Data Summary: A Review of Literature Regarding California Clapper Rail (*Rallus longirostris obsoletus*) Demographics, Habitat Use, Home Range, Movements, and Effects of Disturbance

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This report outlines the state of knowledge regarding California clapper rail (*Rallus longirostris obsoletus*) population demographics, habitat use, home range, movements, and effects of disturbance to rails or rail habitat. This information was obtained through review and synthesis of over 75 peer-reviewed scientific articles, theses and dissertations, governmental reports and project plans and proposals. The purpose of this review is to evaluate current literature as a tool for assessing the potential effects of non-native *Spartina* control on the California clapper rail. This data summary is intended to inform regional efforts to control invasive cordgrass (*Spartina*) in the San Francisco Estuary. In areas where potentially important information was found to be limited or lacking, this report recommends additional studies. This review is not intended to be a complete account of all aspects of California clapper rail biology. Readers should refer to the AOU species account (Eddleman and Conway 1998) and additional references for a more complete understanding of California clapper rail ecology (Eddleman and Conway 1994, Wilbur and Tomlinson 1976, Gill 1979).

California clapper rail habitats and impacts on population demographics

Dominant vegetation in California salt marshes often includes Pacific cordgrass (*Spartina foliosa*). Non-native cordgrass species important as California clapper rail habitat include exotic *S. alterniflora*, *S. foliosa x alterniflora* hybrids*, and *S. densiflora*. Although less established in San Francisco Bay *S. patens* provides exceptional habitat for Gulf Coast clapper rails and *S. anglica* may also provide suitable cover and/or nesting substrate.

Many marshes in South and Central San Francisco Bay have been invaded by hybrid *Spartina foliosa x alterniflora*, which has become dominant in some marshes. *S. densiflora* has also heavily invaded salt marsh in one North San Francisco Bay watershed. Additional species common in San Francisco Bay include pickleweed (*Salicornia virginica*), annual pickleweed (*Sa. europea*), saltgrass (*Distichilis spicata*), gumplant (*Grindelia stricta*), and jaumea (*Jaumea carnosa*). Transitional marsh vegetation, containing both low salt marsh and brackish marsh zone plants, include bulrush (*Scirpus* spp.) and Baltic rush (*Juncus balticus*; Gill 1979, Rigney et al.1989). Cattail (*Typha* spp.) and bulrush replace native *Spartina foliosa* in brackish marshes (Rigney et al. 1989).

California clapper rails use the high, middle and low zones of brackish, transitional, and salt marsh habitats (Rigney et al. 1989). Although typically occupying, and more abundant within, salt marsh habitats (Gould 1973, Rigney et al. 1989), California clapper rails utilize transitional and brackish marshes in San Pablo Bay, Suisun Bay and isolated pockets in South San Francisco Bay (Gill 1979). All three marsh types used by the California clapper rail are similar to marsh types used by the endangered Light-footed clapper rail (*R. l. levipes*) of Southern California (Zembal et al. 1989). Brackish marsh vegetation in northern San Francisco Bay and Suisun Bay is similar in structure to habitats used by the Yuma clapper rail (*R. l. yumanesis*; Harvey 1980, Conway et al. 1993).

The low marsh zone and associated vegetation is generally considered the most important for California clapper rails, especially for nesting (Harvey 1988, Gould 1973, Foerester et al. 1990, Evens and Collins 1992). However, high marsh with sufficient vegetation structure is necessary for refugia during winter high tides (Harvey 1980, Eddleman et al. 1988). Low marsh habitats which include hybrid *Spartina* clones have been used by California clapper rail in recent years and found to have relatively high nesting densities (J. Albertson, USFWS, pers. comm., Baye 2004).

