

ABUNDANCE AND DISTRIBUTION OF THE SANTA CATALINA ISLAND SHREW (*SOREX ORNATUS WILLETTI*) ON SANTA CATALINA ISLAND, CALIFORNIA

ANGELA J. AARHUS

Catalina Island Conservancy, P.O. Box 2739, Avalon, CA 90704
Present address: 607 12th Avenue, Two Harbors, MN 55616; ajaarhus@hotmail.com

Abstract—Little information exists on the population status, distribution, and habitat associations of the Santa Catalina Island shrew (*Sorex ornatus willetti*), a subspecies of the mainland ornate shrew found only on Santa Catalina Island (hereafter Catalina). From 1941, when it was first described, until 2002, only nine shrew sightings had been documented. In February 2002, U.S. Geological Survey (USGS) began monthly monitoring of reptiles, amphibians, small mammals, and invertebrates on Catalina. Using permanently placed pitfall trap arrays, two additional shrews were captured in Cottonwood Canyon, a major drainage on Catalina. This information, combined with historical captures of shrews, suggested that Cottonwood Canyon might provide important habitat critical for the survival of this rare insular endemic. In 2003, the Catalina Island Conservancy initiated an intensive study to determine the abundance and distribution of *S. o. willetti* in Cottonwood Canyon. Between April and September, three existing USGS pitfall trap arrays ($n = 21$ traps) located in maritime cactus scrub and chaparral habitats in Cottonwood Canyon were continuously monitored for shrews. Twenty-four additional transects were established to trap in the area surrounding these arrays and into the nearby riparian community, using pitfall ($n = 33$) and Sherman ($n = 360$) live traps. Three shrews were captured during 3,638 trap-nights using both types of traps. Pitfall traps proved to be the most successful method for capturing shrews. Consistent with past accounts, these recent sightings suggest that *S. o. willetti* is most closely associated with mesic sites (e.g., riparian habitats), which are scarce on Catalina (<1% of vegetative cover). Further monitoring is necessary to fully understand the abundance, distribution, and habitat associations of this rare shrew in Cottonwood Canyon and elsewhere on Catalina.

Keywords: *capture rate, habitat association, live trapping, pitfall trap, Sherman trap, Santa Catalina Island shrew, Sorex ornatus willetti*

INTRODUCTION

The Santa Catalina Island shrew (*Sorex ornatus willetti* von Bloeker) was first described in 1941 based on a single specimen collected from Avalon Canyon, Santa Catalina Island, California (von Bloeker 1941; Fig. 1). Although originally considered a new species, this shrew's taxonomic status was subsequently relegated to subspecies of the mainland ornate shrew (*Sorex ornatus*; von Bloeker 1967). Recent genetic analysis of this island population in relation to other *S. ornatus* mainland populations supports their subspecific status, while at the same time revealing *S. o. willetti* to be one of the most genetically distinct populations in the southern part of the species



Figure 1. Santa Catalina Island Shrew (*Sorex ornatus willetti*). Photo credit: Frank Starkey.

range, in addition to one of the most endangered (Maldonado et al. 2001).

Since 1941, only a small number of sightings of the Santa Catalina Island shrew have been documented, despite several studies attempting to determine its abundance, distribution, and status on Catalina (Williams 1983, 1986, Collins and Martin 1985, Maldonado pers. comm.; Table 1, Fig. 2). In the early 1980s, pitfall traps were used to capture shrews in various vegetative communities (i.e., scrub oak woodland, chaparral, marsh, grassland, coastal sage scrub, and riparian; Williams 1983, Collins and Martin 1985). Despite a combined effort of more than 6,780 trap-nights (one trap night equals one pitfall or Sherman trap left open for one night), only one shrew was captured in a riparian area located in Cottonwood Canyon, one of Catalina's two major drainages with a year-round water source (Williams 1983, Collins and

Martin 1985, Brylski et al. 1996). In 1993, two shrews were captured in a riparian area in Middle Canyon after 350 trap-nights using Sherman live traps (Maldonado pers. comm.). In 1986, the Santa Catalina Island shrew was declared a Mammal Species of Special Concern by the California Department of Fish and Game due to its restricted range, rarity, and the paucity of information concerning its life history, abundance, and distribution (Williams 1986).

