Final Programmatic Environmental Impact Statement/
Environmental Impact Report

San Francisco Estuary Invasive Spartina Project: Spartina Control Program

Volume 2: Appendices

September 2003

State Clearinghouse #2001042058

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Notice of Intent

established pursuant to the settlement in *In Re Agent*-product liability litigation, M.D.L. No. 381 (E.D.N.Y.);

(xii) Payments received under the Maine Indian Claims Settlement Act of 1980 (25 U.S.C. 1721);

(xiii) The value of any child care provided or arranged (or any amount received as payment for such care or reimbursement for costs incurred for such care) under the Child Care and Development Block Grant Act of 1990 (42 U.S.C. 9858q);

(xiv) Earned income tax credit (EITC) refund payments received on or after January 1, 1991 (26 U.S.C. 32(j));

(xv) Payments by the Indian Claims Commission to the Confederated Tribes and Bands of Yakima Indian Nation or the Apache Tribe of Mescalero Reservation (Pub. L. 95–433);

(xvi) Allowances, earnings and payments to AmeriCorps participants under the National and Community Service Act of 1990 (42 U.S.C. 12637(d));

(xvii) Any allowance paid under the provisions of 38 U.S.C. 1805 to a child suffering from spina bifida who is the child of a Vietnam veteran (38 U.S.C. 1805);

(xviii) Any amount of crime victim compensation (under the Victims of Crime Act) received through crime victim assistance (or payment or reimbursement of the cost of such assistance) as determined under the Victims of Crime Act because of the commission of a crime against the applicant under the Victims of Crime Act (42 U.S.C. 10602); and

(xix) Allowances, earnings and payments to individuals participating in programs under the Workforce Investment Act of 1998 (29 U.S.C. 2931).

Dated: April 12, 2001.

Mel Martinez,

Secretary.

[FR Doc. 01–9746 Filed 4–19–01; 8:45 am]

BILLING CODE 4210–33–P

DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

Notice of Intent To Prepare a Joint Environmental Impact Statement/ Environmental Impact Report for the Invasive Spartina Project

AGENCY: Fish and Wildlife Service, Interior (Lead Agency).

ACTION: Notice of intent.

SUMMARY: The Fish and Wildlife Service (Service) and the California State Coastal Conservancy (Conservancy) are preparing a programmatic Environmental Impact Statement/ Environmental Impact Report (EIS/R) on implementation of a regional eradication and/or control program for nonnative, invasive *Spartina*, a perennial cordgrass, in the San Francisco Bay Estuary. The EIS/R is intended to provide National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) compliance for the overall Invasive Spartina Project, including identification of all necessary permits and approvals from lead agencies and supporting environmental documentation for other necessary local, State, and Federal permits. The EIS/R would also provide supporting documentation for future grant applications to obtain funding necessary to implement certain elements of the overall project.

DATES: A public scoping meeting to solicit comment on possible alternatives for the eradication and/or control on nonnative, invasive *Spartina* in the San Francisco Bay Estuary will be held on April 24th, 2001 at the Office of the Association of Bay Area Governments, Joseph P. Bork Metro Center, 101 8th Street (8th & Oak Streets), Oakland, California, 94607 at 7 p.m. to 9 p.m. Written comments are encouraged and should be received on or before June 4, 2001.

ADDRESSES: Information or comments related to the NEPA process should be submitted to Wayne White, Field Supervisor, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, 2800 Cottage Way, W–2605, Sacramento, California 95825. Written comments may also be sent by facsimile to (916) 414–6713. All comments, including names and addresses, will become part of the administrative record and may be released.

FOR FURTHER INFORMATION CONTACT: Questions regarding the NEPA process, including scoping, may be directed to Ms. Marla Macoubrie, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, 2800 Cottage Way, W–2605, Sacramento, California 95825 (telephone (916) 414–6600). For questions concerning the CEQA process, please contact Ms. Maxene Spellman, California State Coastal Conservancy, 1330 Broadway, 11th Floor, Oakland, California, 94612 (telephone (510) 286–0332).

SUPPLEMENTARY INFORMATION:

Project Description

This EIS/R will evaluate the environmental effects of adopting and implementing a regional program, the Invasive Spartina Project, being established to eradicate and/or control invasive species of *Spartina* in the San Francisco Bay Estuary. This programmatic document may be supplemented in the future by project-specific CEQA/NEPA documents at up to four pilot project sites. These project-level studies would allow for consideration of techniques specifically tailored for conditions at each site.

The primary goal of the Invasive Spartina Project is to eradicate and/or control invasive *Spartina* in the tidal marshlands and intertidal mudflats along margins of the San Francisco Bay, an area providing habitat for several Federal and State listed species. These efforts will be regionally coordinated with other resource and wildlife agencies in order to minimize disturbance to sensitive habitats and species.

It is estimated that eradication of *S. alterniflora* could provide restoration and possible preservation of up to 40,000 acres of tidal wetlands and up to 29,000 acres of intertidal mud flats. Three other nonnative, introduced species of *Spartina (S. anglica, S. densiflora,* and *S. patens*) would be targeted by this project along margins of the San Francisco Bay.

An ongoing project in Washington State provides preliminary information to this effort on six methods to control and/or eradicate invasive *Spartina.* These methods, listed below, will be evaluated in the EIS/R. Any alternative in the EIS/R process may consider one or more of the following control methods in conjunction with habitat type or setting and geographic location:

- Covering *Spartina* with fabric and/or plastic materials to prevent photosynthesis;
- Mowing *Spartina* with mowers or ''weed-eaters'' and/or mowing and burying with sediments;
- Physical removal of *Spartina* seedlings and plants by digging, pulling, pushing or seedhead clipping;
- Chemical control of *Spartina* with registered herbicide (Rodeo) or experimentally permitted herbicides (Sonar, Arsenal) and surfactants using ground application (backpack, truck, airboat, hovercraft, all terrain vehicles) or aerial application;
- Temporary diking of wetlands;
- Prescribed burns; and
- Combinations of the above methods (such as mowing and herbicide application).

The EIS/R will evaluate individual and cumulative impacts of alternatives based on the above control methods, as well as the no project/no action alternative, in accordance with NEPA and CEQA. Additional methods may be added following the public scoping process. The alternatives will be developed in coordination with the Service, the California Department of Fish and Game (DFG), the Conservancy (Invasive Spartina Project team), and private landowners with populations of nonnative *Spartina* on their properties.

The following actions and approvals are anticipated to be necessary to implement *Spartina* eradication and/or control efforts that might be established as a result of completion of this EIS/R process:

- U.S. Army Corps of Engineers permit(s) for Section 10 of the Rivers and Harbor Act and Section 404 of the Federal Clean Water Act;
- Federal and State Endangered Species Act consultations;
- California State Coastal Conservancy Plan approval;
- California Department of Transportation (Caltrans) Encroachment permit(s);
- DFG Streambed Alteration Agreement(s), Section 1601 of the DFG Code;
- California State Regional Water Quality Control Board 401 Certification(s) and/or Discharge permit(s);
- California State Bay Area Air Quality Management District permit(s);
- Certified Unified Program Agency permit(s) (CUPA Fire Department coordination);
- San Francisco Bay Conservation and Development Commission permit(s); and
- Local agency approval of specific implementation of projects.

Project Location

The geographic scope of the Invasive Spartina Project includes intertidal zones of 10 Bay Area counties bordering and including the San Francisco Bay. Seven of these counties have known populations of nonnative, invasive *Spartina*, including Contra Costa, Alameda, Santa Clara, San Mateo, San Francisco, Marin and Solano counties. The remaining three counties, Napa, Sacramento and Sonoma, do not currently have known populations and are being monitored.

Distribution of invasive *Spartina* is generally greatest in the Central and South San Francisco Bays with the North Bay and far reaches of the South Bay being the least infested. The largest infestations of *S. alterniflora* currently exist at four general sites within the Central and South Bays. These sites include the Hayward Regional Shoreline, Old Alameda Creek, the Alameda Flood Control Channel, and in San Bruno, just north of the San Francisco International Airport. Populations at these locations exceed 100 net acres of *S. alterniflora.* Populations between 10 and 100 net acres occur along the Oakland and Alameda Shoreline, San Leandro Bay, the Don Edwards National Wildlife Refuge, Greco Island, and Bair Island. Small scattered populations occur at Richmond, Emeryville, Coyote Creek, Stevens Creek, Coyote Point vicinity, Candlestick Cove, Yosemite Channel, Richardson Bay, along the Eastshore State Park shoreline, Guadalupe Slough, Palo Alto Baylands, Corte Madera, and San Rafael. The greatest infestation of *S. densiflora* exists along the length of Corte Madera Creek in Marin County. Populations of *S. densiflora* have also become established in San Rafael, Point Pinole, and in Burlingame. *Spartina anglica* is found only at Creekside Park in Marin County and *S. patens* is found only in Benecia and at Tolay Creek.

Potential Effects of Alternative Control Methodologies

The direct effects of physical and mechanical eradication/control measures may include disruption of soil/sediment, potentially resulting in erosion, increased water turbidity, and related adverse effects on aquatic biota. These measures also may have the potential to cause accidental mortality of non-target species, including sensitive species such as the California clapper rail (*Rallus longirostris obsoletus*), California black rail (*Laterallus jamaicensis*), salt marsh harvest mouse (*Reithrodontomys raviventris*), and others. In addition, by possibly disrupting the soil/sediment, these measures could facilitate subsequent colonization by nonnative *Spartina* or other invasive species.

Any possible chemical measures (herbicides) have the potential to kill non-target plant species such as native salt marsh plants, eelgrass, and algae. This could result in adverse indirect impacts to the salt marsh community in general, including sensitive species such as the California clapper rail, California black rail, salt marsh harvest mouse, and others. Loss of eelgrass and other marine flora, if occurring as a result of these measures, could provide for the loss of nursery and feeding habitat for many species of fish and invertebrates, including sensitive species such as the winter-run chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and others. These areas also provide foraging habitat for many marine bird species, including the California least tern (*Sterna antillarum*). The toxicity to animals from herbicides under consideration is generally considered to be low. However, the environmental analysis will evaluate this toxicity, as well as the persistence and transport of these herbicides and their potential toxic effects away from the application site.

Spartina eradication and/or control also has the potential to change existing sediment accretion (shoaling) and erosion patterns, possibly affecting hydrodynamic patterns (currents, circulation, and waves). This could potentially degrade water quality (turbidity, flushing) as well as any associated biological communities (eelgrass, kelp beds, or marshes).

Scoping Process

The EIS/R will be prepared in compliance with NEPA and the Council on Environmental Quality NEPA Regulations, contained in 40 CFR parts 1500–1508; and with CEQA, Public Resources Code Sec 21000 et. seq., and the CEQA Guidelines, as amended. Because requirements for NEPA and CEQA are somewhat different, the document must be prepared to comply with whichever requirements are more stringent. The Service will be the lead agency for the NEPA process and the Conservancy will be the lead agency for the CEQA process. In accordance with both CEQA and NEPA, these lead agencies have the responsibility for the scope, content, and legal adequacy of the document. Therefore, all aspects of the EIS/R scope and process will be fully coordinated between the two agencies.

The draft EIS/R will incorporate public concerns associated with the project alternatives identified in the scoping process and will be distributed for at least a 45-day public review and comment period. During this time, both written and verbal comments will be solicited on the adequacy of the document. The final EIS/R will address the comments received on the draft EIS/R during public review and will be made available to all commenters on the draft EIS/R and anyone requesting a copy during the 45-day public review period. The final EIS/R shall (1) provide a full and fair discussion of the proposed action's significant environmental impacts, and (2) inform the decision-makers and the public of the reasonable measures and alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment.

The final step in the Federal EIS process is preparation of a Record of Decision (ROD), a concise summary of the decision(s) made by the Service. The

ROD can be published immediately after the final EIS comment period has ended. The final step in the State EIR process is certification of the EIR which includes preparation of a Mitigation Monitoring and Reporting Plan and adoption of its findings should the project be approved. A certified EIR indicates the following: (1) The environmental document has been completed in compliance with CEQA; (2) the decision-making body of the lead agency reviewed and considered the final EIR prior to approving the project; and (3) the final EIR reflects the lead agency's independent judgement and analysis.

This notice is provided pursuant to regulations for implementing the National Environmental Policy Act of 1969 (40 CFR 1506.6).

Dated: April 12, 2001.

Steve Thompson,

Acting Manager, California/Nevada Operations Office.

[FR Doc. 01–9702 Filed 4–19–01; 8:45 am]

BILLING CODE 4310–55–P

DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Federal Geographic Data Committee (FGDC); Public Review of the Address Data Content Standard

ACTION: Notice; request for comments.

SUMMARY: The FGDC is conducting a public review of the draft Address Data Content Standard. An interagency team under the FGDC Subcommittee on Cultural & Demographic Data developed this draft standard over several years and the FGDC Coordination Group comprised of representatives from Federal agencies approved releasing this standard for public review. The FGDC invites software vendors and data users and producers in public and private sectors to comment on this standard to ensure that the standard meets their needs.

Comments that address specific issues/changes/additions may result in revisions to the draft NSDI Address Data Content Standard. After comments have been evaluated, participants will receive notification of how their comments were addressed. After formal endorsement of the standard by the FGDC, the standard and a summary analysis of the changes will be made available to the public.

DATES: Comments must be received on or before June 22, 2001.

ADDRESSES: The draft standard may be downloaded via Internet address *http://www.fgdc.gov/standards/status/sub2__4.html*

Request for printed copies of the standard should be addressed to ''Address Data Content Standard,'' FGDC Secretariat (attn: Julie Binder Maitra), U.S. Geological Survey, 590 National Center, 12201 Sunrise Valley Drive, Reston, Virginia 20192 or facsimile 703–648–5755 or Internet at *jmaitra@usgs.gov.*

Reviewer's comments may be sent to FGDC via Internet mail to gdc-address@*www.fgdc.gov.* Reviewer's comments may also be sent to the FGDC Secretariat at the above postal address. Please send one hardcopy version of the comments and a softcopy version on 3.5-inch diskette in Microsoft Word or Rich Text Format. All reviewers are strongly urged to use the template for sending comments that may be downloaded from Internet address *http://www.fgdc.gov/standards/directives/dir2d.html*

SUPPLEMENTARY INFORMATION: Following is information about the draft Address Data Content Standard, submitted by the FGDC Subcommittee on Cultural and Demographic Data (SCDD):

Addresses are widely used by many organizations. Addresses reference and uniquely identify particular points of interest, are used to access and deliver information to specific locations, and can serve as the basis for aggregating data by location.

Many organizations maintain address lists or have databases and datasets that contain addresses. Organizations typically have detailed specifications about the structure of their address information but documentation about the content of the address information is limited. Knowledge of both structure and content is required to successfully share information.

The purpose of this standard is to facilitate the sharing of address information. The Address Data Content Standard (the Standard) accomplishes this by providing a method for documenting the content of address information and simplifies the documentation process by recognizing some commonly used discrete units of address information.

Objective: The objective of the Standard is to provide a method for documenting the content of address information. The Standard is a Federal Geographic Data Committee (FGDC) data usability standard. Data usability standards describe how to express the applicability or essence of a dataset or data element and include data quality, assessment, accuracy, and reporting or documentation standards.

The Standard additionally standardizes some commonly used discrete units of address information, referred to as ''descriptive elements''. It provides standardized terms and their definitions to alleviate inconsistencies in the use of the descriptive elements and to simplify the documentation process.

Scope: The Standard establishes the requirements for documenting the content of addresses.

The Standard is applicable to addresses that reference and uniquely identify particular points of interest. The standard is applicable to the following address types: geographic, mailing, or physical. It specifically excludes electronic addresses.

The Standard is applicable to shared addresses. The Standard does not require addresses be shared and does not provide guidelines for determining whether addresses can be shared. Some organizations cannot share addresses or some part of address information due to requirements for confidentiality and security. However, the principles of the Standard can be extended to all addresses, including addresses maintained within an organization that are not shared.

Applicability: Data producers or maintainers shall comply with the requirements of the Standard when they share their address information with data users.

The Standard places no requirement on internal organization use of address data.

Dated: April 11, 2001.

Karen Siderelis,

Geographic Information Officer.

[FR Doc. 01–9768 Filed 4–19–01; 8:45 am]

BILLING CODE 4310–Y7–M

DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Federal Geographic Data Committee (FGDC); Public Review of the NSDI Framework Transportation Identification Standard

ACTION: Notice; request for comments.

SUMMARY: The FGDC is conducting a public review of the draft NSDI Framework Transportation Identification Standard. An interagency team under the FGDC Ground Transportation Subcommittee developed this draft standard over several years and the FGDC Coordination Group comprised of representatives from Federal agencies approved releasing this standard for

Appendix B
Notice of Preparation

NOTICE OF PREPARATION/NOTICE OF INTENT

TO: DISTRIBUTION

DATE: April 6, 2001

SUBJECT: **Notice of Preparation/Intent of a Draft Joint Environmental Impact Statement/Environmental Impact Report**

LEAD AGENCY: United States Fish and Wildlife Service under NEPA
State Coastal Conservancy under CEQA

PROJECT NAME: Invasive Spartina Project

PROJECT AREA: San Francisco Bay Estuary

CASE NUMBERS:

USFWS, as Lead Agency under NEPA and the Conservancy, under CEQA, will prepare a joint environmental impact statement/ report for the Invasive Spartina Project. We need to know the views of your agency as to the scope and content of the environmental information which is germane to your agency's statutory responsibilities in connection with the proposed project. Your agency may need to use this EIR when considering your permit or other approval for the project.

The project description, location, and environmental issues are contained in the attached **Notice of Preparation/Intent.**

Due to the time limits mandated by State law, your response must be received at the earliest possible date but not later than 30 days after receipt of this notice. A public scoping hearing will be held on April 24, 2001 at 7 p.m. Location : Association of Bay Area Governments Joseph P. Bork MetroCenter. 101 8th Street (8th & Oak Streets) Oakland, CA 94607

Please send your written response, including the name of a contact person with your agency, to **California Coastal Conservancy, attention Maxene Spellman** at the address below.

DATE ISSUED: APRIL 6, 2001

NOTICE OF PREPARATION/NOTICE OF INTENT OF A DRAFT JOINT ENVIRONMENTAL IMPACT STATEMENT /ENVIRONMENTAL IMPACT REPORT

The State Coastal Conservancy (Conservancy) and the U.S. Fish and Wildlife Service (USFWS) will prepare a joint Environmental Impact Statement /Environmental Impact Report (EIS/R) in compliance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) for the following Invasive Spartina Project (ISP). This Notice of Preparation (NOP) has been prepared to satisfy the requirements of CEQA. In compliance with NEPA, a Notice of Intent (NOI) will be published in the Federal Register.

This EIS/R will evaluate the environmental effects of adoption and implementation of a regional program for the control of non-native *Spartina* in the San Francisco Bay Estuary. The goal of the Invasive Spartina Project is to control *S. alterniflora* and restore tidal marshlands and intertidal mudflats along the San Francisco Bay margins, which provide habitat for several threatened and endangered species. It is estimated that the control of *S. alterniflora* could preserve 40,000 acres of tidal wetland and 29,000 acres of intertidal mud flats. Three other introduced species of *Spartina* found in San Francisco Bay, *S. anglica, S. densiflora,* and *S. patens,* also would be targeted by this project.

Environmental impacts of the proposed control methods would be evaluated throughout San Francisco Bay. Project specific impact evaluation would be conducted at up to four pilot project sites yet to be determined.

The USFWS is the lead agency under NEPA and the Conservancy is the lead agency under CEQA. The project will be conducted in close coordination with California Department of Fish and Game (CDFG), other local agencies, and landowners with populations of invasive *Spartina*.

The NOP and NOI are important steps in the environmental scoping process, which is designed to determine the range of the issues to be addressed in the EIS/R. The objectives of scoping include:

- Ensuring agency and public involvement in the environmental review process,
- Determining which specific impacts must be evaluated in the EIS/R,
- Establishing a reasonable range of alternatives, and
- Identifying the scope of issues that must be discussed in order to adequately and accurately address the potential impacts of the project as they relate permitting and approval authority.

The USFWS and the California State Coastal Conservancy request your comments on the scope and content of the draft EIS/R.

Pursuant to CEQA Section 21080.4(a) responsible and trustee agencies are asked to provide in writing the scope and content of the environmental information that is germane to their statutory responsibilities, as these agencies will need to use the EIS/R prepared by the Conservancy and the USFWS when considering permits or other approvals for the project. Responsible and trustee agencies are also requested to provide a list of the permits and/or other approvals that must be obtained in order to implement the project.

A Notice of Preparation/Intent, prepared pursuant to CEQA Section 21080.6, is attached and includes: 1) a description of the proposed action and alternatives and the basis for selecting the alternatives, 2) a list of the potentially significant effects on the environment of the project, and 3) the scope of, and analyses and methodology for, EIS/R preparation. As indicated in the NOP, the major environmental issues to be addressed include water quality, biological resources, risk of upset/health and safety, visual resources, land use, air quality, and noise.

For additional information about the project or the scoping process, please contact:

Maxene Spellman
California State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, Ca 94612
Phone: 510-286-1015
Fax: 510-286-0470

Written comments on the scope and content of the Joint EIS/R should be directed to Maxene Spellman and must be received at the above address no later than May 10, 2001.

A formal scoping hearing, designed to solicit public comment on the proposed action and alternatives, has also been scheduled for **April 24, 2001 at 7 p.m. Location : Association of Bay Area Governments** Joseph P. Bork MetroCenter. 101 8th Street (8th & Oak Streets) Oakland, CA 94607.

ATTACHMENT: Notice of Preparation/Notice of Intent

NOP/NOI DISTRIBUTION:

This Notice of Preparation/Intent was sent to the following agencies, organizations, firms, and individuals:

Counties

Marin
Solano
San Francisco
Contra Costa
San Mateo
Alameda
Santa Clara

State

State Clearinghouse

Federal

National Fish and Wildlife Foundation
U. S. Fish and Wildlife Service
Calfed Bay Delta Program
Don Edward National Wildlife Refuge

Cities

Brisbane
Burlingame
Daly City
Millbrae
Mountain View
Belmont
Menlo Park
San Bruno
San Carlos
Sunnyvale
Redwood City
San Mateo
South San Francisco
Palo Alto
Foster City
Alameda
San Francisco
Hayward
Fremont
Benecia
Newark
San Leandro
San Rafael
Tiburon
Richmond
Oakland
Larkspur
Corte Madera
San Jose

Local/Special Districts

Santa Clara Valley Water District
East Bay Regional Parks District
San Mateo Mosquito Abatement District

Others

Urban Creeks Council
Save The Bay
BayKeeper
California Native Plant Society
Citizens to Complete the Refuge
Ducks Unlimited
Bay Area Audoban
The Bay Institute
Sierra Club
Silicon Valley Toxics Coalition
San Francisco Bay Joint Venture

NOTICE OF PREPARATION/INTENT

FOR THE INVASIVE SPARTINA PROJECT (ISP) EIS/EIR

INTRODUCTION:

The Conservancy and the USFWS are preparing a joint Environmental Impact Statement/Report (EIS/R) to address the potential impacts of the proposed regional program for the control and eradication of non-native *Spartina*. The joint EIS/R will be prepared to address the design, implementation, and maintenance of *Spartina alterniflora* and three other invasive *Spartina* species (*S. densiflora, S. anglica,* and *S. patens*). The EIS/R is intended to cover all aspects of the project including all necessary permits and approvals from the lead agencies, as well as other local, state, and federal agencies. The EIS/R and the approved plan can also form the basis for future grant applications to obtain funding necessary to implement certain elements of the overall project.

The EIS/R will be prepared in compliance with the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) NEPA Regulations, contained in 40 C.F.R. Parts 1500-1508; the California Environmental Quality Act (CEQA) and the CEQA Guidelines, as amended. Because NEPA and CEQA are somewhat different with regard to procedural and content requirements, the document must be prepared to comply with whichever requirements are more stringent. The U.S. Fish and Wildlife Service (USFWS) will be the lead agency under the National Environmental Policy Act (NEPA) and the Conservancy will be the lead agency under the California Environmental Quality Act (CEQA). In accordance with both CEQA and NEPA, the lead agencies have the responsibility for the scope, content, and legal adequacy of the document. Therefore, all aspects of the EIS/R scope and process will be fully coordinated with the two agencies.

The Draft EIS/R will incorporate public concerns associated with the Proposed Action and associated project alternatives, and will be sent out for a 45-day public review period, during which time both written and verbal comments will be solicited on the adequacy of the document. The Final EIS/R will address the comments received on the DEIS/R during public review. The document will be furnished to all who commented on the DEIS/R, and made available to anyone that requests a copy during the 45-day public comment period. The draft and final EIS/R must 1) provide a full and fair discussion of the proposed action's significant environmental impacts, and 2) inform the decision-makers and the public of reasonable alternatives that would avoid or minimize adverse impacts.

The final step in the review process for the Federal EIS is preparing a Record of Decision (ROD) and, for the State EIR, certifying the EIR and adopting a Mitigation Monitoring and Reporting Plan. The ROD is a concise summary of the decisions made by the Service (in cooperation with the U.S. Army, Corps of Engineers [Corps]) from among the alternatives presented in the FEIS/R. The ROD can be published immediately after the FEIS comment period ends. A certified EIR indicates that the environmental document has been completed in compliance with CEQA; that the decision-making body of the lead agency reviewed and considered the FEIR prior to approving the project; and that the FEIR reflects the lead agency's independent judgement and analysis.

SCOPING PROCESS:

Public participation in the environmental scoping process is an important step in determining the full scope of issues to be addressed in the EIS/R. The Conservancy and the USFWS request your comments on the scope and content of the draft Joint EIS/R, as outlined in this NOP/NOI. Written comments must be provided to Maxene Spellman, California Coastal Conservancy, 1330 Broadway, 11th Floor, Oakland, CA 94612. **no later than May 10, 2001.**

A formal scoping hearing has also been scheduled for **April 24 at 7:00 PM** at the **Association of Bay Area Governments** Joseph P. Bork MetroCenter. 101 8th Street (8th & Oak Streets) Oakland, CA 94607

PROJECT SUMMARY:

This EIS/R will evaluate the environmental effects of adoption and implementation of a regional program for the control of invasive *Spartina* in the San Francisco Bay Estuary. The EIS/R will be a programmatic evaluation of the environmental impacts of the proposed eradication and control methods at several locations throughout San Francisco Bay, supplemented by project specific evaluations at up to four pilot project sites.

The habitats subject to exotic species control efforts include tidal marshlands, lagoons, intertidal mudflats, and the saline reaches of creeks and rivers flowing into the San Francisco Estuary. Eradication/control efforts would be regionally coordinated with other programs in order to minimize disturbance to sensitive habitats and species, while successfully controlling invasive *Spartina.* The project intends to restore native plant communities and sensitive species habitats associated with tidal marshlands and intertidal mudflats along the Bay margins by eliminating introduced *Spartina* species. The control efforts and alternatives evaluated in the EIS/R will be consistent with the USFWS policies and goals.

PROJECT LOCATION:

The geographic scope of the Invasive Spartina Project encompasses ten Bay Area counties. Environmental impacts of the proposed eradication and control methods will be evaluated throughout San Francisco estuary as part of the Programmatic EIS/R evaluation. Project specific evaluations will be conducted at up to four pilot project sites. These four project-level studies will allow consideration of specific techniques tailored to these specific environments.

BACKGROUND:

The direct effects of physical and mechanical measures include disruption of soil/sediment, potentially resulting in erosion, increased water turbidity, and related adverse effects on aquatic biota. These measures also have the potential to cause mortality of desirable, non-target species of both plants and animals. In addition, by disrupting the soil/sediment, they could actually facilitate subsequent colonization by *S. alterniflora* or other invasive species.

Chemical measures (herbicides) have the potential to kill non-target plant species, such as native salt marsh plants, eelgrass, and algae. This could result in adverse indirect impacts to the salt marsh community in general, including sensitive species such as the California clapper rail, California black rail, salt marsh harvest mouse, and others. Loss of eelgrass and other marine flora would result in the loss of nursery and feeding habitat for many species of fish and invertebrates, including sensitive species such as winter-run chinook salmon, coho salmon, steelhead, and others. These habitats also provide foraging habitat for marine bird species, including the California least tern.

The toxicity to animals from the herbicides under consideration is generally considered to be low. However, the environmental analysis will have to include an evaluation of this toxicity, as well as the persistence and transport of these herbicides, and their potential to have toxic effects at distance from the application site. *Spartina* control has the potential to change existing sediment accretion (shoaling) and erosion patterns, which could affect hydrodynamic (currents, circulation, and waves) patterns. This could result in effects on water quality (turbidity, flushing) as well as effects on biological communities (eelgrass, kelp beds, or marshes).

PURPOSE:

The goal of the Invasive Spartina Project (ISP) is to control and where possible eliminate species of introduced *Spartina*.. Removal of invasive *Spartina w*ould remove a significant threat to the native communities of tidal marshlands and intertidal mudflats along the San Francisco Bay margins. These areas provide habitat for several threatened and endangered species. Three other introduced species of *Spartina* found in San Francisco Bay, *S. anglica, S. densiflora,* and *S. patens*, also would be targeted by this project. It is estimated that eradication of *S. alterniflora* could preserve 40,000 acres of native tidal wetlands and 29,000 acres of intertidal mud flats.

PROJECT DESCRIPTION:

Methods which have been identified to control and eradicate invasive *Spartina* are listed below. Proposed alternatives considered in the EIS/R may be selected from among these methods. Additional methods may be considered following the scoping process. Alternatives may involve one or more of these methods. Methods under consideration include:

Physical Methods:

- Digging and Pulling
- Clipping seedheads to prevent pollination/seed dispersal
- Mowing with weed-eaters or small mechanical cutters/mowers/shredders
- Prescribed burns
- Temporary diking of marshes
- Covering with geo-textile fabric or black plastic

Chemical Methods:

- Ground application of herbicide (via injection, backpack sprayer, spray truck, boat, all terrain vehicle)
- Aerial application of herbicide (helicopter)

Combination Methods:

- Mowing followed by herbicide application
- Mowing followed by burying, smothering, and mechanical trampling/shredding
- Mowing followed by covering (fabric/plastic)

The EIS/R will evaluate individual and cumulative impacts of four alternatives, as well as the no project/no action alternative, in accordance with NEPA and CEQA. The four alternatives will be developed in coordination with USFWS, CDFG, the Conservancy/ISP team, and private landowners with populations of *Spartina*.

POTENTIAL DISCRETIONARY ACTIONS AND APPROVALS:

The following actions and approvals are anticipated to be required:

Potentially Required Agency Approvals:

- U. S. Army Corps of Engineers 404 and Section 10 permits of the Rivers and Harbor Act and Section 404 of the Federal Clean Water Act;
- Federal and State Endangered Species Act Consultations;
- California State Coastal Conservancy Plan approval;
- California Department of Transportation (Caltrans) Encroachment Permit(s);
- California Department of Fish and Game Streambed Alteration Agreements(s), Section 1601 of the DFG code;

- California State Regional Water Quality Control Board 401 Certification and/or Discharge Permit (s);
- California State Bay Area Air Quality Management District Permit (s);
- San Francisco Bay Conservation and Development Commission permit (s);
- Local agency approval of specific implementation of projects (s);

Responsible, cooperating, and trustee agencies are requested to review and refine this list of required actions and approvals.

CONTENT OF THE EIS/R:

The EIS/R will analyze, describe, and evaluate all potential environmental impacts of the range of alternatives presented in the document. Individual and cumulative impacts of four alternatives, as well as the no project/no action alternative, in accordance with NEPA and CEQA will be evaluated. The range of alternatives being considered may be refined, revised, or expanded as a result of the scoping process. A variety of potential methods for controlling Invasive *Spartina* will be presented along with the potential environmental impacts for each type.

EIS/R FORMAT

The EIS/R will be prepared in accordance with the EIS Format specified in the CEQA NEPA Regulations, Part 1502 and Table 2 of Supplementary Document T of the CEQA Guidelines. Some minor changes to this format may be required to fully comply with the guidelines for implementing NEPA, as developed by the U.S. Department of the Interior, Fish and Wildlife Service.

ISSUE ANALYSIS (ENVIRONMENTAL CONSEQUENCES)

For each issue listed below, the EIS/R will include a discussion of the parameters used in evaluating impacts; potential impacts from the various alternatives; recommended mitigation, indicating the effectiveness of mitigation measures proposed to be implemented and what, if any, additional measures would be required to reduce the impacts to below a level of significance. Impact analysis will include a discussion of direct and indirect impacts, short- and long-term impacts, cumulative impacts, and unavoidable impacts. In addition, the impact discussion will also identify any areas of known controversy. Finally, the EIS/R will identify any unavoidable adverse impacts that would result from project implementation.

The list of issues presented below are preliminary both in scope and number. Additional issues may be identified during the scoping process.

a. *Water Quality*

The EIS/R will:

Describe existing water quality conditions in San Francisco Bay, with emphasis on marsh habitat.

Characterize regional water quality conditions from data of ongoing studies sponsored by the State Water Resources Control Board, California Mussel Watch Program, regional and site-specific studies by the U.S. Geological Survey.

Address direct impacts to water quality from each of the project alternatives (i.e., proposed methods for treating *Spartina*), as well as indirect effects due to the project. Where impacts to water quality are considered significant, possible mitigation measures that potentially can reduce the level of impact to less than significant will be evaluated and described.

Consider erosion of marsh sediments and remobilization of buried sediment contaminants; accumulation of organic detritus from physical/mechanical control approaches in tidal channels, with potentials for inducing stagnation and causing reductions in dissolved oxygen levels and/or increased turbidity and suspended solids; and other impacts described by previous programs for controlling invasive plant species.

b. *Biological Resources*

The EIS/R will:

Identify potential sensitive species and habitats in or near the potential *Spartina* eradication project areas based on site visits, data review, and CNDDB data search. Data collected during site visits will be summarized and included in the EIS/EIR in text and table format.

Determine the abundance and distribution of sensitive species and the extent of sensitive habitats (including buffer zone areas) that may be impacted by *Spartina* control efforts at priority ISP sites and pilot project sites. Specific species to be addressed include California clapper rail, black rail, salt-marsh harvest mouse, Soft Bird's Beak, and anadromous salmonids. Other sensitive species identified in consultation with CDFG and the USFWS also will be addressed.

Identify and analyze temporary and permanent, direct and indirect project and cumulative impacts to sensitive species and sensitive habitats of *Spartina* eradication/control methods. Control methods that will be considered in the impact analysis include covering, mowing, smothering, digging, shredding, temporary diking, direct removal/pulling/seed removal, chemical application, burning, or a combination of methods. These methods will be analyzed in the context of their potential to cause the spread of *Spartina*, introduce toxics into the food chain via application of herbicides, and impact sensitive species and habitats. Direct and indirect impacts that will be analyzed include trampling, noise productivity, biodiversity, modification of tidal drainage patterns, loss of cover, and other physical/chemical processes that may disturb sensitive species or habitats. The analysis will include an evaluation of the efficacy of individual and a combination of control methods as well as any other feasible methods (e.g., revegetation with natives following treatment) that would reduce the rate of spread of *Spartina* in the Bay. The focus of the analysis and field study will be in tidal marshlands and intertidal mudflats along the Bay margin and ISP priority sites. For all identified impacts, feasible mitigation measures will be developed with the goal of reducing significant or potentially significant impacts to an insignificant level.

c. *Risk of Upset/Health and Safety*

The EIS/R will:

This section will address to the direct and indirect environmental health hazards to humans and aquatic biological resources from implementation of the chemical applications proposed in the *Spartina* program.

d. *Visual Resources*

The EIS/R will:

Analyze visual resources based on site reconnaissance and review of ground level and aerial photographs, topographic maps, GIS and other pertinent data.

Document the existing visual character of the marsh and mudflat environments, identify the representative visual conditions within the overall study area, and conditions at the four priority sites. Representative land and water views accessible to the public will be documented as part of the visual baseline.

The project visual setting will be described in terms of the local and regional landscape context. It will include a description of the overall project viewshed as well as the specific visual conditions at priority sites in terms of topography, vegetation, land, water and built form that can be seen by the public. Baseline visual conditions will be described including representative photographs. Public use areas such as the shoreline, the highways, and recreational and residential areas also will be documented.

Visual impacts will focus on the foreseeable visual changes associated with the ISP and their effects on baseline visual resource conditions. Changes in vegetative cover, changes in color and texture and changes in level of visual screening associated with both the programmatic and site specific aspects of the ISP will be described. Seasonal change effects also will also be considered.

e. *Land Use*

The EIS/R will:

Describe and map existing land uses, land use designations, and zoning district boundaries at a programmatic level for the project area, and at a project level for the four pilot project sites and include narrative evaluation supported by photographs and graphics.

Applicable zoning and general plan designations and policies, including BCDC policies, will be identified and summarized. Potential conflicts associated with the proposed program and existing planning and zoning designations will be evaluated. Conflicts with surrounding or nearby land uses will be determined generally for the overall program area, and specifically for the priority sites. Appropriate measures to mitigate any identified adverse land use impacts will be identified.

f. *Air Quality*

The EIS/R will:

Analyze changes to air quality caused by the proposed *Spartina* control measures that would most affect air quality, e.g., the use of gas-powered mowers or “weed eaters,” chemical control using herbicides or surfactants, or prescribed burns. The analysis will be conducted in accordance with procedures recommended by the Bay Area Air Quality Management District (BAAQMD). The BAAQMD will be consulted regarding the appropriate significance thresholds for short-term eradication/control measures.

Describe physical and regulatory air quality for the affected area (i.e., specific sites identified in the Bay Area), based on air quality data at the two closest air monitoring stations. The Bay Area currently exceeds state standards for ground-level ozone and PM-10, and federal standards for ground-level ozone. Applicable air quality regulations, significance thresholds and planning efforts will be described for the San Francisco Bay Area. Specific federal, state and BAAQMD rules and policies that pertain to agricultural burning and the application of pesticides will be identified. BAAQMD CEQA guidelines and the Bay Area Clean Air Plan developed by the local air district will be consulted for this analysis.

Air quality impacts will be assessed by describing the potential “worst-case” dispersion of pollutants. The two scenarios that could most affect local air quality would be widespread applications of herbicides or surfactants. Emissions from controlled burns will be described, since the BAAQMD has rules that address these types of emissions. It is assumed that controlled burns would be limited to designated “Burn Days” that are intended to limit the effects of air pollutants from these activities. If necessary, emissions associated with widespread applications (aerial or hovercraft) will be modeled using the appropriate screening model approved by the US EPA and BAAQMD.

Assess regional emissions through prediction of the air quality burden associated with the project. This will include predicted changes in air pollutant emissions associated with air pollutant emissions sources associated with the project. Predicted changes in air pollutant emissions will be tabulated for each project alternative.

g. *Noise*

The EIS/R will:

Characterize existing noise levels in the various ISP areas based on existing data and spot noise readings. Noise levels generated by equipment used as part of various *Spartina* eradication techniques will be estimated and projected out to sensitive receptor locations. Short-term ambient noise measurements at the four pilot project sites will be conducted. Noise measurements will be made at up to two additional sites if the initial survey indicates sensitive receptors or resources that could be affected by noise generated by the project. Project-generated noise will be compared to ambient noise levels and to appropriate local General Plan Noise Element and Noise Ordinance standards.

Appendix C
Initial Study

INITIAL STUDY
SAN FRANCISCO ESTUARY INVASIVE SPARTINA PROJECT

California State Coastal Conservancy

Project Title: The San Francisco Estuary Invasive *Spartina* Project

Lead Agency Name and Address:

United States Fish and Wildlife Service (NEPA)
2800 Cottage Way, Suite W-2605
Sacramento, CA 95825-1846

California State Coastal Conservancy (CEQA)
1330 Broadway, 11th Floor
Oakland, California 94612-2530

Contact Person and Phone Number:

United States Fish and Wildlife Service

Marla Macoubrie
(916) 414-6600

California State Coastal Conservancy

Maxene Spellman
(510) 286-1015

Project Description

Project Background :

Four species of invasive *Spartina*, commonly called cordgrasses, are rapidly spreading and establishing in the tidal marshes and mudflats of the San Francisco Estuary. First introduced twenty-five years ago, nonnative *Spartina alterniflora* has now spread to more than 1,000 net acres*. Invasive *Spartina* can significantly alter the estuary both physically and biologically in ways which imperil the ecological balance and diversity of fragile habitats. Of primary concern is the potential of *S. alterniflora* to convert unvegetated tidal flats (mudflats) to vast, dense meadows of cordgrass. A large-scale, regional conversion of tidal flats will alter nutrient cycling within the estuary, and represent a regional loss of essential foraging habitat for shorebirds. A number of other impacts associated with the continued spread of invasive *Spartina* are also of concern. Research indicates that *S. alterniflora* and the common, native *Spartina foliosa* hybridize and if *S. alterniflora* populations are left unchecked, native *S. foliosa* will become locally extinct. The on-going spread of *S. alterniflora* is resulting in significant hydrologic alteration of salt marsh sloughs, creeks and flood control channels.

* A net acre is a measure of the total square acres of invasive *Spartina* if scattered populations were compressed into one contiguous population.

The San Francisco Estuary Invasive *Spartina* Project is funded by grants from the Calfed Bay-Delta Ecosystem Restoration Program, California Coastal Conservancy, National Fish and Wildlife Foundation and the U.S. Fish and Wildlife Service Coastal Program.

Populations of invasive *Spartina* are directly and indirectly displacing native species in both the lower and upper marsh zones and marginalizing or eliminating endangered species habitat. Continued spread of *Spartina* hybrids will preclude the recovery of *Suaeda californica* a locally extirpated plant. Recovery of this endangered species is dependent on suitable habitat for recovery efforts within San Francisco Bay.

Significant efforts are underway to restore thousands of acres of land in the San Francisco Estuary to tidal marsh over the next few decades. These efforts are driven in part by regional efforts to improve the water quality of the Bay, prevent flooding, and recover essential habitat for native and endangered species. The continued spread of invasive *Spartina* threatens to undermine the success of meeting the intended objectives of these habitat restoration efforts by significantly altering the structure and composition of salt marshes and tidal flats. *Spartina* hybrids may also result in a significant sediment sink by trapping and stabilizing sediment which otherwise would be available for future restoration projects.

Project Purpose:

The California State Coastal Conservancy established The San Francisco Estuary Invasive *Spartina* Project (Project), in 2000. The goal of the Project is to build a regionally coordinated effort aimed at the prevention, containment, methodical reduction, and where feasible, the eradication of four nonnative, introduced *Spartina* species throughout the San Francisco Estuary; *S. alterniflora, S. densiflora, S. anglica and S. patens.* The objectives of this project are to reverse the negative impacts associated with the spread of introduced *Spartina* on bayland habitats and to prevent further degradation of the rich biological resources of the ecosystem.

Project Location:

Species of *Spartina,* in the San Francisco Estuary, grow within the intertidal zone. This zone is comprised of those areas subject to inundation by the tides ; tidal flats (mudflats, sandflats, and shellflats), tidal marsh and channels, lagoons, rocky shore (including rip rap), sandy shore and the saline reaches of rivers and creeks. Invasive *Spartina* can tolerate a wide range of salinities (1-35 ppt), from fresh water to full ocean salinity. Therefore, both salt and brackish marshes are subject to invasion.

The geographic scope of the Project includes the shoreline of ten Bay Area Counties, an area that correlates with the predicted, potential distribution range for invasive *Spartina* species within the San Francisco Estuary. Seven counties, Contra-Costa, Alameda, Santa Clara, San Mateo, San Francisco, Marin and Solano currently have populations of invasive *Spartina.* Napa, Sacramento and Sonoma will be routinely surveyed and monitored to prevent populations from establishing. Control efforts are anticipated in any county in which invasive *Spartina* is currently established or may, in the future, become established. The current distribution of the four invasive *Spartina* species within the San Francisco Estuary are shown in Figures 1 and 2.

In year 2000, the distribution of *Spartina alterniflora* extends from the most southern reaches of the South Bay to the North Bay (San Pablo Bay) . The largest infestations of *Spartina alterniflora* occur at a number of general sites within the Central and South Bays. These sites include western Alameda Island and San Leandro Bay, the Hayward Regional Shoreline, Alameda Creek, the Alameda Flood Control Channel, and in San Bruno, just north of the San Francisco International Airport. At these locations, each population is greater than 50 net acres of *S. alterniflora*. Populations estimated between 10 and 50 net acres occur along the Oakland and Alameda Shoreline, the Don Edwards National Wildlife Refuge Newark area, Greco Island, and Bair Island. Smaller but significant, scattered populations occur at Richmond, Emeryville, Coyote Creek, Mowry Slough, Stevens Creek, Coyote Point vicinity, Candlestick Cove, Yosemite Channel, Tiburon and Richardson Bay. Isolated, small populations exist along the Eastshore State Park shoreline, Guadalupe Slough, Palo Alto Baylands, Corte Madera, and San Rafael. Scattered small populations can generally be found along most of the San Mateo and Alameda County shoreline. The greatest infestation of *Spartina densiflora* exists the length of Corte Madera Creek in Marin County. Populations of *S. densiflora* have also established in San Rafael, Tiburon, Pt. Pinole, and in Burlingame. *S. anglica* is found only at Creekside Park, Marin. *S. patens* is known to exist only in Benecia and near Tolay Creek.

Integrated Pest Management Program:

The Project will utilize an Integrated Pest Management (IPM) approach. IPM is an approach to invasive weed problems that utilizes regular monitoring and record keeping to determine if and when control treatments are needed. IPM employs a combination of strategies and tactics to control or eradicate invasive weeds. By tailoring control techniques to specific sites resource managers can maximize control efficacy while minimizing negative environmental, economic and social impacts. Site specific combinations of cultural, physical, mechanical, educational and chemical control methods are used to solve a vegetation problem. Local conditions and precautions needed to protect sensitive species, human health and water quality and other concerns can be evaluated before, during and following the implementation of control measures. Only treatment methods that provide a long term net benefit to the habitat will be considered for use by the Project.

Potential treatment methods are summarized in Table 1 and include the following:

<u>Physical Methods:</u>

- Digging and Pulling
- Clipping seedheads to prevent pollination/seed dispersal
- Mowing with weed-eaters or amphibous mechanical cutters/mowers/shredders
- Prescribed burns
- Temporary diking of marshes
- Covering with geo-textile fabric or black plastic

<u>Chemical Methods:</u>

- Ground application of herbicide (via injection, backpack sprayer, spray truck, boat, all terrain vehicle)
- Aerial application of herbicide (helicopter)

Combination Methods:

- Mowing followed by herbicide application
- Mowing followed by burying, smothering, and mechanical trampling/shredding
- Mowing followed by covering (fabric/plastic)

The EIS/R will evaluate individual and cumulative impacts of four alternatives, as well as the no project/no action alternative, in accordance with NEPA and CEQA. The four alternatives will be developed in coordination with USFWS, CDFG, the Conservancy/ISP team, and private landowners with populations of *Spartina*.

Table

Table 1, page 2

Figure

2 Distribution of *Spartina densiflora, Spartina anglica, and Spartina patens*

Bio-control Methods:

- Bio-control methods will not be considered for use by the Project. Biological control agents with potential for controlling invasive *Spartina* would cause probable harm to the native *Spartina foliosa* due to the close genetic relationship of these species.

Surrounding Land Uses:

The San Francisco Bay Estuary is surrounded by intensely urbanized commercial, industrial, residential, and open space lands. San Francisco International Airport as well as the Oakland, Hayward, San Carlos, and Palo Alto airports are located around San Francisco Bay, as are the ports of Oakland, San Francisco, Redwood City, and Richmond.

Potentially Required Agency Approvals:

- U. S. Army Corps of Engineers 404 and Section 10 permits of the Rivers and Harbor Act and Section 404 of the Federal Clean Water Act;
- Federal and State Endangered Species Act Consultations;
- California State Coastal Conservancy Plan approval;
- California Department of Transportation (Caltrans) Encroachment Permit(s);
- California Department of Fish and Game Streambed Alteration Agreements(s), Section 1601 of the DFG code;
- California State Regional Water Quality Control Board 401 Certification and/or Discharge Permit (s);
- California State Bay Area Air Quality Management District Permit (s);
- San Francisco Bay Conservation and Development Commission permit (s);
- Local agency approval of specific implementation of projects (s);

Environmental Factors Potentially Affected

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages. An EIS/EIR will be prepared to address the identified potentially significant impacts.

X	Aesthetics	____	Agricultural Resources	X	Air Quality
X	Biological Resources	X	Cultural Resources	X	Geology/Soils
X	Hazardous Materials	X	Hydrology/Water Quality	X	Land Use/Planning
____	Mineral Resources	X	Noise	____	Transportation
____	Public Services	X	Recreation		
____	Population/Housing	____	Utilities/Service Systems		

MANDATORY FINDINGS OF SIGNIFICANCE

On the basis of the initial evaluation:

______I find that the proposed project COULD NOT have a significant effect on the environment and a NEGATIVE DECLARATION will be prepared.

______I find that although the proposed project could have a significant effect on the environment there will not be a significant effect because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

______I find that the proposed project MAY have a significant effect on the environment, and ENVIRONMENTAL IMPACT REPORT is required.

______I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

______I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________	______________________
Signature	Date
______________________________	______________________
Printed Name	For

EVALUATION OF ENVIRONMENTAL IMPACTS

1. AESTHETICS

Would the project:	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Have a substantial adverse effect on a scenic vista?	X				
b. Substantially damage scenic resources, including, but not limited to trees, rock outcroppings, and historic buildings within a state scenic highway?			X		
c. Substantially degrade the existing visual character or quality of the site and its surroundings?	X				
d. Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?				X	

Environmental Setting:

Heavy urbanization and industrial uses currently characterize the Bay Area, although major portions of the area around San Francisco Bay remain undeveloped.

Many recreational users of the region's waterfront, including birders, bicyclists, joggers and pedestrians, value the aesthetic of the Bay edge. Open space views of tidal flats and salt marshes in many areas around the bay afford spectacular views of wildlife and afford long distance views otherwise unavailable in a dense, urban setting. To the unknowing observer a marsh of non-native vegetation may rank as visually pleasing as a native one although composed of very different looking vegetation. An abundance of *S. alterniflora* is located on the eastern side of San Francisco Bay, along areas of intertidal flats and salt ponds. Native species of the marsh and mudflats include pickleweed and *Spartina foliosa*. These low growing species generally reach a height of 1 to 3 feet. *Spartina alterniflora* and hybrids generally reaches a height of 4 to 5 feet, overshadowing the native species. In addition, *Spartina alterniflora* grows in dense patches which displace native species and can visually dominate the character of a marsh.

Impact Discussion:

a. *Have a substantial adverse impact on a scenic vista? **- PS***

In most areas of low to medium infestation in the Bay, the visual appearance of native marshes would be restored without significantly altering the visual character of the marshes. Tidal flats would be restored to their natural unvegetated state. In areas of medium to heavy infestation, where invasive Spartina has displaced the majority of native vegetation, control measures would have the potential to significantly change the visual character of the tidal wetlands. The character of these areas would change from relatively tall (4-6 ft) densely vegetated areas to sparsely vegetated or unvegetated areas temporarily. These changes would be most dramatic when mowing was implemented. Herbicide treatment does not immediately remove vegetation. Stems die back over a period of months in a manner similar to that which naturally occurs each winter. This change would not create objectionable views, and it would be visually compatible with existing scenic vistas.

b. *Substantially damage scenic resources, including state scenic highways? **- LS***

Implementation of the proposed project would remove invasive species from marshes and would not potentially damage scenic resources. The proposed project would control invasion of native vegetation by a non-native species. There are no designated state scenic highways in the immediate project area.

c. *Substantially degrade existing visual character or quality of the site? **- PS***

Removal of Spartina by all control methods would remove tall, dense vegetation from tidal flats and wetland areas. The visual character of a site would therefore change over time. Depending on the control method, the removal would take differing amounts of time. Passive and active restoration, in selected areas, of native species would return sites to their natural condition. The alteration of the visual character of marshes due to *Spartina* control will be discussed in the EIS/ EIR.

d. *Create light or glare? **- NI***

The activities associated with the proposed project would not introduce light and glare onto the project area, and the control of *S. alternflora* would not introduce any physical structures or lighting into the project area.

2. AGRICULTURAL RESOURCES

Would the project:	**Potentially Signif. Impact**	**Less Than Signif. w/ Mitig.**	**Less Than Signif.**	**No Impact**	**Reviewed Under Previous Document**
a. Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?				X	
b. Conflict with existing zoning for agricultural use, or a Williamson Act contract?				X	
c. Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?				X	

Environmental Setting:

Although significant amounts of farmland are located in the Bay region, the areas affected invasive *Spartina* are not used for agriculture. Most of the irrigated agricultural land remaining in production in the Bay Area, occurs in Contra Costa, Solano, and Sonoma outside the immediate Bay Area counties (CALFED Bay-Delta Program EIS/EIR). *Spartina* grows in intertidal flats and is not located in areas currently used or designated as farmland.

Impact Discussion:

a. *Convert Prime Farmland to non-agricultural use? - **NI***

Significant farmland is located adjacent to the Bay in Marin and Sonoma counties. However, *Spartina* removal would not result in the conversion of any prime farmland to non-agricultural use. Treatment areas are located in areas of the shoreline of the Bay that are subject to inundation by the tides. *Spartina* removal would not affect any prime farmland.

b. *Conflict with existing agricultural zoning or Williamson Act contract? - **NI***

No agricultural resources would be affected by *Spartina* removal, as discussed above. Removal would not occur in areas zoned for agriculture or protected under Williamson Act contracts. There would be no conflicts with any adopted plans or the Williamson Act.

c. *Result in conversion of Farmland to non-agricultural use? - **NI***

The proposed project involves removal of invasive weeds. As described above, this activity would not occur on farmland and would not convert existing marshland to any other type of use.

3. AIR QUALITY

Would the project:	**Potentially Signif. Impact**	**Less Than Signif. w/ Mitig.**	**Less Than Signif.**	**No Impact**	**Reviewed Under Previous Document**
a. Conflict with or obstruct implementation of the applicable air quality plan?	X				
b. Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	X				
c. Result in a cumulative 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 that exceed quantitative thresholds for ozone precursors)?	X				
d. Expose sensitive receptors to substantial pollutant concentrations?	X				
e. Create objectionable odors affecting a substantial number of people?			X		

Environmental Setting:

The project area generally has good air quality, due to its attainment of most ambient air quality standards. However, the San Francisco Bay Area Air Basin (SFBAAB) presently exceeds state standards for ground-level ozone and particulates (Particulate Matter less than 10 microns diameter [PM_{10}]), and federal standards for ground-level ozone. These air quality conditions are the same in the north and south bay. Ozone concentrations are the highest during the warmer months. The Bay Area Air Quality Management District (BAAQMD) is responsible for regulating stationary sources of air emissions within the SFBAAB and sets guidelines to determine the significance of air quality impacts for CEQA purposes. The 1997 Clean Air Plan is used by the BAAQMD to address attainment of the state ozone standard.

Impact Discussion:

a. *Conflict with air quality plan?* ***- PS***

The Bay Area is presently in non-attainment status for state and federal air quality standards. Violation of air quality standards, as discussed below, would potentially conflict with the 1997 Clean Air Plan. Impacts will be evaluated further in the EIS/ EIR.

b. *Violate air quality standards? - **PS***

Not all proposed control techniques have the potential to violate air quality standards. However, gas-powered mowers, chemical control using herbicides or surfactants, or prescribed burns, would include emissions of nitrogen oxides (NO_x), reactive organic compounds (ROC), and PM_{10}. Therefore, these activities have the potential to violate existing air quality standards. These impacts will be evaluated in the EIS/ EIR.

c. *Result in cumulatively considerable air pollutants? - **PS***

Due to the existing non-attainment status in the Bay Area, air emissions from the proposed project, when considered with the other existing and projected projects generating air pollutants, the proposed project could result in cumulatively considerable pollutants. This impact will be evaluated in the EIS/ EIR.

d. *Expose sensitive receptors to substantial concentrations? - **PS***

Sensitive receptors potentially affected by the Project include hospitals and residences within close proximity to areas infested with invasive *Spartina*. Drift of emissions associated with chemical spraying and burning would potentially affect these receptors. Impacts would be potentially significant and evaluated in further detail in the EIS/ EIR.

e. *Create objectionable odors affecting significant number of people? - **LS***

Chemical removal, burning, and decaying vegetation may generate some objectionable odors. However, given the limited extent of these control methods, impacts would be less than significant.

4. BIOLOGICAL RESOURCES

Would the project:	**Potentially Signif. Impact**	**Less Than Signif. w/ Mitig.**	**Less Than Signif.**	**No Impact**	**Reviewed Under Previous Document**
a. Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game, or U.S. Fish and Wildlife Service?	X				
b. Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	X				
c. Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	X				
d. Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	X				
e. Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	X				
f. Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	X				

Environmental Setting:

Bayland habitats can be categorized as being either subject to tidal action or diked (Goals Project, 1999). The primary habitats within tidal baylands include tidal flats, tidal marshes (saline and brackish), and lagoons. Diked baylands in the San Francisco Bay ecosystem were historically subject to tidal action but have been deprived of tidal action (in some cases for many decades) by man-made levees. Diked bayland habitats include diked wetlands (formerly tidal marshes; not used for agricultural purposes), managed marshes (managed for wildlife and waterfowl), and diked marsh (not actively managed for wildlife; occasionally used for agriculture). Agricultural baylands are diked, formerly tidal marshes that are intensively used for agricultural activities including crop production and/ or grazing.

The Bay ecosystem is composed of many non-native plant and animal species, which have been introduced to the Bay through shipping activity since the late 1800's and into the present (Cohen and Carlton, 1995). The phytoplankton in the Bay is a community of diatoms, silicoflagellates, coccolithophores, cryptomonads, green algae, and dinoflagellates. Consumptive grazing by zooplankton and larger filter feeders, such as benthic invertebrates and fish, controls the phytoplankton population, as do variations in temperature, salinity, light, currents, river inflow, and nutrient availability (Cloern, 1982). Zooplankton abundance is highest in the shallow areas of the Bay, as this community is intrinsically coupled with its phytoplanktonic food source. The San Francisco Bay zooplankton is mainly a community of invertebrate larvae and copepods.

The abundance and distribution of adult benthic invertebrates in the Bay depends on tolerance of temporal fluctuations in salinity, substrate type, and the presence of competitive invasive species (Nichols and Patamat, 1988). Regions such as the Suisun Bay and North Bay, where there is seasonal freshwater input, are characterized by only a few species that are particularly tolerant of low salinity or large changes in salinity. This is the case for the Asian clam *Potamocorbula amurensis,* an opportunistic and competitive invasive species. The benthic community in deeper regions (high salinity with little freshwater input), such as Central Bay and South Bay, is similar to coastal muddy bottom marine communities.

The majority of the marine mammals in the San Francisco Bay are found in the Central Bay region near the Golden Gate. They also utilize intertidal mudflats throughout lower North Bay and upper South Bay as haulout sites. Common species include the California sea lion (*Zalophus californianus*), harbor seals (*Phoca vitulina*), and harbor porpoises (*Phocoena phocoena*). Marine mammals, such as the California sea lion and harbor seal, often use South Bay subregion intertidal mudflats as haulout sites. They are otherwise more commonly located in the Central subregion. Haulouts are particularly common in marsh areas adjacent to sloughs in South Bay (SFEI, 1999).

Common aquatic birds in San Francisco Bay are cormorants, gulls, scoters, scaups , grebes, and others. Large concentrations of diving ducks use the open bay and some of the deeper salt ponds, while the dabbling ducks use the shallow intertidal mudflats and some fo the shallow salt ponds.

Impact Discussion:

a. *Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game, or U.S. Fish and Wildlife Service?* ***- PS***

The project has the potential to cause direct adverse impacts on federal and state listed special status species, including the salt marsh harvest mouse (*Reithrodontomys raviventris*), the California clapper rail (*Rallus longirostris obsoletus*), the California black rail (*Laterallus jamaicensis coturniculus*), and soft bird's beak (*Cordylanthus mollis*). Substantial habitat modifications are anticipated in the tidelands that are heavily colonized by invasive Spartina. Impacts through habitat modifications would be potentially significant where control measures affect large areas that are used by sensitive species for life history activities such as cover, foraging, and breeding. These long-term impacts are potentially significant because it is not known how rapidly native marsh species would recover in treated areas and whether sensitive species would utilize areas where control measures have been applied. The project could also result in significant short-term impacts on sensitive species by interrupting breeding or foraging activities, and physical disturbance (e.g., trampling, noise, etc. from equipment and personnel) of occupied habitats.

Marine intertidal and subtidal organisms, such as several fish and invertebrate species, may be particularly sensitive to the proposed actions, as the removal of invasive *Spartina* may remove foraging, feeding, and breeding habitat. The winter run Chinook salmon, a federally listed threatened species, is potentially at risk, as are the forage fish populations and zooplankton it feeds on. Herbicide application may also adversely affect this species by effecting non-target plant species, such as the ecologically significant eelgrass or native cordgrasses. These impacts will be addressed in the EIS/ EIR.

b. *Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service? -* ***PS***

Due to the coexistence of non-native *Spartina* among remnant patches of native *S. foliosa* and large expanses of estuarine (pickleweed, *Salicornia virginica*) salt marsh, the project could result in potentially significant impacts on sensitive, native wetland communities. Over the long-term, the project is expected to benefit sensitive natural communities. Removing invasive *Spartina* will open up primary space (i.e. mudflats) and invaded areas for native salt marsh flora and fauna.

Chinook salmon utilize the eelgrass beds in the San Francisco Bay estuary for feeding, rearing, and shelter from larger predators. Removal of the invasive *Spartina* foliage using the proposed techniques (particularly burning and herbicide application) may inadvertently remove eelgrasses as well, causing an adverse effect on important habitat for chinook salmon and other marine species. One of the five proposed control methods, covering to prevent photosynthesis, may also have secondary effects on the intertidal habitat. Loss of photosynthesis and covering may promote anoxia in intertidal sediments, providing ideal conditions for the methylation of mercury to occur. Mercury is a major contaminant in San Francisco Bay, and its bacterially mediated transformation into the highly toxic and lipid soluble methyl form would add to the potential contamination of the San Francisco Bay food web. These impacts will be discussed in the EIS/ EIR.

c. *Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means? -* ***PS***

Wetland habitats in the Bay are considered jurisdictional waters of the United States under Section 404 of the Clean Water Act (1972). The implementing regulations at 40 CFR Part 230 and 33 CFR Parts 320-331 require that a permit be issued by the Army Corps of Engineers (Corps) prior to discharges of dredged or fill materials into waters of the United States, including wetlands (defined at 33 CFR Part 328). In addition, lands subject to tidal action, such as tidelands occupied by non-native *Spartina*, are also considered navigable waters under Section 10 of the Rivers and Harbors Act (1899); thus structures or work in navigable waters is also subject to authorization by the Corps. The proposed project could entail temporary diking which may require a permit from the Corps. Small scale excavation or digging of Spartina may require Army Corp permits. It is not anticipated that dredging would be required for any of the control methods. Over the long-term, the impact of non-native *Spartina* control measures are expected to benefit regulated waters of the United States and wetland habitats in the Bay. Removal of invasive Spartina will restore and increase flow capacity of many tidal channels and flood control channels. These impacts will be discussed further in the EIS/ EIR.

d. *Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites? - **PS***

Some of the control methods (i.e. mowing, burning) may have the potential to interfere with the movement of native resident and migratory wildlife in all intertidal zones including high marsh habitats, and impede the use of intertidal nursery habitats (see discussion of impacts on marine resources) if large areas of treated Spartina are left in place to decay. Mats of dead and decaying *Spartina* would potentially temporarily preclude native marsh vegetation species (such as pickleweed and *S. foliosa*) from recolonizing rapidly and restoring suitable nursery habitats for native species. Aquatic and wildlife species that require substantial cover for foraging, nesting or other life history functions (such as California clapper rail and salt marsh harvest mouse) are also expected to be impacted since each alternative has the potential to remove native [pickleweed] and non-native [*Spartina*] cover, refuge, and foraging areas. Both resident and migratory fishes, such as the Chinook salmon and its prey items, utilize cordgrass and eelgrass beds for feeding, foraging, and rearing. These beds also serve as shelter for juveniles to avoid larger, deep-water predators. Migration patterns of these fishes and the forage fish (prey) populations may be altered, as fish would loose vital cover and habitat, albeit temporary. These impacts will be discussed further in the EIS/ EIR.

e. *Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance? - **PS***

The project is not expected to conflict with local policies or ordinances protecting biological resources, except in those communities that have policies regarding prohibitions on use of herbicides. The potential conflicts with local policies or ordinances related to the use of herbicides will be discussed further in the EIS/ EIR.

f. *Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan? - **PS***

Control or eradication of Invasive *Spartina* would benefit the San Francisco Bay ecosystem by removing a non-native invasive species thereby ensuring the continued survival of native plant species along San Francisco Bay. This would be consistent with habitat conservation plans that encourage the continuance of native species throughout the Bay Area. The proposed *Spartina* Control Program is expected to implement the regionally adopted Invasive *Spartina* Program, which over the long-term would benefit the San Francisco Bay ecosystem. Chemical control techniques would not be consistent with policies prohibiting the use of herbicides. This will be evaluated further in the EIS/ EIR.

5. CULTURAL RESOURCES

Would the project:	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Cause a substantial adverse change in the significance of a historical resource as defined in '15064.5?				X	
b. Cause a substantial adverse change in the significance of an archaeological resource pursuant to 15064.5?	X				
c. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?			X		
d. Disturb any human remains, including those interred outside of formal cemeteries?	X				

Environmental Setting:

The San Francisco Bay marks the division between the North and South Coast ranges. This region of central California is characterized by a variety of ecological settings and has a long history of human occupation ranging from 10,000 B.C. to the present. Areas used by the native populations during the prehistoric period included bayshore, estuary, and riparian settings; valley floor and associated wetlands; riverine and upland areas. After B.C. 2000, settlement and subsistence revolved more heavily around bayshore and marsh habitats (Moratto 1984). Prehistoric site types recorded in the Bay Area include village sites, temporary campsites, milling sites, petroglyphs, lithic scatters, quarry sites, shell and ash middens, and burial sites.

Impact Discussion:

a. *Cause a substantial adverse change in the significance of a historical resource as defined in CEQA Guidelines Section '15064.5?- **NI***

Proposed removal methods would target invasive *Spartina* and would not affect aboveground structures. No impacts on historical resources would occur.

b. *Cause a substantial adverse change in the significance of an archaeological resource pursuant to CEQA Guidelines Section '15064.5? - **PS***

The largest amount of ground disturbance would be associated with digging, which could remove a substantial portion of soil associated with the root system. Larger plants can have underground parts extending as much as 1.2 m (4 ft) below the soil surface, and removing a one-square meter (10.8 sf) patch of *S. alterniflora* by digging might require removal of wet mud weighing more than 1 metric ton (1.1 tons). Depending on their age, buried archaeological sites could be located in the soil to this depth. The size of archaeological sites can vary from several thousand square feet to several acres. The potential for impacting archaeological resources would generally increase with the number of plants that would be removed, as the extent of disturbed ground surface would be expanded. Cultural resources located in areas where digging would occur would potentially become damaged or destroyed. In some cases, plant removals within a concentrated area could result in the destruction of an entire archaeological site, or the destruction of a substantial portion of a larger archaeological site. Although only a few archaeological sites would potentially be impacts in any one restoration area, the incremental destruction of the non-renewable cultural resources within the program's jurisdiction over time would be potentially widespread. Impacts on cultural resources would be potentially significant and will be addressed further in the EIS/ EIR.

c. *Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?* ***- LS***

Paleontological resources would not be expected within marshland areas. Removal of soil to a depth of up to 1.2 meters would alter local topography. However, these changes would not be of sufficient magnitude to alter geologic features.

d. *Disturb any human remains, including those interred outside of formal cemeteries?* ***- PS***

Human remains associated with archaeological sites would potentially be disturbed, similar to the potential for removing archaeological sites described under (a). Impacts would be potentially significant and addressed further in the EIS/ EIR.

6. GEOLOGY AND SOILS

Would the project:	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:			X		
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X	
ii) Strong seismic ground shaking?				X	
iii) Seismic-related ground failure, including liquefaction?				X	
iv) Landslides?				X	
b. Result in substantial soil erosion or the loss of topsoil?	X				
c. Be located on a geological unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?			X		
d. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994) creating substantial risks to life or property?				X	
e. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?				X	

Environmental Setting:

The San Francisco Bay and the Bay Area are located within the Coast Ranges Geomorphic Province of California, which is characterized by a system of northwest-southeast trending longitudinal mountain ranges and valleys that are controlled by faulting and folding. The Bay itself started to form in the Late Pleistocene due to subsidence associated with localized oblique displacements on the San Andreas and Hayward faults. Flooding of the area occurred several times with Pleistocene sea level fluctuations.

The San Francisco Bay/Delta estuarine system drains over 40 percent of the land area in the state of California. Shoaling of navigation channels results from a combination of new sediments entering the system (primarily from the Sacramento/San Joaquin rivers) and resuspension of existing sediment resulting from fluvial, tidal, and wind-driven waves and currents. Annual amounts of new and resuspended sediments for the entire San Francisco Bay Area are estimated to be 8 million cubic yards (mcy) and 100 mcy, respectively.

The San Francisco Bay Area is well known as a seismically active region. Historically, numerous moderate-to-strong earthquakes are related to the San Andreas and Hayward fault systems. The Bay Area fault system is composed of four major faults: the San Andreas fault, the Northern and Southern segments of the Hayward fault, and the Concord and Calaveras faults. Combined the probability of an earthquake of magnitude 7 (M7) or greater occurring on one of these faults between 1990 and 2020 has been estimated at 67 percent.

Topography controls the distribution of water and sediment. The topography of tidal baylands determines the frequency and duration of tidal inundation and where the tides go. The topography of diked baylands and adjacent uplands affects runoff and groundwater recharge. Slight variations in topography can have ecologically significant effects on the distribution of water on the ground surface. Like climate, topography changes slowly, except for the local effects of floods, landslides, earthquakes, and people.

The slope of the terrain near the Estuary strongly influences the width of local baylands. In areas where the shoreline is steep, as in many parts of Central Bay and along the Carquinez Strait, the baylands are restricted to narrow fringes bordering deeper water. In areas where the terrain is flatter, as in much of South Bay, North Bay, and Suisun, the baylands are broader.

Impact Discussion:

a. *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: **- LS***
i) Rupture of a known earthquake fault?
ii) Strong seismic ground shaking?
iii) Seismic-related ground failure, including liquefaction?
iv) Landslides?

The proposed project would require the use of personnel and vehicles to accomplish the control program in a seismically active region. A small number of people and vehicles would be used intermittently to implement the Invasive *Spartina* program. The potential for substantial injury or death would be low, because of their location away from buildings and other structures during the *Spartina* control activities. Additionally, the proposed removal methods would not contribute to increased hazards in the event of an earthquake. No structures are located in the areas of proposed *Spartina* removal. In addition, no structures are proposed that would be subject to the effects of an earthquake.

b. *Result in substantial soil erosion or the loss of topsoil? **- PS***

The potential for soil erosion or loss of topsoil varies, depending on the method or methods used to control *Spartina*. Some of the control techniques may result in areas bare and prone to short-term erosional impacts. Several of the techniques considered leave root structures intact thereby reducing the potential for erosion. Potential soil erosion impacts are discussed further in Section 8, Hydrology and Water Quality. These impacts will be evaluated in the EIS/ EIR.

c. *Be located on a geological unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse? - **LS***

The proposed project does not include structural development. An earthquake, however, would cause lateral spreading and subsidence throughout the tidelands that could adversely affect persons or equipment working on-site during such an earthquake. Although erosion could result from removal of vegetation, as discussed under (b), removal of plants and associated topsoil would not be at volumes large enough to result in increased hazards of landslides, subsidence, liquefaction, or collapse.

d. *Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994) creating substantial risks to life or property? - **NI***

The proposed project does not include development of structures that would potentially be placed on expansive soils. No impacts would occur.

e. *Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater? - **NI***

No septic tanks or waste water systems are proposed or would be required for the proposed project.

7. HAZARDS AND HAZARDOUS MATERIALS

Would the project:		Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a.	Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	X				
b.	Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	X				
c.	Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	X				
d.	Be located on a site that is included on a list of hazardous material sites compiled pursuant to Government Code Section 65962.5; and, as a result, would it create a significant hazard to the public or the environment?	X				
e.	For a project located within an airport land use plan, or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport; would the project result in a safety hazard for people residing or working in the project area?	X				
f.	For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?			X		
g.	Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X	
h.	Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?			X		

Environmental Setting:

The project includes numerous sites around San Francisco Bay. Potential project activities at these sites include use of herbicides and surfactants in wetlands and intertidal mudflats of the

San Francisco Bay Estuary. At least three schools are located within 0.25 mile of one or more project sites, including Garfield Elementary in San Leandro, La Escuelita Elementary and Laney College in Oakland, with others located 0.25 to 0.5 mile from one or more sites.

Some project sites may be located at or near various known hazardous waste sites, e.g., the Hunters Point Annex (a National Priorities List hazardous waste site) in San Francisco, Cooley Landing Salt Pond restoration site near East Palo Alto, and various sites in and adjacent to San Leandro Bay.

At least six public airports are located within 2 miles of one or more project sites: San Francisco International Airport, Metropolitan Oakland International Airport, Hayward Air Terminal, San Carlos Airport, Palo Alto Airport, and Seaplane Harbor in Alameda. Although no private airstrips are known to lie within 2 miles of any sites, several private airstrips are located in the general vicinity. Seaplanes sometimes land in undesignated locations of the Bay, but no designated public or private seaplane landing facilities are known within 2 miles of any site except Seaplane Harbor in Alameda.

Impact Discussion:

a. *Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials? – **PS***

All potentially significant hazards to the public or the environment which may arise from the application of herbicides (Rodeo, Sonar, Arsenal) and surfactants to control or eradicate *Spartina* will be evaluated in the EIS/ EIR. Rodeo has been used elsewhere to control noxious aquatic vegetation. Glyphosate, the active ingredient in Rodeo, is a non-selective, post-emergent herbicide that must be applied with an inactive surfactant that promotes penetration of the herbicide into the waxy cuticle of the plant. Product information indicates that glyphosates have low toxicity to aquatic organisms, are not expected to bioaccumulate, are rapidly biodegraded in water, and have strong affinities for particles with low potential for migration to groundwater. The residence time of glyphosate in sediment is considerably longer than in water. At present, disagreements exist concerning the toxicity of glyphosate plus surfactants to aquatic organisms. Fluridone (Sonar) and Imazapyr (Arsenal) similarly are only slightly toxic to animals, are not persistent in the environment, and do not bioaccumulate.

Any potential adverse affects on fishes in San Francisco Bay will be evaluated in the EIS/ EIR. Herbicides may be used on non-submerged vegetation. Indirect impacts due to spray drift and runoff will be evaluated as well as the decomposition of vegetative matter which may result in the a reduction or depletion of dissolved oxygen.

Mitigation measures which will greatly reduce impacts to sensitive resources are all-important in this control project. Factors that are important to mitigation of potentially significant hazards to the public or the environment include timing of herbicide use (e.g., endangered species reproductive cycles, thresholds of disturbance, weather conditions, avoidance of treatment during high public use days), area of treatment (vicinity to schools), and site specific control technique(e.g., physical, chemical or combination).

b. *Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment? -* ***PS***

Both direct and indirect human exposures could occur due to the routine use and/or accidental release of herbicides and surfactants. Aerial application could result in transport of herbicides offsite, and potential exposure of downwind populations/visitors via inhalation and dermal contact pathways. Food chain exposures to herbicides (i.e., due to bioaccumulation of contaminants in fish or shellfish) are unlikely, however, exposure during recreational fishing/harvesting activities could occur. Improper disposal of herbicides could also result in potentially significant hazards to the public or the environment. Impacts on human health from the herbicides under consideration are not likely to be significant if appropriate mitigation measures are employed.

c. *Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school? -* ***PS***

At least three schools are located within 0.25 mile of one or more project sites, including Garfield Elementary in San Leandro, La Escuelita Elementary and Laney College in Oakland, with others located 0.25 to 0.5 mile from one or more sites. Both direct and indirect human exposures could occur through the routine use and/or accidental release of herbicides and surfactants. Impacts on human health, however, are not likely to be significant if appropriate mitigation measures are employed. Potentially significant impacts will be evaluated in the EIS/EIR.

d. *Be located on a site that is included on a list of hazardous material sites compiled pursuant to Government Code Section 65962.5; and, as a result, would it create a significant hazard to the public or the environment? –* ***PS***

Some project sites may be located at or near various known hazardous waste sites, e.g., the Hunters Point Annex (a National Priorities List hazardous waste site) in San Francisco, Cooley Landing Salt Pond restoration site near East Palo Alto , and various hazardous waste sites in and adjacent to San Leandro Bay. Potential impacts of herbicide application in these areas on public health and safety or the environment will be evaluated in the EIS/EIR.

e. *For a project located within an airport land use plan, or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport; would the project result in a safety hazard for people residing or working in the project area? -* ***PS***

At least six public airports are located within 2 miles of one or more project sites: San Francisco International Airport, Metropolitan Oakland International Airport, Hayward Air Terminal, San Carlos Airport, Palo Alto Airport, and Seaplane Harbor in Alameda. Herbicide application could potentially occur within an airport land use plan or within 2 miles of an airport. Such application potentially could have an adverse effect on people residing or working in the area. . Impacts on human health from the herbicides under consideration are not likely to be significant if appropriate mitigation measures are employed. Potential impacts of herbicide application on public health and safety will be evaluated in the EIS/EIR.

f. *For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area? - **LS***

No private airstrips are known to lie within 2 miles of any project site. For private airstrips at distances greater than 2 miles, it is unlikely that project activities would result in a safety hazard due to the short duration of project activities. All equipment, personnel, and project activities would be located outside of any private airstrip property.

g. *Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan? - **NI***

Activities would not impair implementation of or physically interfere with any emergency response or evacuation plans.

h. *Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands? - **LS***

The herbicides/ surfactants proposed for use are not flammable, and would not result in significant impacts due to wildland fires. The proximity of the properties to water would substantially reduce the potential for any wildland fires from controlled burns.

8. HYDROLOGY AND WATER QUALITY

Would the project:	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Violate any water quality standards or waste discharge requirement?	X				
b. Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?			X		
c. Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	X				
d. Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?			X		
e. Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?			X		
f. Otherwise substantially degrade water quality?			X		
g. Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?			X		
h. Place within a 100-year flood hazard area structures that would impede or redirect flood flows?			X		
i. Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?			X		
j. Inundation by seiche, tsunami, or mudflow?			X		

Environmental Setting:

Hydrology

The northern reach of the San Francisco Bay (comprising Suisun Bay, Carquinez Strait, and San Pablo Bay) is geographically and hydrologically distinct from the Central and South bays. South Bay is a tidally oscillating, lagoon-type estuary, where variations are determined by water exchange between the northern reach and the ocean. Water residence times are much longer in South Bay than in North Bay. The northern reach is a partially-to-well-mixed estuary (depending on the season) that is dominated by seasonally varying river inflow. The timing and magnitude of the highly seasonal river inflow modulates permanent estuarine circulation, which is largely maintained by salinity-controlled density differences between river and ocean waters.

Freshwater inflows, tidal flows, and their interactions largely determine variations in the hydrology of the Bay/Delta. Hydrology has profound effects on all species that live in the Bay/Delta because it determines the salinity in different portions of the Estuary and controls the circulation of water through the channels and bays. 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).

Water Quality

The primary water quality parameters include salinity, dissolved oxygen, pH, total suspended solids (TSS), turbidity, and pollutants.

Salinity

The salinity of water entering the Estuary varies greatly. The Sacramento River and eastside streams flowing into the Delta are low in salts, with salinity averaging less than 0.1 parts per thousand (ppt). San Joaquin River water is more saline than these tributaries and, since the 1930s, its average salinity has increased from less than 0.2 ppt to about 0.4 ppt, primarily as a result of increased agricultural drainage. Seasonal changes in the salinity distribution within the Estuary are controlled mainly by the exchange of ocean and Bay 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.

Dissolved Oxygen

The Estuary's waters are generally well oxygenated, except during summer in the extreme southern end of South Bay where concentrations are reduced by poor tidal mixing and high water temperature. Typical concentrations of DO range from 9 to 10 mg/l throughout the entire Estuary during periods of high riverine flow, 7 to 9 mg/l during moderate riverine flow, and 6 to 9 mg/l during the late summer months when flows are the lowest. 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 waters in San Francisco Bay is relatively constant and typically ranges from 7.8 to 8.2.

Total Suspended Solids and Turbidity

Turbidity and total suspended solids (TSS) are generally used as measures of the quantity of suspended particles. The distinction lies mainly in the method of measurement; i.e. turbidity measurements are optical, while TSS measurements are gravimetric. In general, higher TSS results in more turbid water. 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). Shallow areas and channels adjacent to shallow areas have the highest suspended sediment concentrations. TSS levels vary throughout the Estuary depending upon season, tidal stage, and depth (Buchanan and Schoellhamer 1995). 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 have 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 of 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.

Sediment Quality

Sediment quality in the Estuary varies greatly according to the physical characteristics of the sediment, proximity to historical waste discharges, the physical/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. Overall, 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.

Impact Discussion:

a. *Violate any water quality standards or waste discharge requirement? **- PS***

The proposed project would not generate wastes that would be intentionally discharged to surface waters. Decaying vegetation may create a high oxygen demand and/or increased turbidity in adjacent waters, resulting in reduced water quality. Additionally, removal of marsh vegetation could disturb sediments, thereby causing remobilization of sediment-associated pollutants and potentials for bioaccumulation of chemical pollutants in organisms. Impacts may be potentially significant. Potentially significant impacts to water quality will be evaluated further in the EIS/EIR.

b. *Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)? **- LS***

In general, the project is not expected to affect groundwater or aquifer levels because the project would not withdraw groundwaters. Also, groundwaters in the vicinity of the marsh treatment sites likely are brackish and nonpotable and unsuitable for irrigation. Thus, movement/leaching of herbicides or remobilized contaminants is not expected to significantly affect groundwater quality.

c. *Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site? **- PS***

Removal of marsh vegetation, and/or disturbances to marsh sediments, could increase potentials for erosion and transport offsite of sediments to other areas that, in turn could affect marsh circulation or drainage patterns. Impacts would be potentially significant. This impact will be evaluated further in the EIS/EIR. One intended goal of the proposed project is to preserve and restore natural drainage patterns.

d. *Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site? **- LS***

Some changes to surface drainage patterns in the marsh could occur in the vicinity of the treatment sites. However, the magnitude of these changes would not be substantial and would not result in flooding on or off-site.

e. *Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff? **- LS***

The proposed project would not increase runoff volumes or add pollutants to stormwater flows to the Bay. As mentioned, herbicides applied to target vegetation, as well as marsh sediments, could be transported off-site by tidal flows within the marsh. However, these processes would not add significantly to the flux of pollutants to the Bay.

f. *Otherwise substantially degrade water quality? - **LS***

Based on the above considerations, these potential impacts on water quality would be considered less than significant.

g. *Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map? - **LS***

No housing is proposed as part of the proposed project. Therefore, no impacts would result.

h. *Place within a 100-year flood hazard area structures that would impede or redirect flood flows? - **LS***

No structures would be constructed as part of the proposed project. Therefore, no impacts would result.

i. *Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam? - **LS***

Although some changes to surface drainage patterns in the marsh could occur in the vicinity of the treatment sites, these changes generally would not be expected to increase potentials for flooding in adjacent developed areas or expose people or structures to a significant risk of loss, injury or death as a result of the failure of a levee or dam.

j. *Inundation by seiche, tsunami, or mudflow? - **LS***

Although some changes to surface drainage patterns in the marsh could occur in the vicinity of the treatment sites, these changes generally would not be expected to increase potentials for inundation by seiche, tsunami, or mudflow.

9. LAND USE AND PLANNING

Would the project:		**Potentially Signif. Impact**	**Less Than Signif. w/ Mitig.**	**Less Than Signif.**	**No Impact**	**Reviewed Under Previous Document**
a.	Physically divide an established community?				X	
b.	Conflict with any applicable land use plan, policy or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	X				
c.	Conflict with any applicable habitat conservation plan or natural community conservation plan?	X				

Environmental Setting:

The project area includes the San Francisco Bay Estuary and, in particular, the tidelands located between developed areas and water. The land uses surrounding areas where *Spartina* grows within the San Francisco Estuary vary and include residential, open space, and industrial areas. *Spartina* 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. *Spartina* 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 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, *Spartina* 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, are also located along the bay shoreline where *Spartina* is found. Some of the areas around San Francisco Bay provide sensitive habitats that may be subject to Habitat Conservation Plans.

Impact Discussion:

a. *Would the project physically divide an established community? -* ***NI***

The proposed project would not physically divide an established community. The proposed project would not alter existing or planned land uses and would not result in the development of any structures. The proposed action would only require occasional access to tideland areas by personnel and equipment. Therefore, impacts would not occur.

b. *Would the project conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect? -* ***PS***

The project will 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 *Spartina* removal (i.e., mechanical, manual, spraying, etc.) in a given area can be selected or rejected based on any restrictions presented by relevant plans, policies, or regulations. However, because of the number of jurisdictions affected by the proposed project, evaluation of relevant plans and policies will be undertaken in the EIS/ EIR to identify any conflicts and provide the opportunity for resolution prior to project initiation.

c. *Would the project conflict with any applicable habitat conservation plan or natural community conservation plan? -* ***PS***

It is not anticipated that the proposed project would conflict with any applicable habitat conservation plan or natural community conservation plan. The proposed action is intended to implement goals presented in habitat conservation and natural community conservation plans developed by several agencies with jurisdiction in the region. However, because of the number of jurisdictions affected by the program, the potential for conflict with these plans will be evaluated. The compatibility of the proposed project with these plans will be discussed in the EIS/ EIR.

10. MINERAL RESOURCES

Would the project:	**Potentially Signif. Impact**	**Less Than Signif. w/ Mitig.**	**Less Than Signif.**	**No Impact**	**Reviewed Under Previous Document**
a. Result in the loss of availability of a known mineral resource that would be of value to the region and residents of the state?				X	
b. Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?				X	

Environmental Setting:

A number of mineral resources are present in the San Francisco Bay Area. Salt and sand is currently produced. The Cargill Salt Company produces salt from evaporation ponds located along the southeastern margin of the bay in Alameda County. Hanson Aggregates and RMC Pacific Materials currently dredge sand from the bay in the vicinity of Alcatraz Island. Salt ponds total some 36,000 acres in South Bay and some 10,000 acres in North Bay.

Impact Discussion:

a. *Result in the loss of availability of a known mineral resource that would be of value to the region and residents of the state? - **NI***

The proposed project would not compromise the availability of any known mineral resources. Removal of *Spartina* would occur adjacent to salt evaporator ponds in South Bay. However, removal activities would be restricted to marshes and would not interfere with salt or sand production.

b. *Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan? - **NI***

The salt ponds are an economically important and productive use of the waters of the Bay (for extracting salt), and the salt is an important raw material for the Bay Area chemical industry. However, neither salt nor sand production would be compromised by the proposed project, as discussed above. Removal of *Spartina* would not affect the availability of important mineral resources.

11. NOISE

Would the project result in :	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance or applicable standards of other agencies?	X				
b. Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	X				
c. A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?			X		
d. A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	X				
e. For a project located within an airport land use plan, or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?			X		
f. For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?			X		

Environmental Setting:

The noise environment surrounding marsh treatment sites vary due to the widespread distribution of *Spartina* in the Estuary. The open space nature of the marsh treatment sites results in few noise-producing activities at the sites themselves. The noise environment is primarily influenced by off-site noise generators. Ambient noise levels vary from above 65 dBA in marshes adjacent to industrial developed areas, such as the ports of Oakland and Redwood City and the San Francisco Airport, to below 45 dBA in areas of the San Francisco Bay Refuge Complex and marshes that are surrounded by salt evaporator ponds.

The number and type of noise sensitive receptors vary with the location. However, receptors include residences, schools, and hospitals that are within 1,600 feet of the treatment sites.

Impact Discussion:

a. *Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance or applicable standards of other agencies?* ***- PS***

Temporary increases in noise levels would result from increased human presence in marsh areas during removal activities. Up to five people may be present at the site over a period of days. Use of mechanized equipment, including boats and aircraft at selected site could contribute to increased noise levels of up to 65 dBA within 1,600 feet of treatment areas. Impacts would be potentially significant and would be discussed in further detail in the EIS/ EIR.

b. *Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?* ***- PS***

Sensitive receptors, including residences, schools, and hospitals, located within 1,600 feet of removal activity could be subjected to increased noise levels of up to 65 dBA as discussed above. Impacts would be potentially significant and would be discussed in further detail in the EIS/ EIR.

c. *A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?* ***- LS***

Removal activities would occur over a limited duration, from one day to a period of weeks. Periodic monitoring of the sites would be conducted, although the presence of a monitor evaluating the presence of invasive *Spartina* through personal observations would not result in substantial noise-generating activity. Therefore, no permanent increases in ambient noise levels would occur.

d. *A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?* ***- PS***

As discussed under (a) and (b), removal activities could result in temporary increases in noise levels. Impacts would be potentially significant and discussed in further detail in the EIS/ EIR.

e. *For a project located within an airport land use plan, or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?* ***- LS***

Some control activities would take place adjacent to San Francisco International and Oakland airports. These activities would not expose residents or workers in these areas to excessive noise levels. Control activities would result in temporary increases to noise levels, but not excessive levels over time. All removal activities would be coordinated with applicable airport land use plans.

f. *For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?* ***- LS***

The proposed project would not be located within the vicinity of a private airstrip.

12. POPULATION AND HOUSING

Would the project:	**Potentially Signif. Impact**	**Less Than Signif. w/ Mitig.**	**Less Than Signif.**	**No Impact**	**Reviewed Under Previous Document**
a. Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X	
b. Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X	
c. Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X	

Environmental Setting:

According to Association of Bay Area Governments (ABAG) data, the nine-county San Francisco Bay Area had an estimated population of 6.9 million persons in 2000. The Bay Area population is projected to increase to 7.6 million by 2010 and to 8.0 million by 2020. ABAG estimates the number of Bay Area households at 2.4 million in 2000. The number of households is projected to increase to 2.7 million by 2010 and to 2.8 million by 2020. (ABAG 1999)

Impact Discussion:

a. *Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)? - **NI***

The proposed project does not include any new homes, business, or roads. No development would occur that would induce population growth and associated housing.

b. *Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere? - **NI***

No demolition of housing would occur as a result of removal activities. The project would be conducted in areas devoid of housing. Therefore, displacement of housing would not occur. Indirect impacts on residential areas elsewhere would not be expected to occur. No impacts would result.

c. *Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere? - **NI***

The proposed project area includes tidelands with minimal to no population and no structures. Displacement of people would not occur as a result of the proposed project.

