for free solution. The studies by Paveglio *et al*. 1996, Kilbride and Paveglio 2001, Killbride *et al*. 1995, indicate relatively rapid dispersion and dilution of glyphosate to undetectible levels in energetic estuarine conditions. These same factors (high turbidity, high turnover of sediment and tidal water, strong tidal currents) would also tend to dissipate the impact of any speculative glyphosate/unknown complex. No evidence of chronic toxicity was found in the Washington State estuarine studies. Therefore, the possibility of chronic toxicity of glyphosate in the San Francisco Estuary appears to be largely speculative, and inconsistent with the preponderance of available scientific data. The monitoring program for the ISP should determine whether any of the necessary conditions for chronic toxicity (persistence, net desorption, free glyphosate or glyphosate complexes in solution) occur under field conditions.

Comment M 15: CEQA requires monitoring for the total toxicity on the water and soil s part of mitigation, particularly in areas that may become chronically over-toxic.

Please see responses to comments M 2, M 4, and M 14, above.

Comment M 16: Adsorbed glyphosate on sediment ingested by benthic organisms may have toxic effects.

Even free, unbound glyphosate, at concentrations above those found in actual estuarine conditions following herbicide application, has low toxicity to aquatic and benthic invertebrates, including oysters (Giesy et al. 2000; Grue et al. 2002; see Draft EIR/S, p. 3.3-28, line 25 et seq.). In the San Francisco Estuary, open mudflat surface sediments are eroded, resuspended, and redeposited with each tidal cycle. The uppermost mudflat surface in potential contact with glyphosate tank mixes would be resuspended, diffused, and dispersed daily with each rising tide. Mudflat surfaces in contact with glyphosate sprays during low tide emergence would be superficially reworked by the subsequent rising tide. This leaves minimal potential for ingestion of glyphosate-contaminated sediments by benthic organisms during the submergence phase of the subsequent high tide, when active feeding would occur. Highly sheltered mudflats areas in breached diked conditions (restored tidal marsh) would be less likely to undergo strong surface sediment resuspension, however, on a daily basis.

The ISP staff will be working with the California Department of Food and Agriculture, the University of California, Davis, and the San Francisco Estuary Institute's Aquatic Pesticide Monitoring Program to assist their independent research projects to study effects of the *Spartina* invasion and of *Spartina* control on benthic invertebrates. The results of their studies will help guide the program's future control strategies.

Comment M 17: R-11 has been shown to have anadverse impact on amphibian populations as an endocrine-blocking agent.

Potential endocrine effects of R-11 on amphibians could occur only if amphibian species are present within treatment areas or drift-areas of applied herbicide spray while R-11 is present. Several geographic, ecological, and schedule factors make this extremely unlikely, and indicate a low level of potential impact even if unlikely impacts occurred.

The primary potential herbicide treatment areas of the ISP are in the tidal marshes of central and south San Francisco Bay, including sloughs and creeks connected to freshwater streams) and adjacent diked wetlands. The tidal marshes of south San Francisco Bay are variably saline, but may fall within the physiological tolerances of amphibians during winter or early spring in wet years. However, amphibians native to the Bay Area generally cannot complete their life-cycles (survive to breed successfully) within a full year of annual salinity variation in non-native *Spartina*-infested tidal marshes, or adjacent saline diked baylands. Thus, amphibians are generally excluded from wetlands that annually vary in salinity above species tolerances.

Two amphibians that may occur in fresh/brackish seasonal wetlands near tidal marshes include the tree frog (*Hyla regilla*) and the California red-legged frog (*Rana aurora draytonii*). Tree frogs, a very common species, occur in some diked, nontidal, seasonal fresh-brackish marshes in the North Bay (San Pablo Bay), and banks of freshwater channels discharging to the bay, but above saline influence. They breed in winter and spring. They could also occur in fresh-brackish areas near the landward limits of a few tidal marshes in San Francisco Bay, where vegetation indicates very limited annual influence of salinity. California red-legged frogs can tolerate salinities at (and perhaps somewhat above) 4 parts per thousand in fresh to brackish wetlands of coastal lagoons, marshes, and stream mouths. Potentially suitable habitat for red-legged frogs is extremely scarce in San Francisco Bay, and surveys have failed to detect California red-legged frogs in the few remaining suitable habitats that do occur adjacent to tidal marshes with *Spartin*a populations. There is a chance that dispersal of red-legged frogs from inland breeding habitats (such as stock ponds and pools in streams) could repopulate scarce suitable freshwater marsh habitats near the bay with *Spartina* populations, such as near Coyote Hills. Surveys by land managers of adjacent Bay wetlands, however, have failed to detect red-legged frogs.

Non-native cordgrasses in San Francisco Bay (with one exception at Southhampton Marsh, Benicia, Solano County) occur only in saline marshes well above potential physiological tolerance of native frogs. Other amphibians, such as California tiger salamanders, are rare and restricted to few nontidal seasonal wetlands in the south Bay far from invasive cordgrass treatment areas. *Spartina* herbicide treatment occurs in tidal, saline wetlands in summer and fall. Native amphibians occur in primarily in nontidal, fresh-brackish wetlands, and breed in winter-spring. Therefore, there is an inherent divergence in potential *Spartina* herbicide drift impacts and potential occurrence of amphibians.

Even if indirect effects of R-11 on amphibians could occur within the geographic constraints of San Francisco Bay, *Spartina* herbicide treatment season (summer-fall) does not coincide with amphibian breeding season (winter-spring). If Spartina control work occurs near potential occupied amphibian breeding habitat, indirect impacts to amphibians could be avoided by using Agridex as a surfactant instead of R-11, or restricting the time of spray applications to gentle breeze conditions directing minimized drift away from the direction of breeding habitat.

R-11 consists primarily of alkylphenol ethoxylates (APEs) derived from nonylphenols (NPs). APEs are widely used as detergents, emulsifiers, solubilizers, wetting agents, and dispersants. The widespread production and use of APEs in industrial production, as cleaners, and in household products leads to their discharge to treatment plants, and the discharge of their degradation by-products into the environment. It was through the study of the effects of wastewater plumes that researchers learned that nonylphenol has estrogenic effects on fish. Studies have found that it is not alkylphenol ethoxylate that cause these effects, but rather the degradation by-product, nonylphenol, which occurs briefly during the environmental breakdown of the ethoxylate product.