Marsh channelization is the most commonly recognized factor associated with many aspects of California clapper rail habitat use. Nest placement, probability of site occupancy, foraging behavior and pair density are all positively correlated with the presence and density of 2nd and 3rd order slough channels or tributaries (Harvey 1988, Garcia 1995, Foerster 1990, Gould 1973, Varoujean 1972, Evens and Collins 1992). High marsh zones with a network of 1st order channels on levee faces also have increased use by rails (Foin et al. 1997, Evens and Collins 1992).

The influence of vegetation community or structure on the breeding success of California clapper rails is less understood. Nest sites indicate a shift during the early 1900s from *Grindelia* to low marsh *Spartina-Salicornia* vegetation associations (De Groot 1927). This observation may be related to changes in research methodology, such as changes in the timing of nest searches, as nests tend to be placed higher in *Spartina* during later nesting attempts to avoiding flooding by high tides (De Groot 1927, Harvey 1988). Flooding is the primary cause for California and light-footed clapper rail nest failures in the low marsh, while high marsh nests tended to be depredated at higher rates (Massey et al. 1984, Foin et al. 1997, USFWS 1991, Harding et al. 2001). Nests placed in *Grindelia* are particularly susceptible to inundation by high tides, although tides at or above 7.0 feet (2.13 meters) will damage nests in *Spartina* as well (Zucca 1954). Predation is due

mostly to native raptor and exotic mammalian pressure (USFWS 1991, Harding et al. 2001). Loss of nests to both flooding and predation is lessened when *Spartina* density is 100 stems per square meter or more and vegetation height is >50 cm tall (Zedler 1993, Evens and Collins 1992).

Short vegetation heights and low density of both *Spartina* and *Salicornia* are also implicated in lower California clapper rail density and site occupancy (Harvey 1988, Garcia 1995, Gill 1979). Sparsely vegetated marshes are associated with lower instances of calling rails during surveys for all west coast rail species (Harvey 1980, Jorgenson 1975, Conway et al. 1993). Experiments using radio-marked Yuma clapper rails indicate this is due to calling frequency and not avoidance of sparse habitats (Conway et al. 1993). Contiguous blocks of habitat greater than 100 ha in area supported the highest densities of breeding California clapper rails (nearly 0.5 rails/ha) in the early 1990s (Evens and Collins 1992). However, other rail species will use much smaller habitat patches (2 ha marshes, 50 m x 10 m strip marshes; Holliman 1978 *in* Lewis and Garrison 1983) and the minimum patch size necessary to support California clapper rail breeding is unknown. Large habitat patches are rare in San Francisco Bay (~10% of habitat patches >100 ha); the majority of patches (~80%) are less than 20 ha (Evens and Collins 1992).

California clapper rail home range

Only one published study has examined the movements and home range of California clapper rails using telemetry (Albertson 1995). The findings of this study illustrated fairly uniform annual (11 month) home range size among 29 California clapper rails in three South San Francisco Bay marshes (average 100% minimum convex polygon [MCP] home range size 8.46 ha, average per marsh ranged from 7.58 to 11.51 ha; Albertson 1995). Annual core use areas were also similar between marshes (average 50% MCP 0.87 ha, range per marsh 0.65 to 1.39 ha; Albertson 1995). However, seasonal home range size did vary between marshes (average 95% MCP ranged from 1.13 to 6.18 ha; Figure 1, Albertson 1995). Marshes with higher California clapper rail density had smaller core use areas during the breeding season (Albertson 1995). Zembal et al. (1989) estimated smaller seasonal home ranges for the light-footed clapper rail (average = 0.81 ha; range 0.36 to 1.66 ha), though differences in study duration and intensity of data collection may make estimates between subspecies incomparable. Juvenile light-footed clapper rails had home range size up to three times as large as established males (Zembal et al. 1989).