13. PUBLIC SERVICES

Would the project:	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:					
Fire protection?			X		
Police protection?				X	
Schools?				X	
Parks?	X				
Other public facilities?				X	

Environmental Setting:

Various departments within the cities and counties of the Bay region provide fire protection, police protection, and emergency medical services to members of their respective communities.

Impact Discussion:

a. *Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:*

*Fire Protection? - **LS***

The proposed project includes controlled burns as a method of removal. Participation of the fire department may be required to ensure that activities would not result in public safety hazards. Since the marsh treatment sites are dispersed throughout the bay, demands on fire department personnel would be spread among a number of fire departments and would not excessively burden any one station. This would allow fire departments to maintain acceptable service ratios while addressing the needs of the proposed project.

*Police protection? - **NI***

The proposed project would not require police services. No impacts would occur.

Schools? - ***NI***

No schools are located along the shoreline, but some are in the immediate vicinity of the project area. The proposed project, however, would not lead to population increases and associated student generation.

Parks? - ***PS***

A number of local and state parks and are located within the Bay Estuary. Many removal sites are adjacent to the Bay Trail. Removal activities could temporarily constrain access to these parklands and to some trails. Depending on the length of time such constraints occurred, impacts could be potentially significant. Please see Section 14, Recreation, for additional detail. This issue will be discussed further in the EIS/ EIR.

Other public facilities? - ***LS***

The activities associated with the control of Spartina would not adversely affect public facilitates because of the small number of persons and vehicles undertaking these activities and the intermittent nature of the activities. The potential for the proposed project to have adverse impacts on public services would be less than significant.

14. RECREATION

Would the project:	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	X				
b. Include recreation facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment?				X	

Environmental Setting:

Recreational facilities surrounding the Bay provide a variety of activities. Recreational demand in the Bay area has resulted in development of parks, marinas, launching ramps, fishing piers, and beaches.

Proposed treatment areas are located in the tidelands, which are generally not accessible to the public for recreational use. However, these sites abut recreational areas adjacent to the estuaries, although most project locations are generally not considered recreational areas themselves. Several treatment sites are located within the East Bay regional Parks District, including Crown Beach, Martin Luther King Jr. Park, Oyster Bay, Hayward Shoreline, and Coyote Hills parks.

Impact Discussion:

a. *Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated? **- PS***

The proposed project may affect park use at selected sites during application of control methods by means of temporary trail closures and other access roads. Removal activities may constrain access, as portions of parks may be inaccessible while removal methods that could potentially affect public safety (chemical use, burning) are applied. Some techniques could be applied over a period of days with access being constrained commensurately. This would be a potentially significant impact and will be discussed further in the EIS/ EIR.

b. *Include recreation facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment? **- NI***

The project does not propose to construct or modify existing recreational facilities. As discussed above, removal activities could occur adjacent to parkland. No population increases are associated with the proposed project. Therefore, no increased demand on recreational facilities would result.

15. TRANSPORTATION/TRAFFIC

Would the project:		**Potentially Signif. Impact**	**Less Than Signif. w/ Mitig.**	**Less Than Signif.**	**No Impact**	**Reviewed Under Previous Document**
a.	Cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections?			X		
b.	Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?			X		
c.	Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that result in substantial safety risks?			X		
d.	Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersection) or incompatible uses (e.g., farm equipment)?				X	
e.	Result in inadequate emergency access?				X	
f.	Result in inadequate parking capacity?				X	
g.	Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?			X		

Environmental Setting:

Regional access from the north and south is provided by U.S. Highway 101, which generally parallels the west side of San Francisco Bay. U.S. Interstate 280 (I-280) also provides north-south access to the Bay Area, but is located further inland. Regional access from the north and south on the east side of the Bay is provided by I-880 from San Jose to Oakland, and then by I-580 and I-80 in the northern portions of the Bay. Several major roadways provide east-west access to the Bay. In the South Bay subregion, these include State Highways 237 and 84 (Dumbarton Bridge). In the Central Bay subregion, east-west access is provided by State Highway 92 (San Mateo Bridge) and the San Francisco-Oakland Bay Bridge. State Highways 4 and 37 are the primary east-west regional access roadways in the North Bay and Suisun Bay subregions.

Access to the control sites will be via regional and local roadways. Access to coastal areas will require the use of public and private roads. Access to privately owned coastal areas would require permission from the property managers and/ or owners.

Impact Discussion:

a. *Would the project cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, of congestion at intersections? - **LS***

The proposed project would not result in a substantial increase in traffic nor have the potential to result in a substantial increase in the number of vehicle trips, the volume to capacity ratio on roads or congestion at intersections. It is anticipated that the maximum number of trucks in a particular area under the worst case scenario (i.e., volunteer groups hand pulling plants) would be 20. This would occur a maximum of five times during the year.

b. *Would the project exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways? - **LS***

As described above, the proposed project would generate negligible traffic and as such would not exceed a level of service standard, either individually or cumulatively.

c. *Would the project result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks? - **LS***

It is not anticipated that the project would result in a substantial change in air traffic, although the use of helicopters for the transport of equipment (e.g., boats and aerial spraying) is a consideration. However, the use of helicopters would be localized, temporary and would not significantly affect air traffic levels or result in substantial safety risks. Air activities taking place near airports would be coordinated with local air traffic control stations.

d. *Would the project substantially increase hazards due to a design feature (i.e., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)? - **NI***

The proposed project would not result in any new construction and therefore would not present hazards due to a design feature.

e. *Would the project result in inadequate emergency access? - **NI***

No aspect of the proposed project would have the potential to affect emergency access.

f. *Would the project result in inadequate parking capacity? - **NI***

The proposed would not have the potential to affect parking capacity. As described under "a," above, traffic generated by the proposed project would be minimal and would only occur on an occasional basis.

g. *Would the project conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)? - **LS***

Only a small amount of traffic would be generated by the project at intermittent periods during the plants growth cycle. These vehicles would use existing streets and facilities, including the Bay Trail.

16. UTILITIES AND SERVICE SYSTEMS

Would the project:	Potentially Signif. Impact	Less Than Signif. w/ Mitig.	Less Than Signif.	No Impact	Reviewed Under Previous Document
a. Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?				X	
b. Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X	
c. Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?				X	
d. Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?				X	
e. Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?				X	

Environmental Setting:

Urban areas have a complex maze of underground utilities. Utility pipelines and cables are usually buried beneath roadways or within road or railroad rights-of-way (ROWs). Bay Area electric infrastructure consists of a large and complex grid of power plants, transmission lines, and substations. Generating facilities in the region are primarily fired with natural gas and oil. A description of all underground utilities that cross or lie within the Bay Area would not be necessary. Locations and types of buried utilities in the Bay Area would not be affected by the proposed project.

Impact Discussion:

a. *Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?* ***- NI***

A Waste Discharge Requirements Permit (WDRs) may be required from the RWQCB. However, it is not expected that the proposed project would exceed current requirements. Please see section 8, Hydrology and Water Quality, for additional detail.

b. *Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? **- NI***

The proposed project does not include structural development that would require water delivery or would generate wastewater.

c. *Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects? **- NI***

No development would occur as a result of the proposed project. Removal of *Spartina* would not alter storm water drainage patterns.

d. *Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed? **- NI***

The proposed project does not include structural development that would require water delivery. No increased demands on the water supply would result.

e. *Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments? **- NI***

The proposed project would not require wastewater treatment services. No impacts would occur.

Appendix D
NOP/NOI Public Comment Letters

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-4082
(916) 657-5390 - Fax

April 16, 2001

Maxene Spellman
California State Coastal Conservancy
1330 Broadway, Suite 1100
Oakland, CA 94612

RE: SCH# 2001042058– The San Francisco Estuary Invasive Spartina Project

Dear Ms. Spellman:

The Native American Heritage Commission has reviewed the above mentioned NOP. To adequately assess the project-related impact on archaeological resources, the Commission recommends the following action be required:

1. Contact the appropriate Information Center for a records search. The record search will determine:
   - Whether a part or all of the project area has been previously surveyed for cultural resources.
   - Whether any known cultural resources have already been recorded on or adjacent to the project area.
   - Whether the probability is low, moderate, or high that cultural resources are located within the project area.
   - Whether a survey is required to determine whether previously unrecorded cultural resources are present.

2. The final stage of the archaeological inventory survey is the preparation of a professional report detailing the findings and recommendations of the records search and field survey.
   - Required the report containing site significance and mitigation be submitted immediately to the planning department.
   - Required site forms and final written report be submitted within 3 months after work has been completed to the Information Center.

3. Contact the Native American Heritage Commission for:
   - A Sacred Lands File Check.
   - A list of appropriate Native American Contacts for consultation concerning the project site and assist in the mitigation measures.

Lack of surface evidence of archeological resources does not preclude the existence of archeological resources. Lead agencies should include provisions for accidentally discovered archeological resources during construction per California Environmental Quality Act (CEQA) §15064.5 (f). Health and Safety Code §7050.5 and Public Resources Code §5097.98 mandates the process to be followed in the event of an accidental discovery of any human remains in a location other than a dedicated cemetery and should be included in all environmental documents. If you have any questions, please contact me at (916) 653-4038.

APR 19 2001

Sincerely,

Debbie Pilas-Treadway
Associate Governmental Program Analyst

cc: State Clearinghouse

1600 Broadway, Suite 300
Oakland, CA 94612-2100

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www.savesfbay.org

May 10, 2001

Ms. Maxene Spellman
California Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612

Dear Ms. Spellman:

Save The Bay has been working for four decades to protect and restore the San Francisco Bay-Delta Estuary. We are a regional membership organization committed to keeping the Bay healthy and beautiful. Save The Bay supports the preparation of a Joint EIS/R to study the environmental impacts of the invasive *Spartina alterniflora*.

We believe the invasion of *S. alterniflora* may have caused harmful effects to the Bay's existing wetlands, threatened habitat for endangered species, and hindered wetland restoration projects.

However, the potential negative environmental impacts of a large scale *Spartina* eradication project may be too great to warrant particular actions. Therefore, we believe a thorough, scientific study of eradication impacts and alternatives is merited. Specifically, we would like to see the EIS/R look at the benefits and negative impacts of eradication strategies on current wetland restoration projects, fish and wildlife, water quality, and human health.

Thank you for allowing us to comment on this important issue.

Sincerely,

David Lewis

David Lewis
Executive Director

SAVE THE BAY

Save San Francisco Bay Association

City of Alameda • California

May 10, 2001

Maxine Spellman
California State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, CA 94612

RE: Notice of Preparation/Intent of a Draft Joint Environmental Impact Statement/Environmental Impact Report for the Invasive Spartina Project

Dear Ms. Spellman:

Thank you for the opportunity to review and provide comments on the subject Notice of Preparation/Intent for the Invasive Spartina Project. The City of Alameda offers the following comments:

Environmental Setting

1. The Seaplane Harbor at Alameda Point is no longer a designated landing facility.

Air Quality

1. Encinal High, Paden Elementary, Lum Elementary, Wood Middle, Otis Elementary, Lincoln Middle, Bay Farm Elementary, and Earhart Elementary schools within the City of Alameda are all located within 1/4 mile of either San Francisco Bay or San Leandro Bay. The impacts of proposed treatment methods on these schools must be addressed in the EIS/EIR.

2. As a residential community, Alameda has a large number of residences located within 1/4 mile of both San Franscisco Bay and San Leandro Bay. In addition, a number of other sensitive receptors, such as elderly care and day care facilities, are located within 1/4 mile of *spartina alterniflora* sites around Alameda, including, but not limited to, Bay Harbour Residential Care Home, Waters Edge Nursing Home, and Alameda Tiny Tots. The impacts of proposed treatment methods on these sensitive receptors must be addressed in the EIS/EIR.

Planning Department

2263 Santa Clara Avenue, Room 120
Alameda, California 94501
510 748.4554 • Fax 510 748.4593 • TDD 510 522.7538

Maxine Spellman
May 10, 2001

Biological Resources

1. City of Alameda General Plan policy 5.2.a is to "Protect and preserve Bay waters and vegetation as nurseries and spawning grounds for fish and other aquatic species, both as a part of habitat preservation and to encourage continued use of the Bay for commercial fishing production." The EIR/EIS must address the impacts on vegetation and the potential impacts on nurseries and spawning grounds within the waters of San Francisco and San Leandro Bays.

2. Two federally listed endangered species are found in Alameda, the California Least Tern and the California Clapper Rail. Attached is Figure 8-3 from the Draft *Alameda General Plan Update: Existing Conditions and Planning Issues* report, which identifies the location of eelgrass beds within the City of Alameda and the location of the Elsie D. Roemer Bird Sanctuary. The eelgrass beds are vital to the preservation of the Least Terns, as it provides a nursery for the fish species on which the Least Terns forage. The cordgrass is critical to the survival of the Clapper Rail. The EIR/EIS must address the impacts of proposed treatment methods on these two endangered species and their habitats.

3. Attached are pages 76 and 77 of the City of Alameda General Plan. These pages list species of fish, shrimp, crab, and shore-inhabiting birds of special status which have been observed around Alameda. The impacts of proposed treatment methods on these species must be addressed in the EIR/EIS.

4. Alameda has wetlands and a lagoon system that could be affected by the proposed treatment methods. There are two critical wetland areas within the proposed Wildlife Refuge at Alameda Point, and a smaller wetland area located along Main Street in western Alameda. Extensive lagoon systems are located at Marina Village, along the historic shoreline of the Main Island, and on Bay Farm Island. The EIR/EIS must address the impacts of the proposed treatment methods on the wetlands and lagoon systems.

5. City of Alameda General Plan policy 5.1.bb is to "Require a biological assessment of any proposed project site where species or the habitat of species defined as sensitive or special status by the California Department of Fish and Game or the U.S. Fish and Wildlife Service might be present." The EIR/EIS should include a biological assessment for the *spartina alterniflora* sites around Alameda.

Hazardous Materials

1. The former Alameda Naval Air Station has been designated as a National Priorities List site. The potential impact of chemical treatments in this area on public health and safety or the environment must be evaluated in the EIS/EIR.

Maxine Spellman
May 10, 2001

Please provide us with two copies of the Draft EIR/EIS once it is available. Thank you again for the opportunity to provide comments. If you have any questions, please call Kevin Bryant, Planner II, at (510) 748-4554.

Sincerely,

Cynthia Eliason

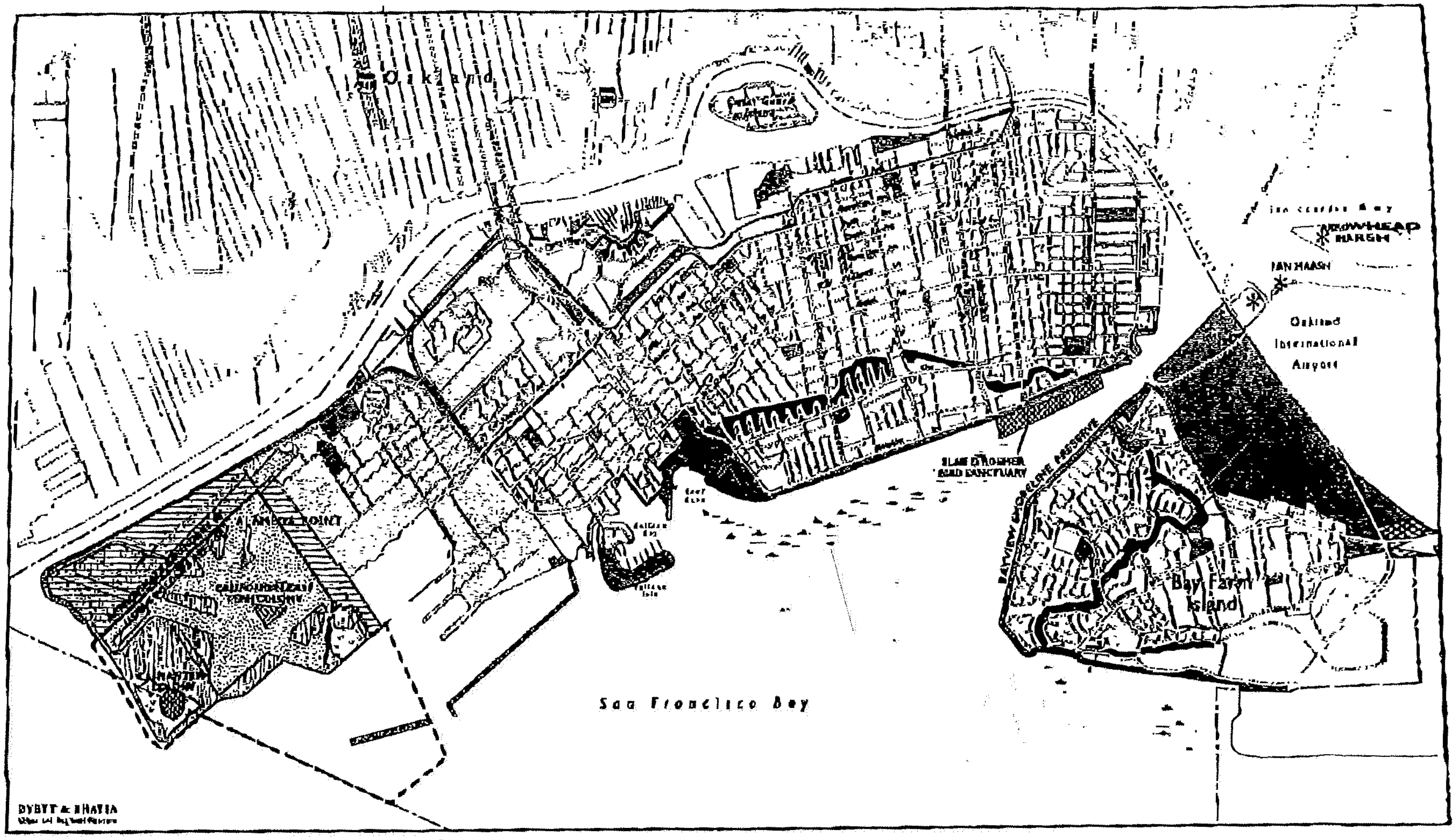
Cynthia Eliason, AICP
Planning Manager

Attachments

xc: Colette Meunier, Planning Director
Dina Tasini, Environmental Policy & Operations Manager

G:\PLANNING\ENVIRREV\CORRES\SPARTINA.NOP

D-6



Sources:
US Navy, Natural Resource Management Plan, Naval Air Station, Alameda, USDA Soil Conservation Service, January 1986.
Dr. Chris Kitting, Biologist, CSU Hayward, 1990.
Sandy Wylie Echeverria and Patrick J. Rutten, Inventory of Eelgrass in San Francisco/San Pablo Bays, National Marine Fisheries Service, Southwest Region, October 1989.
LSA Biological Report, Harbor Bay Ferry Terminal, prepared for the City of Alameda, January 1990. Includes Figure 5, Proposed Ferry Approach Route (eelgrass bed locations derived from surveys), and Figure 8, Transect Locations, Pacific Aerial Photo of Ferry Approach Vicinity, June 1989.
California Natural Diversity Database, January 2001

Grassland
Wetlands
Water
Rock Breakwaters and Riprap
Eelgrass Beds
Open Space/Habitat
Airfield/Tarmac
Developed/Undeveloped Parkland
Intensively Developed
Lagoons
Wildlife Refuge Impact Area
Snowy Plover, California Seablite, Alkali Milkvetch

0 1500 3000
FEET

* Significant Habitat- exists under others' jurisdictions

Figure 8-3
Alameda Environmental Resources

fortunate to contain unique habitat that supports members of species which are known to be diminishing throughout all or part of their natural ranges.

According to the State Department of Fish and Game, a variety of fish, shrimp, and crab inhabit the waters surrounding Alameda, some of the more common including:

Yellowfin Goby
(*Acanthogobius flavimauus*)

American Shad
(*Alosa sapidissima*)

Speckled Sanddab
(*Citharicthys stigmaeus*)

Shiner Surfperch
(*Cymatogaster aggregata*)

White Croaker
(*Genyonemus lineatus*)

Staghorn Sculpin
(*Leptocottus armatus*)

Bat Ray
(*Myliobatus californicus*)

Starry Flounder
(*Platichthys stellatus*)

Striped Bass
(*Roccus saxitilis*)

Leopard Shark
(*Triakis semifasciata*)

Dungeness Crab
(*Cancer magister*)

Oriental Shrimp
(*Palaemon macrodactylus*)

White Sturgeon
(*Acipenser transmontanus*)

Jacksmelt
(*Atherinopsis californiensis*)

Pacific Herring
(*Clupea harengus*)

Northern Anchovy
(*Engraulis mordax*)

Bay Goby
(*Lepidogobius lepidus*)

Brown Smoothhound
(*Mustelus henlei*)

English Sole
(*Parophrys vetulus*)

Northern Midshipman
(*Porichthys notatus*)

Longfin Smelt
(*Spirinchus thaleichthys*)

Bay Shrimp
(*Crangon* sp.)

Mud Crab
(*Hemigrapsus oregonensis*)

Spider Crab
(*Pyromaia tuberculata*)

California cordgrass (*Spartina foliosa*) is present in the Bayview Shoreline Preserve. This species and the Eelgrass (*Zostera marina*) which grows in several locations off of Alameda and Bay Farm islands are of prime importance to the aquatic and wetlands ecosystems. The endangered California Clapper Rail (*Rallus longirostris obsoletus*) is known to frequent cordgrass areas, including those comprising the Bayview Shoreline Preserve and in the nearby Arrowhead Marsh. The endangered Least Tern nests at the Naval Air Station and Oakland Airport, and forages for Pacific Herring which are found in the eelgrass beds. The Alameda song sparrow (*Melospiza melodia pusillula*), one of several unique sub-species of song sparrow unique to the San Francisco Bay, is listed by the State Department of Fish and Game as a species of special status and was categorized by the Federal Government in 1989 as a Candidate 2, a species which is being considered for listing by the U.S. Fish and Wildlife Service.

The Department of Fish and Game and the local Audubon Society monitor the presence and condition of both water-oriented and land-oriented bird species. According to them, shore-inhabiting birds which have been observed around Alameda include:

Snowy Plover
(*Charadrius alexandrinus nivosus*)

California Brown Pelican
(*Pelicanus occidentalis*)

Harlequin Duck
(*Histrionicus histrionicus*)

Northern Harrier
(*Circus cyaneus*)

California Gull
(*Larus californicus*)

Elegant Tern
(*Sterna elegans*)

Common Loon
(*Gavia immer*)

Double-breasted Cormorant
(*Phalacrocorax auritus*)

Barrow's Goldeneye
(*Bucephela islandica*)

California Black Rail
(*Laterallus jamaicensis*)

Salt Marsh Yellowthroat
(*Geothlypis trichas sinuosa*)

Land birds thought to be present at least occasionally within the City of Alameda and vicinity include the Merlin (*Falco columbarius*), Peregrine Falcon (*Falco peregrinus*), Short-eared Owl (*Asio flammeus*), and Burrowing Owl (*Athene cunicularia*). All of these species are considered to be of

CONTRA COSTA
WATER DISTRICT

1331 Concord Avenue
P.O. Box H20
Concord, CA 94524
(925) 688-8000 FAX (925) 688-8122

May 15, 2001 *Via Fax 510/286-0470*

Maxene Spellman
California State Coastal Conservancy
1330 Broadway, 11th Floor
Oakland, California 94612

Subject: Notice of Preparation Response to the Invasive Spartina Project

Dear Ms. Spellman:

Thank you for the opportunity for Notice of Preparation/Notice of Intent response to the preparation of a Draft EIR/EIS on the Invasive Spartina Project. The project is not within the existing Contra Costa Water District (CCWD) service area boundaries.

The project is to implement a regional program for the control of invasive *Spartina* in the San Francisco Bay Estuary. The habitats subject to exotic species control efforts include tidal marshlands, lagoons, intertidal mudflats, and the saline reaches of creeks and rivers flowing into the San Francisco Estuary. Eradication/control efforts would be regionally coordinated with other programs in order to minimize disturbance to sensitive habitats and species, while successfully controlling invasive *Spartina*. The project intends to restore native plant communities and sensitive species habitats associated with tidal marshlands and intertidal marshflats along the Bay margins by eliminating introduced *Spartina* species. The control efforts and alternatives evaluated in the EIR/S will be consistent with U.S. Fish and Wildlife Service policies and goals.

In light of the California Department of Boating and Waterways Water Hyacinth Spraying Program's experience with the Regional Water Quality Control Board, the District assumes the project will need either a Section 401 Water Quality Certification or Section 402/404 Waste Discharge Requirements permit. CCWD would like to review these permits at the appropriate time. If the exotic *Spartina* moves north or east of Richmond and the project is expanded, please notify CCWD in order to evaluate any potential impact to the CCWD Mallard Slough intake located northwest of Pittsburg.

If you have any questions on the response, please call Dennis Pisila at 925/688-8119.

Sincerely,

Gregory Gartrell
Director of Planning

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

June 4, 2001

Mr. Wayne White
Field Supervisor
US Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, CA. 95825

Dear Mr White:

The Environmental Protection Agency (EPA) has reviewed the Notice of Intent (NOI) for the **Invasive Spartina Project, San Francisco Bay Estuary, California.** Our review and comments are 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 goal is to help ensure full and understandable disclosure of critical issues, concerns, and proposed actions, and the potential impacts of these actions on the environment and the San Francisco Bay region.

The US Fish and Wildlife Service (Service) and California State Coastal Conservancy (Conservancy) are preparing a programmatic Environmental Impact Statement (PEIS) on implementation of a regional eradication and/or control program for nonnative, invasive Spartina, a perennial cordgrass, in the San Francisco Bay Estuary (Invasive Spartina Project). The primary goal of the Invasive Spartina Project is to eradicate and/or control invasive Spartina in the tidal marshlands and intertidal mudflats along margins of the San Francisco Bay, an area providing habitat for several Federal and State listed species. These efforts will be regionally coordinated with other resource and wildlife agencies in order to minimize disturbance to sensitive habitats and species. The PEIS will evaluate six control methods: mowing, physical removal, chemical control, temporary diking of wetlands, prescribed burns, and a combination of these methods.

EPA strongly supports the effort to control invasive Spartina which is a real environmental threat. We believe the proposed effort is consistent with the goals of the Invasive Species Management Plan released on January 18, 2001 by the National Invasive Species Council. We urge collaboration and coordination with other local, State, and Federal research and efforts to control Spartina. For instance, the National Science Foundation (NSF) has recently given a multi-million dollar research grant to an entity in California to study Spartina and its control.

Additional detailed comments are enclosed. We appreciate the opportunity to review this NOI. Please send three copies of the draft PEIS to our office when it is officially filed with our HQ EPA Office of Federal Activities. If you have any questions, please call Laura Fujii, of my staff, at 415-744-1601, email: fujii.laura@epa.gov.

Sincerely,

Lisa B. Hanf

Lisa B. Hanf, Manager
Federal Activities Office
Cross Media Division

Enclosure: Detailed Comments (6 pages)
MI003666
Filename: spartinanoi.wpd

cc: US COE
Ms. Maxene Spellman, CA State Coastal Conservancy
Perry Herrgesell, Central Valley-Bay Delta Branch, CDFG
Dick Whitsel, Region 2, RWQCB
BAAQMD

DETAILED COMMENTS

Specific Scoping Comments for the Invasive Spartina Project

Chemical Control

1. The scoping notice states that chemical control of Spartina will be evaluated. Chemical control may be with a registered herbicide (Rodeo) or experimentally permitted herbicides (Sonar, Arsenal) and surfactants.

Comments and Recommendations:

Regardless of the pesticides used, these pesticides must be registered with EPA and the Department of Pesticide Regulation, California EPA. The sites and pests for the intended use must also be on the pesticide label. The pesticide must be used in accordance with the label directions.

The active ingredients in Rodeo (glyphosate) and Arsenal (imazapyr) have very low aquatic toxicity to fish and invertebrates. Fluridone (in Sonar) has low toxicity to fish, but it is an order of magnitude more toxic than glyphosate or imazapyr. Of more concern are the unidentified surfactants, since there are surfactants more toxic than any of the above active ingredients (e.g., certain alkyl/arylphenols).

We recommend the PEIS include a specific section describing and evaluating, in detail, the control chemicals which may be used. This section should describe the characteristics of the chemicals; their registration status; their potential toxicity to the environment, especially aquatic organisms; and the sites/pests for which they are registered. Chemical compounds should be evaluated separately and not lumped. For instance, provide a separate evaluation for different types of surfactants such as alkylphenols and arylphenols.

2. It is our understanding that the US National Marine Fisheries Service (NMFS) has rejected Spartina control with glyphosate and a surfactant in Willapa Bay, Washington, at least once.

Recommendation:

If chemical control is selected as a management option, we recommend the Service and Conservancy coordinate with NMFS to ensure they concur with the use of the chosen control chemicals.

3. Chemical control may include direct application of the herbicide to water.

Recommendation:

Pursuant to the recent 9th Circuit Court of Appeals' decision in the Headwaters, Inc. v. Talent Irrigation case, the California State Water Resources Control Board (State Board) has determined that applications of aquatic pesticides for resource or pest management require coverage by a National Pollutant Discharge Elimination System (NPDES) permit. The State Board is developing a general permit for this purpose. If the Service and Conservancy decide to use herbicides to control Spartina, they will be subject to this requirement to obtain NPDES permit coverage. We recommend the Service and Conservancy contact and work with the State Board regarding this NPDES permit requirement.

4. It is unclear which herbicides would be toxic to Spartina and less toxic to native plant species. Although it may temporarily impact nontarget plant species, an herbicide that is more effective against Spartina than against the native plant species would be beneficial in the long term.

Recommendation:

The PEIS should include an evaluation of the potential effect of control chemicals on nontarget species and mitigation measures to minimize these effects.

5. It is likely there will be public concern over the application of herbicides, if selected as a control measure.

Recommendation:

We recommend the Service and Conservancy implement a public outreach and education process, as soon as possible, about the relative risks to public health and the environment of herbicides versus Spartina.

6. The scoping notice mentions the experimental use of herbicides.

Comment and Recommendation:

In cases where there may be a deviation from the pesticide label, it will be necessary to apply for an exemption under Section 18 of the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA). The PEIS should describe the experimental use of herbicides and the FIFRA exemption requirements.

7. The use of herbicides in Washington State for Spartina control raised the issue of potential impacts on phytoplankton.

Recommendation:

Although impacts to phytoplankton and benthic algae may be minimal or temporary, these potential impacts should be addressed in the PEIS.

General Comments for the Invasive Spartina Project

1. Many have urged the Federal government to consider invasive species issues a priority and to develop a coordinated national effort to address the problem. In response, the President issued Executive Order 13112 on Invasive Species (Order) in February 1999. The Order established the National Invasive Species Council (Council), co-chaired by the Secretaries of Agriculture, Commerce and the Interior; and includes the Secretaries of State, Treasury, Defense, and Transportation, and the Administrator of the Environmental Protection Agency. The Order directs the Council to form a non-Federal Invasive Species Advisory Committee (ISAC) to advise the Council in its work. The Council will provide national leadership on invasive species; see that their Federal efforts are coordinated and effective; promote action at local, State, tribal and ecosystem levels; identify recommendations for international cooperation; facilitate a coordinated network to document and monitor invasive species; develop a web-based information network; provide guidance on invasive species for Federal agencies to use in implementing the National Environmental Policy Act; and prepare the Invasive Species, Management Plan. This Plan presents nine interrelated and equally important areas that the Council considers priorities in addressing invasive species problems.

Recommendation:

We recommend the Service and Conservancy consult the Invasive Species Management Plan to ensure the proposed Spartina control program is consistent with and helps further the recommendations made in the Plan.

2. The scoping notice briefly mentions the ongoing Spartina control experiments in Washington State.

Recommendation:

We recommend the PEIS describe in more detail these experiments and the current evaluation regarding their success and promise as effective control measures.

3. Safety issues such as sinking into the mud when hand pulling or during herbicide application should be addressed in the PEIS.

4. The scoping notice does not mention EPA among the groups from which approval is needed.

Comment and Recommendation:

As stated below, EPA will review the proposed action for compliance with Section 404(b)(1) of the Clean Water Act (CWA). We will also review and comment on the proposed action and PEIS 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. We recommend the above information be provided in the PEIS.

5. It is likely any Spartina control program will take years, if not decades, to assure eradication and/or control of Spartina. For instance, if Spartina is killed with herbicide and/or plastic covers, it leaves a root mat that can last for years. Thus, the ecosystem would not necessarily return to "native" conditions quickly.

Recommendation:

The PEIS should describe the time frame for the proposed Spartina control program and potential measures for increasing the efficiency of specific control measures (e.g., use of herbicides followed by burning).

Generic Scoping Comments

Water Resources

Water Quality

1. The PEIS should briefly discuss how the proposed Invasive Spartina Project will comply with State and local water quality management plans and State-adopted, EPA-approved water quality standards. Provide information on how the project will assure compliance with the State nonpoint source pollution program. EPA recommends that the project proponents fully coordinate with the appropriate Regional Water Quality Control Board to ensure protection of water quality and maintenance of beneficial uses.

2. In addition, the PEIS should fully disclose potential beneficial and/or adverse impacts to water quality, wetlands, and aquatic ecosystems. The discussion should include an evaluation of potential impacts on existing fisheries, especially threatened and endangered species.

Include information on:

a. The potential of the proposed project to cause beneficial and/or adverse aquatic impacts such as increased siltation and turbidity; changes in the direction of stream flow, substrate, dissolved oxygen, and temperature; and habitat deterioration.

b. Critical fisheries habitat, especially spawning and rearing areas; and other sensitive aquatic sites such as wetlands. Outline past and potential beneficial uses of these areas, and disclose potential impacts from the proposed Spartina control activities.

c. The process which will be used to evaluate cumulative effects from past, present and foreseeable actions in the San Francisco Bay Estuary.

3. Discuss specific monitoring programs that will be implemented before and after proposed Spartina control actions to determine potential impacts on water quality and beneficial uses, and whether maintenance and protection of water quality is being guaranteed.

Wetlands: Section 404 Comments

The PEIS should identify impacts to water, floodplains, and wetlands, including identification of Section 404 Clean Water Act requirements, and management and mitigation proposals to ensure compliance with these requirements.

EPA will review the proposed action for 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:

- 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.

Air Quality

If prescribed burns are proposed, the PEIS should provide a discussion of air quality standards, ambient conditions, and potential air quality impacts for the Invasive Spartina Project. Cumulative and indirect impacts should be fully evaluated.

Federal agencies are required by the Clean Air Act to assure that actions conform to an approved air quality implementation plan. If the proposed project area is in a nonattainment area, the Service may need to demonstrate compliance with conformity requirements of the Clean Air Act [Section 176(c)]. General Conformity Regulations can be found in 40 CFR Parts 51 and 93 (58 Federal Register, page 63214, November 30, 1993). These regulations should be examined for applicability to the proposed project.

Species Viability

The PEIS should fully evaluate the proposed Invasive Spartina Project in the context of the potential for habitat restoration, habitat fragmentation, habitat connectivity, and the cumulative effects on species viability. Although endangered species and species-of-concern are notable focal points for evaluation, the PEIS should also evaluate potential impacts on other significant or keystone species.

We recommend an ecosystem management approach which considers sustainable, long-term management of the ecosystem and species viability. The PEIS should address the ability of the proposed flood control project to help reestablish and maintain long-term species viability and productivity within the project area.

Indicate what measures will be taken to protect critical wildlife habitat areas from potential adverse effects of proposed Spartina control and management activities. The feasibility of proposed mitigation measures should be fully demonstrated.

National Environmental Policy Act

EPA recommends the PEIS include a clear description of the basic project purpose and need, control alternatives, potential impacts to the environment, and mitigation for these impacts. Particular attention should focus on an evaluation of the environmental impacts of the proposed control measures and alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options for the decisionmaker and the public (40 CFR 1502.14). In addition, NEPA requires evaluation of indirect and cumulative effects which are caused by the action (40 CFR 1508.8(b) and 1508.7).

Alternatives Analysis

We recommend consideration of ideas provided by the public and of reasonable alternatives not within the jurisdiction of the lead agency (40 CFR Section 1502.14(c)). There should be a clear discussion of how each alternative was developed and the reasons for the elimination of alternatives not evaluated in detail. We recommend developing a range of alternatives which would encompass any potential Spartina control approach.

Funding and Administration

The PEIS should provide full disclosure and discussion of possible funding, implementation, and monitoring commitments of the Invasive Spartina Project. If this information (e.g., funding agreements) has been relegated to the appendices, we recommend it be summarized in the main body of the PEIS.

Appendix E
Herbicide and Surfactant Information

APPENDIX E TABLE OF CONTENTS

Glyphosate Information

Surfactant Information

Exposure and Risk

Glyphosate Information

EXTOXNET

Extension Toxicology Network

Pesticide Information Profiles

A Pesticide Information Project of Cooperative Extension Offices of Cornell University, Oregon State University, the University of Idaho, and the University of California at Davis and the Institute for Environmental Toxicology, Michigan State University. Major support and funding was provided by the USDA/Extension Service/National Agricultural Pesticide Impact Assessment Program.

EXTOXNET primary files maintained and archived at Oregon State University

Revised June 1996

Glyphosate

Trade and Other Names: Trade names for products containing glyphosate include Gallup, Landmaster, Pondmaster, Ranger, Roundup, Rodeo, and Touchdown. It may be used in formulations with other herbicides.

Regulatory Status: Glyphosate acid and its salts are moderately toxic compounds in EPA toxicity class II. Labels for products containing these compounds must bear the Signal Word WARNING. Glyphosate is a General Use Pesticide (GUP).

Chemical Class: Not Available

Introduction: Glyphosate is a broad-spectrum, nonselective systemic herbicide used for control of annual and perennial plants including grasses, sedges, broad-leaved weeds, and woody plants. It can be used on non-cropland as well as on a great variety of crops. Glyphosate itself is an acid, but it is commonly used in salt form, most commonly the isopropylamine salt. It may also be available in acidic or trimethylsulfonium salt forms. It is generally distributed as water-soluble concentrates and powders. The information presented here refers to the technical grade of the acid form of glyphosate, unless otherwise noted.

Formulation: Glyphosate itself is an acid, but it is commonly used in salt form, most commonly the isopropylamine salt. It may also be available in acidic or trimethylsulfonium salt forms. It is generally distributed as water-soluble concentrates and powders.

Toxicological Effects:

- **Acute toxicity:** Glyphosate is practically nontoxic by ingestion, with a reported acute oral LD50 of 5600 mg/kg in the rat. The toxicities of the technical acid (glyphosate) and the formulated product (Roundup) are nearly the same [58,96]. The oral LD50 for the trimethylsulfonium salt is reported to be approximately 750 mg/kg in rats, which indicates moderate toxicity [58]. Formulations may show moderate toxicity as well (LD50 values between 1000 mg/kg and 5000 mg/kg) [58]. Oral LD50 values for glyphosate are greater than 10,000 mg/kg in mice, rabbits, and goats [8,96]. It is practically nontoxic by skin exposure, with reported dermal LD50 values of greater than 5000 mg/kg for the acid and isopropylamine salt. The trimethylsulfonium salt has a reported dermal LD50 of greater than 2000 mg/kg. It is reportedly not irritating to the skin of rabbits, and does not induce skin sensitization in guinea pigs [58]. It does cause eye irritation in rabbits [58]. Some formulations may cause much more extreme irritation of the skin or eyes [58]. In a number of human volunteers, patch tests produced no visible skin changes or sensitization [58]. The reported 4-hour rat inhalation LC50 values for the technical acid and salts were 5 to 12 mg/L [58], indicating moderate toxicity via this route. Some formulations may show high acute inhalation toxicity [58]. While it does contain a phosphatyl functional group, it is not structually similar to organophosphate pesticides which contain organophosphate esters, and it does not significantly inhibit cholinesterase activity [1,58].

- **Chronic toxicity:** Studies of glyphosate lasting up to 2 years, have been conducted with rats, dogs, mice, and rabbits, and with few exceptions no effects were observed [96]. For example, in a chronic feeding study with rats, no toxic effects were observed in rats given doses as high as 400 mg/kg/day [58]. Also, no toxic effects were observed in a chronic feeding study with dogs fed up to 500 mg/kg/day, the highest dose tested [58,97].

- **Reproductive effects:** Laboratory studies show that glyphosate produces reproductive changes in test animals very rarely and then only at very high doses (over 150 mg/kg/day) [58,96]. It is unlikely that the compound would produce reproductive effects in humans.

- **Teratogenic effects:** In a teratology study with rabbits, no developmental toxicity was observed in the fetuses at the highest dose tested (350 mg/kg/day) [97]. Rats given doses up to 175 mg/kg/day on days 6 to 19 of pregnancy had offspring with no teratogenic effects, but other toxic effects were observed in both the mothers and the fetuses. No toxic effects to the fetuses occurred at 50 mg/kg/day [97]. Glyphosate does not appear to be teratogenic.

- **Mutagenic effects:** Glyphosate mutagenicity and genotoxicity assays have been negative [58]. These included the Ames test, other bacterial assays, and the Chinese Hamster Ovary (CHO) cell culture, rat bone marrow cell culture, and mouse dominant lethal assays [58]. It appears that glyphosate is not mutagenic.

- **Carcinogenic effects:** Rats given oral doses of up to 400 mg/kg/day did not show any signs of cancer, nor did dogs given oral doses of up to 500 mg/kg/day or mice fed glyphosate at doses of up to 4500 mg/kg/day [58]. It appears that glyphosate is not carcinogenic [97].

- **Organ toxicity:** Some microscopic liver and kidney changes, but no observable differences in function or toxic effects, have been seen after lifetime administration of glyphosate to test animals [97].

- **Fate in humans and animals:** Glyphosate is poorly absorbed from the digestive tract and is largely excreted unchanged by mammals. At 10 days after treatment, there were only minute amounts in the tissues of rats fed glyphosate for 3 weeks [98]. Cows, chickens, and pigs fed small amounts of glyphosate had undetectable levels (less than 0.05 ppm) in muscle tissue and fat. Levels in milk and eggs were also undetectable (less than 0.025 ppm). Glyphosate has no significant potential to accumulate in animal tissue [99].

Ecological Effects:

- **Effects on birds:** Glyphosate is slightly toxic to wild birds. The dietary LC50 in both mallards and bobwhite quail is greater than 4500 ppm [1].

- **Effects on aquatic organisms:** Technical glyphosate acid is practically nontoxic to fish and may be slightly toxic to aquatic invertebrates. The 96-hour LC50 is 120 mg/L in bluegill sunfish, 168 mg/L in harlequin, and 86 mg/L in rainbow trout [58]. The reported 96-hour LC50 values for other aquatic species include greater than 10 mg/L in Atlantic oysters, 934 mg/L in fiddler crab, and 281 mg/L in shrimp [58]. The 48-hour LC50 for glyphosate in Daphnia (water flea), an important food source for freshwater fish, is 780 mg/L [58]. Some formulations may be more toxic to fish and aquatic species due to differences in toxicity between the salts and the parent acid or to surfactants used in the formulation [58,96]. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms [96].

- **Effects on other organisms:** Glyphosate is nontoxic to honeybees [1,58]. Its oral and dermal LD50 is greater than 0.1 mg/ bee [98]. The reported contact LC50 values for earthworms in soil are greater than 5000 ppm for both the glyphosate trimethylsulfonium salt and Roundup [58].

Environmental Fate:

- **Breakdown in soil and groundwater:** Glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days [58,11]. Reported field half-lives range from 1 to 174 days [11]. It is strongly adsorbed to most soils, even those with lower organic and clay content [11,58]. Thus, even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter) [3,11]. One estimate indicated that less than 2% of the applied chemical is lost to runoff [99]. Microbes are primarily responsible for the breakdown of the product, and volatilization or photodegradation losses will be negligible [58].

- **Breakdown in water:** In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms [6]. Its half-life in pond water ranges from 12 days to 10 weeks [97].

- **Breakdown in vegetation:** Glyphosate may be translocated throughout the plant, including to the roots. It is extensively metabolized by some plants, while remaining intact in others [1].

Physical Properties:

- **Appearance:** Glyphosate is a colorless crystal at room temperature [1].
- **Chemical Name:** N-(phosphonomethyl) glycine [1]
- **CAS Number:** 1071-83-6
- **Molecular Weight:** 169.08
- **Water Solubility:** 12,000 mg/L @ 25 C [1]
- **Solubility in Other Solvents:** i.s. in common organics (e.g., acetone, ethanol, and xylene) [1]
- **Melting Point:** 200 C [1]
- **Vapor Pressure:** negligible [1]
- **Partition Coefficient:** -3.2218 - -2.7696 [58]
- **Adsorption Coefficient:** 24,000 (estimated) [11]

Exposure Guidelines:

- **ADI:** 0.3 mg/kg/day [12]
- **MCL**: Not Available
- **RfD:** 0.1 mg/kg/day [13]
- **PEL:** Not Available
- **HA**: 0.7 mg/L (lifetime) [98]
- **TLV**: Not Available

Basic Manufacturer:

Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, MO 63167

- **Phone:** 314-694-6640

- **Emergency:** 314-694-4000

References:

References for the information in this PIP can be found in Reference List Number 10

DISCLAIMER: The information in this profile does not in any way replace or supersede the information on the pesticide product labeling or other regulatory requirements. Please refer to the pesticide product labeling.

Reference List 10

(1) Kidd, H. and James, D. R., Eds. The Agrochemicals Handbook, Third Edition. Royal Society of Chemistry Information Services, Cambridge, UK, 1991 (As Updated).10-2

(2) World Health Organization. Environmental Health Criteria Number 148: Benomyl. Geneva, Switzerland,10-3

(3) Edwards, I. R., Ferry, D. G. and Temple, W. A. Fungicides & related compounds, In Handbook of Pesticide Toxicology. Hayes, W. J. and Laws, E. R., Eds. Academic Press, New York, NY, 1991.10-4

(4) Cummings, A. M., Ebron McCoy, M. T., Rogers, J. M., Barbee, B. D. and Harris, S. T. Developmental effects of methyl benzimidazole carbamate following exposure during early pregnancy. Fundam. Appl. Toxicol. 18: 288 293, 1992.10-5

(5) National Research Council. Regulating Pesticides in Food: The Delaney Paradox. National Academy Press, Washington, DC, 1987.10-6

(6) U.S. Department of Agriculture (U.S. Forest Service). Pesticide Background Statements. Vol. I: Herbicides. Washington, DC, 1984.10-7

(7) Food and Agriculture Organization of the United Nations. Pesticide Residues in Food - 1983: Evaluations, FAO Plant Production and Protection Paper 61. Geneva, Switzerland, 1983.10-8

(8) U.S. National Library of Medicine. Hazardous Substances Databank. Bethesda, MD, 1995.10-9

(9) Howard, P. H., Ed. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Vol. III: Pesticides. Lewis Publishers, Chelsea, MI, 1991.10-10

(10) Potter, D. A., Buxton, M. C., Redmond, C. T., Patterson, C. T. and Powell, A. J. Toxicity of pesticides to earthworms (Oligochaeta: Lumbricidae) and effects on thatch degradation in Kentucky bluegrass turf. J. Econ. Entomol. 83(6): 2362 2369, 1990.10-11

(11) Wauchope, R. D., Buttler, T. M., Hornsby A. G., Augustijn Beckers, P. W. M. and Burt, J. P. SCS/ARS/CES Pesticide properties database for environmental decisionmaking. Rev. Environ. Contam. Toxicol. 123: 1-157, 1992.10-12

(12) Lu, F. C. A review of the acceptable daily intakes of pesticides assessed by the World Health Organization. Regul. Toxicol. Pharmacol. 21: 351-364, 1995.10-13

(13) U.S. Environmental Protection Agency. Integrated Risk Information System Database, Washington, DC, 1995.10-14

(14) U.S. Occupational Safety and Health Administration. Permissible Exposure Limits for Air Contaminants, (29 CFR 1910. 1000, Subpart Z). U.S. Department of Labor, Washington, DC, 1994.10-15

(15) Chemical Information Systems, Inc. Oil and Hazardous Materials/Technical Assistance Data System, Baltimore, MD, 1988.10-16

(16) U.S. Environmental Protection Agency. Captan: Intent to cancel registrations; Conclusion of special reviews. Fed. Regist. 54: 8116-50, 1989.10-17

(17) American Conference of Governmental Industrial Hygienists. Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices, Sixth Edition. Cincinnati, OH ,1991 (as updated).10-18

(18) U.S. Environmental Protection Agency. Health Advisory Summary: Carboxin. Office of Drinking Water, Washington, DC, 1987.10-19

(19) Ciba-Giegy, Agricultural Division. Letter of April 20, 1992.10-20

(20) U.S. Environmental Protection Agency. Pesticide Abstracts. Office of Pesticides and Toxic Substances, Management Support Division, 79 0210, 81 3526, Washington, DC, 1968-81.10-21

(21) National Research Council. Drinking Water and Health. National Academy Press, Washington, DC, 1977.10-22

(22) National Institute for Occupational Safety and Health. Registry of Toxic Effects of Chemical Substances. Cincinnati, OH, 1981-86.10-23

(23) Clayton, G. D. and Clayton, F. E. Eds. Patty's Industrial Hygiene and Toxicology, Third Edition. Vol. 2: Toxicology. John Wiley and Sons, New York, NY, 1981.10-24

(24) U.S. Environmental Protection Agency. Guidance for Reregistration of Pesticide Products Containing Copper Sulfate. Fact Sheet Number 100. Office of Pesticide Programs, Washington, DC, 1986.10-25

(25) New York State Department of Health. Chemical Fact Sheet: Copper Sulfate. Bureau of Toxic Substances Management. Albany, NY, 1984.10-26

(26) Gangstad, E. O. Freshwater Vegetation Management. Thomson Publication, Fresno, CA, 1986.10-27

(27) Tucker, R. and Crabtree, D. G. Handbook of Toxicity of Pesticides to Wildlife. U.S. Department of Agriculture, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, U.S. Government Printing Office, Washington, DC, 1970.10-28

(28) Pimentel, D. Ecological Effects of Pesticides on Nontarget Species. Executive Office of the President's Office of Science and Technology, U.S. Government Printing Office, Washington, DC, 1971.10-29

(29) Gasiewicz, T. A. Ch 18 Nitro Compounds and Related Phenolic Pesticides. In Handbook of Pesticide Toxicology, Hayes, W. J. and Laws, E. R., Eds. Academic Press, New York, NY, 1991.10-30

(30) Gosselin, R. E., Smith, R. P. and Hodge, H. C. Clinical Toxicology of Commercial Products, Fifth Edition. Williams and Wilkins, Baltimore, MD, 1984.10-31

(31) Sax, N. I. Dangerous Properties of Industrial Materials, Sixth Edition.VanNostrand Reinhold Co., New York, NY, 1984.

(32) Wagner, S. L. Clinical Toxicology of Agricultural Chemicals. Oregon State University Environmental Health Sciences Center, Corvallis, OR, 1981.10-33

(33) U.S. Environmental Protection Agency. Dinocap: Notice of intent to cancel registrations; Conclusion of special review. Fed. Regist. 54: 5908 20, 1989.10-34

(34) U.S. Environmental Protection Agency, Health Effects Research Lab. Postnatal Alterations in Development Resulting from Prenatal Exposure to Pesticides. Research Triangle Park, NC, 1986.10-35

(35) U.S. Environmental Protection Agency. Dinocap: Special Review, Technical Support Document. Office of Pesticide Programs, Washington, DC, 1986.10-36

(36) Hill, E. F. and Camardese, M. B. Lethal Dietary Toxicities of Environmental Contaminants to Coturnix, Technical Report Number 2. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC, 1986.10-37

(37) Johnson, W. W. and Finley, M. T. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates, Resource Publications 137. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 1980.10-38

(38) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 65: Dinocap. Office of Pesticides and Toxic Substances, Washington, DC, 1978.10-39

(39) Harding, W. C. Pesticide Profiles. University of Maryland Cooperative Extension Service, College Parks, MD, 1979.10-40

(40) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 135: Dodine. Office of Pesticides and Toxic Substances, Washington, DC, 1987.10-41

(41) Food and Agriculture Organization of the United Nations. Pesticide Residues in Food 1977. FAO Plant Production and Protection Paper 10. FAO, Geneva, Switzerland, 1977.10-42

(42) Food and Agriculture Organization of the United Nations. Pesticide Residues in Food 1985. FAO Plant Production and Protection Paper 72/2. FAO, Geneva, Switzerland, 1985.10-43

(43) U.S. Environmental Protection Agency. Final Rule: Pesticide Tolerance for Iprodione. Fed. Regist. 55: 2834-5, 1990.10-44

(44) Martin, C., Davet, P., Vega, D. and Cosste, C. Field effectiveness and biodegradation of cyclic imides in lettuce field soils. Pestic. Sci. 32(4): 427 8, 1991.10-45

(45) Suta, V., Trandafirescu, M., Popescu, V., Voica, E. and Fugel, S. Proceedings of the British Crop Protection Conference Pests and Diseases. 1979, British Crop Protection Council, Croydon, England.10-46

(46) U.S. Environmental Protection Agency. Pesticide Fact Sheet: Metalaxyl. Office of Pesticides and Toxic Substances, Washington, DC, 1988.10-47

(47) Kimmel, E. C., Casida, J. E. and Ruzo, L. O. Formamidine insecticides and chloroacetanilide herbicides: Disubstituted anilines and nitrobenzenes as mammalian metabolites and bacterial mutagens. J. Agric. Food Chem. 34: 157 61, 1986.10-48

(48) Williams, W. M., Holden, P. W., Parsons, D. W. and Lorber, M. N. Pesticides in Groundwater

Database: 1988 Interim Report. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, DC, 1988.10-49

(49) Menzie, C. M. Metabolism of Pesticides, Update III. Special Scientific Report, Wildlife No. 232. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 1980.10-50

(50) U.S. Environmental Protection Agency. Rules and Regulations. Fed. Regist. 52: 17954-55, 1987.10-51

(51) Rankin, G. O. Comparative acute renal effects of three carboximide fungicides: Succinimide, vinclozolin and iprodione. Toxicol. 56(3): 263 272, 1989.10-52

(52) U.S. Environmental Protection Agency. Pesticide Environmental Fate One Liner Summaries: Vinclozolin. Environmental Fate and Effects Division, Washington, DC, 1991.10-53

(53) Augustijn-Beckers, P. W. M., Hornsby, A. G. and Wauchope, R.D. SCS/ARS/CES Pesticide Properties Database for Environmental Decisionmaking II. Additional Compounds. Rev. Environ. Contam. Toxicol. 137: 1-82, 1994.10-54

(54) U.S. Environmental Protection Agency. Health Advisory Draft Report: Acifluorfen. Office of Drinking Water, Washington, DC, 1987.10-55

(55) Quest, J. A., Phang, W., Hamernik, K. L., van Gemert, M., Fisher, B., Levy, R., Farber, T. M., Burnam, W. L. and Engler, R. Evaluation of the carcinogenic potential of pesticides, 1: Acifluorfen. Regul. Toxicol. Pharmacol. 10: 149 159, 1989.10-56

(56) BASF Corporation. Material Safety Data Sheet for Blazer Herbicide. Research Triangle Park, NC, 1991.10-57

(57) Johnson, W. O., Kollman, G. E., Swithenbank, C. and Yih, R. Y. RH 6201 (Blazer): A new broad spectrum herbicide for postemergence use in soybeans. J. Agric. Food Chem. 26(1): 285 6, 1978.10-58

(58) Weed Science Society of America. Herbicide Handbook, Seventh Edition. Champaign, IL, 1994.10-59

(59) Ritter, R. L. and Coble, H. D. Influence of temperature and relative humidity on the activity of acifluorfen. Weed Sci. 29: 480 5, 1981.10-60

(60) U.S. Environmental Protection Agency. Health Advisory: Alachlor. Office of Drinking Water, Washington, DC, 1987.10-61

(61) Monsanto Company. Material Safety Data Sheet. Alachlor Technical (94%). St Louis, MO, 1991.10-62

(62) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 97.1: Alachlor. Office of Pesticides and Toxic Substances, Washington, DC, 1987.10-63

(63) Hudson, R. H., Tucker, R. K. and Haegele, M. A. Handbook of Toxicity of Pesticides to Wildlife. Resource Publication 153. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, 1984.10-64

(64) Holden, L. and Graham, J. A. Results of the National Alachlor Well Water Survey. Environ. Sci. Tech. 26: 935 43, 1992.10-65

(65) U.S. Environmental Protection Agency. National Primary Drinking Water Standards, 810 F 94 001A. Washington, DC, 1994.10-66

(66) E. I. DuPont de Nemours. Technical Data Sheet (on Ammonium Sulfamate). Wilmington, DE, 1972.10-67

(67) U.S. Environmental Protection Agency. Health Advisory: Ammonium Sulfamate. Office of Drinking Water, Washington, DC, 1988.10-68

(68) Morgan, D. P. Recognition and Management of Pesticide Poisonings, Third Edition. U.S. Environmental Protection Agency, U.S. Government Printing Office, Washington, DC, 1982.10-69

(69) U.S. Environmental Protection Agency. Health Advisory Summary: Bentazon. Office of Drinking Water, Washington, DC, 1989.10-70

(70) Hallenbeck, W. H. and Cunningham Burns, K. M. Pesticides and Human Health. Springer Verlag, New York, NY, 1985.10-71

(71) U.S. Environmental Protection Agency. Guidance for the Reregistration of Pesticide Products Containing Bentazon as the Active Ingredient. EPA Case Number: 182. Office of Pesticide Programs, Washington, DC, 1985.10-72

(72) U.S. Environmental Protection Agency. Chemical Fact Sheet Number 64: Bentazon and Sodium Bentazon. Office of Pesticide and Toxic Substances, Washington, DC, 1985.10-73

(73) U.S. Environmental Protection Agency. Pesticides in Ground Water Database. Office of Pesticide Programs (EPA 734-12-92-001), Washington, DC, 1992.10-74

(74) U.S. Environmental Protection Agency. Health Advisory: Bromacil. Office of Drinking Water, Washington, DC, 1988.10-75

(75) U.S. Environmental Protection Agency. Initial Scientific and Minieconomic Review of Bromacil. 540/1 75 006. Office of Pesticide Programs, Washington, DC, 1975.10-76

(76) VanDriesche, R. G. Pesticide Profiles: Bromacil. Cooperative Extension Service, Department of Entomology, University of Massachusetts, Amherst, MA, 1985.10-77

(77) Smith, A. E. An analytical procedure for bromoxynil and its octanoate in soils; persistence studies with bromoxynil octanoate in combination with other herbicides in soil. Pestic. Sci. 11: 341 346, 1980.10-78

(78) U.S. Environmental Protection Agency. Pesticide tolerance for 2 (2 chlorophenyl) methyl 4,4 dimethyl 3 isoxazolidinone [clomazone]. Fed. Regist. 56: 42574 5, 1991.10-79

(79) Salamon, C. M. and Borders, C. K. 2 Generation Reproduction Study in Albino Rats with FMC 57020 Technical Final Report. Toxigenics, Inc., Philadelphia, PA, 1984.10-80

(80) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 90: Command Herbicide. Office of Pesticides and Toxic Substances, Washington, DC, 1986.10-81

(81) Wu, J. Photodegradation of FMC 57020 in Water (FMC Report No. P 0869). Unpublished report prepared by FMC Corp., Philadelphia, PA, 1984.10-82

(82) Dziedzic, J. E. Hydrolysis Study (FMC Report No. P 0465). Unpublished report prepared by FMC Corp., Philadelphia, PA, 1982.10-83

(83) U.S. Environmental Protection Agency. Pesticide Fact Sheet 130: Dinoseb. Office of Pesticides and Toxic Substances, Washington, DC, 1986.10-84

(84) Call, D. J., Brooke, L. T., Kent, R. S., Poirier, S. H., Knuth, M. L. and Shick, E. J. Toxicity, uptake, and elimination of the herbicides alachlor and dinoseb in freshwater fish. J. Environ. Qual. 13(3): 493 8, 1984.10-85

(85) Hall, L., Linder, R., Scotti, T., Bruce, R., Moseman, R., Heiderscheit, T., Hinkle, D., Edgerton, T., Chaney, T., Goldstein, J., Gage, M., Farmer, J., Bennett, L., Stevens, J., Durham, W. and Curley, A. Subchronic and reproductive toxicity of dinoseb. Toxicol. Appl. Pharmacol. 45(1): 235 6, 197810-86

(86) Spacie, A. and Hamelink, J. L. Alternative models for describing the bioconcentrations of organics in fish. Environ. Toxicol. Chem. 1: 309 20, 1982.10-87

(87) Stevens, J. T. and Sumner, D. D. Herbicides. In Handbook of Pesticide Toxicology. Hayes, W. J., Jr. and Laws, E. R., Jr., Eds. Academic Press, New York, NY, 1991.10-88

(88) Chevron Chemical Company. Diquat Herbicide h/a for Aquatic Plant Treatment. (Number 8616 DIQ 45.) Agricultural Chemicals Division, San Francisco, CA, 1986.10-89

(89) Chevron Chemical Company. Material Safety Data Sheet: Ortho Diquat Herbicide. Chevron Environmental Health Center, Inc., Richmond, CA, 1986.10-90

(90) U.S. Environmental Protection Agency. Final Rule: Diquat. Tolerances and exemptions from tolerances for pesticide chemicals in or on raw agricultural commodities. Fed. Regist. 46: 30342-43, 1981.10-91

(91) U.S. Environmental Protection Agency. Guidance for Reregistration of Pesticide Products Containing as the Active Ingredient Diquat Dibromide (032201). Office of Pesticide Programs, Washington, DC, 1986.10-92

(92) Simonin, H. A. and Skea, J.C. Toxicity of diquat and cutrine to fingerling brown trout. NY Fish & Game J. 24(1): 37 45, 1977.10-93

(93) Bimber, K. L. Respiratory stress in yellow perch induced by subtoxic concentrations of diquat. Ohio J. Sci. 76(2): 87 90, 1976.10-94

(94) Tucker, B. V. Diquat Environmental Chemistry. Chevron Chemical Corporation, Ortho Agricultural Division. Richmond, VA, 1980.10-95

(95) Gillett, J. W. The biological impact of pesticides in the environment. Environmental Health Sciences Series No. 1. Oregon State University, Corvallis, OR, 1970.10-96

(96) Monsanto Company. Toxicology of Glyphosate and Roundup Herbicide. St. Louis, MO, 1985.10-97

(97) U.S. Environmental Protection Agency. Pesticide tolerance for glyphosate. Fed. Regist. 57: 8739 40, 1992.10-98

(98) U.S. Environmental Protection Agency. Health Advisory: Glyphosate. Office of Drinking Water, Washington, DC, 1987.10-99

(99) Malik, J., Barry, G. and Kishore, G. Minireview: The herbicide glyphosate. BioFactors. 2(1): 17 25, 1989.10-100

(100) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 106: Metolachlor. Office of Pesticides and Toxic Substances, Washington, DC, 1987.10-101

(101) U.S. Environmental Protection Agency. Health Advisory Draft Report: Metolachlor. Office of Drinking Water, Washington, DC, 1987.10-102

(102) Zimdahl, R. L. and Clark, S. K. Degradation of three acetanilide herbicides in soil. Weed Sci. 30: 545 8, 1982.10-103

(103) U.S. Environmental Protection Agency. Pesticide Environmental Fate One Liner Summaries: Devrinol. Environmental Fate and Effects Division, Washington, DC, 1991.10-104

(104) U.S. Environmental Protection Agency. Environmental Effects Branch. Chemical Profile: Napropamide. Environmental Fate and Effects Division, Washington, DC, 1984.10-105

(105) U.S. Environmental Protection Agency. Pesticide Environmental Fate One Liner Summaries: Napropamide. Environmental Fate and Effects Division, Washington, DC, 1991.10-106

(106) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 211: Oryzalin. Office of Pesticides and Toxic Substances, Washington, DC, 1987.10-107

(107) U.S. Environmental Protection Agency. Pesticide tolerance for oryzalin. Fed. Regist. 55: 25140 1, 1990.10-108

(108) U.S. Environmental Protection Agency. Pesticide tolerances for oxyfluorfen. Fed. Regist. 57: 22202 3, 1992.10-109

(109) U.S. Environmental Protection Agency. Environmental Effects Branch. Chemical Profile: Oxyfluorfen. Washington, DC, 1984.10-110

(110) U.S. Environmental Protection Agency. Pesticide Environmental Fate One Liner Summaries: Oxyfluorfen. Environmental Fate and Effects Division, Washington, DC, 1992.10-111

(111) U.S. Environmental Protection Agency. Health Advisory Draft Report: Paraquat. Office of Drinking Water, Washington, DC, 1987.10-112

(112) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 131: Paraquat. Office of Pesticides and Toxic Substances, Washington, DC, 1987.10-113

(113) Rao, P. S. C. and Davidson, J. M. Estimation of pesticide retention and transformation parameters required in nonpoint source pollution models. In Environmental Impact of Nonpoint Source Pollution. Overcash, M. R., Davidson, J. M. Eds. Ann Arbor Science Publishers, Ann Arbor, MI, 1980.10-114

(114) Kosinski, J. R., and Merkle, M. G. The effect of four terrestrial herbicides on the productivity of artificial stream algal communities. J. Environ. Qual. 13(1): 75 82, 1984.10-115

(115) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 50: Pendimethalin. Office of Pesticides and Toxic Substances, Washington, DC, 1985.10-116

(116) U.S. Environmental Protection Agency. Pesticide tolerance for pendimethalin. Fed. Regist. 52: 47734 5, 1987.10-117

(117) Zulalian, J. Study of the absorption, excretion, metabolism, and residues in tissues of rats treated with carbon 14 labeled pendimethalin, Prowl herbicide. J. Agric. Food Chem. 38: 1743 54, 1990.10-118

(118) National Research Council. Drinking Water and Health. Vol. 5. Board on Toxicology and Environmental Health Hazards, Commission on Life Sciences, Safe Drinking Water Committee, National Academy Press, Washington, DC, 1983.10-119

(119) Newton, M. and Dost, F. N. Biological and Physical Effects of Forest Vegetation Management. Washington Department of Natural Resources, Olympia, WA, 1984.10-120

(120) U.S. Environmental Protection Agency. Health Advisory: Picloram. Office of Drinking Water, Washington, DC, 1987.10-121

(121) U.S. Environmental Protection Agency. Health Advisory: Pronamide. Office of Drinking Water, Washington, DC, 1988.10-122

(122) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 70: Pronamide. Office of Pesticides and Toxic Substances, Washington, DC, 1986.10-123

(123) Rohm and Haas Company. Kerb Technical Herbicide (Key: 906750 0). Philadelphia, PA, 1991.10-124

(124) U.S. Environmental Protection Agency. Guidance for Reregistration of Pesticide Products Containing Pronamide as the Active Ingredient. Office of Pesticide Programs, Washington, DC, 1986.10-125

(125) Rohm and Haas Company. STAM Tech 98% DCA Herbicide (Key: 904399 2). Philadelphia, PA, 1991.10-126

(126) U.S. Environmental Protection Agency. Pesticide tolerances for 2[1 (ethoxyimino)butyl] 5 [2 (ethylthio)propyl] 3 hydroxy 2 cyclohexen 1 one. Fed. Regist. 56: 11677 8, 1991.10-127

(127) U.S. Environmental Protection Agency. EEB Chemical Profile: Sethoxydim. Washington, DC, 1989.10-128

(128) U.S. Environmental Protection Agency. Terbacil Registration Standard. Office of Pesticide Programs, Washington, DC, 1982.10-129

(129) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 206: Terbacil. Office of Pesticides and Toxic Substances, Washington, DC, 1989.10-130

(130) U.S. Environmental Protection Agency. Health Advisory: Terbacil. Office of Drinking Water, Washington, DC, 1988.10-131

(131) McEwen, F. L. and Stephenson, G. R. The Use and Significance of Pesticides in the Environment. John Wiley and Sons, New York, NY, 1979.10-132

(132) U.S. Environmental Protection Agency. Estimating Pesticide Sorption Coefficients for Soils and Sediments. Green, R. E. and Karickhoff, S. W. Environmental Research Laboratory, Athens, GA, 1986.10-133

(133) Hanley, T. R., Thompson, D. J., Palmer, A. K., Bellies, R. P. and Schwetz, B. A. Teratology and reproductive studies with triclopyr in the rat and rabbit. Fundam. Appl. Toxicol. 4: 872 82, 1984.10-134

(134) Dow Chemical Company. Environmental and Toxicology Profile of Garlon Herbicides. Technical Data Sheet No. 137 1639 83. Agricultural Products Department, Midland, MI, 1983.10-135

(135) Carmichael, N. G. Assessment of hazards during pesticide application. Food Add. Contam. 6(S1): S21 27, 1989.10-136

(136) Gersich, F. M., Mendoza, C. G., Hopkins D. L. and Bodner, K. M. Acute and chronic toxicity of triclopyr triethylamine salt to Daphnia magna straus. Bull. Environ. Contam. Toxicol. 32: 497 502, 1984.10-137

(137) Dow Chemical Company. Technical Information of Triclopyr, the Active Ingredient of Garlon Herbicides Technical Data Sheet No. 137 859 483. Agricultural Products Department, Midland, MI, 1983.10-138

(138) U.S. Environmental Protection Agency. Guidance for the Reregistration of Pesticide Products Containing Trifluralin as the Active Ingredient. Office of Pesticides and Toxic Substances, Washington, DC, 1987.10-139

(139) U.S. Environmental Protection Agency. Health Advisory Summary: Trifluralin. Office of Drinking Water, Washington, DC, 1989.10-140

(140) Mayer, F. L. and Ellersieck, M. R. Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. Resource Publication 160. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC, 1986.10-141

(141) Lankas, G. R and Gordon, L. R. Toxicology. In Ivermectin and Abamectin. Campbell, W. C., Ed. Springer Verlag, New York, NY, 1989.10-142

(142) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 89.2: Avermectin B1. Office of Pesticides and Toxic Substances, Washington, DC, 1990.10-143

(143) Ray, D. E. Pesticides derived from plants and other organisms. In Handbook of Pesticide Toxicology. Hayes, W. J., Jr. and Laws, E. R., Jr., Eds. Academic Press, New York, NY, 1991.10-144

(144) Thongsinthusak, T. Estimation of Exposure of Persons in California to Pesticide Products That Contain Abamectin. HS 1567. California Department of Food and Agriculture, Division of Pest Management, Sacramento, CA, 1990.10-145

(145) Wislocki, P. G., Grosso, L. S. and Dybas, R. A. Environmental aspects of abamectin use in crop protection. In Ivermectin and Abametin. Campbell, W. C., Ed. Springer Verlag, New York, NY, 1989.10-146

(146) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 93: Bacillus thuringiensis. Office of Pesticides and Toxic Substances, Washington, DC, 1986.10-147

(147) Roe, R. M. Vertebrate toxicology of the solubilized parasporal crystalline proteins of Bacillus thuringiensis israelensis. In Reviews in Pesticide Toxicology 1: Toxicological Studies of Risks and Benefits. Hodgson, E., Roe, R. M. and Motoyama, N., Eds. North Carolina State University, Raleigh, NC, 1991.10-148

(148) Abbott Laboratories. Toxicology Profile: Dipel, Bacillus thuringiensis Insecticide. Chemical and Agricultural Products Division, North Chicago, IL, 1982.10-149

(149) Spiegel, J. P. and Shadduck, J. A. Clearance of bacillus sphaericus and bacillus thuringiensis israelensis from mammals. Econ. Entomol. 83: 347 55, 1990.10-150

(150) Agriculture Canada. Report of New Registration: Bacillus thuringiensis SerotypeH14. Food Protection and Inspection Branch, Ottawa, Canada, 1982.10-151

(151) Vandenberg, J. D. Safety of four entomopathogens for caged adult honeybees (Hymenoptera: Apidae). Econ. Entomol. 83(3): 756 59, 1990.10-152

(152) Ghassemi, M. Environmental Fates and Impact of Major Forest Use Pesticides. U.S. Environmental Protection Agency. Washington, DC, 1982.10-153

(153) Dunkle, R. L. and Shasha, B. S. Response of starch encapsulated Bacillus thuringiensis containing ultraviolet screens to sunlight. Environ. Entomol. 18(6): 1035 41, 1989.10-154

(154) U.S. Environmental Protection Agency. Pesticide Environmental Fate One-Line Summary: Hydramethylnon. Environmental Fate and Effects Division, Washington, DC, 1992.10-155

(155) U.S. Environmental Protection Agency. Guidance for the Reregistration of Pesticide Products Containing Methoprene as the Active Ingredient. Office of Pesticide Programs, Washington, DC, 1982.10-156

(156) U.S. Environmental Protection Agency. Methoprene: Tolerances and exemptions from tolerances for pesticide chemicals in or on raw agricultural commodities. Fed. Regist. 46: 59248 9, 1981.10-157

(157) U.S. Environmental Protection Agency. R.E.D. Facts: Methoprene. Office of Pesticides and Toxic Substances, Washington, DC, 1991.10-158

(158) Zoecon Corporation. Technical Bulletin on Altosid. Toxicological properties, Dallas, TX, 1974.10-159

(159) Zoecon Corporation. Technical Bulletin on Altosid. Environmental Properties. Dallas, TX, 1974.10-160

(160) Clarkson, T. W. Inorganic and organometal pesticides. In Handbook of Pesticide Toxicology. Hayes, W. J. and Laws, E. R., Eds. Academic Press, New York, NY, 1991.10-161

(161) California Dept. of Food and Agriculture. Information on the Safe Handling of Pesticides Containing Sulfuryl Fluoride (Vikane). HS-599. Division of Pest Management, Environmental Protection and Worker Safety, California Department of Food and Agriculture, Sacramento, CA, 1979.10-162

(162) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 51: Sulfuryl Fluoride. Office of Pesticides and Toxic Substances, Washington, DC, 1985.10-163

(163) Gollapudi, B.B. Evaluation of Sulfuryl Fluoride in the Rat Hepatocyte Unscheduled DNA Synthesis (UDS) Assay, Summary (Study ID TXT: K 016399 043). Dow Elanco Company, Indianapolis, IN, 1991.10-164

(164) Gollapudi, B.B. Evaluation of Sulfuryl Fluoride in the Mouse Bone Marrow Micronucleus Test, Summary (Study ID TXT: K 016399 033). Dow Elanco Company, Indianapolis, IN, 1990.10-165

(165) Gollapudi, B.B. Evaluation of Sulfuryl Fluoride in the Ames Salmonella/Mammalian Microsome Bacterial Mutagenicity Assay, Summary (Study ID TXT: K 016399 037). Dow Elanco Company, Indianapolis, IN, 1990.10-166

(166) Breslin, W.J. Sulfuryl Fluoride: Two Generation Inhalation Reproduction Study in Sprague Dawley rats, Summary. Dow Elanco Company, Indianapolis, IN, Not Dated.10-167

(167) U.S. Environmental Protection Agency. Pesticide Registration Standard: 4 Aminopyridine: Avitrol. Office of Pesticides and Toxic Substances, Washington, DC, 1980.10-168

(168) U.S. Environmental Protection Agency. Chemical Fact Sheet Number 26: Daminozide. Office of Pesticides and Toxic Substances, Washington, DC, 1986.10-169

(169) Uniroyal. Database on Daminozide. Health and Regulatory Compliance Department, Uniroyal Corporation, Middlebury, CT, 1993.10-170

(170) U.S. Environmental Protection Agency. Daminozide: Notice of final determination for non food uses and termination of the daminozide Special Review. Fed. Regist. 57: 46436 44, 1992.10-171

(171) U.S. Environmental Protection Agency. Pesticide tolerance for daminozide. Fed. Regist. 54: 6392 6, 1989.10-172

(172) Pelfrene, A. F. Synthetic organic rodenticides. In Handbook of Pesticide Toxicology. Hayes, W. J. and Laws, E. R., Eds. Academic Press, New York, NY, 1991.10-173

(173) U.S. Environmental Protection Agency. Pesticide Environmental Fate One-Line Summary:

Diphacinone. Environmental Fate and Effects Division, Washington, DC, 1991.10-174

(174) Bell Laboratories Incorporated. Diphacinone Technical: Material Safety Data Sheet. Bell Labs, Madison, WI, 1990.10-175

(175) Letz, G. A., Pond S. M., Osterloh, J. D., Wade, R. L. and Becker, C. E. Two fatalities after acute occupational exposure to ethylene dibromide. J. Am. Med. Assoc. 252: 2428 31, 1984.10-176

(176) Broda, C., Nachtomi, E. and Alumot, E. Differences in liver morphology between rats and chicks treated with ethylene dibromide. Gen. Pharmacol. 7: 345 8, 1976.10-177

(177) Wong, O., Utidjian, H. M., Karten, V. S. Retrospective evaluation of reproductive performance of workers exposed to ethylene dibromide. J. Occup. Med. 21:98 102, 1979.10-178

(178) Short, R. D., Winston, J. M., Minor, J. L., Hong, C. B., Seifter, J., Lee, C. C. Toxicity of vinylidene chloride in mice and rats and its alterations by various treatments. Toxicol. Appl. Pharmacol. 45: 173 82, 1978.10-179

(179) Wong, L. C., Winston, J. M., Hong, C. B. and Plotnick, H. Carcinogenicity and toxicity of 1,2-dibromoethane in the rat. Toxicol. Appl. Pharmacol. 63(2): 155 65, 1982.10-180

(180) Li, F. Technical data submitted in support of the San Luis Drain Report of Waste Discharge. U.S. Department of Interior, Bureau of Reclamation, Sacramento, CA, 1982.10-181

(181) Pignatello, J. J., Sawhney, B. L., Frink, C. R. EDB: Persistence in soil. Science. 236: 898-902, 1987.10-182

(182) McConnel, J. B. Investigation of Ethylene Dibromide (EDB) in Groundwater in Seminole County, Georgia. U.S. Geological Survey Circular, Washington, DC, 1984.10-183

(183) Mackay, D. Volatilization of Organic Pollutants from Water, 600/53 82 019. U.S. Environmental Protection Agency, Washington, DC, 1982.10-184

(184) U.S. Environmental Protection Agency. Health Advisory: Ethylene thiourea. Office of Drinking Water, Washington, DC, 1989.10-185

(185) Knowles, C. O. Miscellaneous pesticides. In Handbook of Pesticide Toxicology. Hayes, W. J. and Laws, E. R., Eds. Academic Press, New York, NY, 1991.10-186

(186) U.S. Environmental Protection Agency. Suspended, Cancelled, and Restricted Pesticides. Office of Pesticides and Toxic Substances, Washington, DC, 1990.10-187

(187) U.S. Environmental Protection Agency. Pesticide Fact Sheet Number 191: Metaldehyde. Office of Pesticides and Toxic Substances, Washington, DC, 1988.10-188

(188) Gehring, P. J., Nolan, R. J., Watanabe, P. G. and Schumann, A. M. Solvents, fumigants, and related compounds. In Handbook of Pesticide Toxicology. Hayes, W. J., Jr. and Laws, E. R., Jr., Eds. Academic Press, New York, NY, 1991.10-189

(189) Mitsumori, K., Maita, K., Kosaka, T., Miyaoka, T. and Shirasu, Y. Two year oral chronic toxicity

and carcinogenicity study in rats of diets fumigated with methyl bromide. Food Chem. Toxicol. 28(2): 109-19, 1991.10-190

(190) Danse, L. H., Van Velsen, F. L. and Vander Heijden, C. A. Methylbromide: Carcinogenic effects in the rat forestomach. Toxicol. Appl. Pharmacol. 72: 262 71, 1984.10-11

(191) Kaloyanova, F. P. and El Batawi, M. A., Eds. Human Toxicology of Pesticides. CRC Press, Boca Raton, FL, 1991.10-192

(192) Boyer, I. J. Toxicity of dibutyltin, tributyltin and other organotin compounds to humans and experimental animals. Toxicol. 55(3): 253 98, 1989.10-193

(193) Krajnc, E. I., Wester, P. W., Loeber, J. G., van Leeuwen, F. X. R., Vos, J. G., Vaessen, H. A. M. G. and van der Heijden, C. A. Toxicity of bis(tri n butyltin)oxide in the rat. I: Short term effects ongeneral parameters and on the endocrine and lymphoid systems. Toxicol. Appl. Pharmacol. 75: 363 86, 1984.10-194

(194) Vos, J. G., de Klerk, A., Krajnc, E. I., Kruizinga, W., van Ommen, B. and Rozing, J. Toxicity of Bis(tri n butyltin)oxide in the Rat. II: Suppression of thymus dependent immune responses and of parameters of nonspecific resistance after short term exposure. Toxicol. Appl. Pharmacol. 75: 387 408, 1984.10-195

(195) Noda, T., Monith, S., Yamano, T., Shinizn, M., Sartoh, M. Teratogenicity study of tributyl u acetate on rats on oral administration. Toxicol. Lett. 55(1): 109 15, 1991.10-196

(196) Gardlund, A., Archer, T., Danielsen, K., Danielsson, B., Frederiksson, A., Lindquist, N.G., Lindstrom, H. and Luthman, J. Effects of prenatal exposure to tributyltin and trihexyltin on behavior in rats. Neurotoxicol. Teratol, 13(1): 99 105, 1991.10-197

(197) Solectis, R., Hilbig, V., Pfeil, R., Gericke, S., Gottscholk, M. Bis(tri-n-butyltin Oxide): Comparison of Effects of Single and Paired Housing on Subchronic Reproductive Toxicity Endpoints in Japanese Quail (Coturnix Coturnix Japonica) in a 13-Week Dietary Study, UBA-FB--93-025 (Original Title in German), Umweltbundesamt (Ministry of Environment), Federal Republic of Germany, 1992.10-198

(198) Huggett, R. J, Unger, M. A., Seligman, P. F. and Valkis, A. D. The marine biocide tributyltin: Assessing and managing the environmental risks. Environ. Sci. Technol. 26(2): 232 37, 1992.10-199

(199) Michigan Department of Natural Resources. Fact Sheet on Tributyltin Compounds. Lansing, MI, 1987.10-200

(200) U.S. Environmental Protection Agency. Technical Support Document: Tributyltin. Office of Pesticide Programs, Washington, DC, 1985.10-201

(201) Short, J. W. and Thrower, F. P. Accumulation of Butyltins in Muscle Tissue of Chinook Salmon Reared in Sea Pens Treated With Tri n butyltin. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, U.S. National Oceanic and Atmospheric Administration, Auke Bay, AK, 1986.10-202

(202) Clark, A. C., Steritt, R. M., Lester, J. N. The fate of Tributyltin in the aquatic environment. Environ. Sci. Technol. 22(6): 600-5, 1988.10-203

(203) Laughlin, R.B., Jr., French, W. and Guard, H.E. Accumulation of Bis(tributyltin) Oxide by the marine mussel Mytilis edulis. Environ. Sci. Technol. 20(9):884-890, 1986.10-204

(204) Herbicide Handbook of the Weed Science Society of America. 1983. Fifth edition. Champaign, IL. 515 pp.

(205) Herbicide Handbook of the Weed Science Society of America. 1989. Sixth edition. Champaign, IL.

(206) Farm Chemicals Handbook. 1995. Meister Publishing Co. Willoughby, OH.

(207) Thomson, W.T. 1993. Agricultural Chemicals. Book II: Herbicides. Thomson Publications, Fresno, CA.

(208) OHS Database. February, 1995. MSDS for Acetochlor. MDL Information Systems Inc., San Leandro, CA.

(209) U.S. Environmental Protection Agency. 1994. Pesticide Tolerances for Acetochlor. Federal Register. Vol. 59, No. 56. Rules and Regulations. Wednesday, March 23, 1994.

(210) CENET. 1995. Pesticide Management and Education. Chemical Profiles Library.

(211) Meister, R.T. (ed.). 1992. Farm Chemicals Handbook '92, Meister Publishing Co., Willoughby, OH.

(212) US Environmental Protection Agency. 1992. Office of Pesticides and Toxic Substances, Fact Sheet Number 118: Aluminum Phosphide/Magnesium Phosphide. Washington, DC.

(213) Shaheen, D. 1996. Technical Vice President, Degesch America, Inc., Weyers cave, VA, Personal Communication.

(214) Degesch America, Inc. 1988. Material Safety Data Sheet: Aluminum Phosphide, Phostoxin, Degesch America, Weyers Cave, VA.

(215) U.S. Department of Health and Human Services. 1994. File: Aluminum Phosphide Hazardous Substance Data Base (HSDB). HHS. Washington, DC.

(216) Newton, P.E., Shroeder, R. E., Sullivan, J. B., Busey. W.M. and Banas, D.A. 1993. Inhalation toxicity of Phosphine in the rat: acute, subchronic and developmental Inhal Toxicol 5(2):223-239.

(217) Garry, V.F., Griffith, J., Danzl, T. J., Nelson, R. J., Whorton, E. B., Krueger, L. A. and Cervenka, J., Human Genotoxicity: Pesticide Applicators and Phosphine. Science 246 (35) pp. 251-254.

(218) World Health Organization (WHO). 1988. Environmental Health Criteria 73, Phosphine and Selected Metal Phosphides. World Health Organization, Geneva.

(219) Klimmer, O.R. 1969. Contribution to the study of action of phosphine. Archiv fur Toxikologie, 24(23):164-187.

(220) Leuschner, F. 1984. Evaluation of the acute toxicity of Phostoxin (active ingredient: aluminum phosphide) to rainbow trout. Laboratory for Pharmacology and Toxicology. Hamburg, German Federal Republic.

(221) U.S. Environmental Protection Agency. 1994. File: Aluminum Phosphide Integrated Risk Information System (IRIS). US EPA, Washington, DC.

(222) Sullivan, J.B. and Krieger, G.R. 1992. Hazardous Materials Toxicology, Clinical Principles of Environmental Health. Williams & Wilkins, Baltimore, MD.

(223) Meister, R.T., (ed.). 1994. Farm Chemicals Handbook 1994. Meister Publishing Company. Willoughby, OH.

(224) U.S. Environmental Protection Agency. 1987. EPA Fact sheet No. 147 Amitraz. U.S. EPA. Washington, DC.

(225) Budavari, Susan, (ed.). 1989. The Merck Index, Eleventh Edition. Merck and Company Inc. Rahway, NJ.

(226). Briggs, Shirley. 1992. Basic Guide to Pesticides, Hemisphere Publishing. Washington, DC.

(227) Hayes Jr., Wayland, and E.R. Laws, Jr., (eds.) 1991. Handbook of Pesticide Toxicology Volume 1. Academic Press, Inc., NY, NY.

(228) Walker, M.M. and L.H. Keith. 1992. EPA Fact Sheet Database. Lewis Pubishers. Ann Arbor, MI.

(229) U.S. Environmental Protection Agency. 1989. Toxchem No. 431 Documents 002372 ,002373, 0040344, and 0044586. U.S. EPA. Washington, DC.

(230) Edwards, Dennis, U.S. EPA Product Manager. July 25, 1994. Phone conversation. U.S. EPA. Washington, DC.

(231) Farm Chemicals Handbook. 1995. Meister Publishing Co. Willoughby, OH.

(232) Thomson, W.T. Agricultural Chemicals. Book I: Insecticides. 1992. Thomson Publications, Fresno, CA.

(233) U.S. Environmental Protection Agency. 1993. Azadirachtin: Tolerance Exemption. Federal Register. Vol. 58, No. 30. Rules and Regulations. Wednesday, February 17, 1993.

(234) National Research Council. 1992. Neem: A tree for solving global problems. National Academy Press, Washington, DC.

(235) AgriDyne Technologies, Inc. March, 1994. Greenhouse Grower. Floritech report: Tough on pests, easy on cropsÑand the environment. AgriDyne Technologies, Inc., Salt Lake City, UT.

(236) Grace-Sierra Crop Protection Co. 1990. Margosan-O technical bulletin. Grace-Sierra Crop Protection Co., Milpitas, CA.

(237) W. R. Grace & Co. 1991. MSDS for Margosan-O. Washington Research Center, Columbia, MD.

(238) Martineau, Jess. AgriDyne Technologies, Inc. January 26, 1994. MSDS for Azatin-EC Biological Insecticide.

(239) Sadre, N. L., V. Y. Deshpande, K. N. Mendulkar and D. H. Nandal. 1983. "Male antifertility activity of azadirachta indica in different species" (paper presented at the Proceedings of the 2nd International Neem Conference, Rauischholzhausen, Germany, 1983). pp. 473-482.

(240) Rossner, J. and C. P. W. Zebitz. 1986. "Effect of soil treatment with neem products on earthworms (Lumbricidae)" (paper presented at the Proceedings of the 3rd International Neem Conference, Nairobi, 1986). pp. 627-632.

(241) Review by AgriDyne Technologies, Inc. May, 1995.

(242) C. R. Worthing (ed.). 1983. The Pesticide Manual: A World Compendium. Seventh edition. Published by The British Crop Protection Council.

(243) W.T. Thomson. 1992. Agricultural Chemicals. Book IV: Fungicides. Thomson Publications, Fresno, CA.

(244) OHS Database. 1993 (December). Occupational Health Services, Inc. MSDS for Captafol. OHS Inc., Secaucus,NJ.

(245) U.S. Environmental Protection Agency. February, 1985. Office of Pesticides. TOX Oneliners - Captafol.

(246) U.S. Environmental Protection Agency. September, 1984. Guidance for the Reregistration of Pesticide Products Containing Captafol as the Active Ingredient. US EPA, Office of Pesticide Programs, Registration Div., Washington, DC

(247) U.S. Environmental Protection Agency. October, 1984. Pesticide Fact Sheet Number 35: Captafol. US EPA, Office of Pesticide Programs, Registration Div., Washington, DC.

(248) Review by Rallis India Ltd. December 1994.

(249) FAO/WHO. 1970. 1969 Evaluation of some pesticide residues in food. FAO, Rome.

(250) Kennedy, G., O. E. Fancher and J. C. Calandra. 1967. Report, Chevron Chemical Co., USA.

(251) Kennedy, G., O. E. Fancher and J. C. Calandra. 1968. Toxicol. Appl. Pharmacol. 13:421-430.

(252) Vondruska, J.F., O. E. Fancher and J. C. Calandra. 1971. Toxicol. Appl. Pharmacol., 18:619-624.

(253) Seiler, J. P. 1973. Experientia. 29:622.

