Salt marsh wandering shrew, *Sorex vagrans halicoetes*

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Description: A small to medium sized (100-110 mm TL), dark shrew, sooty seal brown to black above with a relatively long (37-41 mm), unicolored tail; dark brown ventrum; and moderately large high-domed skull (Grinnell 1913). Distinguished from upland *S. v. vagrans* by its darker dorsum and brown ventrum (silvery brown in *vagrans*), slightly larger body size, broader rostrum, and longer maxillary tooth-row (Grinnell 1913, Jackson 1928, Findley 1955). Distinguished from *S. o. sinuosus* by its slightly lighter color, larger size, browner ears, and high, dome-shaped cranium (Grinnell 1913). Weight from 3.1 to 7.2 g (males) and from 2.7 to 7.0 g (females) (Rudd 1955b). Distinguished from upland *S. v. vagrans* by darker dorsal and ventral pelage (Grinnell 1913).

Taxonomic Remarks: The salt-marsh wandering shrew was first described as *S. halicoetes* Grinnell (1913). Jackson (1928) relegated *halicoetes* to a subspecies of *S. vagrans*, a convention followed by subsequent authors (Grinnell 1933, Findley 1955, Hennings and Hoffmann 1977, Junge and Hoffmann 1981, Carraway 1990). The taxonomy of *S. vagrans* group has had a confusing history (Merriam 1895, Grinnell 1913, Jackson 1928). There is little controversy about the taxonomic status of *S. v. halicoetes*, although the karyotype from *halicoetes* was identical to *S. v. vagrans* from the northern part of the San Francisco Bay region (Brown 1974). This taxon still needs a more thorough biochemical and morphometric analysis to help clarify its phylogenetic and taxonomic relationship to other members of the *S. vagrans* complex. Carraway's (1990) morphometric analysis of the *S. vagrans* complex along the Pacific coast, which did not include *halicoetes*, resulted in the recognition of five species (*S. sonomae*, *S. bairdii*, *S. monticolus*, *S. pacificus*, and *S. vagrans*) and one new subspecies (*S. s. tenelliodus*) in the *S. vagrans* complex.

Distribution: Based on available museum specimen records, *halicoetes* occurred historically in salt marshes bordering the southern arm of the San Francisco Bay from San Pablo, south along the bay margin through Oakland, Hayward, and Alviso, then north through Palo Alto, Belmont, and South San Francisco (Grinnell, 1913, 1933, Ford 1986). Today, it is confined to small remnant stands of salt marsh found around the southern arm of the San Francisco Bay in San Mateo, Santa Clara, Alameda and Contra Costa counties (Ford 1986). The known elevational range extends from approximately 6 to 9 ft.

Life History: There are few data on the life history of *S. v. halicoetes*, although its biology is probably similar to that described for *S. vagrans* (Clothier 1955, Ingles 1960, 1961, Eisenberg 1964, Newman 1976, Hawes 1977). *S. v. halicoetes* is active all year long but tends to be most active at night with some limited nocturnal activity. Its activity pattern is probably regulated to some degree by daily and seasonal tide cycles. Based on comparisons with other salt marsh shrews (see *S. o. sinuosus* account), the diet of *halicoetes* is probably composed largely of amphipods, isopods, crustaceans, and insects that inhabit salt marshes.

Foraging probably takes place under litter and debris found on moist ground, and in moist accumulations of dead plant material (Zeiner et al. 1990). According to Johnston (1957), salt marsh wandering shrews are fairly good swimmers both above and below the surface of the water. On several occasions he observed salt marsh wandering shrews dive underwater to avoid being captured.

S. v. halicoetes breeds from February through June, with most young born during April (Johnston and Rudd 1957). Another smaller peak of breeding occurs in September, contributed to by reproduction by young of the year born in the previous spring. Gestation lasts about 20 days, and average litter size is 5.16 young (range 2-9 young). Less than half the salt marsh wandering shrews

survive to weaning. Two kinds of nests, one for breeding and the other for resting, are constructed. The breeding nest is constructed of dead plant material (*Spartina*, *Distichlis*, and *Salicornia*) by the female, and is typically located on the ground either under or in driftwood, planks, or woodblocks found along the higher tide line where they may escape flooding. Resting nests are used by both sexes and are generally placed off the ground in *Salicornia*. Of the 45 salt marsh wandering shrew nests located by Johnston (1957), only three were situated below elevations 1.8 m above mean sea level.

On average, salt marsh wandering shrews live less than 18 months, indicating high population turnover. Populations also show substantial multi-annual fluctuations. Raptors such as northern harrier (*Circus cyaneus*), white-tailed kite (*Elanus caeruleus*), and short-eared owl (*Asio flammeus*) occasionally prey on salt marsh wandering shrews (Johnston and Rudd 1957). Other likely predators are egrets, herons, feral cats (*Felis silvestris*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and the long-tailed weasel (*Mustela frenata*). The principal causes of mortality for salt marsh wandering shrews are drowning, starvation, and exposure (Johnston and Rudd 1957).