In early 2002, the Catalina Island Conservancy (the Conservancy) contracted U.S. Geological Survey's Western Ecological Research Center (USGS-WERC) to conduct monthly monitoring of reptiles, amphibians, small mammals, and invertebrates on Catalina as part of a three-year baseline study. A total of 20 permanent pitfall trap arrays were constructed in various habitat types (i.e., coastal sage scrub, scrub oak woodland,

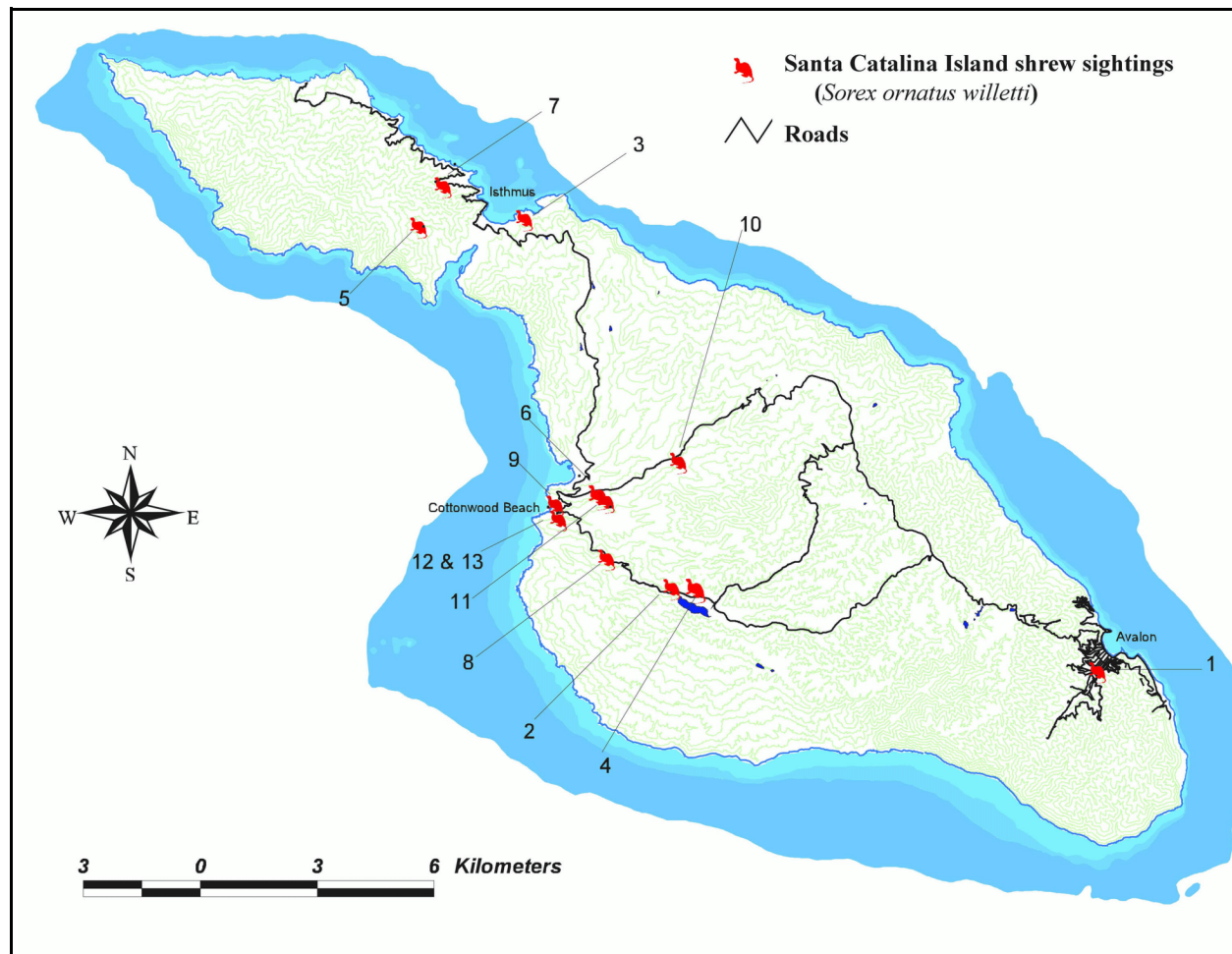


Figure 2. Locations of sightings of the Santa Catalina Island Shrew (*Sorex ornatus willetti*) on Santa Catalina Island, California, 1941 to 2003. Numbers correspond with sightings in Table 1.