(254) Collins, T. F. X. 1972. Food Cosmet. Toxicol. 10:363-371.

(255) Kennedy, G. L., Jr., D. W. Arnold and M. L. Keplinger. 1975. Food Cosmet. Toxicol. 13:55-61.

(256) Moriya, M., K. Kato, Y. Shirasu and T. Kada. 1975. Mutat.Res. 38:333-354.

(257) Agnihothrudu, V. and M. S. Mithyantha. 1978. Pesticide Residues - a review of Indian Work. Rallis India Ltd.,Bangalore.

(258) Chemtox Online. 1995. Resource Consultants, Inc. Brentwood, TN.

(259) Roark, R.C. 1934. USDA Miscellaneous Publication No. 176. A Bibliography of Chloropicrin 1848-1932. United States Department of Agriculture. Washington, DC.

(260) Thomson, W.T. 1991-2. Agricultural Chemicals Book III. Miscellaneous Agricultural Chemicals. Thomson Publications Fresno, CA.

(261) American Conference of Governmental Industrial Hygienists. 1992. Documentation of Threshold Limit Values and Biological Exposure Indices, Sixth Ed. Cincinnati, pp. 299-300.

(262) American Industrial Hygiene Association. 1987. Emergency Response Planning Guidelines: Chloropicrin. AIHA, Washington, DC.

(263) Chun, J.S. and W.J. Kintigh. 1993. Chloropicrin: Ninety-Day Inhalation Toxicology Study in Rats and Mice. Bushy Run Research Center. Export, PA. (Unpublished study submitted to USEPA).

(264) Yoshida, M. et. al. 1987. Subchronic Inhalation Toxicity of Chloropicrin Vapor in Rats. J. Pesticide Sci.,12:673-681.

(265) Schardein, J.L. 1994. Two Generation Inhalation Reproduction/ Fertility Study in Rats. International Research and Development Corp. Mattawan, MI. (Unpublished study submitted to USEPA)

(266) Schardein, J.L. 1993. Inhalation Developmental Toxicity Study in Rats. International Research and Development Corp. Mattawan, MI. (Unpublished study submitted to USEPA)

(267) Schardein, J.L. 1993. Inhalation Developmental Toxicity Study in New Zealand White Rabbits. International Research and Development Corp. Mattawan, MI. (Unpublished study submitted to USEPA)

(268) San, R.H. and Valentine Wagner III. 1990. Salmonella/Mammalian- Microsome Plate Incorporation Mutagenicity Assay (Ames Test) with a Confirmatory Assay. Microbiological Associates, Inc. Rockville MD. (Unpublished study submitted to USEPA)

(269) Putman, D.L. and Marcia Morris. 1990. Chromosome Aberrations in Chinese Hamster Ovary (CHO) Cells With Confirmatory Assay. Microbiological Associates, Inc. Rockville, MD. (Unpublished study submitted to USEPA)

(270) San, R.H. and Cynthia Sigler. 1990. L5178Y TK+/- Mouse Lymphoma Mutagenesis Assay With Confirmation. Microbiological Associates, Inc. Rockville, MD. (Unpublished study submitted to USEPA)

(271) Curren, R.D. 1990. Unscheduled DNA Synthesis in Rat Primary Hepatocytes With a Confirmatory Assay. Microbiological Associates, Inc. Rockville, MD. (Unpublished study submitted to USEPA)

(272) Ulrich, C.E. 1995. Two Year Oral (Gavage) Chronic Toxicity Study of Chloropicrin in Rats. International Research and Development Corp. Mattawan, MI. (Unpublished study submitted to USEPA)

(273) Wisler, J.A. 1994. Evaluation of Chloropicrin in a One Year Oral (Capsule) Toxicity Study in Dogs. International Research and Development Corp. Mattawan, MI. (Unpublished study submitted to USEPA)

(274) Burleigh-Flayer, H.D., W.J. Kintigh and C.L. Benson. 1995. Chloropicrin: Vapor Inhalation Oncogenicity Study in CD-1 Mice. Bushy Run Research Center. Export, PA. (Unpublished study submitted to USEPA)

(275) Burleigh-Flayer, H.D., W.J. Kintigh and C.L. Benson. 1995. Chloropicrin: Vapor Inhalation Oncogenicity Study in CD-1 Rats. Bushy Run Research Center. Export, PA. (Unpublished study submitted to USEPA)

(276) National Institutes of Health. 1978. Bioassay of Chloropicrin for Possible Carcinogenicity. NCI Technical Report No. 65, DHEW Publication No. (NIH) 78-1315.

(277) Secara, S.R. 1990. Chloropicrin - Octanol/Water Partition Coefficient. Bolsa Research Associates Inc. Hollister, CA. (Unpublished study submitted to USEPA)

(278) United States Department of Agriculture Forest Service. 1986. Pesticide Background Statements. Volume II. Fungicides and Fumigants. Agriculture Handbook Number 661.

(279) U.S. Environmental Protection Agency. 1992. Pesticide Environmental Fate One Line Summary: Chloropicrin. USEPA Environmental Fate and Effects Division. Washington, DC.

(280) Shepler, K., C. Hatton and L. Ruzo. 1995. Aerobic Soil Metabolism of [14C]Chloropicrin. PTRL West Inc. Richmond, CA. (Unpublished study submitted to USEPA)

(281) Ivancovich, A. 1987. Chloropicrin - Field Dissipation Study. Bolsa Research Associates. Hollister, CA. (Unpub-lished study submitted to USEPA)

(282) Shepler, K., C. Hatton and L. Ruzo. 1995. Anaerobic Aquatic Metabolism of [14C]Chloropicrin. PTRL West Inc. Richmond, CA. (Unpublished study submitted to USEPA)

(283) Hazardous Substances Data Bank (HSDB). Accession Number 977. National Library of Medicine, Bethesda, MD. 1993 CD ROM version: Micromedix Inc., Denver CO.

(284) Lee, H. and T. Moreno. 1993. Photohydrolysis of Chloropicrin. Bolsa Research Associates. Hollister, CA. (Unpublished study submitted to USEPA)

(285) Evaluation Summary, Ground Water Protection Data, Record No. 63408. 1989. California Department of Food and Agriculture Pesticide Registration Branch.

(286) Duguet, J.P., Y. Tsutsumi and A. Bruchet. 1988. Chloropicrin in Potable Water: Conditions of Formation and Production During Treatment Processes. Environ. Technol. Lett. 9(4) 299-310.

(287) Fair, P. S., R.C. Barth and J. Flesch. 1988. Measurement of Disinfection By-Products in Chlorinated Drinking Water. Proc.- Water Qual. Technol. Conf:, 15:339-53. Office of Drinking Water, USEPA Cincinnati, OH.

(288) U.S. Environmental Protection Agency. 1992. Pesticides in Groundwater Database, A Compilation of Monitoring Studies: 1971-1991, National Summary. EPA 734-12-92-0001.

(289) Craine, E.M. 1985. An Adsorption Study With Soil and Chloropicrin. Wil Research Laboratories, Inc. Ashland, OH. (Unpublished study submitted to USEPA)

(290) Lawrence, L.J. 1990. Quantitative Characterization of [14C]Residues Present in Soil, Strawberries, Green Beans and Red Beets Grown Under Actual Field Conditions Following Treatment of Soil with [14C]Chloropicrin. PTRL East Inc., Richmond, KY. (Unpublished study submitted to USEPA)

(291) Wilhelm, S. et. al. 1995. Environmental Fate of Chloropicrin. American Chemical Society Division of Agrochemicals Picogram and Abstracts Vol 49.

(292) Moilanen, K.W., D.G. Crosby and J. Humphrey. 1978. Vapor-Phase Photodecomposition of Chloropicrin. Tetrahedron, 34, pp. 3345-3349.

(293) Handbook of Environmental Data on Organic Chemicals. 1983. Verschueren Publishing Co. p. 384

(294) US Environmental Protection Agency. 1992. Office of Pesticides and Toxic Substances, Fact Sheet Number 230: Clethodim. Washington, DC.

(295) Valent USA. 1993. Material Safety Data Sheet for Valent Select 2 EC Herbicide. Valent USA Corporation. Walnut Creek, CA.

(296) Sullivan, J.B. and Krieger, G.R. 1992. Hazardous Materials Toxicology, Clinical Principles of Environmental Health. Williams & Wilkins, Baltimore, MD.

(297) Mirsalis, J.C. and Steinmetz, K.L. 1986. In Vivo-In Vitro Hepatocyte DNA Repair Assay: In Vitro Evaluation of Unscheduled DNA Synthesis (UDS) Following Oral Administration of Chevron RE-45601 Technical to B6C3F1 Mice (Study No. LSC-1960). Stanford Research Institute, Menlo Park, CA.

(298) Putnam, D.L. 1987. Cytogenetic Assay in Bone Marrow Cells of Rats Following Acute Oral Exposure to RE-45601 Technical (Study T-5072.105). Microbiological Associates. Fremont, CA.

(299) Ashworth, D. J. 1988. Clethodim Technical Product Chemistry: Series 63 (Study No. 8828545). Chevron Chemical Company. Richmond, CA.

(300) Herbicide Handbook of the Weed Science Society of America. 1989. Sixth edition. Champaign, IL.

(301) OHS Database. June, 1994. MSDS for Diclofop-Methyl. MDL Information Systems Inc., San Leandro, CA.

(302) Montgomery, J. H. 1993. Agrochemicals Desk Reference: Environmental Data. Lewis Publishers. Chelsea, MI.

(303) U. S. Environmental Protection Agency. 1986. Pesticide Tolerance for Diclofop-Methyl. Federal Register. Vol. 51, No.102. Rules and Regulations. Wednesday, May 28, 1986.

(304) Shell Agriculture. 1994. Dimethomorph: The New protection Against Oomycete Fungi. Princeton, NJ.

(305)Marks, G.C. and Smith, I.W. 1990. Control of experimental Phytophthora cinnamomi stem infections of Rhododendron, Leucadendron and Eucalyptus by dimethomorph, fosetyl-Al and metalaxyl. Australian Journal of Experimental Agriculture, V olume 30, 139-143.

(306) American Cyanamid Co. Agricultural Research Division. 1994. Conversation with Susan McIntyre. August 31, 1994.

(307) U.S. Department of Health and Human Services. 1993. Hazardous Substance Data Base. HHS. Washington, DC.

(308) Bohmont, Bert. 1981. The New Pesticide Users Guide. B & K Enterprises. Fort Collins, CO.

(309) Ware, G.W. 1986. Fundamentals of Pesticides - A Self Instruction Guide, Second edition. Thomson Publications. Fresno, CA.

(310) U.S. Environmental Protection Agency. Office of Drinking Water. 1987. Endothall Health Advisory. USEPA. Washington, DC.

(311) U.S. Environmental Protection Agency. 1992. Accession no. 252010, document # 005257. USEPA. Washington, DC.

(312) Reinert, K.H. and J.H. Rodgers. 1987. Fate and Persistence of Aquatic Herbicides. Springer Verlag. New York,NY.

(313) OHS Database. August, 1993. MSDS for Ethephon. MDL Information Systems Inc., San Leandro, CA.

(314) U.S. Environmental Protection Agency. 1992. Office of Pesticides. TOX Oneliners -- ethephon. September, 1992.

(315) U.S. Environmental Protection Agency. September, 1988. Guidance for the Reregistration of Pesticide Products Containing Ethephon as the Active Ingredient. US EPA, Office of Pesticide Programs, Registration Div., Washington, DC.

(316) U.S. Environmental Protection Agency. September 29, 1988. Pesticide Fact Sheet Number 176: Ethephon. US EPA, Office of Pesticide Programs, Registration Div., Washington, DC.

(317) OHS Database. March, 1993. MSDS for Folpet. MDL Information Systems Inc., San Leandro, CA.

(318) U.S. Environmental Protection Agency. 1986. Office of Pesticides. TOX Oneliners -- Folpet. February, 1986.

(319) CENET. 1994. Pesticide Management and Education. Chemical Profiles Library.

(320) Worthing, C. R. (ed.) 1979. The Pesticide Manual: A World Compendium, 6th ed. The British Crop Protection Council, Croydon, England. 655 pp.

(321) U.S. Environmental Protection Agency. June, 1987. Guidance for the Reregistration of Pesticide Products Containing Folpet as the Active Ingredient. US EPA, Office of Pesticide Programs, Washington, DC.

(322) U.S. Environmental Protection Agency. June, 1987. Pesticide Fact Sheet Number 215: Folpet. US EPA, Office of Pesticides and Toxic Substances, Office of Pesticide Programs, Washington, DC.

(323) U.S. Environmental Protection Agency. 1986. Pesticide Tolerances for Imazaquin. Federal Register. Vol. 51, No. 63. Rules and Regulations. Wednesday, April 2, 1986.

(324) U.S. Environmental Protection Agency. March 20, 1986. Pesticide Fact Sheet Number: 83. US EPA, Office of Pesticide Programs, Registration Div., Washington, DC.

(325) OHS Database. MDL Information Systems, Inc. 1994 (June) MSDS for Imazethapyr. MDL Information Systems, Inc., San Leandro, CA.

(326) U.S. Environmental Protection Agency. 1992. Pesticide Tolerances for Imazethapyr. Federal Register. Vol. 57, No. 102. Rules and Regulations. Wednesday, May 27, 1992.

(327) Review by American Cyanamid Company. February 21, 1996.

(328) U.S. Environmental Protection Agency. 1995. Imidacloprid; Pesticide Tolerance and Raw Agricultural commodities. 40 CFR Part 180 Section 472.

(329) Pike, K.S., G.L. Reed, G.T. Graf and D. Allison. 1993. Compatibility of Imidacloprid with Fungicides as a Seed-Treatment Control of Russian Wheat Aphid (Homoptera: Aphidae) and Effect on Germination, Growth, and Yield of Wheat Barley. J.Econ.Entomol. 86(2): 586-593.

(330) Doull, J., C.D. Klassen, and M.O. Amdur (eds.). 1991. Cassarett and Doull's Toxicology. The Basic Science of Poisons. Fourth Edition. Pergamon Press, Elmsford, NY.

(331) Federal Register. Imidacloprid; Pesticide Tolerances. July 5, 1995. 60(128): 34943-24945.

(332) Avery, M.L., D.G. Decker and D.L. Fischer. 1994. Cage and Flight Pen Evaluation of Avian Repellancy and Hazard Associated with Imidacloprid-Treated Rice Seed. Crop Protection 13(7): 535-540.

(333) Avery, M.L., D. Decker, D.L. Fischer and T.R. Stafford. 1993. Responses of Captive Blackbirds to a New Seed Treatment. J. Wildl. Manage. 57(3): 652-656.

(334) Scholz, K., and M. Spiteller. 1992. Influence of Groundcover on the Degradation of 14C-Imidacloprid in Soil. Brighton Crop Protection Conference. Pests and Diseases. pp. 883-888.

(335) Rouchard, J., F. Gustin and A. Wauters. 1994. Soil Organic Matter Aging and its Effect on Insecticide Imidacloprid Soil Biodegradation in Sugar Beet Crop. Toxicol. Environ. Chem. 45(3-4): 149-155.

(336) Hellpointer, E. 1994. Degradation and Translocation of Imidacloprid (NTN 33893) Under Field Conditions on a Lysimeter. Miles Report No. 106426, pp. 1-71. Miles Inc., Agricultural Division, PO Box 4913, Kansas City, MO.

(337) Jenkins, J.J. 1994. Use of Imidacloprid for Aphid Control on Apples in Oregon. Potential for Ground and Surface Water Contamination. Department of Agricultural Chemistry. Oregon State University, Corvallis, OR.

(338) Placke, F.J. and E. Weber. 1993. Method of Determining Imidacloprid Residues in Plant Materials. Pflanzenschutz-Nachrichten Bayer. 46(2): 109-182.

(339) Valent USA. 1993. Material Safety Data Sheet for Valent Cobra Herbicide. Valent USA Corporation. Walnut Creek, CA.

(340) US Environmental Protection Agency. 1995. File: Lactofen, Integrated Risk Information System (IRIS). National Library of Medicine "Toxline" Database, 4/95.

(341) US Environmental Protection Agency. 1987. Fact Sheet Number 128: Lactofen. Washington, DC.

(342) Wauchope, R.D., Buttler, T.M., Hornsby A.G., Augustijn-Beckers, P.W.M. and Burt, J.P. 1992. SCS/ARS/CES Pesticide Properties Database for Environmental Decisionmaking. Reviews of Environmental Contamination and Toxicology, Vol. 123.

(343) US Environmental Protection Agency. 1993. Environmental Fate and Effects Division. Pesticide Environmental Fate One Line Summary: Lactofen. Washington, DC.

(344) Bruce, E., Product Manager, Personal Communication. 1995. Valent USA Corporation. Walnut Creek, CA.

(345) Thomson, W. T. 1981. Agricultural Chemicals Book III Fumigants, Growth Regulators, Repellents, and Rodenticides. Thomson Publications. Fresno, CA.

(346) Wingard, Lemuel, T Brody et. al. 1991. Human Pharmacology Molecular-to-Clinical. Mosby Year Book . Baltimore, MD.

(347) Katzung, B.G. 1987. Basic and Clinical Pharmacology, Third Edition. Appleton and Lange. Norwalk, CT.

(348) OHS Database. 1993. Occupational Health Services, Inc. 1993 (August) MSDS for Sodium chlorate. OHS Inc., Secaucus, NJ.

(349) U.S. Environmental Protection Agency. 1986. Office of Pesticides. TOX Oneliners -- Sodium chlorate. May, 1986.

(350) Briggs, S. A. 1992. Basic Guide to Pesticides: Their Characteristics and Hazards. Hemisphere Publishing Corp., Washington, Philadelphia, London.

(351) U.S. Environmental Protection Agency. 1988. Fact Sheet Number 186 Streptomycin. USEPA. Washington, DC.

(352) U.S. Environmental Protection Agency. 1988. Guidance for the Registration of Pesticide Products Containing Streptomycin and Streptomycin Sulfate as the Active Ingredient Case Number 0169. USEPA. Washington, DC.

(353) U.S. Environmental Protection Agency. 1992. R.E.D.(Registration Eligibility Document) Facts. Streptomycin and Streptomycin Sulfate. USEPA. Washington, DC.

(354) OHS Database. 1993. Occupational Health Services, Inc. 1993 (August) MSDS for Sulfur. OHS Inc., Secaucus, NJ.

(355) U.S. Environmental Protection Agency. 1988. Office of Pesticides. TOX Oneliners -- Sulfur.

August, 1988.

(356) Pesticide Management and Education. An on-line pesticide information database in CENET, Cornell Cooperative Extension Network. Cornell University, Ithaca, NY.

(357) U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document Facts: Sulfur. US EPA, Pesticides and Toxic Substances, Washington, DC.

(358) U.S. Environmental Protection Agency. May, 1991. Reregistration Eligibility Document (RED): Sulfur. US EPA, Office of Pesticide Programs, Washington, DC.

(359) U.S. Environmental Protection Agency. December, 1982. Sulfur Pesticide Registration Standard, L. Rossi, et al. US EPA, Office of Pesticides and Toxic Substances, Washington, DC.

(360) The Saprol Fungicide Fact File. Shell Agrichemicals.

(361) OHS Database. Occupational Health Services, Inc. 1994. MSDS for Triforine. OHS Inc., Secaucus, NJ.

(362) U.S. Environmental Protection Agency. 1993. Office of Pesticides. TOX Oneliners -- Triforine. April, 1993.

(363) Pesticide Management and Education. An on-line pesticideinformation database in CENET, Cornell Cooperative Extension Network. Cornell University, Ithaca, NY.

(364) National Institute for Occupational Safety and Health (NIOSH). 1993. Registry of Toxic Effects of Chemical Substances (RTECS). NIOSH. Cincinnati, OH.

(365) U.S. Environmental Protection Agency. 1994. GENE-TOX in Toxicology Data Network. U.S. Dept. Health and Human Services. Bethesda, MD.

(366) OHS Database. 1994. Occupational Health Services, Inc. 1994. MSDS for Vernolate. OHS Inc., Secaucus, NJ.

(367) U.S. Environmental Protection Agency. 1993. Office of Pesticides. TOX Oneliners --Vernolate. May, 1993.

(368) Pesticide Management and Education. An on-line pesticide information database in CENET, Cornell Cooperative Extension Network. Cornell University, Ithaca, NY.

(369) Thomson, W.T. 1991. Agricultural Chemicals. Book III: Rodenticides. Thomson Publications, Fresno, CA.

(370) OHS Database. 1994. Occupational Health Services, Inc. 1994 (June) MSDS for Warfarin. OHS Inc., Secaucus, NJ.

(371) U.S. Environmental Protection Agency. 1989. Office of Pesticides. TOX Oneliners -- warfarin. July, 1989.

(372) Montgomery, J. H. 1993. Agrochemicals Desk Reference: Environmental Data. Lewis Publishers.

Chelsea, MI.

(373) Hayes, W. J. Jr. 1982. Pesticides Studied in Man. Williams and Wilkins. Baltimore, MD.

(374) Windholz, M. (ed.) 1983. The Merck Index. Tenth edition. Rahway, NJ. Merck and Company.

(375) Hayes, W. J., Jr. 1963. Clinical Handbook on Economic Poisons: Emergency Information for Treating Poisoning. US Department of Health, Education, and Welfare, Public Health Service, Communicable Disease Center, Toxicology Section. Atlanta, Georgia.

(376) Pesticide Management and Education. An on-line pesticide information database in CENET, Cornell Cooperative Extension Network. Cornell University, Ithaca, NY.

(377) United States Environmental Protection Agency. August, 1981. Warfarin and Its Sodium Salt: Pesticide Registration Standard. USEPA, Office of Pesticides and Toxic Substances. Washington, DC. 193 pp.

(378) U.S. Environmental Protection Agency. June, 1991. R.E.D. Facts: Warfarin. USEPA, Office of Pesticides and Toxic Substances. Washington, DC.

United States Environmental Protection Agency
Prevention, Pesticides And Toxic Substances (7508W)
EPA-738-F-93-011
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EPA R.E.D. FACTS

Glyphosate

Pesticide Reregistration

All pesticides sold or distributed in the United States must be registered by EPA, based on scientific studies showing that they can be used without posing unreasonable risks to people or the environment. Because of advances in scientific knowledge, the law requires that pesticides which were first registered years ago be reregistered to ensure that they meet today's more stringent standards.

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. The Agency imposes any regulatory controls that are needed to effectively manage each pesticide's risks. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment.

When a pesticide is eligible for reregistration, EPA announces this and explains why in a Reregistration Eligibility Decision (RED) document. This fact sheet summarizes the information in the RED document for glyphosate.

Use Profile

Glyphosate is a non-selective herbicide registered for use on many food and non-food field crops as well as non-crop areas where total vegetation control is desired. When applied at lower rates, glyphosate also is a plant growth regulator.

Glyphosate is among the most widely used pesticides by volume. It ranked eleventh among conventional pesticides used in the U.S. during 1990-91. In recent years, approximately 13 to 20 million acres were treated with 18.7 million pounds of glyphosate annually. The largest use sites include hay/pasture, soybeans and field corn.

Three salts of glyphosate are used as active ingredients in registered pesticide products. Two of these active ingredients, plus technical grade glyphosate, are contained in the 56 products that are subject to this RED.

The isopropylamine salt, an active ingredient in 53 registered products, is used as a herbicide to control broadleaf weeds and grasses in many food and non-food crops and a variety of other sites including ornamentals, lawns and turf, residential areas, greenhouses, forest plantings and industrial rights-of-way. It is formulated as a liquid, solid or pellet/tablet, and is applied using ground or aerial equipment.

The sodium salt of glyphosate, an active ingredient in two registered pesticide products, is used as a plant growth regulator for peanuts and sugarcane, to modify plant growth and hasten the ripening of fruit. It is applied as a ground spray to peanut fields and as an aerial spray to sugarcane. Preharvest intervals are established for both crops.

The monoammonium salt of glyphosate is an active ingredient in an additional seven herbicide/growth regulator products. This form of glyphosate was initially registered after November 1984, so it is not subject to reregistration or included in this RED. However, in reassessing the existing glyphosate tolerances (maximum residue limits in or on food and feed), EPA included those for the monoammonium salt.

Regulatory History

EPA issued a Registration Standard for glyphosate in June 1986 (NTIS PB87-103214). The Registration Standard required additional phytotoxicity, environmental fate, toxicology, product chemistry and residue chemistry studies. All of the data required have been submitted and reviewed, or were waived.

Human Health Assessment

Toxicity

Glyphosate is of relatively low oral and dermal acute toxicity. It has been placed in Toxicity Category III for these effects (Toxicity Category I indicates the highest degree of acute toxicity, and Category IV the lowest). The acute inhalation toxicity study was waived because glyphosate is non-volatile and because adequate inhalation studies with end-use products exist showing low toxicity.

A subchronic feeding study using rats showed blood and pancreatic effects. A similar study with mice showed reduced body weight gains in both sexes at the highest dose levels. A dermal study with rabbits showed slight reddening and swelling of the skin, decreased food consumption in males and decreased enzyme production, at the highest dose levels.

Several chronic toxicity/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 in the study. In June 1991, EPA classified glyphosate as a Group E oncogen--one that shows evidence of non-carcinogenicity for humans--based on the lack of convincing evidence of carcinogenicity in adequate studies.

In developmental toxicity studies using pregnant rats and rabbits, glyphosate caused treatment-related effects in the high dose groups including diarrhea, decreased body weight gain, nasal discharge and death.

One reproductive toxicity study using rats showed kidney effects in the high dose male pups; another study showed digestive effects and decreased body weight gain. Glyphosate does not cause mutations.

In one metabolism study with rats, most of the glyphosate administered (97.5 percent) was excreted in urine and feces as the parent compound; less than one percent of the absorbed dose remained in tissues and organs, primarily in bone tissue. Aminomethyl phosphonic acid (AMPA) was the only metabolite excreted. A second study using rats showed that very little glyphosate reaches bone marrow, that it is rapidly eliminated from bone marrow, and that it is even more rapidly eliminated from plasma.

Dietary Exposure

The nature of glyphosate residue in plants and animals is adequately understood. Studies with a variety of plants indicate that uptake of glyphosate or AMPA from soil is limited. The material which is taken up is readily translocated throughout the plant and into its fruit. In animals, most glyphosate is eliminated in urine and feces. Enforcement methods are available to detect residues of glyphosate and AMPA in or on plant commodities, in water and in animal commodities.

85 tolerances have been established for residues of glyphosate and its metabolite, AMPA, in or on a wide variety of crops and crop groups, as well as in many processed foods, animal feed and animal tissues (please see 40 CFR 180.364, 40 CFR 185.3500 and 40 CFR 186.3500). EPA has reassessed the existing and proposed tolerances for glyphosate. Though some adjustments will be needed, no major changes in existing tolerances are required. EPA also has compared the U.S. tolerances with international Codex maximum residue limits (MRLs), and is recommending certain adjustments to achieve greater compatibility.

EPA conducted a dietary risk assessment for glyphosate based on a worst-case risk scenario, that is, assuming that 100 percent of all possible commodities/acreage were treated, and assuming that tolerance-level residues remained in/on all treated commodities. The Agency concluded that the chronic dietary risk posed by glyphosate food uses is minimal.

A reference dose (RfD), or estimate of daily exposure that would not cause adverse effects throughout a lifetime, of 2 mg/kg/day has been proposed for glyphosate, based on the developmental toxicity studies described above.

Occupational and Residential Exposure

Occupational and residential exposure to glyphosate can be expected based on its currently registered uses. However, due to glyphosate's low acute toxicity and the absence of other toxicological concerns (especially carcinogenicity), occupational and residential exposure data are not required for reregistration.

Some glyphosate end-use products are in Toxicity Categories I or II for primary eye irritation or 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.

EPA is not adding any personal protective equipment (PPE) requirements at this time, but any existing PPE label requirements must be retained.

The Worker Protection Standard (WPS) for Agricultural Pesticides (please see 40 CFR 156 and 170) established an interim restricted entry interval (REI) of 12 hours for glyphosate. The Agency has decided to retain this REI as a prudent measure to mitigate risks to workers. During the REI, workers may reenter areas treated with glyphosate only in the few, narrow exceptions allowed in the WPS. The REI applies only to glyphosate uses within the scope of the WPS, so homeowner and commercial uses are not included.

Human Risk Assessment

EPA's worst case risk assessment of glyphosate's many registered food uses concludes that human dietary exposure and risk are minimal. Existing and proposed tolerances have been reassessed, and no significant changes are needed to protect the public.

Exposure to workers and other applicators generally is not expected to pose undue risks, due to glyphosate's low acute toxicity. However, splashes during mixing and loading of some products can cause injury, primarily eye and skin irritation. EPA is continuing to recommend PPE, including protective eye wear, for workers using end-use products that are in Toxicity Categories I or II for eye and skin irritation. To mitigate potential risks associated with reentering treated agricultural areas, EPA is retaining the 12 hour REI set by the WPS.

Environmental Assessment

Environmental Fate

Glyphosate adsorbs strongly to soil and is not expected to move vertically below the six inch soil layer; residues are expected to be immobile in soil. Glyphosate is readily degraded by soil microbes to AMPA, which is degraded to carbon dioxide. Glyphosate and AMPA are not likely to move to ground water due to their strong adsorptive characteristics. However, glyphosate does have the potential to contaminate surface waters due to its aquatic use patterns and through erosion, as it adsorbs to soil particles suspended in runoff. If glyphosate reached surface water, it would not be broken down readily by water or sunlight.

Ecological Effects

Glyphosate is no more than slightly toxic to birds and is practically non-toxic to fish, aquatic invertebrates and honeybees. Due to the presence of a toxic inert ingredient, some glyphosate end-use products must be labeled, "Toxic to fish," if they may be applied directly to aquatic environments. Product labeling does not preclude off-target movement of glyphosate by drift. EPA therefore is requiring three additional terrestrial plant studies to assess potential risks to nontarget plants.

EPA does not expect that most endangered terrestrial or aquatic organisms will be affected by the registered uses of glyphosate. However, many endangered plants as well as the Houston toad (due to its habitat) may be at risk. EPA is deferring any use modifications or labeling amendments until it has published the Endangered Species Protection Plan and has given registrants guidance regarding endangered species precautionary labeling.

Ecological Effects Risk Assessment

Based on current data, EPA has determined that the effects of glyphosate on birds, mammals, fish and invertebrates are minimal. Under certain use conditions, glyphosate may cause adverse effects to nontarget aquatic plants. Additional data are needed to fully evaluate the effects of glyphosate on nontarget terrestrial plants. Risk reduction measures will be developed if needed, once the data from these studies are submitted and evaluated.

Additional Data Required

EPA is requiring three generic studies (Tier II Vegetative Vigor, Droplet Size Spectrum, and Drift Field Evaluation) which are not part of the target data base and do not affect the reregistration eligibility of glyphosate. The Agency also is requiring product-specific data including product chemistry and acute toxicity studies, as well as revised Confidential Statements of Formula and revised labeling.

Product Labeling Changes Required

All end-use glyphosate products must comply with EPA's current pesticide product labeling requirements. In addition:

- **Protection of Aquatic Organisms**

Non-Aquatic Uses - End-use products that are not registered for aquatic uses must bear the following label statement:

> *Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters and rinsate.*

Aquatic Uses - End-use products registered for aquatic uses must bear the following label statement:

> *Do not contaminate water when disposing of equipment washwaters and rinsate. Treatment of aquatic weeds can result in oxygen loss from decomposition for dead plants. This loss can cause fish kills.*

- **Worker Protection Standard (WPS) Requirements**

Any product whose labeling permits use in the production of an agricultural plant on any farm, forest, nursery or greenhouse must comply with the labeling requirements of:

- PR Notice 93-7, "Labeling Revisions Required by the Worker Protection Standard (WPS)," and

• PR Notice 93-11, "Supplemental Guidance for PR Notice 93-7."

Unless specifically directed in the RED, all statements required by these two PR Notices must appear on product labeling exactly as instructed in the Notices. Labels must be revised by April 21, 1994, for products distributed or sold by the primary registrant or supplementally registered distributors, and by October 23, 1995, for products distributed or sold by anyone.

- **Personal Protective Equipment (PPE)**

No new PPE requirements must be added to glyphosate labels. However, any existing PPE requirements on labels must be retained.

- **Entry Restrictions**

Products Not Primarily Intended for Home Use:

○ Uses Within the Scope of the WPS - A 12-hour restricted entry interval (REI) is required for all products with uses within the scope of the WPS, except products intended primarily for home use. The PPE for early entry should be that required for applicators of glyphosate, except any applicator requirement for an apron or respirator is waived. This REI and PPE should be inserted into the standardized statements required by PR Notice 93-7.

• Sole Active Ingredient End-Use Products - Labels must be revised to adopt the entry restrictions set forth in this section. Any conflicting entry restrictions on current labeling must be removed.

• Multiple Active Ingredient Products - Registrants must compare the entry restrictions set forth in this section to those on their current labeling and retain the more protective. A specific time period in hours or days is considered more protective than "until sprays have dried" or "dusts have settled."

○ Uses Not Within the Scope of the WPS - No new entry restrictions must be added. However, any entry restrictions on current product labeling with these uses must be retained.

Products Primarily Intended for Home Use:

○ No new entry restrictions must be added. However, any entry restrictions on current product labeling must be retained.

Regulatory Conclusion

The use of currently registered pesticide products containing the isopropylamine and sodium salts of glyphosate in accordance with the labeling specified in this RED will not pose unreasonable risks or adverse effects to humans or the environment. Therefore, all uses of these products are eligible for reregistration.

These glyphosate products will be reregistered once the required product-specific data, revised Confidential Statements of Formula and revised labeling are received and accepted by EPA.

Products which contain active ingredients in addition to glyphosate will not be reregistered until all their other active ingredients also are eligible for reregistration.

For More Information

EPA is requesting public comments on the Reregistration Eligibility Decision (RED) document for glyphosate during a 60-day time period, as announced in a Notice of Availability published in the Federal Register. To obtain a copy of the RED document or to submit written comments, please contact the Pesticide Docket, Public Response and Program Resources Branch, Field Operations Division (7506C), Office of Pesticide Programs (OPP), US EPA, Washington, DC 20460, telephone 703- 305-5805.

Following the comment period, the glyphosate RED document will be available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, telephone 703-487-4650.

For more information about EPA's pesticide reregistration program, the glyphosate RED, or reregistration of individual products containing glyphosate, please contact the Special Review and Reregistration Division (7508W), OPP, US EPA, Washington, DC 20460, telephone 703-308-8000.

For information about the health effects of pesticides, or for assistance in recognizing and managing pesticide poisoning symptoms, please contact the National Pesticides Telecommunications Network (NPTN). Call toll-free 1-800-858-7378, between 8:00 am and 6:00 pm Central Time, Monday through Friday.

PREFACE

Washington State Department of Ecology EIS Element E

This element of the Washington State EIS document is included in the Invasive *Spartina* Project (ISP) PEIS/PEIR as a technical appendix for several reasons. It provides relevant information on the persistence and potential toxicity of the herbicide (glyphosate) and surfactants that have been used in Washington State and that are also being considered for use in San Francisco Bay to control infestations of non-native *Spartina*. It also provides a comprehensive summary of laboratory test results on acute and chronic toxicity for a variety of taxonomic groups as well as the human population that may be affected by herbicide or surfactants in the ISP project area. Although some of the information contained herein has been superceded by more recent studies, this document provides a substantial amount of current information, and the report addresses many issues that are expected to arise in the ISP, therefore this element and the Washington State EIS are referenced extensively within this PEIS/PEIR.

ENVIRONMENTAL IMPACT STATEMENT - FINAL
NOVEMBER 1993

CO-LEAD AGENCIES:
Washington Department of Agriculture
Washington State Department of Ecology
Washington State Department of Natural Resources
Washington State Department of Fisheries
Washington State Department of Wildlife
Washington State Noxious Weed Control Board

NOXIOUS EMERGENT PLANT MANAGEMENT

ELEMENT E : ENVIRONMENTAL EFFECTS OF GLYPHOSATE

(Section 1)

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SECTION 1

ENVIRONMENTAL EFFECTS OF GLYPHOSATE

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1.0 INTRODUCTION

This report examines the potential environmental effects of using glyphosate to control emergent wetland vegetation. The two aquatic weeds that are of most concern in Washington state are purple loosestrife (*Lythrum salicaria*), a freshwater plant, and cordgrass (*Spartina* spp.), a marine plant. The toxic effects (both acute and chronic) of glyphosate on nontarget plants, animals, and aquatic organisms are described. In addition, secondary effects such as possible increases in erosion resulting from the loss of vegetation, water quality degradation caused by release of nutrients from decaying vegetation, and habitat damage are also described.

Rodeo®, manufactured by Monsanto Agricultural Products Company, is the only glyphosate formulation that is commercially available and registered for aquatic use in Washington state. Rodeo® contains 53.8 percent glyphosate as the isopropylamine salt and 46.2 percent inert ingredients i.e., water (Monsanto 1992). Consequently, this report focuses on those studies that describe the environmental effects of Rodeo® or its active ingredient, glyphosate. However, in situations where no data are available for Rodeo®, existing information for Roundup® (a glyphosate herbicide containing 41 percent of the isopropylamine salt of glyphosate and 59 percent inert ingredients, including a proprietary surfactant) are presented. The surfactant in Roundup® is considered more toxic than the active ingredient, glyphosate. Mitchell et al. (1987a) report that Roundup® is significantly more toxic to fish than is Rodeo® (96-hour LC_{50} values for rainbow, chinook, and coho salmon ranged from 12 to 60 mg/L with Roundup®, compared to 600 to 1,070 mg/L with Rodeo®). Therefore, environmental effects information for Roundup® may be considered as a conservative estimate of the potential effects from Rodeo® before it is mixed with a nonionic surfactant. Label instructions require that Rodeo® be used with a surfactant.

The environmental effects of glyphosate and other degradation products of the parent compound depend on the transport and fate of these substances within the environment, which in turn are governed by the chemical and physical properties of these substances and the chemical, physical, and biological characteristics of the receiving environment. The acute and chronic effects of glyphosate and its degradation products on plants and animals depend on their persistence, bioaccumulation, biotransformation and elimination properties. Environmental impacts are also dependent on the frequency of exposure, duration of exposure, and concentrations of glyphosate in the environment.

Toxicity information presented here focuses on the active ingredient, N-(phosphonomethyl)glycine, or technical glyphosate. Rodeo® must be used with a nonionic surfactant, which may increase the toxicity of glyphosate spray formulations, as discussed in the section on environmental effects of adjuvants.

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2.0 TOXICITY OVERVIEW

The toxic effects of glyphosate and its degradation products are partially dependent on the transport, fate, and transformation of these substances in the environment. Because glyphosate has a very low vapor pressure and is stable in water and sunlight, the transport, fate, and environmental effects of glyphosate are strongly related to microbial biodegradation rates in both soil and water.

Glyphosate is a systemic, nonselective, broadleaf herbicide that inhibits plant growth by interfering with production of amino acids. Because of these properties, glyphosate is generally lethal on contact with broadleaf plants. Glyphosate residues in soils generally are not absorbed by plant roots, and residues do not adversely affect germination or establishment of plants. Adverse impacts to nontarget plants within the treatment area would include death unless nontarget vegetation is avoided during glyphosate application. In addition, because glyphosate phytotoxicity is variable among different species depending on absorption and translocation rates as well as other physiological factors, adverse impacts to nontarget vegetation also are likely to be variable. In other words, different plant species may have different tolerance levels to glyphosate.

Glyphosate and its primary degradation product, aminophosphonic acid (AMPA) are generally nontoxic to animals (U.S. EPA 1988). Most studies indicate that glyphosate is quickly and completely degraded in periods of days to weeks by microbial organisms in both terrestrial and aquatic environments. Some studies of both terrestrial and aquatic environments have, however, indicated that low levels of glyphosate may persist up to a year or more (O'Keefe 1985; Torstensson et al. 1989). However, normal application rates used for control of emergent vegetation do not result in doses of glyphosate shown to cause acute effects, and because glyphosate is biodegradable and nonbioaccumulative, acute lethal effects are unlikely. In addition, in studies where glyphosate persists for longer periods, levels are generally orders of magnitude below those shown to cause adverse effects to terrestrial or aquatic organisms.

Because glyphosate only persists for longer periods (up to a year or more) at low levels and does not generally bioconcentrate or bioaccumulate, the risk of long-term exposure and associated chronic effects is low. Animals may be exposed to glyphosate by

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ingesting treated vegetation, by grooming activities, and by drinking water containing glyphosate. Glyphosate generally has very low bioconcentration factors in animals and does not appear to strongly bioaccumulate. Once glyphosate concentrations in the environment are reduced, or the animal is removed from the contaminated environment, glyphosate is quickly excreted by most animals. In addition, long-term, chronic toxicity studies of rats and dogs indicate that glyphosate does not appear to have any mutagenic, carcinogenic, teratogenic, developmental, or reproductive effects on animals.

However, other pesticides or herbicides (e.g., Sevin®) in the receiving environment may interact with glyphosate, thereby exerting an additive, synergistic, or antagonistic effect on glyphosate toxicity to plants and animals. There is no information currently available on the interaction or combined toxicity of Sevin® and glyphosate. However, Sevin® appears to be several times more toxic to plants and animals than glyphosate. For instance, Brown et al. (1979) report that LC_{50} values for channel catfish fry in a 4-day experiment ranged from 0.14 to 1.56 mg/L of Sevin®, whereas Folmar et al. (1979) report an LC_{50} value of 130 mg/L glyphosate for similar-sized fry in a 4-day experiment.

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3.0 POTENTIAL IMPACTS TO SOIL AND SEDIMENT

3.1 PERSISTENCE AND ACCUMULATION

Both glyphosate and AMPA generally undergo rapid biodegradation (days to weeks) and completely degraded in most temperate soils. Soil half-lives and glyphosate accumulation are strongly related to biodegradation rates as well as factors influencing degradation processes (e.g., adsorption, temperature, pH, and soil moisture). Because microbial degradation occurs in both aerobic and anaerobic conditions (Rueppel et al. 1977), glyphosate and its degradation products are not likely to persist or accumulate in soils or sediments in emergent wetlands and adjacent upland areas that may receive overspray or drift. However, recent studies have demonstrated low level persistence in marine sediments and upland soils (Kroll 1991; Torstensson et al. 1989).

3.2 STABILITY AND EROSION

Following the application of glyphosate, there may be a short interim period when little or no vegetation exists in the target area. Assuming that desirable emergent vegetation does not immediately replace eliminated vegetation and that decomposing vegetation provides little soil or sediment stability, there may be a short-term risk of soil erosion and sediment instability within the glyphosate application area. No long-term erosion or sediment transport impacts are likely once the treated area is recolonized by desirable emergent or shrub vegetation. The potential for soil instability and erosion in application areas depends on a number of factors including the wetland system, watershed position and topography, water regime and gradient, and the physical and chemical characteristics of the soil and sediment.

In general, purple loosestrife and cordgrass occur in natural and manmade wetland areas having low gradient and low erosive potential. Wetlands have important ecological and economic functions, including but not limited to sediment storage and retention, nutrient cycling, food chain support, fish and wildlife habitat, water quality protection, and flood control (Mitsch and Gosselink 1986). Wetland environments often are rich in fine sediments and organic materials, which are susceptible to wind and wave erosion. Whether these sediments are eroded after herbicide treatment depends on sediment size, location, prevailing wind direction and speed, and surrounding vegetation. For instance, in many cases winds are disrupted by surrounding trees that reduce wind speed and erosion potential. Erosive wind forces in smaller wetlands are lower because of the smaller area of open water exposed to winds. In undisturbed wetlands, soil and sediment instability and erosion generally are unlikely because native trees and vegetation provide a buffer around the treatment area.

In intertidal salt marshes treated with glyphosate to control cordgrass species, there is likely to be some short-term risk of sediment erosion and transport. Evans (1986) indicates that when cordgrass is killed by herbicide application, the roots stabilizing fine surface sediments decay over a period of several years, exposing sediments to wave erosion. Wind, wave, and rainstorm events may cause erosion, transport, and redistribution of fine sediments. The amount of erosion depends on the size of the storm event, the size of the treated area, the magnitude of tidal exchanges, and the length of exposure to erosive forces. If such events occur, sediments containing glyphosate residues could be transported and deposited in clean areas. The risk of erosion impacts can be mitigated and minimized by expediting regrowth and recolonization using revegetation techniques for desirable species.

Similar scenarios for wind and wave erosion during storm events exist for lakeshore wetlands if there are large areas of open space, permitting unimpeded winds to generate waves that may erode fine-grained sediments in the treatment area. As with the intertidal salt marsh scenario described above, there is some temporary, short-term risk of erosion and transport of glyphosate-contaminated sediments. Fine-grained silt and clay-sized sediments with adsorbed glyphosate (or its degradation products) may be suspended in the water column by wind-generated waves and transported outside the treated area. Because microbial activities will, over time, decrease the amount of glyphosate and its degradation products, it is unlikely that transport of contaminated sediments pose a risk to the receiving environment. Clean sediments may be transported to the treated area and deposited. Potential erosion impacts depend on water level fluctuations as well as the size of the treated area, the depth of water above barren sediment, decomposition rates of noxious vegetation, reestablishment rates of desirable vegetation, and proximity to adjacent vegetation. The last three factors affect sediment stability and strongly influence erosion potential. Unless water level fluctuations are extreme because of reservoir management operations or natural seasonal variation, potential erosion impacts are likely to be negligible to low. The short-term risk of erosion impacts can be reduced by

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planting desirable emergent vegetation or shrubs to promote stabilization of sediments in treated areas.

Because of the erosive potential of flowing water, erosion and sediment transport impacts are more likely on riverbanks and unlined canal banks. In riverine environments, large treated bank areas may become destabilized and susceptible to cutting, slumping, or sloughing prior to regrowth and stabilization by desirable vegetation. In irrigation canal systems, because removal of nuisance emergent vegetation (e.g., loosestrife) restores irrigation canals and ditches to their unvegetated design capacity, it is unlikely that glyphosate treatment contributes to significant adverse erosion and sediment transport impacts. However, as treated vegetation decomposes, sediments trapped and retained by the living purple loosestrife may be released and transported downstream. Potential erosion impacts can be mitigated or minimized by using erosion control and revegetation techniques. Without mitigation, large quantities of sediment with adsorbed glyphosate residues could be transported to downstream areas in riverine systems. Clean sediments from upstream areas may likewise be deposited in the treated area. Neither transport of glyphosate-contaminated soils into clean areas nor transport of clean soils into glyphosate treatment sites is likely to have adverse effects on soil organisms or sediment quality, because low levels of glyphosate residuals in soils are rapidly reduced through biodegradation in most cases.

3.3 MICROFLORA

Microflora in the soil and sediment are important to decomposition, mineralization, soil fertility, and nutrient cycling processes (i.e., denitrification, nitrification, and ammonification) in terrestrial and aquatic environments. Biodegradation and inactivation of glyphosate by microorganisms are also the primary mechanisms in the breakdown and detoxification of glyphosate in soil and water (Grossbard 1985).

Laboratory studies using pure cultures of microorganisms have reported adverse effects on microflora from exposure to glyphosate (Grossbard 1976, 1974; Quilty and Geoghegan 1976, 1975). In an extensive examination of 46 cultures (Cooper et al. 1978), severe adverse effects on saprophytic soil fungi, which are important decomposers of plant cellulose, were observed only at very high concentrations of glyphosate (500 μg/mL). Forty-three percent of the isolates were killed at a glyphosate concentration of 500 μg/mL, whereas only 21 and 17 percent of the isolates failed to grow in media containing

100 and 50 $\mu g/mL$ of glyphosate, respectively. By contrast, in an earlier test (Cooper et al. 1978), 91 percent of soil fungi were inhibited to varying degrees by exposure to media containing 50 $\mu g/mL$ of glyphosate. The fungi used in this earlier study were unidentified, random isolates from soil.

Laboratory experiments, which are most useful for herbicide registration purposes, may not be completely reliable for predicting effects of glyphosate on microflora activity under field conditions. Greaves et al. (1980) criticize pure culture tests because:

- Isolated culture organisms may be atypical of natural soil forms
- Organisms are often stimulated to artificially high metabolic rates in culture media
- Organisms are removed from their typical ecological associations
- Interpretation of laboratory results is difficult, and extrapolation to *in situ* conditions is not possible.

Responses of microflora exposure to glyphosate in field studies are considerably different from those observed in pure laboratory cultures. For example, numbers of fungi propagules in peat and treated soils under field conditions were higher than those in controls (Roslycky 1982; Quilty and Geoghegan 1976). At concentrations of 300 $\mu g/g$ of glyphosate, cellulolytic and proteolytic bacteria exhibited transient increases, whereas nitrifying bacteria were little affected (Kruglov et al. 1980; Quilty and Geoghegan 1976). Roslycky (1982) concludes that notable increases in actinomycetes at concentrations as high as 1,000 $\mu g/g$ may indicate that microbes use glyphosate as a substrate.

Muller et al. (1981) report that denitrification does not appear to be adversely affected in soils at glyphosate application rates up to 2.6 kg/ha. This rate is close to the rate of 2.8 kg/ha used to control emergent vegetation in prairie pothole wetlands (Henry 1992). In addition, ammonification and nitrification processes are not inhibited at glyphosate concentrations of up to 100 $\mu g/g$. Marsh et al. (1977) report that nitrogen mineralization was increased in 100 ppm glyphosate-treated soils. These results indicate that glyphosate may be used as an energy source and may stimulate rather than inhibit fungal and bacterial growth.

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Although many species of microorganisms are inhibited by glyphosate in pure culture, this effect is selective, variable in magnitude, and frequently dose-related (Grossbard 1985). Grossbard (1985) suggests that microorganisms generally tolerate glyphosate in soil much better than in pure cultures because glyphosate is strongly adsorbed to soil and is thus less likely to result in fungus mortality, although it may extend the lag phase or reduce growth rates. Concentrations that produce inhibitory effects in laboratory studies are several orders of magnitude higher than maximum concentrations typically observed in the field (i.e., 0.162 to 0.600 mg/L) (Feng et al. 1990; Henry 1992; Newton et al. 1984). In addition, glyphosate behavior *in situ* is considerably different from behavior in laboratory experiments.

Based on the information available, it is unlikely that microflora biodegradation and nutrient cycling activities will be adversely affected by concentrations of glyphosate in the receiving environment resulting from emergent vegetation control applications.

4.0 POTENTIAL IMPACTS TO AIR

Because glyphosate is essentially odorless and has a very low vapor pressure (Monsanto 1985), it can be considered nonvolatile. Therefore, air quality is unlikely to be adversely affected by glyphosate applications. However, crops or other nontarget plants could be adversely affected if they come in contact with glyphosate resulting from overspray or drift losses during application. To avoid drift and potential impacts to nontarget plant species, Monsanto (1990) specifies that glyphosate should not be applied if conditions are gusty or winds exceed 5 mph.

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5.0 WATER

Some glyphosate is introduced to surface waters during application to emergent vegetation. The amount of glyphosate introduced to surface waters depends on the application rate, foliar interception, overspray, and drift. In addition, glyphosate may be introduced to surface waters from target vegetation washed by rainfall or tidal inundation when there is insufficient foliar absorption time (i.e., less than 6 hours).

5.1 SURFACE WATER

As noted in the fate and transport section, the physical and chemical characteristics of glyphosate (e.g., solubility, volatility, and mobility) contribute to its degradability in terrestrial and aquatic environments. Because aquatic environments sometimes have fewer microorganisms, biodegradation of glyphosate in surface waters generally is slower than in soils. Nonetheless, biodegradation is generally rapid (i.e., days to weeks) in freshwater and saltwater.

The degree of water quality degradation is dependent on the amount of glyphosate introduced to a given receiving water. Because interception by foliage reduces the amount of glyphosate reaching the water surface, overspray and drift are the primary sources of glyphosate introduction to surface waters. Other sources of glyphosate to surface waters, such as runoff and washoff from treated plant surfaces, are generally negligible (refer to fate and transport section). Dilution, dissipation, and biodegradation quickly diminish the concentration of glyphosate in the water column, minimizing degradation of surface water quality. For instance, the concentrations of glyphosate observed in the surface waters of prairie pothole wetlands during emergent vegetation control activities ranged from 0.140 to 0.600 mg/L 12 hours after application (Henry 1992). Eight days after glyphosate treatment, concentrations had fallen considerably, ranging from 0.035 to 0.490 mg/L. Feng et al. (1990) report a maximum concentration of 0.162 mg/L in streams intentionally oversprayed with glyphosate. Therefore, surface water quality impairment from glyphosate in the water column is not expected to occur during purple loosestrife or cordgrass control activities.

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In another field study, Goldsborough and Beck (1989) found that glyphosate dissipated rapidly in small forest ponds, the half-lives varying from 1.5 to 3.5 days. They observed initial glyphosate concentrations from 215 to 352 μg/L 30 minutes following application at a treatment rate of 0.89 kg/ha. Pond surface area ranged from 0.2 to 0.7 hectares and depth ranged from 0.9 to 1.5 meters.

These field studies indicate that glyphosate dissipation is rapid in water. The results of Goldsborough and Beck (1989) appear to indicate that glyphosate treatment may contribute to increases in total digestible (Kjeldahl) nitrogen (TKN) and total phosphorus. Inorganic nitrogen (NO_3+NO_2-N) decreased from 0.14 to <0.01 mg/L in pond water 30 days after treatment. By contrast, TKN and total phosphorus increased from 1.6 to 2.5 and 0.04 to 0.29 mg/L, respectively. The bioavailability of the various nitrogen and phosphorus fractions to algae and the potential impacts on water quality require further study.

Although there is no evidence showing that normal application rates result in glyphosate concentrations in surface water causing human or environmental health risks, the Rodeo® product label (Monsanto 1990) recommends that glyphosate not be applied within 0.5 miles of surface water intakes. Because of the rapid biodegradation and dissipation of glyphosate in surface water, it is unlikely that normal applications of glyphosate in municipal wastewater treatment facilities (e.g., sewage lagoons or oxidation ditches) will result in effluent glyphosate concentrations that pose risks to the environment.

However, there may be some short-term, secondary effects on surface water quality from glyphosate treatment of noxious emergent plants. Dissolved oxygen and nutrient levels may be temporarily affected during decomposition of treated vegetation. Decomposition of dense stands of purple loosestrife and cordgrass following glyphosate application may result in temporarily reduced dissolved oxygen levels and elevated levels of nutrients (nitrogen, phosphorus, and carbon) in treated areas. Increases in nitrates, phosphates, and dissolved carbon may contribute to algal blooms. Addition of limiting nutrients, such as phosphorus or nitrogen, in surface waters are known to contribute to algal blooms (Wetzel 1975).

By contrast, release of nutrients (e.g., nitrogen, phosphorus, and carbon) from decaying emergent vegetation in treated areas may be beneficial to primary productivity and food chain support, particularly in estuarine ecosystems. No studies have been conducted to

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demonstrate the effects on dissolved oxygen levels, nutrient levels, or the rate of primary productivity as a result of glyphosate application and the accompanying decomposition of vegetation.

5.2 SEA-SURFACE MICROLAYER

The sea-surface microlayer has been generally described as that layer of water lying between the surface film or nanolayer (0.03 μm) and the surface millilayer (0.1-1.0 mm) (Word et al. 1986). The sea-surface microlayer provides habitat for a wide variety of biota including bacteria, protozoans, metazoans, and the eggs or larvae of fish, lobster, and crab. Because of this important habitat, there is concern that the introduction of toxicants into the aquatic environment may eventually find their way into the microlayer.

The sea-surface microlayer is rich in naturally occurring organic matter and nutrients which are derived from the natural production that occurs in subsurface waters. Samples collected from the upper 350 μm of the sea surface indicate that the majority of material present consists of nonpolar compounds (Word et al. 1986). This material is generally composed of relatively insoluble surfactants. These compounds migrate to the sea surface and become oriented according to their hydrophilic or hydrophobic fractions (Word et al. 1986).

Levels of inorganic materials are also elevated in the surface microlayer (Word et al. 1986). Surface samples collected by Szekielda et al. (1972) indicate that up to 80 percent of the materials present may be composed of silica sand particles rather than organic materials. Hardy et al. (1985) report a residence time of 1.5 to 15 hours in the sea-surface microlayer for metals associated with particulates. While surface winds (3.6 m/sec) were observed to decrease the microlayer concentrations and residence time of these particulates, microlayer enrichment was observed.

Application of glyphosate within or adjacent to the aquatic environment could result in direct contact with the water surface or indirect contact via precipitation and runoff or tidal action. As noted previously, the toxicity of glyphosate (or other herbicides) is a function of the available concentration over a given period of time. Dilution within the water column would be expected to rapidly reduce the surface microlayer concentration and thus the toxicity of glyphosate. Because glyphosate is highly soluble in water, it would not be expected to accumulate appreciably in the surface microlayer. However,

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because compounds such as glyphosate are strongly adsorbed onto particulate matter, fate and transport mechanisms similar to those observed for particulate metals may operate in the surface microlayer. Thus, based on the observed residence time of particulate metals, persistence of glyphosate in the surface microlayer for up to 15 hours might be anticipated as a worst case.

No sea-surface microlayer studies have been conducted to examine the presence or toxicity of glyphosate (Hardy 1992 personal communication; Gardiner 1992 personal communication). Because those life-forms and life stages of biota present in the surface microlayer are susceptible to toxicants, adverse impacts on various species may occur if glyphosate enters surface waters located in the vicinity of application areas. Such impacts might be expected to occur, at least over short periods of time, until dispersion and dilution reduce the levels of glyphosate in the surface microlayer.

5.3 GROUNDWATER

Although highly soluble in water (1.2x104 mg/L), glyphosate does not have a high potential for leaching into groundwater (U.S. EPA 1988). Soil mobility is limited due to the rapid degradation and strong soil sorption characteristics of glyphosate and its degradation products. Therefore, routine applications are unlikely to contribute to degradation of groundwater quality. No studies have been conducted to examine or document groundwater quality degradation from glyphosate use.

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6.0 POTENTIAL IMPACTS TO BIOTA

6.1 PLANTS

Acute and chronic effects of glyphosate exposure to target and nontarget plants, including macrophytes, phytoplankton, and algae, are identified in this section. A brief discussion is presented on factors that may influence glyphosate toxicity (e.g., uptake and translocation) to target and nontarget plants. Toxicological characteristics are summarized in Table 1.

6.1.1 Terrestrial and Aquatic Macrophytes

Because glyphosate is a nonselective, systemic herbicide, exposure of target and nontarget broadleaf terrestrial and aquatic macrophytes is generally lethal. However, the phytotoxic effects of glyphosate among species and among individuals of the same species are variable and depend on several factors. Factors that influence the effectiveness of glyphosate on target and nontarget plant species include application rates, timing of application, contact time, method of application, physiological factors (e.g., uptake and translocation rates), and life history stage and age of the plant.

The phytotoxicity of glyphosate to purple loosestrife and cordgrass is variable. In the only study on the effectiveness of glyphosate on purple loosestrife, total control of purple loosestrife was achieved on small test plots (20 m^2) with an application rate of 1.7 kg/acre in mid-August (Malecki and Rawinski 1985). By contrast, extensive information exists regarding the effectiveness of glyphosate in controlling cordgrass. Studies in Great Britain report variable success in using glyphosate to control cordgrass, with mortality varying from zero to 50 percent (Nature Conservancy Council undated). Furthermore, the council reports that no herbicide, including glyphosate, effectively killed young cordgrass (seedlings to 3 years). Treatment of young cordgrass was ineffective because the young plants grow close to the substrate, are exposed for shorter period between tides, and have a small leaf area. Among the factors influencing variations in mortality rate were application method, limited contact time between tides, and runoff from leaves.

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Table 1. Acute and chronic effects of glyphosate in plants.

Organism	Effect	Duration	Concentration (ppb)	Life Stage	Reference
Green Algae					
Euglena gracilis	CLS	6 days	203,000	Log phase	Richardson et al. 1979
	PGR	6 days	203,000	Log phase	Richardson et al. 1979
	PSE	1.67 hours	5,100	Log phase	Richardson et al. 1979
	PSE	4 days	510,000	Log phase	Richardson et al. 1979
	PSE	1.67 hours	10,100	Log phase	Richardson et al. 1979
	PGR	4 days	200,000	Log phase	Richardson et al. 1979
Chlamydomonas eugametos	PGR	2 days	17,000	Log phase	Grossbard 1985
Dunaliella bioculata	PGR	2 days	100	Log phase	Hess 1980
Selenastrum capricornutum	EC50-BM	14-21 days	4	Log phase	Turbak et al. 1986
	EC50-OX	NR	10	Log phase	Turbak et al. 1986
	EC50-GR	7 days	13,800	Log phase	Heydens 1991
Chlorella sorokiniana	PGR	NR	2,000	Log phase	Christy et al. 1981
Chlorella pyrenoidosa	EC50-GR	NR	590,000	Log phase	Maule and Wright 1984
Chlorococcum hynosporum	EC50-GR	NR	68,000	Log phase	Maule and Wright 1984
Blue-green Algae					
Anabaena flos-aquae	EC50-GR	7 days	15,000	NR	Heydens 1991
Diatoms					
Skeletonema costatum	EC50-GR	7 days	640	NR	Heydens 1991
Navicula pelliculosa	EC50-GR	7 days	42,000	NR	Heydens 1991
Periphyton					
Lotic	PGR	NR	>300	NR	Austin et al. 1991
Lentic	EC50-GR	NR	42,000	NR	Goldsborough and Brown 1988

Continued....

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Table 1. Acute and chronic effects of glyphosate in plants (continued)

Organism	Effect	Duration	Concentration (ppb)	Life Stage	Reference
Submerged and Floating Macrophytes					
Elodea canadensis	EC50-GR	NR	>1,000		Forney and Davis 1981
Myriophyllum spicatum	EC50-GR	NR	>1,000		Forney and Davis 1981
Water Milfoil	EC50-GR	NR	>1,000		Forney and Davis 1981
Vallisneria americana	EC50-GR	NR	>1,000		Forney and Davis 1981
Lemna spp. (duckweed)	EC50-GR	NR	>1,000		Forney and Davis 1981
Lemna minor	PHY	NR	1,690		O'Brien and Prendeville 1979

CLR - Measurable change in chlorophyll content
EC50 - Median effective concentration
BM - Measurable change in biomass
OX - Measurable change in oxygen production
GR - Measurable change in growth
NR - Not reported
PHY - Physiological effects: changes in organic functions or functions of organs
PRG - Changes in population growth
PSE - Photosynthesis effect: change in plant productivity

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Other studies on the efficacy of glyphosate have cited physiological causes for variations in phytotoxicity. Boerboom et al. (1990) found that clones of birdsfoot trefoil exhibited differential rates of glyphosate translocation. These authors report that tolerance to glyphosate was correlated to 5-enolpyruvylshikimate 3-phosphate synthase enzyme activity. They further conclude that differential rates of tolerance to glyphosate among individuals may be due to differential rates of spray retention, absorption, and translocation. D'Anieri et al. (1990) also suggest that variations in the translocation among species may explain some of the variability in glyphosate phytotoxicity among different species of plants. D'Anieri et al. (1990) report an interactive effect among glyphosate translocation efficiency, water stress, and application timing (e.g., during fall dormancy) in red maple and loblolly pine seedlings.

Results of these studies suggest that glyphosate phytotoxicity to target and nontarget plants appears to depend on several factors, including plant physiological status, plant retention, uptake and translocation rates, timing of application, and application rate. The magnitude of adverse effects on nontarget plants also depends on the extent of overspray and drift losses during glyphosate application, as well as species-specific uptake and translocation rates. Any adverse effects on nontarget plant species are expected to be short-term, because glyphosate biodegrades rapidly and does not appear to inhibit seed germination or establishment immediately after application (Chakravarty and Chatarpaul 1990).

6.1.2 Submerged Aquatic Vegetation

Limited studies have been conducted on the effects of glyphosate on submerged aquatic plants. In a laboratory growth inhibition study, no adverse effects were observed on the growth of *Elodea canadensis* (elodea), *Myriophyllum spicatum* (water milfoil), or *Vallisneria americana* (wild celery) exposed to glyphosate concentrations of up to 1,000 ppb for 3 to 6 weeks (Forney and Davis 1981). The authors conclude that glyphosate was essentially nontoxic to the tested species. These results appear consistent with the findings of other investigators who report that submerged aquatic plants are either resistant (Evans 1978) or affected by only very high glyphosate concentrations (Peverly and Crawford 1975).

Although available information on the effects of glyphosate on submerged aquatic plants suggests that there is no risk to this group of plants, additional information regarding

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impacts on ecologically important species, such as eelgrass, is needed. No information is currently available on the effects of glyphosate on eelgrass. However, information on the potential impacts of glyphosate on eelgrass and other submerged aquatic vegetation is likely to come from a *Spartina alterniflora* control study being conducted in Willapa Bay, Washington by the U.S. Fish and Wildlife Service and the University of Washington School of Fisheries.

6.1.3 Algae, Periphyton, and Phytoplankton

Results of laboratory and field studies of both freshwater and marine algae, periphyton, and phytoplankton generally indicate that glyphosate is slightly toxic to practically nontoxic to these plant groups (see Table 1). However, there is considerable intraspecific and interspecific variation among studies on the reported population growth effects of glyphosate. For example, glyphosate growth inhibition of various algal species ranges from a level of 100 mg/L in a 2-day exposure of the green alga *Dunaliella bioculata* (Felix et al. 1988) to a level of 203,000 mg/L for the flagellated euglenoid (*Euglena gracilis*) in a 6-day exposure experiment (Richardson et al. 1979). Some of the variation in toxicity is explained by the increased sensitivity or susceptibility of test organisms in laboratory cultures and environments. Several studies report adverse effects for low levels (<1 ppm) of glyphosate (Heydens 1991; Felix et al. 1988; Turbak et al. 1986). However, glyphosate concentrations that cause adverse effects on algae and periphyton are generally several orders of magnitude greater than concentrations that would occur with normal application for aquatic weed control. Moreover, toxicities observed in the laboratory have not been corroborated by similar results in field studies (Garnett 1991; Heydens 1991). Tooby (1985) attributes the lack of toxicity *in situ* to the rapid loss of chemical from the water, primarily through adsorption and dilution.

Growth rates and biomass accrual of lotic periphyton (i.e., plants attached to surfaces in moving water environments) in experimental streams were not adversely affected by low concentrations of glyphosate (1 to 300 ppb) (Austin et al. 1991). The authors report that periphyton biomass accrual appears to be stimulated by glyphosate addition, indicating that glyphosate may be used as a source of phosphorus. Bothwell (1985) demonstrated that lotic periphyton growth rates are saturated at very low phosphorus levels (0.003 ppm). Austin et al. (1991) conclude that there may be some potential for glyphosate to contribute to cultural eutrophication in oligotrophic, nutrient-limited ecosystems.

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Therefore, the potential for glyphosate to be used as a source of phosphorus and to contribute to cultural eutrophication requires further study.

Growth inhibition of algae, periphyton, and phytoplankton are unlikely to occur because maximum observed glyphosate concentrations in the receiving environment are generally lower than levels that inhibit growth, and these concentrations decrease rapidly over a period of days to weeks. If growth inhibition of algae, periphyton, and phytoplankton occurs, it is likely to be only temporary due to the rapid biodegradation and dissipation of glyphosate in the environment.

Because of the importance of freshwater and marine algae, periphyton, and epiphytes to the food chain, additional studies are needed to evaluate potential chronic effects of glyphosate (e.g., mutagenicity, bioconcentration, and bioaccumulation). Moreover, quantification of environmental concentrations resulting from routine emergent weed control applications is needed, particularly for marine environments. Additional toxicity information, particularly for critically important species such as eelgrass, is also needed. There appears to be no information available on potential bioaccumulation, effects on species composition, or trophic transport. However, based on glyphosate's chemical characteristics (i.e., high solubility in water and low octanol/water partition coefficient), it is not likely to bioaccumulate. Finally, information is needed on secondary effects due to nutrient release from decomposing vegetation after glyphosate treatment, particularly in nutrient-limited systems.

7.0 POTENTIAL IMPACTS TO ANIMALS

Acute and sublethal effects of glyphosate exposure on various animal groups are summarized in this section. Information is presented on the bioconcentration and bioaccumulation of glyphosate in these animal groups, and gaps in data on the chronic and acute effects of glyphosate and its degradation products are summarized.

7.1 MAMMALS

Wetland environments that support purple loosestrife and cordgrass are important to a number of terrestrial and aquatic mammals. Riverine, lakeshore, estuarine, and some manmade wetlands (e.g., retention/detention facilities and irrigation canals) may be important habitat areas for large and small mammals. Glyphosate applications to control noxious emergent weeds in these environments may adversely affect animals by altering habitat quality and quantity.

The effects of glyphosate applications on large and small mammals is primarily related to alteration of habitat, food quality, food preference, exposure concentration, persistence, and accumulation. Adverse effects are measured and evaluated by examining the effects of exposure on reproductive success, growth, survival, and population. Overspray and drift from treated areas may adversely affect adjacent nontarget plant communities. These adverse effects may be manifested as changes in vegetational species composition, density, diversity, and abundance. Herbivorous animals such as small mammals and deer may be attracted to changes in vegetational communities resulting in abundance and diversity of preferred foods or cover types.

The response of mammals to herbicide application can be predicted if data are available on the range of habitats occupied by a species and its density in these habitats (Morrison and Meslow 1983). In other words, the potential adverse effects of noxious emergent weed control activities using glyphosate depend on the numbers and types of mammals using treated areas; the availability of other suitable habitats if unfavorable alterations in habitat occur; and the effects of exposure on reproduction, growth, and survival of these animals. Adverse effects from glyphosate treatment on preferred habitat areas are likely to be temporary, pending regrowth of desirable emergent vegetation in the treated area.

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All of the existing acute and chronic toxicity information on glyphosate effects on small mammals in field conditions is based on Roundup® application in coniferous forest ecosystems. Roundup® is not registered for aquatic use in Washington state. However, because no data are available for Rodeo®, these results are presented here to provide an indication of the potential acute and chronic effects of glyphosate (Rodeo®) on small mammals under field conditions.

Sullivan (1990) and Ritchie et al. (1987) report short-term increases in the abundance and quality of food and cover (i.e., grasses and herbs) for deer mouse and Oregon vole 1 year after Roundup® application. No adverse effects on reproduction, growth, or survival have been observed in Oregon vole or deer mouse in test plots treated with Roundup® (Sullivan 1990; Sullivan and Sullivan 1981). Based on these data, it appears unlikely that Rodeo®, which has been proven less toxic than Roundup® to fish (acute toxicity basis), will cause acute or chronic effects in small mammals (Mitchell et al. 1987a).

7.1.1 Acute Effects

Available acute toxic effects data for glyphosate are based primarily on analyses using rats and rabbits. Acute oral and dermal glyphosate toxicities occur at high concentrations (see Table 2). The single dose acute oral toxicities (i.e., LD_{50}) of glyphosate in rabbits and rats range from 3,800 mg/kg for rabbits to 5,600 mg/kg for rats (USDA 1981; Monsanto 1983). Acute dermal toxicity of glyphosate to rabbits is also very high, ranging from >5,000 to >7,940 mg/kg (Weed Science Society of America 1983; Monsanto 1983). The variation in dermal toxicity is a result of different testing methods. The higher dermal toxicity value (>7,940 mg/kg) represents the minimum lethal dose for skin absorption, whereas the lower value (>5,000) is reported as an LD_{50} (median lethal dose). In all cases, these concentrations are several orders of magnitude above the potential dose from exposure to the maximum observed concentrations in streams and ponds resulting from normal application rates (0.162 to 0.600 mg/L) (Henry 1992; Feng et al. 1990; Newton et al. 1984).

Significant gaps exist in the available acute toxicity information on pure glyphosate effects on mammals that are likely to inhabit or use emergent wetlands. For example, no information is available on the toxicity of glyphosate or its degradation products to raccoons, bears, mustelids (e.g., minks, weasels, and ermines), foxes, elks, beavers, muskrats, shrews, or other terrestrial or aquatic mammals. However, based on

Table 2. Acute and chronic toxicity of glyphosate to mammals.

Organism	Nature of Exposure	Effect	Concentration (mg/kg)	Toxicity Category	Reference
Rabbit	Single dose acute oral (8 day)	LD50	3,800	Practically nontoxic	U.S. Dept. of Energy 1983
Rat	Single dose acute oral (8 day)	LD50	5,400	Practically nontoxic	Weed Sci. Soc. Am. 1983
	Single dose acute oral (8 day)	LD50	>5,000	Practically nontoxic	Monsanto 1983
	Single dose acute oral (8 day)	LD50	4,040	Practically nontoxic	USDA 1981
Rabbit	Single dermal application - 24-hr exposure	MLD	0-300	Practically nontoxic	Weed Sci. Soc. Am. 1983
	Single dermal application - 24-hr exposure	LD50	>5,000	Practically nontoxic	Monsanto 1983
Rat	0, 30, 100 or 300 ppm dietary for 2 yrs; chronic	No significant differences	0-300		Monsanto 1983
Dog	0, 30, 100 or 300 ppm dietary for 2 yrs; chronic	No significant differences	0-300	No carcinogenic or histopathologic effects	USDA 1981
Mouse	0, 30, 100 or 300 ppm dietary for 2 yrs; chronic	No significant differences	0-300	No evidence of increase in cytoplasmic vacuolation	USDA 1981

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Table 2. Acute and chronic toxicity of glyphosate to mammals (continued).

Organism	Nature of Exposure	Effect	Concentration (mg/kg)	Toxicity Category	Reference
Rat	3 gen. reprod. dietary intake 30, 100, or 300 ppm	No significant differences	0-300	No reproductive or teratogenic effects	USDA 1981
Rat	Teratology test	NOEL	3,500	No teratogenic effects	U.S. EPA 1982
Rabbit	Fetotoxicity test	NOEL	175		U.S. EPA 1982
Mouse	0, 100, or 300 ppm dietary for 18 mos.	No significant differences	0-300	No correlation between treatment and carcinogenicity	USDA 1981
Mouse	Dominant lethal test		5 or 10	No mutagenic effects	USDA 1981

MLD - Minimum lethal dose
NOEL - No-observed-effects level

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glyphosate toxicities to rats and rabbits, it appears unlikely that glyphosate will adversely affect terrestrial or aquatic mammals.

7.1.2 Chronic Effects

Laboratory studies of the chronic effects of glyphosate show that it is slightly to practically nonirritating to the eyes of rabbits and also practically nonirritating to their skin (Monsanto 1983). Ninety-day studies on the subchronic oral toxicity of glyphosate to rats and dogs indicate that high oral doses of up to 2,000 ppm do not significantly affect behavior, survival, or body weight. No significant reproductive, teratogenic, mutagenic, or carcinogenic effects from exposure to concentrations of glyphosate of up to 300 ppm are reported in long-term (2-year) laboratory studies of rats, dogs, rabbits, and mice. Therefore, based on these studies, it appears unlikely that glyphosate will have adverse chronic effects on mammals that inhabit or use emergent wetlands.

7.2 BIRDS

Acute and toxic effects of glyphosate on birds have been evaluated using bobwhite quails and mallard ducks. The diet of gallinaceous birds, such as the bobwhite quail, consists primarily of vegetation and seeds. Bobwhite quails, which are smaller and ingest more food per unit of body weight than their larger gallinaceous allies, are used to assess glyphosate toxicity because they are more likely to be exposed to higher doses of glyphosate than are other members of this group (Heydens 1991). Therefore, the bobwhite quail is a good indicator of potential adverse effects of pesticide exposure to this group of birds. Similarly, mallard ducks are used to evaluate the potential toxicity of glyphosate to dabbling ducks. The diet of dabbling ducks consists primarily of terrestrial and aquatic vegetation and some aquatic insects.

7.2.1 Acute Effects

Acute toxicological characteristics of glyphosate in birds are summarized in Table 3. The toxicity of glyphosate to bobwhite quail chicks and mallard ducklings has been assessed using both single dose acute oral (followed by an 8-day observation period) and dietary intake tests. Bobwhite quail chicks and mallard ducklings were exposed to dietary glyphosate concentrations of up to 4,640 mg/kg. No mortality or treatment-related signs (e.g., abnormal weight gain) were observed in either species. Because there were no

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Table 3. Acute and chronic toxicity of glyphosate to birds.

Organism	Effect	Nature of Exposure	Concentration (mg/kg)	Toxicity Classification*
Bobwhite quail chicks	LD50	Single dose acute oral (8 day)	>4,640	Practically nontoxic
Bobwhite quail chicks	LC50	8-day dietary	994 mg/kg-day or >4,640 ppm	Practically nontoxic
Mallard duck chicks	LC50	8-day dietary	1,106 mg/kg-day or >4,640 ppm	Practically nontoxic
Bobwhite quail adult female	None	One-generation study of reproduction effects	>1,000 ppm or 96 mg/kg-day	Practically nontoxic
Mallard duck adult female	None	One-generation study of reproduction effects	>1,000 ppm or 126 mg/kg-day	Practically nontoxic

Source: Heydens 1991
* Toxicity classification follows Christensen 1976

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adverse reactions at these exposure levels, the LD_{50} and LC_{50} values are reported as >4,640 mg/kg and >4,640 ppm, respectively. The latter figure is equivalent to an average dietary intake of 994 mg/kg-day for bobwhite quail and 1,106 mg/kg-day for mallards, well above potential exposures at normal application rates (Heydens 1991).

This information indicates that glyphosate is practically nontoxic to bobwhite quails and mallard ducks and presumably to other members of the gallinaceous and dabbling duck bird groups. Because lethal toxicities are unlikely to be reached, no adverse effects on gallinaceous or dabbling duck bird populations are expected from normal applications of glyphosate for control of aquatic weeds. Additional lethal toxicity information is needed on other birds groups that use wetland areas, such as perching birds and shorebirds. These birds nest and feed in emergent wetlands and may have different tolerances to glyphosate because of different metabolic rates and diets.

7.2.2 Chronic Effects

Reproductive effects of glyphosate on bobwhite quails and mallard ducks have been studied. Females of these two species were exposed to dietary concentrations of up to 1,000 ppm throughout a one-generation study (17 weeks). The numbers of eggs laid, eggs cracked, viable embryos, and normal hatchlings, as well as eggshell thickness and post-hatchling growth and survival, were measured to assess the reproductive effects of exposure to glyphosate. No measurable effects were identified at any of the dietary concentrations evaluated. The highest evaluated concentration, 1,000 ppm, is equivalent to an average daily intake of 96 and 126 mg/kg in quails and mallard ducks, respectively (Heydens 1991).

Based on this information, it appears unlikely that adverse effects on successful reproduction will occur as a result of routine glyphosate applications for the control of noxious emergent vegetation.

Additional information is needed on other potential chronic effects of glyphosate on birds. No information is currently available on mutagenic, carcinogenic, or teratogenic effects of glyphosate on birds. Although glyphosate is unlikely to bioconcentrate in birds (based on its low water/octanol partition coefficient and the bioconcentration factors determined for fish), additional information is needed on the bioconcentration and accumulation of glyphosate in birds.

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7.3 FISH

7.3.1 Acute Effects

Acute toxicities of glyphosate in fish have been reported by several investigators. The range of glyphosate concentrations causing acute toxic effects are summarized in Table 4. Reported lethal concentrations for glyphosate vary considerably among studies for individuals of one species and for different species. For instance, 96-hour LC_{50} values for fathead minnows range from 97 to 127 mg/L. Similarly, lethal concentrations for rainbow trout vary from 130 to 240 mg/L. In all cases, the reported lethal concentrations for salmonids and other fishes are classified as slightly to practically nontoxic (see Table 4). Furthermore, these concentrations are one to three orders of magnitude higher than the highest concentration (0.600 mg/L) observed for a 2.8 kg/ha (2.5 lb/acre) treatment application rate using Rodeo® to control cattails in prairie pothole wetlands (Henry 1992). Other investigations report similar concentrations of glyphosate in water, ranging from 162 to 352 ppb for application rates of 2.0 to 3.3 kg/ha (Feng et al. 1990; Goldsborough and Beck 1989; Newton et al. 1984). Still other investigations report that no acute toxicity hazards are likely at usual application rates (Mitchell et al. 1987a; Tooby 1985).

Mitchell et al. (1987a) report lethal concentrations for rainbow trout (*Salmo gairdneri*), chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*O. kisutch*) of 680 to 1,070 mg/L, 750 to 1,440 mg/L, and 600 to 1,000 mg/L, respectively, for a mixture of Rodeo® and Valent X-77 surfactant (formerly Ortho X-77). Higher toxicities were observed for the Rodeo®/X-77 mixture than for pure glyphosate, indicating that the surfactant is more toxic than glyphosate. For example, lethal concentrations to rainbow trout were 1,100 mg/L for Rodeo® (i.e., pure glyphosate), compared to 680 mg/L for Rodeo®/X-77. These results indicate that pure glyphosate was practically nontoxic to rainbow trout, chinook salmon, and coho salmon (Mitchell et al. 1987a). (Note that the Rodeo® label requires a nonionic surfactant be used with Rodeo®.)

Variation in acute toxicity to salmonids and other species may be caused by several factors including variation in water quality characteristics (e.g., pH, hardness, alkalinity, temperature, and conductivity) and differences in toxicity testing methods. Differences in water quality can affect acute toxicity of pesticides (Rand and Petrocelli 1985). Although inconclusive, some authors have indicated or suggested that glyphosate toxicity to

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Table 4. Acute and chronic effects of glyphosate in fish.

Organism	Effect	Duration	Concentration (ppb)	Life Stage	Toxicity Classification*	Reference
Rainbow trout	LC50	4 days	130,000	0.8 grams	Practically nontoxic	Johnson and Finley 1980
	LC50	1 day	140,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	1 day	240,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	140,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	140,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	240,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	240,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	AVO	4 days	10,000	Fry	Moderately toxic	Folmar 1976
Bleak	LC50	4 days	16,000	Fingerling	Slightly toxic	Linden et al. 1979
Bluegill	LC50	1 day	150,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	1 day	230,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	1 day	240,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	135,000	0.9 grams	Practically nontoxic	Johnson and Finley 1980
	LC50	4 days	140,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	140,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	220,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
Channel catfish	LC50	1 day	130,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	130,000	0.5-2.2 grams	Practically nontoxic	Folmar et al. 1979
	LC50	4 days	130,000	2.2 grams	Practically nontoxic	Johnson and Finley 1980
Common carp	LC50	1 day	12,800	4.5 cm, 110 grams	Slightly toxic	Li and Chen 1981
	LC50	4 days	115,000		Practically nontoxic	Li and Chen 1981
Fathead minnow	LC50	1 day	97,000	0.5-2.2 grams	Slightly toxic	Folmar et al. 1979
	LC50	4 days	97,000	0.5-2.2 grams	Slightly toxic	Folmar et al. 1979
	LC50	4 days	97,000	0.5-2.2 grams	Slightly toxic	Johnson and Finley 1980
	LC50	NR	127,000	0.6 grams	Practially nontoxic	Henry 1992

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Table 4. Acute and chronic effects of glyphosate in fish (continued).

Organism	Effect	Duration	Concentration (ppb)	Life Stage	Toxicity Classification*	Reference
Flagfish	LC20-D	2 hours	2,940	8 days posthatch	Moderately toxic	Holdway and Dixon 1988
	LC20-D	2 hours	29,600	8 days posthatch	Slightly toxic	Holdway and Dixon 1988
Grass carp	LC50	1 day	26,000	Fingerling 1st yr	Slightly toxic	Tooby et al. 1980
	LC50	2 days	24,000	Fingerling 1st yr	Slightly toxic	Tooby et al. 1980
	LC50	4 days	15,000	Fingerling 1st yr	Slightly toxic	Tooby et al. 1980

LC50 - Median lethal concentration (96-hr)
LC20-D - Lethal concentration to 20 percent of the population
* Toxicity classification follows Christensen 1976
NR - Not reported

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salmonids is related to changes in dilution water hardness, pH, alkalinity, temperature, and conductivity. Folmar et al. (1979) reported increased acute toxicity (96 hr-LC_{50}) to rainbow trout and bluegill relative to increases in water temperature and pH (6.5 to 7.5). However, no increase in acute toxicity was observed when pH changed from 8.5 to 9.5. By contrast, Mitchell et al. (1987a) reported no significant differences ($p < 0.05$) in glyphosate toxicity as a function of dilution water pH, hardness (4.5 to 85 mg/L $CaCO^3$), and conductivity. However, they concluded that the toxicity of a Rodeo®/X77 mixture to coho and chinook salmon and rainbow trout did appear to decrease in waters with relatively high pH (7.8), hardness (77 mg/L $CaCO^3$), and conductivity (130 umhos/cm). Wan et al. (1989) also reported decreasing acute toxicity (96 hr-LC_{50}) to coho, chum, pink, and chinook salmon and rainbow trout relative to increasing pH and hardness. They reported 96 hr-LC_{50} values of 10-27 mg/L glyphosate in slightly acidic (pH 6.3), soft water (3.5-10 mg/L $CaCO^3$) and 96 hr-LC_{50} values of 148-211 mg/L glyphosate in slightly basic (pH 8.2), hard water (86 mg/L $CaCO^3$). In addition, they concluded that hardness and pH of dilution waters appear to be the key factors influencing acute toxicity of glyphosate to salmonids. Mitchell et al. (1987a) suggest that differences in toxicity testing methods among studies may explain the wide range in lethal concentrations reported in the literature.

Another source of variation in the reported lethal concentrations may be varying percentages of impurities in different batches of glyphosate. Glyphosate reportedly may contain up to 0.1 ppm N-(nitrosoglyphosate), for which no toxicity information exists (USDA 1992).

Differences in the kind of surfactant used in a glyphosate formulation (i.e., surfactant plus technical grade glyphosate) also have been suggested as a potential source of variation in lethal concentrations (Henry 1992; Mitchell et al. 1987a; Hildebrand et al. 1982). Several researchers suggest that the surfactant used in a glyphosate formulation has additive effects on the lethal toxicity level and that the surfactant itself is more toxic to salmonids than technical glyphosate alone (Wan et al. 1989; Mitchell et al. 1987a; Hildebrand et al 1982). Wan et al. (1989) report lethal concentrations in salmonids exposed to pure glyphosate ranging from 16 to 184 mg/L, depending on the dilution water type. By contrast, they report lethal effects in salmonids for surfactant concentrations ranging from 1.6 to 3.3 mg/L. Similar findings are reported by Mitchell et al. (1987a) as discussed above.

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Additional lethal toxicity information is needed to more accurately assess the potential effects of glyphosate on salmonids and other fishes, particularly on larvae and fry, which may be more vulnerable to pollutants. Available acute toxicity information concentrates primarily on freshwater fishes. Information is lacking on the acute toxicity of glyphosate on all life history stages of marine fishes. No information is currently available on glyphosate toxicity to herring, ocean perch, sturgeon, or sea-run cutthroat trout. For accurate assessment of the potential effects of glyphosate on fish populations, information on the acute toxicity to larvae, fry, fingerlings, smolts, and adults is needed.

7.3.2 Chronic Effects

Few studies have been conducted on the chronic effects of glyphosate on fish. Some studies identify chronic effect threshold concentrations for rainbow trout and salmon fry and fingerlings in freshwater (Table 4). All of these studies found that threshold effect concentrations were above receiving water concentrations expected for usual application rates of glyphosate to control emergent vegetation. In addition, concentrations of glyphosate causing chronic effects are between 2.5 and 5 times those allowed by label restrictions. The maximum glyphosate concentration following label requirements (Monsanto 1991) for control of purple loosestrife over a one-acre area containing 6 inches of water would be approximately 2 mg/L, which is five times lower than the concentration resulting in rainbow trout avoidance behavior. This assumes even diffusion of the glyphosate over the entire area. Similarly, the maximum glyphosate concentration for Spartina control that would occur by following the manufacturer specifications (up to 7.5 pints Rodeo®/acre) would be approximately 4 mg/L, which is 2.5 times lower than the concentration causing avoidance in rainbow trout.

Information on chronic toxicity effects of glyphosate on osmoregulation and smoltification of salmonids is limited to findings of a study of Roundup®. Unlike Rodeo®, Roundup® contains glyphosate, inert ingredients, and a surfactant (although the Rodeo® label requires use of a surfactant). Mitchell et al. (1987b) examined the effects of Roundup® exposure on the osmoregulation of coho salmon smolts. They found that yearling smolt survival after 24 hours in seawater was unaffected by exposure to Roundup® concentrations of up to 10 times those encountered in water immediately after aerial application (2.78 mg/L). Furthermore, they report no abnormal responses in smolts when a 10-day freshwater recovery period was permitted between herbicide and seawater exposures. These investigators suggest that coho smolt osmoregulation and survival

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would not be affected by Roundup® applied at rates specified on the product label. Based on this information, it appears likely that application of Rodeo® without a surfactant will not adversely affect smoltification, smolt survival, or completion of the freshwater-to-saltwater transition phase of salmonid or other anadromous fish life cycles. However, the use of Rodeo® without a surfactant would likely be considered a violation of label requirements.

Chronic toxicity information on salmonids and other fishes also appears to be limited to studies of the toxic effects of Roundup®. Morgan and Kiceniuk (1992) examined the effects of 1- and 2-month exposures to various concentrations of Vision® (the same formulation as Roundup®) on growth, carcinogenicity, feeding, and agonistic behavior in rainbow trout hatchery fingerlings. They found no significant adverse affects on the feeding or agonistic behavior of rainbow trout exposed to Vision® concentrations of 4.25, 8.0, and 45.75 ppb. In addition, exposures to these concentrations resulted in no significant adverse effects on growth in length or body weight or in the number of gill lesions. These investigators conclude that the sublethal levels of Roundup® test concentrations are relatively nontoxic. As in the smoltification toxicity results, these results suggest that Rodeo® (which has been found less toxic than Roundup® in acute toxicity studies), is unlikely to adversely affect salmonid behavior, growth, or cancer rates.

Glyphosate bioaccumulation and excretion in fish has not been extensively studied. Sacher (1978) reports a bioconcentration factor of 1.6 for bluegill sunfish exposed to 0.6 ppm glyphosate for a period of 28 days. However, Sacher (1978) reports much lower bioconcentration factors for rainbow trout, largemouth bass (*Micropterus salmoides*), and channel catfish (*Ictalurus punctatus*), of 0.03, 0.04, and 0.18, respectively. These bioconcentration factors resulted from exposure to 10 ppm of glyphosate for a period of 14 days, followed by a 35-day period in clean water. In clean water, the rainbow trout and catfish eliminated approximately 50 percent of the initial concentration within 4 to 6 days. Brandt (1984) reports similar findings, with bioconcentration factors in fish tissue ranging from 0.2 to 0.3 after fish were exposed to glyphosate for 10 to 14 days. The tested fish species are not named. These low bioconcentration factors indicate that there is a low bioaccumulation potential for glyphosate and therefore a low potential for adverse, long-term impacts on fish (Reinert and Rodgers 1987). Tooby (1985) concludes that based on these bioconcentration factors, depuration rates, and the low octanol/water partition coefficient of glyphosate, bioaccumulation is unlikely to occur in the tested fish species. Based on these data, glyphosate appears to be nonaccumulative.