Population density and home range size for this taxon are expected to be similar to those reported for other populations of vagrant shrews. In Washington state, *S. vagrans* have been recorded at densities ranging from 36.6 to 50.2 individuals per ha (Newman 1976). *S. vagrans* in Washington and California have home ranges from 24 to 678 m^2 and population densities of 6.1-6.9 per ha (Ingles 1961, Newman 1976).

Habitat: Salt marsh wandering shrews inhabit a narrow band of *Salicornia* marsh which is inundated daily by tidal waters (Ford 1986). According to Johnston and Rudd (1957), salt marsh wandering shrews are most frequent in salt marshes that provide dense cover, an abundant source of invertebrates for food, suitable nesting and resting sites, and continuous ground moisture. In one study, most individuals restricted their activity to middle marsh habitat, about 6 to 8 ft above sea level, and to lower-lying marsh not regularly inundated. Suitable middle marsh habitat frequented by this taxon is usually inundated only by high tides and is characterized by 30-60 cm high *Salicornia* with driftwood and other debris resting directly on the vegetation (Johnston and Rudd 1957). The surface debris provides nesting and resting sites and foraging habitat during dry periods. The high salt marsh, from 2.4 to 2.7 m in elevation, provides refuge for shrews during extremely high tides. The low marsh, dominated by *Spartina* and subjected to daily tidal floods, is used by this taxon as foraging habitat only during low tides (Johnston and Rudd 1957).

Status: Class II. *S. v. halicoetes* is currently restricted in distribution to only a few scattered, isolated remnants of tidal salt marsh around the southern arm of the San Francisco Bay (Ford 1986). Museum specimen records and the available literature, including reports from live-trapping surveys, indicate that *S. v. halicoetes* inhabited most *Salicornia* marshes between South San Francisco and San Pablo, and occurred at 54 sites in five counties (Ford 1986). Ford (1986) undertook surveys within the species' historic range and reported the following: *i)* populations were found at four marshes within its historic range (Mowry Slough, Bair Island, Dumbarton Point, and Alameda Creek Mouth); *ii)* the status of shrew populations at 31 historic locations in San Mateo and Alameda counties was unknown; *iii)* twelve historic shrew locations had been extirpated; and *iv)* fifteen additional locations contained suitable salt marsh wandering shrew habitat. Ford (1986) recommended that *S. v. halicoetes* be listed and protected under the State and Federal Endangered Species Acts. However, a more intensive range-wide population assessment of the distribution and status of extant salt marsh wandering shrew populations is needed before a decision can be made on whether to pursue this recommendation.

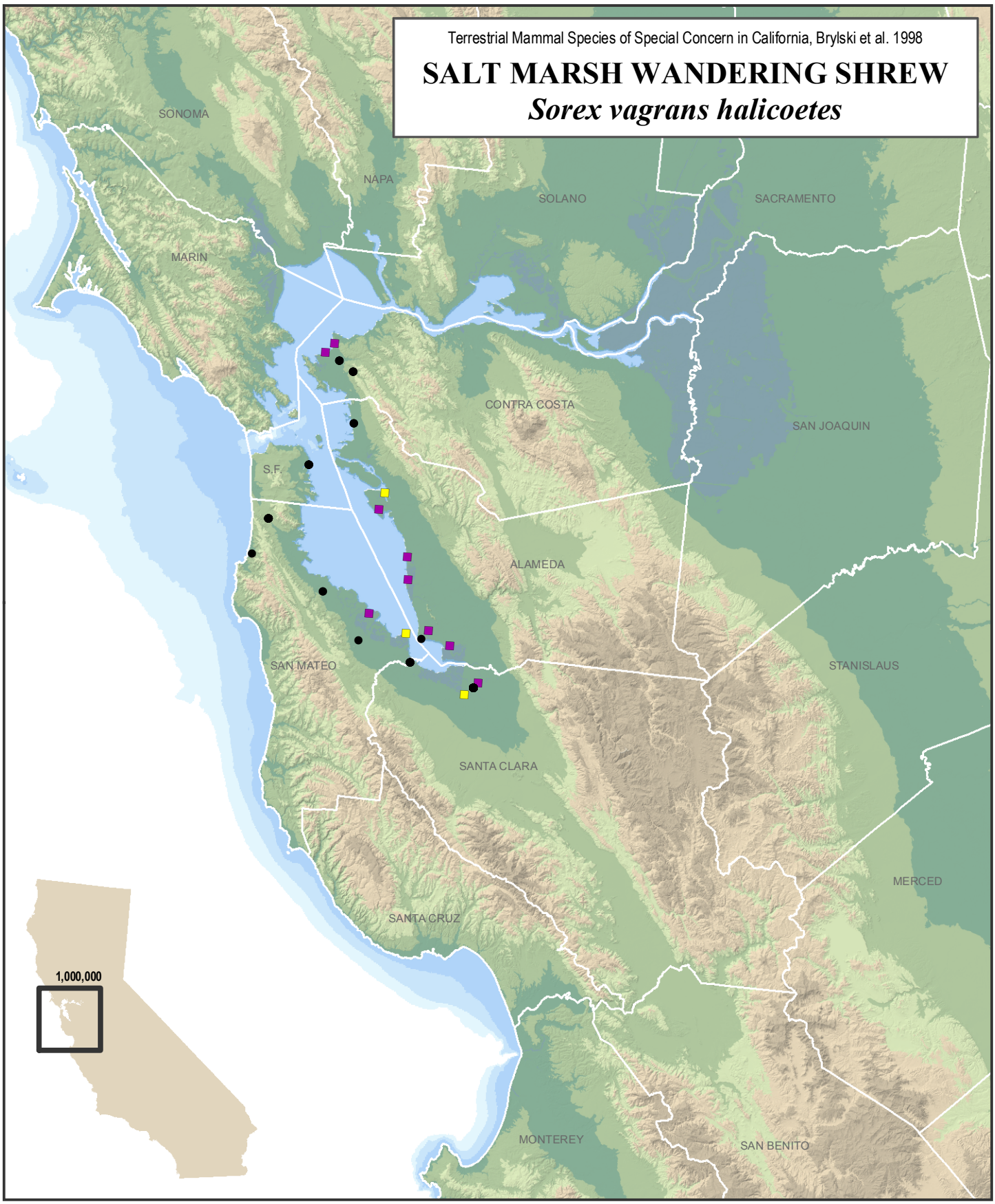
The salt marsh wandering shrew has been adversely affected by the degradation and loss of salt and brackish marsh habitats that occurred historically around the San Francisco Bay. When Europeans first reached the San Francisco Bay region over 200 years ago, there were more than 73,000 acres of salt and brackish marsh habitat present around the southern arm of the San Francisco Bay (Ford 1986). Approximately 91 percent (66,458 acres) of these tidal wetlands have been lost to urban, industrial and agricultural development, diking, filling, flooding, dredging, erosion, and/or conversion to other types of vegetation (Ford 1986). Today there are only about 6,546 acres of natural, undiked, tidal salt marsh remaining within the shrew's historic range (Ford 1986). The loss of this amount of marsh habitat has had a profound effect on the size and distribution of salt marsh wandering shrew populations, and is the principal reason for concern about the present status of this taxon.