Data relating R-11 to endocrine disruption are typically from fresh water studies, and most positive findings are in reduced oxygen (anoxic) environments. In these environments, the degradation process is slowed, and there is increased opportunity for the by-product nonylphenol to persist long enough to effect biota. Studies by California Department of Food and Agriculture (Trumbo 2002) found no detectable levels of R-11 or nonylphenol, and no toxicity at sites where there was moving water. Based on this and similar studies, we have concluded that it is very unlikely that the particular breakdown products associated with endocrine disruption, nonylphenols, will exist for a sufficient length of time in the energetic marsh environments to be metabolized by organisms.

The ISP will be monitoring the sediment and the water column for R-11 and nonylphenol after treatment. If these products are found at detectable levels, the use of R-11 may be suspended and additional studies done.

Comment M 18: The EIR/S must address the potential impact of herbicide drift on California red-legged frogs, and the possibility of future project impacts, even though the EIR assumes the habitat for this species will not overlap with eradication operations.

The EIS/R is not required to address purely speculative impacts for species that occur outside the geographic and ecological range of a project. California red-legged frogs do not occur in tidal salt marshes of San Francisco Bay. Cordgrass species in San Francisco Bay do not occur in or even near the fresh to fresh-brackish marsh, pond, and stream habitats where California red-legged frogs historically occurred. No known populations or habitats of California red-legged frogs occur in potential herbicide drift areas where eradication work may occur. Only one population of this species is known to occur near contemporary San Francisco Bay marshes, and it lies on the inland side of a major freeway and airport. Vegetation associated with red-legged frog habitat around the bay includes tall tules, cattails, and willows (riparian vegetation), which intergrade with cordgrass only at salinities lethal to red-legged frogs in summer and fall, during the season of treatment. If new scientific evidence about the distribution and ecology of California red-legged frogs changes this understanding, the ISP will revise its conclusions and mitigation policy regarding this species.

Comment M 19: There is documentation that glyphosate causes mutations in lab species. The EIR/S must address this potential impact of glyposate.

The ISP technical staff is aware of no evidence that glyphosate exposure in ecologically realistic conditions of estuarine environments (high turbidiy, adsorption, physiological inactivation, rapid diffusion and dilution to undetectible levels) is associated with significant increases in mutation rate in wild species. We also aware of no evidence that glyphosate concentrations in the range of maximum concentrations observed in field conditions following applications is associated with elevated mutation rates. A great many substances administered to test organisms at high concentrations in laboratory conditions are associated with mutations. It is not always clear whether apparent mutation responses are artifacts of laboratory test conditions (such as extremely elevated concentrations). The EIS/R relies on the best available scientific data to assess impacts of actions proposed as part of its program. Therefore, the issue of increased mutation rates is considered a less than a significant impact of glyphosate use within the scope of the ISP.

Comment M 20: The EIR should go beyond labeling requirements to keep applicators from accidental exposure to toxins, and should recommend change of clothes and showers before coming in contact with other people.

Please see discussion of signal words in response to comments I 16 and I 17. The suggested mitigations are included in the precautionary statements on the product labels.

Comment M 21: Since sediment toxicity could be a potential hazard for an unknown period of time, measures should be taken to ensure people do not come into contact with contaminated patches of land.

Mudflats and low salt marsh sediments where most *Spartina alterniflora* control occurs in San Francisco Bay typically do not bear the weight of human beings. Some entry to marshes by humans does occurs in *Spartina* control areas in the North Bay, but tidal marshes are generally closed to public access due to sensitive wildlife. All treated areas would be closed to public access during and following treatment. All available data indicate that human toxicity of glyphosate is very low, compared with both pesticides and common household cleaning solvents (detergents, bleach, ammonia, etc.).

Comment M 22: The EIR should delineate why the 0.25-mile zone is sufficient buffer between spray zone and schools, hospitals, or other sensitive receptors.

The referenced buffer zone is a reasonable and protective buffer for human health, given the constraints for application included in the mitigation measures and on the product label. A quarter mile, for perspective, is 1,320 feet, or 440 yards, the length of four football fields. Spray will be managed to minimize drift. Considering the very low toxicity of the glyphosate mixture and the extensive management controls to be implemented to minimize exposure, a quarter mile is ample buffer. See also responses to comments I 32, I 16, and 1 17.

Comment M 23: Describe process for getting permission to spray on private lands. Address possibility of unforeseen contact with herbicide on private lands.

See response to comment H 2. *Spartina* grows in the intertidal areas along the shoreline, and intertidal areas in California are typically publicly owned. The majority of intertidal lands in San Francisco Bay are owned and managed by public entities such as the State Lands Commission, U.S. Fish and Wildlife Service, East Bay Regional Parks District, and California Department of Fish and Game. The issue will be acquiring access to the intertidal area through private lands. Several private landowners in Marin County and on Alameda Island have already contacted the ISP requesting assistance with *Spartina* control on their lands. In cases where the ISP would like to gain access for treatment, the landowners will be contacted, provided information regarding *Spartina*, and given an opportunity to discuss control options. In many situations, given adequate ground access to the site, alternatives besides spray will be possible if the landowner desires. In situations where ground access through private lands is denied, the ISP will consider helicopter or boat access. In all cases where spray is applied, the mitigations regarding buffer zones and spray control will be implemented.

Comment M 24: The buffer zone must account for the possibility of drift during application and for the time period that herbicide particles could again become airborne due to strong coastal winds. The monitoring plan must make sure it addresses the overall water and sediment quality in spray areas and surrounding communities for the full term of the project, not just during the time of application.

See responses to comments M 22 and M 23, above. Consistent with label requirements and County Agricultural Commission regulations, spray will not be applied during periods of high winds or when high winds are expected soon after treatment. There is no reasonable justification to expect that the quality of water in surrounding communities could possibly be affected by drift from glyphosate spray, and no water quality monitoring in adjacent surrounding communities is planned. The water quality monitoring plan will include sampling of "downstream" or "down-current" areas immediately after and 1-2 days after application.

Comment M 25: The EIR should contain a worst-case scenario evaluation of the concentration of Glyphosate that could occur when applied in accordance with label instructions. Dr G. Fred Lee's preliminary calculations [see comment L 4] indicated that there is at least a hundred-fold margin of safety between worst-case concentrations and acute toxicity in the water column.

Please see response to comment L 4.

Comment M 26: If glyphosate tends to become rapidly detoxified and degraded in the aqueous environment [of San Francisco Bay] the issue becomes whether it interacts with other combinations of chemicals in the environment to become more toxic.

Please see response to comment M 2, above. In order for potentially toxic chemical interactions to occur with physiological impact, both glyphosate and the interacting chemical must be present in sufficient concentrations where target organisms occur: the pathway of exposure and concentrations of contaminants are the critical first step. In the San Francisco Estuary, open mudflat surface sediments are eroded, resuspended, and redeposited with each tidal cycle. The uppermost mudflat surface in potential contact with glyphosate tank mixes would be resuspended, diffused, and dispersed daily with each rising tide.