Table 1. Sightings of the Santa Catalina Island Shrew on Santa Catalina Island, California, 1941 to 2003.

Map ^a	Date	Location	Type of Record	Source	Comments
1	25 April 1941	Avalon Canyon	Specimen	von Bloeker (1941)	First shrew record for Catalina-brought into house by domestic cat
2	1950s	Middle Canyon	Sighting	Williams (1983)	Anecdotal sighting of a shrew running across the road
3	1960s	Isthmus	Specimen	Brylski et al. (1996)	One shrew collected from the Hancock Marine Research Station
4	August 1980	Middle Canyon	Sighting	Collins and Martin (1985)	Anecdotal sighting of domestic cat carrying live shrew into bunkhouse
5	Summer 1980 or 1981	Isthmus	Sighting	Collins and Martin (1985)	Anecdotal sighting of shrew crossing road by dump
6	13 January 1983	Cottonwood Canyon	Specimen	Williams (1983)	One shrew captured in a water-filled pitfall trap 100 m below Cottonwood Dam in riparian habitat
7	16 March 1991	Cherry Valley Cove	Specimen	Maldonado (pers. comm.)	One dead shrew found behind warehouse
8	24 April 1993	Middle Canyon	Sighting	Maldonado (pers. comm.)	Two live shrews captured via Sherman live traps at old Ben Weston road junction in riparian habitat
9	17 April 2002	Cottonwood Canyon	Sighting	USGS-WERC (unpubl. data)	One live shrew captured in pitfall trap located in maritime cactus scrub habitat
10	9 March 2003	Cottonwood Canyon	Sighting	USGS-WERC (unpubl. data)	One live shrew captured in pitfall trap located in chaparral habitat by creek
11	20 April 2003	Cottonwood Canyon	Sighting	Current Study	One live shrew captured in pitfall trap 65 m above Cottonwood Dam in riparian habitat
12	27 April 2003	Cottonwood Canyon	Sighting	Current Study	One live shrew captured in pitfall trap next to water filled basin by Cottonwood Beach in riparian habitat
13	22 August 2003	Cottonwood Canyon	Sighting	Current Study	One live shrew captured in pitfall trap next to dry basin by Cottonwood Beach in riparian habitat

^a Numbers correspond with shrew sighting locations on map (see Fig. 2).

grassland, chaparral, riparian, maritime cactus scrub) in the central part of the island (Backlin et al. 2001). Since February 2002, two shrews have been captured in these pitfall traps (USGS-WERC unpubl. data; Table 1). Both captures came from arrays located in Cottonwood Canyon.

These recent shrew captures, combined with historical data, suggest that Cottonwood Canyon may provide important habitat critical for the survival of this rare insular endemic. In an effort to document this, the Conservancy initiated a study to determine the abundance and distribution of *S. o. willetti* in Cottonwood Canyon in 2003.

MATERIALS AND METHODS

We utilized a combination of several field-proven live-trapping techniques for shrews. First, we continuously monitored each of the three

existing USGS pitfall trap arrays in Cottonwood Canyon. Each array consisted of seven 5-gal. buckets (depth = 35 cm) buried flush with the ground and connected by shade cloth drift fences, with 15-m arms arranged in a Y-configuration (Stokes et al. 2001). Two of these arrays were placed in maritime cactus scrub habitat (as defined by Thorne 1976) while the third was located in island chaparral habitat near Cottonwood Creek (Fig. 3).

