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Baseline Biodiversity Survey for Santa Catalina Island: Herpetofauna and Ants with Remarks on Small Mammals and Others

Final Report 2005

Prepared for:

Catalina Island Conservancy

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Baseline Biodiversity Survey for Santa Catalina Island: Herpetofauna and Ants with Remarks on Small Mammals and Others

By: Adam R. Backlin, Sara L. Compton, Zsolt B. Kahancza, and Robert N. Fisher

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ABSTRACT

The Catalina Island Conservancy's mandate is "the preservation and protection of the magnificent natural heritage of Santa Catalina Island" (Catalina Island Conservancy, 2005). In upholding this mandate, the conservancy contracted the U.S. Geological Survey to conduct surveys to help establish baseline species data for reptiles, amphibians, small mammal, ants and other invertebrates. Pitfall trapping was conducted from February 2002 through December 2004. Our survey efforts resulted in the detection of 35 animal species across Santa Catalina Island. Species detected include 3 lizards, 4 snakes, 3 amphibians, 3 small mammals, 20 ant species, and 2 other species of interest.

1. INTRODUCTION

The Catalina Island Conservancy (CIC) was created in 1972 with a strong mandate to protect the Santa Catalina Island's natural resources and restore the island to a more natural state (Landis, 2000). To accomplish these goals on-going inventory and monitoring programs are being implemented to provide the CIC with comprehensive, scientifically based information about the status of selected biological resources.

Santa Catalina Island's relatively large size and close proximity to shore allow for a high probability of colonization from the mainland (Schoenherr et al., 1999). This is likely one contributing reason why more species of reptiles and amphibians occur on Santa Catalina Island than on any of the other Channel Islands (Schoenherr et al., 1999). The native herpetofauna consists of five snake species, three lizard species, one salamander species, and one frog species. The native terrestrial mammal species found include two mice, a shrew, a ground squirrel, and a fox (Schoenherr et al., 1999). Due to their long isolation from the mainland, most of these animals are potentially unique island endemics.

In 1995, the United States Geological Survey (USGS) began an intensive autecological study of the herpetofauna of southern California, from the Los Angeles basin to the Mexican border, to identify what reptile and amphibian species are present, the habitats they are associated with, and their activity patterns. In 2002, as part of a continuation of this larger ongoing project, USGS established an infrastructure, commissioned by the CIC, to inventory the current populations of reptiles, amphibians, small mammals, and ants on Santa Catalina Island. The focus was to provide the CIC with an understanding of the diversity of species that are present and their distribution. This information can be used to address both short-term and long-term management concerns regarding the maintenance of a diverse herpetofauna community, and provide the baseline information necessary to implement long-term monitoring of these ecological resources. The infrastructure we established to inventory these biological communities were pitfall arrays, which have been widely used to obtain data on a variety of reptiles, amphibians, small mammals, and arthropods throughout southern California (Fisher and Case, 2000; Laakkonen et al., 2001). Pitfall trapping is an effective capture method, because it allows for continuous 24-hour captures while the traps are open. This provides an opportunity to capture species that are active at different times of the day and night and are present in the habitat in low abundance.

Historically, the information known about the herpetofauna species diversity and distribution on Santa Catalina Island was scattered. Most herpetofauna data collected prior to pitfall trapping are incidental captures collected and stored across various museums, books, manuscripts, and observations. We attempted to compile all available information and present our findings throughout this report.

2. STUDY AREA

Santa Catalina Island is a 194 km^2 island located 40 km off the coast of Los Angeles. The elevation ranges from sea level to 640 m (Schuyler et al., 2002). Santa Catalina Island is one of the Channel Islands, which range along the California coast from Point Conception to San Clemente. The island has a Mediterranean climate, dry warm summers and wet cool winters (Landis, 2000). During our study, the mean average rainfall was 28 cm per year (Catalina Island Conservancy, 2005).

3. MATERIALS AND METHODS

3.1 Pitfall Arrays

Reptile, amphibian, small mammal and invertebrate species were sampled using the pitfall drift-fence array design, described in detail in Fisher et al., (in press). In short, each array consisted of seven 5 or 6-gallon buckets that were placed in the ground and served as pitfall arrays. These were connected by three shade-cloth drift-fences forming an array in the shape of a Y with 15-meter arms. A meter long hardware cloth funnel trap was placed along each of the three arms to capture large snakes and lizards. Each of these traps had a funnel on each end, which allowed animals to enter but not exit and a piece of polyvinyl chloride (PVC) pipe with foam insulation placed inside to provide shelter and insulation for captured animals. While in use, the funnel traps were covered with boards to provide shade. In addition, all buckets contained PVC piping with foam insulation for shelter and wetted sponges to help prevent desiccation of amphibians.