Mudflat surfaces in contact with glyphosate sprays during low tide emergence would be superficially reworked by the subsequent rising tide. This leaves minimal potential for ingestion of glyphosate-contaminated sediments by benthic organisms during the submergence phase of the subsequent high tide, when active feeding would occur. There would be minimal potential for exposure by either 'pure' bound glyphosate or chemical interactions if glyphosate is diluted and dispersed by the energy of waves and currents. Highly sheltered mudflats areas in breached diked conditions (restored tidal marsh) would be less likely to undergo strong surface sediment resuspension, however, on a daily basis. These less dispersive environments will be monitored to determine whether glyphosate is detectible after several tidal cycles, and thus potentially available for toxic interactions with other chemicals.

Low *Spartina* marsh (*S. alterniflora*/hybrids), when submerged at high tide, provides shelter (cover) for larval fish evading predators. No fish or other aquatic life directly graze on *Spartina*; most marsh food webs are based on detritus (decomposing plant litter), which microbes decompose. Microbes similarly decompose glyphosate. Once habitat structure is destroyed by the first application of glyphosate, the low density of surviving *Spartina* provides minimal cover, and would attract few fish seeking cover; thus, "repeated applications" would not have similar impacts because of initial change in habitat structure. Conversion of marsh to mudflat would cause habitat conversion: destruction of one habitat type (low non-native marsh) but replacement with another, natural type (mudflat), or eventually native marsh, depending on the physical environmental setting.

Comment M 27: Sediment must be monitored for toxicity.

The ISP Water Quality Monitoring Plan includes testing sediment for toxicity.

Comment M 28: EIR should evaluate impacts from mixing chemicals.

Please see response to comment M 26, above.

Comment M 29: It is essential that a highly comprehensive monitoring program be conducted.

Please see responses to comments L 15 and M 2, above. The ISP is developing a comprehensive Water Quality Monitoring Plan and Quality Assurance Plan as part of the NPDES permit process. See note below.

Comment M 30: The final comprehensive monitoring and reporting plan should be included in the EIR. Glyphosate is the EIR's chosen method because its harm on the environment is unknown, but that doesn't mean it's mitigated. Short-term, long-term, and cumulative effects and the impact of potential alternatives must be outlined in the EIR's monitoring plan and studied before the agency can justify its decision to use glyphosate.

Please see response to comment L 15. Glyphosate is among the most studied and best understood of all of the herbicides (see EIS/R pages 2-12 through 2-17, 3.2-9 through 3.2-12, 3.3-24 through 3.3-31, and Appendix E). The only relevant aspect that has not been evaluated is its fate and transport when applied to tidal marshes in the San Francisco Estuary. For purposes of defining the initial control program, reasonable assumptions have been made based on the best available science and by extrapolationg from existing data and local experience. The monitoring program that will be implemented by the ISP will be used to evaluate and confirm our assumptions, regarding fate and transport, and to test for any toxicity possibly caused by the herbicide mixtures in the environment. Mitigation WQ-1 includes a requirement for developing a water quality monitoring program, including toxicological studies, prior to spraying herbicides. The ISP, in compliance with CEQA, is preparing a Mitigation Monitoring and Reporting Program by which the ISP, lead agencies, and public will be assured that all mitigation measures, including the development and implementation of a water quality monitoring plan, is carried out.

Comment M 31: Colorants should be analyzed as thoroughly as the active ingredients in glyphosate and R-11.

Please see response to comment L 15. The colorant Blazon is a water-soluble polymeric product, formulated specifically to be inert in combination with other chemicals. Inertness is a critical characteristic for a colorant because they are added to very low concentration, multiple chemical mixtures, and must not cause any interference. It is extremely unlikely that addition of this colorant will cause any toxicity, and it is an important factor in assuring proper herbicide coverage and worker safety. If any toxicity were caused by the addition of colorant, it will be detected in the standard toxicity tests.

Comment M 32: The chart does not specify water quality objective in the 96-hour LC50 toxicity tests.

Please see response to comment L 15. The referenced chart was incomplete. The objective for all toxicity tests, consistent with the Basin Plan, is "no toxicity."

Comment M 33: The monitoring plan should include more specific monitoring techniques for the long-term potential for chronic toxicity and bioaccumulation.

Please see response to comment L 15. Chronic toxicity tests will be consistent with U.S. EPA standard procedures. The need and possible procedure for evaluating the potential for bioaccumulation are currently being discussed with experts from U.C. Davis, CDFA, SFEI, and the Regional Water Quality Control Board.

Comment M 34: The final EIR should outline specific sediment quality objectives.

Please see response to comment L 15. In response to this comment, the following section is added on page 3.2-8 of the FEIS/R, just before the 'Alternatives 1":impacts discussion

> ***Sediment Quality Criteria.*** *There currently are no Basin Plan objectives or other regulatory criteria for sediment quality. However, there are sediment quality guidelines that may be used as screening tools. The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) has developed sediment screening and testing guidelines for determining the general suitability of dredged material for beneficial reuse (wetland restoration) projects (SFRWQCB 2000). The guidelines include sediment chemistry, acute toxicity, contaminant mobility, and elutriate chemistry and toxicity.*
>
> *Chemistry. The guidelines for sediment chemistry are shown in Table 3.2-6. The sediment chemistry guidelines are divided into two levels, one for material that will be placed at or near the wetland surface ("surface material") and one*

for material that will be placed at a minimum specified distance below the wetland surface ("foundation material").

Toxicity. The recommended acute toxicity screening guideline for surface material is "no significant toxicity" for benthic bioassays. Benthic tests are to be interpreted following guidelines in SFBRWQCB Public Notice 93-3. For benthic bioassays, mortality in a test sediment that is statistically significant and 10 percentage points greater (20 percentage points for amphipods) than that in the reference is considered to be indicative of acute toxicity.

Contaminant Mobility. There are no screening levels for contaminant mobility for wetland surface material because toxicity and chemistry screening for this material will result in concentrations for which mobility is not considered of concern. The screening levels for wetland foundation material are based on Water Quality Objectives found in the Basin Plan. While the foundation material is not expected to be in direct contact with biological receptors, levels of contaminants in effluent discharged during placement of material or in leachate produced after placement of material must be below levels of concern.