Annual home ranges overlapped considerably between adjacent individuals; however, core use areas were nearly exclusive, especially during the breeding season (Albertson 1995). Similar overlap in both annual and seasonal home ranges was observed in light-footed clapper rail populations (Zembal et al. 1989). Seasonal home ranges for the Yuma clapper rail were greatest in late winter (Conway et al. 1993). The California clapper rail did not follow this trend; the largest seasonal home ranges occurred during the late breeding season (Albertson 1995, Figure 1). Analysis of the occupancy rate of 1st order stream channels could not be compared in North Bay marshes due to unknown home range sizes of California clapper rail (Evens and Collins 1992). Home range and habitat use estimates generated by Albertson (1995) for California clapper rails in the South San Francisco Bay may be reasonable for North Bay populations, but further study is needed as habitat availability and movement patterns could vary markedly throughout the San Francisco Bay region owing to differences in habitat structure and composition.

California clapper rail movements

Movements of California clapper rails are typically short with largest movements prior to breeding season (Albertson 1995). While large movements are uncommon they are responsible for dispersal, primarily of juveniles in the fall which may range far from typical California clapper rail habitat (Linsdale 1936, Orr 1939). In a banding study by the U.S. Fish and Wildlife Service in the 1980s, three of 54 banded rails in South San Francisco Bay moved ≥1 km or more, one additional bird moved 10 km from Dumbarton Marsh to Alameda Creek (USFWS, unpublished data). In the mid 1990s a radio-marked female moved >2 km early in the breeding season before establishing and successfully defending a territory (Albertson 1995). Large variation between winter and breeding season surveys and occasional winter sightings in areas known to contain no breeding pairs (e.g. Triangle Marsh and west of Drawbridge, California) indicate possible seasonal habitat shifts in portions of South San Francisco Bay (Gill 1979, Rigney et al.1989). The literature suggests that California clapper rails detected in Suisun may represent birds dispersing during the fall from North San Francisco Bay and not necessarily established or successful breeding populations (Gill 1979, Evens and Collins 1992). However, California clapper rails have been detected in Suisun Bay during recent breeding seasons (Foin et al. 1997, H. Spautz pers. comm.).

Telemetry studies on the light-footed clapper rail show similar site fidelity and rare long distance dispersal. Maximum movement for radio-marked rails tracked every 15 to 30 minutes was often related to territory defense and averaged 262 m (range 111 to 413) over 15 to 56 days of tracking (Zembal et al. 1989). Resightings of marked individuals indicate <400 m movements for most light-footed clapper rails (Zembal et al. 1998). However, three longer distance movements indicate the potential for dispersal; 756 m and 1,020 m from the trap site and 21.7 Km movement between Newport Bay and Seal Beach (the largest movement of any west coast clapper rail; Zembal et al. 1998; Figure 2).

California clapper rails use stream channels to maneuver through the marsh during low tides, especially in areas with high stream banks (Foin et al. 1997). Forage sites are often small, e.g., a single 200 foot (61m) path used for foraging by one rail for several days (Williams 1929). The Yuma clapper rail has similar short daily (average 146m) and within day (average 125m) movements, which are larger during winter and early breeding seasons (Conway et al. 1993).

Population response to disturbance, weather patterns, and predation pressure

There are conflicting reports of California clapper rail susceptibility to disturbance. The light-footed clapper rail often habituates to human presence (Zembal et al. 1998). California clapper rails frequently live within urbanized landscape and birds in some areas can be approached quite closely (Orr 1939; H. Spautz pers. comm.), however infrequent disturbance can result in territory displacement (Foin et al. 1997, Albertson 1995). Disturbance when territories or nests are first established, for nests of younger birds, or birds in poor body condition could result in more frequent abandonment as demonstrated in other species (Sowls 1951, Zucca 1954, Braithwaite 1982, Johnson et al. 1992). Populations of California clapper rail can recover quickly from reductions in abundance. An estimated 40% decline in South Bay populations due to drought and

habitat loss in 1972 was apparently recovered by 1979 (Harvey 1980). However, it should be noted that by 1988, Bay-wide population estimates were 25-36% of estimates in the early 1970s, although different survey techniques were used (Harvey 1988, Harvey et al. 1992). Additionally, call counts in 1992 were 85% lower than surveys at the same sites in 1980 (Albertson 1995). California clapper rails also responded dramatically to red fox removal efforts at Don Edwards San Francisco Bay National Wildlife Refuge, showing population increases of nearly 100% (Harding et al. 2001). Recent research suggests predation on California clapper rail eggs may reduce productivity by as much as 33% while egg hatchability was only about 65-70%, likely due to contaminant levels (Schwarzbach et al. 2006).