One additional array and five pitfall trap transects were constructed in riparian areas along Cottonwood Creek (Fig. 3) and monitored concurrently with USGS arrays. Pitfall transects consisted of four to six 2-gal. buckets (depth = 23 cm) buried flush with the ground, at 7.5-m intervals, and connected by shade cloth drift fencing. Pitfall transect length varied due to limitations imposed by the steep, narrow streambed and hard, rocky substrate. Eighteen 100-m transects, with Sherman

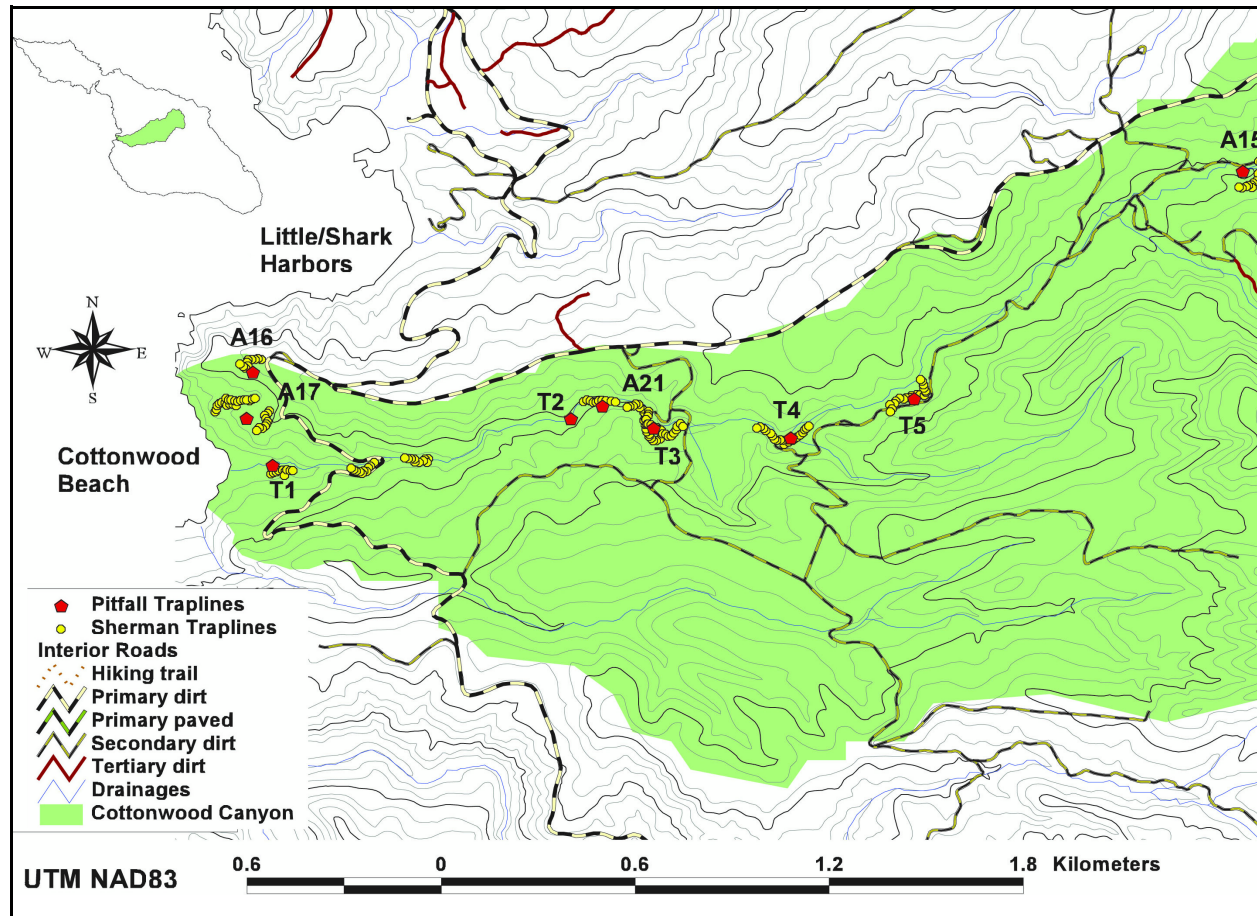


Figure 3. Pitfall (T = transect; A = array) and Sherman traplines for the Santa Catalina Island Shrew in Cottonwood Canyon, Santa Catalina Island, California, April to September 2003. Source: Catalina Island Conservancy's GIS.

live traps spaced at 10-m intervals (two traps per station, for a total of 20 traps per transect), were also established (Fig. 3). Two Sherman transects were set in the area surrounding each of the nine pitfall trap arrays or transects, baited with mealworms, peanut butter, and oats, and run for four consecutive nights at each site. All traps were provided with cotton for nesting material.