Elutriate Chemistry and Toxicity. If dewatering will occur as part of material placement, discharge water must meet screening guidelines for both chemistry and toxicity. The screening guidelines for discharged water chemistry are the Water Quality Objectives listed in the Basin Plan. The screening guideline for toxicity is no significant toxicity. For the elutriate bioassay, this is met when the survival of organisms in effluent has a median value of not less than 90% and a 90^{th} *percentile value of not less than 70% survival.*

These guidelines will be used as screening criteria in situations where sediment will be dredged or excavated, to evaluate beneficial reuse options for dredged material and the potential adverse effects of these and other sediment disturbing activities. The guideline approach will also be used to evaluate effects of herbicide and surfactant residue in sediment. These criteria will be reviewed by the SFRWQCB as part of the NPDES Water Quality Monitoring Plan, and other criteria may be established by the SFRWQCB at that time. The SFRWQCB may also require different or additional criteria for specific sites as part of CWA Section 401 review.

Table 3.2-6. *Sediment Chemistry Screening Guidelines (from Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines [SFBRWQCB 2000])*

ANALYTE	Wetland Surface Material		Wetland Foundation Material	
	Concentration	Decision Basis	Concentration	Decision Basis
METALS (mg/kg)				
Arsenic	15.3	Ambient Values	70	ER-M
Cadmium	0.33	Ambient Values	9.6	ER-M
Chromium	112	Ambient Values	370	ER-M
Copper	68.1	Ambient Values	270	ER-M
Lead	43.2	Ambient Values	218	ER-M
Mercury	0.43	Ambient Values	0.7	ER-M
Nickel	112	Ambient Values	120	ER-M
Selenium	0.64	Ambient Values		
Silver	0.58	Ambient Values	3.7	ER-M
Zinc	158	Ambient Values	410	ER-M
ORGANOCHLORINE PESTICIDES/PCBS (mg/kg)				
DDTS, sum	7.0	Ambient Values	46.1	ER-M
Chlordanes, sum	2.3	TEL	4.8	PEL
Dieldrin	0.72	TEL	4.3	PEL
Hexachlorocyclohexane, sum	0.78	Ambient Values		
Hexachlorobenzene	0.485	Ambient Values		
PCBs, sum	22.7	ER-L	180	ER-M
POLYCYCLIC AROMATIC HYDROCARBONS (mg/kg)				
PAHs, total	3,390	Ambient Values	44,792	ER-M
Low molecular weight PAHs, sum	434	Ambient Values	3,160	ER-M
High molecular weight PAHs, sum	3,060	Ambient Values	9,600	ER-M
1-Methylnaphthalene	12.1	Ambient Values		
1-Methylphenanthrene	31.7	Ambient Values		
2,3,5-Trimethylnaphthalene	9.8	Ambient Values		
2,6-Dimethylnaphthalene	12.1	Ambient Values		
2-Methylnaphthalene	19.4	Ambient Values	670	ER-M
2-Methylphenanthrene		Ambient Values		
3-Methylphenanthrene		Ambient Values		
Acenaphthene	26.0	Ambient Values	500	ER-M
Acenaphthylene	88.0	Ambient Values	640	ER-M
Anthracene	88.0	Ambient Values	1,100	ER-M
Benz(a)anthracene	412	Ambient Values	1,600	ER-M
Benzo(a)pyrene	371	Ambient Values	1,600	ER-M
Benzo(e)pyrene	294	Ambient Values		
Benzo(b)fluoranthene	371	Ambient Values		
Benzo(g,h,i)perylene	310	Ambient Values		
Benzo(k)fluoranthene	258	Ambient Values		
Biphenyl	12.9	Ambient Values		
Chrysene	289	Ambient Values	2,800	ER-M
Dibenz(a,h)anthracene	32.7	Ambient Values	260	ER-M
Fluoranthene	514	Ambient Values	5,100	ER-M
Fluorene	25.3	Ambient Values	540	ER-M
Indeno(1,2,3-c,d)pyrene	382	Ambient Values		
Naphthalene	55.8	Ambient Values	2,100	ER-M
Perylene	145	Ambient Values		
Phenanthrene	237	Ambient Values	1,500	ER-M
Pyrene	665	Ambient Values	2,600	ER-M

Ambient Values – Ambient or "background" concentration statistically derived by the SFBRWQCB from data collected by the Regional Monitoring Program for Trace Substances (SFEI 1999) and the Bay Protection and Toxic Substances Cleanup Program Reference Study (SWRCB 1998)

TEL, PEL – Threshold Effects Level and Probable Effects Level - Sediment chemistry values developed by the Florida Department of Environmental Protection (FDEP 1994) as those below which biological effects are unlikely (TEL), and above which biological effects are likely (PEL).

ER-L, ER-M – Effects Range-Low and Effects Range-Median – Sediment chemistry values developed by Long et al. (1995) using the sediment chemistry and toxicity database of the National Oceanographic and Atmospheric Administration as those below which biological effects are unlikely (ER-L) and above which biological effects are likely (ER-M).

The following references are added to Chapter 9, References:

Florida Department of Environmental Protection (FDEP). 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Vol. 1. Development and Evaluation of Sediment Quality Assessment Guidelines. Prepared by MacDonald Environmental Sciences Ltd.

Long, E.R., D.D. MacDonald, S.L. Smith, and F. D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environ. Manage. 19(1):81-97.

Long, E.R., L.J. Field, and D.D. MacDonald. 1998. Predicting Toxicity in Marine Sediments with Numerical Sediment Quality Guidelines. .

San Francisco Bay Regional Water Quality Control Board (SFRWQCB). 2000. Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines. Staff report prepared by Fred Hetzel and Glynnis Collins, San Francisco Bay Regional Water Quality Control Board, Oakland, CA May 2000. 31 pp.

State Water Resources Control Board (SWRCB). 1998. Evaluation and Use of Sediment Reference Sites and Toxicity Tests in San Francisco Bay. April 1998.

Comment M 35: The [Water Quality Monitoring Plan] should more fully explain the reasoning behind collecting at high tides.

Please see response to comment L 15. Samples will be collected at high tide because that is when we expect to find the highest concentrations of herbicide in the water column. At low tide, there is no water to sample, as the tides are out and the treatment area is exposed. At high tide, the water will have come in and inundated the treatment area, and will have had the longest time to dissolve and suspend herbicide on the plant surface. The ISP technical staff will review other possible scenarios that would lead to other preferred sampling times with the expert peer reviewers assisting with the plan.

Comment M 36: Water quality samples should be evaluated for all chemicals, surfactants, and colorants applied in the herbicide process and other chemicals that are already present in the water to ensure that there are no negative impacts from the combination of all the chemicals.