Although limited information on the chronic effects (e.g., reproductive, carcinogenic, behavioral, and physiological effects) of Roundup® formulations exists, additional information is needed to assess the potential mutagenic, teratogenic, carcinogenic, and reproductive effects of pure glyphosate on salmonids and other fishes. Additional data on the latent secondary effects of glyphosate exposure, such as immunosuppression, susceptibility to parasites or diseases, and reduced fitness, are also lacking. Significant information gaps also exist on chronic toxicities to marine fish species. No information is currently available on the effects of glyphosate degradation products on fish.

7.4 AQUATIC INVERTEBRATES

7.4.1 Acute Effects

Lethal toxicities of glyphosate to various freshwater and marine organisms are summarized in Table 5. Lethal toxicities range from 22 ppm for a harpacticoid copepod to 1,157,000 ppb for a freshwater leech (*Nepahelopsis obscura*), indicating that glyphosate is only slightly toxic (10,000 to 100,000 ppb) to practically nontoxic (100,000 to 1,000,000 ppb) for most of those freshwater and marine invertebrates tested. Glyphosate has been classified as an insignificant hazard (LC_{50} >1,000 ppb) for a few organisms. Tolerance to glyphosate and lethal toxicities vary depending on the life history stage of the organism, receiving environment conditions, and toxicity testing methods. Based on these data, it appears unlikely that lethal toxicities will occur in either freshwater or marine environments for most organisms during application of glyphosate to control emergent aquatic vegetation.

Henry (1992) found no significant differences in the survival of six species of invertebrates between treated and control wetlands at an application rate of 2.8 kg/ha. Although low levels of glyphosate may persist in some soils and sediments for up to a year, glyphosate generally has a short half-life (days to weeks) in water and sediment (where many invertebrates live), and maximum concentrations of glyphosate in the receiving waters are typically well below lethal levels. Therefore, it is unlikely that populations of freshwater or marine invertebrates will be adversely affected through emergent vegetation control activities.

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Table 5. Acute and chronic effects of glyphosate in freshwater and marine aquatic invertebrates.

Organism	Effect	Concentration (ppb)	Life Stage	Toxicity Classification*	Reference
Freshwater					
Daphnia magna (Waterflea)	EC50-MOR	545,000	1st instar	Practically nontoxic	Henry 1992
Chironomous riparius (Midge)	EC50-MOR	1,308,000	4th instar	Insignificant hazard	Henry 1992
Chironomus plumosus	EC50-IM	55,000		Moderately toxic	Folmar et al. 1979
Chironomous riparius (Midge)	96-hr EC50-M	727,000	Adult	Practically nontoxic	Henry 1992
Stagnicola elodes (Pond snail)	EC50	242,000	Adult	Practically nontoxic	Henry 1992
Nephaelopsis obscura (Leech)	LC50	1,157,000	Adult	Insignificant hazard	Henry 1992
Anopheles quadrimaculatus (Mosquito)	LC50	673,000	4th instar	Practically nontoxic	Holck and Meek 1987
Red swamp crayfish	LC50	47,310	Immature, 25-40 mm	Slightly toxic	Holck and Meek 1987
Marine					
Palaemonetes vulgaris (Grass shrimp)	TL50-MOR	281,000	NR	Practically nontoxic	Heydens 1991
Mysidopsis bahia (Mysid shrimp)	LC50	>1,000,000	NR	Insignificant hazard	Heydens 1991

Continued...

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Table 5. Acute and chronic effects of glyphosate in freshwater and marine aquatic invertebrates (continued).

Organism	Effect	Concentration (ppb)	Life Stage	Toxicity Classification*	Reference
Marine (continued)					
Crassostrea virginica (Atlantic oyster larvae)	EC50	>10,000	Egg/larvae	Slightly toxic	Heydens 1991
Tripneustes esculentus (Sea urchin)	96-hr EC50-I	>1,000,000	NR	Insignificant hazard	Heydens 1991
Uca pugilator (Fiddler crab)	LC50	934,000	NR	Practically nontoxic	Heydens 1991

* Toxicity classification follows Christensen 1976
LC50 - Median lethal concentration; 96-hr unless indicated otherwise
EC50- 48 hr. unless indicated otherwise
IM - Immobility
TL - Tolerance limit to produce effect in 50 percent of test organisms
NR - Not reported

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7.4.2 Chronic Effects

There are limited studies on the chronic or sublethal effects of glyphosate on aquatic invertebrates. A few studies present information on the behavioral, mutagenic, and bioconcentration characteristics of glyphosate. Except for some depression in the copulation rate of *Rivulogammus pulex*, Kikuth (1979) found no evidence of behavioral abnormalities in *R. pulex* or *Carcinogammus roesilli* exposed to a glyphosate concentration of 16 μg/L. *R. pulex*, which inhabits clean, fast-flowing streams, was considered a more sensitive species. Another behavioral trait that has been used to assess adverse effects of chemical pollution in water is invertebrate drift. Tooby (1985) found no effect on the drift of midge (*Chironomus* spp.) larvae exposed to glyphosate concentrations of 2 mg/L in artificial streams. Based on these data, it appears unlikely that adverse behavioral effects will result from the expected low concentrations of glyphosate in the water column.

Glyphosate does not appear to be mutagenic. Heydens (1991) reports normal larval development in fertilized eggs of the Atlantic oyster (*Crassostrea virginica*) exposed to concentrations of glyphosate ranging from 0.24 to 10 ppm for 48 hours. Although glyphosate does not appear to be a mutagen based on this information, additional information on the mutagenicity of glyphosate is needed to confirm this conclusion.

Bioconcentration factors have been calculated for a marine mollusk and a freshwater crayfish. The marine mollusk *Rangia cuneata* was exposed to a glyphosate concentration of 0.54 ppm for 35 days, followed by a 42-day depuration (recovery) period (Heydens 1991). The average tissue glyphosate concentration at the end of the recovery phase was 2.4 ppm. Approximately 50 percent of the accumulated glyphosate was excreted during the depuration period. The bioconcentration factor was calculated as 9.6 (Heydens 1991). (Heydens notes that a bioconcentration factor greater than 100 indicates the potential to bioaccumulate.) Heydens (1991) calculated a bioconcentration factor of 0.27 for crayfish based on a similar experiment, using an initial glyphosate concentration of 0.53 ppm, an exposure period of 28 days, and a depuration period of 44 days. Both experiments used initial glyphosate concentrations similar to the maximum glyphosate concentration (0.600 mg/L) in water observed by Henry (1992) following emergent vegetation control activities. Therefore, these bioconcentration factors appear representative of the glyphosate levels and effects that are likely to result from application

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for control of loosestrife and cordgrass emergent vegetation. Based on these findings, it appears that glyphosate will not bioconcentrate or bioaccumulate in deposit feeders (e.g., mollusks) or detritivores (e.g., crabs, crayfish, and shrimp). While it appears that adverse biological affects to shellfish populations are unlikely from glyphosate applications, it is not known how residual levels, if they occur, will affect commercial shellfish production in areas such as Willapa and Padilla bays.

Considering the information presented here, it appears unlikely that application of glyphosate to control emergent aquatic vegetation will cause adverse behavioral, mutagenic, or bioaccumulation effects on aquatic invertebrates. However, additional information is needed on the potential carcinogenic, teratogenic, and reproductive effects of glyphosate.

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8.0 ADDITIONAL INFORMATION NEEDS

8.1 SOIL AND SEDIMENT

Because some studies indicate that low levels of glyphosate may persist for up to a year or more, additional research is needed to quantify and evaluate glyphosate degradation and persistence in both emergent freshwater and emergent saltmarsh sediments.

8.2 WATER

Glyphosate application may contribute to increases in bioavailable nitrogen and phosphorus fractions thereby contributing to eutrophication and associated adverse effects to water quality. The potential effects of glyphosate applications on nutrient availability, particularly phosphorus, requires further study.

8.3 PLANTS

8.3.1 Submerged Aquatic Vegetation

Although available information on the toxicity of glyphosate to submerged aquatic plants suggests there is no risk to this group of plants, additional information is needed on the potential effects to ecologically important species such as eelgrass. Such additional information is likely to come from a *Spartina alterniflora* control study being conducted in Willapa Bay, Washington by the U.S. Fish and Wildlife Service and the University of Washington School of Fisheries.

8.3.2 Algae, Periphyton, and Phytoplankton

Based on the available data, it appears unlikely that glyphosate application will cause growth inhibition and other adverse chronic or acute effects to algae, periphyton, and phytoplankton. However, because of the position of these organisms at the base of the food web and their importance to marine and freshwater ecosystems, additional information is needed to confirm and support these findings. In particular, additional

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information is needed on the persistence and chronic effects of repeated glyphosate treatments on these plants.

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8.4 ANIMALS

8.4.1 Mammals

Significant gaps exist in the available acute toxicity information on pure glyphosate effects on mammals that are likely to inhabit or use emergent wetlands. For example, no information is available on the toxicity of glyphosate or its degradation products to raccoons, bears, mustelids (e.g., minks, weasels, and ermines), foxes, elks, beavers, muskrats, shrew, or other terrestrial or aquatic mammals. However, based on glyphosate toxicities to rats and rabbits, it appears unlikely that glyphosate will adversely affect terrestrial or aquatic mammals.

8.4.2 Birds

Additional acute toxicity information is needed on other bird groups that use wetland areas, such as perching birds and shorebirds. These birds nest and feed in emergent wetlands and may have different tolerances to glyphosate because of different metabolic rates and diets.

Also, additional information is needed on the potential mutagenic, carcinogenic, and teratogenic effects of glyphosate on birds. Furthermore, the potential bioconcentration and bioaccumulation of glyphosate in birds requires additional study. No information is currently available on these topics.

8.4.3 Fish

More information is needed to assess the potential impacts of water quality parameters, such as pH, hardness, conductivity, and temperature on glyphosate toxicity to fish. Although limited information on the chronic effects (e.g., reproductive, carcinogenic, behavioral, and physiological effects) of Roundup® formulation exists, there is little information on the chronic effects of Rodeo® or Rodeo®/nonionic surfactant mixtures to salmonids or other fishes. In addition, there is no information on the latent secondary effects of glyphosate to fish, such as immunosuppression, susceptibility to parasites or diseases, and reduced fitness. Significant information gaps also exist on both the chronic and acute toxicity of glyphosate to all life phases of marine fish species. No information is currently available on the effects of glyphosate degradation products to fish or on the effects of repeated applications to fish.

8.4.4 Amphibians and Reptiles

There is no available information on the acute chronic effects of glyphosate to amphibians and reptiles. Because many amphibian species are dependent on wetlands for successful reproduction and juvenile development, the potential effects of glyphosate to amphibian reproduction and growth are of particular importance.

8.4.5 Invertebrates

Although glyphosate does not appear to be a mutagen based on existing toxicity data, additional research on the potential mutagenicity of glyphosate and Rodeo®/nonionic surfactant mixtures is needed to confirm this conclusion. In addition, further information is needed on the potential carcinogenic, teratogenic, and reproductive effects of glyphosate and Rodeo®/nonionic surfactant mixtures to ecologically and commercially important invertebrates such as amphipods, Dungeness crab, mussels, clams, and oysters.

8.5 GENERAL

A potential source of the variation in reported lethal and chronic toxicities of glyphosate may be varying percentages of impurities in different batches of glyphosate. Glyphosate reportedly may contain up to 0.1 ppm N-(nitrosoglyphosate), for which no toxicity information exists (USDA 1992).

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9.0 SUMMARY AND CONCLUSIONS

Although glyphosate may persist at low levels for up to a year or more in soils and sediments, glyphosate generally undergoes rapid biodegradation (days to weeks), and is thus unlikely to adversely affect soil or sediment quality or soil microflora. However, there may be some risk of short-term soil or sediment instability and erosion following treatment in emergent wetlands, prior to regrowth or recolonization of treated areas by desirable vegetation. Revegetation and replanting techniques can be used to promote site stabilization and to mitigate these potential impacts.

Air quality is unlikely to be adversely affected by glyphosate application due to its low volatility.

Glyphosate application is not expected to affect surface water or groundwater quality. However, additional information is needed to determine the potential for glyphosate to contribute to cultural eutrophication in oligotrophic surface waters. Information is not available on the potential impacts of glyphosate on the sea-surface microlayer or its inhabitants.

Because it is a systemic, broadleaf plant herbicide, glyphosate is generally toxic to target and nontarget plants that it contacts. However, the phytotoxicity of glyphosate varies depending on several factors, including foliar retention, plant absorption, translocation, and timing of application.

Available information indicates that phytoplankton generally are not adversely affected by low levels of glyphosate. However, because of the importance of phytoplankton to the food web, additional information is needed to assess the potential toxic effects of glyphosate on freshwater and marine phytoplankton found in emergent wetlands. Field studies on the environmental effects of glyphosate on commercially or ecologically important Pacific Northwest species, such as eelgrass, are also needed.

Adverse impacts on nontarget plant species may result from overspray and drift during glyphosate application, but these potential impacts can be mitigated using careful application practices.

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Glyphosate appears to have acute or chronic effects on animals only at very high concentrations. These concentrations are unlikely to be reached as a result of using glyphosate to control purple loosestrife and cordgrass. Therefore, it is unlikely that significant short- or long-term, acute or chronic effects on animals will result from an aquatic weed control program that uses glyphosate.

Although glyphosate appears to be nonbioaccumulative and is unlikely to adversely affect most animals, additional information is needed to assess the potential effects of glyphosate on some animal groups. For instance, no information is available on the mutagenic, carcinogenic, or teratogenic effects of glyphosate on birds. There are large information gaps on the chronic and acute effects of glyphosate on all life stages of marine fishes. Additional information is also needed on the effects of glyphosate on commercially important species, such as anadromous salmonids.

Rodeo®, the only formulation of glyphosate registered for use in aquatic environments in this state, requires the use of a surfactant. The potential impacts of surfactants on the Environment are discussed in a separate section on adjuvants.

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10.0 ENVIRONMENTAL EFFECTS OF ADJUVANTS

Adjuvants are chemicals that are added to a pesticide mixture prior to application to enhance the performance of the original pesticide formulation. They encompass a wide variety of products including acidifiers, attractants, buffers, defoaming agents, deposition aids, extenders, spray colorants, spreader-stickers, surfactants, and thickeners that perform one or more of the following functions:

- Improve foliage wetting and coverage
- Reduce evaporation rate of the spray
- Improve weatherability of spray deposit
- Enhance penetration and translocation
- Adjust pH
- Improve compatibility of mixtures.

This report describes the environmental fate and effects of the following three agricultural adjuvants:

- R-11 Spreader Activator
- LI-700 Penetrating Surfactant
- Valent X-77 Spreader.

These three adjuvants are marketed primarily as surface active agents, or surfactants. Their main function is to provide an even coverage of the herbicide on the surface of the plant, although they may also improve herbicide penetration. For aquatic plants, whose foliage often has a waxy surface that resists wetting, surfactants are commonly needed to reduce surface tension and promote wetting.

Of the two herbicides being considered for control of aquatic weeds in Washington state (glyphosate and 2,4-D), surfactant use is required only for glyphosate. Glyphosate functions by disrupting photosynthesis, respiration, and the synthesis of nucleic acids in plant tissue. It must absorb through the plant foliage (i.e., leaves and stems) to be effective. Studies have shown that 20 to 30 percent of glyphosate applied to leaf vegetation is absorbed within 12 hours of application (Garnett 1991). Therefore, use of surfactants to promote even coverage on plant foliage will improve the effectiveness of glyphosate. In comparison, 2,4-D is usually applied in a petroleum hydrocarbon carrier, such as kerosene, or is applied in granular form (e.g., Aquakleen®). Thickeners such as NalcoTrol® are sometimes used with 2,4-D at a rate of about 0.5 percent to reduce wind drift.

Pesticide adjuvants must be approved by the U.S. Environmental Protection Agency under 40 CFR 180.1001. Because chemical adjuvants are not part of the original pesticide formulation and are not considered active ingredients, they are not subject to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requirements for pesticide registration (40 CFR 152). As a result, much of the environmental fate and toxicity information available for pesticides is not currently available for many of the adjuvants. Only limited toxicity data are available for the three adjuvants (R-11, LI-700, and X-77) of interest for aquatic weed control in Washington state. While all adjuvants are of some interest, this report, because of its limited scope, summarizes compound-specific information that is available from the manufacturers or reported in the scientific literature for three of the most widely available nonionic surfactants. Where compound-specific information is unavailable, information regarding other similar adjuvants is presented.

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11.0 ENVIRONMENTAL FATE OF ADJUVANTS

This section summarizes available information on the chemical characteristics of each of the three adjuvants that affect its environmental persistence and mobility (e.g., solubility and biodegradation).

11.1 CHEMICAL CHARACTERISTICS

R-11 Spreader Activator. R-11, distributed by Wilbur-Ellis Company, contains octylphenoxypoly(ethoxyethanol), isopropyl alcohol, and compounded silicone. It is an alkylphenol ethoxylate nonionic surfactant with the following general chemical formula:

R-11 is a clear liquid with an alcohol-like odor. It is soluble in water and has a specific gravity of 1.0.

LI-700 Penetrating Surfactant. LI-700 is manufactured by Loveland Industries, Inc. It contains a mixture of phosphatidylcholine and methylacetic acid. Phosphatidylcholine, otherwise known as lecithin, is a naturally occurring complex lipid, or phosphoglyceride (Lehninger 1975). Phosphoglycerides are constituents of most plant and animal cell membranes. The phosphatidylcholine molecule contains both positive and negative charges and is referred to as zwitterionic. The chemical formula for phosphatidylcholine is shown below:

$$CH_2(R)CH(R')CH_2OPO(OH)O(CH_2)2N(OH)(CH_3)_3$$

where R and R' represent fatty acid groups.

LI-700 is a dark brown liquid with a vinegar-like odor. It is miscible in water and has a specific gravity of 1.0302. Although it is not classified as corrosive, because it contains methylacetic acid, LI-700 is often used as an acidifying agent. LI-700 is incompatible with strong oxidizers.

Valent X-77 Spreader. X-77 spreader activator, distributed by Valent U.S.A. Corporation contains alkylarylpoly(oxyethylene), glycols, free fatty acids, and isopropyl alcohol. Like R-11, X-77 is an alkylphenol ethoxylate nonionic surfactant. It is highly

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volatile and flammable. Valent U.S.A. Corporation declines to reveal the chemical formulation for X-77. The generic formula for alkyarylpoly(oxyethylene) surfactants is shown below:

11.1.1 Solubility

Information concerning the solubility of the adjuvants R-11, LI-700, and X-77 is not available. Because surfactants tend to concentrate at interfaces rather than in the bulk solution, it is likely that when applied in aquatic environments for weed control, the concentration of these adjuvants would be greatest near the water surface. Both R-11 and X-77 are soluble in water (Wilbur-Ellis 1992; Valent 1991). However, LI-700, which is composed primarily of phosphatidylcholine (a zwitterionic surfactant that has an extremely low solubility in water [Tadros 1984], is likely to be less soluble than either R-11 or X-77).

Surfactant molecules are composed of hydrophilic and hydrophobic groups. The presence of the hydrophilic group provides the surfactant's water solubility. In the two nonionic alkylphenol ethoxylate surfactants (R-11 and X-77), the hydrophilic group is composed of polyoxyethylene $(CH_2CH_2O)n$ and the hydrophobic group is composed of alkylphenol. Nonionic surfactant solubility generally increases with increasing polyoxyethylene content (Kirk-Othmer 1983).

Because heating reduces the hydration of the hydrophilic portion of the surfactant molecule, solubility of the ethoxylates is inversely related to temperature (Tadros 1984). As dehydration occurs, surfactant molecules aggregate into micelles. The temperature at which micelle formation occurs, as evidenced by an increase in turbidity of the solution, is known as the cloud point. Nonionic surfactants are typically most effective at temperatures between 10 °C below and 20 °C above the cloud point (Tadros 1984).

The addition of electrolytes such as sodium chloride also reduces the solubility of nonionic surfactants (Meguro et al. 1987), which suggests that these surfactants may be less effective when used in marine environments.

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11.1.2 Biodegradation

No product-specific biodegradation studies have been conducted using R-11, LI-700, or X-77. Studies using other alkylphenol ethoxylates similar to R-11 and X-77 have shown that with proper acclimation, substantial biodegradation of these surfactants can occur under both field and laboratory conditions (Swisher 1987). However, biodegradation of surfactants with alkylphenol hydrophobes (similar to the R-11 and X-77 adjuvants) containing either linear or branched alkyl groups is generally much more difficult than that of other nonionic surfactants. The degree and rate of biodegradation is influenced by several factors, including the number of ethylene oxide units per mole of surfactant, shape of the alkyl group, location of the benzene ring attachment in the alkyl chain, and temperature (Swisher 1987; Sivak et al. 1980). In general, biodegradation is more rapid for nonionic surfactants with chemical structures that exhibit less branching of the alkyl groups, fewer numbers of ethylene oxide units, and benzene ring attachment to a primary carbon in the alkyl chain (Arthur D. Little 1977; Swisher 1987).

Studies indicate that biodegradation of nonionic ethoxylate surfactants occurs via three main pathways (Swisher 1987):

- Cleavage of the hydrophilic and hydrophobic units
- Attack at the far end of the hydrophobe, with biodegradation proceeding inward
- Attack at the far end of the ethoxylate chain.

The major degradative pathway appears to be shortening of the ethoxylate chain (Swisher 1987).

The alkylphenol ethoxylates are generally considered to undergo fairly complete primary degradation (i.e., degradation to the extent that the surfactant characteristics are eliminated). However, ultimate degradation, or the complete conversion to carbon dioxide and water, is slow and may not be complete (Swisher 1987). Incomplete breakdown of the ethoxylates results in the generation of chemical intermediates, primarily polyethylene glycol (Swisher 1987). Studies have shown that polyethylene glycol is biodegradable, but breakdown occurs relatively slowly. Because its toxicity is much lower than that of its precursors (Conway et al. 1983), polyethylene glycol does not

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appear to be a significant problem in the receiving environment. Additional information on the persistence of polyethylene glycol is needed to assess its environmental impact.

Short ethoxylates have also been identified as potential intermediates (Swisher 1987). Because the aquatic toxicity of these short ethoxylates is relatively high, there is some concern about potential environmental effects. However, insufficient data are available to determine whether the formation of these intermediate by-products represents a problem for aquatic use.

No information concerning the breakdown of phosphatidylcholine surfactants such as LI-700 was found during this review. Because phosphatidylcholine is a naturally occurring lipid, it is likely that this product is subject to biodegradation. The rate and degree of breakdown are unknown.

Data summarized by Swisher (1987) demonstrate that biodegradation rates and effectiveness for the octylphenol ethoxylates vary considerably (see Appendix A). Three to 100 percent reductions in surfactant concentration occurring over a period of 1 to 77 days have been reported (Swisher 1987). Most of these studies were conducted under laboratory conditions with higher concentrations of the microorganisms than might typically be present under field conditions. Therefore, it is likely that degradation may occur more slowly in the aquatic environment.

Acclimation can reduce the time for breakdown to occur. Lashen et al. (1967) studied surfactant degradation in water samples from the Schuylkill River (Delaware) and Ohio River using a tertiary octylphenol ethoxylate (t-OPE_{10}). In laboratory tests, biodegradation of the surfactant in unacclimated river samples took at least 1 week compared to several days using acclimated samples.

Lashen et al. (1966) studied the breakdown of a tertiary octylphenol ethoxylate (t-OPE_{10}) in a continuous-flow activated sludge system. The results indicate that 90 to 100 percent removal of the surfactant was achieved after 10 to 15 days of acclimation with only 65 percent removal of the polyethoxylate chain. No information is available for degradation of the phenolic compounds.

Studies also indicate that microorganisms capable of degrading surfactants may not be ubiquitous. In laboratory tests of an octylphenol ethoxylate (OPE_9) in an activated sludge

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system using indigenous bacteria, Mann and Reid (1971) report that less than 20 percent of the surfactant was degraded after 46 days of operation. When activated sludge from a municipal wastewater treatment plant was added to the system, biodegradation of the surfactant increased to about 80-90 percent.

Temperature also plays a significant role in biodegradation. Mann and Reid (1971) conducted field trials on a trickling filter system and found that degradation of a tertiary octylphenol ethoxylate increased from a low of 20 percent between March and June to 80 percent between September and October, dropping back to 20 percent in December. In comparison, removal rates for linear primary alcohol ethoxylates were 80-90 percent during the winter months.

Birch (1984) also documented temperature-related changes in bacterial growth rates in a laboratory activated sludge unit. The activated sludge system was operated at temperatures ranging from 6 °C to 15 °C with sludge retention times of 2 to 10 days. At 15 °C and 2 to 10 day retention times, degradation of tertiary octylphenol ethoxylate ranged from about 90 to 95 percent. However, at 6 °C and retention times of 2 and 4 days, surfactant removal decreased to 5 percent and 50 percent, respectively. These results indicate that lower growth rates that occurred at the lower temperatures resulted in lower surfactant removal.

11.2 IMPURITIES

Because synthesis of pure nonionic surfactants is difficult, most commercial surfactants typically contain a number of impurities (Meguro et al. 1987). Impurities that are commonly present in the alkylphenol ethoxylates include (Tadros 1984):

- Polyethylene glycol (present at concentrations of 0.2 to 3 percent, depending on the molecular weight of the surfactant)
- Aldehydes (present at concentrations of 10 to 30 ppm in ethylene oxide, which is used in the production of ethoxylate surfactants)
- Inorganic catalyst residues (i.e., sodium, potassium, acetate, and phosphate, present at levels up to 0.1 percent if the ethoxylate is not filtered).

In addition, X-77 reportedly can contain trace amounts of ethylene oxide (Valent 1991). Ethylene oxide is considered to be a probable human carcinogen by the International Agency for Research on Cancer (IARC). However, because ethylene oxide is highly volatile, it is not likely to persist in the aquatic environment and probably poses a greater threat to workers handling this material than to aquatic organisms.

11.3 ENVIRONMENTAL EFFECTS

As explained earlier, registration requirements for adjuvants are not as stringent as those for pesticides. Consequently, only limited toxicity information (i.e., mammalian and aquatic organism acute toxicity) is available for most adjuvants. Available toxicity information for the three adjuvants of concern is summarized in Table 6.

11.3.1 Aquatic Toxicity

The acute toxicity of alkylphenol ethoxylates (R-11 and X-77) generally ranges from 4 to 12 mg/L for fish and from 1 to 100 mg/L for invertebrates (Sivak et al. 1980). Aquatic toxicity is affected by the length of the ethoxylate and alkyl chains on the surfactant molecule. Longer ethoxylate chain lengths result in lower toxicity, while longer alkyl chain lengths result in greater toxicity (Sivak et al. 1980).

Product-specific acute toxicity data for the three surfactants of interest, summarized in Table 1 indicate that the two nonionic alkylphenol ethoxylate products (R-11 and X-77) are generally more toxic to aquatic organisms than is the phosphatidylcholine surfactant (LI-700). In particular, available data suggest that X-77 may be highly toxic to *Daphnia magna*. LI-700 is practically nontoxic to two species of fish (rainbow trout and bluegill sunfish) and to *Daphnia magna*.

Given the typical application rates of these surfactants (i.e., 0.12 to 0.5 gallons per 100 gallons of spray solution), it is unlikely that concentrations in the receiving water environment would exceed the acute toxicity thresholds. Using conservative assumptions (1 foot water depth and maximum application rates for both the adjuvants and the herbicide, i.e., 0.94 gal/acre of glyphosate in a 0.75 percent spray solution), the estimated water column concentration of these adjuvants is approximately 0.2 to 0.3 mg/L, which is up to 3 orders of magnitude lower than the acute toxicity threshold

Table 6. Physiochemical characteristics of adjuvants used with aquatic herbicides

	R-11	LI-700	X-77
CAS Number	9036-19-5 (a)		
Manufacturer	Wilbur-Ellis	Loveland Ind.	Valent U.S.A.
Application Rate (qt/100 gal)	2	0.5-2	0.25-2
TOXICITY DATA (LC50) (Concentrations in ppm)			
Fish			
Channel catfish (g)			4.4 (b)
Rainbow trout (g)	3.8 (c)	130 (c)	4.2 (c)
Bluegill sunfish (g)	4.2 (c)	210 (c)	4.3 (c) 5.5 (d)
Toxicity Rating	Moderately toxic	Practically nontoxic	Moderately toxic
Aquatic invertebrates			
Daphnia magna (f)	19 (c)	170 (c)	1 (b) 2 (c) 1.4-2.6 (e)
Hyalella azteca (g)			4-7 (e)
Nephelopsis obscura (g)			8-16 (e)
Chironomus spp. (f)			7-14 (e) 8.6 (h)
Toxicity Rating	Slightly toxic	Practically nontoxic	Slightly toxic to highly toxic
Marine organisms			
Grass shrimp (g)			10 (b)
Toxicity Rating			Moderately toxic
Mammals			
Oral			
Rat	NA	>5000	>5000
Rabbit	5840 (i)	NA	NA
Toxicity Rating	Practically nontoxic	Practically nontoxic	Practically nontoxic
Dermal			
Rat	NA	5000	NA
Rabbit	13000 (i)	NA	>5000
Primary Irritation Index	NA	6.2	4

Blank spaces indicate data not available.

(a) For octylphenoxypoly(ethoxyethanol)
(b) Bruce 1992 pers. comm.
(c) Monsanto no date
(d) Watkins et al. 1985
(e) Henry 1992
(f) 48-hr acute toxicity tests
(g) 96-hr acute toxicity test
(h) Buhl and Faerber 1989
(i) For isopropyl alcohol

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levels. However, in some cases, e.g., treatment of Spartina, concentrations may be greater.

Mitchell et al. (1987a) report that a mixture of Rodeo® (a glyphosate herbicide) and X-77 (31 percent Rodeo®, 0.4 percent X-77, and 69 percent water v:v) was more toxic to rainbow trout than Rodeo® used alone. The 96-hour LC_{50} (lethal concentration, mean) values for Rodeo® calculated in terms of the total formulation and for the isopropylamine salt of glyphosate were 1,100 mg/L and 580 mg/L, respectively. In comparison, the LC50 values for the Rodeo®/X-77 mixture were 680 mg/L and 130 mg/L, respectively, based on the total formulation and the isopropylamine salt of glyphosate. These values indicate that both Rodeo® and Rodeo® mixed with the surfactant X-77 are practically nontoxic to rainbow trout.

Henry (1992) reports similar results with Rodeo® and Rodeo®/X-77 mixtures used on *Chironomus* spp. (midge larvae), *Daphnid* (water flea), *Hyalella azteca* (scud), and *Nephelopsis obscura* (leech). Although X-77 was generally more toxic than the Rodeo® alone, no synergistic effects were observed when the two chemicals were combined. Toxic effects were simply additive, with the Rodeo®/X-77 mixture exhibiting greater toxicity to all four aquatic species than Rodeo® alone:

	LC_{50} (mg/L)		
Species	Rodeo®	Rodeo®/X-77	X-77
Midge	1,308	293	10
Water flea	545	130	2
Scud	727	213	6
Leech	1,157	201	11

These data indicate that Rodeo® and Rodeo®/X-77 mixtures are practically nontoxic to aquatic organisms while X-77 alone is moderately toxic. The Rodeo®/X-77 mixture contained Rodeo®, X-77, and Chem-Trol® (a drift retardant) in proportions of 29:1:3 by volume.

Sublethal effects on aquatic organisms have been observed with other nonionic surfactants (i.e., linear alkylbenzene sulfonates and alcohol ethoxylates) at concentrations of 0.5

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mg/L (Sivak et al. 1980). These concentrations are below the acute toxicity levels for these surfactants. Sublethal effects observed in fish include impaired swimming activity, altered breathing rate, and opercular movement. Sublethal effects, such as reduced swimming activity, reduced heart rate, inhibition of siphon retraction, reduced burrowing activity, inhibition of formation of byssal threads, and intestinal damage, have also been reported in aquatic invertebrates at concentrations greater than 1 mg/L of linear alkylbenzene sulfonates and alcohol ethoxylates (Sivak et al. 1980). However, no information on sublethal effects is available for the alkylphenol ethoxylates.

11.3.2 Mammalian Toxicity

Oral and dermal acute toxicity data for the three adjuvants addressed here are summarized in Table 6. All three adjuvants are classified as practically nontoxic based on rat and rabbit studies. Although no product-specific data are available, chronic toxicity studies using other alkylphenol ethoxylates administered at doses of 1,000 mg/kg/day over a 2-year period to rats and dogs showed no significant toxicity (Sivak et al. 1980).

The Material Safety Data Sheet (MSDS) provided by the manufacturers rate both X-77 and LI-700 as corrosive based on eye and skin irritation tests in rabbits. X-77 caused irreversible destruction of ocular tissue or irritation persisting for more than 21 days. The primary irritation index (dermal) for X-77 for a 24-hour exposure is 4.0 (range 0-8).

LI-700 produced corrosion, corneal opacity, and irritation persisting for 10 days. The primary irritation index (dermal) for LI-700 was reported to be 6.2 with moderate irritation persisting 72 hours after application. Evidence of tissue damage (i.e., corrosion) was observed in all animals at 7 days. Based on these data, LI-700 was classified in Toxicity Category I for both eye and dermal application.

No eye or dermal irritation rating is provided for R-11. The MSDS states that R-11 may cause eye irritation and corneal inflammation as well as skin irritation, scaling, or dermatitis.

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11.4 SUMMARY

Because adjuvants are not regulated under FIFRA, little information is available concerning the environmental fate and effects of R-11, LI-700, and X-77 surfactants. Surfactants are typically soluble in water. Based on their chemical composition, it is expected that R-11 and X-77 are more soluble than LI-700. In addition, because surfactants characteristically concentrate at interfaces, these products may be expected to accumulate primarily at the water surface and thus may affect the sea-surface microlayer.

Data for other, similar surfactants indicate that these products are subject to biodegradation. Degradation to the extent that the surfactant characteristics are no longer evident occurs fairly rapidly. However, complete breakdown of the component hydrophilic and hydrophobic units may proceed more slowly. Intermediate degradation products include the relatively low toxicity polyethylene glycol and more highly toxic short-chain ethoxylates. Insufficient data are available to assess potential impacts from these intermediates.

Acute toxicity information based on limited studies with fish and aquatic invertebrates indicates that X-77 and R-11 are more toxic than LI-700. X-77 and R-11 are moderately toxic to fish and slightly toxic to highly toxic to aquatic invertebrates. LI-700 is practically nontoxic to both fish and aquatic invertebrates. Mammalian studies indicate that these products are practically nontoxic to rats and rabbits. However, no data exist to evaluate avian toxicity of these products.

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12.0 REFERENCES

Arthur D. Little, Inc. 1977. Human safety and environmental aspects of major surfactants. NTIS PB 301 193/9ST (as cited by Sivak et al. 1980).

Austin, A.P., G.E. Harris, and W.P. Lucey. 1991. Impact of an organophosphate herbicide (glyphosate) on periphyton communities developed in experimental streams. Bull. Environ. Contam. Toxicol. 47: 29-35.

Balogh, J.C. and W.J. Walker (eds). 1992. Golf course management and construction: Environmental issues. Lewis Publishers, Chelsea, MI.

Birch, R.R. 1984. Biodegradation of nonionic surfactants. JAOCS 61:340-343 (as cited by Swisher 1987).

Boerboom, C.M., D.L. Wyse, and D.A. Somers. 1990. Mechanism of glyphosate tolerance in birdsfoot trefoil (*Lotus corniculatus*). Weed Sci. 38: 463-467.

Bothwell, M.L. 1985. Phosphorus limitations of lotic periphyton growth rates: An intersite comparison using continuous-flow troughs (Thomson River system, British Columbia). Limnol. Oceanogr. 30: 527-542.

Brandt, E.J. 1984. A health and environmental report on Rodeo® herbicide. Bulletin No. 2. Monsanto Company, St. Louis, MO.

Brown, K.W., D.C. Anderson, S.G. Jones, L.E. Deuel, and J.D. Price. 1979. The relative toxicity of four pesticides in tap water from flooded rice paddies. Int. J. Environ. Stud. 14(1):49-54 (as cited by Balogh and Walker 1992).

Bruce, E. June 11, 1992. Personal communication (letter to R.J. Stevens concerning aquatic toxicity of Valent X-77 spreader). Valent U.S.A. Corporation, Walnut Creek, CA.

Buhl, K.J. and N.L. Faerber. 1989. Acute toxicity of herbicides and surfactants to larvae of the midge *Chironomus riparius*. Arch. Environ. Contam. Toxicol. 18:530-536.

Chakravarty, P. and L. Chatarpaul. 1990. Non-target effect of herbicides: II. The influence of glyphosate on ectomycorrhizal symbiosis of red pine (*Pinus resinosa*) under greenhouse and field conditions. Pesticide Sci. 28: 243-247.

Christensen, H.E. (ed). 1976. Registry of toxic effects of chemical substances. U.S. Department of Health, Education, and Welfare, National Institute of Occupational Safety and Health, Rockeville, MD (as cited by Henry 1992).

Christy, S.L., E.P. Karlander, and J.V. Parochetti. 1981. Effects of glyphosate on the growth rate of *Chlorella*. Weed Sci. 29(1):5-7 (as cited by Balogh and Walker 1992).

Conway, R.A., G.T. Waggy, M.H. Spiegel, and R.L. Berglund. 1983. Environmental fate and effects of ethylene oxide. Env. Sci. Technol. 17:707-112 (as cited by Swisher 1987).

Cooper, S.L., G.I. Wingfield, R. Lawley, and M.P. Greaves. 1978. Miniaturized methods for testing the toxicity of pesticides to microorganisms. Weed Res. 18:105-107 (as cited by Grossbard 1985).

D'Anieri, P., S.M. Zedaker, J.R. Seiler, and R.E. Kreh. 1990. Glyphosate translocation and efficacy relationships in red maple, sweetgum, and loblolly pine seedlings. Forest Sci. 36:438-447.

Evans, D.M. 1978. Aquatic weed control with the isopropylamine salt of N-(phosphonomethyl)glycine. Weed Abst. 29: 22 (as cited by Forney and Davis 1981).

Evans, P.R. 1986. Use of the herbicide dalapon for control of *Spartina* encroaching on intertidal mudflats: Beneficial effects on shorebirds. Colonial Waterbirds 9(2):171-175.

WASHINGTON STATE 1993 FINAL EIS - ELEMENT E

W A S H I N G T O N S T A T E 1 9 9 3 F I N A L E I S - E L E M E N T E

Felix, H.R., R. Chollet, and J. Harr. 1988. Use of the cell wall-less alga *Dunaliella bioculata* in herbicide screening tests. Ann. Appl. Biol. 113(1):55-60 (as cited by Balogh and Walker 1992).

Feng, J.C., D.G. Thompson, and P.E. Reynolds. 1990. Fate of the glyphosate in a Canadian forest watershed: 1. Aquatic residues and off-target deposit assessment. J. Agric. Food Chem. 38:1100-1118.

Folmar, L.C., H.O. Sanders, and A.M. Julin. 1979. Toxicity of the herbicide glyphosate and several of its formulations to fish and aquatic invertebrates. Arch. Environ. Contam. Toxicol. 8: 269-278 (as cited by Henry 1992)

Folmar, L.C. 1976. Overt avoidance reaction of rainbow trout fry to nine herbicides. Bull. Environ. Contam. Toxicol. 15(5):509-514 (as cited by Balogh and Walker 1992).

Forney, D.R. and D.E. Davis. 1981. Effects of low concentrations of herbicides on submersed aquatic plants. Weed Sci. 29:677-685.

Gardiner, W. September 8, 1992. Personal communication (telephone conversation with W. Trial, Herrera Environmental Consultants). Battelle Pacific Northwest Marine Research Laboratory, Sequim, WA.

Garnett, R.P. 1991. The control of *Spartina* on salt marshes and mudflats using Roundup® Pro herbicide: An overview of efficacy and ecotoxicology.

Garnett, R.P. 1991 (unpublished). The control of *Spartina* on salt marshes and mudflats using Roundup Pro herbicide: An overview of efficiency and ecotoxicity.

Goldsborough, L.G. and A.E. Beck. 1989. Rapid dissipation of glyphosate in small forest ponds. Arch. Environ. Contam. Toxicol. 18:537-544.

Goldsborough, L.G. and D.J. Brown. 1988. Effects of glyphosate (Roundup®) on periphytic algal photosynthesis. Bull. Environ. Contam. Toxicol. 41(2):253-260 (as cited by Balogh and Walker 1992).

W A S H I N G T O N S T A T E 1 9 9 3 F I N A L E I S - E L E M E N T E

Greaves, M.P., N.J. Poole, K.H. Domsch, G. Jagnow, and W. Verstraete. 1980. Recommended tests for assessing the side-effects of pesticides on the soil microflora. Tech. Rept. No. 59. Agricultural Research Council, Weed Research Organization (as cited by Grossbard 1985).

Grossbard, E. 1976. Effects on the soil microflora. pp. 99-147 in: Herbicides, Physiology, Biochemistry, Ecology. Vol. 2. Edited by L.J. Audus. Academic Press, New York, NY.

Grossbard, E. 1974. The effect of herbicides on the decay of pure cellulose and vegetation. Weed Research Organization: Research and Development at Begbroke. Chemistry and Industry 15:611 (as cited by Grossbard 1985).

Grossbard, E. 1985. Effects of glyphosate on the microflora, with reference to the decomposition of treated vegetation and interaction with some plant pathogens. pp. 159-185 in: The Herbicide Glyphosate. Edited by E. Grossbard and D. Atkinson. Butterworths, Boston, MA.

Hardy, J. September 8, 1992. Personal communication (telephone conversation with W. Trial, Herrera Environmental Consultants). Western Washington University, Bellingham, WA.

Hardy, J.T., C.W. Apts, E.A. Crecelius, and G.W. Fellingham. 1985. The sea-surface microlayer: Fate and residence times of atmospheric metals. Limnol. Oceanogr. 30(1):1985.

Henry, C. 1992. Effects of Rodeo® herbicide on aquatic invertebrates and fathead minnows. Masters thesis, South Dakota State University.

Henry, C.J. 1992. Effects of Rodeo® herbicide on aquatic invertebrates and fathead minnows. Masters thesis. South Dakota State University.

Hess, F.D. 1980. A *Chlamydomonas* algal bioassay for detecting growth inhibitor herbicides. Weed Sci. 28(5):515-520 (as cited by Balogh and Walker 1992).

WASHINGTON STATE 1993 FINAL EIS - ELEMENT E

WASHINGTON STATE 1993 FINAL EIS - ELEMENT E

Heydens, W.F. 1991. Rodeo® herbicide use to control *Spartina*: Impact of glyphosate on marine and terrestrial organisms. Monsanto Company, St. Louis, MO.

Hildebrand, L.D., D.S. Sullivan, and T.P. Sullivan. 1982. Experimental studies of rainbow trout populations exposed to field applications of Roundup® herbicide. Arch. Environ. Contam. Toxicol. 11:93-98 (as cited by Morgan and Kiceniuk 1992).

Holck, A.R. and C.L. Meek. 1987. Dose-mortality responses of crawfish and mosquitoes to selected pesticides. J. Am. Mosq. Control Assoc. 3(3):407-411 (as cited by Balogh and Walker 1992).

Holdway, D.A. and D.G. Dixon. 1988. Acute toxicity of permethrin or glyphosate pulse exposure to larval white sucker (*Catostomus commersoni*) and juvenile flagfish (*Jordanella floridae*) as modified by age and ration level. Environ. Toxicol. Chem. 7(1):63-68 (as cited by Balogh and Walker 1992).

Johnson, W.W. and M.T. Finley. 1980. Handbook of acute toxicity of chemicals to fish and aquatic invertebrates. Res. Pub. 137. U.S. Department of the Interior, Fish and Wildlife Service (as cited by Henry 1992).

Kikuth, R. 1979. Modified trophic signals in ecosystems. Proceedings seminar on the mode of action of glyphosate (as cited by Garnett 1991).

Kirk-Othmer. 1983. Encyclopedia of chemical technology. 3d edition. Volume 14. John Wiley and Sons, New York, NY.

Kroll, R.B. 1991. Field investigation of the environmental fate of Rodeo® (glyphosate) in two tidal marshes. Technical Report No. 115. Maryland Department of the Environment, Water Management Administration, Standards and Certification Division. August 1991.

Kruglov, Yu. V., N.B. Gersh, and M. Shtal'berg. 1980. The influence of glyphosate on the soil microflora. Khimiya v Sel'skom Khozayisteve 18:42-44 (as cited by Grossbard 1985).

Lashen, E.S., F.A. Blankenship, K.A. Booman, and J.Dupre. 1966. Biodegradation studies on a *p-t*-octylphenoxypolyethoxyethanol. JAOCS 43:371-376 (as cited by Swisher 1987).

Lashen, E.S., G.F. Trebbi, K.A. Booman, and J. Dupre. 1967. Biodegradability of nonionic detergents. Soap Chem. Specialties 43(1):55-58, 122-129 (as cited by Swisher 1987).

Lehninger, A.L. 1975. Biochemistry. 2d edition. Worth Publishers, Inc., New York, NY.

Li, G.C. and C.V. Chen. 1981. Study on the acute toxicities of commonly used pesticides to two kinds of fish. K'O Hsueh Fa Chan Yueh K'an 9(2):146-152 (as cited by Balogh and Walker 1992).

Linden, E., B.E. Bengtsson, O. Svanberg, and G. Sandstrom. 1979. The acute toxicity of 78 chemicals and pesticide formulations against two brackish water organisms, the bleak (*Alburnus alburnus*) and the harpacticoid (*Nitocra spinipes*). Chemosphere 8:11/12843-851 (as cited by Balogh and Walker 1992).

Maleki, R.A. and T.J. Rawinski. 1985. New methods for controlling purple loosestrife. New York Fish and Game J. 32:8-19.

Mann, A.H. and V.W. Reid. 1971. Biodegradation of synthetic detergents evaluation by community trials. II. Alcohol and Alkylphenol ethoxylates. JAOCS 48:588-594 (as cited by Swisher 1987).

Marsh, J.A.P., H.A. Davies, and E. Grossard. 1977. The effect of herbicides on respiration and transformation of nitrogen in two soils. I. Metribuzin and glyphosate. Weed Res. 17: 77-82 (as cited by Grossbard 1985).

Maule, A. and S.J.L. Wright. 1984. Herbicide effects on the population growth of some green algae and cyanobacteria. J. Appl. Bacter. 57:369-379.

Meguro, K, M. Ueno, and K. Esumi. 1987. Micelle formation in aqueous media. pp. 109-184 in: Nonionic Surfactants, Physical Chemistry, Vol. 1. M.J. Schick (ed). Marcel Dekker, Inc., New York, NY.

Mitchel, D.G., P.M. Chapman, and T.J. Long. 1987. Acute toxicity of Roundup« and Rodeo® herbicides to rainbow trout, chinook, and coho salmon. Bull. Environ. Contam. Toxicol. 39:1028-1035.

Mitchell, D.G., P.M. Chapman, and T.J. Long. 1987a. Acute toxicity of Roundup® and Rodeo® herbicides to rainbow trout, chinook, and coho salmon. Bull. Environ. Contam. Toxicol. 39:1028-1035.

Mitchell, D.G., P.M. Chapman, and T.J. Long. 1987b. Seawater challenge testing of coho salmon smolts following Roundup® herbicide exposure. Environ. Toxicol. Chem. 6:875-878.

Mitsch, W.J. and J.G. Gosselink. 1986. Wetland. Van Nostrand Reinhold Co., Inc., New York, NY.

Monsanto Agricultural Products Company. Undated. Table of LC50 values for different surfactants.

Monsanto. 1983. Rodeo® herbicide bulletin No. 1. Monsanto Company, St. Louis, MO (as cited by USDA 1984).

Monsanto. 1985. Rodeo® herbicide for aquatic vegetation management: Technical manual. Monsanto Company, St. Louis, MO.

Monsanto. 1990. Rodeo® herbicide product label. Monsanto Company, St. Louis, MO.

Monsanto. 1992. Rodeo® herbicide product label. Monsanto Company, St. Louis, MO.

Morgan, M.J. and J.W. Kiceniuk. 1992. Response of rainbow trout to a two month exposure to Vision®, a glyphosate herbicide. Bull. Environ. Contam. Toxicol. 48:772-780.

WASHINGTON STATE 1993 FINAL EIS - ELEMENT E

Morrison, M.L. and E.C. Meslow. 1983. Impacts of forest herbicides on wildlife: Toxicity and habitat alteration. Transactions of the 48th North American Wildlife Conference (as cited by Sullivan 1988).

Muller, M.M., C. Rosenberg, H. Siltanen, and T. Wartiovaara. 1981. Fate of glyphosate and its influence on nitrogen-cycling in two Finnish agricultural soils. Bull. Environ. Contam. Toxicol. 27:724-730.

Nature Conservancy Council. Undated. A review of *Spartina* control methods. Great Britain Headquarters, Peterborough, UK.

Newton, M., K.M. Howard, B.R. Kelpsas, R. Danhaus, C.M. Lottman, and S. Dubelman. 1984. Fate of glyphosate in an Oregon USA forest ecosystem. J. Agric. Food Chem. 32: 1144-1151.

O'Brien, M.C. and G.N. Prendeville. 1979. Effect of herbicides on cell membrane permeability in *Lemna minor*. Weed Res. 19(6):331-334 (as cited by Balogh and Walker 1992).

O'Keefe, M.G. 1985. The evaluation of glyphosate degradation in a bird sanctuary. Monsanto internal report. (as cited by Garnett 1991.)

Peverly, J.H. and T.W. Crawford, Jr. 1975. Glyphosate as an herbicide for two submerged aquatic weed species, *Myriophyllum spicatum*, *Potamogeton crispus*. Proc. Northeast Weed Control Conf. 29:107-109 (as cited by Forney and Davis 1981).

Quilty, S.P. and M.J. Geoghegan. 1975. Effects of glyphosate on fungi. Second Proceedings of the Society for General Microbiology (as cited by Grossbard 1985).

Quilty, S.P. and M.J. Geoghegan. 1976. Effects of Roundup« on microbial populations in cultivated peat. Third Proceedings of the Society for General Microbiology (as cited by Grossbard 1985).

WASHINGTON STATE 1993 FINAL EIS - ELEMENT E

Rand, G.M. and S.R. Petrocelli. 1985. Fundamentals of Aquatic Toxicology. Hemisphere Publishing Co., New York, NY.

Reinert, K.H. and J.H. Rodgers. 1987. Fate and persistence of aquatic herbicides. pp. 61-98 in: Reviews of Environmental Contamination and Toxicology. Edited by G.W. Ware. Springer-Verlag, Inc., New York, NY.

Richardson, J.T., R.E. Frans, and R.E. Talbert. 1979. Reactions of *Euglena gracilus* to fluorometuron, MSMA, metribuzin and glyphosate. Weed Sci. 27(6):619-624 (as cited by Balogh and Walker 1992).

Ritchie, D.C., A.S. Harestad, and R. Archibald. 1987. Glyphosate treatment and deer mice in clearcut and forest. Northwest Sci. 61:199-202 (as cited by Sullivan 1988).

Roslycky, E.B. 1982. Glyphosate and the response of soil microbiota. Soil Bio. Biochem. 14:87-92 (as cited by Grossbard 1985).

Rueppel, M.L., B.B. Brightwell, J. Schaefer, and J.T. Marvel. 1977. Metabolism and degradation of glyphosate in soil and water. J. Agric. Food Chem. 25:517-528.

Sacher, R.M. 1978. Safety of Roundup® in the aquatic environment. Proceedings of the European Weed Research Society, 5th Symposium on Aquatic Weeds 5:315-322.

Sivak, A., M. Goyer, J. Perwak, and P. Thayer. 1980. Environmental and human health aspects of commercially important surfactants. pp. 161-188 in: Solution Behavior of Surfactants, Theoretical and Applied Aspects, Vol. 1. K.L. Mittal and E.J. Fendler (eds). Plenum Press, New York, NY.

Sullivan, T.P. and D.S. Sullivan. 1981. Responses of a deer mouse population to a forest herbicide application: Reproduction, growth, and survival. Can. J. Zool. 59:1148-1154 (as cited by Sullivan 1990).

WASHINGTON STATE 1993 FINAL EIS - ELEMENTE

Sullivan, T.P. 1988. Non-target impacts of the herbicide glyphosate: A compendium of references and abstracts. Mammal Pest Management Ltd., Langley, B.C., Canada.

Sullivan, T.P. 1990. Influence of forest herbicide on deer mouse and Oregon vole population dynamics. J. Wild. Manag. 54(4):566-576.

Swisher, R.D. 1987. Surfactant biodegradation. 2d edition. Marcel Dekker, New York, NY.

Szekielda, K.H., S. Kupperman, V. Klemas, and D. Polis. 1972. Element enrichment in organic films and foam associated with aquatic frontal systems. J. Geophysical Res. 77:5278-5282.

Tadros, T.F. 1984. Surfactants. Academic Press, New York, NY.

Tooby, T.E., J. Lucey, and B. Stott. 1980. The tolerance of grass carp, *Ctenopharyngodon idella*, to aquatic herbicides. J. Fish Biol. 16(4):591-597 (as cited by Tooby 1985).

Tooby, T.E. 1985. Fate and biological consequences of glyphosate in the aquatic environment. In: The Herbicide Glyphosate. Edited by E. Grossbard and D. Atkinson. Butterworths, Boston, MA.

Torstensson, N.T.L., L.N. Lundgren, and J. Stenstr÷m. 1989. Influence of climatic and edaphic factors on persistence of glyphosate and 2,4-D in forest soils.

Turbak, S.C., S.B. Olson, and G.A. Mcfeters. 1986. Comparison of algal assay systems for detecting waterborne herbicides and metals. Water Res. 20(1):91-96 (as cited by Balogh and Walker 1992).

U.S. Department of Energy. 1983. Final environmental impact statement: Transmission facilities vegetation management program. DOE/EIS-0097. Bonneville Power Administration, Washington, D.C. (as cited by USDA 1984).

WASHINGTON STATE 1993 FINAL EIS - ELEMENT E

U.S. EPA. 1982. Federal Register 47(208):47549-47550. U.S. Environmental Protection Agency (as cited by USDA 1984).

U.S. EPA. 1988. Pesticide fact sheet number 173. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C.

USDA. 1981. Herbicide background statements. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Portland, OR (as cited by USDA 1984).

USDA. 1984. Pesticide background statements. Vol. 1. Herbicides. Agriculture Handbook No. 633. U.S. Department of Agriculture, Forest Service, Washington, D.C.

USDA. 1992. Glyphosate pesticide information profile. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region.

Valent U.S.A. Corporation. 1991. Material safety data sheet for Valent X-77 spreader. Walnut Creek, CA.

Wan, M.T., R.G. Watts, and D.J. Moule. 1989. Effects of different dilution water types on the acute toxicity of juvenile Pacific salmonids and rainbow trout of glyphosate and its formulated products. Bull. Environ. Contam. Toxicol. 43:378-385.

Watkins, C.E., D.D. Thayer, and W.T. Haller. 1985. Toxicity of adjuvants to bluegill. Bull. Environ. Contam. Toxicol. 34:138-142.

Weber, J. 1977. The pesticide scorecard. Env. Sci. Technol. 11:756-761.

Weed Science Society of America. 1983. Herbicide handbook. 5th edition. Weed Science Society of America, Champaign, IL (as cited by USDA 1984).

Wetzel, R.G. 1975. Limnology. W.B. Saunders Co., Philadelphia, PA.

WASHINGTON STATE 1993 FINAL EIS - ELEMENTE

Wilbur-Ellis Company. 1992. Material safety data sheet for R-11 spreader activator. Fresno, CA.

Word, J.Q., J.N. McElroy, L.S. Word, and R.M. Thom. 1986. The surface microlayer: Review of literature and evaluation of potential effects in dredge activities in Puget Sound. Prepared by Evans-Hamilton, Inc. for the U.S. Army Corps of Engineers.

United States
Department of
Agriculture

Forest Service
Pacific Northwest Region

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Healthy Forests Make
A World of Difference

Glyphosate

HERBICIDE INFORMATION PROFILE

This information profile is produced by the USDA Forest Service, Pacific Northwest Region, for employees, forest workers, and for the public. It provides information on forest and land management uses, environmental and human health effects, and safety precautions for the herbicide glyphosate and its formulations. A list of definitions is included in Section VIII of the information profile. For general information on herbicide use by the Forest Service, refer to the PNW Region Treatment Methods Profile for Herbicides.

The principal sources of information and findings in this profile are the PNW Region FEIS (Final Environmental Impact Statement) for Managing Competing and Unwanted Vegetation; Forest Service "Herbicide Background Statement: Glyphosate;" and herbicide and surfactant product labels and Material Safety Data Sheets. Information from other sources is specifically referenced.

The PNW Region periodically publishes a bibliography of recent anecdotal and scientific accounts, and analyzes reported worker health effects. This herbicide information profile has been updated to reflect new information from a review of new literature through 1995.

I. BASIC INFORMATION

COMMON NAME: Glyphosate

CHEMICAL NAME: N-(phosphonomethyl) glycine

COMMON PRODUCT NAMES: Accord®, Rodeo®, Roundup®, Roundup Pro®

PESTICIDE CLASSIFICATION: Herbicide

REGISTERED USE STATUS: "General Use"

FORMULATIONS: Commercial glyphosate products generally contain one or more inert ingredients. An inert ingredient is anything added to the product other than the active plant-killing ingredient. The names of inert ingredients are not usually listed on the label. The contents of three glyphosate formulations are listed below:

Accord®
glyphosate (41.5%) and water (58.5%)

Rodeo®
glyphosate (53.5%) and water (46.5%)

Roundup®
glyphosate (41.0%); related organic acids of glyphosate (1.5%); isopropylamine (0.5%); polyethoxylated tallow amine surfactant (15.4%) and water (41.6%) (Monsanto, a. undated.)

Roundup Pro®
glyphosate (41%); phosphate ester neutralized ethoxylated tallow amine surfactant (14.5%) and water (44.5%)

Rodeo® and Accord® labels require that other chemicals, called surfactants, be added to the herbicide for certain kinds of spray applications. A herbicide + surfactant mixture may be equivalent to a formulation of the herbicide. Surfactants, when sold separately, are not tested as extensively as the herbicide itself. The PNW Region has reviewed available information on six surfactants recommended by Monsanto for use with Accord® or Rodeo®. This profile reviews publicly available information on potential effects on the human environment from using these surfactants in Forest Service applications. The surfactants and their manufacturers are:

Accord® herbicide + Entry II®	Monsanto

Entry II surfactant consists of the same compounds, other than glyphosate, that are found in Roundup®. Roundup® formulation information in this profile characterizes potential effects from Accord® plus Entry II used in Forest Service applications.

Rodeo® herbicide + R-11®	Wilbur-Ellis
LI-700®	Loveland Industries
Agri-Dex®	Helena Chemical
Latron AG-98®-AG	Rohm and Haas
Latron AG-98®-N	Rohm and Haas

Many surfactants could be used with Rodeo® to comply with label directions. These surfactants are recommended by Monsanto for use with Rodeo® in the Pacific Northwest (Yoder 1996). The chemical constituents of these surfactants, and data and evaluations of their effects are presented in this profile where information is available.

Residue Assay Methods: Gas/liquid chromatography and high performance liquid chromatography methods are available for residue assay. In laboratory tests, an average of 82 percent of known glyphosate concentrations was recovered. New detection methods report 1.0 ppb detection limit, using simpler and shorter processes. (Oppenhuizen and Cowell, 1991).

II. Herbicide Uses

Registered Forestry, Rangeland, Right-of-Way Uses: Planting site preparation, conifer release, forest nurseries, rights-of-way and facilities maintenance, and noxious weed control. Rodeo® is labeled for control of plants growing in or immediately adjacent to water.

Operational Details:

Target Plants: Glyphosate is used to control grasses, herbaceous plants, including deep rooted perennial weeds, brush, some broadleaf trees and shrubs, and some conifers. Glyphosate does not control all broadleaf woody plants. Timing is critical for effectiveness on some broadleaf woody plants and conifers.

Mode of Action: Glyphosate is applied to foliage. It is absorbed by leaves and rapidly moves through the plant. Glyphosate prevents the plant from producing amino acids that are the building blocks of plant proteins. The plant, unable to make proteins, stops growing and dies. Glyphosate is metabolized or broken down by some plants, while other plants do not break it down. AMPA (aminomethylphosphonic acid) is the main break-down product of glyphosate in plants.

Method of Application: Aerial spraying, spraying from a truck, backpack or hand-held sprayer; wiper application; frill treatment; cut stump treatment, and by cartridge injecting lance (E-Z-Ject®).

Use Rates: 0.3 to 4.0 pounds of active ingredient per acre.

Special Precautions:

Always read all of the information on the product label before using any pesticide. Read the label for application restrictions.

Timing of Application: Apply after leaves expand fully but before fall color change.

Drift Control: Do not allow careless application or spray drift. Do not permit spray or spray drift to contact desirable plants.

III. Environmental Effects/Fate

Soil:

Residual Soil Activity: Glyphosate does not have herbicidal properties once it contacts soil. It is not absorbed from the soil by plant roots.

A related chemical, called N-nitroso-glyphosate or NNG, has been detected in test soils after applying glyphosate at five times the normal use rate. No studies have found conclusive evidence of NNG production using normal application rates (Khan and Young 1977; Newton et al., 1984).

Adsorption: Glyphosate and the surfactant used in Roundup® are both strongly adsorbed by the soil.

Persistence and Agents of Degradation: Glyphosate remains unchanged in the soil for varying lengths of time, depending on soil texture and organic matter content. The half-life of glyphosate in soil can range from 3 to 249 days. Soil microorganisms break down glyphosate. The surfactant in Roundup® has a soil half-life of less than 1 week. Soil microorganisms break down the surfactant.

Metabolites/Degradation Products and Potential Environmental Effects: The main break-down product of glyphosate in soil is AMPA (aminomethylphosphonic acid), which is broken down further by soil microorganisms. The main break-down product of the surfactant used in Roundup® is carbon dioxide.

Water:

Solubility: Glyphosate dissolves easily in water.

Potential for Leaching into Ground-water: The potential for leaching is low. Glyphosate and the surfactant in Roundup® are strongly adsorbed to soil particles and are not easily released back into water moving through soil. Monitoring found neither glyphosate nor AMPA were susceptible to leaching after a forest application in British Columbia (Feng and Thompson 1989).

Surface Waters: Test shows that the half-life for glyphosate in water ranges from 35 to 63 days. The surfactant half-life ranges from 3 to 4 weeks. Studies examined glyphosate and AMPA residues in surface water after forest application in British Columbia with and without no-spray streamside zones. With a no-spray streamside zone, very low concentrations were sometimes found in water and sediment after the first heavy rain. Where glyphosate was sprayed over the stream, higher peak concentrations in water always occurred following heavy rain, up to 3 weeks after application. Glyphosate and AMPA residues peaked later in stream sediments, where they persisted for over 1 year. These residues were not easily released back into the water (Wan 1986).

Air:

Volatilization: Glyphosate does not evaporate easily.

Potential for By-Products from Burning of Treated Vegetation: Major products from burning treated vegetation include phosphorus pentoxide, acetonitrile, carbon dioxide and water. Phosphorous pentoxide forms phosphoric acid in the presence of water. None of these compounds is known to be a health hazard at the levels which would be found in a vegetation fire.

IV. Ecological Effects

Soil Microorganisms:

Most studies have shown no adverse effects on soil microorganisms, including soil nitrogen cycling processes (USDA-FS 1984). One study found a significant reduction in nitrogen fixation by bacteria associated with clover that was planted in a sandy soil 120 days after glyphosate was applied. The authors could not conclude whether the reduction was due to direct glyphosate effects on the bacteria, or on plant processes that support nitrogen fixation (Eberbach and Young 1983). Monitoring of Roundup® application to British Columbia forest soils found no long-term effects to any soil animals or microorganism populations over six months. Some populations were reduced after spraying but recovered within thirty days (Preston and Trofymow 1989). Monitoring of pine seedlings and associated mycorrhizal fungi found no effect on seedling growth or ectomycorrhizal development following field applications of glyphosate in Ontario, Canada (Chakravarty, P. and Chartapaul, L. 1990).

Plants:

Contact with non-target plants may injure or kill plants. Roundup® was not toxic to algae species in British Columbia forest streams at post-spray levels, and appears to act as a source of phosphorus for algal growth where the nutrient is in short supply. (Austin et al., 1991).

Aquatic Animals:

Glyphosate is no more than slightly toxic to fish, and practically non-toxic to amphibians (McComb 1990) and aquatic invertebrate animals. Glyphosate is more toxic in alkaline water than in acidic water. Glyphosate and its formulations have not been tested for long-term effects in aquatic animals.

The Roundup® formulation is moderately toxic to freshwater fish and slightly toxic to aquatic invertebrate animals. No synergistic effects between glyphosate and the surfactant POEA have been measured (SERA, Inc. 1997a). In contrast to glyphosate, POEA is less toxic in alkaline water than in acidic water. Acute toxic levels for Roundup® are:

species	LC50
frog	7.7 to 39.7 ppm
fish	5 to 26 ppm
invertebrates	4 to 37 ppm

Although the surfactant in Roundup Pro® is chemically similar to POEA in Roundup®, no data are available to assess its actual toxicity to aquatic organisms.

The Accord® and Rodeo® formulations are practically non-toxic to freshwater fish and aquatic invertebrate animals.

Rodeo® and Accord® species	LC50
fish	>1,000 ppm
invertebrates	930 ppm

Monsanto conducted aquatic toxicity studies on three surfactants recommended for use with Rodeo® (McLaren/Hart 1995). Studies for R-11® and LI-700 were reviewed and accepted by California EPA (Lapurga 1996). R-11® would be classified as Moderately Toxic to fish and Slightly Toxic to invertebrates; LI-700® and Agri-Dex® would be classified as Practically Non-toxic to both fish and invertebrates.

species	surfactant	LC50
fish	R-11®	3.8 mg/l
	LI700®	130.0 mg/l
	Agri-Dex®	> 1000.0 mg/l
invertebrates	R-11®	19.0 mg/l
	LI700®	190.0 mg/l
	Agri-Dex®	> 1000.0 mg/l

These data do not allow any conclusions of absolute toxicity of formulations, or of relative toxicity among Rodeo® + surfactant formulations. The combined toxicity of Accord® + Entry II® (tested as Roundup®) is lower that would be predicted based on acute toxicity of the two components (SERA, Inc. 1997b).

Glyphosate does not build up (bioaccumulate) in fish. A misprinted concentration in fish fillets in one published study has caused confusion (Folmar 1984).

Terrestrial Animals:

Glyphosate has been tested on a variety of wildlife birds and mammals in both laboratory and wildland environments. Data for a single toxic dose (LD50) classify glyphosate as Practically Non-toxic to tested insects and birds. Data for multiple dietary doses classify glyphosate as no more than Slightly Toxic to birds (US EPA 1993a.).

Glyphosate

species	LD50	LC50
bobwhite quail	>1000 mg/kg	>4640 mg/kg
mallard duck		>4640 mg/kg
bee	>100 micrograms/bee =~1075 mg/kg (SERA 1996d)	

Data for laboratory mice adequately characterized acute toxicity of glyphosate to seven of nine tested wildlife mammal and amphibian species; adequacy could not be predicted for two other amphibian species (McComb 1990).

No significant effects on survival and reproduction of deer mice and Oregon voles were observed over five years following Roundup® release treatment of Douglas-fir plantations in British Columbia. Roundup® had little or no direct effect on development of young mice or vole populations; however possible health effects on individual animals were not directly studied (Sullivan 1990). Non-lethal or behavioral effects on rough-skinned newts and Townsend's chipmunks could not be detected following glyphosate application in PNW forests (McComb 1990). Field studies indicate that application rates of glyphosate greater than the rates used in Forest Service applications, toxic effects on terrestrial mammals will be secondary to habitat changes resulting from vegetation treatment (SERA, Inc. 1996e.)

In mammals, most glyphosate is excreted, unchanged, in urine and feces. Glyphosate was not broken down in rats given oral doses, and it did not bioaccumulate (Brewster et al. 1991).

Glyphosate and its formulations have not been tested for chronic toxicity on wildlife species. Testing on laboratory mammals of glyphosate and its formulations are reported in Section V.

Threatened and Endangered Species:

Glyphosate may be a hazard to endangered plants if it is applied to areas where they live. EPA identified 76 species that may be endangered by glyphosate use, including 74 plant, one toad and one beetle species.

V. Health Effects Testing

These data are results of laboratory animal studies. These data have been evaluated by the Forest Service and are used to make inferences relative to potential human health effects.

For glyphosate and its formulations, findings are from studies conducted by the manufacturer. These studies have been presented to EPA to support product registration, but may not be available to the public.

For glyphosate, the Environmental Protection Agency has evaluated these studies during the registration process. For Roundup® formulations, data are from studies supported by the manufacturer that are cited in the Material Safety Data Sheet. The Rodeo® and Accord® formulations, which consist of glyphosate and water only, are not cites because they are not expected to cause any greater health effects than concentrated glyphosate.

For LI-700® surfactant, data are from studies reviewed by California Department of Pesticide Regulation (Lapurga 1996). Product manufacturers reported the data for the other surfactants in MSDS or technical information sheets.

Table 2-1. Acute Toxicity

PRODUCT NAME	ACUTE ORAL TOXICITY (tests in male & female rats)	ACUTE DERMAL TOXICITY (tests on rabbits)
Glyphosate	Median lethal dose: 4,320 mg/kg. Slightly toxic (Category III)	Median lethal dose (males): 5,010 mg/kg (females): 794 mg/kg Slightly toxic (Category III)
Roundup® formulation	Median lethal dose: 5,000 mg/kg. Slightly toxic (Category III)	Median lethal dose: >5,000 mg/kg Practically nontoxic (Category IV)
Roundup Pro® formulation	Median lethal dose: >5,000 mg/kg. Practically nontoxic (Category IV)	Median lethal dose: >5,000 mg/kg Practically nontoxic (Category IV)
Agri-Dex® surfactant	Median lethal dose: >5,010 mg/kg. Practically nontoxic (Category IV)	Median lethal dose: >2,020 mg/kg Slightly toxic (Category III)
Entry II® surfactant	Median lethal dose: >100 mg/kg. Moderately toxic (Category II)	Median lethal dose: >100 mg/kg Moderately toxic (Category II)
Latron AG-98®-AG & AG-98®-N	Not specified	Not specified
LI-700® surfactant	Median lethal dose: >5,000 mg/kg. Practically nontoxic (Category IV)	Median lethal dose: >5,000 mg/kg Practically nontoxic (Category IV)
R-11® surfactant	Not specified	Not specified
PRODUCT NAME	**PRIMARY SKIN IRRITATION** (tests on rabbits)	**PRIMARY EYE IRRITATION** (tests on rabbits)
Glyphosate	Not an irritant. (Category IV)	Mild eye irritant. (Category III)
Roundup® formulation	Slightly irritating (Category III)	Moderately irritating (Category II)
Roundup Pro® formulation	Essentially non-irritating	Slightly irritating (Category III)
Agri-Dex® surfactant	Moderately irritating (Category II)	Slightly irritating (Category III)
Entry II® surfactant	Irritating, may cause allergic reaction	Severely irritating to corrosive (Category I)
Latron AG-98®-AG surfactant	Severely irritating (Category I)	Moderately irritating (Category II)
Latron AG-98®-N surfactant	Moderately irritating (Category II)	Severely irritating to corrosive (Category I)
LI-700® surfactant	Severely irritating (Category I)	Severely irritating (Category I)
R-11® surfactant	Moderately irritating (Category II)	Moderately irritating (Category II)
PRODUCT NAME	**ACUTE INHALATION** (this requirement was waived by the EPA for glyphosate)	
Roundup® formulation	Median lethal concentration: 3.18 mg/l (Rat) Slightly toxic (Category III)	
Roundup Pro® formulation	Median lethal concentration: 4.2 mg/l Practically nontoxic (Category IV)	

Chronic Toxicity:

These data are also based on tests in laboratory animals. EPA requires chronic toxicity tests only for the active ingredient glyphosate. Please refer to Section X for an explanation of how NOEL (No Observable Effects Level) is calculated.

The Pacific Northwest Region FEIS risk assessment evaluated the quality of the testing that had been done for glyphosate up to 1988. Quality consideration for individual studies included: ranges of doses and species that were tested; length of test; identification of the most sensitive effect. Additionally, the degree of quantitative agreement among all tests for an effect was considered. Please refer to Section X for an explanation of qualitative ratings in this section.

Systemic Toxicity:

NOEL for glyphosate: 31 mg/kg/day (rat); 20 mg/kg/day (dog)

The PNW Region FEIS rated the quality of testing as Marginally Adequate; the dose at which effects are seen in animal studies varies widely.

After repeated skin exposure for three weeks to Roundup® formulation at five times recommended use concentration, severe skin irritation and systemic toxic effects were observed in rabbits. Slight to moderate skin irritation was the only effect in rabbits treated with three times recommended use strength.

Carcinogenicity:

The PNW Region FEIS rated the quality of testing as Marginally Adequate, and assumed that glyphosate could cause cancer. Since the 1988 rating, EPA has concluded that glyphosate should be classified as having evidence of non-carcinogenicity for humans. There was no convincing evidence of carcinogenicity in new studies in two animal species (Dykstra and Ghali 1991).

Glyphosate was negative in tests for mutagenicity (the ability to cause genetic damage).

Reproduction/Developmental:

The EPA and the PNW Region FEIS used a NOEL of 10mg/kg/day, based on observed kidney effects in rat pups.

The PNW Region FEIS evaluated the testing as Marginally Adequate for these effects.

Immune System Effects

The PNW Region FEIS evaluated the testing as Inadequate for these effects.

Nervous System Effects

The PNW Region FEIS evaluated the testing as Inadequate for nervous system effects.

VI. Human Health Effects

Forest Service Evaluation of Human Health Risks:

The Pacific Northwest Region evaluated a range of glyphosate health effects data, including some laboratory studies cited in Section V. Both quantitative (numerical) estimates of toxicity, and the quality of data used to make numerical estimates were evaluated. The new information cited in Section V would improve the "quality of information" ratings in those categories. No new studies indicated a reduced margin of safety which would warrant additional restrictions on use of glyphosate beyond those specified in the FEIS.

The FEIS Quantitative Risk Assessment predicts the amount of human exposure—both to project workers and to the public—from typical forestry operations, and also from a large accidental spill. The Risk Assessment used this information to assess health risks from typical uses. These risks were compared to EPA standards of acceptable risk for human health effects. The FEIS risk assessment identified as "Moderate" or "High" any predicted risks from Forest Service operations that were greater than EPA standards.

Specific mitigation measures were designed to reduce human exposure from these operations; they are mandatory for every applicable project on National Forest lands.

The complete set of risk ratings is displayed in Sec. X.

The quality of the existing data affects the reliability of these risk ratings. The FEIS judged the overall quality of available data on glyphosate toxicity to be "Marginal." There were studies of adequate quality and results did not vary greatly, but more information would increase reliability. Although new studies may change estimates of health effects, the results are considered moderately reliable.

Potential for Health Effects to the Public:

Forest visitors and nearby residents could be exposed to herbicide drift, to vegetation with herbicide residues, and to accidental spraying. They also could eat food or drink water containing herbicide residues.

No studies of public exposure to forest herbicide applications were available. Public doses were estimated based on the behavior of the herbicide in the environment. "Routine Application" estimates maximum possible public exposure under normal operating conditions. The "Large Spill" situation models the highest doses that could ever be reasonably be expected to occur. Typical public exposures and risks would be much lower than either situation.

Mitigating Measures to Reduce Glyphosate Risks to Public:

"Low" risk of general health effects for all routine projects. "Moderate" risk of reproductive health effects for people who receive multiple exposures to glyphosate from a large (400-acre) aerial application project. "Low" risk for smaller (40-acre) aerial projects, and for all ground-based applications:

Consider potential for public exposure when designing contact procedures, posting and signing needs in the Herbicide Application Plan.

"Moderate" risk of general health effects, and "High" risk of reproductive effects if exposed to concentrated glyphosate from a large spill:

Prevent all public contact with accidental spills (emergency spill notification system, restrict public access to spill site).

Probability of a Worker Receiving a Dose which Affects General Helath or Reproduction:

Worker exposure and dose are estimated for typical forestry applications. Worker doses do not account for any reduction in exposure from following safety precautions or mitigating measures (such as wearing protective clothing).

Studies are available that measure actual worker doses of herbicide for some typical forestry applications. Backpack applicators of Roundup® in forest plantations have been monitored for the doses they absorbed in actual spray operations (Middendorf 1993). The measured doses for workers averaged 1/1000 the amount that was predicted in the PNW Region FEIS for Routine applications, and 1/67 the amount predicted for a Worst-case application situation. The worker risks would be much lower than the risk estimates used in the PNW Region FEIS (shown in this Profile) if these new operational doses were used.

Mitigating Measures to Reduce Identified Glyphosate Risks to Workers:

The probability of worker exposure to a toxic concentration for general health effects was rated "Low" or "Negligible" for all application methods. The probability of worker exposure to a toxic concentration for reproductive effects was rated "Low" or "Negligible" for aerial and tank truck mixer/loaders; "Moderate" for backpack spray and hack-and-squirt applicators.

In the PNW Region FEIS, Mitigating Measure

13 requires workers applying any herbicide to wear protective clothing. Mitigating Measure 23 requires worker exposure monitoring for all herbicide application projects.

The 1992 Amendment to the ROD requires workers to review this Information Profile before agreeing to apply glyphosate herbicides. The worker may request reassignment without penalty. Additional personal protective equipment will be available at the worksite for workers who want to reduce their exposure to the herbicide.

Acute Toxicity (Poisoning)

Reported Effects: Most incidents reported in humans have involved skin or eye irritation in workers after exposure during mixing, loading or application of glyphosate formulations. Nausea and dizziness have also been reported after exposure.

Swallowing the Roundup® formulation caused mouth and throat irritation, pain in the abdomen, vomiting, low blood pressure, reduced urine output, and in some cases, death. These effects have only occurred when the concentrate was accidentally or intentionally swallowed, not as a result of the proper use of Roundup®. The amount swallowed averaged about 100 milliliters (about half a cup).

Chronic Toxicity:

Reported Effects: There are no reported cases of long term health effects in humans due to glyphosate or its formulations.

Potential for Adverse Health Effects from Inert Ingredients and Surfactants:

The manufacturer has identified the inert ingredients in glyphosate formulations to the EPA and to the public. Inert ingredients in the Roundup® formulation include water the and surfactant POEA. POEA is a skin irritant and a severe eye irritant in concentrate form (Entry II). The surfactant compounds are more dilute and less toxic in the Roundup® formulation. The only inert ingredient in Rodeo® or Accord® is water, which is considered nontoxic.

EPA classified all inerts into one of four categories, called "Lists." List 1 contains chemicals of known toxic concern. List 2 contains chemicals of suspected toxic concern which are high priority for testing. List 4A contains chemicals of minimal concern, and List 4B contains chemicals with sufficient information to conclude that current uses will not adversely affect public health and the environment. All other chemicals were classified on List 3: Inerts of unknown toxicity. EPA did not find enough information available on the toxic properties of List 3 chemicals to classify them on Lists 1, 2, or 4.

The EPA classifications for all identified compounds in the four surfactants recommended for use with Rodeo®. Some compounds were not classified by EPA; other compounds were not identified precisely enought to be correlated with any chemical on the EPA Lists.

Table 2-2. EPA inerts list classification for constituents of selected surfactants.[a]

Surfactant Product	Chemical Constituents[b]	CAS No.	EPA Inerts Classification
Agri-Dex®	Polyol fatty acid esters[c]	NA	—
	Polyoxyethyl polyol fatty acid esters[c]	NA	—
	Paraffin base petroleum oil	64741-88-4	NC
		64741-89-5	NC
LI-700®	Phosphatidylcholine	8002-43-5[d]	4A
	Propionic acid	74-09-4	4B
	Alkylpolyoxyethylene ether[c]	NA	—
R-11®	Octylphenoxypolyethoxyethanol	9036-19-5[e]	4B
	n-Butanol	71-36-3	4B
	Compounded silicone[c]	NA	—
Latron AG-98®-AG	Octylphenoxypolyethoxyethanol	9036-19-5	4B
	Isopropanol	67-63-0	4B
	Polydimethylsiloxane	63148-62-9	4B
Latron AG-98®-N	Nonylphenoxypolyethoxyethanol	68412-54-4	3
	n-Butanol	71-63-3	4B
	Silicone antifoam compound[c]	NA	—

[a] EPA classification of Inert Ingredients in Pesticides (US EPA 1994): List 1 = Toxicological concern; List 2 = Potentially toxic with high priority for testing; List 3 = Unknown toxicity; List 4 = minimal concern (further subdivided into: List 4A = classified in US EPA 1987 as List 4; and List 4B = *sufficient information to conclude that current use patterns in pesticide products will not adversely affect public health and the environment*).

[b] Sources: Technical data sheets, material data safety sheets for surfactant products.

[c] Not sufficiently described to identify the specific constituent(s).

[d] licithins

[e] polyoxyethylene (1, 1, 3, 3-tetramethylbutyl) phenyl ether

NA, not available; NC, not classified

Health Effects of Exposure to Formulated Products:

Because Accord® and Rodeo® contain water as the only inert ingredient, health effects are assumed to be no greater than those for pure glyphosate. The Roundup® formulation is moderately toxic, and may cause skin irritation and eye irritation. Effects of Roundup® characterize the effects expected for a spray mix of Accord® with Entry II surfactant. Roundup Pro® appears to be similar in toxic properties to Roundup® except it may be less irritating to the skin and eyes (SERA, Inc. 1997d).

Inadequate data exists for Rodeo® + surfactant formulations to assess their potential for toxic effects. Aquatic and mammalian toxicology data for some of the surfactants is displayed in Sections IV, V, VI, and VII of this profile. However, these data alone are insufficient for predicting either the toxicity of the formulations, or the potential for various surfactants to affect the toxicity of Rodeo® (SERA 1997e).

Health Effects Associated with Contaminants:

Glyphosate contains the contaminant N-nitroso glyphosate (NNG) at 0.1 ppm or less. The potential for NNG to cause cancer is unknown. The EPA has not assessed the health risks of NNG.

No carcinogenic effects were observed in tests of glyphosate; the EPA concluded these tests were evidence of noncarcinogenicity. (Dykstra and Ghali, 1991)

1,4-dioxane, a known cancer-causing agent, is a common contaminant of ethoxylated surfactants. The EPA decided that reported trace levels of 1,4-dioxane (0.030%) in the Roundup® formulation were not likely to result in unreasonable adverse health effects. More recently, Monsanto reports that 1,4-dioxane contamination has been further reduced to 23 ppm (Monsanto Corp. Undated(b)).

Health Effects Associated with Other Formulations:

Some formulations contain glyphosate mixed with other herbicides such as 2,4-D or dicamba. This profile does not fully describe the potential for health or environmental effects from these formulations containing multiple herbicides. Additional information on properties and potential effects of these formulations will be prepared before they are used in the PNW Region.

Societal Perceptions:

Public opinion about herbicide use in general ranges from a perception that herbicides are completely safe, to a perception that they are very hazardous. A full range of opinion is available in the FEIS.

VII. Safety Precautions:

Signal Word and Definition:

Roundup®: WARNING - Causes substantial but temporary eye injury. Harmful if inhaled.

Rodeo®: CAUTION - May cause eye irritation. May be harmful if inhaled.

Accord®: CAUTION - May cause eye irritation.

Agri-Dex®: CAUTION - Mild skin and eye irritant.

Entry II®: DANGER - Causes eye burns. Causes skin irritation. Harmful if swallowed. May cause allergic skin reaction.

Latron AG-98®-AG: WARNING - Causes severe eye and skin irritation. Vapor harmful if inhaled. Harmful if swallowed.

Latron AG-98®-N: WARNING - Causes severe eye irritation and possible permanent injury. Causes skin irritation. Vapor harmful if inhaled. Harmful if swallowed.

LI-700®: DANGER - Liquid causes skin and eye injury.

R-11®: CAUTION - Causes eye irritation. May cause skin irritation. Harmful if swallowed.

Protective Precautions for Workers:

Avoid contact with eyes, skin or clothing. Avoid breathing vapors or spray mist. Wash thoroughly with soap and water after handling.

Medical Treatment Procedures (Antidotes):

There is no specific antidote for glyphosate; treat symptoms. For exposure to the eyes, flush with plenty of water for at least 15 minutes. Get medical attention. For exposure to the skin, flush skin with plenty of water. In case of emergency, call your local poison control center for advice.

Handling, Storage and Disposal:

Glyphosate is corrosive to unlined steel and galvanized steel. Do not mix, store or apply glyphosate in galvanized steel or unlined steel containers of spray tanks. Glyphosate is stable under normal storage conditions for at least 5 years. Wastes should be disposed of in a landfill approved for pesticide disposal or according to federal, state, and local rules. Do not contaminate water, food, animal feeds or seed by storage.

Emergency (Spill) Hazards and Procedures:

Spills that soak into the ground should be dug up and put in plastic-lined metal drums for disposal. Spills on floors or other hard surfaces should be contained or diked. An absorbent clay should be used to soak up the spill. The contaminated absorbent should be put in plastic-lined metal drums. Drums of contaminated soil should be disposed of in a landfill approved for pesticide disposal or according to federal, state and local rules. Do not contaminate water, food, animals feeds or seeds by disposal. In case of a large spill, call CHEMTREK at 1-800-424-9300 for advice.

VIII. Definitions

acute toxicity - the amount of a substance, as a single dose, to cause poisoning in a test animal

adsorption - the process of attaching to a surface

basal treatment - applied to the stem of a plant just above the soil

bioaccumulate - the uptake of a chemical by an organism from its environment

broadcast application - applied over an entire area

carcinogenicity - ability to cause cancer

chronic toxicity - toxic effects produced in test animals exposed for long periods to a chemical

dermal - of, or related to, the skin

EC50 - the concentration which will cause a toxic effect in 50% of the subjects

formulation - the form in which the pesticide is supplied by the manufacturer for use

half-life - the time required for a chemical to be reduced by natural processes to one half its original amount

herbicide - a substance used to destroy plants or to slow down their growth

LC50 - the concentration in air or water which will kill 50% of the subjects

LD50 - the dose which will kill 50% of the subjects

leach - to dissolve out by the action of water

mg/kg - milligrams of the substance per kilogram of body weight. Equals ppm

mg/l - milligrams of dissolved substance per liter of water. Equals ppm

microorganisms - living things too small to be seen without a microscope

mutagenicity - ability to cause genetic changes

non-target - animals or plants other than the ones which the pesticide is intended to kill

persistence - tendency of a pesticide to remain in the environment after it is applied

ppb - parts per billion parts

ppm - parts per million parts. Equal to mg/kg, and mg/l

residual activity - the remaining amount of activity as a pesticide

sensitizer - a delayed allergic response to a substance; symptoms usually resemble an acute toxic response

surfactant - a chemical added to a spray mixture to improve the ability of the pesticide to stick to and be absorbed by the plant surface

teratogen - a compound having the property of causing birth defects

volatility - the tendency to become a vapor at relatively low temperature

IX. Information Sources

U.S. Government Agency Publications

Forest Service, U.S. Department of Agriculture, 1984. *Herbicides.* Agriculture Handbook No. 633.

Pacific Northwest Region, Forest Service, USDA, Portland, OR, 1988. *Final Environmental Impact Statement for Managing Competing and Unwanted Vegetation.*

Chapter IV, Environmental Consequences: Human Health Effects Characterization and Management of Risk

Appendix C: Herbicide Use and Efficacy

Appendix D: Quantitative Risk Analysis

Appendix J: Herbicide Review with Wildlife-oriented Effects

U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, DC, 1986. *Pesticide Background Statements. Volume 1.* EPA Publication No. 540/FS-88-124

U.S. Environmental Protection Agency, Office of Prevention, Pesticides, and Toxic Substances, Washington D.C. 1993a. *Reregistration Eligibility Decision: Glyphosate.* EPA Publication No. EPA 738-R-93-014.

U.S. Environmental Protetion Agency, Office of Prevention, Pesticides, and Toxic Substances, Washington D.C. 1993b. *Pesticide Tolerances for Glyphosate (Proposed Rule).* Federal Register, Vol. 58, No. 85, May 5, 1993, pp. 26725-26727.

U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, Washington, DC. 1986. *Guidance for the Reregistration of Pesticide Products Containing Glyphosate as the Active Ingredient.* EPA Publication No. 540/RS-R6-156,

Forest Service, USDA, Atlanta, GA. 1989. *Final Environmental Impact Statement. Vegetation Management in the Coastal Plan/Piedmont.* Management Bulletin R8-MB-23.

Forest Service, USDA, San Francisco, California, 1989. *Final Environmental Impact Statement. Vegetation Management for Reforestation.*

Monsanto Agricultural Company Publications

Monsanto Corp. (anon.). 1992. *Roundup® Material Safety Data Sheet.*

Monsanto Corp. (anon.). 1993a. *Accord® Material Safety Data Sheet.*

Monsanto Corp. (anon.). 1993b. *Rodeo® Material Safety Data Sheet.*

Monsanto Corp. (anon.). Undated(a). *Backgrounder; Roundup® Herbicide Ingredients.*

Monsanto Corp. (anon.). Undated(b). *1,4-Dioxane Questions and Answers.*

Other Sources

American Conference of Governmental Industrial Hygienists, Inc. 1991. *Documentation of the Threshold Limit Values and Biological Exposure Indices.* ACGIH, Inc. Cincinnati, OH. pp 512-515.

Austin, A.P., Harris, G.E., and Lucey, W.P. 1991. *Impact of an Organophosphate Herbicide (Glyphosate) on Periphyton Communities Developed in Experimental Streams.* Bull. Environ. Contam. Toxicol. 47: 29-35.