California clapper rail response to habitat changes

Published information about responses by California clapper rails to habitat restoration is limited because major restoration activities are relatively recent and California clapper rail use of restored sites has not been adequately tracked. A few examples from the North Bay indicate the potential for California clapper rail reestablishment in restored tidal wetlands. Restoration of Muzzi marsh began in 1974 (Azevedo 2000). It took 5 years for Inner Muzzi marsh and about 14 years for Outer Muzzi marsh to revegetate to 50% cover (Phillip Williams and Associates, Ltd. unpublished data, presented to the Napa-Sonoma Marsh Restoration Group Meeting, November 2001). Rails recolonized Muzzi marsh 10 years after restoration efforts began; 3 years later an estimated 15 pairs of clapper rails were in the marsh (Evens and Collins 1992, Azevedo 2000). Creekside marsh was similarly recolonized in 1984 or earlier, following restoration of tidal action (Evens and Collins 1992). More recently, Petaluma River Marsh, originally restored in 1994-95, was colonized by breeding California clapper rail in 2004 (Avocet Research Associates 2004).

Rail responses to habitat reduction and degradation are also not well documented. Large scale tidal marsh conversion to human uses, including agriculture, salt ponds and urbanization, has been implicated as the major factor in the decline of the California clapper rail (Gill 1979). Burning vegetation to promote re-growth in Suisun marsh was expected to eliminate cover for California clapper rail (Harvey 1980), but specific responses and the ability to mitigate effects of habitat loss are unknown.

Potential long-term effects of hybrid *Spartina* on California clapper rails have been investigated by the San Francisco Estuary Invasive *Spartina* Project (Baye 2004). Short-term increases in nesting cover, and increased habitat quality due to vegetation structure and reduced predation may be off-set by ecological engineering processes inherent in mature hybrid *Spartina* stands (Baye 2004). Establishment of hybrid *Spartina* from mid- to low-marsh and mudflats would likely result in the development of broad, monotypic salt marsh plains with poorly developed tidal channels and reduced foraging areas for California clapper rail (Meanly 1985, Baye 2004). California clapper rails could be relegated to the peripheral, leading bayward edge of *Spartina* hybrid marsh (Baye 2004).

Recommendations for filling information needs

To the extent that invasive *Spartina* control efforts can be performed with minimal direct impacts to California clapper rails, potential indirect impacts are poorly understood and can not be accurately predicted. The goals of the Invasive *Spartina* Project Control Program include eradication of non-native *Spartina* in San Francisco Bay Estuary

(California Coastal Conservancy and US Fish and Wildlife Service 2003). These control efforts are expected to change habitat quality within the project area, at least for the short-term. We consider individual rails to have two general responses to changing vegetation structure or composition:

- Rails can change compositional habitat use patterns within the existing territories in response to change in habitat availability resulting from control efforts

- Rails can disperse to alternate habitat

An appropriate metric for evaluating the success of a given response might be the resulting breeding success of the affected individual rails. If the affected rails are able to reproduce successfully, especially over multiple breeding seasons, the interpreted impacts would be minimal.

The extent of indirect effects of *Spartina* control on California clapper rail populations and habitat use is likely influenced by two site-specific factors: density of rails and proportion of affected habitat. The probability with which these two response patterns occur is a critical issue in assessing the impact of *Spartina* removal on clapper rails. Recommendations to evaluate these potential effects include studies of habitat selection and movement using radio telemetry techniques, monitoring efforts to evaluate changes in population size (absolute or index), and survival analysis either through banding or concurrent with telemetry studies.