See response to comments L 15, M 31 and M 35, above.

Comment M 37: The [Water Quality Monitoring Plan] should evaluate the impacts of non-herbicide removal techniques, including incidental takes of species.

Please see response to comment L 15. The draft Water Quality Monitoring Plan reviewed by Bay Keeper staff was for compliance with the Statewide General NPDES Permit for Application of Aquatic Pesticides, and does not include non-herbicide impacts. A supplementary plan will address water quality impacts associated with non-herbicide treatment methods. This plan will undergo the same peer review, and will be included as a requirement of a Water Quality Certification and/or Waste Discharge Requirements from the San Francisco Bay Regional Water Quality Control Board

(N)

May 31, 2003

Ms. Peggy Olofson, Project Director
Olofson Environmental, Inc.
California Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, California 94612

Subject: San Francisco Estuary Invasive Spartina Project: Spartina Control Program. April 2003

Dear Peggy Olofson:

Over the years we have observed the steady and insidious spread of non-native cordgrass in San Francisco Bay along the shorelines of Hayward, San Leandro, and Alameda. At the rate of expansion of this cordgrass there is no time to lose in attempts to control its invasion. Every means possible should be implemented as soon as possible to stamp out the non-native cordgrass. ALTERNATIVE 1 appears to be the most effective means of control, and we support ALTERNATIVE 1.

The planned program to restore salt ponds by opening some ponds to tidal water could create fertile conditions for the spread of non-native cordgrass into these ponds. Therefore, it is important to move quickly with ALTERNATIVE 1. 1

The section on BIOLOGICAL RESOURCES is an excellent documentation as it brings into sharp focus the effect the non-native cordgrass has and will have on the flora, fauna, and hydrology of the San Francisco Estuary.

ALTERNATIVE 1 will have short term negative impacts, but using lesser control systems will have greater long term impacts to the wildlife and their habitats.

We thank the many persons who have contributed to the draft Spartina Control Program, and we encourage rapid implementation of the control program.

Sincerely yours,

Frank Delfino Janice Delfino

Frank and Janice Delfino
18673 Reamer Road
Castro Valley, California 94546

N. FRANK AND JANICE DELFINO

Comment N 1: Watched the invasion for many years – no time to lose in attempts to control it. Every means possible should be implemented, support Alternative 1.

Comment noted.

(0)

June 2, 2003

Maxine Spellman, Project Manager
State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, California 94612

Subject: Comments on the Draft Programmatic Environmental Impact Statement/ Environmental Impact Report for the San Francisco Estuary Invasive Spartina Project Control Program

Dear Ms. Spellman:

As a City of Fremont homeowner and concerned citizen, I am writing to support efforts by you, your staff and the State Coastal Conservancy for any work toward the organization and funding of a San Francisco Bay Estuary-wide Integrated Pest Management Program to eradicate, or control exotic cordgrass species (*Spartina spp.*) and hybrids. Please be aware that the contents of this letter are my own and that the observations and opinions do not necessarily represent those of the Alameda County Public Works Agency.

Since 1989, I have worked as a licensed and registered Pest Control Advisor for the Alameda County Public Works Agency. In that capacity, I have had the opportunity to direct or personally attempt different types of eradication or control methods on many weed species including Spartina alterniflora. The interactions of aquatic site characteristics such as deep soft mud, debris in the treatment areas, tidal conditions, non-target species concerns and regulatory climate combine to make this the most challenging weed I have ever worked on to date. 1

In my opinion the best alternative in the Draft EIS/EIR is Alternative 1. This is the only alternative that has a chance of success given the conditions in the Estuary. We need to integrate all available tools, personnel and technologies to be able to control/eradicate this invasive weed pest.

As part of an Integrated Pest Management Program, the Spartina Control Program should consider several other tools including the use of quarantines and to not allow the planting of Spartina or at least delay the opening of new marsh areas to tidal action until Spartina is controlled or eradicated in adjacent areas. Pursue the registration of Arsenal (Imazapyr) or other new products and obtain experimental use permits, since this is probably the most effective and economical chemical 2 control. When conditions are appropriate Glyphosate work on Perennial Pepperweed (Lepidium latifolium) on adjacent lands may be beneficial as well. 2 (cont.)

For the past nine years working for the Alameda County Public Works Agency, I have cooperated with the Don Edwards San Francisco Bay National Wildlife Refuge and the East Bay Regional Park District and others, to research and demonstrate safe and effective eradication and control measures. Yet because of the large Spartina infested area, geographical and political areas involved, no one agency can effectively manage the whole project at this time. Representatives of these Agencies including myself, now realize that we need an umbrella Agency to coordinate a region wide Spartina Management Program. Your help to facilitate and integrate the involvement of other marshland owners and management agencies can lead to a more effective eradication program. 3

Sincerely,

Stephen R. Jones

P.O. Box 6334
Hayward, CA 94540

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OAKLAND, CALIF.

O. STEPHEN JONES

Comment O 1: Supports the ISP in effort to control exotic cordgrass and hybrids. Many years in weed control, *Spartina* is the most challenging. Support Alternative 1, need all available tools, personnel, and technologies.

Comment noted.

Comment O 2: ISP should consider other tools, including the use of quarantines and to not allow the planting of *Spartina* or at least delay the opening of new marsh areas until *Spartina* is controlled in adjacent areas.

The ISP will actively investigate and test new, more effective treatment methods, and will work with others to test and expedite the registration of Arsenal for use in estuarine environments. Unfortunately, the ISP is not currently a regulatory authority, and it has little ability to control land use decisions or require *Spartina* control on public or private lands. We are working to list *Spartina Alterniflora* as a California "noxious weed" which, unfortunately, still brings no regulatory authority. The Governor of the State of Washington declared a state of emergency regarding the *Spartina Alterniflora* invasion in that State, an approach we could consider in the future.

Consistent with the IVM (integrated vegetation management) approach, the Invasive Spartina Project will consider project-specific needs for addressing indirect effects of treatment on other wetland weed populations, including perennial pepperweed (*Lepidium latifolium*). Where access-related impacts or direct Spartina treatment impacts could increase seedling establishment of perennial pepperweed, control strategies may include targeted local reduction of *Lepidium latifolium* and revegetation with native species that interfere with its seedling establishment. Monitoring of this and other wetland weeds in the overall impact area of control work (access, staging, treatment areas) will be included in local control projects as needed. The ISP is also open to collaboration with other multi-species wetland weed control programs conducted by local wetland managers. The ISP is, however, itself limited in scope to multiple species within the genus *Spartina*.