Brewster, D. W., Warren, J., and Hopkins, W.E. 1991. *Metabolism of Glyphosate in Sprague-Dawley Rate: Tissue Distribution, Identification, and Quantitation of Glyphosate-Derived Materials following a Single Oral Dose.* Fundamental and Applied Toxicology 17: 43-51.

Chakravarty, P., and Chartapaul, L. 1990. *Non-target Effect of Herbicides: II. The Influence of Glyphosate on Ectomycorrhizal Symbiosis of Red Pine under Greenhouse and Field Conditions.* Pestic. Sci. 0031-613X.

Dykstra, W., and Ghali, G. 1991. *Second Peer Review of Glyphosate.* U.S. Environmental Protection Agency Memo.

Eberbach, P. L.; Douglas, L. A. 1983. *Persistence of Glyphosate in a Sandy Loam. Soil Biology and Biochemistry* 15 (4). 485-487.

Feng, J.C., and Thompson, D.G. 1989. *Persistence and Dissipation of Glyphosate in Foliage and Soils of a Canadian Coastal Forest Watershed.* In: Proceedings of the Carnation Creek Herbicide Workshop. Forestry Canada, FRDA Report ISSN 0835-0752; 063.

Folmar, Dr. Leroy C. , U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1984. *Personal Communication to Dr. Robert A. Campbell re: Error in Published Roundup® Concentration in Fish Fillets.*

Khan, Shahamat U., and Young, J. Christopher. 1977. *N-Nitrosamine Formation in Soil from the Herbicide Glyphosate.* Journal of Agricultural and Food Chemistry 25; no. 6: 1430-1432.

Middendorf, P.J. 1993. *Forest worker exposures to glyphosate during directed foliar applications of Roundup® herbicide.* Rep. Project #A-8196-000. Ga. Tech. Res. Inst., Ga. Inst. Tech., Environ. Sci. and Technol. Lab. 71 p.

Newton, Michael, et al. 1984. *Fate of Glyphosate in an Oregon Forest Ecosystem.* Journal of Agricultural and Food Chemistry 32, no. 5. 1144-1151.

Oppenhuizen, M.E.; Cowell, J.E. 1991. *Liquid Chromotographic Determination of Glyphosate and AMPA in Environmental Water: Collaborative Study.* J. Assoc. Off. Anal. Chem. Vol. 74, No. 2.

Preston, C.M. and Trofymow, J.A. 1989. *Effects of Glyphosate (Roundup®) on Biological Activity of Two Forest Soils.* In: Proceedings of the Carnation Creek Herbicide Workshop. Forestry Canada, FRDA Report ISSN 0835-0752; 063.

Sullivan, Thomas P. 1990. *Influence of Forest Herbicide on Deer Mouse and Oregon Vole Population Dynamics.* J. Wildlife Management, Vol 54, No. 4: 566-576.

Wan, M.T.K. 1989. *The Persistence of Glyphosate and its Metabolite Amino-methylphosphonic Acid in Some Coastal British Columbia Streams. Environment.* Canada, Environmental Protection Service, Pacific and Yukon Region, Regional Program Report 85-0

For more information on glyphosate contact your local Forest Service Office

February 1997

X. Toxicity and Risk Categories

Estimates of Health Risks to the Public and to Workers from Forest Service Operations

The FEIS predicts levels of human exposure (dose) for project workers and for the public, for both a typical field project and for a large accidental spill. These dose levels are compared to the highest dose level in animal tests that showed no health effect (No Observed Effects Level). The risk is ranked from "Negligible" to "High" based on the margin between the expected human dose and the highest NOEL—"no effect" dose. A "High" risk rating means that the highest NOEL dose is not more than ten times larger than predicted human dose under the specified conditions. A "Moderate" risk rating means that the highest NOEL dose is between 10 and 100 times larger than the expected human dose.

Estimated Health Risks To The Public		
Situation	**General Health**	**Reproduction**
Routine Large Aerial Application	Moderate	Moderate
Routine Application Other	Low	Low
Large Spill	High	High

Estimated Health Risks To Project Workers		
Situation	**General Health**	**Reproduction**
Aerial Mixer/Loader	Low	Low
Backpack Sprayer	Moderate	Moderate
Right-of-way Mixer/Loader	Negligible	Negligible
Hack-and-Squirt	Low	Low

* Glyphosate was presumed not to be used in hack-and-squirt operations.

Ecotoxological Categories

Mammalian (Acute Oral):	
mg/kg	*Risk Category*
<10	very highly toxic
10-50	highly toxic
51-500	moderately toxic
501-2000	slightly toxic
>2000	practically non toxic

Avian (Acute Oral):	
mg/kg	*Risk Category*
<10	very highly toxic
10-50	highly toxic
51-500	moderately toxic
501-2000	slightly toxic
>2000	practically non toxic

Avian (Dietary):	
ppm	*Risk Category*
<50	very highly toxic
50-500	highly toxic
501-1000	moderately toxic
1001-5000	slightly toxic
>5000	practically non toxic

Aquatic Organisms:	
ppm	*Risk Category*
<0.1	very highly toxic
0.1-1	highly toxic
>1-10	moderately toxic
>10-100	slightly toxic
>100	practically non toxic

Human Hazards				
		Route of Administration		
Risk Category	**Signal Word**	**Oral (mg/kg)**	**Dermal (mg/kg)**	**Inhalation (mg/kg)**
I	**DANGER--Poison**	0-50	0-200	0-0.2
II	**WARNING**	>50-500	>200-2000	>0.2-2.0
III	**CAUTION**	>500-5000	>2000-20,000	>2.0-20
IV	**NONE**	>5000	>20,000	>20

	Hazard	
Category	**Eye Irritation**	**Skin Irritation**
I	Corrosive: corneal opacity not reversible within 7 days	corrosive
II	corneal opacity reversible within 7 days; irritation persisting for 7 days	severe irritation at 72 hours
III	no corneal opacity; irritation reversible within 7 days	moderate irritation at 72 hours
IV	no irritation	mild or slight irritation at 72 hours

Categories of Quality of Health Effects Data	
Inadequate:	Inadequate information available for evaluating toxicity. There were too few studies of sufficient quality to yield useful or reliable information.
Marginal-Inadequate:	Some useful information exists for evaluating toxicity. There were studies of marginal quality that provided useful information, but studies were inconsistent and some contained flaws. It is likely that new studies would change estimates of health effects.
Marginal:	Marginal but useful information available for evaluating toxicity. There were studies of adequate quality, and results did not vary greatly, but more information would increase reliability. Although new studies may change estimates of health effects, the results are considered moderately reliable.
Adequate:	Adequate information is available. Studies are of sufficient quality and quantity that estimates of human health are considered reliable. New studies are unlikely to change estimates of health effects.

PREFACE

Journal of Pesticide Reform Herbicide Factsheet – Glyphosate (Roundup) and Response by Monsanto

The following three articles are included to illustrate the breadth of debate surrounding the safety of glyphosate herbicides and provide context for interpretation of prevailing scientific views. The Journal of Pesticide Reform is a publication of the National Coalition for Alternatives to Pesticides (NCAP), a group opposed to pesticide use. Caroline Cox, the author of the article, is the Journal's editor and primary author. The rebuttal is by Monsanto, one of the primary producers of glyphosate herbicides. Finally is an article by Environmental Toxicologist, Allan Felsot, who discusses interpretation of toxicity data.

MONSANTO

Backgrounder
Glyphosate and _Journal of Pesticide Reform_ Articles
July, 2002

Monsanto Company

The *Journal of Pesticide Reform* (JPR) is a magazine produced by the Northwest Coalition for Alternatives to Pesticides (NCAP), an anti-pesticide activist group based in Eugene, Oregon. The group has used its magazine to publish articles they call "Fact Sheets" about a number of pest-control products, including glyphosate. The magazine is not peer reviewed, meaning that articles submitted for publication are not sent to independent scientists for review of technical content. JPR is in fact a publication for NCAP members and is used to advocate its agenda in opposition to pesticides.

JPR has compiled and updated "Fact Sheets" on glyphosate, the active ingredient in Roundup® agricultural herbicides. (JPR, 1998) Caroline Cox, editor of the magazine and a staunch pesticide opponent, is listed as the author of the reports. The fact sheets cite published studies to give the impression of veracity and impartiality, but Cox frequently misrepresents the findings of the referenced studies or quotes them out of context.

A typical and completely misleading JPR statement is this: "Glyphosate-containing products are acutely toxic to animals, including humans. Symptoms include…" The article then lists skin and eye irritation and several more-alarming effects. The term "acutely toxic" is not explained, leaving readers to perhaps interpret its meaning as "very toxic." The term simply means that at some dose a single exposure can cause an adverse effect. Only the skin and eye irritation have been experienced as a result of actual use of the product. The other listed effects occurred in laboratory animals given extremely high doses (including injection into the lungs and stomach), or in some unfortunate cases where people attempted suicide by drinking a large amount of a commercial herbicide. In fact, the U.S. Environmental Protection Agency, the World Health Organization and independent experts have concluded that glyphosate and formulated glyphosate products have very low toxicity. (EPA, 1993; WHO, 1994; Giesy et al., 2000; Williams et al., 2000; EXTOXNET, 2001)

Recently, an independent toxicologist did a thorough evaluation of the *Journal's* glyphosate reports and found them seriously flawed. Dr. Frank N. Dost, emeritus professor of Agricultural Chemistry and Forest Toxicology at Oregon State University, was retained by a Canadian railroad company to assess the "fact sheets."

Calling the JPR article "bad work," he writes: "The tone of the paper is set by generalizations at the beginning suggesting that glyphosate is severely toxic and represents an environmental threat. No source quoted in the article, or any other evidence supports those contentions."

His report faults Cox for implying that effects seen at very high doses could also occur at any lower dose. "Ms. Cox generally ignores the essential dose-response information in the references she uses… Also cast aside in these references are authors' conclusions that glyphosate use is unlikely to result in harm."

Dost writes that regulatory officials and their scientific advisors world-wide have concluded, in regulatory documents, that glyphosate formulations have very limited toxicity, and that "toxicological risks and environmental impacts associated with use of glyphosate are minute for all non-plant species. ... However, Ms. Cox lifts words from those official documents out of context in attempts to imply substantial risk with glyphosate use, and ignores the conclusions of minimal risk in the same pages."

He concludes: "When the data and the conclusions of authors and regulatory publications reviewed by Cox are compared with her interpretation, it is difficult to avoid a conclusion that the purpose of this paper is political, not informative."

Allan S. Felsot, an extension toxicologist at Washington State University, has also critiqued points raised by NCAP's glyphosate article. His review, "Giddy 'bout Glyphosate," November 2000, examines what he refers to as "tricks" by the activist group to make glyphosate appear more hazardous than it is. The review is available at http://www.tricity.wsu.edu/aenews/Nov00AENews/NovAENews00.pdf (page 6).

References

Cox C. (2002) Glyphosate (Roundup). Journal of Pesticide Reform 18(3): 3-17. On-line version updated June 2002. http://www.pesticide.org/gly.pdf

Dost F. (1999) Evaluation Of Herbicide Factsheet, Glyphosate (Roundup) by Caroline Cox in Journal of Pesticide Reform (JPR) 18/3 pp 3-15, 1998. An update of papers prepared for B. C. Railway and by the City of Santa Cruz, CA. Unpublished.[1]

EXTOXNET. (1996) Glyphosate Pesticide Information Profile. Extension Toxicology Network. http://ace.ace.orst.edu/info/extoxnet/pips/ghindex.html

Giesy JP, Dobson S, Solomon KR. (2000) Ecotoxicological Risk Assessment for Roundup Herbicide. *Reviews of Environmental Contamination and Toxicology* 167: 35-120. Backgrounder: http://www.monsanto.com/monsanto/content/products/productivity/roundup/ecotoxicological_risk_backgrounderfinal.pdf

USEPA (1993) Reregistration eligibility decision (RED): Glyphosate. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Washington, DC. http://www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf

WHO (World Health Organization) (1994) Glyphosate: Environmental health criteria 159. World Health Organization, Geneva, Switzerland. http://www.inchem.org/documents/ehc/ehc/ehc159.htm

Williams GM, Kroes R, Munro IC (2000) Safety evaluation and risk assessment of the herbicide Roundup and its active ingredient, glyphosate, for humans. *Regulatory Toxicology and Pharmacology,* 31: 117-165. Abstract: http://www.idealibrary.com/links/doi/10.1006/rtph.1999.1371 Backgrounder : http://www.monsanto.com/monsanto/content/products/productivity/roundup/glyphosate_human_risk_backgrounder.pdf

[1] Unpublished references can be requested from Monsanto's Public Affairs Director for Agricultural Chemicals at 314-694-3546.

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AQUAMASTER™
Herbicide by Monsanto

Complete Directions for Use in Aquatic and Other Noncrop Sites.

EPA Reg. No. 524-343

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION IS LIKELY TO RESULT.

2000-1

Read the entire label before using this product.

Use only according to label instructions.

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION OR REPACKAGING. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:
*Glyphosate, N-(phosphonomethyl)glycine,
in the form of its isopropylamine salt 53.8%
OTHER INGREDIENTS: 46.2%
100.0%

*Contains 648 grams per litre or 5.4 pounds per U.S. gallon of the active ingredient, glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per litre or 4 pounds per U.S. gallon of the acid, glyphosate.

2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE,
1-800-332-3111
2. IN CASE OF AN EMERGENCY INVOLVING THIS PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT,
(314)-694-4000

3.0 PRECAUTIONARY STATEMENTS

3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

Remove contaminated clothing and wash clothing before reuse.

Wash thoroughly with soap and water after handling.

3.2 Environmental Hazards

Do not contaminate water when disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of: SPILL or LEAK, soak up and remove to a landfill.

3.3 Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

4.0 STORAGE AND DISPOSAL

Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

STORAGE: STORE ABOVE 10°F (-12°C) TO KEEP PRODUCT FROM CRYSTALLIZING. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using.

DISPOSAL: Wastes resulting from the use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state, or local procedures.

Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned, or destroyed.

FOR REFILLABLE PORTABLE CONTAINERS: Do not reuse this container except for refill in accordance with a valid Monsanto Repackaging or Toll Repackaging Agreement. If not refilled or returned to the authorized repackaging facility, triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR METAL CONTAINERS (non-aerosol): Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

FOR BULK CONTAINERS: Triple rinse emptied bulk container. Then offer for recycling or reconditioning, or dispose of in a manner approved by state and local authorities.

FOR PLASTIC 1-WAY CONTAINERS AND BOTTLES: Do not reuse container. Triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

FOR DRUMS: Do not reuse container. Return container per the Monsanto container return program. If not returned, triple rinse container, then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

5.0 GENERAL INFORMATION

This product, a water-soluble liquid, mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants.

This product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days but on most perennial brush species may not occur for 7 days or more. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "WEEDS CONTROLLED" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product per acre within the recommended range when vegetation is heavy or dense.

Do not treat weeds or brush under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced results may also occur when treating weeds or brush heavily covered with dust.

Reduced control may result when applications are made to any weed or brush species that have been mowed, grazed or cut, and have not been allowed to regrow to the recommended stage for treatment.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may wash the product off the foliage and a repeat treatment may be required.

When this product comes in contact with soil (on the soil surface or as suspended soil or sediment in water) it is bound to soil particles. Under recommended use situations, once this product is bound to soil particles, it is not available for plant uptake and will not harm off-site vegetation where roots grow into the treatment area or if the soil is transported off-site. Under recommended use conditions, the strong affinity of this product to soil particles prevents this product from leaching out of the soil profile and entering ground water. The affinity between this product and soil particles remains until this product is degraded, which is primarily a biological degradation process carried out under both aerobic and anaerobic conditions by soil microflora.

This product does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

ATTENTION

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

6.0 MIXING

Clean sprayer parts immediately after using this product by thoroughly flushing with water.

NOTE: REDUCED RESULTS MAY OCCUR IF WATER CONTAINING SOIL IS USED, SUCH AS VISIBLY MUDDY WATER OR WATER FROM PONDS AND DITCHES THAT IS NOT CLEAR.

6.1 Mixing with Water and Surfactant

This product mixes readily with water. Mix spray solutions of this product as follows: 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. Use caution to avoid siphoning back into the carrier source. Use approved anti-back-siphoning devices where required by state or local regulations. During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, terminate by-pass and return lines at the bottom of the tank and, if needed, use an approved anti-foam or defoaming agent.

Maintain good agitation at all times until the contents of the tank are sprayed. If the spray mixture is allowed to settle, thorough agitation may be required to resuspend the mixture before spraying is resumed.

Keep by-pass line on or near the bottom of the tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh.

When using this product, mix 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. Use a nonionic surfactant labeled for use with herbicides. The surfactant must contain 50 percent or more active ingredient.

These surfactants should not be used in excess of 1 quart per acre when making **broadcast** applications.

Always read and follow the manufacturer's surfactant label recommendations for best results. Carefully observe all cautionary statements and other information appearing in the surfactant label.

6.2 Mixing for Hand-Held Sprayers

Prepare the desired volume of spray solution by mixing the amount of this product in water as shown in the following table:

Spray Solution

DESIRED VOLUME	AMOUNT OF AQUAMASTER™ 3/4%	1%	1 1/4%	1 1/2%	5%	8%
1 Gal	1 oz.	1 1/3 oz.	1 2/3 oz.	2 oz.	6 oz.	10 1/4 oz.
25 Gal	1 1/2 pt.	1 qt.	1 1/4 qt.	1 1/2 qt.	5 qt.	2 gal.
100 Gal	3 qt.	1 gal.	1 1/4 gal.	1 1/2 gal.	5 gal.	8 gal.

2 tablespoons = 1 fluid ounce

For use in backpack, knapsack or pump-up sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution and add the correct amount of surfactant.

6.3 Colorants or Dyes

Agriculturally-approved colorants or marking dyes may be added to this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilution. Use colorants or dyes according to the manufacturer's recommendations.

7.0 APPLICATION EQUIPMENT AND TECHNIQUES

Do not apply this product through any type of irrigation system.

APPLY THESE SPRAY SOLUTIONS IN PROPERLY MAINTAINED AND CALIBRATED EQUIPMENT CAPABLE OF DELIVERING DESIRED VOLUMES.

SPRAY DRIFT MANAGEMENT

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

AERIAL SPRAY DRIFT MANAGEMENT

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications or to public health uses.

1. The distance of the outermost nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

Importance of Droplet Size

The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see the **"WIND"**, **"TEMPERATURE AND HUMIDITY"**, and **"TEMPERATURE INVERSION"** sections of this label).

Controlling Droplet Size

- **Volume:** Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with the higher rated flows produce larger droplets.
- **Pressure:** Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy protection. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of nozzles:** Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle orientation:** Orienting nozzles so that the spray is released backwards, parallel to the airstream, will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- **Nozzle type:** Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.
- **Boom length:** For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.
- **Application height:** Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces the exposure of the droplets to evaporation and wind.

Swath Adjustment

When applications are made with a crosswind, the swath will be displaced downward. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller droplets, etc.).

Wind

Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **NOTE:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions

Applications should not occur during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas

The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

7.1 Aerial Equipment

DO NOT APPLY THIS PRODUCT USING AERIAL SPRAY EQUIPMENT EXCEPT UNDER CONDITIONS AS SPECIFIED WITHIN THIS LABEL.

FOR AERIAL APPLICATION IN CALIFORNIA, REFER TO THE FEDERAL SUPPLEMENTAL LABEL FOR AERIAL APPLICATIONS IN THAT STATE FOR SPECIFIC INSTRUCTIONS, RESTRICTIONS AND REQUIREMENTS.

AVOID DRIFT—DO NOT APPLY DURING LOW-LEVEL INVERSION CONDITIONS, WHEN WINDS ARE GUSTY OR UNDER ANY OTHER CONDITION WHICH FAVORS DRIFT. DRIFT IS LIKELY TO CAUSE DAMAGE TO ANY VEGETATION CONTACTED TO WHICH TREATMENT IS NOT INTENDED. TO PREVENT INJURY TO ADJACENT DESIRABLE VEGETATION, APPROPRIATE BUFFER ZONES MUST BE MAINTAINED.

Use the recommended rates of this product and surfactant in 3 to 20 gallons of water per acre as a broadcast spray, unless otherwise specified.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing on the additive label.

Ensure uniform application—To avoid streaked, uneven or overlapped application, use appropriate marking devices.

PROLONGED EXPOSURE OF THIS PRODUCT TO UNCOATED STEEL SURFACES MAY RESULT IN CORROSION AND POSSIBLE FAILURE OF THE PART. The maintenance of an organic coating (paint) which meets aerospace specification

MIL-C-38413 may prevent corrosion. To prevent corrosion of exposed parts, thoroughly wash aircraft after each day of spraying to remove residues of this product accumulated during spraying or from spills. Landing gear are most susceptible.

7.2 Ground Broadcast Equipment

Use the recommended rates of this product in 3 to 40 gallons of water per acre as a broadcast spray unless otherwise specified. See the "WEEDS CONTROLLED" section of this label for specific rates. As density of weeds increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select proper nozzles to avoid spraying a fine mist. For best results with ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

7.3 Hand-Held and High-Volume Equipment

Use Coarse Sprays Only

For control of weeds listed in this label using backpack or knapsack sprayers or high-volume spraying equipment utilizing handguns or other suitable nozzle arrangements—Prepare a 3/4 to 2 percent solution of this product in water, add a nonionic surfactant and apply to foliage of vegetation to be controlled. For specific rates of application and instructions for control of various annual and perennial weeds, see the "WEEDS CONTROLLED" section in this label.

Applications should be made on a spray-to-wet basis. Spray coverage should be uniform and complete. Do not spray to point of runoff.

This product may be used as a 5 to 8 percent solution for low-volume directed sprays for spot treatment of trees and brush. It is most effective in areas where there is a low density of undesirable trees or brush. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zig-zag motion. Ensure that at least 50 percent of the leaves are contacted by the spray solution. For flat fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. Small, open-branched trees need only be treated from one side. If the foliage is thick or there are multiple root sprouts, applications must be made from several sides to ensure adequate spray coverage.

7.4 Selective Equipment (Wiper Applications)

A wiper or sponge applicator applies the herbicide solution onto weeds by rubbing the weed with an absorbent material containing the herbicide solution.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "WEEDS CONTROLLED" section in this label for recommended timing, growth stage and other instructions for achieving optimum results.

AVOID CONTACT OF HERBICIDE WITH DESIRABLE VEGETATION AS SERIOUS INJURY OR DEATH IS LIKELY TO OCCUR.

For wick or wiper applications, mix 2 1/2 gallons of this product plus 1 quart of a nonionic surfactant with 7 1/4 gallons of clean water to prepare a 25 percent solution.

Mix only the amount of solution to be used during a 1-day period, as reduced activity may result from use of leftover solutions. Clean wiper parts immediately after using this product by thoroughly flushing with water.

8.0 SITE AND USE RECOMMENDATIONS

Detailed instructions follow alphabetically, by site.

Unless otherwise specified, applications may be made to control any weeds listed in the annual, perennial and woody brush tables. Refer also to the "SELECTIVE EQUIPMENT" section.

8.1 Aquatic and Other Noncrop Sites

When applied as directed and under the conditions described in the "WEEDS CONTROLLED" section in this label, this product will control or partially control the labeled weeds growing in the following industrial, recreational and public areas or other similar aquatic and terrestrial sites.

Aquatic Sites

This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas, and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

This product does not control plants which are completely submerged or have a majority of their foliage under water.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

NOTE: Do not apply this product **directly to water** within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does **NOT** apply to intermittent inadvertent overspray of water in terrestrial use sites.

For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.

Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.

Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.

When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

Other Noncrop-Type Sites—This product may be used to control the listed weeds in terrestrial noncrop sites and/or in aquatic sites within these areas:

Airports
Golf Courses
Habitat Restoration & Management Areas
Highways
Industrial Plant Sites
Lumberyards
Natural Areas
Parking Areas
Parks
Petroleum Tank Farms
Pipeline, Power, Telephone & Utility Rights-of-Way
Pumping Installations
Railroads
Roadsides
Schools
Storage Areas
Similar Industrial and Non-crop Sites

8.2 Cut Stump Application

Cut stump treatments may be made on any site listed on this label. This product will control many types of woody brush and tree species, some of which are listed below. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut trees or resprouts close to the soil surface. **Apply a 50 to 100 percent solution of this product to the freshly-cut surface immediately after cutting.** Delays in application may result in reduced performance. For best results, applications should be made during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will CONTROL, PARTIALLY CONTROL or SUPPRESS most woody brush and tree species, some of which are listed below:

Alder
Alnus spp.
Coyote brush*
Baccharis consanguinea
Dogwood*
Cornus spp.
Eucalyptus
Eucalyptus spp.
Hickory*
Carya spp.
Madrone
Arbutus menziesii
Maple*
Acer spp.
Oak
Quercus spp.
Poplar*
Populus spp.
Reed, giant
Arundo donax
Salt cedar
Tamarix spp.
Sweet gum*
Liquidambar styraciflua
Sycamore*
Platanus occidentalis
Tan oak
Lithocarpus densiflorus
Willow
Salix spp.

*This product is not approved for this use on these species in the State of California.

DO NOT MAKE CUT STUMP APPLICATIONS WHEN THE ROOTS OF DESIRABLE WOODY BRUSH OR TREES MAY BE GRAFTED TO THE ROOTS OF THE CUT STUMP. INJURY RESULTING FROM ROOT GRAFTING IS LIKELY TO OCCUR IN ADJACENT WOODY BRUSH OR TREES.

8.3 Habitat Restoration and Management

This product is recommended for the restoration and/or maintenance of native habitat and in wildlife management areas.

Habitat Restoration and Management

This product may be used to control exotic, alien and other undesirable vegetation in habitat management and natural areas, including riparian and estuarine areas, and wildlife refuges. Applications can be made to allow recovery of native plant species, prior to planting desirable native species, and for similar broad spectrum vegetation control requirements. Spot treatments can be made to selectively remove unwanted plants for habitat management and enhancement.

Wildlife Food Plots

This product may be used as a site preparation treatment prior to planting wildlife food plots. Any wildlife food species, including natives, may be planted after applying this product, or native species may be allowed to repopulate the area. If tillage is needed to prepare a seedbed, wait 7 days after application before tillage to allow translocation into underground plant parts.

8.4 Injection and Frill Applications

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment WILL CONTROL the following woody species:

Oak
Quercus spp.
Poplar
Populus spp.
Sweet gum
Liquidambar styraciflua
Sycamore
Platanus occidentalis

This treatment WILL SUPPRESS the following woody species:

Black gum*
Nyssa sylvatica
Dogwood
Cornus spp.
Hickory
Carya spp.
Maple, red
Acer rubrum

DO NOT MAKE INJECTION OR FRILL APPLICATIONS WHEN THE ROOTS OF DESIRABLE WOODY BRUSH OR TREES MAY BE GRAFTED TO THE ROOTS OF THE TREATED TREES. INJURY RESULTING FROM ROOT GRAFTING IS LIKELY TO OCCUR IN ADJACENT WOODY BRUSH OR TREES.

*This product is not approved for this use on this species in the State of California.

8.5 Roadsides

RELEASE OF DORMANT BERMUDAGRASS AND BAHIAGRASS

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4- to 6-leaf stage.

WEEDS CONTROLLED

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

WEEDS CONTROLLED OR SUPPRESSED*

NOTE: C = Control
S = Suppression

	AQUAMASTER FLUID OZ/ACRE					
WEED SPECIES	6	9	12	18	24	48
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	C
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop Trifolium campestre	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

*These rates apply only to sites where an established competitive turf is present.

RELEASE OF ACTIVELY GROWING BERMUDAGRASS

NOTE: USE ONLY ON SITES WHERE BAHIAGRASS OR BERMUDAGRASS ARE DESIRED FOR GROUND COVER AND SOME TEMPORARY INJURY OR YELLOWING OF THE GRASSES CAN BE TOLERATED.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "WEEDS CONTROLLED" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass	Johnsongrass**
Dallisgrass	Trumpetcreeper*
Fescue (tall)	Vaseygrass

*Suppression at the higher rate only.

**Johnsongrass is controlled at the higher rate.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

BAHIAGRASS SEEDHEAD AND VEGETATIVE SUPPRESSION

When applied as directed in the "NONCROP SITES" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

ANNUAL GRASS GROWTH SUPPRESSION

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

9.0 WEEDS CONTROLLED

9.1 Annual Weeds

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "DIRECTIONS FOR USE", "GENERAL INFORMATION" and "MIXING AND APPLICATION INSTRUCTIONS" for labeled uses and specific application instructions.

Broadcast Application—Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application—Use a 3/4 to 1 1/2 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled. Use the higher rate for tough-to-control species or for weeds over 24 inches tall.

When applied as directed under the conditions described in this label, this product plus nonionic surfactant WILL CONTROL the following ANNUAL WEEDS:

Balsamapple**
Momordica charantia

Barley
Hordeum vulgare

Barnyardgrass
Echinochloa crus-galli

Bassia, fivehook
Bassia hyssopifolia

Bluegrass, annual
Poa annua

Bluegrass, bulbous
Poa bulbosa

Brome
Bromus spp.

Buttercup
Ranunculus spp.

Cheat
Bromus secalinus

Cheeseweed
Malva parviflora

Chickweed, mouseear
Cerastium vulgatum

Cocklebur
Xanthium strumarium

Corn, volunteer
Zea mays

Crabgrass
Digitaria spp.

Dwarfdandelion
Krigia cespitosa

Falseflax, smallseed
Camelina microcarpa

Fiddleneck
Amsinckia spp.

Flaxleaf fleabane
Conyza bonariensis

Fleabane
Erigeron spp.

Foxtail
Setaria spp.

Foxtail, Carolina
Alopecurus carolinianus

Groundsel, common
Senecio vulgaris

Horseweed/Marestail
Conyza canadensis

Kochia
Kochia scoparia

Lambsquarters, common
Chenopodium album

Lettuce, prickly
Lactuca serriola

Morningglory
Ipomoea spp.

Mustard, blue
Chorispora tenella

Mustard, tansy
Descurainia pinnata

Mustard, tumble
Sisymbrium altissimum

Mustard, wild
Sinapis arvensis

Oats, wild
Avena fatua

Panicum
Panicum spp.

Pennycress, field
Thlaspi arvense

Pigweed, redroot
Amaranthus retroflexus

Pigweed, smooth
Amaranthus hybridus

Puncturevine
Tribulus terrestris

Ragweed, common
Ambrosia artemisiifolia

Ragweed, giant
Ambrosia trifida

Rocket, London
Sisymbrium irio

Rye
Secale cereale

Ryegrass, Italian*
Lolium multiflorum

Sandbur, field
Cenchrus spp.

Shattercane
Sorghum bicolor

Shepherd's-purse
Capsella bursa-pastoris

Signalgrass, broadleaf
Brachiaria platyphylla

Smartweed, Pennsylvania
Polygonum pensylvanicum

Sowthistle, annual
Sonchus oleraceus

Spanishneedles*
Bidens bipinnata

Stinkgrass
Eragrostis cilianensis

Sunflower
Helianthus annuus

Thistle, Russian
Salsola kali

Spurry, umbrella
Holosteum umbellatum

Velvetleaf
Abutilon theophrasti

Wheat
Triticum aestivum

Witchgrass
Panicum capillare

*Apply 3 pints of this product per acre.

**Apply with hand-held equipment only.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

9.2 Perennial Weeds

Apply a 3/4 to 1 1/2 percent solution of this product to control or destroy most vigorously growing perennial weeds. Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "GENERAL INFORMATION," "DIRECTIONS FOR USE" and "MIXING AND APPLICATION" sections in this label for specific uses and application instructions.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low volume directed spot treatments, apply a 5 to 8 percent solution of this product.

Unless otherwise directed, allow at least 7 days after application before disturbing vegetation. If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

When applied as recommended under the conditions described, this product plus surfactant WILL CONTROL the following PERENNIAL WEEDS:

Alfalfa
Medicago sativa

Alligatorweed*
Alternanthera philoxeroides

Anise/Fennel
Foeniculum vulgare

Artichoke, Jerusalem
Helianthus tuberosus

Bahiagrass
Paspalum notatum

Beachgrass, European
Ammophila arenaria

Bermudagrass
Cynodon dactylon

Bindweed, field
Convolvulus arvensis

Bluegrass, Kentucky
Poa pratensis

Blueweed, Texas
Helianthus ciliaris

Brackenfern
Pteridium spp.

Bromegrass, smooth
Bromus inermis

Canarygrass, reed
Phalaris arundinacea

Cattail
Typha spp.

Clover, red
Trifolium pratense

Clover, white
Trifolium repens

Cogongrass
Imperata cylindrica

Cordgrass
Spartina spp.

Cutgrass, giant*
Zizaniopsis miliacea

Dallisgrass
Paspalum dilatatum

Dandelion
Taraxacum officinale

Dock, curly
Rumex crispus

Dogbane, hemp
Apocynum cannabinum

Fescue
Festuca spp.

Fescue, tall
Festuca arundinacea

Guineagrass
Panicum maximum

Hemlock, poison
Conium maculatum

Horsenettle
Solanum carolinense

Horseradish
Armoracia rusticana

Ice Plant
Carprobrotus edulis

Ivy, German, cape
Senecio mikanoides
Delairea odorata

Johnsongrass
Sorghum halepense

Kikuyugrass
Pennisetum clandestinum

Knapweed, Russian
Centaurea repens

Lantana
Lantana camara

Lespedeza: common, sericea
Lespedeza striata
Lespedeza cuneata

Loosestrife, purple
Lythrum salicaria

Lotus, American
Nelumbo lutea

Maidencane
Panicum hematomon

Milkweed
Asclepias spp.

Muhly, wirestem
Muhlenbergia frondosa

Mullein, common
Verbascum thapsus

Napiergrass
Pennisetum purpureum

Nightshade, silverleaf
Solanum elaeagnifolium

Nutsedge:
purple
Cyperus rotundus
yellow
Cyperus esculentus

Orchardgrass
Dactylis glomerata

Pampasgrass
Cortaderia jubata

Paragrass
Brachiaria mutica

Pepperweed, perennial
Lepidium latifolium

Phragmites**
Phragmites spp.

Quackgrass
Agropyron repens

Reed, giant
Arundo donax

Ryegrass, perennial
Lolium perenne

Smartweed, swamp
Polygonum coccineum

Spatterdock
Nuphar luteum

Starthistle, yellow
Centaurea solstitialis

Sweet potato, wild*
Ipomoea pandurata

Thistle, artichoke
Cynara cardunculus

Thistle, Canada
Cirsium arvense

Timothy
Phleum pratense

Torpedograss*
Panicum repens

Tules, common
Scirpus acutus

Vaseygrass
Paspalum urvillei

Velvetgrass
Holcus spp.

Waterhyacinth
Eichornia crassipes

Waterlettuce
Pistia stratiotes

Waterprimrose
Ludwigia spp.

Wheatgrass, western
Agropyron smithii

*Partial control.

**Partial control in southeastern states. See specific recommendations below.

Alligatorweed—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.

Bermudagrass—Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seed heads appear.

Bindweed, field / Silverleaf Nightshade / Texas Blueweed—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.

Brackenfern—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.

Cattail—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.

Cogongrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.

Cordgrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.

Cutgrass, giant—Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7- to 10-leaf stage prior to retreatment.

Dogbane, hemp / Knapweed / Horseradish—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.

Fescue, tall—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.

Guineagrass—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.

Johnsongrass / Bluegrass, Kentucky / Bromegrass, smooth / Canarygrass, reed / Orchardgrass / Ryegrass, perennial / Timothy / Wheatgrass, western—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.

Lantana—Apply this product as a 3/4 to 1 percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.

Loosestrife, purple—Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.

Lotus, American—Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.

Maidencane / Paragrass—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7- to 10-leaf stage prior to retreatment.

Milkweed, common—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.

Nutsedge: purple, yellow—Apply 4 1/2 pints of this product per acre as a broadcast spray, or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.

Pampasgrass—Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.

Phragmites—For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer of fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.

Quackgrass / Kikuyugrass / Muhly, wirestem—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3- to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.

Reed, giant / Ice Plant—For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

Spatterdock—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.

Sweet potato, wild—Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

Thistle: Canada, artichoke—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.

Torpedograss—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.

Tules, common—Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.

Waterhyacinth—Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.

Waterlettuce—For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.

Waterprimrose—Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.

Other perennials listed on this label—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached early head or early bud stage of growth.

9.3 Woody Brush and Trees

Apply a 1 to 2 percent solution of this product to control or partially control the woody brush and tree species listed below. Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "GENERAL INFORMATION", "DIRECTIONS FOR USE" and "MIXING AND APPLICATION" sections in this label for specific uses and application instructions.

Ensure thorough coverage when using spray-to-wet treatments using hand-held equipment. When using hand-held equipment for low volume directed spot treatments, apply a 5 to 8 percent solution of this product.

When applied as recommended under the conditions described, this product plus surfactant CONTROLS or PARTIALLY CONTROLS the following woody brush plants and trees:

Alder
Alnus spp.

Ash*
Fraxinus spp.

Aspen, quaking
Populus tremuloides

Bearclover, Bearmat
Chamaebatia foliolosa

Birch
Betula spp.

Blackberry
Rubus spp.

Broom:
French
Cytisus monspessulanus
Scotch
Cytisus scoparius

Buckwheat, California*
Eriogonum fasciculatum

Cascara*
Rhamnus purshiana

Castor bean
Ricinus communis

Catsclaw*
Acacia greggi

Ceanothus
Ceanothus spp.

Chamise
Adenostoma fasciculatum

Cherry:
Bitter
Prunus emarginata
Black
Prunus serotina
Pin
Prunus pensylvanica

Cottonwood, eastern
Populus deltoides

Coyote brush
Baccharis consanguinea

Creeper, Virginia*
Parthenocissus quinquefolia

Cypress, swamp, bald
Taxodium distichum

Deerweed
Lotus scoparius

Dewberry
Rubus trivialis

Dogwood
Cornus spp.

Elderberry
Sambucus spp.

Elm*
Ulmus spp.

Eucalyptus, bluegum
Eucalyptus globulus

Gallberry
Ilex glabra

Hackberry, western
Celtis occidentalis

Hasardia*
Haplopappus squamosus

Hawthorn
Crataegus spp.

Hazel
Corylus spp.

Hickory
Carya spp.

Honeysuckle
Lonicera spp.

Hornbeam, American
Carpinus caroliniana

Huckleberry
Vaccinium spp.

Kudzu
Pueraria lobata

Locust, black*
Robinia pseudoacacia

Magnolia, sweetbay
Magnolia virginiana

Manzanita
Arctostaphylos spp.

Maple:
Red**
Acer rubrum
Sugar
Acer saccharum
Vine*
Acer circinatum

Monkey Flower*
Mimulus guttatus

Oak:
Black*
Quercus velutina
Northern pine
Quercus palustris
Post
Quercus stellata
Red
Quercus rubra
Southern red
Quercus falcata
White*
Quercus alba

Orange, Osage
Maclura pomifera

Peppertree, Brazilian—(Florida Holly)
Schinus terebinthifolius

Persimmon*
Diospyros spp.

Poison Ivy
Rhus radicans

Poison Oak
Rhus toxicodendron

Poplar, yellow*
Liriodendron tulipifera

Prunus
Prunus spp.

Raspberry
Rubus spp.

Redbud, eastern
Cercis canadensis

Redcedar, eastern
Juniperus virginiana

Rose, multiflora
Rosa multiflora

Russian-olive
Elaeagnus angustifolia

Sage: black, white
Salvia spp.

Sagebrush, California
Artemisia californica

Salmonberry
Rubus spectabilis

Saltcedar, tamarisk*
Tamarix spp.

Saltbush, Sea myrtle
Baccharis halimifolia

Sassafras
Sassafras aibidum

Sourwood*
Oxydendrum arboreum

Sumac:
Laurel*
Rhus toxicodendron
Poison*
Rhus vernix
Smooth*
Rhus glabra
Sugarbush*
Rhus ovata
Winged*
Rhus copallina

Sweet gum
Liquidambar styraciflua

Swordfern*
Polystichum munitum

Tallowtree, Chinese
Sapium sebiferum

Thimbleberry
Rubus parviflorus

Tobacco, tree*
Nicotiana glauca

Toyon*
Herteromeles arbutifolia

Trumpetcreeper
Campsis radicans

Waxmyrtle, southern*
Myrica cerifera

Willow
Salix spp.

Yerbasenta, California
Eriodictylon californicum

*Partial control

**See below for control or partial control instruction.

NOTE: If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Apply the recommended rate of this product plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "DIRECTIONS FOR USE" and "MIXING AND APPLICATION INSTRUCTIONS" sections in this label for labeled use and specific application instructions.

Applied as a 5 to 8 percent solution as a directed application as described in the "HAND-HELD AND HIGH-VOLUME EQUIPMENT" section, this product will control or partially control all species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Apply the product as follows to control or partially control the following woody brush and trees.

Alder / Blackberry / Dewberry / Honeysuckle / Oak, Post / Raspberry—For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Aspen, Quaking / Hawthorn / Trumpetcreeper—For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Birch / Elderberry / Hazel / Salmonberry / Thimbleberry—For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Broom: French, Scotch—For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.

Buckwheat, California / Hasardia / Monkey Flower / Tobacco, Tree—For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Castorbean—For control, apply a 1 1/2 percent solution of this product with hand-held equipment.

Catsclaw—For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Cherry: Bitter, Black, Pin / Oak, Southern Red / Sweet Gum / Prunus—For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.

Coyote brush—For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Dogwood / Hickory / Salt cedar—For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.

Eucalyptus, bluegum—For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6- to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.

Kudzu—For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.

Maple, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.

Maple, Sugar / Oak: Northern Pin, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Peppertree, Brazilian (Holly, Florida) / Waxmyrtle, southern—For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.

Poison Ivy / Poison Oak—For control, apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.

Rose, multiflora—For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.

Sage, black / Sagebrush, California / Chamise / Tallowtree, Chinese—For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Saltbush, Sea myrtle—For control, apply this product as a 1 percent solution with hand-held equipment.

Willow—For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Other woody brush and trees listed in this label—For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

10.0 LIMIT OF WARRANTY AND LIABILITY

Monsanto Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation.

This Company does not warrant any product reformulated or repackaged from this product except in accordance with this Company's stewardship requirements and with express written permission of this Company.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES.

Upon opening and using this product, buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement. If terms are not acceptable, return at once unopened.

EPA Reg. No. 524-343

In case of an emergency involving this product,
or for medical assistance,
Call Collect, day or night, (314) 694-4000.

SUPPLEMENTAL LABELING

READ AND FOLLOW THE ENTIRE LABEL FOR AQUAMASTER™ HERBICIDE BEFORE PROCEEDING WITH THE USE DIRECTIONS CONTAINED IN THIS SUPPLEMENTAL LABELING.

"Label" as used in this supplemental labeling refers to the label booklet for Aquamaster herbicide and this supplement.

AQUAMASTER™ Herbicide by Monsanto

EPA Reg. No. 524-343

Aquamaster is a trademark of Monsanto Company.

FOR AERIAL APPLICATION IN CALIFORNIA ONLY.

Keep out of reach of children.

CAUTION!

In case of an emergency involving this product, Call Collect, day or night, (314) 694-4000.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

This label must be in the possession of the user at the time of the herbicide application.

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION IS LIKELY TO RESULT.

AQUATIC AND OTHER NONCROP SITES

When applied as directed and under the conditions described in the "WEED CONTROLLED" section of the Aquamaster™ label booklet, this product will control or partially control the labeled weeds growing in the following industrial, recreational, and public areas or other similar sites.

This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas, and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

This product does not control plants which are completely submerged or have a majority of their foliage under water.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

NOTE: Do not apply this product **directly to water** within 0.5 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 0.5 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 0.5 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does **NOT** apply to intermittent inadvertent overspray of water in terrestrial use sites.

AVOID DRIFT—DO NOT APPLY WHEN WINDS ARE GUSTY OR UNDER ANY OTHER CONDITION WHICH FAVORS DRIFT. DRIFT MAY CAUSE DAMAGE TO ANY VEGETATION CONTACTED TO WHICH TREATMENT IS NOT INTENDED. TO PREVENT INJURY TO ADJACENT DESIRABLE VEGETATION, APPROPRI-ATE BUFFER ZONES MUST BE MAINTAINED.

AERIAL APPLICATIONS

Aerial applications may be made with helicopters only.

Use the following guidelines when aerial applications are made near perennial crops after bud break and before total leaf drop and/or near emerged annual crops.

1. Do not apply within 100 feet of all crops.
2. If wind up to 5 miles per hour is blowing toward the crop(s), do not apply within 500 feet of the crop(s).
3. Winds blowing from 5 to 10 miles per hour toward the crop(s) may require buffer zones in excess of the 500 foot minimum.
4. Do not apply when winds are in excess of 10 miles per hour or when inversion conditions exist.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the air-stream and do not increase spray volume by increasing nozzle pressure above the manufacturer's recommendation.

Ensure uniform application—To avoid streaking, uneven, or overlapped application, use appropriate marking devices.

Thoroughly wash aircraft, especially landing gear, after each day of spraying to remove residues of this product accumulated during spraying or from spills.

Read the "LIMIT OF WARRANTY AND LIABILITY" in the label booklet for Aquamaster herbicide before buying or using this product. Those terms apply to this supplemental labeling and if those terms are not acceptable, return the product unopened at once.

ST. LOUIS, MISSOURI 63167

21195Z2-6 11/1/2000

MONSANTO Company

Material Safety Data Sheet

Commercial Product

1. PRODUCT AND COMPANY IDENTIFICATION

Product name

AQUAMASTER[TM] Herbicide

EPA Reg. No.
524-343

Product use
Herbicide

Chemical name
Not applicable

Synonyms
None

Company
MONSANTO Company, 800 N. Lindbergh Blvd., St. Louis, MO, 63167
Telephone: 800-332-3111, **Fax:** 314-694-5557

Emergency numbers
FOR CHEMICAL EMERGENCY, SPILL LEAK, FIRE, EXPOSURE, OR ACCIDENT Call CHEMTREC - Day or Night: 1-800-424-9300 toll free in the continental U.S., Puerto Rico, Canada, or Virgin Islands. For calls originating elsewhere: 703-527-3887 (collect calls accepted).
FOR MEDICAL EMERGENCY - Day or Night: 314-694-4000 (collect calls accepted).

2. COMPOSITION/INFORMATION ON INGREDIENTS

Active ingredient
Isopropylamine salt of N-(phosphonomethyl)glycine; {Isopropylamine salt of glyphosate}

Composition

COMPONENT	CAS No.	% by weight (approximate)
Isopropylamine salt of glyphosate	38641-94-0	53.5
Water	7732-18-5	46.5

OSHA Status
This product is not hazardous according to the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

3. HAZARDS IDENTIFICATION

Emergency overview
Appearance and odour (colour/form/odour): Colourless - Amber / Liquid, (viscous) / Odourless

CAUTION!

Potential health effects

Likely routes of exposure
Skin contact, eye contact, inhalation

Eye contact, short term
Not expected to produce significant adverse effects when recommended use instructions are followed.

Skin contact, short term
Not expected to produce significant adverse effects when recommended use instructions are followed.

Inhalation, short term

Not expected to produce significant adverse effects when recommended use instructions are followed.

Refer to section 11 for toxicological and section 12 for environmental information

4. FIRST AID MEASURES

Eye contact
Immediately flush with plenty of water.
If easy to do, remove contact lenses.

Skin contact
Take off contaminated clothing, wristwatch, jewellery.
Wash affected skin with plenty of water.
Wash clothes before re-use.

Inhalation
Remove to fresh air.

Ingestion
Immediately offer water to drink.
Do NOT induce vomiting unless directed by medical personnel.
If symptoms occur, get medical attention.

Advice to doctors
This product is not an inhibitor of cholinesterase.

Antidote
Treatment with atropine and oximes is not indicated.

5. FIRE FIGHTING MEASURES

Flash point
None.

Extinguishing media
Recommended: Water, foam, dry chemical, carbon dioxide (CO2)

Unusual fire and explosion hazards
None.
Environmental precautions: see section 6.

Hazardous products of combustion
Carbon monoxide (CO), phosphorus oxides (PxOy), nitrogen oxides (NOx)

Fire fighting equipment
Self-contained breathing apparatus.
Equipment should be thoroughly decontaminated after use.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protection recommended in section 8.

Environmental precautions
SMALL QUANTITIES:
Low environmental hazard.

LARGE QUANTITIES:
Minimize spread.
Keep out of drains, sewers, ditches and water ways.
Notify authorities.

Methods for cleaning up
SMALL QUANTITIES:
Flush spill area with water.
LARGE QUANTITIES:
Absorb in earth, sand or absorbent material.
Dig up heavily contaminated soil.
Collect in containers for disposal.
Refer to section 7 for types of containers.
Flush residues with small quantities of water.
Minimize use of water to prevent environmental contamination.

Refer to section 13 for disposal of spilled material.

7. HANDLING AND STORAGE

Handling
Good industrial practice in housekeeping and personal hygiene should be followed.
Avoid contact with skin and eyes.
When using do not eat, drink or smoke.
Wash hands thoroughly after handling or contact.
Thoroughly clean equipment after use.
Do not contaminate drains, sewers and water ways when disposing of equipment rinse water.
Refer to section 13 for disposal of rinse water.
Emptied containers retain vapour and product residue.
Observe all labelled safeguards until container is cleaned, reconditioned or destroyed.

Storage
Minimum storage temperature: -15 °C
Maximum storage temperature: 50 °C
Compatible materials for storage: stainless steel, aluminium, fibreglass, plastic, glass lining
Incompatible materials for storage: galvanised steel, unlined mild steel, see section 10.
Keep out of reach of children.
Keep away from food, drink and animal feed.
Keep only in the original container.
Partial crystallization may occur on prolonged storage below the minimum storage temperature.
If frozen, place in warm room and shake frequently to put back into solution.
Minimum shelf life: 5 years.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Airborne exposure limits

Components	Exposure Guidelines
Isopropylamine salt of glyphosate	No specific occupational exposure limit has been established.
Water	No specific occupational exposure limit has been established.

Engineering controls
No special requirement when used as recommended.

Eye protection
No special requirement when used as recommended.

Skin protection
No special requirement when used as recommended.

Respiratory protection
No special requirement when used as recommended.

When recommended, consult manufacturer of personal protective equipment for the appropriate type of equipment for a given application.

9. PHYSICAL AND CHEMICAL PROPERTIES

These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.

Colour/colour range:	Colourless - Amber
Form:	Liquid (viscous)
Odour:	Odourless
Flash point:	None.
Specific gravity:	1.206 @ 20 °C / 15.6 °C
Solubility:	Water: Completely miscible.
pH:	4.6 - 4.8 @ 63 g/l
Partition coefficient (log Pow):	< 0.000 (active ingredient)

10. STABILITY AND REACTIVITY

Stability
Stable under normal conditions of handling and storage.

Hazardous decomposition
Thermal decomposition: Hazardous products of combustion: see section 5.

Materials to avoid/Reactivity
Reacts with galvanised steel or unlined mild steel to produce hydrogen, a highly flammable gas that could explode.

11. TOXICOLOGICAL INFORMATION

This section is intended for use by toxicologists and other health professionals.

Data obtained on product and components are summarized below.

<u>**Acute inhalation toxicity**</u>
Rat, LC50, 4 hours, aerosol: > 1.3 mg/L
Slightly toxic.
FIFRA category III.
<u>**Skin sensitization**</u>
Guinea pig, 9-induction Buehler test:
Positive incidence: 0 %
<u>**Mutagenicity**</u>
Micronucleus test(s):
Not mutagenic.
Ames test(s):
Not mutagenic with and without metabolic activation.

<u>**Isopropylamine salt of glyphosate (62%)**</u>

Acute oral toxicity
Rat, LD50 (limit test): > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.
Mouse, LD50 (limit test): > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.
Acute dermal toxicity
Rabbit, LD50 (limit test): > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.
Skin irritation
Rabbit, 6 animals, Draize test:
Days to heal: 3
Primary Irritation Index (PII): 0.0/8.0
Essentially non irritating.
FIFRA category IV.
Eye irritation
Rabbit, 6 animals , OECD 405 test:
Days to heal: 0
FIFRA category IV.
Acute inhalation toxicity
Rat, LC50, 4 hours, aerosol: > 4.24 mg/L
Practically non-toxic.
FIFRA category IV.
No mortality. Maximum attainable concentration.
Repeated dose toxicity
Dog, oral, 6 months:
LOAEL toxicity: > 300 mg/kg diet
Target organs/systems : None.
Other effects: decrease of body weight gain

N-(phosphonomethyl)glycine; {glyphosate}

Mutagenicity
In vitro and in vivo mutagenicity test(s):
Not mutagenic.
Repeated dose toxicity
Rabbit, dermal, 21 days:
NOAEL toxicity: > 5,000 mg/kg body weight/day
Target organs/systems : None.
Other effects: None.
Rat, oral, 3 months:
NOAEL toxicity: > 20,000 mg/kg diet
Target organs/systems : None.
Other effects: None.
Carcinogenicity
Mouse, oral, 24 months:
NOEL tumour: > 30,000 mg/kg diet
NOAEL toxicity: ~ 5,000 mg/kg diet
Tumours: None.
Target organs/systems : liver
Other effects: decrease of body weight gain, histopathologic effects
Rat, oral, 24 months:

NOEL tumour: > 20,000 mg/kg diet
NOAEL toxicity: ~ 8,000 mg/kg diet
Tumours: None.
Target organs/systems: eyes
Other effects: decrease of body weight gain, histopathologic effects

Toxicity to reproduction/fertility

Rat, oral, 3 generations:
NOAEL toxicity: > 30 mg/kg body weight
NOAEL reproduction: > 30 mg/kg body weight
Target organs/systems in parents: None.
Other effects in parents: None.
Target organs/systems in pups: None.
Other effects in pups: None.

Developmental toxicity/teratogenicity

Rat, oral, 6 - 19 days of gestation:
NOAEL toxicity: 1,000 mg/kg body weight
NOAEL development: 1,000 mg/kg body weight
Other effects in mother animal: decrease of body weight gain, decrease of survival
Developmental effects: weight loss, post-implantation loss, delayed ossification
Effects on offspring only observed with maternal toxicity.

Rabbit, oral, 6 - 27 days of gestation:
NOAEL toxicity: 175 mg/kg body weight
NOAEL development: 175 mg/kg body weight
Target organs/systems in mother animal: None.
Other effects in mother animal: decrease of survival
Developmental effects: None.

12. ECOLOGICAL INFORMATION

This section is intended for use by ecotoxicologists and other environmental specialists.

Data obtained on components are summarized below.

Isopropylamine salt of glyphosate (62%)

Aquatic toxicity, fish

Bluegill sunfish (Lepomis macrochirus):
Acute toxicity (limit test), 96 hours, static, LC50: > 1,000 mg/L
practically non-toxic

Rainbow trout (Oncorhynchus mykiss):
Acute toxicity (limit test), 96 hours, static, LC50: > 1,000 mg/L
practically non-toxic

Aquatic toxicity, invertebrates

Water flea (Daphnia magna):
Acute toxicity (limit test), 48 hours, static, EC50: 930 mg/L
practically non-toxic

Aquatic toxicity, algae/aquatic plants

Green algae (Scenedesmus subspicatus):
Acute toxicity, 72 hours, static, EbC50 (biomass): 72.9 mg/L
slightly toxic

Soil organism toxicity, invertebrates

Earthworm (Eisenia foetida):
Acute toxicity, 14 days, LC50: > 5,000 mg/kg dry soil
practically non-toxic

N-(phosphonomethyl)glycine; {glyphosate}

Avian toxicity

Bobwhite quail (Colinus virginianus):
Dietary toxicity (limit test), 5 days, LC50: > 4,640 mg/kg diet
practically non-toxic

Mallard duck (Anas platyrhynchos):
Dietary toxicity (limit test), 5 days, LC50: > 4,640 mg/kg diet
practically non-toxic

Bobwhite quail (Colinus virginianus):
Acute oral toxicity (limit test), LD50: > 3,851 mg/kg body weight
practically non-toxic

Mallard duck (Anas platyrhynchos):
Reproductive toxicity, 16 weeks, NOEC: >= 1,000 mg/kg diet

Bobwhite quail (Colinus virginianus):
Reproductive toxicity, 17 weeks, NOEC: >= 1,000 mg/kg diet

Arthropod toxicity

Honey bee (Apis mellifera):
Oral/contact, 48 hours, LD50: > 100 µg/bee
practically non-toxic

Bioaccumulation

Bluegill sunfish (Lepomis macrochirus):
Whole fish: BCF: < 1
No significant bioaccumulation is expected.

Dissipation

Soil, field:
Half life: 2 - 174 days
Koc: 884 - 60,000 L/kg
Binds strongly to soil.

Water, aerobic:
Half life: < 7 days

13. DISPOSAL CONSIDERATIONS

Product

Not classified as hazardous waste by the Resource, Conservation and Recovery Act (RCRA), 40 CFR 261.
Recycle if appropriate facilities/equipment available.
Burn in special, controlled high temperature incinerator.
Keep out of drains, sewers, ditches and water ways.
Follow all local/regional/national regulations.
Consult your attorney or appropriate regulatory officials for information on disposal.

Container

Triple rinse empty containers.
Pour rinse water into spray tank.
Store for collection by approved waste disposal service.
Dispose of as non hazardous industrial waste.
Do NOT re-use containers.
Follow all local/regional/national regulations.

14. TRANSPORT INFORMATION

The data provided in this section is for information only. Please apply the appropriate regulations to properly classify your shipment for transportation.

Not hazardous under the applicable DOT, ICAO/IATA, IMO, TDG and Mexican regulations.

15. REGULATORY INFORMATION

TSCA Inventory
All components are on the US EPA's TSCA Inventory

SARA Title III Rules
Section 311/312 Hazard Categories
Not applicable.
Section 302 Extremely Hazardous Substances
Not applicable.
Section 313 Toxic Chemical(s)
Not applicable.

CERCLA Reportable quantity
Not applicable.

16. OTHER INFORMATION

The information given here is not necessarily exhaustive but is representative of relevant, reliable data.
For more information refer to product label.
Please consult Monsanto if further information is needed.
Follow all local/regional/national regulations.
In this document the British spelling was applied.
® Registered trademark of Monsanto Company or its subsidiaries.

Full denomination of most frequently used acronyms. BCF (Bioconcentration Factor), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), EC50 (50% effect concentration), ED50 (50% effect dose), I.M. (intramuscular), I.P. (intraperitoneal), I.V. (intravenous), Koc (Soil adsorption coefficient), LC50 (50% lethality concentration), LD50 (50% lethality dose), LDLo (Lower limit of lethal dosage), LEL (Lower Explosion Limit), LOAEC (Lowest Observed Adverse Effect Concentration), LOAEL (Lowest Observed Adverse Effect Level), LOEC (Lowest Observed Effect Concentration), LOEL (Lowest Observed Effect Level), MEL (Maximum Exposure limit), MTD (Maximum Tolerated Dose), NOAEC (No Observed Adverse Effect Concentration), NOAEL (No Observed Adverse Effect Level), NOEC (No Observed Effect Concentration), NOEL (No Observed Effect Level), OEL (Occupational Exposure Limit), PEL (Permissible Exposure Limit), PII (Primary Irritation Index), Pow (Partition coefficient n-octanol/water), S.C. (subcutaneous), STEL (Short-Term Exposure Limit), TLV-C (Threshold Limit Value-Ceiling), TLV-TWA (Threshold Limit Value - Time Weighted Average), UEL (Upper Explosion Limit)

This Material Safety Data Sheet (MSDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-APPROVED PRODUCT LABELING (attached to and accompanying the product container). This MSDS provides important health, safety, and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course. Use, storage and disposal of pesticide products are regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling, and all necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of federal law to use a pesticide product in any manner not prescribed on the EPA-approved label.

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, MONSANTO Company makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for the purposes prior to use. In no event will MONSANTO Company be responsible for damages of any nature whatsoever resulting from the use of or reliance upon information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR TO THE PRODUCT TO WHICH INFORMATION REFERS.

000000006108

Specimen Label

Dow AgroSciences

Rodeo®

Herbicide

For aquatic weed and brush control. For control of annual and perennial weeds and woody plants in and around aquatic and other noncrop sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression.

Avoid contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees, because severe injury or destruction may result.

Active Ingredient(s):	
glyphosate†: N-(phosphonomethyl)glycine, isopropylamine salt	53.8%
Inert Ingredients	46.2%
Total Ingredients	100.0%

† Contains 5.4 pounds per gallon glyphosate, isopropylamine salt (4 pounds per gallon glyphosate acid).

EPA Reg. No. 62719-324

Keep Out of Reach of Children

CAUTION PRECAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Harmful If Inhaled

Avoid breathing spray mist. Remove contaminated clothing and wash before reuse. Wash thoroughly with soap and water after handling.

Personal Protective Equipment (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks.

Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Controls

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

First Aid

If inhaled: Remove individual to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

Environmental Hazards

Do not contaminate water when disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of leak or spill, soak up and remove to a landfill.

Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

Do not mix, store or apply this product or spray solutions of this product in galvanized steel or unlined steel (except stainless steel) containers or spray tanks. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas, which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

Notice: Read the entire label. Use only according to label directions. **Before buying or using this product, read "Warranty Disclaimer" and "Limitation of Remedies" elsewhere on this label.**

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Agricultural Chemical: Do not ship or store with food, feeds, drugs or clothing.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

This is an end-use product. Dow AgroSciences does not intend and has not registered it for reformulation. See individual container label for repackaging limitations.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls
- Waterproof gloves
- Shoes plus socks

Storage and Disposal

Do not contaminate water, food, feed or seed by storage or disposal.
Storage: Store above 10°F (-12°C) to keep product from crystallizing. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using.
Pesticide Disposal: Wastes resulting from use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, state or local procedures.
Container Disposal: Emptied container retains vapor anpd product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed. Do not reuse this container. Triple rinse (or equivalent). Then puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

General Information

(How this product works)

This product herbicide is a water-soluble liquid which mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants. Rodeo is intended for control of annual and perennial weeds and woody plants in and around aquatic and other noncrop sites; also for use in wildlife habitat areas, for perennial grass release, and grass growth suppression.

The active ingredient in Rodeo_moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days, 7 days or more on most perennial weeds, and 30 days or more on most woody plants. Extremely cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects include gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennials or brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of Rodeo and surfactant within the recommended range when vegetation is heavy or dense.

Do not treat weeds, brush or trees under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced control of target vegetation may also occur if foliage is heavily covered with dust at the time of treatment.

Reduced control may result when applications are made to woody plants or weeds following site disturbance or plant top growth removal from grazing, mowing, logging or mechanical brush control. For best results, delay treatment of such areas until resprouting and foliar growth has restored the target vegetation to the recommended stage of growth for optimum herbicidal exposure and control.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may wash the product off the foliage and a repeat treatment may be required.

Rodeo has no herbicidal or residual activity in the soil. When this product comes in contact with soil (on the soil surface or as suspended soil or sediment in water) it is bound to soil particles. Under recommended use situations, once this product is bound to soil particles, it is not available for plant uptake and will not harm off-site vegetation where roots grow into the treatment area or if the soil is transported off-site. Under recommended use conditions, the strong affinity of this product to soil particles prevents this product from leaching out of the soil profile and entering ground water. The affinity between this product and soil particles remains until this product is degraded, which is primarily a biological degradation process carried out under both aerobic and anaerobic conditions by soil microflora.

Rodeo does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product or other materials that are not expressly recommended in this label. Mixing this product with herbicides or other materials not recommended in this label may result in reduced performance.

ATTENTION: Avoid drift. Extreme care must be used when applying this product to prevent injury to desirable plants and crops.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. **Avoid applying at excessive speed or pressure.**

Mixing and Application Instructions

Clean sprayer and parts immediately after using this product by thoroughly flushing with water and dispose of rinsate according to labeled use or disposal instructions.

Apply these spray solutions in properly maintained and calibrated equipment capable of delivering desired volumes. Hand-gun applications should be properly directed to avoid spraying desirable plants. Note: reduced results may occur if water containing soil is used, such as water from ponds and unlined ditches.

Mixing

Rodeo mixes readily with water. Mix spray solutions of this product as follows:

1. Fill the mixing or spray tank with the required amount of water while adding the required amount of this product (see "Directions for Use" and "Weeds Controlled" sections of this label).
2. Near the end of the filling process, add the required surfactant and mix well. Remove hose from tank immediately after filling to avoid siphoning back into the water source.

Note: If tank mixing with Garlon* 3A herbicide, ensure that Garlon 3A is well mixed with at least 75 percent of the total spray volume before adding Rodeo to the spray tank to avoid incompatibility.

During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators, place the filling hose below the surface of the spray solution (only during filling), terminate by-pass and return lines at the bottom of the tank, and, if needed, use an approved anti-foam or defoaming agent.

Keep by-pass line on or near bottom of tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh. Carefully select correct nozzle to avoid spraying a fine mist. For best results with conventional ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

IMPORTANT: When using this product, unless otherwise specified, mix 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. Use a nonionic surfactant labeled for use with herbicides. The surfactant must contain 50 percent or more active ingredient.

Always read and follow the manufacturer's surfactant label recommendations for best results.

These surfactants should not be used in excess of 1 quart per acre when making **broadcast** applications.

Carefully observe all cautionary statements and other information appearing in the surfactant label.

Colorants or marking dyes approved for use with herbicides may be added to spray mixtures of this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilutions. Use colorants or dyes according to the manufacturer's label recommendations.

Application Equipment and Techniques

ATTENTION: AVOID DRIFT. EXTREME CARE MUST BE EXERCISED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift, or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to crops, plants, or other areas on which the treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

Note: Use of this product in a manner not consistent with this label may result in injury to persons, animals, or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions. The following drift management requirements must be followed to avoid off-target drift movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications, public health uses or to applications using dry formulations.

1. The distance of the outer most nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
2. Nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they should be observed.

The applicator should be familiar with and take into account the information covered in the following **Aerial Drift Reduction Advisory Information:**

Importance of Droplet Size: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversion section of this label).

Controlling Droplet Size: Volume-Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows product larger droplets.

Pressure-Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.

Number of nozzles-Use the minimum number of nozzles that provide uniform coverage.

Nozzle Orientation-Orienting nozzles so that the spray is released backwards, parallel to the airstream will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.

Nozzle Type-Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.

Boom Length-For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

Application-Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

Swath Adjustment: When applications are made with a cross-wind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

Wind: Drift potential is lowest between wind speeds of 2-10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. Note: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect drift.

Temperature and Humidity: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

Temperature Inversions: Applications should not occur during a temperature inversion, because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a connected cloud (under low wind conditions) indicates an inversion, while smoke that moves upwards and rapidly dissipates indicates good vertical air mixing.

Sensitive Areas: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g., residential areas, , bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g., when wind is blowing away from the sensitive areas).

Aerial Equipment

See the supplemental label for use of this product by air in California.

For control of weed or brush species listed in this label using aerial application equipment: For aerial broadcast application, unless otherwise specified, apply the rates of Rodeo and surfactant recommended for broadcast application in a spray volume of 3 to 20 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. Aerial applications of this product may only be made as specifically recommended in this label.

In California, aerial application may be made only in non-residential, forestry sites or chapparal areas.

AVOID DRIFT. Do not apply during inversion conditions, when winds are gusty or under any other condition which will allow drift. Drift may cause damage to any vegetation contacted to which treatment is not intended. To prevent injury to adjacent desirable vegetation, appropriate buffer zones must be maintained.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing in the additive label. The use of a drift control agent for conifer and herbaceous release applications may result in conifer injury and is not recommended.

Ensure uniform application. To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Thoroughly wash aircraft, especially landing gear, after each day of spraying to remove residues of this product accumulated during spraying or from spills. **Prolonged exposure of this product to uncoated steel surfaces may result in corrosion and possible failure of the part. Landing gear are most susceptible.** The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion.

Ground Broadcast Equipment

For control of weed or brush species listed in this label using conventional boom equipment: For ground broadcast application, unless otherwise specified, apply the rates of Rodeo and surfactant recommended for broadcast application in a spray volume of 3 to 30 gallons of water per acre. See the "Weeds Controlled" section of this label for labeled annual and herbaceous weeds and woody plants and broadcast rate recommendations. As density of vegetation increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select correct nozzle to avoid spraying a fine mist. For best results with ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

Hand-Held and High-Volume Equipment

(Use Coarse Sprays Only)

For control of weeds listed in this label using knapsack sprayers or high-volume spraying equipment utilizing handguns or other suitable nozzle arrangements:

High volume sprays: Prepare a **3/4 to 2 percent solution** of this product in water, add a nonionic surfactant and apply to foliage of vegetation to be controlled. For specific rates of application and instructions for control of various annual and perennial weeds, see the "Weeds Controlled" section in this label.

Applications should be made on a spray-to-wet basis. Spray coverage should be uniform and complete. Do not spray to point of runoff.

Low volume directed sprays: Rodeo may be used as a **5 to 8 percent solution** in low-volume directed sprays for spot treatment of trees and brush. This treatment method is most effective in areas where there is a low density of undesirable trees or brush. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zig-zag motion. Ensure that at least 50 percent of the leaves are contacted by the spray solution. For flat fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. Small, open-branched trees need only be treated from one side. If the foliage is thick or there are multiple root sprouts, applications must be made from several sides to ensure adequate spray coverage.

Prepare the desired volume of spray solution by mixing the amount of this product in water, shown in the following table:

Spray Solution

Desired Volume	Amount of Rodeo						
	3/4%	1%	1 1/4%	1 1/2%	2%	5%	8%
1 gal	1 fl oz	1 1/3 fl oz	1 2/3 fl oz	2 fl oz	2 2/3 fl oz	6 1/2 fl oz	10 1/4 fl oz
25 gal	1 1/2 pt	1 qt	1 1/4 qt	1 1/2 qt	2 qt	5 qt	2 gal
100 gal	3 qt	1 gal	1 1/4 gal	1 1/2 gal	2 gal	5 gal	8 gal

2 tablespoons = 1 fluid ounce

For use in knapsack sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill the knapsack sprayer with the mixed solution and add the correct amount of surfactant.

Wiper Applications

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 33 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "Weed Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results

Aquatic and Other Noncrop Sites

Apply Rodeo as directed and under conditions described to control or partially control weeds and woody plants listed in the "Weeds Controlled" section in industrial, recreational and public areas or other similar aquatic or terrestrial sites on this label.

Aquatic Sites

Rodeo may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas, and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

- **Rodeo does not control plants which are completely submerged or have a majority of their foliage under water.**
- There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.
- Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

- **NOTE:** Do not apply this product directly to water within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 parts per million as determined by laboratory analysis. These aquatic applications may be made **only** in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications. This restriction does not apply to intermittent inadvertent overspray of water in terrestrial use sites.
- For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.
- Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.
- Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.
- When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

Other Noncrop Sites

Rodeo may be used to control the listed weeds in the following terrestrial noncrop sites and/or in aquatic sites within these areas:

Habitat Restoration & Management Areas
Highways & Roadsides
Industrial Plant Sites
Petroleum Tank Farms
Pipeline, Power, Telephone & Utility Rights-of-Way
Pumping Installations
Railroads
Similar Sites

Cut Stump Application

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. **Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting.** Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will **control, partially control or suppress** most woody brush and tree species, some of which are listed below:

Common Name	Scientific Name
Alder	*Alnus spp.*
Coyote brush †	*Baccharis consanguinea*
Dogwood †	*Cornus spp.*
Eucalyptus	*Eucalyptus spp.*
Hickory †	*Carya spp.*
Madrone	*Arbutus menziesii*
Maple †	*Acer spp.*
Oak	*Quercus spp.*
Poplar †	*Populus spp.*
Reed, giant	*Arundo donax*
Salt cedar	*Tamarix spp.*
Sweet gum †	*Liquidambar styraciflua*
Sycamore †	*Platanus occidentalis*
Tan oak	*Lithocarpus densiflorus*
Willow	*Salix spp.*

† Rodeo is not approved for this use on these species in the state of California.

Wildlife Habitat Restoration and Management Areas

Rodeo is recommended for the restoration and/or maintenance of native habitat and in wildlife management areas.

Habitat Restoration and Maintenance: When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract waterfowl, and for similar broad-spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants.

Wildlife Food Plots: Rodeo may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reinfest the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tilling to allow for maximum effectiveness.

Injection and Frill Applications

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment will control the following woody species:

Common Name	Scientific Name
Oak	*Quercus spp.*
Poplar	*Populus spp.*
Sweet gum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*

This treatment will suppress the following woody species:

Common Name	Scientific Name
Black gum †	*Nyssa sylvatica*
Dogwood	*Cornus spp.*
Hickory	*Carya spp.*
Maple, red	*Acer rubrum*

† Rodeo is not approved for this use on this species in the state of California.

Release of Bermudagrass or Bahiagrass on Noncrop Sites

Release Of Dormant Bermudagrass and Bahiagrass

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6-leaf stage.

Weeds Controlled

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

Weeds Controlled or Suppressed †

Note: C = Controlled; S = Suppressed

	Rate of Rodeo (Fluid Ounces Per Acre)					
Weed Species	**6**	**9**	**12**	**18**	**24**	**48**
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop *Trifolium campestre*	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

† These rates apply only to sites where an established competitive turf is present.

Release of Actively Growing Bermudagrass

NOTE: Use only on sites where bahiagrass or bermudagrass are desired for ground cover and some temporary injury or yellowing of the grasses can be tolerated.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual vines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass	Johnsongrass †
Dallisgrass	Trumpetcreeper ††
Fescue (tall)	Vaseygrass

† Johnsongrass is controlled at the higher rate.
†† Suppression at the higher rate only.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

Bahiagrass Seedhead and Vegetative Suppression

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

Annual Grass Growth Suppression

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

Weeds Controlled

Annual Weeds

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

Broadcast Application Rates: Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application Rates: Use a 3/4 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled.

When applied as directed, Rodeo plus nonionic surfactant will control the following annual weeds:

Common Name	Scientific Name
Balsamapple †	*Momordica charantia*
Barley	*Hordeum vulgare*
Barnyardgrass	*Echinochloa crus-galli*
Bassia, fivehook	*Bassia hyssopifolia*
Bluegrass, annual	*Poa annua*
Bluegrass, bulbous	*Poa bulbosa*
Brome	*Bromus spp.*
Buttercup	*Ranunculus spp.*
Cheat	*Bromus secalinus*
Chickweed, mouseear	*Cerastium vulgatum*
Cocklebur	*Xanthium strumarium*
Corn, volunteer	*Zea mays*
Crabgrass	*Digitaria spp.*
Dwarfdandelion	*Krigia cespitosa*
Falseflax, smallseed	*Camelina microcarpa*
Fiddleneck	*Amsinckia spp.*
Flaxleaf fleabane	*Conyza bonariensis*
Fleabane	*Erigeron spp.*
Foxtail	*Setaria spp.*
Foxtail, Carolina	*Alopecurus carolinianus*
Groundsel, common	*Senecio vulgaris*
Horseweed/Marestail	*Conyza canadensis*
Kochia	*Kochia scoparia*
Lambsquarters, common	*Chenopodium album*
Lettuce, prickly	*Lactuca serriola*
Morningglory	*Ipomoea spp.*
Mustard, blue	*Chorispora tenella*
Mustard, tansy	*Descurainia pinnata*
Mustard, tumble	*Sisymbrium altissimum*
Mustard, wild	*Sinapis arvensis*
Oats, wild	*Avena fatua*
Panicum	*Panicum spp.*
Pennycress, field	*Thlaspi arvense*
Pigweed, redroot	*Amaranthus retroflexus*
Pigweed, smooth	*Amaranthus hybridus*
Ragweed, common	*Ambrosia artemisiifolia*

Ragweed, giant	*Ambrosia trifida*
Rocket, London	*Sisymbrium irio*
Rye	*Secale cereale*
Ryegrass, Italian ††	*Lolium multiflorum*
Sandbur, field	*Cenchrus spp.*
Shattercane	*Sorghum bicolor*
Shepherd's-purse	*Capsella bursa-pastoris*
Signalgrass, broadleaf	*Brachiaria platyphylla*
Smartweed, Pennsylvania	*Polygonum pensylvanicum*
Sowthistle, annual	*Sonchus oleraceus*
Spanishneedles ††	*Bidens bipinnata*
Stinkgrass	*Eragrostis cilianensis*
Sunflower	*Helianthus annuus*
Thistle, Russian	*Salsola kali*
Spurry, umbrella	*Holosteum umbellatum*
Velvetleaf	*Abutilon theophrasti*
Wheat	*Triticum aestivum*
Witchgrass	*Panicum capillare*

† Apply with hand-held equipment only.
†† Apply 3 pints of this product per acre.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

Perennial Weeds

Apply Rodeo to control most vigorously growing perennial weeds. Unless otherwise directed, apply when target plants are actively growing and most have reached early head or early bud stage of growth. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

NOTE: If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

Specific Weed Control Recommendations: For perennial weeds, apply the recommended rate plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. See the "General Information", "Directions for Use" and "Mixing and Application" sections in this label for specific uses and application instructions.

When applied as directed, Rodeo plus nonionic surfactant will control the following perennial weeds: (Numbers in parentheses "(-)" following common name of a listed weed species refer to "Specific Perennial Weed Control Recommendations" for that weed which follow the species listing.)

Common Name	Scientific Name
Alfalfa (31)	*Medicago sativa*
Alligatorweed † (1)	*Alternanthera philoxeroides*
Anise/Fennel (31)	*Foeniculum vulgare*
Artichoke, Jerusalem (31)	*Helianthus tuberosus*
Bahiagrass (31)	*Paspalum notatum*
Bermudagrass (2)	*Cynodon dactylon*
Bindweed, field (3)	*Convolvulus arvensis*
Bluegrass, Kentucky (12)	*Poa pratensis*
Blueweed, Texas (3)	*Helianthus ciliaris*
Brackenfern (4)	*Pteridium spp.*
Bromegrass, smooth (12)	*Bromus inermis*
Canarygrass, reed (12)	*Phalaris arundinacea*
Cattail (5)	*Typha spp.*
Clover, red (31)	*Trifolium pratense*
Clover, white (31)	*Trifolium repens*
Cogongrass (6)	*Imperata clylindrica*
Cordgrass (7)	*Spartina spp.*
Cutgrass, giant † (8)	*Zizaniopsis miliacea*
Dallisgrass (31)	*Paspalum dilatatum*
Dandelion (31)	*Taraxacum officinale*
Dock, curly (31)	*Rumex crispus*
Dogbane, hemp (9)	*Apocynum cannabinum*
Fescue (31)	*Festuca spp.*
Fescue, tall (10)	*Festuca arundinacea*
Guineagrass (11)	*Panicum maximum*
Hemlock, poison (31)	*Conium maculatum*
Horsenettle (31)	*Solanum carolinense*
Horseradish (9)	*Armoracia rusticana*
Ice Plant (22)	*Mesembryanthemum crystallinum*
Johnsongrass (12)	*Sorghum halepense*
Kikuyugrass (21)	*Pennisetum clandestinum*
Knapweed (9)	*Centaurea repens*
Lantana (13)	*Lantana camara*
Lespedeza, common (31)	*Lespedeza striata*
Lespedeza, sericea (31)	*Lespedeza cuneata*
Loosestrife, purple (14)	*Lythrum salicaria*
Lotus, American (15)	*Nelumbo lutea*
Maidencane (16)	*Panicum hematomon*
Milkweed (17)	*Asclepias spp.*
Muhly, wirestem (21)	*Muhlenbergia frondosa*
Mullein, common (31)	*Verbascum thapsus*
Napiergrass (31)	*Pennisetum purpureum*
Nightshade, silverleaf (3)	*Solanum elaeagnifolium*
Nutsedge, purple (18)	*Cyperus rotundus*
Nutsedge, yellow (18)	*Cyperus esculentus*
Orchardgrass (12)	*Dactylis glomerata*
Pampasgrass (19)	*Cortaderia jubata*
Paragrass (16)	*Brachiaria mutica*
Phragmites †† (20)	*Phragmites spp.*
Quackgrass (21)	*Agropyron repens*
Reed, giant (22)	*Arundo donax*
Ryegrass, perennial (12)	*Lolium perenne*
Smartweed, swamp (31)	*Polygonum coccineum*
Spatterdock (23)	*Nuphar luteum*
Starthistle, yellow (31)	*Centaurea solstitialis*
Sweet potato, wild † (24)	*Ipomoea pandurata*
Thistle, artichoke (25)	*Cynara cardunculus*
Thistle, Canada (25)	*Cirsium arvense*
Timothy (12)	*Phleum pratense*
Torpedograss † (26)	*Panicum repens*
Tules, common (27)	*Scirpus acutus*
Vaseygrass (31)	*Paspalum urvillei*
Velvetgrass (31)	*Holcus spp.*
Waterhyacinth (28)	*Eichornia crassipes*
Waterlettuce (29)	*Pistia stratiotes*
Waterprimrose (30)	*Ludwigia spp.*
Wheatgrass, western (12)	*Agropyron smithii*

† Partial control.
†† Partial control in southeastern states. See "Specific Weed Control Recommendations" below.

Specific Perennial Weed Control Recommendations:

1. **Alligatorweed:** Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.
2. **Bermudagrass:** Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seedheads appear.
3. **Bindweed, field / Silverleaf Nightshade / Texas Blueweed:** Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.
4. **Brackenfern:** Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.
5. **Cattail:** Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.
6. **Cogongrass:** Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.
7. **Cordgrass:** Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.
8. **Cutgrass, giant:** Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7 to 10-leaf stage prior to retreatment.
9. **Dogbane, hemp / Knapweed / Horseradish:** Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.
10. **Fescue, tall:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.
11. **Guineagrass:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.
12. **Johnsongrass / Bluegrass, Kentucky / Bromegrass, smooth / Canarygrass, reed / Orchardgrass / Ryegrass, perennial / Timothy / Wheatgrass, western:** Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.
13. **Lantana:** Apply this product as a 3/4 to 1 percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.
14. **Loosestrife, purple:** Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.
15. **Lotus, American:** Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.
16. **Maidencane / Paragrass:** Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7 to 10-leaf stage prior to retreatment.
17. **Milkweed, common:** Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.
18. **Nutsedge: purple, yellow:** Apply 4 1/2 pints of this product per acre as a broadcast spray, or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at rhizome tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.
19. **Pampasgrass:** Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.
20. **Phragmites:** For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer of fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.
21. **Quackgrass / Kikuyugrass / Muhly, wirestern:** Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3 to 4-leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.
22. **Reed, giant / ice plant:** For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

23. **Spatterdock:** Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.
24. **Sweet potato, wild:** Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.
25. **Thistle, Canada / artichoke:** Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.
26. **Torpedograss:** Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.
27. **Tules, common:** Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.
28. **Waterhyacinth:** Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.
29. **Waterlettuce:** For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.
30. **Waterprimrose:** Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.
31. **Other perennial weeds listed above:** Apply 4 1/2 to 7 1/2 pints of Rodeo per acre as a broadcast spray or apply as a 3/4 to 1 1/2 percent solution with hand-held equipment.

Woody Brush and Trees

NOTE: If brush has been mowed or tilled or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Application Rates and Timing
When applied as a 5 to 8 percent solution as a directed application as described in the "Hand-Held and High-Volume Equipment" section, this product will control or partially control all wood brush and tree species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Specific Brush or Tree Control Recommendations: Numbers in parentheses "(-)" following the common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" which follow the species listing. See this section for specific application rates and timing for listed species.

For woody brush and trees, apply the recommended rate plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full-leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions. **When applied as directed, Rodeo plus nonionic surfactant will control the following woody brush plants and trees:** (Numbers in parentheses "(-)" following common name of a listed brush or tree species refer to "Specific Brush or Tree Control Recommendations" for that species which follow the species listing.)

Common Name	Scientific Name
Alder (1)	*Alnus spp.*
Ash † (20)	*Fraxinus spp.*
Aspen, quaking (2)	*Populus tremuloides*
Bearclover, Bearmat (20)	*Chamaebatia foliolosa*
Birch (3)	*Betula spp.*
Blackberry (1)	*Rubus spp.*
Broom, French (4)	*Cytisus monspessulanus*
Broom, Scotch (4)	*Cytisus scoparius*
Buckwheat, California † (5)	*Eriogonum fasciculatum*
Cascara † (20)	*Rhamnus purshiana*
Catsclaw † (6)	*Acacia greggi*
Ceanothus (20)	*Ceanothus spp.*
Chamise (17)	*Adenostoma fasciculatum*
Cherry, bitter (7)	*Prunus emarginata*
Cherry, black (7)	*Prunus serotina*
Cherry, pin (7)	*Prunus pensylvanica*
Coyote brush (8)	*Baccharis consanguinea*
Creeper, Virginia † (20)	*Parthenocissus quinquefolia*
Dewberry (1)	*Rubus trivialis*
Dogwood (9)	*Cornus spp.*
Elderberry (3)	*Sambucus spp.*
Elm † (20)	*Ulmus spp.*
Eucalyptus, bluegum (10)	*Eucalyptus globulus*
Hasardia † (5)	*Haplopappus squamosus*
Hawthorn (2)	*Crataegus spp.*
Hazel (3)	*Corylus spp.*
Hickory (9)	*Carya spp.*
Holly, Florida (11) (Brazilian peppertree)	*Schinus terebinthifolius*
Honeysuckle (1)	*Lonicera spp.*
Hornbeam, American (20)	*Carpinus caroliniana*
Kudzu (12)	*Pueraria lobata*
Locust, black † (20)	*Robinia pseudoacacia*
Manzanita (20)	*Arctostaphylos spp.*

Maple, red † (13)	*Acer rubrum*
Maple, sugar (14)	*Acer saccharum*
Maple, vine † (20)	*Acer circinatum*
Monkey flower † (5)	*Mimulus guttatus*
Oak, black † (20)	*Quercus velutina*
Oak, northern pin (14)	*Quercus palustris*
Oak, post (1)	*Quercus stellata*
Oak, red (14)	*Quercus rubra*
Oak, southern red (7)	*Quercus falcata*
Oak, white † (20)	*Quercus alba*
Persimmon † (20)	*Diospyros spp.*
Poison-ivy (15)	*Rhus radicans*
Poison-oak (15)	*Rhus toxicodendron*
Poplar, yellow † (20)	*Liriodendron tulipifera*
Prunus (7)	*Prunus spp.*
Raspberry (1)	*Rubus spp.*
Redbud, eastern (20)	*Cercis canadensis*
Rose, multiflora (16)	*Rosa multiflora*
Russian-olive (20)	*Elaeagnus angustifolia*
Sage: black (17), white	*Salvia spp.*
Sagebrush, California (17)	*Artemisia californica*
Salmonberry (3)	*Rubus spectabilis*
Salt cedar † (9)	*Tamarix spp.*
Saltbush, sea myrtle (18)	*Baccharis halimifolia*
Sassafras (20)	*Sassafras aibidum*
Sourwood † (20)	*Oxydendrum arboreum*
Sumac, poison † (20)	*Rhus vernix*
Sumac, smooth † (20)	*Rhus glabra*
Sumac, winged † (20)	*Rhus copallina*
Sweetgum (7)	*Liquidambar styraciflua*
Swordfern † (20)	*Polystichum munitum*
Tallowtree, Chinese (17)	*Sapium sebiferum*
Thimbleberry (3)	*Rubus parviflorus*
Tobacco, tree † (5)	*Nicotiana glauca*
Trumpetcreeper (2)	*Campsis radicans*
Waxmyrtle, southern † (11)	*Myrica cerifera*
Willow (19)	*Salix spp.*

† Partial control (See below for control or partial control instructions.)

Specific Brush or Tree Control Recommendations:

1. **Alder / Blackberry / Dewberry / Honeysuckle / Oak, Post / Raspberry:** For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.
2. **Aspen, Quaking / Hawthorn / Trumpetcreeper:** For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.
3. **Birch / Elderberry / Hazel / Salmonberry / Thimbleberry:** For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.
4. **Broom, French / Broom, Scotch:** For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.
5. **Buckwheat, California / Hasardia / Monkey flower / Tobacco, tree:** For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
6. **Catsclaw:** For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
7. **Cherry, bitter / Cherry, black / Cherry, pin / Oak, southern red / Sweetgum / Prunus:** For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.
8. **Coyote brush:** For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
9. **Dogwood / Hickory / Salt cedar:** For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.
10. **Eucalyptus, bluegum:** For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6 to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.
11. **Holly, Florida / Waxmyrtle, southern:** For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.
12. **Kudzu:** For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.
13. **Maple, red:** For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.
14. **Maple, sugar / Oak: northern pin / Oak, red:** For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.
15. **Poison-ivy / Poison-oak:** For control, apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.
16. **Rose, multiflora:** For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.
17. **Sage, black / Sagebrush, California / Chamise / Tallowtree, Chinese:** For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.
18. **Saltbush, sea myrtle:** For control, apply this product as a 1 percent solution with hand-held equipment.
19. **Willow:** For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment.
20. **Other woody brush and trees listed above:** For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

Warranty Disclaimer

Dow AgroSciences warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. Dow AgroSciences MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks of Use

It is impossible to eliminate all risks associated with use of this product. Crop injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of Dow AgroSciences or the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Dow AgroSciences' election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or

(2) Replacement of amount of product used.

Dow AgroSciences shall not be liable for losses or damages resulting from handling or use of this product unless Dow AgroSciences is promptly notified of such loss or damage in writing. In no case shall Dow AgroSciences be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer above and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of Dow AgroSciences or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

*Trademark of Dow AgroSciences LLC
Dow AgroSciences LLC • Indianapolis, IN 46268 U.S.A.

Label Code: D02-148-001
Initial Printing

EPA-accepted 07/15/99

MATERIAL SAFETY DATA SHEET

Dow AgroSciences

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

RODEO* HERBICIDE

Effective Date: 1/12/00
Product Code: 84825
MSDS: 006694

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: Rodeo* Herbicide

COMPANY IDENTIFICATION:
Dow AgroSciences
9330 Zionsville Road
Indianapolis, IN 46268-1189

2. COMPOSITION/INFORMATION ON INGREDIENTS:

Glyphosate: N-(phosphono-methyl)glycine, Isopropylamine Salt	CAS # 038641-94-0	53.8%
Inert Ingredients, Total		46.2%

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

3. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW
Hazardous Chemical. Clear, pale yellow liquid. May cause eye irritation. LD_{50} for skin absorption in rabbits is >5000 mg/kg. Oral LD_{50} for rats is >5000 mg/kg. Aerosol LC_{50} for rats is >6.37 mg/L for 4 hrs. Slightly toxic to aquatic organisms.
EMERGENCY PHONE NUMBER: 800-992-5994

POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects, which could occur if this material is not handled in the recommended manner.

