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USE OF BRACKISH MARSHES IN THE SOUTH SAN FRANCISCO BAY BY SALT MARSH HARVEST MICE

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The salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris*) is an endangered species endemic to the marshes of the San Francisco Bay (Shellhammer 1982). Both the southern subspecies (*R. r. raviventris*) and northern subspecies (*R. r. halicoetes*) were originally described by Dixon (1908, 1909) as being restricted to salt marshes and primarily to areas dominated by pickleweed (*Sarcocornia pacifica*). Fisler (1965), however, suggested that the northern subspecies was often found in mixtures of salt marsh and various bulrush species (*Schoenoplectus* spp.).

Trapping projects carried out or directed by H. Shellhammer in the South San Francisco Bay (South Bay) in the 1970s and 1980s demonstrated an absence of the mouse in alkali bulrush (*Schoenoplectus robustus*) dominated marshes (Shellhammer et al. 1988). Those marshes were relatively young and did not have extensive understory layers of thatch. In contrast, in the early 2000s L. Barthman-Thompson of the California Department of Fish and Game and P. Quickert of the California Department of Water Resources captured comparatively large numbers of the northern subspecies in several SMHM reserves in the Suisun Bay where the bulrush marshes (largely *Schoenoplectus americanus)* were mature, and had a well developed understory of thatch (Sustaita et al. 2004). Those investigators were especially successful when the marshes were inundated during high tides, when managed (diked) marshes were flooded (Sustaita et al. 2004), and when they used the technique of suspending the traps on top of the thatch layer, or even higher in the vegetation.

In 2006, we trapped salt, transitional, and brackish marshes in the South Bay (H. T. Harvey & Associates 2007), repeating a study of three marshes that we conducted in 1990 (H. T. Harvey & Associates 1990). These marshes were the Calaveras Marsh, a salt marsh-dominated by pickleweed, located in Alameda County approximately 5.5 km west of Drawbridge, Alameda County; Triangle Marsh, a transitional marsh composed of a mixture of pickleweed and alkali bulrush, located in Santa Clara County approximately1.0 km SW of Drawbridge; and Warm Springs Marsh, a brackish marsh dominated by alkali bulrush, located in Alameda County approximately 2.3 km ENE of Drawbridge (Figure 1). We placed the traps in grids on the mud surface beneath the vegetation during very low nocturnal tides during a first phase of trapping (the same technique we used in 1990). During the second phase of trapping, we placed the traps up in and on the thatch of the alkali bulrush-

dominated areas at Triangle and Warm Springs when the nocturnal high tides would cover the mud surface.