Comment O 3: Because of the large *Spartina* infested area, geographical and political areas involved, no one agency can effectively manage the whole project. We need an umbrella agency to coordinate a regionwide *Spartina* Management Program.

Comment noted. The ISP is proposed as an umbrella agency to coordinate region-wide *Spartina* control efforts. Other structures are being studied for future efforts including a Joint Powers Authority (JPA) or nonprofit.

P

Marin Audubon Society Box 599 Mill Valley, California 94942-0599

June 4, 2003

Maxine Spellman
California Coastal Conservancy
1330 Broadway, 11th floor
Oakland, CA 94612

RE: COMMENTS ON DRAFT PROGRAMMATIC EIS/R FOR THE SAN FRANCISCO ESTUARY INVASIVE SPARTINA PROJECT: SPARTINA CONTROL. PROGRAM

Dear Ms Spellman:

The Marin Audubon Society appreciates the opportunity to comment on the San Francisco Estuary Invasive Spartina Project: Spartina Control Program DEIR. We agree that the invasion of non-native cordgrasses is an extremely serious threat to the health of the estuary and its native plant and animal species. Therefore, we support the preferred Alternative that would use all available methods of removal of non-native cordgrass. Further, we are interested and willing to 1
help and participate in the program.

The DPEIS/R is well written and thorough in its treatment of this serious issue. We have only a few questions. We request that the following additional information be provided in the final EIS/R::

Regarding the Prioritization Strategy: Will the identified priorities, other than preventing the establishment of new cordgrass populations which is ranked as first, be considered in any priority order? How will decisions be made, other than considering the first priority first, if there is limited 2
funding? Was a priority of ensuring removal in all geographical sections considered and, if so, why was it rejected?

Page 2-21 fourth paragraph last line: Clarify what "scheduling reestablishment of tidal marsh 3
vegetation" means. Does it mean planting of native cordgrass?

Most of the geomorphology discussion focuses on alternaflora. Provide additional information about the potential geomorphic impacts of the other Spartina species, particularly densiflora 4
which does not have such a wide intertidal range.

Please discuss the feasibility of the following activities as potential mitigation measures for removal of non-native cordgrass species: 5

- revegetation with native cordgrass or pickleweed in the appropriate zone. Could planting of native cordgrass at appropriate elevations be helpful in reducing the potential for reinvasion of non-native in treated marshes? It seems to us that there is a risk that native cordgrass will not recolonize fast enough, particularly where there is no local seed source. 5 (cont.)

Would planting of native cordgrass be helpful in marshes where the invasive species is not the aggressive alternaflora, but one of the other species? 6

- staged removal of portions of non-native cordgrass. This is a particular concern in relatively isolated marshes with Clapper Rail populations, such as Creekside Park on Corte Madera Creek. Clapper rails inhabit that marsh, even with its major densiflora population, and there is really nowhere else for them to go if all the cordgrass is removed. The closest marsh, except for a narrow fringe along the filled banks of the Creek, is the Ecological Reserve at the mouth. Would it have any benefit to remove portions of the densiflora (say one-third to one half), replant with native cordgrass, and then remove the remaining cordgrass in stages during subsequent years. It seems to us this would reserve some habitat for the Clapper Rail, rather than eliminating it all at once. 7

Provide some information about the contemplated project public education/outreach/participation program. While this is not a usual subject for discussion in an EIS/R, some helpful ideas might be generated from the public and involvement could be increased

Is there any advice that could be offered for restoration projects in the North Bay where sequencing does not appear to be an effective tool. Marin Audubon has several large restorations planned and we are interested in taking steps, if any exist, to minimize the potential for invasion of non-natives. 8

Thank you for responding to our questions.

Sincerely,

Barbara Salzman
Conservation committee

P. MARIN AUDUBON SOCIETY

Comment P 1: We agree the invasion of non-native cordgrasses is an extremely serious threat to the health of the estuary and its native plants and animal species. We support the preferred Alternative that would use all available methods of removal. Further, we are interested and willing to help and participate in the program.

Comment noted.

Comment P 2: How are priorities ordered, below first priority of preventing spread? How will decisions be made if funding is limited?

Sites are prioritized based on a number of factors, including removal of outliers, restricting spread by seed or rhizome (particularly into sensitive areas), opportunity to test methods, opportunity for public outreach, availability of funding, and willingness of partners. The approach to prioritization is outlined on page 2-18 of the EIS/R, and a sample site selection matrix is provided in Appendix I.

Since the ISP depends in part on voluntary cooperation with project partners, priorities for projects in any given year may be influenced by availability of funding and feasibility of specific project development with local sponsors. Early eradication may be a priority for some cordgrass species of very limited known distribution, such as *Spartina anglica* and *S. patens*. Given the regulatory and resource management obstacles for mass eradication of core populations of *Spartina alterniflora* hybrids (and prior to development and approval of adequate compensatory mitigation), priorities must of necessity be for limiting spread of populations near expanding range limits, and reducing geographic range of the invasion.

Comment P 2: Was removal/eradication in all geographic areas of the bay considered or rejected as a priority?

The ISP presumes that full eradication of all non-native invasive cordgrass species is feasible in the San Francisco Estuary, since the ISP was initiated while each is still at relatively early stages of invasion.

Comment P 3: Clarify "scheduling of re-establishment of tidal marsh vegetation."

Large treatment sites in low salt marsh that would naturally be vegetated with native Pacific cordgrass cannot be revegetated immediately after treatment. Large treatment sites are subject to low-level resprouting of Spartina alterniflora and hybrid rhizome buds, and some re-infestation by hybrid seedlings. Immediate replanting with native cordgrass would generate "contaminated" mixed hybrid stands that would compound the difficulty of hybrid detection and re-treatment, and may attract clapper rails and cause increased clapper rail impacts. Therefore, replanting with native vegetation, must be scheduled so that it does not interfere with treatment efficacy, cause increased impacts of re-treatment, or with interfere with monitoring of treatment areas. In cases where control of adjacent hybrid seed sources is incomplete, replanting or natural re-establishment by native cordgrass may need to be delayed. These are all examples of factors affecting the scheduling for re-establishment of tidal marsh vegetation.