Habitat use and the effect of vegetation removal on habitat selection need to be investigated to understand the potential impact of *Spartina* control strategies on California clapper rails. The extent of invasive *Spartina* use by rails and the influence of the accelerating pace of the invasion on habitat selection remain unknown. Within many heavily invaded South Bay marshes hybrid *Spartina* is the dominant vegetation in the low-marsh zone, which is apparently preferred by California clapper rails. Although plasticity in habitat use is demonstrated by rails' use of both low and high marsh habitats containing sufficient cover, nesting material, channelization, food resources, and protection from exotic mammalian predators (Foin et al. 1997), survival and reproduction may be negatively affected and should be considered when evaluating habitat use following *Spartina* removal. Currently, the sparse cover and lack of tidal flow in many high marsh habitats suggest few alternatives exist for California clapper rail if vegetation in low marsh habitats is removed (Foin et al. 1997). Researchers interested in responses of California clapper rail to marsh restoration activities have identified a need to better understand dispersal (Foin et al. 1997) and develop habitat use and suitability models (Evens and Collins 1992). Potential short term habitat loss underscores the urgent need to understanding California clapper rail ability to successfully disperse, establish territories, survive and reproduce.

Effects of *Spartina* control on regional and local trends in rail density and distribution should be evaluated with standardized surveys. However, the relationship of clapper rail response to recorded calls has been shown to be influenced by vegetation structure and time of year and thus estimates are not completely reliable (Conway et al. 1993, Gill 1979). The relationship between population indices and actual population size remains unknown. A true census in which all individuals are reliably counted may be possible in smaller marshes, but is not likely in larger marshes which tend to have higher

rail density. Corroborating evidence regarding habitat use and calling rates from telemetry studies with the incorporation of a robust sampling design (e.g. Distance sampling methods in which detectability can be estimated) may improve estimates of population density and distribution.

In conclusion, the emphasis on low marsh habitat restoration to benefit the California clapper rail has been called into question (Foin et al. 1997). The potential loss of additional low marsh habitat used by California clapper rail due to *Spartina* control efforts may be off-set by development of good quality high marsh habitat. Further information needs regarding the effects of *Spartina* control on habitat use of individual rails and the dynamics of metapopulations should be investigated using standardized survey methodology and robust analysis techniques. Population-level impacts may not be as readily apparent as individual-level effects soon after control efforts, especially if dispersal or habitat use changes influence survival and reproduction rates. Therefore, population monitoring should be an on-going and regional effort.

Summary of findings and information needs:

- California clapper rails use salt marsh habitats and are more abundant at larger marshes, with well developed tidal channels and abundant low- and mid-marsh vegetation.

- Home range and movements are typically small and short, with well defended core-use areas during breeding season and overlapping home range boundaries.

- Long distance movements, >400 m, are more common from juvenile birds and during the fall or winter.

- California clapper rails can be disturbed through human activity and may abandon home ranges if disturbed.

- Clapper rails will readily re-colonize restored tidal marsh.

- Control of non-native *Spartina* is likely to result in degradation of California clapper rail habitat, particularly vegetation patches used for nesting.

- Information needs to assess the effect of *Spartina* control on California clapper rail include:

  o Knowledge of the changes in habitat structure following *Spartina* control

  o Knowledge of the degree and manner to which California clapper rails successfully alter their habitat use patterns following removal of non-native *Spartina*.

  o Knowledge of the ability of California clapper rails to disperse to alternative habitats and successfully establish breeding territories following removal of non-native *Spartina*.