EYE: May cause slight eye irritation. Corneal injury is unlikely.

SKIN: Essentially non-irritating to skin. A single prolonged exposure is not likely to result in the material being absorbed through the skin in harmful amounts. The LD_{50} for skin absorption in rabbits is >5000 mg/kg. Did not cause allergic skin reactions when tested in guinea pigs.

INGESTION: Single dose oral toxicity is extremely low. No hazards anticipated from swallowing small amounts incidental to normal handling operations. The oral LD_{50} for rats is >5000 mg/kg.

INHALATION: A single brief (minutes) inhalation exposure is not likely to cause adverse effects. The aerosol LC_{50} for rats is >6.37 mg/L for 4 hours.

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: No relevant information found.

CANCER INFORMATION: Did not cause cancer in laboratory animals.

TERATOLOGY (BIRTH DEFECTS): Birth defects are unlikely. Exposures having no adverse effects on the mother should have no effect on the fetus.

REPRODUCTIVE EFFECTS: No relevant information found.

4. FIRST AID:

EYE: Flush eyes with plenty of water.

SKIN: Wash off in flowing water or shower.

INGESTION: No adverse effects anticipated by this route of exposure incidental to proper industrial handling.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

NOTE TO PHYSICIAN: No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

5. FIRE FIGHTING MEASURES:

FLASH POINT: >214°F (>101°C)
METHOD USED: Setaflash

FLAMMABLE LIMITS:
LFL: Not applicable
UFL: Not applicable

EXTINGUISHING MEDIA: Foam, CO_2, Dry Chemical

FIRE AND EXPLOSION HAZARDS: Foam fire extinguishing system is preferred because uncontrolled water can spread possible contamination. Toxic irritating gases may be formed under fire conditions.

FIRE-FIGHTING EQUIPMENT: Use positive-pressure, self-contained breathing apparatus and full protective equipment.

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MATERIAL SAFETY DATA SHEET

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Dow AgroSciences LLC
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Dow AgroSciences

RODEO* HERBICIDE

Effective Date: 1/12/00
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6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS: Absorb small spills with an inert absorbent material such as Hazorb, Zorball, sand, or dirt. Report large spills to Dow AgroSciences on 800-992-5994.

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapors and spray mist. Handle concentrate in ventilated area. Wash thoroughly with soap and water after handling and before eating, chewing gum, using tobacco, using the toilet or smoking. Keep away from food, feedstuffs, and water supplies. Store in original container with the lid tightly closed. Store above 10°F (-12°C) to keep from crystallizing.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where the potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINES: None established

ENGINEERING CONTROLS: Good general ventilation should be sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

EYE/FACE PROTECTION: Use safety glasses.

SKIN PROTECTION: No precautions other than clean body-covering clothing should be needed.

RESPIRATORY PROTECTION: For most conditions, no respiratory protection should be needed; however, if discomfort is experienced, use a NIOSH approved air-purifying respirator.

APPLICATIONS AND ALL OTHER HANDLERS: Please refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES:

APPEARANCE: Clear, pale yellow liquid
DENSITY: 10.0 - 10.5 lbs/gal
pH: 4.8 – 5.0
ODOR: None
SOLUBILITY IN WATER: Miscible
SPECIFIC GRAVITY: 1.21 gm/L
FREEZING POINT: -7°F - -10°F (-21°C - -25°C)

10. STABILITY AND REACTIVITY:

STABILITY: (CONDITIONS TO AVOID) Stable under normal storage conditions.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Galvanized or unlined steel (except stainless steel) containers or spray tanks may produce hydrogen gas which may form a highly combustible gas mixture.

HAZARDOUS DECOMPOSITION PRODUCTS: None known.

HAZARDOUS POLYMERIZATION: Not known to occur.

11. TOXICOLOGICAL INFORMATION:

MUTAGENICITY: Animal mutagenicity studies were negative.

12. ECOLOGICAL INFORMATION:

ENVIRONMENTAL DATA:

ECOTOXICOLOGY:
Material is slightly toxic to aquatic organisms on an acute basis (LC_{50}/EC_{50} is between 10 and 100 mg/L in most sensitive species).
Acute LC_{50} for rainbow trout (Oncorhynchus mykiss) is 60 mg/L.
Material is practically non-toxic to birds on an acute basis (LD_{50} is >2000 mg/kg).
Acute oral LD_{50} in bobwhite (Colinus virginianus) is >2000 mg/kg.
The LC_{50} in earthworm Eisenia foetida is >1000 mg/kg.

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MATERIAL SAFETY DATA SHEET

Dow AgroSciences

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RODEO* HERBICIDE

13. DISPOSAL CONSIDERATIONS:

DISPOSAL METHOD: Do not contaminate water, food, or feed by storage or disposal. Excess wastes resulting from the use of this product may be disposed of on site according to label directions or at an approved waste disposal facility. Follow all local, state, and federal requirements for disposal.

14. TRANSPORT INFORMATION:

For DOT regulatory information, if required, consult transportation regulations, product shipping papers, or contact your Dow AgroSciences representative.

15. REGULATORY INFORMATION:

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

U.S. REGULATIONS

SARA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

Not to have met any hazard category

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

STATE RIGHT-TO-KNOW: This product is not known to contain any substances subject to the disclosure requirements of

New Jersey
Pennsylvania

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

16. OTHER INFORMATION:

MSDS STATUS: New
Reference: DR-0361-8028
Document Code: D03-148-001

The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult Dow AgroSciences For Further Information.

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PREFACE

Surfactant Information

This section of Appendix E provides the most current manufacturer's labels and Material Safety Data Sheets (MSDS) for several surfactants and one colorant or dye, that may be used to eradicate or control non-native Spartina in San Francisco Bay. At least two of these surfactants (R-11® and LI-700®) were evaluated in Element E of the Washington State EIS, which is cited and references extensively in this PEIS/PEIR; Element E should be reviewed for more additional information on the affects of these products on the environment and biota. The aforementioned surfactants, as well as one other (Agri-dex®) are included in this section of Appendix E because they are all presently registered with the U.S. EPA and California Department of Pesticide Regulation, they have been shown in laboratory tests to have relatively low toxicity to terrestrial and aquatic biota and people, and in field studies, they are effective. Inclusion of product labels and MSDS information in this appendix is not a product endorsement by the Conservancy or the Service.

Helena

AGRI-DEX®

A Non-ionic Spray Adjuvant

*Active Ingredients:
Paraffin base petroleum oil
Polyol fatty acid esters
Polyethoxylated derivatives thereof 99.0%
Components ineffective as adjuvant 1.0%

TOTAL 100.0%

*All ingredients are accepted for use under CFR 40, 180.1001(c).

KEEP OUT OF REACH OF CHILDREN
CAUTION

SEE OTHER PRECAUTIONARY STATEMENTS INSIDE PRODUCT LABEL

CASN 0984/0601 CAL. Reg. No. 5905-50017-AA

PRECAUTIONARY STATEMENT

BEFORE USING THIS PRODUCT, READ ALL PRECAUTIONS, DIRECTIONS FOR USE, CONDITIONS OF SALE—LIMITED WARRANTY AND LIMITATIONS OF LIABILITY AND REMEDIES.

Avoid contact with formulated product. Do not take internally. Avoid contact with or inhalation of the spray mist. Follow all precautionary statements on the accompanying pesticide(s) label(s).

What To Do In Case of Contact:

If Swallowed: Do not induce vomiting. Immediately call a doctor.

Eye Contact: Flush eyes with clean water for 15 minutes. Immediately call a doctor.

Skin Contact: Remove contaminated clothing and wash skin with soap and water. Call a doctor if irritation develops or persists.

If Inhaled: Move to fresh air and call a doctor if irritation develops or persists.

If there is contact made with the spray solution containing pesticides, follow the "Statement of Practical Treatment" statement on the pesticide label.

STORAGE AND DISPOSAL

Keep container tightly closed, do not allow water to be introduced to the contents of the container.

Do not store near heat or open flame.

Do not store with oxidizing agents or ammonium nitrate.

Do not contaminate water sources by cleaning of equipment or disposal of spray waste.

Dispose of empty containers by triple rinsing with detergent solution or puncture and discard empty containers in a landfill in accordance with current local, state and federal regulations.

GENERAL INFORMATION

AGRI-DEX is a non-ionic blend of special surfactants and a superior type of spray oil and is designed for use with a broad range of pesticides where an oil concentrate adjuvant is recommended. Subject to the cautionary statements set forth in the Directions for Use, **AGRI-DEX** may be used with other pesticides and/or fertilizer products. The addition of **AGRI-DEX** to a spray tank improves pesticide application by modifying the wetting and deposition characteristics of the spray solution resulting in a more even and uniform spray deposit. Optimum application and effects, however, can be influenced by the crop, pest, spray equipment, spray volume, pressure, droplet size, spray mixture and environmental factors. Consequently, it is recommended that careful observations of the spray deposit be made and adjuvant concentrations be adjusted accordingly.

DIRECTIONS FOR USE

The addition of an adjuvant to some pesticides or pesticide tank mix combinations may cause phytotoxicity to the foliage and/or fruit of susceptible crops. Prior to the addition of **AGRI-DEX** to spray tank mixes or prior to the use of **AGRI-DEX** with a pesticide or fertilizer where an oil concentrate adjuvant is not specifically recommended but not prohibited by the manufacturer, the user or application advisor must have experience with the combination or must have conducted a phytotoxicity trial.

AGRI-DEX may be applied by Ground, CDA, Aerial or Aquatic spray equipment. In most cases, use enough **AGRI-DEX** to allow for uniform wetting and deposition of the spray onto leaf surfaces without runoff.

GROUND: Use 1-4 pints in 20-100 gallons of spray solution per acre. Do not exceed 2.5% v/v concentration.

AERIAL, LOW VOLUME, CDA: Use 2-16 fl. oz. per acre or follow rate recommendations on the pesticide label if higher rates are required.

AQUATIC: Use 1-4 pints per acre. Do not exceed 2.5% v/v concentration.

NOTE: The above use recommendations are considered to be adequate for most uses. Some pesticides, however, may require higher rates for optimum effect. Follow the pesticide label directions when this occurs.

CAUTION: Do not mix with oxidizing agents unless oxidizing agents are in solution.

MIXING

Fill spray tank one-half full with water and begin agitation. Add pesticides and/or fertilizers as directed by labeling or in the following sequence:

1. Dry flowables or water dispersible granules
2. Wettable powders
3. Flowables
4. Solutions
5. Emulsifiable concentrates

and continue filling. Add **AGRI-DEX** last and continue agitation.

CONDITIONS OF SALE—LIMITED WARRANTY AND LIMITATIONS OF LIABILITY AND REMEDIES

Read the Conditions of Sale—Warranty and Limitations of Liability and Remedies before using this product. If the terms are not acceptable, return the product, unopened, and the full purchase price will be refunded.

The directions on this label are believed to be reliable and should be followed carefully. Insufficient control of pests and/or injury to the crop to which the product is applied may result from the occurrence of extraordinary or unusual weather conditions, the failure to follow the label directions, or good application practices, all of which are beyond the control of Helena Chemical Company (the "Company") or seller. In addition, failure to follow label directions may cause injury to crops, animals, man or the environment. The Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purpose referred to in the directions for use subject to the factors noted above which are beyond the control of the Company. The Company makes no other warranties or representations of any kind, express or implied, concerning the product, including no implied warranty of merchantability or fitness for any particular purpose, and no such warranty shall be implied by law.

The exclusive remedy against the Company for any cause of action relating to the handling or use of this product shall be limited to, at Helena Chemical Company's election, one of the following:

1. Refund of the purchase price paid by buyer or user for product bought, or
2. Replacement of the product used

To the extent allowed by law, the Company shall not be liable and any and all claims against the Company are waived for special, indirect, incidental, or consequential damages or expense of any nature, including, but not limited to, loss of profits or income. The Company and the seller offer this product and the buyer and user accept it, subject to the foregoing conditions of sale and limitation of warranty, liability and remedies.

* ESTABLISHMENT NUMBER STATEMENT

First letter of product batch code indicate producing establishment.

5905-FL-1=TF, 5905-GA-1=CG, 5905-AR-1=WA, 5905-OK-1=AO, 5905-TX-1=AT, 5905-CA-1=KC

MANUFACTURER / EMERGENCY INFORMATION

HELENA CHEMICAL COMPANY
6075 POPLAR, SUITE 500
MEMPHIS, TN 38119

EMERGENCY TELEPHONE NUMBER:
1. (901) 761-0050
2. CHEMTREC (800) 424-9300

EFFECTIVE DATE: 01/23/96

I. IDENTIFICATION

CHEMICAL NAME	NONIONIC OIL CONCENTRATE
CHEMICAL FAMILY	OIL SURFACTANTS
FORMULA	NOT APPLICABLE, FORMULATED MIXTURE.
SYNONYMS	NONE
CAS NUMBER	64741-88-4//64741-89-5
EPA REGISTRY NO.	NONE REQUIRED

II. PHYSICAL DATA

BOILING POINT	625 TO 830 DEG F.
FREEZING POINT	<32 DEGREES F.
SPECIFIC GRAVITY	.879 GMS/CC
VAPOR PRESSURE	.0001 MM HG
VAPOR DENSITY	10+
SOLUBILITY IN WATER	DISPERSIBLE
PER CENT VOLATILES	<1%
EVAPORATION RATE	1000X
MELTING POINT	>10 DEGREES F.
APPEARANCE & ODOR	CLEAR AMBER LIQUID, MINERAL OIL ODOR.

III. INGREDIENTS

.......MATERIAL.................	...%..	...TLV(UNITS)..	...HAZARD......
PROPRIETARY BLEND OF HEAVY RANGE PARAFFIN BASE PETROLEUM OIL, POLYOL FATTY ACID ESTERS, & POLYETHOXYLATED DERIVATIVES --	100.00	5 MG/M3	MILD SKIN & EYE IRRITANT

IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT : >200 DEGREES F.
AUTOIGNITION TEMPERATURE: 670 DEG F.(ESTIMATE)
FLAMMABLE LIMITS : NOT DETERMINED
EXTINGUISHING MEDIA:
- WATER FOG, FOAM, DRY CHEMICAL AND CARBON DIOXIDE.
-

SPECIAL FIRE FIGHTING PROCEDURES:
- WEAR A (POSITIVE PRESSURE) SELF-CONTAINED BREATHING APPARATUS
- WHEN FIGHTING FIRES IN AN ENCLOSED AREA.
-

UNUSUAL FIRE AND EXPLOSION HAZARDS:
- CAN BE MADE TO BURN (FLASH POINT GREATER THAN 200 DEGREES F).
-
-

V. HEALTH HAZARD

-CARCINOGENICITY INFORMATION: NONE CURRENTLY KNOWN.

-ACUTE EFFECTS OF OVEREXPOSURE

SWALLOWING:
- LOW TOXICITY, ORAL LD50 (RAT) >5,010 GM/KG. PULMONARY ASPIRATION
- HAZARD IF SWALLOWED AND/OR VOMITING OCCURS, CAN ENTER LUNGS AND
- CAUSE DAMAGE.

SKIN ABSORPTION:
- LOW TOXICITY, DERMAL LD50 (RABBIT) >2,020 GM/KG.
-

INHALATION:
- NO HAZARD EXPECTED.
-

SKIN CONTACT:
- MODERATE IRRITATION, REMOVES NATURAL OILS AND FATS FROM
- SKIN WITH PROLONGED OR REPEATED CONTACT.

EYE CONTACT:
- CONTACT WITH EYES MAY CAUSE MILD IRRITATION.
-

CHRONIC EFFECTS:
- EXCESSIVE EXPOSURES MAY CAUSE IRRITATION TO EYES, NOSE
- AND THROAT.
-

OTHER HEALTH HAZARD:
- NONE CURRENTLY KNOWN.
-
-

-EMERGENCY AND FIRST AID PROCEDURES

SWALLOWING:
- DO NOT INDUCE VOMITING! DO NOT GIVE LIQUIDS! OBTAIN EMERGENCY
- MEDICAL ATTENTION. SMALL AMOUNTS WHICH ACIDENTALLY ENTER MOUTH
- SHOULD BE RINSED OUT UNTIL TASTE OF IT IS GONE.

SKIN:
- WASH CONTAMINATED AREA WITH SOAP AND WATER. IF IRRITATION
- DEVELOPS, CONSULT A PHYSICIAN.

INHALATION:
- MOVE PERSON TO FRESH AIR. CONSULT A PHYSICIAN IF IRRITATION
- DEVELOPS.

EYES:
- FLUSH EYES WITH WATER FOR 15 MINUTES, HOLDING EYELIDS OPEN.
- IF IRRITATION DEVELOPS, CONSULT A PHYSICIAN.

- NOTES TO PHYSICAN
- IN THE EVENT OF AN ADVERSE RESPONSE, TREATMENT SHOULD BE DIRECTED
- TOWARD CONTROL OF THE SYMPTOMS.

- PULMONARY ASPIRATION HAZARD IF SWALLOWED AND/OR VOMITING OCCURS, CAN
- ENTER LUNGS AND CAUSE DAMAGE.
-
-

VI. REACTIVITY DATA

STABILITY : STABLE
CONDITIONS TO AVOID: NONE CURRENTLY KNOWN

POLYMERIZATION : WILL NOT OCCUR
CONDITIONS TO AVOID: NONE CURRENTLY KNOWN.

INCOMPATIBILITY: ALKALIES AND STRONG OXIDIZERS.
MATERIALS
HAZARDOUS : MAY PRODUCE OXIDES OF CARBON AND ASPHYXIANTS UNDER
COMBUSTION FIRE CONDITIONS.

VII. SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
-CLEAN UP SPILLS WITH AN OIL ABSORBENT MATERIAL, SUCH AS CLAY, SAND, OR
-SAWDUST. SPILL AREA WILL BE QUITE SLIPPERY. PLACE CONTAMINATED MATERIAL
-IN RECOVERY/SALVAGE DRUMS FOR PROPER DISPOSAL.
WASTE DISPOSAL METHOD
-THIS MATERIAL MUST BE DISPOSED OF ACCORDING TO FEDERAL, STATE, OR LOCAL
-PROCEDURES UNDER THE RESOURCE CONSERVATION AND RECOVERY ACT.

VIII. SPECIAL PROTECTION INFORMATION

RESPIRATION : USE ONLY NIOSH CERTIFIED RESPIRATORY PROTECTION. RESPIRATORY PROTECTION NOT NEEDED UNLESS PRODUCT IS HEATED OR MISTED.
VENTILATION : VENTILATE AS NEEDED TO COMPLY WITH EXPOSURE LIMIT.

GLOVES : IMPERVIOUS
EYES : CHEMICAL WORKERS GOGGLES.
OTHERS : EYE WASH STATION, IMPERVIOUS APRON AND FOOTWEAR.

IX. SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
- KEEP OUT OF REACH OF CHILDREN. DO NOT STORE WITH FOOD, FEED, OR OTHER
- MATERIAL TO BE USED OR CONSUMED BY HUMANS OR ANIMALS. DO NOT
- CONTAMINATE WATER SUPPLIES, LAKES, STREAMS, OR PONDS.
-
- DO NOT STORE NEAR OPEN HEAT OR FLAMES. DO NOT STORE WITH OXIDIZING
- AGENTS OR AMMONIUM NITRATE FERTILIZER. KEEP CONTAINER CLOSED, DO NOT
- ALLOW WATER TO BE INTRODUCED TO THE CONTENTS OF THE CONTAINER.

OTHER PRECAUTIONS
- A) RCRA HAZARDOUS WASTE NUMBER:------- NOT LISTED
- B) SARA TITLE III, SECTION 313:------- NOT LISTED
- C) SARA THRESHOLD PLANNING QUANTITY: - NOT LISTED
- D) CERCLA REPORTABLE QUANTITY:-------- NOT LISTED
- E) CALIFORNIA PROPOSITION 65:--------- NOT LISTED
- F) TITLE III, CLEAN AIR ACT:---------- NOT LISTED

X. SHIPPING INFORMATION

D.O.T. DATA - PROPER SHIPPING NAME:
- NOT REGULATED BY DOT, IATA, OR IMO.
-

HAZARD CLASS : NONE
IDENTIFICATION NO.: NONE
LABELS REQUIRED : NONE
PLACARDING : NONE
FREIGHT CLASSIFICATION:
- ADJUVANT, SPREADER OR STICKER, LIQUID, NOIBN
-

..CHEMICAL NAME	EQUIVALENT R.Q.
NOT APPLICABLE	NOT APPLICABLE

XI. GENERAL PRODUCT INFORMATION

NATIONAL FIRE PROTECTION ASSOCIATION RATING:
(RATING LEVEL: 4-EXTREME 3-HIGH 2-MODERATE 1-SLIGHT 0-MINIMUM
HEALTH: 1 FIRE: 1 REACTIVITY: 0
S.A.R.A. TITLE III HAZARD CLASSIFICATION: (YES / NO)

IMMEDIATE (ACUTE) HEALTH :	Y	DELAYED (CHRONIC) HEALTH :	N
SUDDEN RELEASE OF PRESSURE:	N		
FIRE :	N	REACTIVE :	N

HELENA CHEMICAL BELIEVES THAT THE DATA CONTAINED HEREIN IS FACTUAL. THIS DATA IS NOT TO BE TAKEN AS A WARRANTY OR REPRESENTATION OF LEGAL RESPONSIBILITY. IT IS OFFERED SOLELY FOR YOUR CONSIDERATION, INVESTIGATION & VERIFICATION.

WILBUR-ELLIS

IDEAS TO GROW WITH®

R-11®

SPREADER ACTIVATOR

LOW FOAMING, NONIONIC SURFACTANT

CA Reg. No. 2935-50142 EPA Est. No. 2935-TX-02

PRINCIPLE FUNCTIONING AGENTS	% BY WT.
Alkyl Aryl Polyethoxylates, Compounded Silicone and Alkyl Alcohol	90%
Constituents Ineffective as Spray Adjuvant	10%
	100%

KEEP OUT OF REACH OF CHILDREN

CAUTION:

Causes eye irritation. In case of contact with eyes, immediately flush with water for at least 15 minutes. If irritation persists get medical attention. May cause skin irritation. Harmful if swallowed. COMBUSTIBLE LIQUID. Keep away from heat, sparks and fire.

IN CASE OF EMERGENCY CALL CHEMTREC: (800) 424-9300

DIRECTIONS FOR USE

R-11 Spreader-Activator is specially formulated for increasing the efficacy of various agricultural chemicals. It is designed for use where quick wetting and uniform coverage of an agricultural chemical on a target surface is required. R-11 may also increase the absorption and translocation of systemic products.

Rates of R-11 Spreader-Activator may vary with plant and environmental conditions at the time of application. Use the low rates of R-11 if a uniform film on the plant surface is desired. The high rates of R-11 will not result in excessive foaming and should be used in situations such as but not limited to:

Applications of systemic chemicals.
Application rates as recommended on manufacturer's labels.
Applications made under adverse conditions.

Generally R-11 should be added as the last ingredient into the spray tank with the agitator running. However, some manufacturer's labels may recommend the addition of a nonionic surfactant, such as R-11, into the spray tank earlier in the mixing sequence.

NET CONTENTS: ________ GALLONS

STORAGE AND DISPOSAL

1. **PROHIBITIONS:** Do not contaminate water, food or feed by storage, disposal or cleaning of equipment.
2. **STORAGE:** Store in original container only and keep sealed. Store in closed storage areas. Use caution when moving, opening, closing or pouring.
3. **PESTICIDE DISPOSAL:** Improper disposal of excess spray mixtures or rinsate is a violation of federal law. Wastes resulting from use of this product should be disposed of through on site spray application or at an approved waste disposal facility.
4. **CONTAINER DISPOSAL:** Triple rinse (or equivalent), then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or other procedures approved by state and local authorities.

SUGGESTIONS FOR USE

Acaricides, Fungicides & Insecticides: Use 2 to 32 fl. oz. per 100 gallons of spray. The higher rate should be as recommended on the pesticide manufacturer's label.

Herbicides, Defoliants & Desiccants: Use 6 to 48 fl. oz. per 100 gallons of spray for most applications. The application rates should be as recommended on the herbicide manufacturer's label.

Aquatic Use Rates: R-11 may be used with aquatically labeled products, such as, glyphosate, trichlopyr and diquat herbicides at 64 fl. oz. per 100 gallons of spray solution. The application rates should be as recommended on the herbicide manufacturer's label.

Backpack or Hand Held Sprayers: Use 1 to 2 tablespoons (1/2 to 1 fl. oz.) per gallon of spray. The application rates should be as recommended on the manufacturer's label.

Livestock Sprays: Use 4 to 8 fl. oz. per 100 gallons of spray.

Soil Sterilants: Use 1% of total spray.

RATE EXCEPTIONS

Compliance With Manufacturer's Label: For pesticides/herbicides labels that permit use of a nonionic surfactant at a higher rate, follow instructions on that pesticide/herbicide label.

Do not add this product at rate that exceeds 5% of the finished spray volume.

Note: Use caution at the higher application rates. When applying to a sensitive crop, first treat a small area to determine if there may be adverse effects to the crop.

F-0101

MANUFACTURED IN U.S.A. BY
WILBUR-ELLIS COMPANY
P.O. BOX 16458
FRESNO, CALIFORNIA 93755

MATERIAL SAFETY DATA SHEET

WILBUR-ELLIS COMPANY
P.O. BOX 16458
FRESNO, CA 93755

EMERGENCY TELEPHONE NUMBER (209) 226-1934
24 HOUR EMERGENCY TELEPHONE NUMBER CHEMTREC: (800) 424-9300

SECTION 1 NAME
PRODUCT/TRADE NAME:R-11 SPREADER ACTIVATOR
EPA REGISTRATION #:None
CHEMICAL NAME/COMMON NAME:
1-Butanol/Butyl Alcohol
Octyl Phenoxy Polyethoxy Ethanol/Nonionic Surfactants

SECTION 2 HAZARDOUS INGREDIENTS

		CAS#	OSHA PEL	ACGIH TLV
Butyl Alcohol	10%	71-36-3	100 ppm	100 ppm
Nonionic Surfactants	80%	Mixture	NE	

SECTION 3 PHYSICAL DATA
SPECIFIC GRAVITY (H2O = 1):1.02   MELTING POINT:NA
VAPOR DENSITY (AIR = 1):NE   % VOLATILES BY VOL.:NE
ODOR:Alcohol
APPEARANCE:Clear Liquid
FLASH POINT/METHOD:130 Deg. F TCC
VAPOR PRESSURE (mmHg):NE
SOLUBILITY IN H2O:10%

SECTION 4 FIRE & EXPLOSION HAZARD
EXTINGUISHING MEDIA: [X] Water Fog [X] Foam [ ]Alcohol Foam
[X] CO2 [X] Dry Chemical [ ] Other

FIRE FIGHTING PRECAUTIONS & HAZARDS:
Fight fire upwind. Wear positive pressure, self-contained breathing apparatus and full protective equipment. Cool exposed containers with water. Dike area to prevent entering drains, sewers or water courses. Evacuate people downwind from fire.

SECTION 5 CARCINOGEN STATUS
[ ] OSHA   [ ] NTP   [ ] IARC
[X] No Listing   Type

SECTION 6 REACTIVITY
[X] Stable   HAZARDOUS POLYMERIZATION
[ ] Unstable   [ ] May Occur [X] Will Not Occur

AVOID:
Oxidizers, Liquid chlorine, and Concentrated O2

HAZARDOUS DECOMPOSITION PRODUCTS:
COx,

SECTION 7 SPILL OR LEAK PROCEDURES
STEPS TO BE TAKEN IN CASE OF SPILL:
Wear appropriate respiratory and personal protective equipment. Absorb with inert material. Vacuum or sweep up, and place in approved disposal container.
DECONTAMINATION:
Treat area with detergent and water. Absorb with inert material and place in approved container. Repeat as necessary

until area is clean.
ENVIRONMENTAL HAZARDS:
Dike to prevent entering drains, sewers or water courses.
DISPOSAL:
Place in DOT - approved container and dispose of in an approved disposal site.

SECTION 8 HEALTH PRECAUTION DATA
INGESTION:
Acute oral LD50 (rat) Butyl Alcohol 790 mg/kg (SAX)*).
Wash thoroughly before eating, drinking or smoking.
Do not ingest. Do not store near food or feed.

INHALATION:
PEL/TLV Butyl Alcohol 100 ppm. Can cause respiratory irritation in high concentrations. Wear appropriate respiratory protection for exposures above the PEL/TLV.

SKIN ABSORPTION:
Acute dermal LD50 (rabbit) for Butyl Alcohol 4200 mg/kg (SAX*). Can cause mild skin irritation or dermatitis. Wear proper personal protective equipment to reduce exposure.

EYE EXPOSURE:
May be mildly irritating to the eyes. If exposed, flush eyes for a minimum of 15 minutes with water. Wear proper eye protection to reduce splash exposure.

EFFECTS OF OVEREXPOSURE:
May cause eye irritation and corneal inflammation. High concentrations can cause respiratory irritation. May cause skin irritation, scaling or dermatitis. No known chronic effects. Pre-existing medical conditions involving the above symptoms may be aggravated by exposure.

FIRST AID:
In all cases, get prompt medical attention. If ingested, give several glasses of water. Do not induce vomiting. For skin exposure, remove contaminated clothing and wash with soap and water. For eye contact, irrigate for a minimum of 15 minutes with water. If inhaled, remove victim to fresh air, and administer CPR if necessary.

SECTION 9 SPECIAL PROTECTION INFORMATION
RESPIRATORY PROTECTION:
Use NIOSH/MSHA - approved respirator for organic vapors for exposures up to 10 times the PEL/TLV. Positive pressure self-contained breathing apparatus should be used for confined space entry and exposures above 10 times the PEL/TLV.
PERSONAL PROTECTIVE EQUIPMENT:
Not normally required for this product. Recommend chemical goggles, long-sleeved coveralls, and rubber or neoprene boots.
VENTILATION:
Recommend local exhaust ventilation for manufacture and formulation operations.

SECTION 10 SPECIAL PRECAUTIONS
Keep out of the reach of children.
Read and follow all label instructions.
Keep away from open flame, heat, or ignition sources.

SECTION 11 REGULATORY DATA
SARA HAZARD [ ] Acute [ ] Chronic [X] Flammable

```
CLASS:         [ ] Pressure  [ ] Reactive   [ ] None
SARA 313:      [X] Yes [ ] No  Chemical:Butyl Alcohol
SARA 302:      [ ] Yes [X] No  Chemical:
                TPQ:
CERCLA:        [X] Yes [ ] No  Chemical:Butyl Alcohol
                RQ: 1*
RCRA:          [X] Yes [ ] No
NFPA Hazard Rating:                NFPA Hazard Rating Scale:
 Health:       [1]                 0=Minimal     3=Serious
 Fire:         [2]                 1=Slight      4=Severe
 Reactivity:   [0]                 2=Moderate
 Special:      [ ]
HMIS Codes:                        HMIS Hazard Rating Scale:
 Health:       [1]                 0=Minimal     3=Serious
 Fire:         [2]                 1=Slight      4=Severe
 Reactivity:   [0]                 2=Moderate
-------------------------------------------------------------------------------
DATE PREPARED:
DATE PREPARED:May 8, 1985
REVISED DATE:August 7, 1997
Notice:  This information was developed from information on the
constituent materials.  No warranty is expressed or implied
regarding the completeness or continuing accuracy of the
information contained herein, and Wilbur-Ellis disclaims all
liability for reliance thereon.  The user should satisfy himself
that he has all current data relevant to his particular use.
*Technical Material   NE - Not Established   NA - Not Applicable
-------------------------------------------------------------------------------
```

LI 700®

NON IONIC

PENETRANT
ACIDIFIER
DEPOSITION AID
DRIFT CONTROL AGENT

Principal Functioning Agents:
Phosphatidylcholine, methylacetic acid and alkyl polyoxyethylene ether 80%
Constituents Ineffective as Spray Adjuvants 20%
TOTAL 100%

CONTAINS SOYOIL DERIVATIVE

CA Reg. No. 36208-50025

LOVELAND INDUSTRIES INC.
PO Box 1289 • Greeley, CO 80632
970-356-8920

NET CONTENTS: 1 U.S. GALLON (3.785 L)

DANGER: Keep Out of Reach of Children

Liquid Causes Skin and Eye Injury. Wear eye protection and chemical resistant gloves.

First Aid:
- **If in Eyes:** Treat as corrosive. Flush with water for 15 minutes, then get medical attention.
- **If on Skin:** Treat as corrosive. Remove contaminated clothing Wash with soap and water. Get medical attention.
- **If Swallowed:** Call a physician immediately. Drink two (2) glasses of water. Induce vomiting.
- **If Inhaled:** Remove victim to fresh air; apply artificial respiration if necessary.

General: LI 700 is a non-ionic, low foaming penetrant. LI 700 may be used to enhance the activity and effectiveness of agricultural and industrial chemicals. LI 700 provides more uniform coverage of spray solutions and aids in penetration. LI 700 may be used to acidify (lower pH) of spray solutions thus preventing alkaline hydrolysis of pesticides sensitive to high pH. **LI 700** improves deposition and retards drift by producing a more uniform spray pattern. The degree of drift hazard varies with the type of pesticide and application conditions. Common sense and sound application technology must be followed when spraying pesticides. **LI 700** will retard, but not eliminate drift. **LI 700** is compatible with most pesticides formulations including water-soluble, flowable and wettable powders. Application may be by ground or air.

Directions for Use: LI 700 may be used on a wide variety of crops including fruits, vegetables, row crops, citrus, small grains, forage crops, vine crops, or in non-crop sites. Aquatic (including wetlands), Forestry (site preparation and release), Industrial (storage areas, plant sites, and other similar areas including governmental and private lands), Grasslands (including pastures, rangeland and fence rows), Rights-of-ways (utility, railroad and roadsides), Turf (Golf Courses, Parks, and Sod farms), and Ornamentals (container, field or greenhouse). Some pesticides have stated adjuvant use rates. In all cases, the pesticide manufacturer's label should be consulted regarding specific adjuvant use recommendations and that rate followed. Do not add adjuvant at a level that would exceed 5% of the finished spray volume unless otherwise specified by the pesticide label.

Acidifying Agent: Highly alkaline water (pH 8 or higher) 8 to 16 ounces per 100 gallons of spray mixture.
Mildly alkaline/acid water (pH 6.5 to 8) 4 to 8 ounces per 100 gallons of spray mixture.

NOTE: LI 700 is an acidifier and may be physically or chemically incompatible with alkaline spray materials.

General Use: Herbicides (terrestrial or aquatic), Defoliants, Desiccants:
1 to 4 pints per 100 gallons of spray mixture when used as a penetrant.
12 ounces to 2 pints per acre when used in place of crop oil concentrates.

Insecticides, Fungicides, Acaracides, Plant Growth Regulators, Foliar Nutrients:
1/2 to 2 pints per 100 gallons of spray mixture.

Drift Reduction: 1 to 2 quarts per 100 gallons of spray mixture.

Non Crop Sites: 1 to 8 pints per 100 gallons (1 to 6 fluid ounces per 5 gallons) of spray mixture.

Turf and Ornamentals: 1 to 4 pints per 100 gallons (1 to 3 fluid ounces per 5 gallons) of spray mixture.

Note: This product has demonstrated excellent plant safety; however, not all species of ornamentals have been tested. Before treating a large area, test on a small area and observe prior to full-scale application.

Storage: Suggested storage above 40°F. If frozen, warm product before use. Store in cool, dry place. Store in original container. Keep tightly closed. Do not reuse empty container.

Disposal: Do not contaminate water, food or feed by storage or disposal. Wastes may be disposed of on-site or at an approved waste disposal facility. Triple rinse (or equivalent) adding rinse water to spray tank. Offer container for recycling or dispose of container in sanitary landfill, or by other procedures approved by appropriate authorities.

NOTICE: IT IS IMPOSSIBLE TO ELIMINATE ALL RISKS INHERENTLY ASSOCIATED WITH THE USE OF THIS PRODUCT. CROP INJURY, INEFFECTIVENESS, OR OTHER UNINTENDED CONSEQUENCES MAY RESULT BECAUSE OF SUCH FACTORS AS WEATHER CONDITIONS, PRESENCE OF OTHER MATERIALS, OR THE MANNER OF USE OR APPLICATION, ALL OF WHICH ARE BEYOND THE CONTROL OF LOVELAND, THE MANUFACTURER OR SELLER. IN NO CASE SHALL LOVELAND, THE MANUFACTURER OR SELLER BE LIABLE FOR CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT. ALL SUCH RISKS SHALL BE ASSUMED BY THE BUYER.
EXCEPT AS EXPRESSLY PROVIDED HEREIN, LOVELAND, THE MANUFACTURER OR SELLER MAKES NO WARRANTIES, GUARANTEES, OR REPRESENTATIONS OF ANY KIND, EITHER EXPRESS OR IMPLIED, OR BY USAGE OF TRADE, STATUTORY OR OTHERWISE, WITH REGARD TO THE PRODUCT SOLD, INCLUDING, BUT NOT LIMITED TO, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, USE OR ELIGIBILITY OF THE PRODUCT FOR ANY PARTICULAR TRADE USAGE. BUYER'S OR USER'S EXCLUSIVE REMEDY, AND LOVELAND'S, THE MANUFACTURER'S OR SELLER'S TOTAL LIABILITY, SHALL BE FOR DAMAGES NOT EXCEEDING THE COST OF THE PRODUCT.

MATERIAL SAFETY DATA SHEET LI 700

FOR CHEMICAL EMERGENCY, SPILL, LEAK, FIRE OR ACCIDENT, CALL CHEMTREC - DAY OR NIGHT 1-800-424-9300
For Exposure or Medical Emergencies, call 1-800-228-5635 extension 136

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

FORMULATED FOR:
Loveland Industries, Inc.
PO Box 1289
Greeley, CO 80632

24 Hour Emergency Phone:
1-800-424-9300
Medical Emergencies
1-800-228-5635 ext. 136

PRODUCT NAME: LI 700
CHEMICAL NAME: Mixture of Lecithin, propionic acid, surfactant (liquid detergent) and water
CHEMICAL FAMILY: Mixture of Surfactants (liquid detergent)

Date of issue: 05/01/2000 Supersedes: 05/19/94

2. COMPOSITION, INFORMATION ON INGREDIENTS

Component:	Percentage	TLV (Units)
Propionic Acid (CAS # 79-09-4)	35	ACGIH 10 ppm/TWA 15 ppm/15 min STEL
Other Ingredients	65	None established – Not listed as hazardous components

3. HAZARDS IDENTIFICATION SUMMARY

DANGER: LIQUID CAUSES SKIN AND EYE INJURY. KEEP OUT OF REACH OF CHILDREN.

Li 700 is a non-ionic, low foam surfactant. This product is a dark brown liquid, with a vinegar-like odor.

Primary routes of entry: Eyes, inhalation and skin contact. See Section 8 for Proper Personal Protective Equipment

4. FIRST AID MEASURES

Eyes: Flush eyes with water for 15 minutes, get medial attention.
Skin: Wash with soap and water, remove contaminated clothing. Get medical attention.
Inhalation: Remove victim to fresh air. If victim has difficulty breathing, seek medical attention.
Ingestion: Drink 2 glasses of water, induce vomiting. Call a physician immediately.

5. FIRE FIGHTING MEASURES

FLASH POINT (ºF/Test method): > 210 (T.C.C.)
FLAMMABLE LIMITS(LEL & UEL): None established
EXTINGUISHING MEDIA : Carbon dioxide, dry chemical and water spray
SPECIAL FIRE FIGHTING PROCEDURES: Wear a positive pressure self-contained breathing apparatus with proper protective gear.
UNUSAL FIRE AND EXPOSION HAZARD; None

6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Use proper protection equipment, see section 8. Pick up the material with absorbent material and place in a container for proper disposal in accordance with local, state and federal regulations.

7. HANDLING AND STORAGE

PRECAUTIONS: Keep out of reach of children. This material may cause skin and eye injury. Store in a cool dry place. Keep unused material in original container, do not reuse the empty container.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION EQUIPMENT

ENGINEERING CONTROLS: Work in well-ventilated area, local exhaust may be required if working in confined space.

RESPIRTORY PROTECTION: Wear NIOSH/MSHA approved respirator for pesticide handling.
PROTECTIVE GLOVES: Wear rubber or impervious gloves.
EYE PROTECTION: Wear safety goggles or a face shield.
OTHER PROTECTION: Long sleeved shirt, long pants, shoes with socks.

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AND ODOR: A dark brown liquid with vinegar like odor
SOLUBLE IN WATER: Miscible, forms emulsion
BULK DENSITY: 8.58 lbs./gal
SPECIFIC GRAVITY (Water 1.0): 1.03 grams/ ml
pH: (neat) 3.0

10. STABILITY AND REACTIVITY

STABILITY: Stable
INCOMPATIBILITY(Materials to avoid): Strong oxidizers
HAZARDOUS POLYMERIZATION: Will not occur
CONDITIONS TO AVOID: High alkaline conditions
HAZARDOUS DECOMPOSITION PRODUCTS: None known

11. TOXICOLOGICAL INFORMATION

Primary Eye and Dermal irritation studies indicate skin and eye injury may occur from contact with undiluted product.
Acute Oral - LD_{50} is > 5.0 g/kg.
Acute Dermal - LD_{50} is > 5.0 g/kg.
Acute Inhalation - LC_{50} is > 6.04 mg/L.

12. ECOLOGICAL INFORMATION

Aquatic Acute Toxicity - Material will form emulsion with water.

	24 HR LC50	48 HR LC50	96 HR LC50	96 HR No Effect
Rainbow Trout	140 mg / L	130 mg / L	130 mg / L	< 100 mg / L
Bluegill Sunfish	220 mg / L	210 mg / L	210 mg / L	100 mg / L
				48 HR No Effect
Daphnia Magna	450 mg / L	170 mg / L		100 mg / L

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: Do not contaminate water, food or feed by disposal or storage. Dispose of in an approved waste disposal facility in accordance with local, state and federal regulations.

CONTAINER DISPOSAL: Triple rinse adding rinse water to spray tank. Offer containers for recycling or dispose of in an approved landfill.

14. TRANSPORT INFORMATION

This material is not regulated by US DOT for highway transportation.

15. REGULATORY INFORMATION

SARA Hazard Notification/Reporting: None
California Proposition 65: This product does not contain any components that are regulated.

SARA TITLE III Hazard Category:

Immediate	YES	Fire	NO	Sudden Release of Pressure	NO
Delayed	NO	Reactive	NO	Extremely Hazardous Substance	NO

16. OTHER INFORMATION

NFPA / HMISHazard Rating:

0 None		
1 Slight	2	**Health**
2 Moderate	0	**Flammability**
3 High	1	**Reactivity**
4 Severe		

Reviewed by: Environmental/Regulatory Services
Prepared by:

Blazon®

SPRAY PATTERN INDICATOR

Unique Features

- **Colorant** - Blazon® is a water soluble polymeric colorant, not a dye – it is *NON- STAINING* to skin, clothing and equipment.
- **Inert** - Pesticides are active at very low rates, and even a small amount of interference from a dye could affect the entire application. Blazon® is an inert product at all pH's and has been university tested to prove compatibility.
- **No heavy metals** - Blazon®'s unique manufacturing process does not require the use of heavy metals. None are used so there are none in the final product.
- **Highly visible** - The product is designed to be discreet but highly visible to the trained eye. Even on thick foliage or bare ground, the evidence of chemical application is provided by the bright colorant.

Directions for Use

- Application rates will vary due to: turf or vegetation type, cut height, color & density; the color of other spray solution components; spray nozzle type, configuration & pressure; total volume of spray solution per acre (>85 gal./acre may require a higher application rate).
- Initial applications should be made at the highest rates. This allows the operator to become familiar with Blazon®'s appearance on the turf. In subsequent applications, the Blazon® rate should be adjusted to a level appropriate for the individual operator.
- Blazon® may be added anytime during the spray tank filling process. Minimum agitation is required. Blazon® may be applied from a separate container.

General Use Precautions

- Individual operators perceive color differently - adjustments to the above rates may be necessary.
- Use caution before a general application of Blazon® near porous surfaces (e.g. - concrete, rocks, stonework, bricks).
- Decolorization may be obtained by applying a bleach solution (1 part bleach/2 parts water).
- Do not handle the E-Z Pak™ with wet gloves. If E-Z Pak™ does get wet, immediately place in spray tank or mixing container. Always use the appropriate protective equipment when handling chemicals.
- **Not intended for application to edible crops.**

Health Safety & First Aid Information

Effects of overexposure may cause slight eye and skin irritation. In case of contact, flush with water. For additional information, see MSDS.

Transportation, Storage and Disposal

- **Transportation** - Blazon® is a non-hazardous chemical. Not regulated by the U.S. Department of Transportation.
- **Storage** - Store in original container only and keep sealed. Store in secured storage areas. Use caution when moving, opening, closing or pouring.
- **Product Disposal** -- Wastes resulting from use of this product should be disposed of through on-site spray application or at an approved waste disposal facility.
- **Container Disposal** - Triple rinse, then offer for recycling or reconditioning, dispose of in a sanitary landfill, or follow other procedures approved by federal, state and local authorities. Re-use of this container is not recommended.

According to the Office of Pesticides and Toxic Substances of the U.S. E.PA., no clearance is required under 40 CFR 180.1001 for use on non-crop vegetation. Not approved for edible crop use. The information contained herein is provided for the purpose of disclosing product application and does not constitute product specifications regarding which, if any, warranties are expressed or implied.

MILLIKEN
TURF PRODUCTS

Milliken Chemical, Division of Milliken & Company, M-402
P. O. Box 1927, Spartanburg, SC 29304
800-845-8502 or 864-503-6171, Fax: 864-503-6186

rev. 11/01 #190-01

Blazon®

SPRAY PATTERN INDICATOR

General Product Description

Blazon® Spray Pattern Indicator is a non-staining blue liquid colorant designed to be used with pesticide, fertilizer and/or plant growth regulator tank mixes. Blazon® provides visual assurance that these solutions are uniformly applied, with minimum overlap and no missed areas. Blazon® helps to alert the operator to improper equipment operation - the blue color immediately indicates line and/or connection leaks and clogged nozzles. Blazon® is an excellent safety tool - the blue color provides real time feedback in the event of operator exposure to the solution.

Blazon®:

- is a blue liquid, containing 100% non-ionic polymeric colorant
- is patented, non-staining colorant technology
- is non-hazardous
- is ***not*** a dye, and will not permanently stain skin

Package Availability

PRODUCT NAME	CONTAINER	NET CONTENTS
Blazon® Blue	2 x 2.5 gal. cont./cs.	40 lbs/case
Blazon® Blue	55 gal. drum	440 lbs/drum
Blazon® E-Z Pak™	Case	50 water soluble packets/case

Product Characteristics

- pH: 7.0
- Freeze/Thaw Stability: Excellent
- Shelf Stability: Excellent
- Solubility in Water: Complete

Recommended Application Guidelines and Rates

Experience will be the best determinant of the rates required for your application, but the following rates are typically used:

EQUIPMENT	APPLICATION	RATE
Boom	Dormant turf, greens, short cut fairways	8-14oz./acre
	Longer cut fairways, roughs	16-24oz./acre
Hand Gun	High volume applications (>2 gal. /1000 sq. ft.)	24-32oz./acre
	Low volume applications (1-2 gal. /1000 sq. ft.)	18-24oz./acre
Back Pack	Spot spraying or small area coverage w/ mini boom	One oz./gallon of solution

Blazon® E-Z Pak™ Application Rate

Boom or Hand Gun	Dormant turf, greens, fairways, roughs	1 packet per 25 gal. of solution

Your rates may vary based on conditions in your area. Therefore, it is recommended that you begin at the higher rates and reduce with each successive tank to a color that is just visible to the applicator. Fill tank halfway, then add the color. Minimal agitation is required. Avoid contact or spills with the concentrate as it is a highly colored solution.

MILLIKEN
TURF PRODUCTS

Milliken Chemical, Division of Milliken & Company, M-402
P. O. Box 1927, Spartanburg, SC 29304
800-845-8502 or 864-503-6171, Fax: 864-503-6186

MATERIAL SAFETY DATA SHEET

Responsible Care® Good Chemistry at Work

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Identification
Product Name: Blazon® Blue Spray Pattern Indicator
Chemical Family: Polymeric Colorant
CAS Number: Proprietary

Company Identification
Milliken Chemical
P.O. Box 817
1440 Campton Road
Inman, SC 29349 USA
1-864-472-9041 (For questions and emergencies)
1-800-424-9300 or 1-703-527-3887 (CHEMTREC)

MILLIKEN CHEMICAL

PRODUCT USE:
Colorant.

2. COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENT LISTING:

Chemical Name	Amount	CAS Number
WATER	70.0 %	7732-18-5
PROPRIETARY COLORANT	30.0 %	Proprietary

(See Section 8 for exposure guidelines)

(See Section 15 for regulatory information)

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:
The health hazards of this product should be low under normal industrial and commercial uses. May cause skin or eye irritation after repeated or prolonged contact. This material is a concentrated colorant.

HMIS Rating:
Health - 0
Flammability - 0
Reactivity - 0
Personal Protection Index - B

NFPA Rating:
Health - 0
Flammability - 0
Reactivity - 0
Special Hazard - None

POTENTIAL HEALTH EFFECTS

UNCONTROLLED DOCUMENT

EYE:
Not an eye irritant. No hazards expected in normal industrial use at room temperature.

SKIN:
Prolonged or repeated skin contact may cause irritation. No hazards expected in normal industrial use at room temperature.

INHALATION:
No information regarding inhalation available. No known hazards in normal industrial use.

INGESTION:
Essentially non-toxic. No hazards expected in normal industrial use.

4. FIRST AID MEASURES

EYE CONTACT FIRST AID:
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists.

SKIN CONTACT FIRST AID:
Wash affected area with large amounts of soap and water. Get medical attention if irritation develops or persists.

INHALATION FIRST AID:
Although this product is not known to cause respiratory problems, if breathing is difficult, remove to fresh air and provide oxygen. Get medical attention if cough or other symptoms develop.

INGESTION FIRST AID:
If swallowed, immediately give 2 glasses of water. Never give anything by mouth to an unconscious person. Contact a physician.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES
COC Flash Point: > 260.0 C (> 500.0 F)
Autoignition Temperature: N/A

FLAMMABLE LIMITS IN AIR
LEL: N/A
UEL: N/A

EXTINGUISHING MEDIA:
Water, carbon dioxide, foam or dry powder.

FIRE & EXPLOSION HAZARDS:
No known unusual hazards in a fire/explosion situation.

FIRE FIGHTING INSTRUCTIONS:
As in any fire, wear self-contained breathing apparatus pressure-demand MSHA/NIOSH (approved or equivalent) and full protective gear. Avoid breathing smoke, fumes, and decomposition products. Contain runoff water. Contaminated extinguishing water must be disposed of in accordance with applicable regulations.

6. ACCIDENTAL RELEASE MEASURES

SPILL PROCEDURE:
This material is a concentrated colorant. Water will increase the amount of colorant contamination. Do not allow material to enter soil or surface water. Clean up area by absorbent material. Take up and place in secure closed containers. All waste materials should be packaged, labeled, and transported in accordance with all national, state/provincial, and local requirements.

INITIAL CONTAINMENT:
Do not allow material to enter soil or surface water.

7. HANDLING AND STORAGE

HANDLING (PERSONNEL):
Wash hands thoroughly after handling. Wash contaminated clothing before reuse.

HANDLING (PHYSICAL ASPECTS):
Avoid extreme temperatures. Keep container closed to avoid contamination.

STORAGE PRECAUTIONS:
Protect containers from physical damage. Do not stack drums more than three pallets high.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS:
Good general ventilation should be sufficient to control airborne levels.

EYE / FACE PROTECTION REQUIREMENTS:
Wear safety glasses. Where contact with this material is likely, chemical goggles are recommended.

SKIN PROTECTION REQUIREMENTS:
Wear protective gloves to minimize skin contamination. For brief contact, normal work attire should be sufficient. When prolonged or frequently repeated contact could occur, use protective clothing impervious to this material.

RESPIRATORY PROTECTION REQUIREMENTS:
Under normal use conditions, with adequate ventilation, no special respiratory protective equipment is required.

EXPOSURE GUIDELINES:
No Information Available.

9. PHYSICAL AND CHEMICAL PROPERTIES

FORM:	Liquid
COLOR:	Dark Blue
ODOR:	Slight, sweet odor
BOILING POINT:	215 F
VAPOR PRESSURE:	N/A mm Hg
VAPOR DENSITY:	N/A (Air = 1)
SOLUBILITY IN WATER:	Complete
SPECIFIC GRAVITY:	1.07 (Water = 1)
MELTING/FREEZING POINT:	< 32 F
PH:	Mildly acidic
% VOLATILES:	70 (approx) %

10. STABILITY AND REACTIVITY

STABILITY:
This compound is stable at ambient conditions.

POLYMERIZATION:
Hazardous polymerization will not occur.

INITIAL CONTAINMENT:
Do not allow material to enter soil or surface water.

7. HANDLING AND STORAGE

HANDLING (PERSONNEL):
Wash hands thoroughly after handling. Wash contaminated clothing before reuse.

HANDLING (PHYSICAL ASPECTS):
Avoid extreme temperatures. Keep container closed to avoid contamination.

STORAGE PRECAUTIONS:
Protect containers from physical damage. Do not stack drums more than three pallets high.

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9. PHYSICAL AND CHEMICAL PROPERTIES

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10. STABILITY AND REACTIVITY

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Hazardous polymerization will not occur.

PREPARED BY:	John Bruhnke
APPROVED BY:	Kathy Woodward
TITLE:	Environmental Specialist
APPROVAL DATE:	November 1, 1998
SUPERCEDES DATE:	May 7, 1997
MSDS NUMBER:	710190

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END OF MSDS

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EXTOXNET

Extension Toxicology Network

Toxicology Information Briefs

A Pesticide Information Project of Cooperative Extension Offices of Cornell University, Oregon State University, the University of Idaho, and the University of California at Davis and the Institute for Environmental Toxicology, Michigan State University. Major support and funding was provided by the USDA/Extension Service/National Agricultural Pesticide Impact Assessment Program.

EXTOXNET primary files maintained and archived at Oregon State University

Revised 9/93.

DOSE-RESPONSE RELATIONSHIPS IN TOXICOLOGY

"The right dose differentiates a poison and a remedy." Paracelsus

INTRODUCTION

The science of toxicology is based on the principle that there is a relationship between a toxic reaction (the response) and the amount of poison received (the dose). An important assumption in this relationship is that there is almost always a dose below which no response occurs or can be measured. A second assumption is that once a maximum response is reached any further increases in the dose will not result in any increased effect. Click here for a visual representation of the dose-response relationship.

One particular instance in which this dose-response relationship does not hold true, is in regard to true allergic reactions. Allergic reactions are special kinds of changes in the immune system; they are not really toxic responses. The difference between allergies and toxic reactions is that a toxic effect is directly the result of the toxic chemical acting on cells. Allergic responses are the result of a chemical stimulating the body to release natural chemicals which are in turn directly responsible for the effects seen. Thus, in an allergic reaction, the chemical acts merely as a trigger, not as the bullet.

For all other types of toxicity, knowing the dose-response relationship is a necessary part of understanding the cause and effect relationship between chemical exposure and illness. As Paracelsus once wrote, "The right dose differentiates a poison from a remedy." Keep in mind that the toxicity of a chemical is an inherent quality of the chemical and cannot be changed without changing the chemical to another form. The toxic effects on an organism are related to the amount of exposure.

MEASURES OF EXPOSURE

Exposure to poisons can be intentional or unintentional. The effects of exposure to poisons vary with the amount of exposure, which is another way of saying "the dose." Usually when we think of dose, we think in terms of taking one vitamin capsule a day or two aspirin every four hours, or something like that. Contamination of food or water with chemicals can also provide doses of chemicals each time we eat or drink. Some commonly used measures for expressing levels of contaminants are listed in table 1. These measures tell us how much of the chemical is in food, water or air. The amount we eat, drink, or breathe determines the actual dose we receive.

Concentrations of chemicals in the environment are most commonly expressed as ppm and ppb. Government tolerance limits for various poisons usually use these abbreviations. Remember that these are extremely small quantities. For example, if you put one teaspoon of salt in two gallons of water the resulting salt concentration would be approximately 1,000 ppm and it would not even taste salty!

Table 1. Measurements for Expressing Levels of Contaminants in Food and Water.

Dose	**Abbrev**	**Metric. equivalent**	**Abbrev.**	**Approx. amt. in water**
parts per million	ppm	milligrams per kilogram	mg/kg	1 teaspoon per 1,000 gallons
parts per billion	ppb	micrograms per kilogram	ug/kg	1 teaspoon per 1,000,000 gallons

DOSE-EFFECT RELATIONSHIPS

The dose of a poison is going to determine the degree of effect it produces. The following example illustrates this principle. Suppose ten goldfish are in a ten-gallon tank and we add one ounce of 100-proof whiskey to the water every five minutes until all the fish get drunk and swim upside down. Probably none would swim upside down after the first two or three shots. After four or five, a very sensitive fish might. After six or eight shots another one or two might. With a dose of ten shots, five of the ten fish might be swimming upside down. After fifteen shots, there might be only one fish swimming properly and it too would turn over after seventeen or eighteen shots.

The effect measured in this example is swimming upside down. Individual sensitivity to alcohol varies, as does individual sensitivity to other poisons. There is a dose level at which none of the fish swim upside down (no observed effect). There is also a dose level at which all of the fish swim upside down. The dose level at which 50 percent of the fish have turned over is known as the ED50, which means effective dose for 50 percent of the fish tested. The ED50 of any poison varies depending on the effect measured. In general, the less severe the effect measured, the lower the ED50 for that particular effect. Obviously poisons are not tested in humans in such a fashion. Instead, animals are used to predict the toxicity that may occur in humans.

One of the more commonly used measures of toxicity is the LD50. The LD50 (the lethal dose for 50 percent of the animals tested) of a poison is usually expressed in milligrams of chemical per kilogram of body weight (mg/kg). A chemical with a small LD50 (like 5 mg/kg) is very highly toxic. A chemical with a large LD50 (1,000 to 5,000 mg/kg) is practically non-toxic. The LD50 says nothing about non-lethal toxic effects though. A chemical may have a large LD50, but may produce illness at very small exposure levels.

It is incorrect to say that chemicals with small LD50s are more dangerous than chemicals with large LD50s, they are simply more toxic. The danger, or risk of adverse effect of chemicals, is mostly determined by how they are used, not by the inherent toxicity of the chemical itself.

The LD50s of different poisons may be easily compared; however, it is always necessary to know which species was used for the tests and how the poison was administered (the route of exposure), since the LD50 of a poison may vary considerably based on the species of animal and the way exposure occurs. Some poisons may be extremely toxic if swallowed (oral exposure) and not very toxic at all if splashed on the skin (dermal exposure). If the oral LD50 of a poison were 10 mg/kg, 50 percent of the animals who swallowed 10 mg/kg would be expected to die and 50 percent to live. The LD50 is determined mathematically, and in actual tests using the LD50, it would be unusual to get an exact 50% response. One test might produce 30% mortality and another might produce 70% mortality. Averaged out over many tests, the numbers would approach 50%, if the original LD50 determination was valid.

The potency of a poison is a measure of its strength compared to other poisons. The more potent the poison, the less it takes to kill; the less potent the poison, the more it takes to kill. The potencies of poisons are often compared using signal words or categories as shown in the example in table 2.

The designation toxic dose (TD) is used to indicate the dose (exposure) that will produce signs of toxicity in a certain percentage of animals. The TD50 is the toxic dose for 50 percent of the animals tested. The larger the TD the more poison it takes to produce signs of toxicity. The toxic dose does not give anyinformation about the lethal dose because toxic effects (for example, nausea and vomiting) may not be directly related to the way that the chemical causes death. The toxicity of a chemical is an inherent property of the chemical itself. It is also true that chemicals can cause different types of toxic effects, at different dose levels, depending on the animal species tested. For this reason, when using the toxic dose designation it is useful to precisely define the type of toxicity measured, the animal species tested, and the dose and route of administration.

Table 2. Toxicity Rating Scale and Labeling Requirements for Pesticides.

Category	**Signal word required on label**	**LD50 oral mg/kg(ppm)**	**LD50 dermal mg/kg(ppm)**	**Probable oral lethal dose**
I highly toxic	DANGER-POISON (skull and crossbones)	less than 50	less than 200	a few drops to a teaspoon
II moderately toxic	WARNING	51 to 500	200 to 2,000	over 1 teaspoon to 1 ounce
III slightly toxic	CAUTION	over 500	over 2,000	over 1 ounce
IV practically non-toxic	none required			

Toxicity assessment is quite complex, many factors can affect the results of toxicity tests. Some of these factors include variables like temperature, food, light, and stressful environmental conditions. Other factors related to the animal itself include age, sex, health, and hormonal status.

The NOEL (no observable effect level) is the highest dose or exposure level of a poison that produces no noticeable toxic effect on animals. From our previous fish example, we know that there is a dose below which no effect is seen. In toxicology, residue tolerance levels of poisons that are permitted in food or in drinking water, for instance, are usually set from 100 to 1,000 times less than the NOEL to provide a wide margin of safety for humans.

The TLV (threshold limit value) for a chemical is the airborne concentration of the chemical (expressed in ppm) that produces no adverse effects in workers exposed for eight hours per day five days per week. The TLV is usually set to prevent minor toxic effects like skin or eye irritation.

Very often people compare poisons based on their LD50's and base decisions about the safety of a chemical based on this number. This is an over-simplified approach to comparing chemicals because the LD50 is simply one point on the dose-response curve that reflects the potential of the compound to cause death. What is more important in assessing chemical safety is the threshold dose, and the slope of the dose-response curve, which shows how fast the response increases as the dose increases. Figure 1 shows examples of dose-response curves for two different chemicals which have the same LD50. Which of these chemicals is more toxic? Answer this question for doses below the LD50 and it is chemical A which is more toxic, at the LD50 they are the same, and above the LD50, chemical B is more toxic. While the LD50 can provide some useful information, it is of limited value in risk assessment because the LD50 only reflects information about the lethal effects of the chemical. It is quite possible that a chemical will produce a very undesirable toxic effect (such as reproductive toxicity or birth defects) at doses which cause no deaths at all.

A true assessment of chemical toxicity involves comparisons of numerous dose-response curves covering many different types of toxic effects. The determination of which pesticides will be Restricted Use Pesticides involves this approach. Some Restricted Use Pesticides have very large LD50s (low acute oral toxicity), however, they may be very strong skin or eye irritants and thus require special handling.

The knowledge gained from dose-response studies in animals is used to set standards for human exposure and the amount of chemical residue that is allowed in the environment. As mentioned previously, numerous dose-response relationships must be determined, in many different species. Without this information, it is impossible to accurately predict the health risks associated with chemical exposure. With adequate information, we can make informed decisions about chemical exposure and work to minimize the risk to human health and the environment.

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RISK ASSESSMENT BACKGROUND

For most of human history, concern about the toxic effects of chemicals has been focused on poisons which act quickly and result in death. A well known example is hemlock, which was ingested by Socrates to commit suicide. Until recently, exposure to these chemicals was not common and the risks were well known so there was little public concern about these poisons.

In this century, however, people have become increasingly concerned with poisons, including those that cause adverse effects only after long periods of exposure. There are two main reasons for this change. One is that the average human life span has increased tremendously due to cures and treatments for infectious diseases. This longer lifespan has made chronic non-infectious illness more common. The second is that the industrial revolution has led to new and increased uses of known chemicals and the synthesis and widespread use of newly developed compounds. This tremendous increase in both the quantity and variety of chemical use has led to greater awareness of possible health effects of industrial products.

RISK ASSESSMENT

One result of this attention was the establishment of the Environmental Protection Agency in 1970 and the enactment of new legislation during the 1970s to regulate chemicals in the environment. With the passage of these new laws, an important problem was how to evaluate the severity of the threat that each toxic chemical posed under the conditions of use. This evaluation is known as risk assessment, and is based on the capacity of a chemical to cause harm (its toxicity), and the potential for humans to be exposed to that chemical in a particular situation; for example, workplace or home.

Risk assessment was not new in the 1970s. The safety of our food supply has been investigated since early in the 20th century. In addition, scientists in industrial toxicology laboratories had been evaluating the toxic properties of potential products as early as the

1930s. Toxic side effects of drugs had long been of concern and received increased attention in the early 1960s after the discovery that severe birth defects resulted from ingestion of a seemingly safe drug, Thalidomide. During the 1970s risk assessment procedures for all chemicals were reevaluated, improved, and more importantly, formalized. Standardized tests were developed so consistent evaluations could be performed and the scientific basis of regulations could be more easily applied.

During this time of change, the term "risk assessment" took on a variety of meanings. However, its definition is made up of two components: toxicity (dose-response assessment) and exposure assessment. The former is a measure of the extent and type of negative effects associated with a particular level of exposure and the latter is a measure of the extent and duration of exposure to an individual or population. For example, characterizing the risk of a pesticide to applicators requires knowing exactly what dose (amount) of this pesticide causes what effects (dose-response assessment) and what dose workers are exposed to (exposure assessment).

Sometimes, this distinction between an exposure assessment and a dose-response assessment is forgotten and conclusions are drawn without any measures of exposure having been made. For example, dioxin is often referred to as the most toxic man-made chemical known based on dose-response data and thus, is taken to mean that it poses the greatest risk to society. This is not the case because the potential for exposure is usually very small.

EXPOSURE ASSESSMENT

How can exposure assessment be accomplished? There are three basic approaches: analysis of the source of exposure (i.e., levels in drinking water or workplace air), measurements of the environment (i.e., human blood and urine levels), and laboratory tests; for example, blood or urine of the people thought to be exposed. Analyses of air or water often provide the majority of usable information. These tests reveal the level of contamination in the air or water to which people are exposed. However, they only reflect concentration at the time of testing and generally can not be used to quantify either the type or amount of past contamination. Some estimates of past exposures may be gained from understanding how a chemical moves in the environment.

Some other types of environmental measurements may be helpful in estimating past exposure levels. For example, analyses of fish or lake sediments can provide measures of the amounts of persistent chemicals which are and were present in the water. Past levels of a persistent chemical can be estimated using the age and size of the fish, and information about how rapidly these organisms accumulate the chemical.

Analyses of body fluid levels of possibly exposed people provide the most direct exposure measure. However, they do not provide good estimates of past exposure levels because the body usually reaches a balanced state so there is no longer any change in response to continued exposure; many chemicals are excreted from the body after exposure stops; and basic understanding of what happens to chemicals in the human body is often lacking for those that do persist. Thus, direct examination of a population may provide information as to whether or not exposure has occurred but not the extent, duration or source of the exposure.

Overall, exposure assessments can be performed most reliably for recent events and much less reliably for past exposures. The difficulties in exposure assessment often make it the weak link in trying to determine the connection between an environmental contaminant and adverse effects on human health. Although exposure assessment methods will undoubtedly improve, there remains significant uncertainty in the foreseeable future.

DOSE-RESPONSE ASSESSMENT

Turning to the dose-response assessment, a distinction must be made between acute and chronic effects. Acute effects occur within minutes, hours or days while chronic effects appear only after weeks, months or years. The quality and quantity of scientific evidence gathered is different for each type of effect and, as a result, the confidence placed in the conclusions from the test results are also different.

Acute toxicity is easiest to deal with. Short-term studies with animals provide evidence as to which effects are linked with which chemicals and the levels at which these adverse effects occur. Often, some human experience is available as a result of accidental exposures. When these two types of evidence are available, it is usually possible to make a good estimate of the levels of a particular toxicant that will lead to a particular acute adverse effect in humans. This approach is the basis for much of the current regulation of toxic substances, especially in occupational situations.

Chronic toxicity is much more difficult to assess. There are a variety of specific tests for adverse effects such as reproductive damage, behavioral effects, cancer, etc. It is not possible to discuss all of these, but a look at cancer assessment will reveal some of the problems inherent in long-term toxicity assessments and also focus on the health effect which seems to be of most public concern.

In cancer assessment, it is not only the chronic nature of the disease but also the low incidence which is of concern, that causes difficulty. Society has decided that no more than one additional cancer in 100,000 or one million people is acceptable, so assessment measures must be able to detect this small increase. Two types of evidence are utilized to determine the dose of chemical that will result in this change. One is based on experiments on animals and the other is based on experience with humans.

Ideally, to detect an increase of one cancer in a million animals, millions of animals would have to be exposed to environmentally relevant amounts of the chemical. However, there are neither the scientific nor the economic resources to carry out this type of study. Thus, investigations are performed on smaller numbers of animals (a few hundred) who have been exposed to very large amounts of a chemical. These large amounts are necessary to produce a high enough incidence of cancer to be detectable in this small population. Thus, the results of such studies indicate the levels of a chemical that will cause cancer in a high percentage of the population.

How can this information be used to assess the level of chemical that will cause one additional cancer in a million animals or, more importantly, in a million humans? Because our basic understanding is limited, mathematical models must be used to predict this level. There are a variety of possible models and the one generally chosen is that which provides the greatest margin of safety; for example, which overestimates rather than underestimates the ability of the chemical to cause cancer.

The other type of evidence utilized in chronic toxicity assessment is human experience, better known as epidemiological evidence. In this type of study, human populations are carefully observed and possible associations between specific chemical exposures and particular health effects are investigated. Considering the previous discussion about exposure assessment, it should be clear that this is not an easy task. It is made even more difficult in cancer assessment by the requirement of detecting very small changes in incidence; for example, one extra cancer in a million people.

As a result, epidemiological assessments have been most useful in only certain situations. One is exposure in the workplace, a place where levels are usually above environmental ones and where the duration of exposure can be determined. Even there, a sizable increase in cancer incidence is needed before a connection can be established. The conclusion that asbestos causes lung cancer is based on this type of situation. An exception to the need for a high cancer incidence is the situation where the effect is unique so that even a few cases are significant. An example of this was the observation that a small number of vinyl chloride workers developed a rare form of liver cancer. However, even with known occupational carcinogens, the question of what happens at low exposures, for example, common environmental ones, has not been answered.

Thus, the techniques available for assessment of chronic toxicity, especially carcinogenicity, provide rather clear evidence as to whether or not a particular chemical causes a particular effect in animals. However, there is great uncertainty about the amounts needed to produce small changes in cancer incidence in humans. This uncertainty, together with the difficulties in exposure assessment, make it difficult to draw definite conclusions about the relationship between most environmental exposures and chronic health effects.

SUMMARY

Risk assessment is a complex process which depends on the quality of scientific information that is available. It is best for assessing acute risks where effects appear soon after exposure occurs. Uncertainty becomes greater, the longer the period of time between exposure and appearance of symptoms. This is due to greatly increased uncertainties in exposure assessment and also the problems involved in using epidemiological or laboratory animal results in such cases. In many circumstances, these uncertainties make it impossible to come to any firm conclusions about risk. Thus, risk assessment is a process which is often useful but cannot always provide the answers that are needed.

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Appendix F
Sensitive Species Table

Appendix F

Special Status Species Potentially Occurring in the Project Area

(page 1 of 4)

Common Name	*Legal or Conservation Status*	*Typical Habitat and Regional Distribution*
Mammals		
Salt marsh harvest mouse (*Reithrodontomys raviventris)*	FE/SE	Salt marsh and brackish marsh (both non-tidal and tidal) with perennial pickleweed and associated salt-tolerant low-growing subshrubs and herbs; most frequent in dense, continuous vegetation cover with infrequent and brief flooding, and ample flood escape habitat. Does not occur in cordgrass. San Francisco Bay (southern subspecies), San Pablo Bay, Suisun Bay (northern subspecies)
Salt marsh wandering shrew *(Sorex vagrans halicoetes)*	FSC/CSC	Tidal salt marsh plains above cordgrass zone, moist, lower pickleweed-dominated marsh, with abundant invertebrates, tidal debris, and flood escape habitat. South San Francisco Bay.
Southern sea otter (*Enhydra lutris nereis*)	FE/SE	Near-shore marine and estuarine waters; historic inhabitants of San Francisco Bay, now vagrants.
Suisun ornate shrew *(Sorex ornatus sinuosus)*	FSC/CSC	Tidal brackish marsh plains with dense cover, moist substrate, abundant invertebrates, tidal debris, and ample flood escape habitat. Suisun Marsh and marshes along the north shore of San Pablo Bay.
Harbor seal (*Phoca vitulina richardi*)	MMPA	Sloughs, open bay, and haul-outs on tidal marshes, islands, or beaches, San Francisco Bay and San Pablo Bay, occasional to Napa River
Birds		
Alameda song sparrow *(Melospiza melodia pusilla)*	FSC/CSC	Tidal salt and brackish marshes, San Francisco Bay.
California black rail *Laterallus jamaicensis coturniculus)*	FSC/SE	Coastal salt, brackish, and freshwater marshes, usually brackish marshes with tall grass-like emergent marsh vegetation along channels and pickleweed associations on the marsh plain. Suisun Bay and San Pablo Bay, formerly San Francisco Bay (presumed extirpated).
California clapper rail *(Rallus longirostris obsoletus)*	FE/SE	Tidal salt and brackish marshes; most abundant in cordgrass-pickleweed salt marsh with abundant small channels, dense vegetation, and ample flood escape cover. San Francisco Bay, San Pablo Bay, and western Suisun Marsh.
California least tern *(Sterna antillarum browni)*	FE/SE	In San Francisco Bay, forages over open shallow water of bays, salt ponds; roosts and nests on barren levees, and dry salt ponds, and derelict paved areas. Naturally roosts and nests on undisturbed beaches.
California brown pelican *(Pelecanus occidentalis californicus)*	FE/SE	Open bays and ocean; occasional in San Francisco Bay.
Salt marsh common yellowthroat *(Geothylpis trichas sinuosa)*	FSC/CSC	Tidal brackish and salt marsh, non-tidal freshwater riparian woodland, freshwater marsh, throughout San Francisco Estuary
San Pablo song sparrow *(Melospiza melodia samuelis)*	FSC/CSC	Tidal brackish or salt marshes, San Pablo Bay.
Suisun song sparrow *(Melospiza melodia maxillaris)*	FSC/CSC	Tidal brackish marshes, Suisun Bay
Western snowy plover *(Charadrius alexandrinus nivosus)*	FT/CSC	In the San Francisco Estuary, salt pond levees and exposed, emergent salt pond beds (playa-like habitat), San Francisco Bay; rare in San Pablo Bay. Typical coastal habitat is on wide, sandy beaches with scattered debris.

Reptiles and Amphibians		
California red-legged frog (*Rana aurora draytoni)*	FT/ CSC	In the San Francisco Bay region, freshwater to fresh-brackish marshes, ponds, lagoons, riparian woodland, streams; also estivates in terrestrial grassland or scrub. Does not occur in tidal salt or brackish marsh in San Francisco Bay, but may occur in tributaries; possible in fresher reaches of Napa or Petaluma River tidal marshes, but not documented.
San Francisco garter snake *(Thamnophis sirtalis tetrataenia)*	FE/SE	Near or in freshwater marshes and ponds with ample prey (tree frogs, red-legged frogs); estivates in terrestrial grassland or scrub. Population nearest San Francisco Bay is west of the San Francisco International Airport.
Northwestern pond turtle *(Clemmys marmorata marmorata)*	FSC/CSC	Fresh to fresh-brackish ponds, marshes, and riparian woodland with shallow, warm water, basking sites, ample invertebrate prey. In the San Francisco Estuary, tidal sloughs of Suisun Marsh, fresh-brackish reaches of Petaluma and Napa Rivers; doubtful in South San Francisco Bay tidal marshes.
Fish		
Coho salmon *(Oncorhynchus kisutch)*	FT/	Historically known from San Pablo Bay tributaries; rare in San Francisco Estuary and tributaries.
Delta smelt *(Hypomesus transpacificus)*	FT/ST	San Pablo and Suisun Bays, in tidal marsh creeks and shallow open water of sloughs and bays. Spawn in fresh-brackish to fresh tidal sloughs, and non-tidal rivers.
Green sturgeon *(Acipenser medirostris)*	FPT/CSC	California coast; in San Francisco Estuary, spawn in Sacramento River/Delta, forage throughout range.
Longfin smelt *(Spirinchus thaleichthys)*	FSC/ CSC	Sacramento-San Joaquin Rivers, Delta and northern San Francisco Estuary (San Pablo and Suisun Bay, tidal sloughs and open shallow water)
Pacific lamprey *(Lampetra tridentata)*	FSC/	San Francisco Estuary, Sacramento-San Joaquin Rivers/Delta serve as a migration corridor
River lamprey *(Lampetra ayresi)*	FSC/	San Francisco Estuary, Sacramento-San Joaquin Rivers/Delta serve as a migration corridor
Sacramento splittail (*Pogonichthys macrolepidotus)*	FT/CSC	San Francisco Estuary, Sacramento-San Joaquin Rivers/Delta, northern San Francisco Estuary (San Pablo and Suisun Bay, tidal sloughs and open shallow water)
Steelhead trout (coastal central California and Central Valley populations) *(Oncorhynchus mykiss)*	FT/	Central California coastal streams, including many tributaries of the San Francisco Estuary, Sacramento-San Joaquin Rivers, Delta
Tidewater goby (*Eucyclogobius newberryi)*	FE/CSC	Coastal lagoons behind barrier beaches, shallow and low-energy estuarine subtidal habitats, Del Norte to San Diego counties; disperse in near-shore marine waters. Historic records in San Francisco Bay, no recent surveys or records.
Spring-run chinook salmon *(Oncorhynchus tshawytscha)*	FT/ST	San Francisco Estuary, Sacramento-San Joaquin Delta, and tributaries serve as migratory corridors; spawning habitat in upstream reaches of Sacramento River tributaries.
Fall/late fall-run chinook salmon *(Oncorhynchus tshawytscha)*	FSC/	San Francisco Estuary, Sacramento-San Joaquin Delta, and tributaries serve as migratory corridors; spawning habitat in upstream reaches of Sacramento River tributaries.
Winter-run chinook salmon *(Oncorhynchus tshawytscha)*	FE/SE	San Francisco Estuary, Sacramento-San Joaquin Delta, and tributaries serve as migratory corridors; spawning habitat in upstream reaches of Sacramento River tributaries; Sacramento River to Golden Gate identified as critical habitat.

Invertebrates		
Tiger beetles (*Cicendela senilis senilis*) (*C. oregona*) (*C. haemmoragica*)	FSC/--	Mostly maritime coastal distribution, beach and coastal flats and marshes; within San Francisco Estuary, typical habitats include bare upper channel banks, margins of salt pans, unvegetated artificial levees, estuarine beaches.
Plants		
Alkali milk-vetch *(Astragalus tener* var. *tener)*	FSC/CSC/1B	Alluvial seasonally wet grasslands, alkali or sub-saline vernal pools marginal to the San Francisco Estuary; not known to occur within modern tidal marshes, but present in some diked baylands. Historic bay margin locality records from Berkeley, Oakland, Mt. Eden (Hayward), Alameda, Newark, Union City; modern records from Warm Springs (Fremont), Napa, and Montezuma Wetlands site.
Brittlescale *(Atriplex depressa)*	FSC/CSC/1B	Diked baylands, northeastern San Francisco Estuary; potentially alluvial grasslands, alkali or sub-saline vernal pools marginal to the Estuary. Riparian salt marsh habitat.
California seablite *(Suaeda californica)*	FE/SE/1B	Morro Bay (extant) and San Francisco Bay (extinct/reintroduced). Historic range in San Francisco Bay was Richmond to Palo Alto and Alameda. Estuarine beach edges, sandy high salt marsh edges.
Contra Costa goldfields *(Lasthenia conjugens)*	FE/CSC/1B	Alluvial seasonally wet grasslands, alkali or sub-saline vernal pools marginal to the San Francisco Estuary, and edges of salt ponds and pans; not known to occur within modern tidal marshes, but present in some diked baylands. Historic Bay margin locality records from Mt. Eden (Hayward), Suisun Marsh, and Warm Springs (Fremont; extant).
Delta tule-pea *(Lathyrus jepsonii* var. *jepsonii)*	FSC/CSC/1B	Freshwater and brackish marshes, northern San Pablo Bay, Suisun Bay, Sacramento-San Joaquin Delta.
Hispid bird's-beak *(Cordylanthus mollis* ssp. *hispidus)*	FSC/CSC/1B	Alkali vernal pools and inland playa; locally in alluvial seasonal wetlands near tidal marsh edges at Denverton, Suisun Marsh, but not in tidal marsh.
Marin knotweed *(Polygonum marinense)*	FSC/CSC/3	Taxonomy and distribution uncertain; primarily Drakes Bay salt and brackish tidal marshes; also Corte Madera, Greenbrae salt marshes; reported from Napa, Martinez tidal marshes.
Mason's lilaeopsis *(Lilaeopsis masonii)*	FSC/SR	Erosional creek banks, wave-scoured marsh peats at edges of channels and bays, Sacramento-San Joaquin Delta, northern San Pablo Bay (Tubbs Island and tidal reaches of Napa River, Mare Island Strait), Suisun Bay marshes.
Northern salt marsh (Point Reyes) bird's-beak *(Cordylanthus maritimus* ssp. *palustris)*	FSC/CSC/1B	Extirpated in San Francisco Bay south of Sausalito, formerly abundant. Extant populations in the San Francisco Estuary occur rarely from the Petaluma Marsh to Richardson Bay (reintroduced to San Francisco). Now mostly maritime distribution, high sandy salt marshes, Coos Bay (Oregon) to Bolinas Lagoon.
Soft bird's beak *(Cordylanthus mollis* ssp. *mollis)*	FE/CSC/1B	Tidal brackish or salt marsh, high marsh zone and edges of pans, alluvial fans, natural levees of creek banks; mostly Suisun Bay (Suisun Marsh, Contra Costa marshes); Fagan Marsh (Napa River), Point Pinole (Richmond); historic records from Petaluma Marsh and San Rafael.
Suisun Marsh aster (*Aster lentus*)	FSC/CSC/1B	Brackish or freshwater marshes, high marsh zone, natural levees of creek banks; mostly in tidal brackish marshes of Suisun Marsh, northeastern San Pablo Bay; historic records in San Francisco Bay, especially the East Bay.

Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum)*	FE/CSC/1B	Brackish tidal marsh, high marsh zone; Suisun Marsh. Historic range limited to Suisun Marsh; modern range limited to northwestern Suisun Marsh (Peytonia Slough, Rush Ranch vicinity).
Valley spearscale, San Joaquin saltbush *(Atriplex joaquiniana)*	FSC/CSC/1B	Alkali or sub-saline seasonal wetlands, pans, playa. In San Francisco Estuary, diked non-tidal wetlands of northeastern Suisun Marsh, rarely to northeastern San Pablo Bay, but possible in brackish tidal marsh pan edges saline flat (Montezuma area).

Key:
- FE: Federally-listed Endangered
- FD: De-listed under the Federal Endangered Species Act
- FPT: Proposed for Federal listing as Threatened
- SE: State-listed Endangered
- SR: State-listed Rare
- FT: Federally-listed Threatened
- FPE: Proposed for Federal listing as Endangered
- FSC: Federal Species of Concern
- ST: State-listed Threatened
- CSC: California Species of Special Concern
- MMPA: Marine Mammal Protection Act (Federal)

CNDDB: California Natural Diversity Database

CNPS:
- 1A: Plants Presumed Extinct in California
- 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere
- 3: Plants About Which There is Not Enough Information

Appendix G
Best Management Practices for the California Clapper Rail

Best Management Practices
for the Avoidance and Minimization of Indirect Impacts
from Spartina Control Program Activities
on the Endangered California Clapper Rail
(Rallus longirostris obsoletus)

1. Introduction: scope of minimization and avoidance measures.

Spartina Control Program activities in tidal marshes of the San Francisco Estuary involve both direct and indirect impacts to habitats, individuals, and populations of the California clapper rail, a federally and state-listed endangered species. Some direct impacts to clapper rail habitats, individuals, and populations may be unavoidable where extensive stands of Atlantic smooth cordgrass (*Spartina alterniflora*) and its hybrids have become opportunistically colonized by clapper rails. Unavoidable direct impacts, subject to off-site compensatory mitigation, are discussed in Chapter 3 (Biological Resources). Many direct and indirect impacts of Spartina Control Program activities on clapper rails, however, can be minimized or avoided by altering the location or timing of control activities subsequent to early detection of clapper rail presence in project areas.

The following "best management practices" summarize proposed mitigation measures for clapper rails affected by Spartina Control Program activities (control activities). They are based on early detection, monitoring, and adaptive project management to link monitoring to practices of field crews in the vicinity of treatment sites. Treatment sites are also proposed to be monitored following control activities to provide relevant information about changes in local clapper rail distribution and abundance for potential re-treatment activities, and to assess the effectiveness of avoidance and minimization measures.

2. Regulatory Use of Best Management Practices.

The "best management practices" outlined below represent a general, programmatic set of procedures proposed to mitigate indirect impacts of invasive cordgrass activities on clapper rails. They describe the full range of standardized measures proposed for many possible contingencies associated with individual projects and sites. Because site conditions and clapper rail populations change annually and seasonally, the specific combination of practices applied to individual project sites may vary. The selection of mitigation measures (best management practices) required for individual projects may also vary according to site-specific and time-specific circumstances. These would be determined in consultation with the U.S. Fish and Wildlife Service, Endangered Species Program, Sacramento Fish and Wildlife Office. The Service would determine the final "take minimization" (mitigation) requirements for activities affecting California clapper rails, through terms and conditions of the Service's biological opinion (Section 7, Endangered Species Act).

It is likely that the mechanism for consultation, and site-specific reviews and approvals, would be similar to the conventions for "programmatic biological opinions" applied to regional federal permits or regional programs. This convention involves (a) a comprehensive evaluation of the overall proposal or program; (b) general terms and conditions to minimize 'take' of endangered species; (c) annual reporting to the Service of proposed site-specific projects; (d) local project-specific review and written approval by the U.S. Fish and Wildlife Service, with specific conditions of annual activities. The review and approval procedures are typically enforced by terms and conditions set forth by the Service's biological opinion. Projects which exceed the amount or kind of 'take' treated in the biological opinion would require re-initiation of consultation. This procedure allows for typical projects to be reviewed expediently and approved with refined conditions, but also allows the Service to withhold approvals for exceptional actions with impacts and 'take' beyond what was prescribed in the programmatic biological opinion.

3. Survey Protocols.

The protocols (standard practices) for detecting the presence of California clapper rails are generally determined by the U.S. Fish and Wildlife Service, and are enforced through terms and conditions of regulatory instruments, such as incidental take authorizations, and recovery permits issued to qualified biologists with expertise in clapper rail field biology. These determine the specific methods and conditions in which surveys are authorized. Survey protocols are refined and updated according to the best available and most recent data from regional field surveys, and scientific standards. Clapper rail surveys are proposed for an entire project "action area," including the defined site of treatment activities, and any areas influenced by them (including crew and equipment access areas, staging areas, areas of potential substantial visual or auditory influence to the behavior of clapper rails).

Survey methods are subject to the discretion of the U.S. Fish and Wildlife Service, based on the local environmental setting. The call detection (aural or listening) survey is a standard survey technique that minimally disturbs clapper rails. Passive call detection surveys are used for initial detection. Passive call surveys, based on listening only, are performed on calm, nearly windless days in the winter-spring season (active mating or territory defense period) at times when clapper rails are likely to call and be detected. Conditions that limit call detection surveys include tidal stage and background noise interference. If repeated passive call surveys fail to detect rails, active surveys may be required to detect presence of clapper rails. Active surveys are based on eliciting call responses from clapper rails by broadcasting audiotapes of clapper rail calls. Active surveys are generally needed to detect clapper rail calls outside the breeding season, or during molting, or other circumstances in which rails are least likely to vocalize spontaneously. Active surveys provide more precise information on rail numbers and movements than passive surveys. Depending on the type and detail of survey information needed to minimize impacts to a particular project site, one or both call survey types may be used, based on recommendations of clapper rail expert biologists.

Visual survey methods include searching for tracks in mud near cordgrass, nest searches, and winter high tide surveys. Nest searches are seldom authorized because risks of disturbance may outweigh the benefits of detection. Track surveys in conditions that are less likely to disturb habitat are also possible techniques for some sites. Winter high tide surveys from levees or airboats in sloughs or bay edges are used to census rails in some circumstances when quantitative data on clapper rail population size is needed. Winter or early summer high tide surveys are usually limited to larger regional clapper rail survey or census efforts, and are not always site-specific.

Regional surveys of clapper rails, performed by qualified and authorized experts, are prepared in coordination with the *Spartina* Control Program to produce annually updated regional maps of changes in the known distribution of California clapper rails, at least in segments of the subspecies' overall range. Regional surveys do not always provide site-specific information about the presence or absence of clapper rails, but they can be modified to provide site-specific information pertinent to proposed cordgrass treatment sites. Clapper rail distributions in the Estuary, however, change under the influence of habitat changes (e.g. expansion of cordgrass habitats, either native or non-native, conditions of high tide escape habitat) or predation pressures, so regional maps must be updated annually for accuracy.

If a project site includes suitable clapper rail habitat, and lies within a cluster of recent (ca. 5- to 10-year) recorded locations of clapper rails, clapper rails are presumed to be potentially present. In this case, the "action area" (project site and areas which may be affected by its activities) must be surveyed for clapper rails by a qualified biologist during the same breeding season in which activities are proposed. The survey zone would presumably include all marsh within approximately 700 feet of the proposed project site boundaries. Site-specific surveys of clapper rail home ranges can provide additional useful information about patterns of clapper rail travel, potential nest sites, and preferred sensitive locations of high tide escape cover.

If a project site appears to lack suitable clapper rail habitat, and is separated from localities of recent recorded clapper rail populations by extensive areas of adverse habitat conditions (e.g. industrial, port, or other non-marsh shorelines), site-specific surveys by qualified biologists may be required at the discretion of the U.S. Fish and Wildlife Service, especially if there may be new vagrant or resident clapper rails occupying the area. At a minimum, visual searches for clapper rail tracks would be performed at cordgrass-invaded sites judged to be unlikely to support clapper rails. If more elaborate site-specific surveys are not required, Control Program crew supervisors will be trained in endangered species identification (visual, aural detection), and basic identification of tidal marsh vegetation. For exceptional cases of new rail movements into marginal, unoccupied habitat, trained field supervisors will also be capable of on-site identification and avoidance measures. Erratic movement of clapper rails (movements outside of typical primary habitats or established home ranges) tends to occur from mid-August through November, coinciding with the principal window for treatment (non-breeding season).