Pitfall and Sherman live traps were checked at least once daily in the early morning for captures. Shrews were immediately processed and released at the site of capture. Processing involved photographing, weighing, measuring, and marking all shrews. Marking was performed by clipping a small portion off one toe from the forefoot. Recaptured individuals were distinguishable by their distinct toe clips. The tissue from each toe clipping was then collected, preserved in ethanol, and sent along with fecal samples, which were pulled from the cotton in the traps, to J. Maldonado

at the Genetics Program, Smithsonian Institution, for future genetic analysis. Reproductive condition was also assessed and sex and age were recorded when possible.

RESULTS

Trapping for *S. o. willetti* was conducted continuously from 17 April to 18 May 2003 in Cottonwood Canyon using pitfall ($n = 54$) and Sherman ($n = 360$) traps. Additional trapping using only pitfall traps ($n = 54$) was conducted four consecutive nights each month during June, August, and September 2003.

On 20 April 2003, one shrew was captured in a pitfall trap located approximately 65 m above Cottonwood Dam after just three nights of trapping. The pitfall trap was located approximately 10 m from the water in streamside habitat containing

Table 2. Sex, age, reproductive condition, and body measurements (mm) for *S. o. willetti* captured on Santa Catalina Island, California, between 1941 and 2003.

Date	Sex	Reproductive Condition	Age	Total Length	Tail Length	Hind Foot Length	Ear Length	Weight (g)	Source
25 Apr. 1941	M	-	Adult	104	43	12	5	-	von Bloeker (1941)
1960s	F	-	Adult	102	40	12	4.5	-	Collins (pers. comm.)
13 Jan. 1983	F	-	Adult	108	41	13.5	8	4.5	Maldonado (pers. comm.)
16 Mar 1991	F	Active	Adult	99	39	13	-	4.1	Maldonado (pers. comm.)
24 Apr. 1993	M	Active	Adult	100	32	12	6	5.5	Maldonado (pers. comm.)
24 Apr. 1993 ^a	M	Active	Adult	85	20	11	6	5.0	Maldonado (pers. comm.)
27 Apr. 2003	F	Inactive	Juvenile	91	39	12	5	3.3	Current Study
22 Aug. 2003	F	Inactive	Juvenile	97	38	11	4	3.0	Current Study

^a Shrew with broken tail.

willows (*Salix* spp.), mulefat (*Baccharis salicifolia*), poison oak (*Toxicodendron diversilobum*), island scrub oak (*Quercus pacifica*), and non-native grasses. Unfortunately, this shrew escaped before basic information on body condition could be recorded.

A second shrew, a non-reproductive female, was captured on 27 April 2003 in a pitfall trap located where the creek empties into a shallow basin next to Cottonwood Beach. This pitfall trap was located approximately 5 m from the water in riparian habitat dominated by willows, mulefat, bulrushes (*Juncus acutus*), fennel (*Foeniculum vulgare*), giant wild rye (*Leymus condensatus*), and bermuda grass (*Cynodon dactylon*). Another non-reproductive female was captured at this same site in a different pitfall trap on 22 August 2003. At this time, the basin was dry and available fresh water was located approximately 30 m upstream from the trap site. Both shrews were found to be in good condition and released at the site of capture. Table 2 summarizes the sex, age, reproductive condition, and body measurements recorded from these two most recent captures, in addition to six historical specimens.

Overall, three shrews were captured during 3,638 trap-nights of sampling effort (1,878 trap-nights using pitfalls and 1,760 trap-nights using Sherman live traps). The overall trap success rate

(number of individuals caught per 100 trap nights) for *S. o. willetti* was 0.08%, while the trap success from using pitfalls alone was 0.16%. No shrews were captured in Sherman traps. Capture rates for all small mammals captured during the study period are found in Table 3.