Comment P 4: Discuss geomorphologic effects of *Spartina* species other than *S. alterniflora.*

Only two of the San Francisco Estuary's non-native cordgrasses grow in the daily-flooded part of the intertidal zone, below Mean High Water: *S. alterniflora* and its hybrids with *S. foliosa*, and *S. anglica*. These "low marsh" species have the greatest influence on geomorphic processes because most significant sediment transport occurs in this intertidal zone; sediment accretion and erosion of the middle to high marsh zones, where *S. patens* and *S. densiflora* grow, is naturally slow and smaller in magnitude. The middle and high marsh zones are also composed of root-bound muds and peaty materials that resist erosive forces more than recently deposited bay mud of the low marsh and mudflats. Consequently, most of the geomorphic impacts are associated with the low marsh cordgrasses, in connection with both growth and removal. Manual digging of individual clumps of *S. densiflora* (including root mass) in peaty marsh soil is likely to leave small undrained pits. These are likely to fill with bay mud and organic matter over a few years, particularly where they become overgrown with vigorous pickleweed-saltgrass-jaumea vegetation from adjacent marsh.

Comment P 5: Consider revegetation with native cordgrass or pickleweed in the appropriate zone as a mitigation measure.

Please see response to comment D 5.

Comment P 6: Would planting of native cordgrass be helpful in marshes where the invasive species is not *S. alterniflora*, but one of the other non-native cordgrass species?

Generally, planting of native cordgrasses would not be helpful when the invasive species is not *S. alterniflora*, but one of the other non-native cordgrass species. This is because *S. densiflora* and *S. patens* grow well above the elevational range and vegetation zone of native *S. foliosa*, so there would be little effect of native cordgrass planting on their spread. If native cordgrass were for some reason artificially damaged or deficient in infested marshes, planting native Pacific cordgrass may have some other ecological benefit, but this would be exceptional. It is not clear that planting Pacific cordgrass would significantly retard the spread of *S. anglica*, which is likely to compete successfully with it.

Comment P 7: Would it be beneficial to phase removal of *S. densiflora* where clapper rails have no alternative high tide refugia?

It may be necessary to phase removal of *S. densiflora* at locations where it contributes substantially to high tide refugial cover, or provides most of it. In such cases, revegetation or coordinated planting with gumplant (*Grindelia stricta* var. *angustifolia*), a semi-evergreen subshrub native to the high marsh zone, may be warranted. We expect the rate of seedling re-invasion of *S. densiflora* to be slow enough to enable phased removal to be effective for both eradication and clapper rail protection (in contrast with hybrid *S. alterniflora)*. This type of mitigation would be integral to a project-specific eradication plan, developed in coordination (or consultation) with U.S. Fish and Wildlife Service.

Comment P 8: Provide information on public information/outreach program.

The public education, outreach, and participation program is in the planning phase and will be developed with the full participation of stakeholders in the coming months. It is recognized that public input in this area is important. The ISP staff will contact and work with the commenter to provide technical assistance on their planned restoration projects.

10.3 STAFF-INITIATED TEXT CHANGES AND ERRATA

In the Key to Figure 2-3 the caption after "White Squares" is changed to read: "*considered unlikely*".

The following additional references were inadvertently omitted from the DEIS/EIR and are hereby added to Chapter 9.0:

Hedge, P.T.; Summers, D.; Dittmann, L.; Davies, P. (1999). Toxicological Effects of Fusilade on Pacific Oysters, Crassostrea gigas. Department of Primary Industries, Water and Environment, Tasmania, Australia.

Palmer, D.; Parry, G.; Hart, C. ;Greenshields, P.; Crookes, D.; & Lockett, M. (1995). Toxicity of Fusilade to seagrass and near-shore marine fauna. In J.E. Rash;R.C. Williamson; & S.J. Taylor (Eds). Proceedings of the Australasian Conference on Spartina Control. Victorian Government Publication, Melbourne, Australia.

Patten, K. (2003). Evaluating Imazapyr in Aquatic Environments: Searching for ways to stem the tide of aquatic weeds. Agr. & Env. News, May 2003, pp 23-31.

Mitigation BIO-3 has been reviesd for clarity as follows:

New Mitigation BIO-3:

Treatment activities occurring within 1,000 feet of mudflats shall be scheduled to avoid peak fall and spring Pacific Flyway stopovers. Optimal combinations of treatment shall be used to minimize repeat entry to sites near sensitive shorebird roosts or preferred foraging areas, and to minimize need for re-treatment. Field crews shall be mobilized to project sites soon after high tide, before mudflats emerge to discourage shorebird presence. Field crews shall haze shorebird flocks downwind of spray sites to minimize potential direct contact with drifted glyphosate spray mixes. Hazing shall be maintained until flood tide to minimize potential indirect contact with shorebirds returning to sprayed or drift-exposed areas. Spilled herbicide, surfactant, or solution on marsh or mudflats shall be immediately remediated by application and removal of adsorbent materials, suction using portable wet vacuum or pumping equipment, or by other suitable method. Shorebirds will be kept away from the spill area by hazing until the spill is remediated. Broadcast spraying by helicopters shall be restricted to meadows and large stands of cordgrass, or where there is no other reasonable access. Targeted helicopter application of herbicide by "spray ball" will be a preferred treatment option to reduce all negative treatment impacts to shorebirds. Helicopters will not be operated within 1,000 feet of active major roosting or foraging sites.

Old Mitigation Bio-3:

> **MITIGATION BIO-3:** For work within 1,000 feet of mudflats, eradication activities shall be scheduled to avoid peak fall and spring Pacific Flyway stopovers. Crews shall be mobilized to project sites soon after high tide, before mudflats emerge. Optimal combinations of treatment shall be used to minimize repeat entry to sites near sensitive shorebird roosts or preferred foraging areas, and to minimize need for re-treatment. As a last resort, to minimize potential direct contact with long-distance drifted glyphosate spray mixes, shorebird flocks downwind of spray sites could be hazed by field crews. To minimize potential indirect contact with shorebirds returning to sprayed or drift-exposed mud or vegetation, hazing shall be maintained in buffer areas until flood tide disperses and dilutes surfactants and glyphosate, and physiologically inactivates (sediment adsorption) glyphosate. In case of spills of spray solution in mudflats or marshes, exposure to shorebirds shall be prevented by hazing until spills are remediated. Small volumes of spilled glyphosate/surfactant solutions on mudflats shall be removed to the greatest extent feasible by suction of surface muds, using portable wet vacuum or pumping equipment. Flood tides would disperse, dilute, and inactivate residual spray contents. Spray application requirements shall be minimized by pre-treating target cordgrass stands with mechanical methods that reduce cordgrass biomass and density, increase receptivity and coverage of spray, and increase mortality response to glyphosate. Use of helicopters for spraying shall be restricted to only the largest stands of Atlantic smooth cordgrass, or where access requires. Helicopter applications of herbicide to mudflat colonies within 1,000 feet of major habitual roosting or foraging sites shall be avoided.