We established a series of 20 pitfall arrays across the habitat strata available on Santa Catalina Island (Figure 1, Appendices 1 and 2). No pitfall arrays were established north of the isthmus due to logistical concerns. The locations of the arrays were chosen by combining pre-existing vegetation classification types into five generalized categories: grasslands, coastal sage scrub, chaparral, oak woodland, and maritime scrub. We then distributed the 20 arrays into the five vegetation categories based roughly on the percentage of the island that each vegetation type covered, resulting in 8 grassland, 3 coastal sage scrub, 5 oak woodland, 2 chaparral, and 2 maritime scrub arrays. These five vegetation categories were later reduced to four categories for the final analysis. At the request of the CIC, the arrays were then located in close proximity to preexisting land bird monitoring points when possible (Appendix 1).

Sampling was conducted at each array from February 2002 through December 2004 for four consecutive days every 4 to 5 weeks, for 32 sample periods (Appendix 3). We kept all traps closed between the sampling periods.

3.2 Herpetofauna

Data collected for captured reptiles and amphibians included species identification, weight, snout-vent length, age, and determination of gender when possible. Weight was obtained utilizing a Pesola® spring scale and a plastic bag clipped to the scale that contained the specimen. Snout-vent length was measured using either a metric ruler or tape scale, depending on the length of the specimen. Weights were recorded in grams and lengths in millimeters for consistency. To collect recapture data, captured animals were uniquely and permanently marked (except for slender salamanders) by toe-clipping or scale-clipping (snakes) and then released. Rattlesnakes were not handled, but were identified and recorded. All tissue samples were stored in 95% ethanol for future molecular systematic work.

3.3 Small Mammals

All terrestrial small mammals were identified to species and released, except the Santa Catalina shrew (*Sorex ornatus willetti*), a rare shrew species on the island. The CIC requested that we hold this species until they could weigh, measure, photograph and remove a tissue sample before releasing it.

3.4 Ants

Ants were sampled using ant pitfall traps consisting of 50 mL centrifuge tubes filled with approximately 25 mL of Sierra™ brand antifreeze. This product allows for the preservation of the specimens, while remaining environmentally friendly to wildlife (Suarez et al., 1998). Five of these ant pitfall traps overlaid each of the 20 established pitfall arrays in the shape of a "5" on a die. The four corners of the "5" were approximately 20 meters apart from each other, with the center trap placed next to the center pitfall bucket. The ant pitfall traps were inserted into holes in the soil, made using a metal stake. A sleeve constructed of ¾" diameter PVC pipe was placed into each hole, an ant pitfall trap was inserted into this sleeve so that the opening of the centrifuge tube was flush with the ground.

To obtain summer and winter ant samples, each trap was opened for 10 consecutive days twice a year. The traps were kept closed between sample periods by placing empty 50 mL tubes with secured caps into the sleeves. Upon completion of each sample period, CIC personnel first separated ants from non-ants and debris in their lab. Next, the ants were identified and counted by USGS, San Diego Field Station personnel. The ants from the remaining five tubes from each array were then combined for analysis. Winged queens and males were excluded from analysis because they may have originated from outside the site. We then used this data to determine ant diversity by sampling location.

3.5 Invertebrates

We compiled additional data to complement the focus on herpetofauna, small mammals and ants. This included the sampling of invertebrates, which were collected at the end of every sample period from the buckets and stored in 50 mL centrifuge tubes containing 70% ethanol. The invertebrates were sorted for two specific species; *Cnemotettix*

miniatus, the silk spinning cricket, and *Stenopelmatus n.sp.* "Catalina" the Jerusalem cricket. The remaining invertebrates were stored for future analysis at the CIC lab.