Other factors affecting this taxon include widespread loss of high marsh habitat contiguous with remaining areas of low and middle marsh; construction and maintenance of dikes and levees that help to isolate shrew populations; wastewater discharges that change the composition and vigor of salt marsh shrew habitats; and infusion of heavy metals, PCBs, petroleum hydrocarbons, and pesticides that may be accumulating in the food chain on which salt marsh wandering shrews depend (Shellhammer et al. 1984, Ford 1986).

The salt and brackish marsh habitats inhabited by the salt marsh wandering shrew receive Federal and State regulatory oversight and protection because they also support populations of two Federally-listed species (the salt marsh harvest mouse [*Reithrodontomys raviventris*] and California clapper rail [*Rallus longirostris obsoletus]*). All of the marshes which have extant populations of salt marsh wandering shrews are included in the proposed critical habitat for salt marsh harvest mice (Shellhammer et al. 1984). However, this shrew uses a restricted area of salt marsh habitat, and there may be a smaller amount of suitable habitat for it than for salt marsh harvest mice. *S. v. halicoetes* may therefore be under a greater threat of extinction than the Endangered salt marsh harvest mouse.

Management Recommendations: A range-wide trapping program is needed to determine the current distribution and status of *S. v. halicoetes*, and to evaluate the extent of suitable salt marsh habitat. Such an effort should provide the basis for deciding whether to propose the listing of this taxon as Threatened or Endangered. At the same time, a better understanding of the species' life history and population biology are needed, including the population sizes needed to maintain genetically viable populations, and genetic and morphologic studies needed to understand the effect of habitat fragmentation and its relationships to other *S. vagrans* subspecies.

Some or all of the measures recommended or being implemented to protect and enhance tidal marsh habitat for the Endangered salt marsh harvest mouse and California clapper rail (Shellhammer et al. 1984) could also be benefiting salt marsh wandering shrews. Measures for habitat protection and enhancement contained in the recovery plans for these two species should be reviewed and modified where appropriate to ensure that remaining marsh habitat is enhanced for the two listed species and for the salt marsh wandering shrew. Any proposed developments, waste water discharges, dredging activities, and dike repairs within the historic range of this taxon that could modify salt marsh vegetation or change the degree of inundation of salt marsh habitats should be reviewed for their impacts on this species.


Terrestrial Mammal Species of Special Concern in California, Brylski et al. 1998
SALT MARSH WANDERING SHREW
Sorex vagrans halicoetes
SONOMA
NAPA
SOLANO
SACRAMENTO
MARIN
CONTRA COSTA
SAN JOAQUIN
S.F.
ALAMEDA
SAN MATEO
STANISLAUS
SANTA CLARA
MERCED
SANTA CRUZ
MONTEREY
SAN BENITO
1,000,000
RESOURCES AGENCY
CALIFORNIA
DEPARTMENT
FISH & GAME
Locations verified by authors
(captures, observations, museum records)
CNDDB 1979 - 1998
CNDDB 1978 and before
Wildlife Branch:KFien12109