The following edits have been made for clarity. Page numbers refer to original DEIS/R pages. The specific reasons for each change are described in the table below:

Page	line	modification	reason
S-2	9	~~Alteration of~~ interference with	consistent w/ text
S-2	11	~~alteration~~ stabilization	consistent w/ text
S-2	14	~~Preclusion of~~ interference with	clarity
S-6	22-38	<u>environmentally</u> ~~preferred~~ preferable	Clarifies NEPA terms.
1-5	12	~~one quarter to one half of the existing tidal flats~~....significant portion of the existing higher tidal flats	no documentation or citation for controversial quantitative estimate
1-6	8	counterpart~~s~~	agreement (singular)
1-8	8	~~exceed~~ reach nearly	Corrects error inconversion from meters to feet
1-8	17	~~has~~ have....~~defined~~ confirmed	agreement (plural); diction
1-18	15-16	~~up to half of the nearly 19,000 acres of~~ .... significant portion of the existing higher tidal flats	no documentation or citation for controversial quantitative estimate
1-18	19-20	~~The process can be witnessed~~...Extensive invasion of	Clarifies vague statement

		tidal flats by Atlantic smooth cordgrass is also occurring...	
1-18	41-42	~~This process could add decades~~...Stabilization of mudflats by extensive invasion of smooth cordgrass could significantly retard salt marsh restoration in tidally restored salt ponds.	not consistent with p. 3.1-4, lns 1-5; no documentation or citation for controversial, arbitrary 'decades' estimate
1-27	25-27	~~Thus, survival....altered~~. Thus, the habitat structure and distribution of the clapper rail in future the San Francisco Estuary's marshes may be radically altered and reduced by long-term invasion of smooth cordgrass.	inconsistent, overstatement; "survival" (extinction) is not predicted in biological impact chapter
1-27	33	...local extinction in the remaining tidal salt marshes it inhabits.	ambiguity; SMHM survives in diked salt marsh
1-30	1-5	*et seq*.	no period after "et"
2-1	18	~~native ecology~~ native salt marsh vegetation and habitat structure	clarifies vague term
2-9	15	~~pulverization of soil~~ pulping of sediment....	"pulverize" refers to dust or powder (dry); 'pulp' refers to soft, moist ground mass; can be transitive verb
2-9	44	...is unusual in San Francisco Bay, where bay mud prevails over sand in most tidal flats.	vagueness
2-10	9-10	salt pond conditions following cessation of salt production are usually dry, hypersaline, or both; these are lethal to cordgrass.	grammar, clarity
2-10	34	~~weekly~~ more than monthly	
2-11	7	insert text after "..rhizomes.": Fine-textured bay mud losing aeration from cordgrass stems quickly becomes anoxic, increasing root-toxicity of waterlogged soil conditions (black, sulfide-rich mud).	clarification of mechanism of crushing effects
2-17	22	[insert after "...cordgrass'] For the purpose of the Spartina Control Program, the practical criterion for eradication of the *Spartina alterniflora* hybrid swarm will be elimination of genotypes (genetic individuals) exhibiting, or capable of reproducing, the robust, invasive hybrid phenotypes with distinctive ecological traits of *S. alterniflora*. The ISP does not assume that all	Same as above

		genes originating in the *S. alterniflora* genome must be extirpated in the introgressant population to protect the genetic and ecological integrity of *S. foliosa*. This working hypothesis will be re-evaluated in during the SPC in coordination with scientific advisors.	
2-18	24	[insert] Control of pollen and seed production would be a priority for hybrid colonies that are identified as exceptionally productive of seed or fertile pollen.	clarification
2-21	28	insert "Spontaneous recruitment of hybrid cordgrass"	correction
2-21	40	~~April~~ September	correction/update
3.2-15 Mit WQ-5	27	[add] Mitigation would not be needed or appropriate at marsh locations where sediment accretion is a beneficial or neutral impact.	clarify ambiguity
3.3-17	38 soft birds beak	~~one colony is~~ multiple colonies are	Correction
3.3-18	40 (salt marsh owls clover)	*Spartina densiflora*, and at Southampton Marsh, Benicia, near expanding *S. patens* colonies	update/correction
3.3-18	41-42 (salt marsh owls clover)	~~San Francisco Bay~~ Point Pinole population contains mostly early-flowering purple-tinged plants ~~and flowers~~ that .....~~upland grassland.~~....~~in the region~~.	update/correction
3.3-21	23	[insert] Smooth cordgrass stems and foliage provide oxygen pathways to its roots and rhizomes, which "leak" oxygen to otherwise oxygen-starved (anoxic) sediments. Removal of above-ground growth of smooth cordgrass results in an acute increase in the severity of root-toxic, anoxic waterlogged sediment conditions.	clarification, explain mechanism of method
3.3-32	17 Mit Bio-1.1	[insert after "minimized."]: Seasonal timing of glyphosate treatment of *S. patens* shall be adjusted to minimize impacts to non-target native marsh vegetation.	Specify mitigation for potentially significant impact so subsequent tiered NEPA/CEQA documents are covered for "significant" impact

3.3-33	30	~~the shoreline~~ ~~irregular shorelines~~	clarification
3.3-32	29	[insert after 'dominant'.] In patches highly vulnerable to spread of contiguous perennial pepperweed, treated areas shall be replanted with saltgrass and pickleweed in the following spring to discourage seedling microhabitats for perennial pepperweed.	Specify mitigation for potentially significant impact so subsequent tiered NEPA/CEQA documents are covered for "significant" impact
3.3-33	30 Bio 1.2	~~Paste~~	correction
3.3-37	7	insert: ....beneath tracked vehicles while accessing-infested marsh areas...	clarification to avoid confusion: no mice under vehicles in cordgrass itself
3.3-41	32	insert: ....may disturb black rails ~~however~~ and devegetated patches may temporarily degrade habitat quality for black rails where treatment areas occur near tidal creek banks.	correction
3.3-41	36-37	Therefore, some impacts to black rails ~~are considered~~ may be significant and unavoidable at the Southhampton Marsh site.	correction
3.3-41	42	add at end: In treatment areas within 15 feet of tidal creek banks at Southhampton Marsh, treated areas shall be replanted with local gumplant, saltgrass, and pickleweed in the following spring to hasten growth of improved cover for black rails.	appropriate mitigation (reduces impact), based on July site inspection; nearly same mitigation as for perennial pepperweed, needed anyway.
4-3	3-16	[see S-6: NEPA environmentally preferable alternative]	
9-15	26	complete reference: ...northern California: distribution and taxonomic notes. Madroño 32:158-167.	

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