DISCUSSION

Although intensive trapping for *S. o. willetti* occurred during the spring, when populations are expected to be largest due to the presence of both adults and juveniles in the population (Collins and Martin 1985), only two shrews were captured at this time. Trap success using pitfalls during the entire study period (0.16%) was higher than that recorded by Williams (1983) for *S. o. willetti* during the month of January (0.06%), but was substantially lower than the trap success recorded for Maldonado using Sherman traps during the month of April (0.57%; Collins and Martin 1985). Nevertheless, these data suggest that the Santa Catalina Island shrew occurs at very low densities throughout the year.

Of the 54 pitfall traps monitored, disproportionately more traps (61%) were placed in riparian vegetation compared to maritime cactus scrub (26%) and island chaparral (13%) habitats,

Table 3. Capture rates (number of captures per 100 trap nights) for small mammals using pitfall ($n = 1,878$ trap nights) and Sherman ($n = 1,760$ trap nights) live traps located in Cottonwood Canyon, Santa Catalina Island, California, April to September 2003.

Species	Pitfalls	Shermans
<i>Peromyscus maniculatus catalinae</i> (Catalina deer mouse)	0.11	4.60
<i>Reithrodontomys megalotis catalinae</i> (Western harvest mouse)	0.59	0.91
<i>Sorex ornatus willetti</i> (Santa Catalina Island shrew)	0.16	0
<i>Rattus norvegicus</i> ^a (Brown rat)	0.05	0.11

^a Introduced species

suggesting that sampling bias might have played a role in the capture of all three shrews in riparian habitat. However, when these recent captures are considered alongside historical sighting records for which we have habitat use data, *S. o. willetti* appears to be most often (six of eight shrews) associated with riparian areas. While additional research is necessary, this study supports the assertion that, like mainland populations of *Sorex ornatus*, this subspecies may rely heavily on mesic habitats (Owen and Hoffman 1983, Williams 1983, 1986, Collins and Martin 1985, Brylski et al. 1996), a geographically limited resource (<1% of vegetative cover) on Catalina (Knapp 2002). These habitats may be essential for the continued survival of the Santa Catalina Island shrew by providing low, dense vegetation and leaf litter conducive to high invertebrate prey densities, cover for nesting and foraging, and protection from predators (Collins and Martin 1985, Brylski et al. 1996).

Several factors have been proposed which likely restrict the expansion of *S. o. willetti* on Catalina. In particular, the degradation of mesic habitats (i.e., riparian, marsh, woodland) due to a long history of introduced animals, such as goats (*Caprus hircus*), pigs (*Sus scrofa*), bison (*Bison bison*), and deer (*Odocoileus hemionus*), may limit population growth (Williams 1983, 1986, Collins and Martin 1985, Brylski et al. 1996). Since the mid-1990s, the Conservancy has been engaged in a program to remove feral pigs and goats from the island (Schuyler et al. 2002). Efforts to eradicate these non-native species from Catalina are nearing completion, which will allow for recovery of

degraded riparian and wetland habitats. This, in turn, may help the shrew population by restoring habitats critical for its survival. Increased monitoring of the Santa Catalina Island shrew in mesic sites, as well as in other vegetative communities (e.g., coastal sage scrub, island chaparral, maritime cactus scrub) throughout the island is necessary to help us better understand the abundance and distribution of this rare shrew on Catalina.

Predation by feral cats (*Felis catus*) may also constrain shrew population expansion (Williams 1983, 1986, Collins and Martin 1985, Brylski et al. 1996). Of the 14 shrews recorded to date for Catalina, two were captured by domestic cats. While the exact date of their introduction is unknown, feral cats were abundant and widespread on Catalina by the early 1930s (Anonymous 1931). Little information exists on the role these non-native predators play in regulating small mammal populations, particularly *S. o. willetti*. Abundance, distribution, and diet composition of feral cats are currently under investigation on Catalina (Guttilla 2002). This research, coupled with results from ongoing studies of resident raptors and the Santa Catalina Island fox (*Urocyon littoralis catalinae*) population, will help the Conservancy determine the degree to which predation limits shrew densities on Catalina.