The interpretation of field survey results regarding "absence" or "presence" of clapper rails is subject to the discretion of the U.S. Fish and Wildlife Service.

4. Potential seasonal windows for control activities in clapper rail habitats.

If clapper rails are determined to be absent from a proposed project "action area," with concurrence of the U.S. Fish and Wildlife Service, control activities may be performed at any feasible time of year. Typical examples of likely site conditions associated with absence of clapper rails could include isolated, discrete, young, remote mudflat colonies of smooth cordgrass, and outlier colonies along urban shorelines with little or no adjacent tidal marsh.

If clapper rails are determined to be present at a proposed project "action area," most or all control activities may be restricted to the non-breeding season of the clapper rail, as determined by the U.S. Fish and Wildlife Service. The non-breeding season (lack of nesting, brooding) most recently has been interpreted as a relatively short period between September and February. The restriction of control activities to the non-breeding season may depend on local survey information on the density, local distribution, and behavior of clapper rails. If a project "action area" is marginal to the movements (home range) of a clapper rail individual, particularly a juvenile or non-breeding adult, some control activities may be feasible during the off-peak breeding season, if authorized by the U.S. Fish and Wildlife Service. If a project "action area" coincides or overlaps significantly with the home ranges of a breeding adult clapper rail, an active nest, or young brood, restriction of control activities to the non-breeding season is presumed.

5. On-site field biology supervision and training.

In addition to protocols for clapper rail surveys and seasonal timing of cordgrass control activities, activities of field crews performing control activities will require variable degrees of on-site field biologist supervision, depending on the degree of residual risk of clapper rail impacts.

The most sensitive case for field biological supervision is crew operation in occupied clapper rail habitat, even outside the breeding season. All work performed in known, occupied clapper rail habitats will at all times require on-site qualified field biologists with expertise in clapper rails. Supervising biologists will provide immediate instructions and guidance to field crews so that operations will have no inadvertent or excessive impacts to clapper rail habitats or clapper rail individuals. All field technicians and crew supervisors operating in such conditions will also be trained in basic field biology of clapper rails, including visual identification, call detection, and basic salt marsh vegetation and habitat types.

If crews operate in areas determined to be probable unoccupied habitat or non-habitat, field biologist supervision may be required, in addition to crew training, as with known occupied clapper rail habitat. This will depend on the degree of risk determined by supervisory clapper rail experts, in consultation with the U.S. Fish and Wildlife Service. At sites where clapper rails have been determined to be absent, and suitable habitat is either lacking or marginal, crew supervisors and field technicians will be trained in basic field biology of clapper rails, including introduction to visual identification, call detection, and basic salt marsh vegetation and habitat types.

6. Pre-project implementation protocols.

Where cordgrass control activities are to be performed in confirmed or potentially occupied clapper rail habitats, site-specific project plans will be adapted to updated field conditions and most recent field survey information regarding clapper rails before field equipment and crews are mobilized to the project site. Access routes for equipment and field crews will be staked out and described. Clearly visible flags, either set or approved by field biologists with expertise in clapper rail biology, will mark restricted areas and buffer zones for activities. Flags will be removed whenever operations are inactive to avoid providing scent-cues for foraging predators, especially red fox. Configuration of flagged restricted areas will be based on field survey data, and interpretation of rail behavior and habitat structure. Written site-specific precautions for field crews will be prepared by, or in consultation with, clapper rail expert biologists. These precautions will be distributed and explained to field crews by on-site biological supervisors.

If clapper rails or clapper rail nests are detected within any planned treated areas, control activities will be suspended. Locations of clapper rails, and their nests or brood nests, will immediately be recorded by GPS data, and photographed. Data on clapper rail or nest locations will be reported within 24 hours to the supervisory field biologist and the U.S. Fish and Wildlife Service, Endangered Species Program. Similarly, if clapper rails or nests are detected during operations, control activities will be immediately suspended, and information will be reported as described. Treatment activities may resume with conditional authorization from the U.S. Fish and Wildlife Service, in coordination with the clapper rail expert biologist.

7. Post-control monitoring and reporting.

Post-control monitoring applies to project sites within, or marginal to, occupied clapper rail habitat, or large, well-established stands of potential cordgrass habitat. It does not apply to isolated, young, discrete patches of non-native cordgrass surrounded by non-marsh habitat (mudflat or urban developed shorelines). The classification of cordgrass stands for purposes of post-control monitoring will be proposed by the clapper rail expert biologist consulted for site-specific project design, in consultation with the U.S. Fish and Wildlife Service.

Treated areas where cordgrass dieback is incomplete may require repeat or follow-up control measures. If initial treatments leave enough residual cordgrass to support potential recolonization by clapper rails before subsequent treatment, and the date of subsequent treatment is near the beginning of the breeding season, options may include: (1) delay all subsequent treatment to the end of the next growing season (allowing substantial regeneration of invasive cordgrass and possible recolonization by clapper rails); or (2) re-survey for clapper rails at least two weeks prior to potential subsequent treatment to confirm lack of clapper rail recolonization, and perform follow-up treatments (minimizing regeneration of invasive cordgrass and possible recolonization by clapper rails. This would be determined in consultation with the U.S. Fish and Wildlife Service.

Marsh areas adjacent to treated areas will also re-surveyed for clapper rails, covering an area equal to or greater than the approximate estimated or known size of clapper rail home ranges in the region. The survey zone would be presumed to include areas within approximately 700 feet of the project site, but may vary with specific habitat configuration. Any relevant information regarding potential rail movements from treated areas to adjacent or neighboring areas obtained during surveys will be reported and mapped. Any rail nest locations detected will be recorded with GPS data and photographed. All post-treatment survey data collected by authorized clapper rail biologists will be reported to the U.S. Fish and Wildlife Service. Re-treatment of areas with positive clapper rail detections will not resume until reported post-treatment data on clapper rail distribution and abundance have been reviewed, consulted, and approved by the U.S. Fish and Wildlife Service.

For presumed unoccupied or unsuitable habitat areas, field supervisors or crews will report any relevant observations regarding changes in potential clapper rail habitats, or clapper rail movements in the vicinity of project areas.

8. Annual reporting.

All survey and monitoring data on clapper rails associated with control activities will be summarized and synthesized in an annual report to the U.S. Fish and Wildlife Service and the California Department of Fish and Game.

Appendix H
List of Document Recipients

APPENDIX H
DISTRIBUTION LIST

Agencies/Organizations/Individuals	Public Notice	CD Rom	Hardcopy
111th Aerial Photography Squadron	X		
Aerial Info Systems	X		
Alameda County Agriculture	X		
Alameda County Mosquito Abatement District		X	
Alameda County Public Works	X		
Alameda Creek Alliance	X		
Alameda Flood Control		X	
American Canyon Public Works Dept	X		
Aquatic Environments	X		
Aquatic Outreach Institute	X		
Association of Bay Area Governments			X
Audubon Canyon Ranch	X		
Audubon San Francisco Bay Restoration Program	X		
Avocet Research Associates	X		
Bay Area Audubon Council	X		
Bay Area Open Space Council	X		
Bay Planning Coalition	X		
Baykeeper		X	
Bayside Homeowners Assoc.	X		
Benecia State Rec Area	X		
Bishop O'Dowd High School	X		
Blue Waters Kayak Co.	X		
California Canoe and Kayak	X		
California Congresswoman Anna G. Eshoo	X		
California Congresswoman Barbara Lee	X		
California Congressman Wally Herger	X		
California Congressman Tom Lantos	X		
California Congressman George Miller	X		
California Congressman Douglas Ose	X		

Agencies/Organizations/Individuals	Public Notice	CD Rom	Hardcopy
California Congresswoman Nancy Pelosi	X		
California Congressman Richard W. Pombo	X		
California Congressman Fortney Pete Stark	X		
California Congresswoman Ellen O. Tauscher	X		
California Congressman Mike Thompson	X		
California Congresswoman Lynn C. Woolsey	X		
California Dept. Boating and Waterways	X		
California Dept. Food and Agriculture	X		
California Dept. of Fish and Game			X
California Drafting and Survey	X		
California EPA Dept of Pesticide Regulation			X
California EPPC	X		
California Native Plant Society	X		
California Senator Barbara Boxer	X		
California Senator Dianne Feinstein	X		
California State Lands Commission			X
California State Parks and Recreation			X
California State University, Hayward Library			X
California State Water Resources Control Board			X
California Waterfowl Association	X		
Caltrans	X		
Cargill Salt	X		
Central Valley Habitat Joint Venture	X		
Chevron	X		
Citizens' Committee to Complete the Refuge	X		
City of Alameda			X
City of Albany			X
City of Emeryville			X
City of Millbrae			X
City of Oakland			X
City of Palo Alto			X
City of Palo Alto, Palo Alto Baylands			X

Agencies/Organizations/Individuals	Public Notice	CD Rom	Hardcopy
City of San Jose			X
City of San Leandro			X
City of San Mateo			X
City of Tiburon			X
Clean Lakes, Inc.	X		
Center For Env. Assessment and Monitoring	X		
Coast Guard Island Integrated Support Command	X		
College of Marin	X		
Complete the Refuge, Golden Gate	X		
Contra Costa County Agriculture		X	
Contra Costa Creeks Council	X		
Contra Costa County Vector & Mosquito Dist.		X	
Contra Costa Flood Control Dist.		X	X
Council of Bay Area RCDs	X		
County of Alameda			X
County of Contra Costa			X
County of Marin			X
County of Napa			X
County of San Francisco			X
County of San Mateo			X
County of Santa Clara			X
County of Solano			X
County of Sonoma			X
Coyote Pt. Marina	X		
Cypress Grove Preserve/Audubon Canyon Ranch	X		
Dealey, Renton & Associates	X		
Defenders of Wildlife	X		
Dell Computers	X		
Delta Protection Commission	X		
Delta Science Center	X		
Dept of Ecology	X		
Dept. Conservation DLRP	X		

Agencies/Organizations/Individuals	Public Notice	CD Rom	Hardcopy
Dept. Env. Science and Policy	X		
Ducks Unlimited	X		
Earth Team	X		
East Bay Conservation Corps.	X		
East Bay Regional Park District			X
Elkhorn Slough National Estuarine Research Center	X		
Environmental Action Committee of West Marin	X		
Environmental Science Associates	X		
Friends of Corte Madera Creek Watershed	X		
Friends of Five Creeks	X		
Friends of Novato Creek	X		
Friends of Sausal Creek	X		
Friends of Temescal Creek	X		
Friends of the Creeks	X		
Friends of the River	X		
GIS Consultants	X		
Golden Gate Audubon	X		
Golden Gate National Parks Association	X		
Gulf of Farallones	X		
HJW	X		
Hog Island Oyster Co.	X		
Homeowners' Association	X		
HT Harvey & Associates	X		
Jones & Stokes	X		
Kamman Hydrology and Engineering	X		
Lake Merritt Institute	X		
Levine Fricke	X		
Lighthawk	X		
LSA Associates, Inc.	X		
Marin Audubon Society	X		
Marin County Dept. of Ag.	X		
Marin Open Space, Parks and Recreation	X		

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Marin Parks, Open Space and Cult. Services	X		
Marin RCD	X		
Marine Science Institute	X		
MROSD	X		
Napa County Agriculture	X		
Napa County RCD	X		
National Audubon Society	X		
National Estuarine Research Reserve	X		
National Fish and Wildlife Foundation	X		
Natural Resource Conservation Svc.	X		
NFWF	X		
Northbay Riparian Station	X		
Oregon Department of Agriculture	X		
Pacific Coast Joint Venture	X		
Pacific Open Space, Inc.	X		
Palo Alto Open Space	X		
PG&E Corporation	X		
Point Reyes Bird Observatory	X		
Point Reyes National Seashore, NPS	X		
Point San Pablo Yacht Harbor	X		
Port of Oakland		X	
Port of San Francisco		X	
Portland State University	X		
Presidio, GGNRA	X		
Regional Water Quality Control Board, SF Bay Region		X	X
Richardson Bay Regional Agency	X		
Riparian Habitat Joint Venture	X		
Romberg Tiburon Center of Env. Science	X		
Sacramento County Agriculture	X		
SAIC	X		
San Francisco County Agriculture	X		
San Francisco Estuary Institute	X		

Agencies/Organizations/Individuals	Public Notice	CD Rom	Hardcopy
San Francisco Estuary Project	X		
San Francisco County Agriculture	X		
San Mateo County Mosquito Abatement District	X		
San Mateo County Parks	X		
San Mateo RCD	X		
San Pablo Bay NWR		X	X
Santa Clara County Agriculture	X		
Santa Clara Valley Audubon Society	X		
Santa Clara Valley Water District	X		
Save San Francisco Bay Association	X		
Sea Trek Kayaks	X		
SF Arts Commission	X		
SF Bay Bird Observatory	X		
SF Bay Conservation & Development Commission			X
SF Bay Don Edwards NWR		X	X
SF County Agricultural Commission	X		
SF International Airport	X		
SF League of Urban Gardeners	X		
SF State University Main Library			X
Shoreline at Mountain View	X		
Sierra Club	X		
Silicon Valley Toxics Coalition	X		
Silverado District Ca. Parks and Rec	X		
Solano County Agriculture	X		
Sonoma County Agriculture	X		
Sonoma County Ag. Comm. Office	X		
Sonoma Ecology Center	X		
South San Francisco			X
South San Francisco Sewage District	X		
Southern Sonoma County RCD	X		
Spartina Lab/Bodega Marine Lab			X
Suisun RCD	X		

Agencies/Organizations/Individuals	Public Notice	CD Rom	Hardcopy
Tamal Saka Kayak Company	X		
The Bay Institute	X		
The Conservation Fund	X		
The Nature Conservancy	X		
Tomales Bay Advisory Committee/ Marin RCD	X		
Tomales Bay Association	X		
Tomales Bay Oyster Company	X		
Tomales Bay Watershed Council	X		
Toyon Environmental Consultants, Inc.	X		
Trust for Public Land	X		
UC Berkeley Main Library			X
UC Davis Main Library			X
Urban Creeks Council	X		
URS	X		
U.S. Environmental Protection Agency		X	
U.S. Department of Agriculture - Forest Service	X		
U.S. Department of Agriculture - Natural Resources Conservation Service			X
U.S. Department of Agriculture - Agricultural Research Service		X	
U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Fisheries Service		X	
U.S. Department of Defense, Department of the Army, Corps of Engineers, San Francisco District			X
U.S. Department of Interior, Bureau of Land Management			X
U.S. Department of Interior, Bureau of Reclamation			X
U.S. Department of Interior, Bureau of Indian Affairs	X		
U.S. Department of Interior, Fish and Wildlife Service			X
U.S. Department of Interior, Geological Survey, Biological Resources Division		X	
U.S. Department of Interior, Minerals Management Service		X	
U.S. Department of Interior, National Parks Service			X
U.S. Department of Interior, Office of Surface Mining	X		
U.S. Department of Transportation, Coast Guard			X
UW: Olympic Natural Resources Center	X		

Agencies/Organizations/Individuals	Public Notice	CD Rom	Hardcopy
Washington State Dept. of Agriculture	X		
Washington Dept. of Ecology	X		
Washington Dept. of Fish & Wildlife	X		
Washington State Univ., Vancouver	X		
Washington State Univ, Long Beach	X		
WCC Landfill	X		
Wetlands Research Associates	X		
Wildlands, Inc.	X		
Wildlife Conservation Board	X		
Janice Alexander	X		
Stacy Carlson	X		
Jeron Donalds	X		
Alex Dukes	X		
Phyllis Faber	X		
Brenda Grewell	X		
Beth Huning	X		
Stephen Joseph	X		
Marlene Kerr	X		
Sherman May	X		
David Munro	X		
Norm Ploss	X		
Ari Salomon	X		
Stuart Siegel	X		
Doreen Smith	X		
Patty St. Louis	X		
Lisa Stallings	X		
David Yearsley	X		

Appendix I
ISP First-Year Pilot and Demonstration Projects

San Francisco Estuary Invasive *Spartina* Project Possible First Year Pilot and Demonstration Projects

The Invasive *Spartina* Project (ISP) Control Program has identified 16 locations where it may implement pilot or demonstration projects for the 2003 control season. This list is preliminary in nature, and no site-specific plans have been developed. The Control Program anticipates being able to complete six to ten pilot and demonstration projects during the first year, depending on difficulty identifying and coordinating with landowners and partners.

Following is a summary of each of the possible projects, including the reasons for each project's selection. A map showing the location of the sites follows the descriptions (Figure I-1), and a ranked summary of the criteria by which the projects were selected is provided in Table I-1. Additional projects not identified below may be considered for inclusion in the first year, and projects not completed in the first season may be carried over to the 2004 treatment season.

1. Pickleweed Park, Marin County

Landowner: City of San Rafael

Contact: Undetermined

Site location: See attached map.

Acreage to be treated: 0.5 acre

Cordgrass species: *S. densiflora*

Possible project partners: City of San Rafael, Marin County Weed Management Area

Endangered species and other site issues: California clapper rails are *not* known to be present at this site.

Control Work/details: *S. densiflora* control at this site may include a combination of digging, mowing, covering and herbicide depending on landowner and community opinion. USDA-ARS researchers working for the ISP may propose work at this location to examine efficacy of new *S. densiflora* control methods, including alternative herbicides (such as fluridone and imazypyr) and application of herbicide to cut plant stumps.

Reason for selection as a possible demonstration site: ISP surveys identified discrete *S. densiflora* clones along the bay front of Pickleweed Park in 2001. Pickleweed Park is the northern most infestation of *S. densiflora*. Control at this site could contain this northern population and reduce the overall distribution and potential dispersal of *S. densiflora*.

California clapper rail has not been reported in this area, so work could be initiated early in the season when there are numerous low morning tides. Early initiation of work would allow for repeat visits to the site for improved effectiveness.

2. Corte Madera Creek, Marin County

Landowner: The infestation at Corte Madera Creek extends along the length of the Creek to the San Francisco Bay, and so affects numerous public and private landowners. Specific landowners involved in the demonstration project would be known only when the exact demonstration site was selected.

Contact: Sandy Guldman, Friends of Corte Madera Creek

Site location: See attached map.

Acreage to be treated: Approximately 1 of 13 total infested acres

Cordgrass Species: *S. densiflora*

Possible project partners: Marin County Parks and Recreation Department, Friends of Corte Madera Creek, Marin Rowing Association, Marin County Open Space, City of Larkspur/Corte Madera?

Endangered species and other site issues: The local community may be very sensitive about the use of herbicides in this area. California clapper rails have been reported in the area, and surveys for clapper rail must be completed prior to selection of the demonstration site. Control work in areas occupied by clapper rails could occur only as authorized by the USFWS.

Control Work/details: Portions of the site would be suited for a variety of physical and mechanical control such as digging and hand pulling, and other areas would be most effectively and efficiently treated with herbicides. Demonstration work could begin with physical and mechanical control in the upper reach of the infestation.

Reason for selection as a possible demonstration site: Creekside Park and Corte Madera Creek comprise the bulk of the *S. densiflora* population of the San Francisco Estuary. *S. densiflora* was introduced at Creekside Park in Marin County in the mid-1970s during the marsh restoration of this site. In the 30 years since its introduction at Creekside Park, *S. densiflora* has spread to the banks of the Corte Madera Creek, adjacent marsh edges, the Corte Madera Creek mouth, and the bay front of the Corte Madera Marsh Reserve. Propagules from this source population are continuing to be spread along the creek and beyond. A demonstration site at the upper reaches of the creek could serve to illustrate and educate the local landowners on the impacts of these invasive species and the potential for their control. After demonstrating success and establishing partnerships in the upper creek, ISP could extend control work down the length of the creek and to adjacent marshes. Control work in the mid and lower reaches of the Creek (where California clapper rail have been identified) could demonstrate implementation of clapper rail best management practices (BMPs) developed by the ISP.

3. Blackie's Pasture, Marin County

Landowner: City of Tiburon? Marin County Open Space?

Contact: Undetermined

Site location: See attached map.

Acreage to be treated: 0.1 acre

Cordgrass species: *S. densiflora* and *S. alterniflora*/hybrids

Possible project partners: City of Tiburon, Marin County Open Space

Endangered species and other site issues: California clapper rails are *not* known to be present at this site.

Control Work/details: This is a relative small confined site. A combination of control techniques such as digging, mowing, covering and herbicides would be used depending on the extent and size of the individual *S. densiflora* and *S. alterniflora/*hybrid clones. Depending on identification of partners, the Control Program might also include the other discrete clones in the Richardson Bay area such as Strawberry Point and Seminary Cove.

Reason for selection as a possible demonstration site: Blackie's Pasture is one the most northerly population of *S. alterniflora*/hybrids in Marin County. This site is relatively small and contained with a single landowner. Control at this location could illustrate control efficacy, as well reduce the potential dispersal of non-native propagules further into Marin's Richardson Bay marshes, into the North Bay and beyond the Golden Gate to the outer coast. Blackie's Pasture is also a highly visited site, with ample public access, providing a good opportunity for public education.

4. India Basin, San Francisco County

Landowner: Port of San Francisco?

Contact: Undetermined

Site location: See attached map.

Acreage to be treated: 0.1 acre

Cordgrass species: S. *alterniflora*/hybrids

Possible project partners: Port of San Francisco; San Francisco Public Utilities Commission; San Francisco Parks and Recreation Department; League for Environmental Justice

Endangered species and other site issues: Unknown – surveys for California clapper rail would be conducted as part of the site-specific plan. Control work in areas found to be occupied by clapper rails could occur only as authorized by the USFWS.

Control Work/details: This is a relative small confined site. A combination of control techniques such as digging, mowing, covering and herbicides could be used, depending on the extent and size of the *S. alterniflora/*hybrid clones at the time of treatment.

Reason for selection as a possible demonstration site: India Basin is one the most northerly population of *S. alterniflora*/hybrids on the west side of the Bay. This site is relatively small and may have a single owner, thus simplifying planning and coordination. Rapidly implemented treatment at this location could demonstrate control efficacy and help reduce the spread of *S. alterniflora*/hybrids north along the Bay shore to Crissy Field, and beyond the Golden Gate to the outer coast.

If landowners and partners could be identified, we might also include other discrete clones in the area, such as Candlestick Cove.

5. Colma Creek, San Mateo County

Landowner: City of San Mateo?

Contact: Undetermined

Site location: See attached map.

Acreage to be treated: Approximately 7.5 of greater than 50 total infested acres

Cordgrass species: S. *alterniflora*/hybrids

Possible project partners: City of San Mateo, San Mateo Weed Management Team

Endangered species and other site issues: California clapper rails are present on the mudflats, however they have not been reported along the mid and upper reaches of the Creek.

Control Work/details: This area is densely covered by *S. alterniflora*/hybrid meadows, which have spread along the creek banks and onto adjacent mudflats. Control would be initiated at the upstream edge of the invasion, and work progressively down to the mudflats. Techniques to reduce seed set would be implemented in areas that cannot be fully treated the first year. This would be a suitable site to test a range of manual, physical, and chemical eradication and seed-set reduction techniques.

Reason for selection as a possible demonstration site: *S. alterniflora/*hybrids were introduced to Colma Creek (or San Bruno Slough) as transplants from the original introduction site in Hayward, Alameda County. In the 25 years since their introduction at this site, *S. alterniflora* /hybrids have spread down the creek and to the adjacent mudflats, forming very dense meadows. This is one of the densest and most northerly populations on the west side of the Bay. This site serves as a ready source for *S. alterniflora* propagules, which are dispersed further north in the Bay (and potentially beyond the Golden Gate to outer coast marshes).

Because of the density of the population, this would be a suitable site to test a range of manual, physical, and chemical eradication and seed-set reduction techniques. Apart from testing and demonstrating control methods, pilot work at this site would help to slow the spread of *S. alterniflora*/hybrids northward. Control work in clapper rail habitat would demonstrate implementation of clapper rail best management practices (BMPs) developed by the ISP.

6. Bayfront Park, San Mateo County

Landowner: City of San Mateo?

Contact: Undetermined

Site location: See attached map.

Acreage to be treated: 0.65 acre

Cordgrass species: S. *alterniflora*/hybrids

Possible project partners: San Mateo Mosquito Abatement District, San Mateo County Weed Management Area

Endangered species and other site issues: California clapper rails are *not* present at this site.

Control Work/details: The project would focus on control of discrete clones and meadows along the mudflats. The project would demonstrate either a mechanical method of control, or mowing with secondary herbicide application. The site is adjacent to a bike path which may provide access.

Reason for selection as a possible demonstration site: ISP surveys in 2001 found discrete *S. alterniflora*/hybrid clones developing into clusters and small meadows along the length of Bayfront Park, with extensive mudflats adjacent to the Park that are as yet uninvaded. Bayfront Park is located in the midst of several invaded sites, and the mudflats are highly susceptible to further invasion. Demonstration work at this site could help slow or prevent the continued invasion of the mud flats.

Because this site currently has no California clapper rail, control work could begin in early summer, when there are many low tide days for treatment. Early treatment will also allow for multiple treatment days if required. If this site is left without control, the *S. alterniflora*/hybrid population will spread further out onto the adjacent mudflats.

This project would also provide the opportunity to form valuable partnerships. The San Mateo Mosquito Abatement District has already been working with the San Mateo Weed Management Area and the Don Edwards National Wildlife Refuge to control Spartina in the County. As a partner, the Mosquito Abatement District could provide experience, crews, boats, and equipment.

7. Outer Bair Island, San Mateo County

Landowner: Don Edwards National Wildlife Refuge (DENWR), USFWS

Contact: Joy Albertson, DENWR

Site location: See attached map.

Acreage to be treated: 0.36 acre or 28 acres, depending on project definition.

Cordgrass species: *S. alterniflora*/hybrids

Possible project partners: USFWS, Don Edwards Wildlife Refuge

Endangered species and other site issues: California clapper rail has been reported at this location, therefore control in this area would occur only as authorized by USFWS, and would likely have to take place outside the bird's breeding/nesting season.

Control Work/details: Chemical control would be recommend at this location. The populations of *S. alterniflora*/hybrids are quite dense, and boats would be required to access this site and deliver equipment and chemicals. San Mateo Mosquito Abatement District has already been contracted to control the spread of *Spartina* in this area and is thus familiar with the site. All the equipment, including airboats, herbicide applicators, etc. is available. ISP may be able to provide funds for items such as herbicide and labor.

Reason for selection as a possible demonstration site: Bair Island is becoming increasingly infested with *S. alterniflora*/hybrids. This outer area of Bair is highly invaded and is providing numerous propagules for further invasion of the neighboring marshes. Full eradication of this site may be a challenge to achieve given the density of the invasion and difficult access to the site. However, cover and seed set of non-native *Spartina* can be reduced.

8. Westpoint and Ravenswood Sloughs, San Mateo County

Landowner: Don Edwards National Wildlife Refuge (DENWR), USFWS

Contact: Joy Albertson, DENWR

Site location: See attached map.

Acreage to be treated: Approximately 5 acres

Cordgrass species: S. *alterniflora/*hybrids

Possible project partners: USFWS, DENWR; San Mateo Mosquito Abatement District; San Mateo Weed Management Team.

Endangered species and other site issues: California clapper rail has been reported at this location, therefore control in this area would occur only as authorized by USFWS, and would likely have to take place outside the bird's breeding/nesting season.

Control Work/details: This location is well suited for demonstration of herbicide control and various seed set reduction methods. The populations of *S. alterniflora*/hybrids are quite dense. USFWS has contracted San Mateo Mosquito Abatement District to control the spread of *S. alterniflora* in this area. All the equipment, including airboats, herbicide applicators, etc. is available. ISP would provide funds for items such as herbicide and labor, and assistance in planning and coordination, as needed. The site may be selected by USDA-ARS researches working for the ISP to examine the efficacy of other herbicide treatments such as fluridone or imazapyr.

Reason for selection as a possible demonstration site: At the mouth of Ravenswood and Westpoint Sloughs are the densest, most southerly populations of *S. alterniflora*/hybrids on the west side of the Bay. The USFWS Don Edwards National Wildlife Refuge manages this property, and has been trying to control *S. alterniflora*/hybrids. Control at these sites would reduce spread of propagules, seed, and pollen further into the South Bay. Additionally, channels and sloughs in the area are becoming invaded *S. alterniflora*/hybrids and are filling in with plants and sediment. Successful work at these locations could demonstrate restoration of channels and channel habitat, and help prevent flood control problems. Control work in these areas could demonstrate implementation of clapper rail best management practices (BMPs) developed by the ISP.

9. Alviso Slough – Coyote Creek, Santa Clara and Alameda Counties

Landowner: Santa Clara County, Santa Clara Valley Water District (SCVWD) Don Edwards National Wildlife Refuge (DENWR), USFWS

Contact: Lisa Porcella & Gale Rankin, SCVWD; Joy Albertson, DENWR

Site location: See attached map.

Acreage to be treated: Less than 0.5 acre

Cordgrass species: S. *alterniflora*/hybrids

Possible project partners: SCVWD, DENWR, USFWS, Santa Clara County Weed Management Team

Endangered species and other site issues: California clapper rail has been reported at this location, therefore control in this area would occur only as authorized by USFWS, and would likely have to take place outside the bird's breeding/nesting season.

Control Work/details: Spot control by a combination of digging, mowing, covering and herbicide depending on the extent and size of the Spartina clones.

Reason for selection as a possible demonstration site: Alviso Slough and Coyote Creek are properties managed by both the Santa Clara Valley Water District the Don Edward National Wildlife Refuge. ISP surveys in 2001 identified discrete clones along the fringe marsh of Alviso Slough and Coyote Creek, however more detailed mapping is still required. This is one of the most southerly populations of *S. alterniflora*/hybrids on the East Bay. Control at this site could contain the population and reduce the overall distribution. California clapper rails are present in the adjacent marshes, but given limited amounts of non-native cordgrass, control could take place with a minimal impact to the clapper rail population. Control work in clapper rail habitat would demonstrate implementation of clapper rail best management practices (BMPs) developed by the ISP. If this site were left without control, the *S. alterniflora*/hybrid population would likely continue to spread, and thus present more of a challenge to control, particularly in the presence of the California clapper rail.

10. Mowry Slough, Santa Clara and Alameda Counties

Landowner: Don Edwards National Wildlife Refuge (DENWR), USFWS

Contact: Joy Albertson, DENWR

Site location: See attached map.

Acreage to be treated: Approximately 0.5 acre

Cordgrass species: S. *alterniflora*/hybrids

Possible project partners: DENWR, USFWS, Santa Clara Valley Water District

Endangered species and other site issues: California clapper rail has been reported at this location, therefore control in this area would occur only as authorized by USFWS, and would likely have to take place outside the bird's breeding/nesting season.

Control Work/details: Spot control by a combination of digging, mowing, covering and herbicide depending on the extent and size of the *Spartina* clones.

Reason for selection as a possible demonstration site: Mowry Slough is part of the Don Edward National Wildlife Refuge. ISP surveys in 2001 identified discrete clones along the fringe marsh south of Mowry Slough. This is one of the most southerly populations of *S. alterniflora*/hybrids on the East Bay. Control at this site could contain the population and reduce the overall distribution. California clapper rails are present in the adjacent marshes, but given limited amounts of non-native cordgrass, control could take place with a minimal impact to the clapper rail population. Control work in clapper rail habitat would demonstrate implementation of clapper rail best management practices (BMPs) developed by the ISP. If this site were left without control, the *S. alterniflora*/hybrid population would likely continue to spread, and thus present more of a challenge to control, particularly in the presence of the California clapper rail.

11. Alameda Flood Control Channel/Upper Coyote Hills Slough, Alameda County

Landowner: Alameda Flood Control District, Don Edwards National Wildlife Refuge (DENWR)

Contact: Saul Ferdan (AMPA), Joy Albertson (USFWS, DENWR)

Site location: See attached map.

Acreage to be treated: Approximately 14 acres

Cordgrass species: *S. alterniflora*/hybrids

Possible project partners: DENWR, USFWS, Santa Clara Valley Water District

Endangered species and other site issues: California clapper rail are *not* present in the upper reaches of the channel, but are present in the lower reaches and at the channel mouth. Control work in these areas would occur only as authorized by the USFWS, and would likely have to occur outside of the bird's breeding/nesting season.

Control Work/details: Dredging technique from levy edge, or mowing with additional chemical control with glyphosate. In order to control the dense stand of Spartina that line the slough multiple treatments may be required. The upper, eastern reach of the slough would be a good demonstration site given that no California clapper rail are found in this area. Control could possibly begin in the early summer, which would allow for multiple treatments.

Reason for selection as a possible demonstration site: The Alameda Creek Flood Control Channel (a.k.a. Coyote Hills Slough) is managed by the Alameda County Flood Control District primarily for flood control. The original site of *S. alterniflora* introduction in the San Francisco Estuary was a restored salt pond near the mouth of the Channel. ISP surveys in 2001 identified dense stands of *S. alterniflora* along the length of the Channel, as far as five miles upstream from the Bay. The Flood Control District has been doing work to control *S. alterniflora* in the Channel for a number of years, and would likely be receptive to ISP support and partnership. Given the potential for non-native *Spartina* to invade and obstruct flood control channels, it is imperative that the ISP help develop effective control methods. The Flood Control District has also been collaborating with the Alameda Mosquito Abatement District and the Don Edward Wildlife Refuge, sharing boats and working on their adjoining properties. As a partner, the District could provide, crews, experience, and equipment.

Because California clapper rails are not found in the upper/eastern reach of the channel, control in this area might be permitted to begin in early summer, allowing multiple treaments, if necessary. Control work in clapper rail habitat would demonstrate implementation of clapper rail best management practices (BMPs) developed by the ISP. Control work in areas occupied by California clapper rails could occur only as authorized by the USFWS.

12. Whales Tail/Alameda Creek, Alameda County

Landowner: California Department of Fish and Game, City of San Leandro Mitigation Site, USFWS?

Contact: John Krause, CDFG; Norm Ploss, Special Assistant - City of Fremont

Site location: See attached map.

Acreage to be treated: ? of 50 acres total

Cordgrass species: *S. alterniflora*/hybrids

Possible project partners: CDFG, Norm Ploss/ City of San Leandro, EBRPD? DENWR, USFWS?

Endangered species and other site issues: California clapper rail has been reported at this location, therefore control in this area would occur only as authorized by USFWS, and would likely have to take place outside the bird's breeding/nesting season.

Control Work/details: Given the adjacent restoration sites that are at risk, it is recommended that the non-native *Spartina* in the area be controlled. A combination of mowing and chemical control would be recommended for this site. Repeat treatments through the season would most likely be required. Perhaps a novel method of mechanical control could be tested in the areas of dense meadows. If site eradication is not feasible, ISP would recommend that seed set be reduced, either by mechanical means, mowing in the early summer season (July-August) so as not to release floating stems with fertile seed on the tide, or by chemical means, by spraying glyphosate. Permits would be required for early control work in this CLRA habitat.

Reason for selection as a possible demonstration site: This recently restored site has numerous large *S. alterniflora*/hybrid clones developing into dense meadows, especially at the bay front of the marsh. This marsh is becoming increasingly infested with non-native *Spartina* and is providing a large seed source which is dispersing on the tides to other neighboring marshes. Of particular concern is the adjacent property at Eden landing which is being open to tidal flow for restoration. Without control, this new restoration site will likely become infested by seed from the Whales Tail/Alameda Creek area.

13. Oro Loma Marsh, Alameda County

Landowner: East Bay Regional Park District (EBRPD)

Contact: Nancy Brownfield, Joe Didonato, Mark Taylor

Site location: See attached map.

Acreage to be treated: Multiple locations throughout 27 acres

Cordgrass species: *S. alterniflora*/hybrids

Possible project partners: EBRPD

Endangered species and other site issues: California clapper rails are *not* present at this site.

Control Work/details: This recently restored site has numerous large *S. alterniflora*/hybrid clones developing throughout the marsh. Access to the clones is said to be quite labor intensive. EBRPD has recently acquired a vehicle that is specially designed for driving though marsh and mud flats. This machine may be used to smoother clones, or access clones for herbicide treatment. This might also be a suitable site to demonstrate diking/drowning techniques.

Reason for selection as a possible demonstration site: Oro Loma Marsh is part of East Bay Regional Park District. The site was open to tidal action for restoration and has since become invaded by numerous Spartina clones. Neighboring invaded marshes, such as Cogswell Marsh, were probably the source of the non-native propagules. This site should be treated immediately before the infestation is any greater. California clapper rails are not yet present in this marsh, but they are present in adjacent marshes and will likely inhabit Oro Loma as more vegetation becomes established. Given that no California clapper rails are currently present, early summer control may be feasible. If this site is left without control and California clapper rails establish, there will be an even greater challenge to control. As a partner, the EBRPD brings considerable experience, in addition to crews and equipment. This project would provide EBRPD much-needed support, and build on the existing good working relationship between EBRPD and ISP.

14. San Lorenzo Creek Mouth/Roberts Landing, Alameda County

Landowner: City of San Leandro, State Lands?

Contact: Undetermined. Mark Taylor (EBRPD) could help determine actual landowner.

Site location: See attached map.

Acreage to be treated: Approximately 10 acres

Cordgrass species: *S. alterniflora*/hybrids

Possible project partners: City of San Leandro, EBRPD, State Lands, ESA, LSA

Endangered species and other site issues: There are California clapper rails in adjacent marshes, and it is likely that rails use this site for foraging. A survey would be conducted as part of the site-specific plan, and control work in areas occupied by California clapper rails could occur only as authorized by the USFWS.

Control Work/details: The mouth of San Lorenzo Creek has a very, very dense population of *S. alterniflora*/hybrids. Individual clones are coalescing on the mudflats and developing into a meadow. Based on preliminary reconnaissance, it appears that the sediment in this area could probably support the weight of heavy equipment. If this is the case, this would be an excellent to test the efficacy of smothering by tractors to kill and/or reduce the overall biomass of the non-native cordgrass, with herbicide application as a secondary treatment. EBRPD may be able to provide staff and equipment for this location. The site, or a site near here, may be selected by USDA-ARS researches working for the ISP to examine the efficacy of alternative treatment methods.

Reason for selection as a possible demonstration site: The Robert's Landing area, including the San Lorenzo Creek, creek mouth, and interior marshes (including Bunker Marsh, Citation Marsh, North Marsh, East Marsh and San Lorenzo Marsh) are becoming increasingly invaded by *S. alterniflora*/hybrids. Every year, the invasion is increasing "exponentially" (D. Ayres pers. comm.). The creek mouth is particularly infested, with dense meadows establishing. Interior (secondary and tertiary) creeks and channels are becoming increasingly invaded and are filling in with sediment. The loss of such channels is altering the native hydrology of the marsh, and may also lead to future flooding problems. Seed and propagules are spread further into the marshes with the incoming tides, while propagules are becoming dispersed beyond this site with the out-going tides and currents. Just south of this location is a newly restored marsh, Oro Loma. It is becoming increasingly more infested, with the San Lorenzo Creek mouth and marsh being the most likely source of non-native seed as it is its neighbor. Just north of the creek mouth is a narrow band of rare sandy beach habitat that has been proposed for the location of a recovery project for the endangered California sea blite, *Pseuda californica*. This recovery effort will be in vain if *Spartina* is not controlled in the area as its invasion is altering the beach forming processes. A demonstration of *Spartina* control at this location would have many benefits, including reducing bay wide spread, invasion of neighboring restored marshes, clearing channels and restoring rare beach habitat along the bay front. This demonstration site could also help illustrate the efficacy of smothering by tracked vehicles as a means of control of dense *Spartina* meadows.

15. Emeryville Crescent, Alameda County

Landowner: East Shore State Park/ East Bay Regional Park District (EBRPD)

Contact: Nancy Brownfield, Joe Didonato, EBRPD and Jim Hanson, CalTrans

Site location: See attached map.

Acreage to be treated: 0.25 acre

Cordgrass species: *S. alterniflora*/hybrids

Possible project partners: EBRPD, East Shore State Parks, California Department of Transportation (CalTrans), adjacent creek groups? Berkeley Marina?

Endangered species and other site issues: California clapper rails are present in low densities in this area. Control of the discrete clones may be able to minimize impact to the rails. Control work in these areas could occur only as authorized by the USFWS, and California clapper rail surveys would likely be required before, during and after control.

Control Work/details: This marsh has a number of discrete *S. alterniflora*/hybrid clones dispersed along the bay edge. Spot control of the discrete clones would be recommended. However, hybrids that appear like natives will continue to be hidden in the native marsh. Thus, repeated visits will be required for more visual surveys and genetic transects to confirm that the cordgrass in the area is native. A much more conservative approach (to conserving the genetic integrity of this site) would be to control the entire area.

Reason for selection as a possible demonstration site: This site is one of the most northerly populations of *S. alterniflora*/hybrids on the east side of the Bay. *Spartina* control at this location would be relatively feasible given the discrete clones scattered throughout the marsh. Control at this site would also reduce the overall distribution on non-native *Spartina* through out the Bay, and reduce the number of dispersing propagules further into the North Bay or beyond the Golden Gate to the outer coast marshes. Cal-Trans has begun some initial control work in some areas, and has expressed an interest in collaborating with the ISP to expand efforts.

16. Point Pinole Marshes, Contra Costa County

Landowner: East Bay Regional Parks District (EBRPD)

Contact: Nancy Brownfield, Joe Didonato

Site location: See attached map.

Acreage to be treated: 0.01 acre

Cordgrass species: *S. alterniflora*/hybrids and *S. densiflora*.

Possible project partners: EBRPD

Endangered species and other site issues: California clapper rails are scattered but present in adjacent marshes. Surveys would need to be performed as a part of the site-specific plan, and control in areas found to have clapper rails could only be conducted as authorized by the USFWS.

Control Work/details: Spot control with a combination of digging, mowing, covering and herbicides depending on the extent and size of the *S. alterniflora*/hybrid and *S. densiflora* clones at the time of treatment.

Reason for selection as a possible demonstration site: Point Pinole is the location of the most northerly population of *S. alterniflora*/hybrids and *S. densiflora* on the east side of the San Francisco Bay. A minimal number of *S. alterniflora*/hybrid clones have been found at this site. More numerous *S. densiflora* clones have been found scattered throughout Pt. Pinole, in particular Whittel Marsh. EBRPD has done quite a bit of *S. densiflora* control at this site in the past. However, follow up *S. densiflora* control needs to take place. Control at this location would reduce the *S. alterniflora*/hybrid distribution in the East Bay, confining it to the Central and South Bays. Control of both species at this site would help protect the North Bay, Suisun, and the outer coast from further invasion.

17. Southampton Marsh, Contra Costa County

Landowner: Benecia State Park

Contact: Undetermined

Site location: See attached map.

Acreage to be treated: 0.58 acre

Cordgrass species: *S. patens*

Possible project partners: Benecia State Park, CNPS?

Endangered species and other site issues: *S. patens* is growing adjacent to the endangered plant *Cordylathus mollis* spp. *Mollis* (soft birds beak). Also, a survey will need to be conducted to determine whether salt marsh harvest mice are present.

Control Work/details: The demonstration project could begin with the discrete patch of *S. patens* in the northeast corner of the marsh, and implement one or both of two treatment methods. For the first method, adjacent soft birds beak would be temporarily covered with geo-textile fabric, and herbicide would be applied to the patch of S. patens. Alternatively, the patch of *S. patens* could be treated by covering with geotextile fabric, leaving the soft birds beak undisturbed. The second method would likely require follow-up herbicide treatment of surviving *S. patens* plants. Once a suitable means of protecting soft birds beak was developed, the project could be extended to include the remainder of the *S. patens* population.

Reason for selection as a possible demonstration site: *S. patens* is found growing in discrete patches at this site, and this is the only known location of the species in the San Francisco Estuary. Thus, control at this location could lead to the successful eradication of this species in the Estuary. Control of S. patens is particularly important because of the threat it poses to the rare and endangered marsh plant, *Cordylanthus mollis* spp. *mollis,* soft birds beak.

Figure I-1. Possible *Spartina* Control Program First Year Pilot and Demonstration Projects

Table I-1. Possible 2003 Spartina Control Demonstration Sites - Site Selection Criteria With Sites Ranked by Highest Total Score

Weighted Priority #	Map #	Site Name	Outlier population	CLRA absent	CLRA habitat at risk (early invasion)	Small/discrete population	Adjacent mudflats at risk	Invaded channel/Creek at risk	Flood control channel at risk	Landowner partnerships (#)	Landowner partners	Public visibility/ outreach	Restoration site (weighted x 2)	Adjacent to existing restoration site at risk (weighted x 2)	Adjacent to soon to be open restoration site
1	14	San Lorenzo Creek Mouth/Robert's Landing	0	0	0	0	1	1	1	5	City of San Leandro, EBRPD, State Lands, ESA, LSA	1	0	2	0
2	7	Outer Bair Island	0	0	0	0	1	1	0	3	USFWS, DENWR; San Mateo Mosquito Abatement District, San Mateo County Weed Management Area	1	2	2	1
3	2	Corte Madera Creek	1	0	0	0	1	1	1	5	Marin County Parks and Recreation Department, Friends of Corte Madera Creek, Marin Rowing Association, Marin County Open Space, City of Larkspur/Corte Madera	1	0	2	0
4	11	Alameda Flood Control Channel/Coyote Hills Slough	0	1	0	0	1	1	1	2	DENWR, USFWS, Santa Clara Valley Water District	1	0	2	1
5	12	Whales Tail/Alameda Creek	0	0	0	0	1	1	0	3	California Department of Fish and Game, City of San Leandro, USFWS, ….	0	2	2	1
6	13	Oro Loma Marsh	0	1	0	0	1	0	0	1	EBRPD	1	2	2	0
7	4	India Basin	1	1	0	1	1	1	0	4	Port of San Francisco; San Francisco Public Utilities Commission; San Francisco Parks and Recreation Department; League for Environmental Justice	1	0	0	0
8	3	Blackie's Pasture	1	1	0	1	1	1	0	3	City of Tiburon, Marin County Open Space, Marin Audubon…	1	0	0	0

Table I-1. Possible 2003 Spartina Control Demonstration Sites - Site Selection Criteria With Sites Ranked by Highest Total Score

Site Name	Experimental control method	control method	County	Species	Approx. Acreage	Relative size of invasion (1=<1 acre, 2=1-5 acres, 3=5-15 acres, 4=15-50 acres, 5=>50 acres)	Species eradication feasibility	Site eradication feasibility	SUM
San Lorenzo Creek Mouth/Robert's Landing	1	The mouth of San Lorenzo Creek has a very, very dense population of *S. alterniflora* /hybrids. Individual clones are coalescing on the mudflats and developing into a meadow. Based on preliminary reconnaissance, it appears that the sediment in this area could probably support the weight of heavy equipment. If this is the case, this would be an excellent to test the efficacy of smothering by tractors to kill and/or reduce the overall biomass of the non-native cordgrass, with herbicide application as a secondary treatment. EBRPD may be able to provide staff and equipment for this location.	Alameda County	S. *alterniflora* / hybrids	10 of 27 total	3	0	1	**16**
Outer Bair Island	0	Chemical control would be recommend at this location. The populations of *S. alterniflora* /hybrids are quite dense, and boats would be required to access this site and deliver equipment and chemicals. San Mateo Mosquito Abatement District has already been contracted to control the spread of *Spartina* in this area and is thus familiar with the site. All the equipment, including airboats, herbicide applicators, etc. is available. ISP may be able to provide funds for items such as herbicide and labor.	San Mateo County	S. *alterniflora* / hybrids	5-28 of 55 total	5	0	0	**16**
Corte Madera Creek	0	Portions of the site would be suited for a variety of physical and mechanical control such as digging and hand pulling, and other areas would be most effectively and efficiently treated with herbicides. Demonstration work could begin with physical and mechanical control at the Bay front and the upstream reach of the infestation.	Marin County	*S. densiflora*	1 of 13 total	3	0	0	**15**
Alameda Flood Control Channel/Coyote Hills Slough	1	Dredging technique from levy edge, or mowing with additional chemical control with glyphosate. In order to control the dense stand of Spartina that line the slough multiple treatments may be required. The upper, eastern reach of the slough would be a good demonstration site given that no California clapper rail are found in this area. Control could possibly begin in the early summer, which would allow for multiple treatments. The site may be used by researchers from USDA-ARS to examine the efficacy of other herbicide treatments such as fluridone or imazapyr.	Alameda County	S. *alterniflora* / hybrids	14 of 48 total	4	0	0	**15**
Whales Tail/Alameda Creek	0	This recently restored site has numerous large *S. alterniflora* /hybrid clones developing into dense meadows, especially at the bay front of the marsh. This site is adjacent to an area at Eden Landing that is being open to tidal flow for restoration. This site will likely become infested by seed from the Whales Tail/Alameda Creek area. It is recommended that the non-native *Spartina* in the area be controlled if possible, and if not at least seed set be reduced either by mechanical means, mowing in the early summer season (July-August) so as not to release floating stems with fertile seed on the tide, or by chemical means, spraying glyphosate. However, permits would be required for early control work in this CLRA habitat. Ideally a combination of the two methods would be used to control the spread of the plant, not just the seed.	Alameda County	S. *alterniflora* / hybrids	? of 50 total	4	0	0	**14**
Oro Loma Marsh	1	This recently restored site has numerous large *S. alterniflora* /hybrid clones developing throughout the marsh. Access to the clones is said to be quite labor intensive. EBRPD has recently acquired a vehicle that is specially designed for driving though marsh and mud flats. This machine may be used to smoother clones, or access clones for herbicide treatment. This might also be a suitable site to demonstrate diking/drowning techniques.	Alameda County	S. *alterniflora* / hybrids	? of 27 total	4	0	1	**14**
India Basin	0	This is a relative small confined site. A combination of control techniques such as digging, mowing, covering and herbicides could be used, depending on the extent and size of the *S. alterniflora/* hybrid clones at the time of treatment.	San Francisco County	S. *alterniflora* / hybrids	0.1 total (0.76 So.SF total)	1	0	1	**12**
Blackie's Pasture	0	This is a relative small confined site. A combination of control techniques such as digging, mowing, covering and herbicides would be used depending on the extent and size of the individual *S. densiflora* and *S. alterniflora/* hybrid clones. Depending on identification of partners, the Control Program might also include the other discrete clones in the Richardson Bay area such as Strawberry Point and Seminary Cove.	Marin County	*S. densiflora* and *S. alterniflora* / hybrids	0.1 total	1	0	1	**11**

Table I-1. Possible 2003 Spartina Control Demonstration Sites - Site Selection Criteria With Sites Ranked by Highest Total Score

Weighted Priority #	Map #	Site Name	Outlier population	CLRA absent	CLRA habitat at risk (early invasion)	Small/discrete population	Adjacent mudflats at risk	Invaded channel/Creek at risk	Flood control channel at risk	Landowner partnerships (#)	Landowner partners	Public visibility/ outreach	Restoration site (weighted x 2)	Adjacent to existing restoration site at risk (weighted x 2)	Adjacent to soon to be open restoration site
9	15	Emeryville Crescent	1	0	1	1	1	0	0	5	EBRPD, East Shore State Parks, California Department of Transportation (CalTrans), adjacent creek groups? Berkeley Marina?	0	0	0	0
10	1	Pickleweed Park	1	0	1	1	1	1	1	2	City of San Rafael, Marin County Weed Management Area	0	0	0	0
11	5	Colma Creek	0	1	0	0	1	1	0	2	City of San Mateo, San Mateo Weed Management Team	0	0	0	0
12	9	Alviso Slough - Coyote Creek	1	0	1	1	1	1	0	3	USFWS, DENWR; SCVWD; Santa Clara County Weed Management Team	0	0	0	0
13	10	Mowry Slough	1	0	0	1	1	0	0	3	USFWS, DENWR; San Mateo Mosquito Abatement District; San Mateo Weed Management Team	0	0	0	1
14	17	Southampton Marsh	1	0	1	1	0	0	0	2	Benecia State Park, CNPS?	0	0	0	0
15	8	West Point & Ravenswood Slough	0	0	0	0	1	1	0	3	USFWS, DENWR; San Mateo Mosquito Abatement District; San Mateo Weed Management Team	0	0	0	0
16	16	Point Pinole	1	0	1	1	1		0	1	EBRPD	1	0	0	0
17	6	Bayfont Park	0	1	0	0	1	0	0	2	San Mateo Mosquito Abatement District, San Mateo County Weed Management Area	1	0	0	0

Table I-1. Possible 2003 Spartina Control Demonstration Sites - Site Selection Criteria With Sites Ranked by Highest Total Score

Site Name	Experimental control method	control method	County	Species	Approx. Acreage	Relative size of invasion (1=<1 acre, 2=1-5 acres, 3=5-15 acres, 4=15-50 acres, 5=>50 acres)	Species eradication feasibility	Site eradication feasibility	SUM
Emeryville Crescent	0	This marsh has a number of discrete *S. alterniflora* /hybrid clones dispersed along the bay edge. Spot control of the discrete clones would be recommended. However, hybrids that appear like natives will continue to be hidden in the native marsh. Thus, repeated visits will be required for more visual surveys and genetic transects to confirm that the cordgrass in the area is native. A much more conservative approach (to conserving the genetic integrity of this site) would be to control the entire area.	Alameda County	S. *alterniflora* /hybrids	0.25 total	1	0	1	**11**
Pickleweed Park	0	S. densiflora control at this site may include a combination of digging, mowing, covering and herbicide depending on landowner and community opinion. USDA-ARS researchers working with the ISP may propose work at this location to examine efficacy of new S. densiflora control methods, including alternative herbicides (such as fluridone and imazypyr) and application of herbicide to cut plant stumps.	Marin County	*S. densiflora*	0.5 total	1	0	1	**10**
Colma Creek	1	This area is densely covered by *S. alterniflora* /hybrid meadows, which have spread along the creek banks and onto adjacent mudflats. Control would be initiated at the upstream edge of the invasion, and work progressively down to the mudflats. Techniques to reduce seed set would be implemented in areas that cannot be fully treated the first year. This would be a suitable site to test a range of manual, physical, and chemical eradication and seed-set reduction techniques.	San Mateo County	S. *alterniflora* / hybrids	7.5of 50 total	4	0	0	**10**
Alviso Slough - Coyote Creek	0	Spot control by a combination of digging, mowing, covering and herbicide depending on the extent and size of the Spartina clones.	Santa Clara and Alameda Counties	S. *alterniflora* / hybrids	< 0.5 acres total	1	0	1	**10**
Mowry Slough	0	Spot control by a combination of digging, mowing, covering and herbicide depending on the extent and size of the Spartina clones.	Santa Clara and Alameda Counties	S. *alterniflora* / hybrids	0.5 total	1	0	1	**9**
Southampton Marsh	1	The demonstration project could begin with the discrete patch of *S. patens* in the northeast corner of the marsh, and implement one or both of two treatment methods. For the first method, adjacent soft birds beak would be temporarily covered with geo-textile fabric, and herbicide would be applied to the patch of S. patens. Alternatively, the patch of *S. patens* could be treated by covering with geotextile fabric, leaving the soft birds beak undisturbed. The second method would likely require follow-up herbicide treatment of surviving *S. patens* plants. Once a suitable means of protecting soft birds beak was developed, the project could be extended to include the remainder of the *S. patens* population.	Contra Costa County	*S. patens*	0.58 total	1	1	1	**9**
West Point & Ravenswood Slough	0	This location is well suited for demonstration of herbicide control and various seed set reduction methods. The populations of *S. alterni_flora* /hybrids are quite dense. USFWS has contracted San Mateo Mosquito Abatement District to control the spread of *S. alterniflora* in this area. All the equipment, including airboats, herbicide applicators, etc. is available. ISP would provide funds for items such as herbicide and labor, and assistance in planning and coordination, as needed.	San Mateo County	S. *alterniflora* / hybrids	5 of 13 total	3	0	0	**8**
Point Pinole	0	Spot control with a combination of digging, mowing, covering and herbicides depending on the extent and size of the *S. alterniflora* /hybrid and *S. densiflora* clones at the time of treatment.	Contra Costa County	*S. alterniflora* / hybrids and *S. densiflora*	0.01 total	1	0	1	**8**
Bayfont Park	0	The project would focus on control of discrete clones and meadows along the mudflats. The project would demonstrate either a mechanical method of control, or mowing with secondary herbicide application. The site is adjacent to a bike path which may provide access	San Mateo County	S. *alterniflora* / hybrids	0.65 total	1	0	0	**6**

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:
1-1-03-F-0216

Memorandum

To: Assistant Field Supervisor, Habitat Conservation/Environmental Contaminants Program, Sacramento Fish and Wildlife Office, Sacramento, California

From: Assistant Field Supervisor, Endangered Species Program, Sacramento Fish and Wildlife Office, Sacramento, California Cay C. Mordy

Subject: Programmatic Formal Intra-Service Endangered Species Consultation on the San Francisco Estuary Invasive Spartina Project, Marin, Alameda, Contra Costa, San Francisco, Sacramento, Santa Clara, San Mateo, Napa, Solano, and Sonoma Counties, California

This memorandum is in response to your June 16, 2003, request for intra-U.S. Fish and Wildlife Service (Service) section 7 consultation for the effects of the proposed San Francisco Estuary Invasive Spartina Project, Marin, Alameda, Contra Costa, San Francisco, Sacramento, Santa Clara, San Mateo, Napa, Solano, and Sonoma counties, California, on the federally threatened delta smelt (*Hypomesus transpacificus*) and its critical habitat, Sacramento splittail (*Pogonichthys macrolepidotus*), and western snowy plover (*Charadrius alexandrinus nivosus*) and its critical habitat, and the federally endangered California clapper rail (*Rallus longirostris obsoletus*), California least tern (*Sterna antillarum (=albifrons) browni*), California sea-blite (*Suaeda californica*), salt marsh harvest mouse (*Reithrodontomys raviventris*), soft bird's beak (*Cordylanthus mollis* ssp. *mollis*), and Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*), in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Based upon the information provided, we also concur with your determination that the proposed action would have no effect on the federally endangered California brown pelican (*Pelcanus occidentalis californicus*), Callippe silverspot butterfly (*Speyeria callippe callippe*), short-tailed albatross (*Diomedea albatrus*), tidewater goby (*Eucyclogobius newberryi*), Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*), San Bruno elfin butterfly (*Incisalia mossii bayensis*), mission blue butterfly (*Icaricia icarioides missionensis*), Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*), beach layia (*Layia carnosa*), Tidestrom's lupine (*Lupinus tidestromii*), fountian thistle (*Cirsium fontinale* var. *fontinale*), San Francisco garter snake (*Thamnophis sirtalis tetrataenia*), and the federally threatened California red-legged frog (*Rana* *aurora draytonii*), Alameda whipsnake (*Masticophis lateralis euryxanthus*) and its critical habitat, bald eagle (*Haliaeetus leucocephalus*), northern spotted owl (*Strix occidentalis caurina*), California tiger salamander (*Ambystoma californiense*), marbled murrelet (*Brachyramphus marmoratus*), and bay checkerspot butterfly (*Euphydryas editha bayensis*) and its critical habitat. San Francisco Estuary Invasive Spartina Project is unlikely to adversely affect these species because their natural distribution is remote from sites where non-native cordgrass invasions are in progress.

This biological opinion is based on information provided in (1) the "*San Francisco Estuary Invasive Spartina Project: Spartina Control Program*" draft programmatic environmental impact statement/environmental impact report dated February 2003, and (2) additional information in Service files. A complete administrative record of this consultation is on file at the Sacramento Fish and Wildlife Office (SFWO).

Consultation History

On June 16, 2003, the Service initiated programmatic formal intra-Service consultation.

On June 22, 2003, the Service added the three listed plants to the consultation.

BIOLOGICAL OPINION

Description of the Proposed Action

The Service and the California State Coastal Conservancy will implement the San Francisco Estuary Invasive Spartina Project to arrest and reverse the spread of four species of non-native, invasive perennial cordgrass (*Spartina alterniflora*, *S. anglica*, *S. densiflora*, and *S. patens*) in the tidal marshlands and intertidal mudflats of the San Francisco Bay Estuary, and 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.

The Service and the California State Coastal Conservancy will implement the San Francisco Estuary Invasive Spartina Project by employing the following treatment methods: (1) hand-pulling and manual excavation; (2) mechanical excavation and dredging; (3) pruning, flaming, burning, and mowing; (4) crushing and mechanical smothering; (5) covering/blanketing; (6) flooding and draining; and (7) application of herbicides. The Service and the California State Coastal Conservancy will incorporate an Integrated Vegetation Management (IVM) approach including: (1) use of all available information regarding the estuarine ecosystem and cordgrass physiology and ecology; (2) combination with and awareness of likely economic, ecological, and sociological consequences of the cordgrass invasion; (3) implementation of a program that is effective and economical; and (4) protection of public and environmental health.

Individual projects will undergo separate Section 7 consultation.

Hand-Pulling and Manual Excavation

Manual removal methods are the simplest technology for removal of invasive non-native cordgrass and are most effective on isolated seedlings, or very young discrete clones or clumps. Manual excavation in tidal marshes is extremely labor intensive. Manual removal will include 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. Manual removal methods are effective primarily at removing above-ground plant parts, but are less effective at removing below-ground rhizomes that rapidly regenerate shoots. Frequent re-digging and maintenance will be conducted to exhaust rhizome reserves of energy and nutrition, and the population of buds capable of resprouting.

Disposal of manually removed material, especially root/rhizome systems, is problematic. Materials will not be disposed of on-site in marshes because this may cause additional marsh disturbance and may result in spread of invasive cordgrass by regeneration of viable roots. Disposal may occur adjacent to the marsh, if appropriate, where manual removal occurs next to levees, salt ponds, or other nontidal environments. Disposal of manually removed materials may also be accomplished off-site with use of specialized low-ground-pressure equipment (amphibious vehicles).

Mechanical Excavation and Dredging

Mechanical removal in marshes will include use of equipment specially designed for working in semi-terrestrial, semi-aquatic wetland environments. Excavation and dredging will 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). At some locations the implementing agency will use conventional shallow-draft, barge-mounted dredging equipment working within reach of marsh from the margins of navigable channels, particularly at high tide. Where invasive non-native cordgrass colonies lie within the limited reach of track-mounted excavators working from levees, mechanical removal may be performed without entry of equipment to aquatic or wetland environments.

Another mechanical removal technique that may be used is maceration or pulverization of soil and plant remains on site using modified agricultural equipment, "chewing" the cordgrass into particles too small to be viable or regenerate. Floating maceration equipment has been used in inland waterways to control submerged aquatic vegetation. The Service and California State Coastal Conservancy 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.

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 destroy both aboveground and belowground living masses 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 reach of less than 20 feet for the size of 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 the cordgrass vegetation. Excavators with sufficient reach may dispose of excavated marsh soil and biomass in non-tidal areas, such as levees or salt ponds.

Heavy equipment often is used within the San Francisco Estuary's tidal marshes for purposes other than eradication of non-native 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 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, removal of invasive non-native 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 non-native cordgrass on the marsh plain. Some tidal flats invaded by cordgrass occur on sandy deltas with intertidal sand bars where equipment could be staged, but this situation is unusual. The use of any particular mechanical excavation or dredging method at a particular location will be determined based on site-specific conditions and feasibility.

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 Service and California State Coastal Conservancy will "beneficially re-use" excavated or dredged materials from cordgrass eradication sites to facilitate restoration of diked baylands. For example, disposal sites may include abandoned commercial salt evaporation ponds, where thousands of acres of tidal marsh restoration are proposed and where ground surface elevations are usually subsided below the desirable level for restoration. In addition, salt pond condition following discontinuance of salt production operations is usually dry or hypersaline, both of which 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, disposal of materials from eradication projects to assist wetland restoration may also be feasible. "Disposal" of material from invasive non-native 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 (Goals Project 1999). The Service and California State Coastal Conservancy will 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. Beneficial re-use proposals will undergo separate formal section 7 consultation, where appropriate.

Mowing, Burning, Pruning, and Flaming

All species of cordgrass 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. However, 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 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 invasive non-native cordgrass, this may require weekly 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" 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 (*Spartina foliosa*), 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 will be removed from the treatment site and disposed 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. The objective is to smother the plant by preventing the use of stems to transport oxygen to its roots and rhizomes. 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. 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 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 of invasive non-native cordgrass, 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. All species of cordgrass 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 all species of cordgrass, native and non-native alike. Invasive non-native cordgrass are capable of invading tidal marsh pools (salt pans) subject to irregular tidal influence 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. 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 analogous with inflatable cofferdams used in aquatic construction/dewatering operations, may be used. 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 cordgrass 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 non-native cordgrass. Restoring tidal flows to temporary salt ponds, however, may require dilution of brines, which could increase cost. The Service and California State Coastal

Conservancy will 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 cordgrass. Glyphosate, the herbicide proposed for use by the Service and California State Coastal Conservancy, is the only herbicide currently approved by the U.S. Environmental Protection Agency for use in aquatic environments. 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 the plant. Although it is highly toxic to plants, glyphosate has exceptionally low toxicity to mammals, birds, and fish.

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 Service and California State Coastal Conservancy are Agri-dex and LI-700, and 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. 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 Service and California State Coastal Conservancy.

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, – 24 nitrosoglyphosate (NNG). The potential effects of AMPA and NNG are encompassed by the available toxicity data on glyphosate and glyphosate formulations. 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, and potential movement of glyphosate to groundwater is unlikely.

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 and LI-700 have been selected for use by the Control Program as among the least toxic of the available surfactants.

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). 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.

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.

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.

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. Studies of toxicity of glyphosate mixtures in saline or estuarine environments are few, and data are unreliable. The Service and California State Coastal Conservancy will perform studies, including bioassays, during the early phases of the determine if there are additional toxic effects of the herbicide mixtures.

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.

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). 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 will be used infrequently, and primarily at large areas of dense non-native cordgrass infestations, particularly in locations where little native cordgrass and other non-target plants are nearby.

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 after application. The initial tidal submergence of sprayed surfaces disperses a large fraction of applied glyphosate and surfactant.

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.

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). 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 invasive non-native cordgrass in aquatic environments, the product labels specify a 1 to 2 percent solution applied with hand-held or high volume equipment, 5 to 8 percent solution for low volume directed spot treatments, 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 will be added at a ratio 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. The exact solution concentration and application rates for each constituent are determined based on site specific conditions.

High mortality to all species of cordgrass 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 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 will occur July through November, while the plants are in peak flowering stage (or later), and still green. Where appropriate, spraying will 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.

Application of glyphosate will 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.

Integrated Vegetation Management

The proposed San Francisco Estuary Invasive Spartina Project includes a modified "integrated vegetation management" (IVM) approach to prioritize and implement control efforts. 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 proposed San Francisco Estuary Invasive Spartina Project will be implemented on the assumption that full eradication of the invasive non-native 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 cordgrass. 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 proposed San Francisco Estuary Invasive Spartina Project objective would revert to long-term management rather than eradication.

While current "best science" sets the initial course of the proposed San Francisco Estuary Invasive Spartina Project, new information regarding cordgrass species and their effects on the ecosystems screened. During the coming years, the proposed San Francisco Estuary Invasive Spartina Project 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 non-native cordgrass onto mudflats; and the successional processes that will occur at locations invaded by non-native cordgrass. Such information will be used to help guide future planning decisions.

Prioritization Strategy

Particularly during the initial months of the proposed San Francisco Estuary Invasive Spartina Project, it would be important to carefully select which sites would be treated and when. Consistent with the IVM approach, the first priority would be to prevent the establishment of new non-native 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, or near a proposed tidal marsh restoration site where it would quickly infest the newly restored habitat. In addition, the proposed San Francisco Estuary Invasive Spartina Project 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 proposed San Francisco Estuary Invasive Spartina Project would target the control of pollen and seed spread from established non-native and hybrid cordgrass 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. Once the spread of invasive non-native cordgrass to new areas is under control, the proposed San Francisco Estuary Invasive Spartina Project 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. In anticipation of delays implementing control at sites with clapper rails, the proposed San Francisco Estuary Invasive Spartina Project 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. 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.

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 avoidance and impact minimization, adjacent land uses, sensitive receptors, site safety and access, spill prevention, and so on. In all cases, the proposed San Francisco Estuary Invasive Spartina Project would rely heavily on partnerships with the landowners and land managers to plan and complete the work.

In the first few years, the proposed San Francisco Estuary Invasive Spartina Project 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.

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 rail occupied marshes, and necessitate careful planning for efficient use of resources and effective treatment. For example, in 2003, 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 non-native cordgrass had caused sufficient sediment accretion to shift from cordgrass marsh to pickleweed (*Salicornia virginica*) 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.

Monitoring and post-treatment management would also be relatively simple near the range limits of invasive non-native 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 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 non-native 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 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 (non-native cordgrass pollen sources) are substantial. Spontaneous recruitment of cordgrass in treated areas is an important indicator of the effectiveness of regional control. For large treatment sites managed to be restored to native 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 non-native 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 proposed San Francisco Estuary Invasive Spartina Project would implement a number of pilot and demonstration projects during the first control season, beginning approximately April 2003. The first year projects would be selected to be consistent with the proposed San Francisco Estuary Invasive Spartina Project'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 non-native 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).

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. 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 cordgrass would be treated. However, the proposed San Francisco Estuary Invasive Spartina Project anticipates that only six to ten of the fourteen 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.

Conservation Measures

1. Vehicle and foot access pathways in marsh invaded by non-native cordgrass, including marsh access to invaded mudflats will be minimized.

2. Excavating and dredging equipment working in marsh plains will be restricted to mats and geotextile fabric covers.

3. 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.) will be used to minimize incidental overspray and drift.

4. To reduce damage to non-target vegetation, herbicide spraying will not occur if winds exceed 10 mph. Anti-drift cones will be used whenever needed to prevent drift to non-target vegetation.

5. Herbicide spray dose requirements for effective treatment will be minimized by pre-treatments where feasible. Mowing, crushing, or burning pre-treatments to reduce live cordgrass density and increase exposure of receptive young growth will be used where it is determined to be less environmentally damaging than spraying alone.

6. Removal methods other than helicopter applications of herbicide will be used whenever feasible and less environmentally damaging. If new technology is available and feasible, nonspray application techniques (e.g., modified cut-stump herbicide paste or wicking techniques) will be used to reduce herbicide dose and minimize non-target contact.

7. Cleared patches will be monitored for recruitment of invasive plant species including perennial pepperweed (*Lepidium latifolium*) until native vegetation has become dominant.

8. To prevent seed dispersal, mowing/shredding operations will occur before non-native cordgrass plants have viable seeds. In situations where this is not possible, cut debris will be mounded on-site and composted under heat-retaining geotextile fabric or black plastic in warm weather.

9. Excavated nonnative cordgrass, including rhizomes, and excavated sediment will be stockpiled and removed from marsh.

10. Optimal combinations of treatment will 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).

11. Smothering geotextile mats will be stabilized with stakes and weights, and inspected frequently.

12. For work in infested North Bay marshes where delta smelt or Sacramento splittail may occur (currently only Southhampton Marsh, Benicia), impoundment techniques will be prohibited.

13. Any intertidal excavation or dredging in tidal creeks will be restricted to tidal stages when target areas are above water level.

14. Even where environmental conditions indicate low probability of presence, and low potential abundance of the salt marsh harvest mouse, the species will be presumed to be present in project areas containing mixed pickleweed vegetation.

15. Use of vehicles in potential tidal marsh habitat of the salt marsh harvest mouse and tidal marsh shrew species will be minimized. Shortest possible access paths will be determined prior to marsh entry, and will be flagged to limit travel patterns of vehicles to areas with mats or geotextile covers.

16. When possible, work will be scheduled in suitable small-mammal habitat soon after natural mass-mortality events caused by extreme high tides.

17. Spilled glyphosate/surfactant solutions on mudflats will be removed to the greatest extent feasible by suction of surface muds, using portable wet vacuum or pumping equipment.

18. Treatment in potential clapper rail habitat will be conducted outside of the clapper rail breeding season unless breeding season call counts conducted in the spring of the treatment year have determined that the treatment site is unoccupied by clapper rails. Treatment in occupied clapper rail habitat will be conducted outside of the clapper rail breeding season.

19. All dredging proposals will 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, will be used to evaluate sediment samples from proposed cordgrass dredge sites. In addition, the U.S. Fish and Wildlife Service will review and regulate dredging in clapper rail habitat through formal endangered species consultation. These stringent reviews and subsequent authorizations will 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.

20. Prior to levee access in areas where snowy plovers may breed, levee routes will be surveyed for potential nests, including nests in salt pond beds near levee roads.

21. Dredging and excavation of non-native cordgrass will not be conducted when least terns are in the area.

22. Pre-project spring surveys for California sea-blite, soft bird's beak and Suisun thistle will be conducted where these species are known to occur, have recently occurred, or are suspected to occur. Surveys will be done 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 California sea-blite, soft bird's beak and Suisun thistle will be recorded, and field crews on foot or in vehicles will be instructed to avoid and protect those areas.

23. Qualified, experienced on-site botanical supervision will be required if California sea-blite, soft bird's beak and Suisun thistle occur in the vicinity of eradication work.

24. If California sea-blite, soft bird's beak and Suisun thistle occur near the high tide line, mown invasive non-native cordgrass will be removed during the growing season.

25. Burning in marshes supporting California sea-blite, soft bird's beak and Suisun thistle will be prohibited.

Action Area

The action area for the proposed San Francisco Estuary Invasive Spartina Project encompasses 40,000 acres of tidal marsh and 29,000 acres of tidal flats supporting habitats for the California clapper rail, California least tern, California sea-blite, delta smelt and its critical habitat, Sacramento splittail, salt marsh harvest mouse, soft bird's beak, Suisun thistle, and western snowy plover and its critical habitat.

Status of the Species/Environmental Baseline

California Clapper Rail

The clapper rail was federally listed as endangered in 1970 (35 **FR** 16047)(Service 1970). A detailed account of the taxonomy, ecology, and biology of the clapper rail is presented in the Recovery Plan (Service 1984). The clapper rail is a fully protected species under California law (See California Fish and Game Code Section 3511).

The clapper rail is endemic to tidally influenced salt and brackish marshes of California. Historically, the clapper rail occurred in tidal marshes along California's coast from Morro Bay, San Luis Obispo County, to Humboldt Bay, Humboldt County. Currently, clapper rails are known to occur in tidal marshes in San Francisco, San Pablo, Grizzly, Suisun and Honker Bays.

The clapper rail is distinguishable from other rails by its large body size of 32-47 cm from bill to tail, and weighs approximately 250-350 g. It has a long, slightly decurved orange bill, a rufous breast, black and white barred flanks, and white undertail coverts (Ripley 1977). Clapper rails are sexually dimorphic, the males are slightly larger than females (Garcia 1995). Juveniles have a pale bill and dark plumage.

Clapper rails are typically found in the intertidal zone and sloughs of salt and brackish marshes dominated by pickleweed, native cordgrass, gumplant (*Grindelia spp.*), salt grass (*Distichlis spicata*), jaumea (*Jaumea carnosa*) and adjacent upland refugia. They may also occupy habitats with other vegetative components, which include, but are not limited to bulrush *(Scirpus americanus* and *S. maritimus*), cattails (*Typha spp.*), and Baltic rush (*Juncus balticus*).

Pair bonds are typically established during the month of February, and nesting typically occurs from March through August. Estimates of California clapper rail clutch size range from 5-14 eggs (DeGroot 1927, Gill 1972). The clapper rail builds a bowl shaped platform nest of marsh vegetation and detritus (DeGroot 1927, Zucca 1954, Gill 1972, Harvey 1980, Foerster *et al.* 1990, Garcia 1995). The clapper rail typically feeds on benthic invertebrates, but its diet is wide ranging, and includes seeds, and occasionally small mammals such as the harvest mouse.

Similar to the harvest mouse, suitable habitat has been significantly reduced by approximately 84 percent of historic in the San Francisco Bay Area due to habitat conversions for urban and agricultural uses, and is a primary factor in the species decline. Additional impacts which have contributed to the decline in clapper rail populations include over-harvesting, environmental contaminants, and erosion or subsidence of habitat.

California Least Tern

California least tern was federally listed as a threatened species on October 13, 1970, (35 **FR** 16047) (Service 1970). The California least tern is a fully protected species under California law (See California Fish and Game Code Section 3511).

California least terns are small grey and white seabirds with long, narrow, black-tipped wings and a black cap. The California least tern is one of the smallest members of its family, diving head first into the water after a wide variety of small fish.

California least terns are migratory and spend the breeding season, from April through August, along the central and southern California coast, as well as along northern Baja California, Mexico. Historically, the breeding range stretched from Monterey County, California, to Cabo San Lucas, Baja California Sur, Mexico (Atwood and Minsky 1983). California least terns nest in colonies on sandy beaches that are usually associated with river mouths or estuaries. Nesting habitat has been degraded by high levels of human disturbance in Sandy dune areas as well as by the effects of urbanization, including industrial, recreational, and residential development of the shoreline. California least terns, however, have successfully used created sites for nesting, including areas on dredge-spoil islands, open areas adjacent to airport runways, and industrial ports. Like western snowy plovers, California least terns are ground nesting birds. They feed themselves and their chicks with small fish captured from nearshore waters, estuaries, river mouths, and bays (Massey 1974; Atwood and Minsky 1983).

Low rates of reproductive success of California least terns have been linked to several factors. El Nino events, which cause nearshore water temperatures to rise, have depressed food availability for California least terns, which may in turn reduce California least tern productivity. The lowest annual production ever recorded for California least terns occurred after the 1982-1983 El Nino event, when fish populations off the shores of southern California plummeted (Massey *et al.* 1992). In addition to their vulnerability to catastrophic events, California least tern colony sites in California have become restricted to fewer and smaller areas that are often surrounded by highly developed settings, leaving California least tern colonies susceptible to human disturbance as well as to intense predation.

Contaminants bioaccumulated in fish eaten by California least terns may be another contributing factor to California least terns low reproductive success. Preliminary research on contaminants show elevated levels of PCB's in California least tern eggs collected from sites around San Francisco Bay (Hothem and Zador 1995).

Although California least terns can and do nest again after losing eggs and chicks, some adults may abandon further breeding attempts that season (Fancher 1992). California least terns are fairly faithful to breeding sites and return year after year regardless of past nesting success. In addition, there is some evidence that California least terns tend to return to their natal nest sites to breed (Atwood and Massey 1988). This may have major conservation implications because the average expected breeding life of California least terns is estimated at more than 9 years (Massey *et al.* 1992). California least terns breed after their second year, and first-time breeders are more likely to nest later in the breeding season (Massey and Atwood 1981).

Between 1978 and 1994, approximately 50 sites in California supported nesting California least terns (Fancher 1992; DFG 1995). Fewer sites have been used in recent years; for example, only 36 sites were used in 1994 (DFG 1995). Furthermore, most of California least terns nest at only a few select sites. In 1994, 76% of the population nested at nine sites, all in southernmost coastal California. Four of the nine sites (in Los Angeles, Orange, and San Diego counties) supported 48% of the breeding pairs (DFG 1995).

In 1970, the California least tern population was estimated at 600 breeding pairs (Fancher 1992). By 1994, the population had increased to an estimated 2,792 pairs, which represents more than a fourfold increase (DFG 1995). Although the increase in the breeding population has not been consistent from year to year, long term trends have shown steady population growth. California least tern population growth has been sustained even though ratios of fledglings to adults have fluctuated between colony sites and years (Massey *et al.* 1992; DFG 1995). Population growth rates have increased since the mid-1980's, when active management for California least terns was initiated.

Management of California least tern colonies has included intensive monitoring of nesting colonies, site preparation to reduce vegetative cover, protection of sites by means of reduced access to humans, and predator management.

California Sea-Blite

California sea-blite was federally listed as endangered on December 15, 1994 (59 **FR** 64613) (Service 1994a). The species has not been officially listed by the State of California.

California sea-blite is a succulent-leaved perennial plant of the goosefoot family (Chenopodiaceae), and 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 invasive non-native cordgrass. Beach-salt marsh transition zones are also a prime habitat for invasive non-native cordgrass.

Delta Smelt

Delta smelt was federally listed as a threatened species on March 5, 1993, (58 **FR** 12854). Please refer to the Service (1993a, 1994b, 1996) and California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) (1994) for additional information on the biology and ecology of this species.

Description: Delta smelt are slender-bodied fish that typically reach 60-70 mm standard length (measured from tip of the snout to origin of the caudal fin), although a few may reach 120 mm standard length. The mouth is small, with a maxilla that does not extend past the midpoint of the eye. The eyes are relatively large, with the orbit width contained approximately 3.5-4 times in the head length. Small, pointed teeth are present on the upper and lower jaws. The first gill arch has 27-33 gill rakers and there are 7 branchiostegal rays (paired structures on either side and below the jaw that protect the gills). Counts of branchiostegal rays are used by taxonomists to identify fish. The pectoral fins reach less than two-thirds of the way to the bases of the pelvic fins. There are 9-10 dorsal fin rays, 8 pelvic fin rays, 10-12 pectoral fin rays, and 15-17 anal fin rays. The lateral line is incomplete and has 53-60 scales along it. There are 4-5 pyloric caeca. Live fish are nearly translucent and have a steely-blue sheen to their sides. Occasionally there may be one chromatophore (cellular organelle containing pigment) between the mandibles, but usually there is none. Delta smelt belong to the family Osmeridae, a more ancestral member of the order Salmoniformes which also includes the family Salmonidae (salmon, trout, whitefish, and graylings) (Molye and Cech 1988).

Distribution: Delta smelt are endemic to the upper Sacramento-San Joaquin estuary. They occur in the Delta primarily below Isleton on the Sacramento River, below Mossdale on the San Joaquin River, and in Suisun Bay. They move into freshwater when spawning (ranging from January to July) and can occur in: (1) the Sacramento River as high as Sacramento, (2) the Mokelumne River system, (3) the Cache Slough region, (4) the Delta, and, (5) Montezuma Slough, (6) Suisun Bay, (7) Suisun Marsh, (8) Carquinez Strait, (9) Napa River, and (10) San Pablo Bay. It is not known if delta smelt in San Pablo Bay are a permanent population or if they are washed into the Bay during high outflow periods. Since 1982, the center of delta smelt abundance has been the northwestern Delta in the channel of the Sacramento River. In any month, two or more life stages (adult, larvae, and juveniles) of delta smelt have the potential to be present in Suisun Bay (DWR and Reclamation 1994; Molye 1976; and Wang 1991). Delta smelt are also captured seasonally in Suisun Marsh.

The Interagency Ecological Program's (IEP) 20mm Survey recorded delta smelt in the Carquinez Strait in 1995, 1996, 1997, 1998, 1999, 2000, and 2001 (DFG 2000). In 1995, 1996, 1997, 1998, 1999, 2000, 2001, and 2002 delta smelt were collected in Suisun Bay (DFG 2000). Delta smelt have been captured in the 20-mm surveys conducted by DFG in the Napa River Estuary from 1995 through 2001, with the exception of 1997 when delta smelt apparently were absent (DFG 2000). Three individuals were collected over a 4-year period at the Pond 2A Restoration Project in the Napa River Estuary (MEC Analytical Systems 2000).

Habitat Requirements: Delta smelt are euryhaline (a species that tolerates a wide range of salinities) fish that generally occur in water with less than 10-12 parts per thousand (ppt) salinity. However, delta smelt have been collected in the Carquinez Strait at 13.8 ppt and in San Pablo Bay at 18.5 ppt (DFG 2000). In recent history, they have been most abundant in shallow areas where early spring salinities are around 2 ppt. However, prior to the 1800's before the construction of levees that created the Delta Islands, a vast fluvial marsh existed in the Delta and the delta smelt probably reared in these upstream areas. During the recent drought (1987-92), delta smelt were concentrated in deep areas in the lower Sacramento River near Emmaton, where average salinity ranged from 0.36 to 3.6 ppt for much of the year (DWR and Reclamation 1994). During years with wet springs (such as 1993), delta smelt may continue to be abundant in Suisun Bay during summer even after the 2 ppt isohaline (an artificial line denoting changes in salinity in a body of water) has retreated upstream (Sweetnam and Stevens 1993). Fall abundance of delta smelt is generally highest in years when salinities of 2 ppt are in the shallows of Suisun Bay during the preceding spring ($p < 0.05$, $r = 0.50$) (Herbold 1994) (p is a statistical abbreviation for the probability of an analysis showing differences between variables, r is a statistical abbreviation for the correlation coefficient, a measure of the linear relationship of two variables). Herbold (1994) found a significant relationship between number of days when 2 parts per thousand was in Suisun Bay during April with subsequent delta smelt abundance ($p < 0.05$, $r = 0.49$) (Figure 2.2), but noted that autocorrelations (interactions among measurements that make relationships between measurements difficult to understand) in time and space reduce the reliability of any analysis that compares parts of years or small geographical areas. It should also be noted that the point in the estuary where the 2 ppt isohaline is located (X2) does not necessarily regulate delta smelt distribution in all years. In wet years, when abundance levels are high, their distribution is normally very broad. In late 1993 and early 1994, delta smelt were found in Suisun Bay region despite the fact that X2 was located far upstream. In this case, food availability may have influenced delta smelt distribution, as evidenced by the *Eurytemora* found in this area by DFG. In Suisun Marsh, delta smelt larvae occur in both large sloughs and small dead end sloughs. New studies are under way to test the hypothesis that adult fall abundance is dependent upon geographic distribution of juvenile delta smelt.

Life History: Wang (1986) reported spawning taking place in fresh water at temperatures of about 7°-15° Celsius (C). However, ripe delta smelt and recently hatched larvae have been collected in recent years at temperatures of 15°-22° C, so it is likely that spawning can take place over the entire 7°-22° C range. Temperatures that are optimal for survival of embryos and larvae have not yet been determined, although R. Mager, UCD, (unpublished data) found low hatching success and embryo survival from spawns of captive fish collected at higher temperatures. Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures relatively cool, usually less than 20°-22° C in summer. When not spawning, they tend to be concentrated near the zone where incoming salt water and out flowing freshwater mix (mixing zone). This area has the highest primary productivity and is where zooplankton populations (on which delta smelt feed) are usually most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). At all life stages delta smelt are found in greatest abundance in the top 2 m of the water column and usually not in close association with the shoreline.

Delta smelt inhabit open, surface waters of the Delta and Suisun Bay, where they presumably school. In most years, spawning occurs in shallow water habitats in the Delta. Shortly before spawning, adult smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966, Moyle 1976, Wang 1991). Migrating adults with nearly mature eggs were taken at the Central Valley Projects's (CVP) Tracy Pumping Plant, located in the south Delta, from late December 1990 to April 1991 (Wang 1991). In February 2000, gravid adults were found at both CVP and the State Water Projects' (SWP) fish facilities in the south Delta. Spawning locations appear to vary widely from year to year (DWR and Reclamation 1993). Sampling of larval smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone between Frank's and Webb tracts, and possibly other areas (Wang 1991). In years of moderate to high Delta outflow, smelt larvae are often most abundant in Suisun Bay and sloughs of Suisun Marsh, but it is not clear the degree to which these larvae are produced by locally spawning fish and the degree to which they originate upstream and are transported by river currents to the bay and marsh. Some spawning probably occurs in shallow water habitats in Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999 and Wang 1991). Spawning has also been recorded in Montezuma Slough near Suisun Bay (Wang 1986) and also may occur in Suisun Slough in Suisun Marsh (P. Moyle, UCD, unpublished data).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Pre-spawning adults are found in Suisun Bay and the western delta as early as September (DWR and Reclamation 1994). Moyle (1976) collected gravid adults from December to April, although ripe delta smelt were common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1993 as cited in Water Resources and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a University of California at Davis (UCD) study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976; Wang 1986, 1991; Moyle *et al.* 1992). Although delta smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), some researchers believe the adhesive, demersal eggs attach to substrates such as cattails, tules, tree roots, and submerged branches in shallow waters (Moyle 1976, Wang 1991).

Laboratory observations have indicated that delta smelt are broadcast spawners (DWR and Reclamation 1994) and eggs are demersal (sinks to the bottom) and adhesive, sticking to hard substrates such as: rock, gravel, tree roots or submerged branches, and submerged vegetation (Moyle 1976; Wang 1986). At 14°-16° C, embryonic development to hatching takes 9 -14 days and feeding begins 4-5 days later (R. Mager, UCD, unpublished data). Newly hatched delta smelt have a large oil globule that makes them semi-buoyant, allowing them to maintain themselves just off the bottom (R. Mager, UCD, unpublished data), where they feed on rotifers (microscopic crustaceans used by fish for food) and other microscopic prey. Once the swimbladder (a gas-filled organ that allows fish to maintain neutral buoyancy) develops, larvae become more buoyant and rise up higher into the water column. At this stage, 16-18 mm total length, most are presumably washed downstream until they reach the mixing zone or the area immediately upstream of it. Growth is rapid and juvenile fish are 40-50 mm long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). By this time, young-of-year fish dominate trawl catches of delta smelt, and adults become rare. Delta smelt reach 55-70 mm standard length in 7-9 months (Moyle 1976). Growth during the next 3 months slows down considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966). There is no correlation between size and fecundity, and females between 59-70 mm standard length lay 1,200 to 2,600 eggs (Moyle *et al.* 1992). The abrupt change from a single-age, adult cohort during spawning in spring to a population dominated by juveniles in summer suggests strongly that most adults die after they spawn (Radtke 1966 and Moyle 1976). However, in El Nino years when temperatures rise above 18° C before all adults have spawned, some fraction of the unspawned population may also hold over as two-year-old fish and spawn in the subsequent year. These two-year-old adults may enhance reproductive success in years following El Nino events.

In a near-annual fish like delta smelt, a strong relationship would be expected between number of spawners present in one year and number of recruits to the population the following year. Instead, the stock-recruit relationship for delta smelt is weak, accounting for about a quarter of the variability in recruitment (Sweetnam and Stevens 1993). This relationship does indicate, however, that factors affecting numbers of spawning adults (*e.g.*, entrainment, toxics, predation) can have an effect on delta smelt numbers the following year.

Delta smelt feed primarily on (1) planktonic copepods (small crustaceans used by fish for food), (2) cladocerans (small crustaceans used by fish for food), (3) amphipods (small crustaceans used by fish for food) and, to a lesser extent, (4) on insect larvae. Larger fish may also feed on the opossum shrimp, *Neomysis mercedis*. The most important food organism for all sizes seems to be the euryhaline copepod, *Eurytemora affinis*, although in recent years the exotic species, *Pseudodiaptomus forbesi*, has become a major part of the diet (Moyle *et al.* 1992). Delta smelt are a minor prey item of juvenile and subadult striped bass, *Morone saxatilis*, in the Sacramento-San Joaquin Delta (Stevens 1966). They also have been reported from the stomach contents of white catfish, *Ameiurus catus*, (Turner 1966 *in* Turner and Kelley (eds) 1966) and black crappie, *Pomoxis nigromaculatus*, (Turner 1966 *in* Turner and Kelley 1966) in the Delta.