3.6 Vegetation

Vegetation transects were completed for each of the pitfall arrays. These transects were conducted following established protocols of the California Native Plant Society (Sawyer and Keeler-Wolf, 1995). Each transect consisted of two 25-meter line transects that ran north and south beginning from the center bucket of each array. Line intercept methodology was used to record plant species, canopy height, leaf litter depth, and substrate type at 0.5-meter intervals along the transect. At each of the 100 points a measurement was recorded; all the plant species at that point were recorded, as well as any species that occurred within a 100 m radius around the center bucket of each array. We then determined the proportion of habitat type at each herpetofauna pitfall array based on plant indicators of those habitat types (Holland, 1986).

3.7 Historic Data

In order to have a more complete understanding of the herpetofauna that occurred historically on Santa Catalina Island, we queried several museums for their holdings from the island. These include the California Academy of Sciences (CAS), Los Angeles County Museum (LACM) and the Museum of Vertebrate Zoology (MVZ).

4. RESULTS AND DISCUSSION

We conducted 32 sample periods at Santa Catalina Island between February 2002 and December 2004. During each sampling period, all arrays remained opened for the expected four days resulting in 128 sampling days per array. Bad road conditions due to wet weather caused site access limitations and required slight modifications of our predicted sampling schedule. Appendix 3 presents the actual sampling dates for each period.

4.1 Herpetofauna

We captured 681 reptiles and amphibians in pitfall arrays representing seven different families and nine species. From these captures, 92% (n = 628) were lizards (3 species), 3% (n = 22) were snakes (4 species), 3% (n = 22) were salamanders (1 species) and 2% (n = 9) were frogs (1 species) (Table 1). In addition, we recorded one gopher snake (*Pituophis catenifer*), five southern Pacific rattlesnakes (*Crotalus viridis*), and two bullfrogs (*Rana catesbeiana*) as incidental observations (Table 2, Appendix 4). These observations increased the number of arrays at which we observed these snake species. The exotic bullfrog observation represented an amphibian family, Ranidae, not captured at any of the arrays.

Diversity of captures was highest at array 7, which captured 31 individuals comprised of seven different species: all three lizard species, three snake species, and one amphibian (Table 1). We defined it as an oak woodland array with a non-native grass under story

(Tables 3 and 4, Appendices 2 and 4). Diversity was lowest at array 13, defined as a non-native grassland array (Tables 3 and 4), where only one species was captured, side-blotched lizards (*Uta stansburiana*). This array also had the highest number of side-blotched lizard captures with 92 (Table 1) captures total.

4.1.1 Lizards

Side-blotched lizards were, by far, the most common capture accounting for 74.9% (510 of 681) of all herpetofauna species captured, and 81.2% (510 of 628) of all lizards captured. They were captured at every array and ranged from 2 to 92 captures per array. We also captured southern alligator lizards (*Elgaria multicarinata*) at every array except array 13, but 5 ½ times less frequently (n = 91) than the side-blotched lizards. Western skinks (*Eumeces skiltonianus*) were captured at nine arrays with 27 captures (Table 1).

Side-blotched lizards were the most common captures at our pitfall arrays (Table 1); they were detected in all habitat types (Table 5) and across all seasons (Table 6). This species was recently described as being more closely related to the side-blotched lizard in Orange and San Diego Counties and on San Clemente Island, than to the side-blotched lizard on the northern Channel Islands (Mahoney et al., 2003). Ecological and genetic differences suggest that the side-blotched lizard population colonized Santa Catalina Island from either Orange or San Diego Counties and not from the Channel Islands to the north and that these lizards are long-term residents of the island (Mahoney et al., 2003). Even though this lizard is abundant on the island, it appears to have diverged from the side-blotched lizard on the mainland and on the islands to the north (Mahoney et al., 2003) and warrants monitoring.

The southern alligator lizard is found on all of the Channel Islands except San Clemente and Santa Barbara. They were the second most common herpetofauna species caught in our Santa Catalina Island arrays, and the highest number of captures (n=11) was at array 9 (Table 1). They were captured more often in oak woodlands (Table 5) during the spring (Table 6). In addition to the phylogeography work completed by Feldman (2000), more specific analysis of these lizards on Santa Catalina Island is needed to better understand the relationship between populations on the island the mainland.