  o Knowledge of the effect of changing habitat availability on population demographics including survival and recruitment.
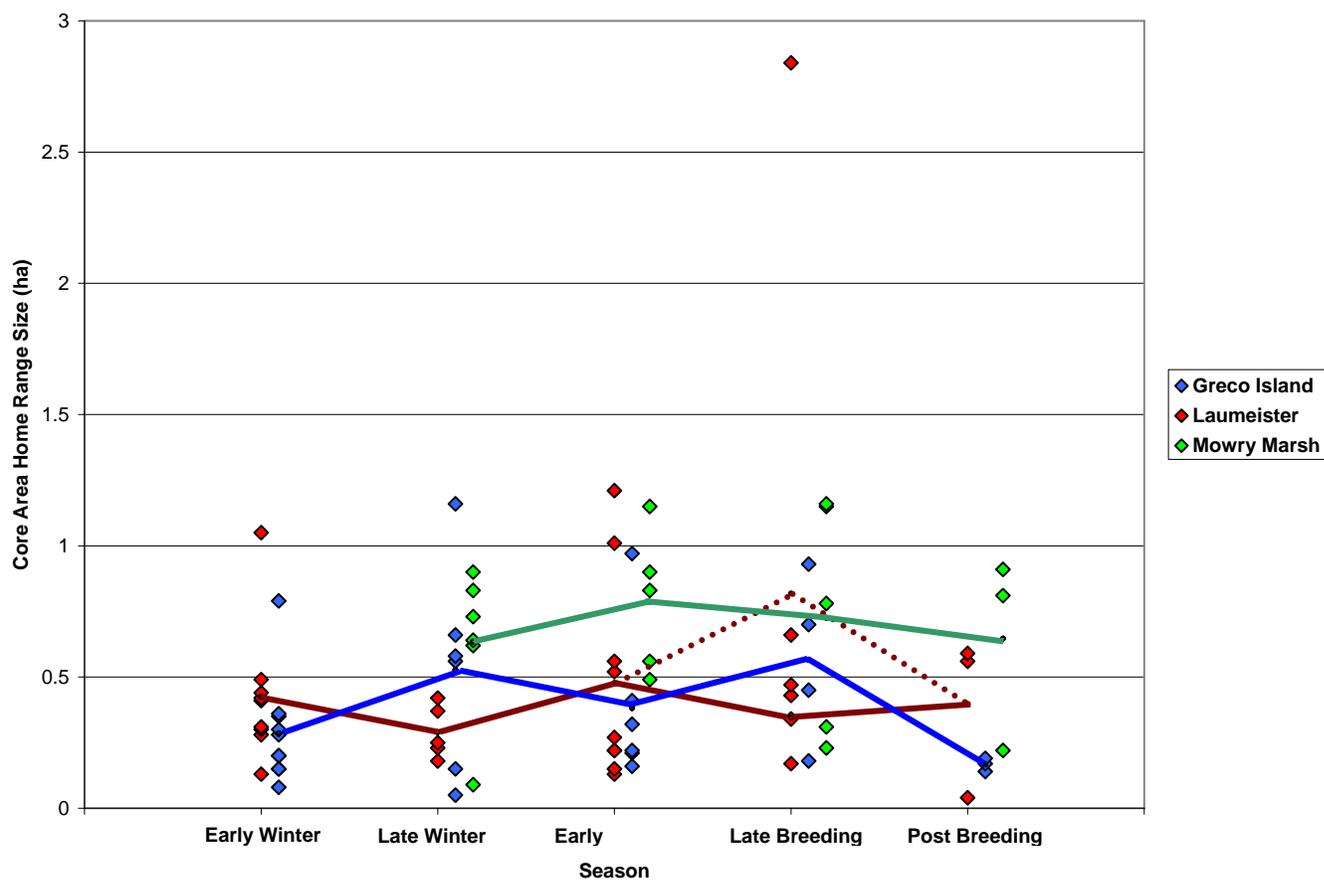
Figure 1. Seasonal core use areas (50% MCP) for California clapper rails in three marshes in South San Francisco Bay (symbols) and marsh average home range size (lines). One home range in Laumeister Marsh during the late breeding period was 