Given the limited sampling effort, our results are best viewed as preliminary. However, with this limited trapping, we have confirmed that the Santa Catalina Island shrew persists on Catalina and now know that pitfall trapping is likely to be the most efficient and effective method for surveying the population. The tissue samples we collected also increase the amount of genetic material available for assessing the taxonomic status of this subspecies and the genetic diversity of this island population. With continued research, the next few years should provide a wealth of information concerning the abundance, distribution, and basic natural history of this rare shrew endemic to Catalina.

ACKNOWLEDGMENTS

I am grateful to the Catalina Island Conservancy for funding this study, to the

Conservancy's Ecological Restoration Department staff for logistical support, to J. Maldonado, P. Stapp, A. Backlin, and P. Collins for their advice regarding study design, to S. Claypool and F. Starkey for their help in the field, and to P. Schuyler, J. Maldonado, and an anonymous reviewer for providing valuable comments on earlier drafts of this manuscript.

REFERENCES

- Anonymous. 1931. Catalina cats and quail. *California Fish and Game* 17(4):450–451.
- Backlin, A., R.N. Fisher, S. Hathaway and T. Touré. 2001. Inventory of the herpetofauna, small mammal, ants and other invertebrates of Santa Catalina Island. Proposal submitted to Catalina Island Conservancy, Avalon, CA, 10 pp.
- Brylski, P.V., P.W. Collins, E.D. Pierson, W.E. Rainey and T.E. Kucera. 1996. Mammal species of special concern in California. Report submitted to California Department of Fish and Game Non-Game Wildlife Management Division, Sacramento, CA, 297 pp.
- Collins, P.W. and T.D. Martin. 1985. Draft final status report on *Sorex ornatus willetti* von Bloeker. Report submitted to U.S. Fish and Wildlife Service, Sacramento Endangered Species Office, Sacramento, CA, 100 pp.
- Guttilla, D. 2002. An investigation into the abundance, distribution, health, and diet of feral cats, *Felis catus*, and the effects of sterilization on feral cat home range size on Santa Catalina Island, California. Proposal submitted to Catalina Island Conservancy, Avalon, CA, 13 pp.
- Knapp, D. 2002. Santa Catalina Island vegetation mapping project report. Unpublished report prepared for Santa Catalina Island Conservancy, Avalon, CA, 20 pp.
- Maldonado, J.E., C. Vila and R.K. Wayne. 2001. Tripartite genetic subdivisions in the ornate shrew (*Sorex ornatus*). *Molecular Ecology* 10:127–147.
- Owen, J.G. and R.S. Hoffman. 1983. *Sorex Ornatus*. *Mammalian Species* 212:1–5.
- Schuyler, P.S., D.K. Garcelon and S. Escover. 2002. Eradication of Feral Pigs (*Sus scrofa*) on Santa Catalina Island, California, USA. Pages 274–286. *In*: Veitch, C.R. and M.N. Clout (eds.), *Turning the tide: The eradication of invasive species*. IUCN, Gland, Switzerland, 414 pp.
- Stokes, D., C. Rochester, R. Fisher and T. Case. 2001. Herpetological monitoring using a pitfall trapping design in Southern California. U.S. Geological Survey Open-File Report, San Diego, CA, 54 pp.
- Thorne, R.F. 1976. Conservation and management of the natural flora of Santa Catalina Island. Unpublished report prepared for Center for Natural Areas, Washington, D.C., 20 pp.
- von Bloeker, J.C., Jr. 1941. A new shrew from Santa Catalina Island, California. *Bulletin of the Southern California Academy of Sciences* 40:163–164.
- von Bloeker, J.C., Jr. 1967. Land mammals of the southern California Islands. Pages 245–266. *In*: Philbrick, R.N. (ed.), *Proceedings of the Symposium on the Biology of the California Islands*. Santa Barbara Botanic Garden, Santa Barbara, CA, 363 pp.
- Williams, D.F. 1983. Population surveys of the Santa Catalina, San Bernardino and Suisun Shrews. Final report submitted to U.S. Department of the Interior, Fish and Wildlife Service, Endangered Species Office, Sacramento, CA, 69 pp.
- Williams, D.F. 1986. Mammalian species of special concern in California. Administrative report 86–1. Wildlife Management Division, California Department of Fish and Game, Sacramento, CA, 112 pp.