Santa Catalina is the only Channel Island, within the United States, where the western skink occurs, although they are also present on Los Coronados and Todos Santos Islands off the coast of Baja California. Although the western skink is widespread and common on the mainland, not much is know of this species from Santa Catalina Island. It appears to prefer chaparral habitat (Table 5) during the spring and summer seasons (Table 6). Complete phylogenetic methods have not been used to evaluate these island individuals (Richmond and Reeder, 2002). Argentine ants appear to negatively affect these lizards in other areas of coastal southern California (Fisher, unpublished). Thus, long-term maintenance of these skinks on Santa Catalina Island may depend on appropriate management practices to control the spread of Argentine ants.

4.1.2 Snakes

We captured or observed four snake species at 13 arrays (Tables 1 and 2). Southern Pacific rattlesnakes (n = 11) were detected at nine arrays, western ringneck snakes (*Diadophis punctatus*) (n = 7) were detected at four arrays, and gopher snakes and common kingsnakes (*Lampropeltis getulus*) (n = 5 each) were detected at four arrays (Tables 1 and 2). Greater than one species of snake was found at arrays 2, 7, 9, 10, and 20. Excluding incidental observations (Table 2), southern Pacific rattlesnakes were captured six times at six arrays, and gopher snakes were captured four times at three arrays. Snake diversity is greater than that of lizards on Santa Catalina Island. Five species of snakes are currently known to exist on the island, compared to the three species of lizards discussed above.

The common kingsnake was detected five times from arrays 2, 3, 7 (2), and 10. It frequents a great variety of habitats (Table 5) and is remarkably adaptable, so further sampling would likely detect this species throughout the island. This snake seems most common where there is access to either natural or artificial waterholes, or in riparian areas, but it may also be encountered far from standing water (Bartlett and Tennant, 2000).

We only detected five gopher snakes at arrays 2, 9 (2) and 20, and one as an incidental capture near array 16. Throughout its range, it frequents all types of habitats but we captured them more often in oak woodlands on the island (Table 5). It eats chiefly small mammals and ground nesting birds. Gopher snakes are frequently seen on both paved and dirt roadways especially during spring when males are following pheromone scent trails of receptive females (Bartlett and Tennant, 2000).

Of all the Channel Islands, Santa Catalina is the only one that has a rattlesnake, the southern Pacific rattlesnake, and it is the only rattlesnake species found on the island. We detected six individuals at arrays 7, 10, 14, 15, 17, and 19 and another five individuals as incidental observations near arrays 7, 9, 15, 18, and 20. A habitat generalist, it appears to be widely distributed across the island. We observed it in all habitat types except chaparral (Table 5) however; it is likely this species also occurs here. This species has likely benefited significantly from the efforts to remove goats and pigs from the island (Ashton, 2000).

We detected seven western ringneck snakes in arrays 6, 7 (2), 9, and 20 (3). Three of the four arrays they were captured occurred in oak woodland habitat. The fourth, array 6, was in grassland habitat (Table 5). It is commonly found in moist coastal sage scrub and woodland habitats (Stebbins, 2003).

No two-striped garter snakes were captured or observed in the areas of our pitfall arrays, none of which are located within the known habitat of this species. During the course of this study, CIC employees had observed this species in Cottonwood Canyon. The two-striped garter snake (*Thamnophis hammondii*) is rare on Santa Catalina Island, and appears to be isolated along a 1.6 km stretch of permanent flow in Cottonwood Canyon that includes a small reservoir (Brown, 1979: Schoenherr et al., 1999). A total of 19 garter snakes were observed in Cottonwood Canyon by Brown in 1974, and even after

severe drought conditions forced the emptying of the reservoir in 1976, this species was still known to persist there (Brown, 1979). This species is semi-aquatic, and closely tied to riparian areas. Its limited range on Santa Catalina is likely due to the lack of suitable habitat for this species on the island. The most likely food sources for this garter snake are Pacific treefrog (*Pseudacris regilla*) adults and their tadpoles. This species faces the threat of predation from bullfrogs and feral cats, which are both exotic species currently found on the island. The presence of bullfrogs in Cottonwood Reservoir can be especially devastating to this small and isolated garter snake population (Brown, 1979). Jennings and Hayes (1994) recommends this population be listed as endangered.

4.1.3 Amphibians

From the 31 amphibian captures, 22 garden slender salamanders (*Batrachoseps major*) were captured at eight arrays, and nine Pacific treefrogs were captured at seven arrays. Almost all of the captures for these two species occurred during the spring and winter seasons (Table 6). In addition, two bullfrogs were incidentally captured and others were heard throughout the island.