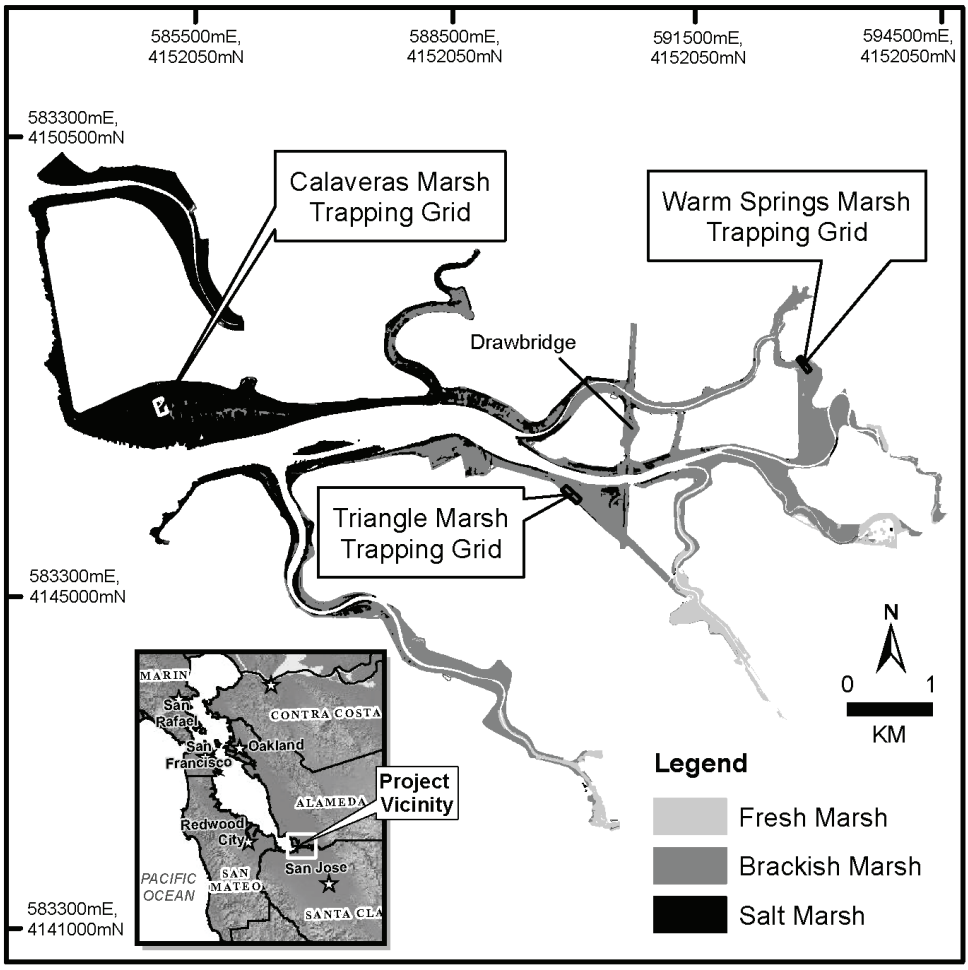

Figure 1. Distribution of marsh types in the South Bay and location of Calaveras marsh and Warm Springs marsh trapping grids, Alameda County, and Triangle Marsh trapping grid, Santa Clara County.

Higher numbers of SMHM were captured in both the transitional Triangle Marsh (17 vs. 10 animals in 400 TN), and the brackish Warm Springs Marsh (8 vs. 2 SMHM) when traps were placed on the bulrush thatch layer instead of on the marsh plain surface. For comparison, the pickleweed dominated Calaveras Marsh yielded 15 animals in 400 TN in the first stage of trapping. In 1990, there were no SMHM captured on the marsh plain of Warm Springs Marsh.

This brackish Warm Springs Marsh differed from other marshes in that it lacked any pickleweed: alkali bulrush and perennial pepperweed (*Lepidium latifolium*) were the dominant plant species. When it was trapped during in the second phase, five SMHM were captured

in bulrush-dominated sites, two at perennial peppergrass-dominated sites with sparse bulrush, and one at a site dominated by perennial peppergrass and spearscale (*Atriplex prostrata*) . We also noted a far more extensive thatch layer than we saw in 1989.

These results demonstrate that SMHM use an alkali bulrush-dominated marsh in the South San Francisco Bay. Of further significance, there was a higher number of SMHM captured in the alkali bulrush-dominated marsh and transitional marshes when the traps were placed high in the vegetation (i.e., on the thatch) than when the traps were on the marsh plain; the mice were found in pepperweed-dominated habitat as well. Moreover, the mice moved higher in the vegetation in response to the tidal inundation. It is likely that in mature bulrush marshes SMHM use the thatch layer as protection from predation. We also note that while our primary explanation of the presence of SMHM in these marshes is that they are mature and thatch has developed, other factors also may have been important. For example, the existing salt marshes are isolated and greatly reduced, thereby putting pressure on the populations to expand into brackish areas. Based on these results we suggest that brackish marshes may be of greater conservation value to the SMHM in the South Bay than previously recognized and, if subsequent investigations bear out our observations, consideration should be given to broadening the habitat description of the SMHM to include mature brackish marshes throughout its range.

Many questions remain. We do not know how the distribution, densities, or the persistence of SMHM will change as the ratio of alkali bulrush to perennial peppergrass shifts both seasonally and over longer periods of time. Neither do we know the size of a mouse's home range within stands of alkali bulrush, how far they move within such stands, or whether they live in them for prolonged periods of time. We also do not know if SMHM utilize monocultures of perennial pepperweed for extended periods, or if they use only mixtures of pepperweed and bulrush, or other species; the latter is important because peppergrass continues to increase in density and distribution throughout the marshes of the southern end of the South Bay.

Nonetheless, we hypothesize that brackish marshes will play a more important role in the long-term preservation and recovery of SMHM than previously had been recognized. The eight SMHM captured in the brackish Warm Springs Marsh were approximately half the number and capture efficiency of those captured at the saline Calaveras Marsh or transitional Triangle Marsh. If such comparatively high capture rates for SMHM can be found consistently in brackish marshes elsewhere in the South Bay, it will suggest that the brackish marshes of the South Bay form a valuable adjunct to SMHM habitat restoration activities. Those brackish marshes may prove to be important to the ability of the species to respond to rising sea levels associated with global warming: bulrush located on the tidal plain is likely to maintain its structure as sea levels rise, while pickleweed marshes may be subject to increasing threats due to inundation.

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