2.84 ha. The dotted line represents the average including this outlier, the solid line represent the average excluding it (Albertson 1995).
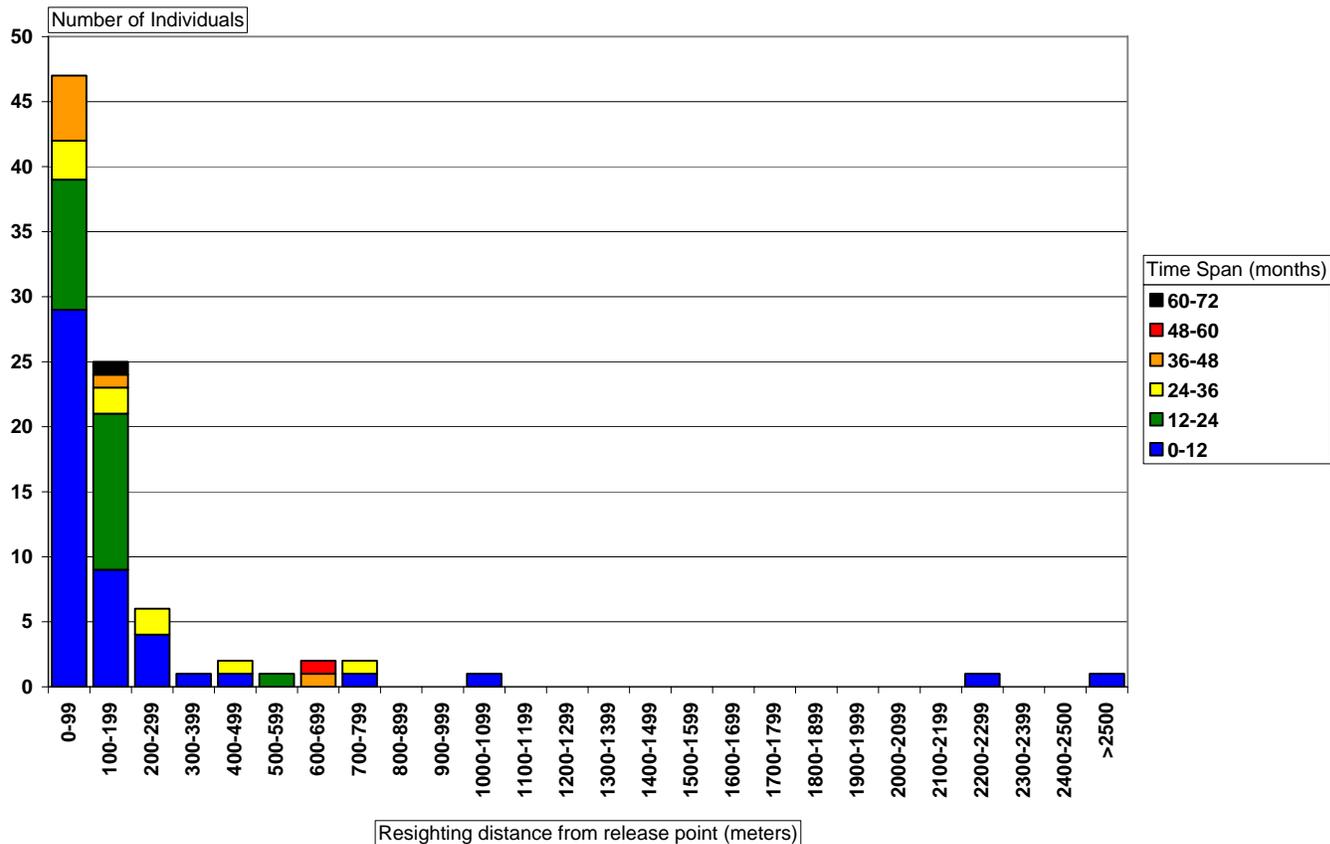
Figure 2. Maximum distance (meters) and time (months) between capture and resight locations of light-footed clapper rails, including one >21 Km movement (Zembal et al.1998).

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