Abundance: The smelt is endemic to Suisun Bay upstream of San Francisco Bay and throughout the Delta, in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties, California. Historically, the smelt is thought to have occurred from Suisun Bay and Montezuma Slough, upstream to at least Verona on the Sacramento River, and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993).

Since the 1850s, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to an increase in siltation and the alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94% of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992). The extensive levee system in the Delta has led to a loss of seasonally flooded habitat and significantly changed the hydrology of the Delta ecosystem, restricting the ability of suitable habitat substrates to re-vegetate.

Delta smelt were once one of the most common pelagic (living in open water away from the bottom) fish in the upper Sacramento-San Joaquin estuary, as indicated by its abundance in DFG trawl catches (Erkkila *et al.* 1950; Radtke 1966; Stevens and Miller 1983). Delta smelt abundance from year to year has fluctuated greatly in the past, but between 1982 and 1992 their population was consistently low. The decline became precipitous in 1982 and 1983 due to extremely high outflows and continued through the drought years 1987-1992 (Moyle *et al.* 1992).

In 1993, numbers increased considerably, apparently in response to a wet winter and spring. During the period 1982-1992, most of the population was confined to the Sacramento River channel between Collinsville and Rio Vista (D. Sweetnam, DFG unpublished data). This was still an area of high abundance in 1993, but delta smelt were also abundant in Suisun Bay. The actual size of the delta smelt population is not known. Stevens *et al.* (1990) estimated the population size to be about 280,000, but they recognized that this value is based on a tenuous relationship between delta smelt numbers and numbers of young striped bass, and is imperfect. However, the pelagic life style of delta smelt, short life span, spawning habits, and relatively low fecundity indicate that a fairly substantial population probably is necessary to keep the species from becoming extinct.

Recreation in the Delta has resulted in the presence and propagation of predatory non-native fish such as striped bass (*Morone saxatilis*). Additionally, recreational boat traffic has led to a loss of habitat from the building of docks and an increase in the rate of erosion resulting from boat wakes. In addition to the loss of habitat, erosion reduces the water quality and retards the production of phytoplankton in the Delta.

In addition to the degradation and loss of estuarine habitat, delta smelt have been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of the steadily increasing proportion of river flow being diverted from the Delta by the Projects, and occasional droughts (Monroe and Kelly 1992).

Reduced water quality from agricultural runoff, effluent discharge and boat effluent has the potential to harm the pelagic larvae and reduce the availability of the planktonic food source. When the mixing zone is located in Suisun Bay where there is extensive shallow water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). The introduction of the Asian clam (*Potamocorbula amurensis)*, a highly efficient filter feeder, presently reduces the concentration of phytoplankton in this area.

According to seven abundance indices which provide information on the status of the delta smelt, this species was consistently at low population levels through the 1980's (Stevens *et al.* 1990). These same indices also showed a pronounced decline from historical levels of abundance (Stevens *et al.* 1990).

For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone, where the salinity is approximately 2 ppt. (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993). The relationship between the portion of the smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988, indicates the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cubic feet per second, placing X2 between Chipps and Roe islands (DWR and Reclamation 1994).

Specifically, the summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959) (DFG 2001). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species (DFG 2001). Since 1983, (except for 1986, 1993, and 1994), this index has remained at consistently lower levels than previously found (DFG 2001). These consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the confluence (DFG 2001).

The final summer townet index for 2000 was 8.0, a decline from the 11.9 index for the 1999 summer townet (DFG 2001). Both of these indices represent an increase from the 1998 index of 3.3. However, both 1999 and 2000 indices are still below the pre-decline average of 20.4 (1959-1981, no sampling in 1966-1968) (DFG 2001).

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990, DFG 1999a). The FMWT indicates the abundance of the adult population just prior to upstream spawning migration (DFG 1999a). The index calculated from the FMWT uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled (DFG 1999a). Until recently, except for 1991, this index has declined irregularly over the past 20 years (DFG 1999a). Since 1983, the delta smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded (DFG 1999a). The 1994 FMWT index of 101.2 was a continuation of this trend (DFG 1999a). This occurred despite the high 1994 summer townet index for reasons unknown (DFG 1999a). The low 1995 summer townet index value of 3.3 was followed by a high FMWT index of 839 reflecting the benefits of higher flows due to an extremely wet year (DFG 1999a, 2001).

The 1999 FMWT index of 717, which is an increase from 1998's index (417.6), is the third highest since the start of decline of delta smelt abundance in 1982 (DFG 1999a). The FMWT abundance index (127) for 1996 represented the fourth lowest on record (DFG 1999a). The 1997 abundance index (360.8) almost tripled since the 1996 survey, despite the low summer townet index (4.0) (DFG 1999a, 2001).

Both 2001 TNS and FMWT abundance indices for delta smelt decreased from 2000 (Souza and Bryant 2002, DFG 1999a and 2001). The 2001 TNS delta smelt index (3.5) is less than 1999 (11.9) and 2000 (8.0) but comparable to recent years (1995, 1997, and 1998) when the index ranged from 3.2 to 4.0 (Souza and Bryant 2002, DFG 2001). The 2001 FMWT delta smelt index (603) decreased by 20% from 2000 (756) (Souza and Bryant 2002, DFG 2001). Both surveys exhibited an overall trend of decline in the last three years, but this decline seems more pronounced in the TNS where the 2001 delta smelt index is 95% lower than the greatest index of record (62.5) in 1978 (Souza and Bryant 2002, DFG 2001).

Abundance in the Napa River is highly variable from year to year and the population has historically rebounded (e.g., the increase in abundance from 1992 to 1993). Freshwater outflow to the project area has the greatest influence on delta smelt abundance in the project area. Delta smelt would be present in the Rapa River Salt Marsh Restoration Project area during the winter and through early summer when salinity levels are between 15 and 5 ppt. It is during this time that species abundance would be highest.

Swimming Behavior: Observations of delta smelt swimming in a swimming flume and in a large tank show that these fish are unsteady, intermittent, slow speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<3 body lengths per second), and during spontaneous, unrestricted swimming in a 1 m tank, smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50% for "stroke and glide" swimming compared to steady swimming. However, the maximum speed smelt are able to achieve using this mode of swimming is less than 3 body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Although juvenile delta smelt appear to be stronger swimmers than adults, forced swimming at 3 body lengths per second in a swimming flume was apparently stressful; the smelt were prone to swimming failure and extremely vulnerable to impingement (Swanson and Cech 1995). Delta smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints (Brett 1976).

Delta Smelt Critical Habitat

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR §424.12(b)).

The Service is required to list the known primary constituent elements together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. space for individual and population growth, and for normal behavior;
2. food, water, air, light, minerals, or other nutritional or physiological requirements;
3. cover or shelter;
4. sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and

5. generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Critical habitat for delta smelt was originally proposed in the lower Sacramento-San Joaquin Delta and Suisun and Honker bays. However, after considerable debate, critical habitat was re-proposed and is now contained within Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties.

Spawning habitat. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

Larval and juvenile transport. Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay and to ensure that rearing habitat is maintained in Suisun Bay. To ensure this, X2 must be located westward of the confluence of the Sacramento-San Joaquin Rivers, located near Collinsville (Confluence), during the period when larvae or juveniles are being transported, according to historical salinity conditions. X2 is important because the "entrapment zone" or zone where particles, nutrients, and plankton are "trapped", leading to an area of high productivity, is associated with its location. Habitat conditions suitable for transport of larvae and juveniles may be needed by the species as early as February 1 and as late as August 31, because the spawning season varies from year to year and may start as early as December and extend until July.

Rearing habitat. An area extending eastward from Carquinez Strait, including Suisun, Grizzly, and Honker bays, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of historical tidal incursion. Rearing habitat is vulnerable to impacts of export pumping and salinity intrusion from the beginning of February to the end of August.

Adult migration. Adequate flow and suitable water quality is needed to attract migrating adults in the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas are vulnerable to physical disturbance and flow disruption during migratory periods.

The Service's 1995 biological opinion provided for adequate larval and juvenile transport flows, rearing habitat, and protection from entrainment for upstream migrating adults (Service 1995). Please refer to 59 **FR** 65255 for additional information on delta smelt critical habitat (Service 1994b).

Sacramento Splittail

The Sacramento splittail was federally listed as threatened on March 8, 1999, (64 **FR** 25). Please refer to the Service (1995, 1996, 1999a), and DWR and Reclamation (1994) for additional information on the biology and ecology of the splittail.

Description: Sacramento splittail are large cyprinids (minnows), growing in excess of 300 mm standard length, and are distinctive in having the upper lobe of the caudal fin larger than the lower lobe. The body shape is elongate with a blunt head. Small barbels may be present on either side of the subterminal mouth. They possess 14 to 18 gill rakers, and their pharyngeal teeth are hooked and have narrow grinding surfaces. Dorsal rays number from 9-10, pectoral rays 16-19, pelvic rays 8-9, and anal rays 7-9. The lateral line usually has 60-62 scales, but ranges from 57-64. The fish are silver on the sides and olive grey dorsally. Adults develop a nuchal hump (*i.e.*, protuberance on the fishes' nape). During the breeding season, the caudal, pectoral, and pelvic fins take on a red-orange hue and males develop small white nuptial tubercles in the head region.

Distribution: The summer through fall distribution of adult Sacramento splittail is primarily limited to tidal fresh and brackish waters of the Sacramento-San Joaquin Delta, Suisun Bay, Napa and Petaluma marshes (Baxter 1994, Meng and Moyle 1995, Baxter *et al.* 1996), yet in the past two years this range has expanded. In the Sacramento River, three adult Sacramento splittail were collected at the Red Bluff Diversion Dam (river kilometer (rkm) 391): one each in April and April 1997 and one in October 1998. Red Bluff is the most upstream location capture for Sacramento splittail in recent years, surpassing the Hamilton City area (rkm 331) reported in Sommer *et al.* (1997). An additional adult Sacramento splittail was collected in August 1997 in a screw trap at the Glenn-Colusa Fish Screen (rkm 331). The Sacramento splittail from August and October are also the first recent captures of adult Sacramento splittail in the Sacramento River upstream of the delta in summer or fall (DFG 1999b). This indicates that some adult Sacramento splittail now spend the summer in the main stem of the Sacramento River instead of migrating back to the estuary after spawning (DFG 1999b).

Sacramento splittail spawn in the Sacramento River upstream of Hamilton City, as evidenced by sporatic collection of adult and age-0 Sacramento splittail at a screw trap near the Glenn-Colusa Fish Screen (DFG 1999b). Some age-0 Sacramento splittail rear in the river through late fall, and the presence of an age-1 Sacramento splittail in May 1997 indicates year-round rearing (DFG 1999b). Adults begin their spawning migration in December (Meng and Moyle 1995, CDFG unpublished data), so collection of adult fish in June, August, and October means that adult use of riverine habitat can extend at least 7 to 11 months (DFG 1999b).

Adult Sacramento splittail forage and may spawn in tributaries of the Sacramento River upstream of the Feather River (DFG 1999b). Three adult fish were collected in tributaries of Big Chico Creek (rkm 312): two from Mud Creek in March 1996 and one from Kusal Slough in March 1997 (Maslin *et al.* 1997).

Plankton sampling also provides evidence of Sacramento splittail spawning relatively high in the Sacramento River system. Johnson Wang identified larval Sacramento splittail from archived plankton samples collected from 1998 through 1994 by the Striped Bass Egg and Larval Survey. Larval Sacramento splittail were collected from the most upstream region the Striped Bass Egg and Larva Survey sampled annually. Catch of larval Sacramento splittail in regions upstream of the City of Sacramento was frequently as high or higher than that of downstream regions. Except for years with some (1989, 1992) or substantial (1993) winter/spring outflows, Sacramento splittail larvae were uncommon in Sacramento River collections downstream of the City of Sacramento. Sacramento splittail larvae were not collected in Suisun Bay or in Suisun Marsh except in 1993. Two interpretations are possible for these data: 1) Sacramento splittail spawn relatively high in the Sacramento River system every year, but downstream dispersal of larvae increases with higher flows, or 2) some Sacramento splittail are able to spawn in Suisun Bay or in Suisun Marsh during high flow years because of reduced salinities and increased small stream flooding (DFG 1999b).

The distribution of age-0 Sacramento splittail from the Beach Seine Survey provides evidence of Sacramento River spawning in both high and low flow years, and also of extended riverine rearing. The age-0 Sacramento splittail distribution from the Beach Seine Survey was similar to that of larvae from the plankton survey: age-0 fish were always collected from the most upstream region the survey sampled. Except for catches in the west and central delta in 1995 and the west delta in 1996, all juveniles caught in fall came from the north delta and Sacramento River. Although only 109 age-0 Sacramento splittail were caught by the beach seine during the fall months (of which 55 were from the west delta in 1995), 80% of the remaining catch came from the far north delta and upstream. Thus, some age-0 Sacramento splittail spent their first summer in the Sacramento River and not in the Delta. Assuming the Beach Seine Survey accurately depicts the distribution of age-0 splittail, then by fall most age-0 Sacramento splittail were in the Sacramento River, outside the sampling area of the Bay Study and FMWT whose index periods include fall months (Sommer *et al.* 1997).

In Winter and spring, the Beach Seine Survey continued to collect age-0 Sacramento splittail in relatively high numbers in the Sacramento River, though they were also collected frequently in delta regions. The Service expands the beach seine sampling in winter, so more data were available for comparison than for fall. The catch of Sacramento splittail was high in the west delta in 1996 as a result of the strong 1995 year class. Nonetheless, about 50% of the 70 age-0 Sacramento splittail collected came from the far north delta and upstream. These data indicate that age-0 Sacramento splittail are difficult to capture with a beach seine in fall and winter, probably because they are good swimmers and their ability to escape increases rapidly with size (Young and Cech 1996). The low catches in the central, west, and south delta during the fall suggests either upstream densities are higher or that age-0 Sacramento splittail were not as restricted to edgewaters <1.5 m deep in the delta as they may have been in the river. In either case, some proportion of the population consistently spent its first summer, fall, and winter in the Sacramento River and was not indexed by other surveys (DFG 1999b).

Sampling in the Sutter Bypass also provides evidence of spawning and first year rearing in the bypass itself or upstream in Butte Creek. Butte Creek enters the Sacramento River between Colusa and Meridan (river kilometer [rkm] 224). At high river flows, Butte Creek and the overflow from Moulton and Colusa weirs are diverted down Butte Slough into the Sutter Bypass, which in turn enters the Sacramento River just upstream of Verona (rkm 129). In 1995, adult Sacramento splittail were electrofished from the riparian strip separating the lower Sutter Bypass from the Sacramento River channel and larvae were caught in plankton tows in the Sutter Bypass plume (Baxter *et al.* 1996). In 1996, 32 adult Sacramento splittail were caught in the flooded Sutter Bypass, 17 were radio tagged and seven tracked to potential spawning areas, also in the bypass (IEP Splittail Spawning Investigations, unpublished data). Light traps set in areas where tagged adults congregated caught 63 larvae in the riparian strip between East Canal and the main Sutter Bypass (IEP Splittail Spawning Investigations, unpublished data). In spring 1998, 102 ripening and ripe adult Sacramento splittail were captured in 44 20-minute gill-net sets in the lower 12 kilometer (km) of the bypass (IEP Sacramento Splittail Spawning Investigations, unpublished data). Light traps set in areas where adults were captured caught 226 Sacramento splittail larvae. These data confirm Sacramento splittail spawn in the lower Sutter Bypass (DFG 1999b).

Sacramento splittail inhabit the San Joaquin River and the valley portions of some tributaries during high outflow years, but are rarely caught in low outflow years (Sommer *et al.* 1997; T. Ford, Turlock Irrigation District, pers. comm.; Baxter *et al.* 1995). Age-0 Sacramento splittail emigrate primarily in the late spring and early summer (Armor *et al.* 1996), so they are rarely collected during the summer or winter (Saiki 1984; Brown and Moyle 1993; Baxter *et al.* 1995).

The most upstream collection from the San Joaquin River occurred from June 15 to 19, 1998, when a joint Service/DFG crew collected juvenile Sacramento splittail from Salt Slough in San Luis National Wildlife Refuge upstream of Lander Ave. (DFG 1999b). The mouth of Salt Slough is at rkm 208.5 and the collection site was about 10 km upstream. Juvenile Sacramento splittail were also collected about 8 km from the mouth of Mud Slough (DFG 1999b). Thus, Sacramento splittail were able to locate flooded habitat well upstream in the San Joaquin River and spawn when conditions were suitable (DFG 1999b).

In late June 1995 and in late April 1998, age-0 Sacramento splittail were collected at Fremont Ford (rkm 201) on the San Joaquin River (Baxter *et al.* 1995; DFG unpublished data). In late June 1995, 26 age-0 Sacramento splittail were captured from a single beach seine haul at Fremont Ford; seven more hauls made over two days in August caught no Sacramento splittail (Baxter *et al.* 1995). Additional age-0 Sacramento splittail were caught in 1995 at locations between Merced and Tuolumne Rivers in July and early August, but were absent in 15 seine hauls in late August and two hauls in early September. In late September, two juveniles were collected in one of five beach seine hauls at Turtle Beach (rkm 92)(Baxter *et al.* 1995). These data show Sacramento splittail spawned high in the San Joaquin River in 1995 and that age-0 fish remained in the river well into summer when the outflow was relatively high (DFG 1999b).

In 1998, age-0 Sacramento splittail were again collected at Fremont Ford. High water levels and runoff from Great Valley Grasslands State Park and Kesterson National Wildlife Refuge, immediately to the south, attracted Sacramento splittail out of the San Joaquin River channel to spawn (DFG 1999b). One of the samples containing Sacramento splittail was collected several hundred meters into Great Valley Grasslands State Park and away from the connecting channel to the San Joaquin River.

When river flows create suitable spawning habitat, as occurred annually from 1995 through 1998, the San Joaquin River is used for spawning and can produce substantial numbers of age-0 Sacramento splittail (DFG 1999b). The 1995 beach seine data and data from trawling at Mossdale in the lower San Joaquin River suggest that most age-0 Sacramento splittail emigrate during the late spring and early summer (Armor *et al.* 1996).

The Petaluma River and Marsh supported Sacramento splittail at the end of the 1987-1992 drought as evidenced by 31 adult fish caught in fyke traps within Petaluma City limits from February to May 1991 (Levy 1993) and six age-0 Sacramento splittail caught by beach seine in the Petaluma Marsh in May 1992 (DFG Bay Study, unpublished data). Sacramento splittail continue to be collected from the Petaluma River: 142 in 1995, 4 in 1996 and an untallied number of age-0, age-1 and adult Sacramento splittail in 1998 (DFG 1999b). These data indicate that Sacramento splittail continuously inhabited the Petaluma River from the early 1980's to present and that they successfully spawned in 1992, 1995 and 1998 (DFG 1999b).

In the Napa Marsh, 40 age-0 Sacramento splittail were collected from six locations sampled in September 21, 1995 (DFG 1999b). In another effort, Sacramento splittail of all ages were collected in Pond 2A of Napa Marsh, July 18 through August 14, 1996 (William Kier and Robert Blizzard 1997, monitoring the use by Sacramento splittail of the Napa-Sonoma Marsh Wildlife Area, unpublished data).

Historic sampling in the Napa Marsh found Sacramento splittail present during seasons and years with high freshwater outflow and rare or absent when the outflow was low (DFG 1999b). From June 1974 through February 1979, four sloughs each in the Napa and Suisun marshes were samples once each in February, June, and October (DFG 1999b). In Napa Marsh, Sacramento splittail were captured in summer and fall of 1974 (a wet year), in winter and summer 1975 (an above normal year), but only in winter of 1976 (a critically dry year) (DFG 1999b). They were not collected in Napa Marsh again until the severe 1976-1977 drought ended in the winter of 1978 (DFG 1999b). In the winters of 1978 and 1979, Sacramento splittail catch was higher than at any time before the drought (DFG 1999b). In Suisun Marsh, Sacramento splittail catch declined from June 1976 through October 1977, except in October 1976, but a few fish were caught throughout the drought (DFG 1999b). Similar to Napa Marsh, Suisun Marsh numbers rebounded strongly when the drought broke in 1978 (DFG 1999b). These data suggest that Sacramento splittail shift their distribution as a result of salinity conditions, and that they are quick to respond and move into an area when conditions become favorable (DFG 1999b).

Splittail were very infrequently collected in the DFG open-water and beach surveys but were regularly collected during the Pond 2A Restoration Project in the Napa River Estuary (MEC Analytical Systems 2000). The species is known to occur in the Napa and Petaluma Rivers and Petaluma Marsh (U.S. Fish and Wildlife Service 1993c, 1996) near the Petaluma River, Novato Creek, and South of SR 37 complexes.

Sacramento splittail are known to have inhabited Coyote Creek, a tributary to South San Francisco Bay, in the late 1800's, but were thought to be extirpated early in the 20th century (Aceituno *et al.* 1976). However, in 1983, Sacramento splittail were again captured in Coyote Creek (Kinnetic Labs Inc. and L.W. Associates 1987). Three age-1 Sacramento splittail were collected, two in May and one in December (DFG 1999b). These Sacramento splittail 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 (DFG 1999b). The winters of 1995, 1997, and 1998 produced similar low salinity conditions.

Habitat Requirements: Sacramento splittail are primarily freshwater fish, but are tolerant of moderate salinities and can live in water with salinities of 10-18 ppt (Moyle 1976, unpublished observation). They have been collected in the Carquinez Straight at 11 ppt salinity (total dissolved solids)(DFG 2000). They have also been collected in the Napa Marsh at salinities ranging from 18 to 21 ppt, which is well above the range where they are normally collected (Sommer *et al.* 1997), yet still within their tolerance (Young and Cech 1996).

In the 1950s, they were commonly caught by striped bass anglers in Suisun Bay. During the past 20 years, however, they have been found mostly in slow-moving sections of rivers and in sloughs and have been most abundant in the Suisun Bay and Marsh region (Meng 1993). In 1995, after an unusually wet winter, over five million juvenile Sacramento splittail were salvaged at the CVP and SWP indicating the magnitude of spawning success in favorable water years. However, substantial losses occur during salvage operations and recruitment may not reflect the high spawning success. They are year around residents in Suisun Marsh, concentrating in the dead-end sloughs that typically have small streams feeding into them (Daniels and Moyle 1983; Moyle *et al.* 1985). They tend to be most abundant where other native fishes are abundant as well. In Suisun Marsh, trawl catches are highest in summer when salinities are 6-10 ppt and temperatures are 15-23° C (Moyle *et al.* 1985), reflecting in part the increased vulnerability of young-of-year fish to capture with increased size. In Suisun Bay, splittail of all sizes are most consistently found in shallow water at salinities less than 2-3 ppt (Meng 1993). In spring, both adult and young-of-year Sacramento splittail are frequently found in shallow, flooded areas, such as the Yolo and Sutter by-passes, low-lying parts of delta islands (*e.g.*, Sherman Lake), and river mouths.

Young-of-year and age-1 Sacramento splittail were common in beach seine sampling by DFG during 1993 along the Sacramento River between Rio Vista and Chipps Island. Furthermore, in the DFG Bay Study samples, Sacramento splittail are more common from stations less than 6.7 m deep. Thus, juvenile Sacramento splittail may be concentrated in the shallow peripheries of the Sacramento River, and they may be more abundant there than indicated by sampling done to date.

Daniels and Moyle (1983) found that year-class success in Sacramento splittail was positively correlated with Delta outflow, and Caywood (1974) found that a successful year class was associated with winter-runoff sufficiently high to flood the peripheral areas of the Delta. These observations were confirmed by the analysis of the State (DFG 1992). Meng (1993) found a strong negative relationship between amount of water diverted from the delta and abundance of young Sacramento splittail, noting that the effect of diversions seemed to be particularly strong in dry years. However, entrainment at CVP and SWP south Delta diversions is highest in wet years as can be seen in the high 1995 salvage numbers.

Life History: Sacramento splittail are relatively long-lived (about 5-7 years) and are highly fecund (up to 100,000 eggs per female). Their populations fluctuate on an annual basis depending on spawning success and strength of the year class (Daniels and Moyle 1983). Both male and female Sacramento splittail mature by the end of their second year (Daniels and Moyle 1983), although occasionally males may mature by the end of their first year and females by the end of their third year (Caywood 1974). Fish are about 180-200 mm standard length when they attain sexual maturity (Daniels and Moyle 1983), and the sex ratio among mature individuals is 1:1 (Caywood 1974).

There is some variability in the reproductive period, with older fish reproducing first, followed by younger fish that tend to reproduce later in the season (Caywood 1974). Generally, gonadal development is initiated by fall, with a concomitant decrease in somatic growth (Daniels and Moyle 1983). By April, ovaries reach peak maturity and account for approximately 18% of the body weight. The onset of spawning seems to be associated with increasing water temperature and day length and occurs between early March and May in the upper Delta (Caywood 1974). However, Wang (1986) found that in the tidal freshwater and euryhaline habitats of the Sacramento-San Joaquin estuary, spawning occurs by late January and early February and continues through July. Spawning times are also indicated by the salvage records from the SWP pumps. Adults are captured most frequently in January through April, when they are presumably engaged in spawning movements, while young-of-year are captured most abundantly in May through July (Meng 1993). These records indicate most spawning takes place from February through April.

Adults migrate into fresh water in late fall and early winter prior to spawning. The onset of spawning is associated with rising water temperature, lengthening photoperiod, seasonal runoff, and possibly endogenous factors from the months of March through May, although there are records of spawning from late January to early July (Wang 1986). There is some variability in the reproductive period because older fish reproduce before younger individuals (Caywood 1974). Spawning occurs in water temperatures from 9° to 20° C over flooded vegetation in tidal freshwater and euryhaline habitats of estuarine marshes and sloughs, and slow-moving reaches along the margins of large rivers (Service 1999a).

Sacramento splittail spawn on submerged vegetation in flooded areas. Because they require flooded vegetation for spawning and rearing, Sacramento splittail are frequently found in areas subject to flooding. The eggs are adhesive or become adhesive soon after contacting water (Caywood 1974, and Bailey, UCD, pers. comm., 1994, as cited in DWR and Reclamation 1994). Spawning also occurs in the lower reaches of rivers (Caywood 1974), dead-end sloughs (Moyle 1976) and in the larger sloughs such as Montezuma Slough (Wang 1986). Larvae remain in the shallow, weedy areas inshore in close proximity to the spawning sites and move into the deeper offshore habitat as they mature (Wang 1986).

Strong year classes have been produced even when adult numbers are low, if outflow is high in early spring (*e.g.*, 1982, 1986). Since 1988, recruitment has been consistently lower than expected, suggesting this relationship may be breaking down (Meng 1993). For example, both 1978 and 1993 were wet years following drought years, yet the young-of-year abundance in 1993 was only 2% of the abundance in 1978.

Sacramento splittail are benthic foragers that feed extensively on opossum shrimp (*Neomysis mercedis*) although detrital material typically makes up a high percentage of their stomach contents (Daniels and Moyle 1983). They will feed opportunistically on earthworms, clams, insect larvae, and other invertebrates. They are preyed upon by striped bass and other predatory fishes. The preference for Sacramento splittail by striped bass has long been recognized by anglers, who fish for Sacramento splittail to use them for bait.

Abundance: Sacramento splittail are endemic to California's Central Valley where they were once widely distributed in lakes and rivers (Moyle 1976). Historically, Sacramento splittail were found as far north as Redding on the Sacramento River and as far south as the site of Friant Dam on the San Joaquin River (Rutter 1908). Rutter (1908) also found Sacramento splittail as far upstream as the current Oroville Dam site on the Feather River and Folsom Dam site on the American River. Anglers in Sacramento reported catches of 50 or more Sacramento splittail per day prior to damming of these rivers (Caywood 1974). Sacramento splittail were common in San Pablo Bay and Carquinez Strait following high winter flows until about 1985 (Messersmith 1966, Moyle 1976, and Wang 1986 as cited in DWR and Reclamation 1994). Since 1985, Sacramento splittail have been rare in San Pablo Bay, reflecting a constriction of their distribution to the upper Bay-Delta areas and to isolated areas like the Petaluma and Napa Rivers.

In recent times, dams and diversions have increasingly prevented upstream access to large rivers and the species is restricted to a small portion of its former range. Sacramento splittail enter the lower reaches of the Feather and American rivers on occasion, but the species is now largely confined to the Delta, Suisun Bay, and Suisun Marsh (Service 1995). Stream surveys in the San Joaquin Valley reported observations of splittail in the San Joaquin River below the mouth of the Merced River and upstream of the confluence of the Tuolumne River (Saiki 1984 as cited in Water Resources and Reclamation 1994).

The 1985 to 1992 decline in Sacramento splittail abundance is concurrent with hydrologic changes to the Estuary. Sacramento splittail have experienced a decline in population as a result of hydrologic changes in the Estuary and loss of shallow water habitat due to dredge and fill and channelization activities. These changes include increases in water diversions during the spawning period from January through July.

Most of the factors that caused delta smelt to decline have also caused the decline of Sacramento splittail. These factors include (1) diversions, (2) dams and (3) reduced outflow, coupled with (4) occasional drought years, (5) introduced aquatic species such as the Asian clam (Nichols *et al.* 1986) and striped bass, and (6) loss of wetlands and shallow-water habitat, and appear to have perpetuated the species' decline. These factors have reduced the species' ability to reverse its decline (Moyle *et al.* 1992).

The IEP's spring 1999 20mm survey shows a significant decrease in Sacramento splittail young of the year abundance. These surveys and spring 2000 20mm surveys also identified a portion of the population to be found in the central and south Delta in the spring and early summer (DFG 2000). In May and June 2000, the Projects entrained over 79,000 Sacramento splittail (DWR, unpublished data, 2000).

The 2001 FMWT's Sacramento splittail index (all ages combined) was 27 (Souza and Bryant 2002, DFG 1999a). Although an increase from the 2000 index (10), the 2001 index is considerably lower than the strong year class of 1998 (281) (Souza and Bryant 2002, DFG 1999a). The age-0 component of the 2001 Sacramento splittail abundance index is 10 (Souza and Bryant 2002, DFG 1999a). Catch in the 2001 FMWT was dominated by age-1+ fish (67%), whereas catch in the 2000 FMWT was dominated by age-0 fish (80%)(Souza and Bryant 2002, DFG 1999a). A total of 24 age-0 and age-1+ Sacramento splittail was caught throughout the survey (Souza and Bryant 2002, DFG 1999a). In September, 92% of the catch was accounted for by a single station on the western side of Montezuma Slough (Souza and Bryant 2002, DFG 1999a). No Sacramento splittail were caught in November, and in December Sacramento splittail were caught from the Napa River to the Sacramento River near Threemile Slough (Souza and Bryant 2002, DFG 1999a).

Analyses of survey data collected from 1967 to 1993 (Meng 1993, Meng and Moyle 1995), and data from 1967 to 1997 by the Service, DFG, UCD, and biologists from several different studies noted the following trends:

1. Overall, Sacramento splittail abundance indices have declined. Sacramento splittail populations are estimated to be 35 to 60% of what they were in the 1940's, and these estimates may be high (Moyle in prep). Department FMWT data indicate a decline from the mid-1960s to the late 1970s, followed by a resurgence, with yearly fluctuations, through the mid-1980s. From the mid-1980s through 1994, Sacramento splittail numbers have declined in the Delta, with some small increases in various years. The 1998 FMWT index of 281 was the highest on record, however, in 1999 the index dropped to 39, which is below mid 1980 levels.

2. Sacramento splittail abundances vary widely between years. Sommer *et al.* (1997) also found that Sacramento splittail recruitment success fluctuates widely from year to year and over long periods of time. During dry years abundance is typically low. During the dry years of 1980, 1984, 1987, and 1988 through 1992, Sacramento splittail abundance indices for young-of-the-year were low, indicating poor spawning success. Additionally, all year class abundances were low during these years. In 1994, the fourth driest year on record, all Sacramento splittail indices were extremely low. Wet years are assumed to provide essential habitat for Sacramento splittail and allow populations to rebound from dry years. Successful reproduction in Sacramento splittail is often highly correlated with wet years. Large pulses of young fish were observed in wet years 1982, 1983, 1986, and 1995. In 1995, one of the wettest years in recent history, an increase in all indices was recorded, as in 1986, which was another wet year following a dry year. However, young of the year taken per unit effort (for example, either the number of fish per net that is towed or the number of fish per volume of water sampled) has actually declined in wet years, from a high of 37.3 in 1978 to 0.6 in 1993. The abundance indices of young of the year Sacramento splittail during the years of 1995, 1996, and 1997 were 44.5, 2.1, and 2.6, respectively. In 1995, a very wet year, Sacramento splittail abundances were high. However in 1996 and 1997, both wet years, abundance indices were low. 1998 was a wet year with a large Sacramento splittail year class produced.

3. Concentration of Sacramento splittail in shallow areas suggests that they are particularly vulnerable to impacts to shallow water habitat.

The above data indicate that Sacramento splittail abundances vary widely in response to environmental conditions, and show that the general population numbers are declining.

Salt Marsh Harvest Mouse

The harvest mouse was federally listed as endangered in 1970 (35 **FR** 16047)(Service 1970). A detailed account of the taxonomy, ecology, and biology of the harvest mouse is presented in the Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan (Service 1984) and the references cited therein. The salt marsh harvest mouse is a fully protected species under California law (see California Fish and Game Code Section 4700).

The harvest mouse is a rodent endemic to the salt and brackish marshes of the San Francisco Bay Area and adjacent tidally influenced areas. The harvest mouse closely resembles the western harvest mouse (*R. megalotis*). The harvest mouse typically weighs about 10 grams, has a head and body length ranging from 69-74 mm, a tail length ranging from 65-82 mm, and a hind foot length of 17-18 mm (Fisler 1965). As stated in the recovery plan, the harvest mouse, when compared to the western harvest mouse, have darker ears, belly and back, and a slightly thicker, less pointed and unicolored tail. The harvest mouse is further distinguished taxonomically into the northern and southern subspecies, *R. raviventris halicoetes* and *R. raviventris raviventris*, respectively. Of the two subspecies, *R. r. halicoetes* more closely resembles *R. megalotis*, and can be difficult to differentiate in the field; body color and color of ventral hairs as well as the thickness and shape of the tail have been used to distinguish the two.

The harvest mouse has evolved to a life in tidal marshes. Specifically, they have evolved to depend mainly on dense pickleweed as their primary cover and food source. However, harvest mice may utilize a broader source of food and cover which includes salt grass and other vegetation typically found in the salt and brackish marshes of this region. In natural systems, harvest mice can be found in the middle tidal marsh and upland transition zones. Upland refugia is an essential habitat component during high tide events. Harvest mice are highly dependent on cover, and open areas as small as 10 meters wide may act as barriers to movement (Service 1984). The harvest mouse does not burrow. It has been noted that the northern subspecies may build nests of loose grasses.

As described by Fisler (1965), male harvest mice are reproductively active from April through September, but may appear active throughout the year. Females are reproductively active from March to November, and have a mean litter size of approximately four offspring.

The historic range of the species included tidal marshes within the San Francisco and San Pablo Bay areas, east to the Collinsville-Antioch areas. It has been estimated that of the 193,800 acres of tidal marsh that existed in 1850, about 30,100 acres currently remain (Dedrick 1993). Based on this estimate, there has been an 84 percent reduction in tidal wetlands in the Bay Area. Since 1850, agriculture and urbanization has claimed much of the former tidal marshes. At present, the distribution of the northern subspecies occurs along Suisun and San Pablo Bays north of Point Pinole in Contra Costa County and Point Pedro in Marin County. The southern subspecies is found in marshes in Corte Madera, Richmond, and South San Francisco Bay mostly south of the San Mateo Bridge (Highway 92).

The California Natural Diversity Data Base (CNDDB) indicates that there is a 1960 report of an occurrence and collection of specimens of the harvest mouse in the marsh between O'Neill Slough and Bayshore Freeway in Foster City, which is approximately 1700 meters from the disposal basin. Other occurrences of the salt marsh harvest mouse include Bair Island between Steinberger Slough and Redwood Creek in Redwood City (1992), Greco Island, 2.5 miles northeast of Redwood City and marshland bordered on the north by Westport Slough and on the west by Seaport Boulevard in the Port of Redwood City. There are no CNDDB reports of the harvest mouse occurring in the disposal basin or Belmont Slough. However, the Environmental Impact Report for this project states that the harvest mouse is likely present in the marsh vegetation along Belmont Slough and, although separated from the marsh habitat along the Slough by a dike and a paved recreation trail, harvest mice could be present in the narrow strip of grassy and marsh vegetation around the perimeter of the basin.

Soft Bird's Beak

Soft bird's-beak was federally listed as endangered on November 20, 1997 (62 **FR** 61916) (Service 1997). This species was listed as rare by the California Department of Fish and Game in

July 1979. The California Native Plant Society has placed it on List 1B (rare or endangered throughout its range)(California Native Plant Society 2000).

Soft bird's-beak is an annual herb of the snapdragon family (Scrophulariaceae). It grows 10 to 16 inches tall, branching sparingly from the middle and above. The oblong to lance-shaped leaves are 0.4 to 1.0 inch long, the lower ones entire and the upper ones with one to three pairs of leaf lobes. Foliage is grayish-green (often tinged a deep red) and hairy. The inflorescence consists of spikes, 2 to 6 inches long. A floral bract (modified leaf) with two to three pairs of lobes occurs immediately below each inconspicuous white or yellowish-white flower. Flowers appear between July and September. The plant is distinguished by its two functional stamens and by its bracts with two or three pairs of lateral lobes. Like other members of *Cordylanthus*, soft bird's-beak is partially parasitic on the roots of other plants.

Soft bird's-beak is found predominantly in the upper reaches of salt grass/pickleweed marshes at or near the limits of tidal action. It is associated with pickleweed, saltgrass, jaumea, alkali seaheath (*Frankenia salina*), and seaside arrowgrass (*Triglochin maritima).*

There have been 19 confirmed locations of soft bird's-beak. Five sites have been extripated by habitat loss or modification. Five other sites surveyed in 1993 no longer had plants, although some potential habitat remained. Nine sites are presumed to still exist. They are widely scattered throughout coastal salt or brackish tidal marshes fringing San Pablo and Suisun bays, in Contra Costa, Napa, and Solano counties. Of the remaining sites, one (McAvoy) has only 23 plants. Three sites, Point Pinole, Rush Ranch, and Joice Island Bridge, have very limited habitat and cover less than one acre each. The population at Fagan Slough covers approximately three acres. The two largest populations are at Hill Slough and at Concord Naval Weapons Station, each covering about 10 acres. The entire distribution of soft bird's-beak currently is restricted to about 31 acres.

At Southhampton Marsh, Benicia, one colony is being encroached by invasive non-native cordgrass and the highly invasive perennial pepperweed. At Point Pinole, the locations of former colonies have been colonized by invasive non-native cordgrass. Most of the species' ecological and geographic range is within the potential range of the invasive non-native cordgrass.

Suisun Thistle

Suisun thistle was federally listed as endangered on November 20, 1997 (62 **FR** 61916) (Service 1997). The species has not been officially listed by the State of California. The California Native Plant Society has placed it on List 1B (rare or endangered throughout its range)(California Native Plant Society 2000).

Suisun thistle is a perennial herb in the aster family (Asteraceae). It has slender, erect stems that are 3.0 to 4.5 feet tall and well branched above. The spiny leaves are deeply lobed. The lower leaves have ear-like basil lobes. The upper leaves are reduced to narrow strips with strongly spine-toothed margins. Pale lavender-rose flower heads, one inch long, frow singly or in loose groups. Flowers appear between July and September (Hickman 1993).

Suisun thistle grows in the upper reaches of tidal marshes, where it is associated with narrowleaf cattail (*Typha angustifolia*), three-square or American bulrush (*Scirpus americanus*), Baltic rush, and saltgrass. It is restricted to Suisun Marsh in Solano County.

In Suisun Bay, most of the 71,000 acres of tidal marshes that existed in 1850 were converted originally to agricultural land and then to diked seasonal wetlands used for waterfowl management. Only 9.340 acres within Suisun Marsh remain as tidal marsh. Most of the remaining tidal marshes are backed by steep levees, allowing for little or no transitional wetland habitat needed for Suisun thistle. In 1975, the plant was reported as possibly extinct because it had not been collected for about 15 years. Extensive surveys, however, relocated the thistle at two locations. Collectively, the occurrences of Suisun thistle total a few thousand plants. Two populations are on California Department of Fish and Game lands and a third occurrence is on Solano County Farmland and Open Space Foundation lands.

All of the remaining habitat for the Suisun thistle is within the potential invasion range of invasive non-native cordgrass (well-established at Southhampton Marsh, the western extreme of Suisun Marsh).

Western Snowy Plover

The western snowy plover was federally listed as threatened in 1993 (58 **FR** 12874) (Service 1993b). A detailed account of the taxonomy, ecology, and biology of the plover is presented in the *Western Snowy Plover (Charadrius alexandrinus nivosus) Pacific Coast Population Draft Recovery Plan* (Service 2001) and the references cited therein.

Charadrinus alexandrinus nivosus is a small shorebird distinguished from other plovers (family Charadriidae) by its small size, pale brown upper parts, dark patches on either side of the upper breast, and dark gray to blackish legs. The species was first described in 1758 by Linnaeus (American Ornithologists' Union, 1957).

The Pacific coast population of the western snowy plover is defined as those individuals that nest beside or near tidal waters, and includes all nesting colonies on the mainland coast, peninsulas, offshore islands, adjacent bays and estuaries from southern Washington to southern Baja California, Mexico. Habitats used by nesting and non-nesting birds include sandy coastal beaches, salt pans, coastal dredged spoils sites, dry salt ponds, salt pond levees and gravel bars of the Eel River, Humboldt County, California.

Historic records suggest that nesting Western Snowy Plovers were once more widely distributed in coastal California. In coastal California, Snowy Plovers bred at 53 locations before 1970 (Page and Stenzel, 1981). Since then, no evidence of breeding birds has been found at 33 of these 53 sites, which represents a 62 percent decline (Page and Stenzel, 1981). The greatest losses were in southern California, within the central portion of the Snowy Plover's coastal breeding range. In 1990 only 6 nesting colonies remained, representing a 79 percent decline in active breeding sites.

A total of 20 plover breeding areas currently occur in coastal California (Page *et al.* 1991). Eight areas support 78 percent of the California coastal breeding population: San Francisco Bay, Monterey Bay, Morro Bay, the Callendar-Mussel Rock Dunes area, the Point Sal to Point Conception area, the Oxnard lowland, Santa Rosa Island, and San Nicolas Island (Page *et al.* 1991).

In the habitats remaining for the Snowy Plover, human activity continues to be a key factor adversely affecting Snowy Plover coastal breeding sites and breeding populations in California. Projects or management activities in plover nesting areas that cause, induce or increase human-associated disturbance during the plover's breeding season (March 1-September 14) adversely impact plovers. These activities may reduce the functional suitability of nesting, foraging and roosting areas. Activities that may adversely affect nesting and/or wintering plovers include beach nourishment (sand deposition, spreading of sand with machinery); beach cleaning (removal of wrack–surfcast kelp and driftwood); construction of breakwaters and jetties (interruption of sand deposition); dune stabilization/restoration using native and nonnative vegetation or fencing (decreased beach width, increased beach slope, reduction in blowouts and other preferred nesting habitat); beach leveling (increased tidal reach, removal of sparse vegetation used by chicks for shelter, destruction of wrackline feeding habitat); and off-road vehicles driven in nesting areas or at night.

Salt ponds of San Francisco Bay and San Diego Bay, which are filled and drained as part of the salt production process, provide breeding and wintering habitat for western snowy plovers. Dry salt ponds and unvegetated salt pond levees are used as western snowy plover nesting habitat. Ponds with shallow water provide important foraging habitat for plovers. Nesting plovers can be attracted to an area when ponds are drained during the breeding season, but flooding can then destroy the nests when the ponds are refilled. Also human disturbance resulting from maintenance activities associated with the operation of commercial salt ponds (i.e. levee reconstruction and maintenance of facilities) can result in the loss of snowy plovers and alteration or disturbance of their habitat. Feeney and Maffei (1991) observed a sizable population of western snowy plovers at the Baumberg and Oliver salt ponds during the breeding and nonbreeding seasons, suggesting that these ponds are important to western snowy plovers throughout the year. They suspected that these ponds are used by western snowy plovers as both a pre-breeding and post-breeding staging area, based on the relatively high numbers of western snowy plovers in mid-February and in late August/September, respectively. The conversion of salt ponds, which provide valuable breeding and wintering habitat for western snowy plovers, into tidal marshes would result in a loss of suitable nesting and wintering habitat for western snowy plovers.

Western Snowy Plover Critical Habitat

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR §424.12(b)).

The Service is required to list the known primary constituent elements together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. space for individual and population growth, and for normal behavior;

2. food, water, air, light, minerals, or other nutritional or physiological requirements;

3. cover or shelter;

4. sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and

5. generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The primary constituent elements for the western snowy plover are those habitat components that are essential for the primary biological needs of foraging, nesting, rearing of young, roosting, and dispersal, or the capacity to develop those habitat components. The primary constituent elements are found in areas that support or have the potential to support intertidal beaches (between mean low water and mean high tide), associated dune systems, and river estuaries. Important components of the beach/dune/estuarine ecosystem include surf-cast kelp, sparsely vegetated foredunes (beach area immediately in front of a sand dune), interdunal flats (flat land between dunes), spits, washover areas, blowouts (a hole or cut in a dune caused by storm action), intertidal flats (flat land between high and low tides), salt flats, flat rocky outcrops, and gravel bars. Several of these components (sparse vegetation, salt flats) are mimicked in artificial habitat types used less commonly by snowy plovers, such as dredge spoil sites, salt ponds, and adjoining levees. Please refer to 64 **FR** 68508 (Service 1999b) for additional information on western snowy plover critical habitat.

Effects of the Proposed Action

Direct and Indirect Effects

General Effects

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. 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." 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; however, the gross invaded area in the South Bay accounts for greater than 15 percent of the existing tidal flats and marshes. The spread of non-native invasive cordgrasses could have tremendous long-term effects on the natural ecology, if the San Francisco Estuary Invasive Spartina Project is not implemented or unsuccessful, as follows:

1. 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.

1. Extensive regional loss of tidal flats. Native Pacific cordgrass, with rare exception, 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 up to half of the nearly 19,000 acres of existing tidal flats in the Central and South Bays. This potential was demonstrated in an area of San Leandro, where in 10 years, nonnative cordgrass invaded and completely covered large segments of a half-mile-wide stretch of tidal flat along the shoreline. The process can be witnessed on a larger scale in the channel off of Alameda Island.

2. 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.

3. 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.

4. 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. This process could add decades to the required time to restore the baylands.

5. 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 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.

6. 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.

7. 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. 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.

8. 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.

9. 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.

If the San Francisco Estuary Invasive Spartina Project is implemented and successful, the long-term beneficial effect would be the avoidance or reversion of the above described detrimental impacts. Additional long-term effects of non-native cordgrass removal would be the recolonization of cleared patches by native brackish marsh vegetation. This would be a beneficial effect to the California clapper rail, California least tern, California sea blite, salt marsh harvest mouse, soft bird's beak, and Suisun thistle. However, it is possible that cleared patches could instead become colonized by the invasive non-native perennial pepperweed, particularly where seed and rhizome sources are adjacent or close to cleared patches. This would be a detrimental effect to the California clapper rail, California least tern, California sea blite, salt marsh harvest mouse, soft bird's beak, and Suisun thistle. Actively managing against this outcome is likely to limit or preclude its likelihood of occurring.

Sacramento Splittail and Delta Smelt Effects

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 non-native cordgrass eradication operations are likely to be few and small in scope for the foreseeable future.

Many estuarine fish, including delta smelt and Sacramento splittail feed in low tidal elevation areas such as intertidal mudflats that may be exposed to glyphosate/surfactant solutions that may be moderately toxic to fish at applied concentrations. Bottom-feeding fish, such as Sacramento splittail, 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. Potential indirect effects of glyphosate/surfactant solutions would be negligible where invasive non-native cordgrass was in the 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.

Mechanical disturbance of mudflat or channel surfaces may expose delta smelt and Sacramento splittail 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 delta smelt and Sacramento splittail because of the limited and infrequent treatment occurrences, and low organic content (hence limited methylization potential) of exposed sediments.

Only dredging methods performed on invasive non-native cordgrass stands at higher tidal stages and/or in large channels could have direct impacts to delta smelt and Sacramento splittail by exposure to elevated turbidity, depressed dissolved oxygen levels, and mobilization of toxic sulfides. Dredging or excavation of invasive non-native cordgrass stands when they are emergent (mid to low tide) would have minimal indirect effects on delta smelt and Sacramento splittail. 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 delta smelt and Sacramento splittail.

Eradication methods based on impoundment and chronic flooding (drowning) of invasive non-native cordgrass would carry risks of entrapment of delta smelt and Sacramento splittail. Entrapment impacts could be similar to those routinely practiced for salt pond intakes, without fish screens, for the last century. During the period of entrapment, dessication, water temperature, salinity, and avian predation could cause mortality of delta smelt and Sacramento splittail. This impact can be minimized by the development and implementation of a program implementation plan with prescriptions for avoiding, minimizing, and mitigating individual project impacts.

In addition, contaminants could enter the water from fuel spills into the waterway during dredging or excavation and spillage or runoff of fuel oils, grease, and other petroleum products used by the mechanical equipment.

California Clapper Rail Effects

Eradication of invasive non-native cordgrass would have 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 and the Whale's Tail marsh mitigation site (Hayward shoreline), eradication of all non-native cordgrass would result in significant adverse impacts to individual rails and the viability of their local populations due to loss of cover and nest sites. The extinction of a clapper rail sub-population distributes the rick of species extinction more heavily on remaining sub-populations, which each have independent risks of population failure at different sites. Therefore, large-scale non-native cordgrass eradication operations in occupied clapper rail habitat would result in significant adverse impacts to clapper rails. This impact can be minimized by the development and implementation of a program implementation plan with prescriptions for avoiding, minimizing, and mitigating individual project impacts, including conducting treatments in phases to reduce the amount of clapper rail habitat lost at one time along with habitat restoration of the treatment area with native vegetation to provide clapper rails with replacement habitat.

Short-term impacts of non-native cordgrass eradication operations will be disturbance of rails present within up to 1,000 feet from operations of field crews and equipment. Outside of the clapper rail breeding season, rails are likely to relocate to adjacent marsh areas during eradication operations. This impact will be less than significant for most control programs. In the clapper rail breeding season, eradication operations ranging from manual work by field crews to mechanized removal would disturb rails, risk nest destruction or abandonment of home ranges. 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. Rails fleeing treatment sites may be subject to increased predation risks, and surviving rails that disperse would risk reduction in reproductive success for the current year. Helicopter applications of glyphosate/surfactant solutions may result in drift and coverage where clapper rails are present, however toxicity of the drift is low and the exposure would be temporary.

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 cordgrass would accrete new sediment from ambient (background) sources, and would then not be a risk for foraging rails.

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. In addition, cordgrass meadows would eventually spread to cover much of the remaining mudflat and eliminate foraging opportunities for the bird. Thus, survival of the California clapper rail in the San Francisco Estuary would be threatened, and the distribution of the endangered species would be radically altered, if the San Francisco Estuary Invasive Spartina Project is unsuccessful. If the San Francisco Estuary Invasive Spartina Project is implemented, the long-term beneficial effect would be the avoidance or reversion of these effects.

Although the eradication of non-native cordgrass is not specifically identified in the recovery plans for the *Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan* (Service 1984), successful eradication of non-native cordgrass is likely to substantially benefit the clapper rail and to assist with its recovery within the San Francisco Estuary and range wide.

Salt Marsh Harvest Mouse Effects

Because small mammals do not generally inhabit cordgrass stands, direct effects of eradication on small mammals would be minimal. Indirect effects to the salt marsh harvest mouse could occur through marsh vehicle disturbance of vegetation (habitat degradation), crushing of mice beneath tracked vehicles, destruction of high tide flood refugia (debris or tall broadleaf vegetation), and exposure of mice to glyphosate/surfactant solutions drifted from cordgrass to adjacent mixed pickleweed vegetation. Trampling of marsh plain vegetation by field crews could crush small mammals or degrade habitat quality, but trampling of individuals would be infrequent since mice could move away. The risk of these potential impacts is low for the salt marsh harvest mouse in many of the potential eradication project sites in San Francisco Bay as trapping studies of the species have indicated 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.

Salt marsh harvest mice generally remain under dense vegetation cover at ground level except during extreme tides (when no spraying would occur) and would have limited exposure to sprays applied to vegetation surfaces. 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.

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.

If the San Francisco Estuary Invasive Spartina Project is unsuccessful, pickleweed habitat essential to the endangered salt marsh harvest mouse would be replaced in lower tidal reaches by "short form" hybrid Atlantic smooth (non-native) cordgrass, and upper tidal reaches by Chilean (non-native) cordgrass and salt-meadow (non-native) 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. If the San Francisco Estuary Invasive Spartina Project is implemented, the long-term beneficial effect would be the avoidance or reversion of these effects.

Although the eradication of non-native cordgrass is not specifically identified in the recovery plans for the *Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan* (Service

1984), successful eradication of non-native cordgrass is likely to substantially benefit the salt marsh harvest mouse and to assist with its recovery within the San Francisco Estuary and range wide.

Western Snowy Plover and California Least Tern Effects

Habitats of western snowy plovers usually would not be directly affected by invasive cordgrass eradication operations, since the species is largely confined to salt pond levees and dry pond bottoms.

Most eradication operations applied to invasive non-native 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. Disturbance could preclude tern foraging while operations persist, however, these disturbances would generally be infrequent and of short duration.

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 invasive non-native 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 waterfowl and shorebirds.

If large stands of invasive non-native cordgrass were eradicated by dredging adjacent to navigable channels, turbidity impacts could affect feeding of least terns. This would depend on tidal stage as 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. This impact can be minimized by the development and implementation of a program implementation plan with prescriptions for avoiding, minimizing, and mitigating individual project impacts.

If the San Francisco Estuary Invasive Spartina Project is unsuccessful, up to half of the nearly 19,000 acres of existing tidal flats in the Central and South Bays would be eventually invaded and this loss of mudflats would represent a substantial loss of foraging habitat. If the San Francisco Estuary Invasive Spartina Project is implemented, the long-term beneficial effect would be the avoidance or reversion of this invasion.

Although the eradication of non-native cordgrass is not specifically identified in the recovery plans for the *Western Snowy Plover (Charadrius alexandrinus nivosus) Pacific Coast Population Draft Recovery Plan* (Service 2001), successful eradication of non-native cordgrass is likely to substantially benefit the western snowy plover and to assist with its recovery within the San Francisco Estuary and range wide.

California Sea-Blite, Soft Bird's-Beak, and Suisun Thistle Effects

Most effects of regional invasive non-native cordgrass eradication on the California sea-blite, soft bird's beak, and Suisun thistle would be indirect and long-term consequences of preventing future non-native cordgrass invasion impacts to occupied and potential habitat (e.g., altered tidal hydrology, altered sedimentation, competition, and massive wracks). This is because most of the non-native cordgrass invasion currently occurs in subregions of the Bay where California sea-blite, soft bird's beak, and Suisun thistle have already become locally extirpated (esp. San Francisco Bay), so eradication efforts in the near-term would be focused away from their populations.

Short-term effects of cordgrass eradication operations on the California sea-blite, soft bird's beak, and Suisun thistle could be adverse, however, particularly for the endangered soft bird's-beak populations at Southhampton Marsh, Benicia (where non-native cordgrass is locally abundant) and Point Pinole (where non-native cordgrass has been largely eradicated, but regenerates at low levels). Soft bird's-beak at Southhampton Marsh grows closely adjacent to one colony of non-native 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 non-native cordgrass may trample seedlings. These impacts can be minimized by the development and implementation of a program implementation plan with prescriptions for avoiding, minimizing, and mitigating individual project impacts. In addition, in subsequent years, small-scale trampling disturbances may provide local gaps in salt marsh vegetation suitable for establishment of new subcolonies of soft bird's-beak, which exploit disturbed areas.

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. If the San Francisco Estuary Invasive Spartina Project is unsuccessful, these important features cannot be established or sustained in the presence of wave-damping, sediment-trapping Atlantic smooth (non-native) cordgrass. In addition, if the San Francisco Estuary Invasive Spartina Project is unsuccessful, salt meadow (non-native) cordgrass threatens local populations of another endangered plant, soft bird's-beak. If the San Francisco Estuary Invasive Spartina Project is successful, in the long term, the eradication program could have significant benefits for the long-term chances of survival and recovery of the California sea-blite, soft bird's beak, and Suisun thistle.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions affecting listed species that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions not related to this proposed action are not considered in determining the cumulative effects, but are subject to separate consultation requirements pursuant to section 7 of the Act.

Sacramento Splittail and Delta Smelt

Any continuing or future non-Federal diversions of water that may entrain adult or larval fish would have cumulative effects to the delta smelt and Sacramento splittail. Water diversions through intakes serving numerous small, private agricultural lands contribute to these cumulative effects. These diversions also include municipal and industrial uses. State or local levee maintenance may also destroy or adversely modify spawning or rearing habitat and interfere with natural long term habitat-maintaining processes.

Additional cumulative effects result from the impacts of point and non-point source chemical contaminant discharges. These contaminants include but are not limited to selenium and numerous pesticides and herbicides as well as oil and gasoline products associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for delta smelt and Sacramento splittail, these contaminants may adversely affect fish reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants, used as substrate for adhesive egg attachment, are lost due to toxic substances.

Other cumulative effects could include: the dumping of domestic and industrial garbage may present hazards to the fish because they could become trapped in the debris, injure themselves, or ingest the debris; golf courses reduce spawning and rearing habitat and introduce pesticides and herbicides into the environment; oil and gas development and production remove spawning habitat and may introduce pollutants into the water; levees built to protect agricultural lands from flooding reduce riparian and wetland habitats; and grazing activities may degrade or reduce suitable spawning and rearing habitat through siltation, sedimentation or erosion, and which could reduce vegetation in or near waterways.

Angling pressure on the Sacramento splittail is not considered highly detrimental at this time but could become a significant adverse effect as human populations increase. Anglers seek gravid females as roe is considered a delicacy. Although removal of spawning females has the potential to reduce populations, the California Fish and Game Commission has elected not to regulate or prohibit sportfishing for the Sacramento splittail.

California Clapper Rail, Western Snowy Plover, California Least Tern, and Salt Marsh Harvest Mouse

Numerous activities continue to eliminate habitats of harvest mice, plovers, terns, and clapper rails. Habitat loss and degradation affecting these species continues as a result of urbanization, road and utility right-of-way management, flood control projects, dredging and disposal, and contaminant inputs. Harvest mice, plovers, terns, and clapper rails are also affected by contaminants, increased predation associated with human development, and reduction of food sources. All of these non-Federal activities are expected to continue to adversely affect listed species considered in this opinion throughout their respective ranges.

Various habitats used by harvest mice, plovers, terns, and clapper rails may be degraded or destroyed by a variety of development and maintenance activities conducted by private organizations, State, or local governments. These include levee maintenance, marina operations, and dredging. Increased urban development has also increased problems associated with non-native predators, freshwater urban run-off, sedimentation, contaminants, and disturbance of breeding and foraging behavior.

California Sea-Blite, Soft Bird's-Beak, and Suisun Thistle

Habitat conversion, water pollution, increases in salinity of tidal marshes due to upstream withdrawals of fresh water, habitat fragmentation, indirect effects of urbanization, competition and hybridization with non-native vegetation, insect predation, projects that alter natural tidal regime, mosquito abatement activities, off-road vehicle use, erosion, and naturally occurring events variously threaten the remaining occurrences of these plant species.

These cumulative effects further contribute to reducing the respective environmental baselines for the California sea-blite, Suisun thistle, soft birds' beak, California least tern, California clapper rail, delta smelt, Sacramento splittail, and salt marsh harvest mouse.

Conclusion

After reviewing the current status of the California sea-blite, Suisun thistle, soft birds' beak, delta smelt, Sacramento splittail, California least tern, California clapper rail, salt marsh harvest mouse, and Pacific coastal population of the western snowy plover, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the extent of take anticipated at the programmatic level is not likely to jeopardize the continued existence of these species. In addition, Service's biological opinion that the effects anticipated at the programmatic level is not likely to destroy or adversely modify critical habitat for delta smelt and the Pacific coastal population of the western snowy plover. No critical habitat has been designated for the Sacramento splittail, California least tern, California clapper rail, California sea-blite, Suisun thistle, soft birds' beak, and salt marsh harvest mouse, therefore none will be destroyed or adversely modified.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act, and Federal regulation pursuant to section 4(d) of the Act, prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as actions that create the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The Service anticipates incidental take of the least tern, snowy plover, clapper rail and harvest mouse will be difficult to detect or quantify because the elusive nature of these species, their small size, and cryptic coloration make the finding of a dead specimen unlikely. However, the following level of take of least tern, snowy plover, clapper rail and harvest mice can be anticipated by the loss of habitat available for breeding, foraging, and sheltering. The Service considers the number of least tern, snowy plover, clapper rails and harvest mice subject to harassment from noise and vibrations to be impracticable to estimate. Conservation measures proposed by the project proponents and described above in the Description of the Proposed Action will reduce, but do not eliminate, the potential for incidental taking of these species during the project. The Service, therefore, anticipates the following levels of take for these species as a result of the proposed project.

Incidental take for the least rails, snowy plover, clapper rail and harvest mouse are expected in the form of:

a. zero (0) mortality of individual least rails, snowy plover and clapper rails due to equipment and machinery use;

b. all least tern, snowy plover, clapper rail and harvest mouse individuals may be harassed from project related noise and vibration, and the displacement of all individuals within the proposed project area;

The Service anticipates that incidental take of the smelt and splittail will be difficult to detect for the following reasons: the aquatic nature of the organisms and their relatively small body size make the finding of a dead specimen unlikely; the secretive nature of these species; losses may be masked by seasonal fluctuations in numbers or other causes; and the species occurs in habitats that makes it difficult to detect. For those reasons, the Service anticipates that non-native cordgrass eradication activities would result in an unquantifiable number smelt and splittail would be subject to harm, harassment, and mortality as a result of stranding within excavated areas for up to 12 hours at a time when the tide recedes. In addition, the Service anticipates an unquantifiable number of smelt and splittail would be subject to harm, harassment, and mortality as a result of exposure to environmental contaminants, glyphosate/surfactant solutions, and sediments.

Due to the programmatic nature of this biological opinion, the project and site specific information necessary to determine the amount and extent of incidental take of listed species associated with individual San Francisco Estuary Invasive Spartina Project activities/actions is lacking. Therefore, the Service will initiate individual intra-Service section 7 consultations for those actions/activities which may affect listed species. Future biological opinions that are tiered under this programmatic biological opinion will estimate, evaluate, and authorize the amount and extent of incidental take associated with project specific actions. Incidental take of listed species is not authorized in this programmatic biological opinion.

Effect of the Take

In the accompanying biological opinion the Service determined that the level of anticipated take is not likely to jeopardize the continued existence of the California clapper rail, California least tern, western snowy plover, salt marsh harvest mouse, delta smelt or Sacramento splittail or result in destruction or adverse modification of critical habitat for the delta smelt or western snowy plover.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impact of take on the California clapper rail, California least tern, western snowy plover, salt marsh harvest mouse, delta smelt or Sacramento splittail:

1. Avoid, minimize, and mitigate the individual project impacts to listed species.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Service must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

1. The following term and condition implements the reasonable and prudent measure:

   Develop and implement a program implementation plan with prescriptions for avoiding, minimizing, and mitigating individual project impacts to listed species.

Reporting Requirements

The Service shall be notified within twenty-four (24) hours of the finding of any injured or dead California least tern, California clapper rail, delta smelt, Sacramento splittail, salt marsh harvest mouse, and western snowy plover, or any unanticipated harm to their habitat as a result of biological sampling activities. Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. The Service contact person is Jan C.

Knight, Division Chief, Endangered Species Program in the Sacramento Fish and Wildlife Office (916) 414-6620. Any dead or injured specimen shall be preserved according to standard museum practices and deposited at an appropriate academic institution approved by the Service, or with the Service's Division of Law Enforcement, 2800 Cottage Way, Room W-2928, Sacramento, California 95825 (916-414-6660). Any killed delta smelt or Sacramento splittail shall be preserved in accordance with Natural History Museum of Los Angeles County's policy of accessioning (10 percent formalin in a quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, water temperature and outflow/tide conditions, and any other relevant information shall be written on 100% rag content paper with permanent ink and included in the container with the specimen.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation for the San Francisco Estuary Invasive Spartina Project. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

If you have any questions regarding this opinion on the San Francisco Estuary Invasive Spartina Project, please contact Mike Nepstad or Dan Buford at (916) 414-6625.

cc:
ARD (ES), Portland, OR
California State Coastal Conservancy, 1330 Broadway, 11th Floor, Oakland, California 94612
(ATTN: Ms. Maxine Speilman)

Literature Cited

Aceituno, M.E., M.L. Caywood, S.J. Nicola, and W.I. Folliett. 1976. Occurrence of native fishes in Alameda and Coyote creeks, California. California Fish and Game 62(3):195-206.

American Ornithologists' Union. 1957. The A.O.U. checklist of North American birds. Fifth edition. 168 pp.

Armor, C., L. Winternitz, D. Sweetnam, P. Brandes, and R. Baxter. 1996. 1995 pilot real-time monitoring program: evaluation and recommendations. Interagency Ecological Program for the San Francisco Estuary. Technical Report 47.

Arthur, J.F. and M.D. Ball. 1978. Entrapment of suspended materials in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Bureau of Reclamation, Sacramento, California.

_____ 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 *in* T.J. Conomos, editor. Pacific Division, American Association for the Advancement of Science, San Francisco, California.

_____ 1980. The significance of the entrapment zone location to the phytoplankton standing crop in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Water and Power Resources Service.

Atwood, J. and D.E. Minsky. 1983. Least tern foraging ecology at three major California breeding colonies. Western Birds 14:5772.

Atwood, J.L. and B.W. Massey. 1988. Site fidelity of least terns in California. Condor 90:389394.

Baxter, R. 1994. Preliminary results of a summer gill-net survey for Sacramento splittail. Interagency Ecological Program for the San Francisco Estuary. Newsletter Autumn 1994:14-15.

Baxter, R., W. Harrell, and L. Grimaldo. 1996. 1995 splittail spawning investigations. Interagency Ecological Program for the San Francisco Estuary. Newsletter 9(4):27-31.

Baxter, R., W. Harrell, L. Grimaldo, and S. Carroll. Splittail Investigations 1995. Interagency Ecological Program for the San Francisco Estuary. Annual Report for 1995.

Brett, J.R. 1976. Scope for metabolism and growth of sockeye salmon *Oncorhynchus nerka*, and some related energetics. Journal of the Fisheries Research Board of Canada 33:307-313.

Brown, L.R. and P.B. Moyle. 1993. Distribution, ecology, and status of the fishes of the San Joaquin River drainage, California. California Fish and Game 79(3):96-114.

California Department of Fish and Game. 1992. San Joaquin chinook salmon enhancement project, annual report, fiscal year 1990-1991: 1991 annual job performance report Project F-51-R-1, subproject number IX, study number 5, jobs 1-7. California Department of Fish and Game, Fresno, California.

_____ 1995. California least tern breeding season: 1994 season. Bird and Mammal Conservation Program Report 95-3.

_____ 1999a. Fall Midwater Trawl [database on the internet]. Available from http://www.delta.ca.gov/data/mwt99/index.html. Accessed on September 18, 2002.

_____ 1999b. Splittail abundance and distribution update [internet]. Available from http://www.delta.dfg.ca.gov/reports/splittail/. Accessed on September 18, 2002.

_____ 2000. 20mm Survey [database on the internet]. Available from http://www.delta.ca.gov/data/20mm/2000/. Accessed on September 18, 2002.

_____ 2001. 2001 Summer Townet Survey [database on the internet]. Available from http://www.delta.dfg.ca.gov/data/skt/skt2002/index.html. Accessed on September 18, 2002.

_____ 2002. Spring Kodiak Trawl [database on the internet]. Available from http://www.delta.dfg.ca.gov/data/skt/skt2002/index.html. Accessed on September 18, 2002.

California Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1993. Effects of the Central Valley Project and State Water Project on delta smelt. Sacramento County, California. 134 pp.

_____ 1994. Effects of the Central Valley Project and State Water Project on delta smelt and Sacramento splittail. Sacramento, California. 230 pp.

California Native Plant Society. 2000. CNPS Inventory of Rare and Endangered Vascular Plants (Sixth Edition). CNPS Special Publication No. 1.

Caywood, M.L. 1974. Contributions to the Life History of the Splittail *Pogonichthys macrolepidotus* (Ayres). M.S. Thesis, California State University, Sacramento, California. 77 pp.

Daniels, R.A. and P.B. Moyle 1983. Life history of splittail (Cyprinidae: *Pogonichthys macrolepidotus*) in the Sacramento-San Joaquin estuary. Fishery Bulletin 84-3:647-654.

Dedrick, K. 1993. San Francisco Bay tidal marshland acreages: recent and historic values. In

O.T. Magoon (ed.): Proceedings of the Sixth Symposium on Coastal and Ocean Management (Coastal Zone '89). Charleston, South Carolina, July 11-14, 1989. Publ. by Am. Society of Civil Eng.

DeGroot, D.S. 1927. The California clapper rail: its nesting habitats, enemies, and habitat. Condor. 29:259-270.

Erkkila, L.F., J.F. Moffett, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin Delta fishery resources: effects of Tracy pumping plant and delta cross channel. U.S. Fish and Wildlife Services Special Report. Fisheries 56. 109 pp.

Fancher, J.M. 1992. Population status and trends of the California least tern. Transactions of the Western Section of the Wildlife Society 28:5966.

Feeney, L.R. and W.A. Maffei. 1991. Snowy plovers and their habitat at the Baumberg area and Oliver salt ponds, Hayward, California, March 1989 through May 1990. City of Hayward, Hayward, California. 162 pp.

Fisler, G.F. 1965. Adaptations and speciation in harvest mice of the marshes of San Francisco Bay. University of California Publications in Zoology, Volume 77. University of California Press, Berkeley, CA 108 pp.

Foerster, K.S., J.E. Takekawa, and J.D. Albertson. 1990. Breeding density, nesting habitat, and predators of the California clapper rail. Unpubl. Rpt. No. SFBNWR-116400-90-1, prep. for San Francisco Bay NWR, Fremont, CA. 46 pp.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pp.64-94 *in* D.W. Kelley, ed.: Ecological studies of the Sacramento-San Joaquin Estuary, Part 1. California Department of Fish and Game, Fish Bulletin No. 133.

Garcia, E.J. 1995. Conservation of the California clapper rail: An analysis of survey methods and habitat use in Marin County, California. Master Thesis, University of California-Davis. 135 pp.

Gill, R., Jr. 1972. South San Francisco Bay breeding bird survey, 1971. Wildlife Management Branch Administrative Report 72-6. Sacramento, CA. 69 pp.

Harvey, T.E. 1980. A breeding season survey of the California clapper rail in south San Francisco Bay, California. Unpubl. Final Rpt. prep. for San Francisco Bay NWR, Fremont, CA. 45 pp.

Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Ecological Studies Program Newsletter, Winter 1994. California Department of Water Resources, Sacramento, California.

Hickman, J.C. (Ed.). 1993. The Jepson Manual: Higher Plants of California. Berkeley: University of California Press. Sacramento, California.

Hothem, R.L. and S.G. Zador. 1995. Environmental contaminants in eggs of California least terns (*Sterna antillarum browni*). Bulletin of Environmental Contamination and Toxicology 55:658665.

Kinnetic Labs Incorporated and Larry Walker Associates. 1987. South Bay Dischargers Authority Water Quality Monitoring Program: Final Monitoring Report December 1981 - November 1986. South Bay Dischargers Authority Final Monitoring Report, 467 pages plus appendices.

Knutson, A.C., Jr. and J.J. Orsi. 1983. Factors regulating abundance and distribution of the shrimp *Neomysis mercedis* in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society 112:476-485.

Levy, C. 1993. Appendix A: Fish and invertebrate observations of the Petaluma River, City of Petaluma, Sonoma County, California. A report prepared for the U.S. Army Corps of Engineers, San Francisco District. 28 pp.

Maslin, P., M. Lennox, J. Kindopp, and W. McKinney. 1997. Intermittent streams as rearing habitat for Sacramento River chinook salmon (*Oncorhynchus tshawytscha*). Chico, California. California State University, Chico.

Massey, B.W. 1974. Breeding biology of the California least tern. Proceedings of the Linean Society of New York 72:124.

Massey, B.W. and J.L. Atwood. 1981. Second wave nesting of the California least tern: age composition and reproductive success. Auk 98:596605.

Massey, B.W., D.W. Bradley, and J.L. Atwood. 1992. Demography of a California least tern colony including the effects of the 1982-1983 El Nino. The Condor 94:976983.

MEC Analytical Systems, Inc. 2000. Baseline monitoring of the Pond 2a tidal restoration project. Carlsbad, California.

Meng, L. 1993. Status of Sacramento splittail and longfin smelt. Report submitted to U.S. Fish and Wildlife Service, August 1993.

Meng, L. and P.B. Moyle. 1995. Status of Sacramento splittail in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society. 124:538-549.

Messersmith, J.D. 1966. Fishes collected in Carquinez Straight in 1961-1962. Pages 57-62 *in*: D.W. Kelly (editor). Ecological Studies of the Sacramento-San Joaquin Estuary, Part 1. California Department of Fish and Game, Fisheries Bulletin 133.

Monroe, M.W. and J. Kelly 1992. State of the Estuary: A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Estuary Project, Oakland, California.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley, California. 405 pp.

Moyle, P. B., R.A. Daniels, B. Herbold, and D.M. Baltz. 1985. Patterns in distribution and abundance of a noncoevolved assemblage of estuarine fishes in California. Fisheries Bulletin 84:105-117.

Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society 121:67-77.

Moyle, P. B. and J. Cech, Jr. 1988. Fishes: An Introduction to Ichthyology. Prentice Hall, Englewood Cliffs, New Jersey. 559 pages.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson 1986. The modification of an Estuary. Science 231:567-573.

Orsi, J.J. and W.L. Mecum. 1986. Zooplankton distribution and abundance in the Sacramento-San Joaquin Delta in relation to certain environmental factors. Estuaries 9(4B):326-339.

Page, G.W. and L.E. Stenzel, eds.. 1981. The breeding status of the snowy plover in California. Western Birds 12(1):1-40.

Page, G.W., L.E. Stenzel, W.D. Shuford, and C.R. Bruce. 1991. Distribution and abundance of the snowy plover on its western North American breeding grounds. J. Field Ornithol. 62(2):245-255.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta. Pp. 115-119. *In*: J. L. Turner and D. W. Kelley (eds.). Ecological studies of the Sacramento-San Joaquin Estuary, Part 2. California Department of Fish and Game Fish Bulletin No. 136.

Ripley, S.D. 1977. Rails of the world. David R. Godine, Publisher. Boston, Massachusetts.

Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of their distribution and variation. Bulletin of U.S. Bureau of Fisheries 27(637):103-152.

Saiki, M.K. 1984. Environmental conditions and fish faunas in low elevation rivers on the irrigated San Joaquin Valley floor, California. California Fish and Game 70:145-157.

Shellhammer, H.S., R, Jackson, W. Davilla, A.M. Gilroy, H.T. Harvey, and L. Simmons. 1982.

Habitat preferences of salt marsh harvest mice (*Reithrodontomys raviventris*). Wasmann Journal of Biology 46:89-103.

Sommer, T., R. Baxter and B. Herbold. 1997. Resilience of splittail in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society. 126:961-976.

Souza, K. and M. Bryant. 2002. Townet Survey and Fall Midwater Trawl. Interagency Ecological Program for the San Francisco Estuary. Newsletter 15(2):21-24.

Stevens, D. E. 1996. Distribution and food habits of American Shad (*Alosa sapidissima*) in the Sacramento-San Joaquin Delta. Pp. 97-107. *In*: J.L. Turner and D.W. Kelley (Eds.). Ecological studies of the San Francisco Bay Estuary. California Fish and Game Bulletin No. 136.

Stevens, D. E. and S. W. Miller. 1983. Effects of river flow on abundance of young chinook salmon, American shad, longfin smelt, and Delta smelt in the Sacramento-San Joaquin river system. North American Journal of Fisheries Management 3:425-437.

Stevens, D. E., S. W. Miller, and B. C. Bolster 1990. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. California Department of Fish and Game Candidate Species Status Rept. 90-2. 149 pages.

Swanson, C. And J. J. Cech, Jr. 1995. Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report. Davis, California. 77 pp.

Sweetnam, D.A. 1999. Status of delta smelt in the Sacramento-San Joaquin Estuary. California Fish and Game 85(1):22-27.

Sweetnam, D.A. and D.E. Stevens 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. Candidate Species Status Report 93-DS. Sacramento, California. 98 pages plus appendices.

Turner, J.L. and D.W. Kelley. 1966. Ecological studies of the Sacramento-San Joaquin Delta. California Department of Fish and Game Bulletin. 136.

U.S. Fish and Wildlife Service. 1970. United States List of Endangered Native Fish and Wildlife. October 13, 1970. **Federal Register** 35(199): 16047-16048

______1984. Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan. Portland, Oregon. 141 pages.

______1993a. Endangered and threatened wildlife and plants: Determination of threatened status for the delta smelt. March 5, 1993. **Federal Register** 58(42): 12854-12864.

______1993b. Endangered and threatened wildlife and plants: Determination of threatened status for the western snowy plover. March 5, 1993. **Federal Register** 58(42): 12874.

______1993c. Fish and wildlife coordination act draft report: Petaluma River Section 205, Flood Control Study. Sonoma, California.

______ 1994a. Endangered and threatened wildlife and plants: Endangered or Threatened Status for Five Plants and the Morro Shoulderband Snail From Western San Luis Obispo County, California. December 15, 1994. **Federal Register** 59: 64613.

______ 1994b. Endangered and threatened wildlife and plants: Critical habitat determination for the delta smelt. December 19, 1994. **Federal Register** 59(242): 65256-65279.

______ 1995. Formal consultation and conference on the effects of long-term operation of the Central Valley Project and State Water Project on the threatened delta smelt, delta smelt critical habitat, and proposed threatened Sacramento splittail. Sacramento, California. 52 pages, plus figures and attachment.

______ 1996. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. Portland, Oregon. 195 pages.

______ 1997. Endangered and threatened wildlife and plants: Determination of Endangered Status for Two Tidal Marsh Plants - *Cirsium hydrophilum* var. *hydrophilum* (Suisun Thistle) and *Cordylanthus mollis* spp. *mollis* (Solf Bird's Beak) From the San Francisco Bay Area of California. November 20, 1997. **Federal Register** 62(224): 61916-61925.

______ 1999a. Endangered and threatened wildlife and plants: Determination of threatened status for the Sacramento splittail. March 10, 1999. **Federal Register** 64(25): 5963-5981.

______ 1999b. Endangered and threatened wildlife and plants: Critical habitat determination for for the Western Snowy Plover. December 7, 1999. **Federal Register** 64: 68507.

______ 2001. Western Snowy Plover (*Charadrius alexandrinus nivosus*) Pacific Coast Population Draft Recovery Plan. Portland, Oregon. 228 pages.

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Program for the San Francisco Estuary. Sacramento, California. Technical Report 9.

______ 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Program for the San Francisco Estuary. Sacramento, California. Technical Report 28.

Wang, J.C.S. and R.L. Brown. 1993. Observations of early life stages of delta smelt *Hypomesus transpacificus* in the Sacramento-San Joaquin Estuary in 1991, with a review of its ecological status in 1998 to 1990. Interagency Ecological Program for the San Francisco Estuary. Technical Report 35.

Weihs, D. 1974. Energetic advantages of burst swimming of fish. Journal of Theoretical Biology 48:215-229.

Young, P.S. and J.J. Cech. Jr. 1996. Environmental tolerances and requirements of splittail. Transactions of the American Fisheries Society 125:664-678.

Zucca, J.J. 1954. A study of the California clapper rail. Wasmann Journal of Biology. 12(2): 135-153.

APPENDIX K: MITIGATION MONITORING AND REPORTING PROGRAM: INVASIVE SPARTINA PROJECT, SPARTINA CONTROL PROGRAM

SEPTEMBER 2003

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MMRP

1.0 INTRODUCTION

BACKGROUND

Assembly Bill 3180 became law in California in January 1, 1989. This bill requires all public agencies to adopt monitoring or reporting programs when they approve projects subject to Environmental Impact Reports (EIRs) or Negative Declarations that identify significant impacts. The reporting or monitoring program must be adopted when a public agency makes its findings under the California Environmental Quality act (CEQA) so that the program can be made a condition of project approval in order to mitigate significant effects on the environment. The program must be designed to ensure compliance during project implementation to mitigate or avoid significant environmental effects.

This MMRP includes both a complete listing of all required mitigation measures identified in the San Francisco Estuary Invasive Spartina Project: Spartina Control Plan EIS/EIR, and a table describing who is responsible for monitoring the implementation of those measures, and how that monitoring shall be implemented.

Mitigation measures are grouped by the impact categories used in this EIR, and numbered sequentially below. This Monitoring and Reporting Program includes a Checklist designed to facilitate verification and monitoring of project compliance with required mitigation measures. This document will be used by the California Coastal Conservancy to verify inclusion of required project design features and ongoing mitigation measures. The Checklist serves as a summary so that public officials, the Applicant, and the public can easily determine which measures have been complied with, and to what extent.

2.0 MITIGATION MONITORING AND REPORTING PROGRAM CHECKLIST

The Mitigation Monitoring and Reporting Program Checklist is proposed for monitoring the implementation of the mitigation measures contained in the Environmental Impact Report (see Attachment 1 for a listing of mitigation measures). The Conservancy should implement the monitoring program as follows:

- The Program Coordinator, or designee, should be responsible for coordination of the monitoring program including the monitoring checklist (Attachment 2).

- Each responsible individual or agency will be responsible for determining whether the mitigation measures contained within the checklist have been complied with. Once all mitigation measures have been complied with, the responsible individual or agency should submit a Verification Report Form (Attachment 3), or similar form, and a completed checklist to the Coordinator.

- If a responsible individual or agency determines that a non-compliance has occurred, a written notice should be delivered to the Coordinator describing the non-compliance and requiring compliance within a specified period of time.

3.0 IMPLEMENTATION

The Invasive Spartina Project Program Coordinator shall be responsible for overall implementation and administration of the Mitigation Monitoring and Reporting Program Checklist for the proposed Spartina Control Program.

Duties of the Coordinator would include the following:

- Coordinate with applicable agencies that have mitigation monitoring and reporting responsibilities.
- Assure follow-up and response to citizens' complaints.
- Develop forms and checklists for reporting. A sample Verification Report Form is included (Attachment 3).
- Maintain the Mitigation Monitoring and Reporting Program Checklist or other suitable mitigation compliance summary.

As described in the Checklist table, most of the actual on the ground monitoring for implementation of mitigation measures will be undertaken by the ISP Field Supervisor or the agency implementing the measures. In all cases, these monitors shall submit verification forms to the Program Coordinator.

ATTACHMENT 1: MITIGATION MEASURES IDENTIFIED IN THE SAN FRANCISCO ESTUARY INVASIVE SPARTINA PROJECT: SPARTINA CONTROL PLAN EIS/EIR

This section lists all of the mitigation measures identified in the Final Invasive Spartina Project Spartina Control Program EIS/EIR, by topic, for Alternative 1, the CEQA proposed project.

HYDROLOGY AND GEOMORPHOLOGY

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.

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.

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.

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).

WATER QUALITY

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.

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.

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.

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.

BIOLOGICAL RESOURCES

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.

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 paste 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.

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

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.

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.

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.

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.

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.

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. 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.

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.

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.

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.

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.

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.

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.

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.

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.

AIR QUALITY

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.

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

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 <u>10</u> 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.

NOISE

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.

HUMAN HEALTH AND SAFETY

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.

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.

MITIGATION HS-3:

- 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.

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.

VISUAL RESOURCES

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).

CULTURAL 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

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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.

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.

CUMULATIVE IMPACTS

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.

MITIGATION CUM-2: Mosquito abatement districts generally propose annual work plans to regulatory agencies, as the Control Program also proposes. The potential for cumulative impacts may be minimized by implementing the following: mosquito abatement agencies shall cooperate joint planning and field coordination to avoid or minimize cumulative impacts. This planning, in addition to the mitigations identified elsewhere in this EIS/R, would reduce impacts to less than significant levels.

ATTACHMENT 2:

Mitigation Monitoring and Reporting Program

for the San Francisco Estuary Invasive Spartina Project Programmatic EIS/R

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
Hydrology and Geomorphology									
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.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Treating contractor, agency, or organization	ISP Field Superviso r	Prior to start of removal operations
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 Applicabl e	Applicabl e	Not applicable	Not Applicabl e	Applicabl e	Applicabl e	Treating contractor, agency, or organization	ISP Field Superviso r	During removal operations
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.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Treating contractor, agency, or organization	ISP Field Superviso r	During removal operations
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 Applicabl e	Applicabl e	Not Applicabl e	Not Applicabl e	Not Applicabl e	Not Applicabl e	Treating contractor, agency, or organization	ISP Field Superviso r	During removal operations

ISP Field Supervisor – Field Operations Manager, Field Biologist, or designee assigned to specific project site.

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
Water Quality									
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 ISP Control Program shall monitor and evaluate projects.	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Applicable	Herbicide applicat-ors	ISP field supervisor	During treatment operations
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	Herbicide applicat-ors Treating contractor, agency, or organization	ISP field supervisor ISP field supervisor	During treatment operations Prior to treatment operations
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	Treatment crews/contractors Treating contractor, agency, or organization	ISP field supervisor ISP field supervisor	During treatment operations Prior to treatment operations
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	Treeating agency or organization	ISP field supervisor	Prior to treatment operations

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
Biological Resources									
BIO-1.1. Bio 1.2, and Bio-1.3: Tidal marsh plant communities. Minimize vehicle and foot access pathways. Restrict equipment 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.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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 Applicabl e	Not Applicabl e	Applicabl e	Not Applicabl e	Not Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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 cordgrass pollen and seed rain is minimal.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
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 1,000 feet of spray operations. Remediate small volumes of spilled solutions on mudflats.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
BIO-5.1: California clapper rail. To minimize or avoid indirect impacts of eradication operations on clapper rails, follow "best management practices" in EIS/R Appendix G, as modified by the US Fish and Wildlife Service's 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	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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	Treating contractor, agency, or organization	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
BIO-5.3: Tidal marsh song sparrow subspecies and salt marsh common yellowthroats. Adapt protocols for minimization and avoidance of California clapper rails (EIS/R, 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	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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	Treating contractor, agency, or organization	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
BIO-6.1: Chinook salmon and steelhead (anadromous 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 Applicabl e	Applicabl e	Not Applicabl e	Applicabl e	Not Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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 Applicabl e	Applicabl e	Not Applicabl e	Applicabl e	Not Applicabl e	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
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	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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	Treating contractor, agency, or organization	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
Air Quality									
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	Treating contractor, agency, or organization	ISP field supervisor	During treatment
Mitigation AQ-2: Smoke and ash emissions. For prescribed burns, notify the Bay Area Air Quality Management District 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	Treating contractor, agency, or organization	ISP field supervisor	Prior to treatment
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. Avoid spraying when winds exceed 10 miles per hour, consistent with California supplemental labeling 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	Treating contractor, agency, or organization	ISP field supervisor	Prior to treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
Noise									
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	Applicable	Applicable	Not Applicable	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
Human Health and Safety									
Mitigation HS-1: Worker injury from accidents associated with non-native cordgrass treatment. Appropriate safety procedures and equipment shall be used by treatment workers. All workers shall be provided adequate training to ensure worker safety.	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
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	Treating contractor, agency, or organization	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
Mitigation HS-3: 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. 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. 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. Large-scale 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.	Not Applicabl e	Not Applicabl e	Not Applicabl e	Not Applicabl e	Not Applicabl e	Applicable	Treating contractor, agency, or organizati on	ISP field supervisor	During treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
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 to the public from exposure to fuel spills or other petroleum products, and herbicides.	Not Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Treating contractor, agency, or organization	ISP field supervisor	During treatment
Visual Resources									
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).	Applicable	Applicable	Applicable	Applicable	Applicable	Applicable	Treating contractor, agency, or organization	ISP field supervisor	Prior to treatment
Cultural Resources									
Mitigation CUL-1: Disturbance or destruction of cultural resources from access and treatment. a. For all sites proposed for ground-disturbing control methods and ground-disturbing access (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.	Applicable	Applicable	Applicable	Applicable	Not Applicable	Not Applicable	Treating contractor, agency, or organization	ISP field supervisor	Prior to treatment

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*	*Implementing Responsibility*	*Monitoring Responsibility*	*Mitigation Timing*
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 treatment 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.	Applicabl e	Applicabl e	Applicabl e	Applicabl e	Not Applicabl e	Not Applicable	Treating contractor, agency, or organizati on	ISP field supervisor	During treatment
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 Applicabl e	Applicabl e	Not Applicabl e	Applicabl e	Applicabl e	Not Applicable	Treating contractor, agency, or organizati on	ISP Field supervisor	Prior to and during treatment

Note: The mitigation measures are summarized in this table. The actual mitigation measures are attached as ATTACHMENT 1

VERIFICATION REPORT

Date:______________ Arrival Time:_____________ Departure:_________________

Location:_____________________________________ Discipline:

_____________________________________ Archaeology Dust/Air Quality

_____________________________________ Biology Noise

_____________________________________ Soils/Geology

Construction Sheet No.:____________________ Other_____________________________

Condition:____

Compliance: Acceptable Unacceptable Delay Activity
Remedial Action Implemented
Work Stop
Follow-up Conference Required

Activity:____

____

____

Observations:____

____

____

Recommendations:____

____

By:______________________________Report Approval:_________________________

Receipt by Project Supervisor:

Signature:_________________________________Date:________________Time:________________

Comments/Actions:____

____

____

Copies to:____

Date Entered to Environmental Monitoring File:_______________________________
By:_______________________________