The island has two common species of amphibians, both of which we detected in the pitfall arrays. The garden slender salamander, known to frequent a great variety of habitats, showed an affinity toward oak woodland and chaparral habitats on Santa Catalina Island (Table 5). These woody habitats likely provide more cool and moist refugia where these salamanders can retire during hot summer days. Of the 22 individuals captured, 18 were caught during the winter (Table 6). Jockusch and Wake (2002) recently identified this island population as more closely related to slender salamanders in Los Angeles and Riverside Counties than to slender salamanders found on the Channel Islands to the north. This suggests that the slender salamanders colonized Santa Catalina Island from the mainland separately than the slender salamanders on the northern Channel Islands and that there is likely no contact between the salamanders on Santa Catalina and the other Channel Islands.

The Pacific treefrog is the only native frog on Santa Catalina Island, and choruses of these frogs can be heard commonly throughout the island. Though it is frequently found in low-lying vegetation near slow moving water, it commonly occurs in upland habitat quite some distance from water. We captured them in all four habitat types (Table 5) during the spring and winter seasons (Table 6). Artificial reservoirs and ponds also provide excellent habitat for this species. Because this species has adhesive toe pads, which allow them to climb smooth vertical surfaces, pitfall arrays are not the best method for detecting this species. They probably represent an important food source for the rare two-striped garter snake.

The introduced bullfrog appears to be abundant in most of the reservoirs across the island (John Floberg, personal communication). All large standing water on the island should be surveyed for bullfrogs to better understand their current distribution across the island, at which time a bullfrog eradication plan should be developed and implemented to remove or reduce this threat to the native herpetofauna.

4.1.4 Rare or Undetected Species

Several herpetofaunal species have been recorded on Santa Catalina Island that have very little information associated with them and may represent mainland introductions associated with shipments of materials to the island. Below we present a compilation of information on these species.

The desert night lizard (*Xantusia vigilis*) is known from a single record, collected in 1952 from the Wrigley Botanical Garden in Avalon (Savage, 1952). This lizard most likely does not currently occur on Santa Catalina Island and the single record may represent an escaped pet.

The California mountain kingsnake (*Lampropeltis zonata*) has been reported a few times from the island. C. F. Holder (1910) first reported it on the island between Little Harbor and the Isthmus and described it as "… a beautiful coral snake with alternate rings of red and black". Most recently a photograph was taken by Scott Panzer of an animal at Black Jack Campground (Figure 2). It is unclear if there is a breeding population of California mountain kingsnakes on the island or if these animals are escaped pets. We recommend focused surveys for this species in the future.

The leopard frog (*Rana sp.*) is an introduced frog that has been reported from 1.5 km east of Isthmus Cove (Rorabaugh et al., 2002) most likely from Summit Reservoir on Santa Catalina Island. It is know from a single specimen and is unclear if other leopard frogs currently inhabit the island. This frog's presence would be the result of a released pet as there are no dispersal routes for this animal to colonize naturally on the island. The results of this frog establishing on the island would be similar to that of the bullfrog. This frog is a voracious predator and could aid in the decline of any native aquatic animals.

Even though we did not detect the arboreal salamanders (*Aneides lugubris*), a reproducing population may occur on the island. This species is known from one specimen collected in 1941 from Middle Ranch (Hilton, 1945). The island's oak woodland habitat could potentially support a population of this species. Two recommendations that would afford the best opportunity to detect an arboreal salamander population would be to supplement pitfall trapping with visual encounter surveys in riparian or oak woodland habitat, and focused and continuous sampling of arrays located in chaparral and oak woodland habitat, particularly during and after moderate to heavy rains. Alternatively, this individual could have been transferred with materials from the mainland like *Aneides ferreus* populations on Vancouver Island (Jackman, 1998).

4.2 Small Mammals

During the study period, three species of small mammals were captured (Table 1). A total of 218 small mammals were captured. The most commonly captured species was the Santa Catalina Island harvest mouse (*Reithrodontomys megalotis catalinae*) with 151 captures, which comprised 69% of the total small mammal captures. They were captured at 18 of the 20 arrays on the study site. Arrays 7 and 8 were the only two arrays in which they were not captured. The Santa Catalina Island deer mouse (*Peromyscus maniculatus catalinae*) with 63 captures was the next most common small mammal and was found at

every array. Four Santa Catalina shrews (*Sorex ornatus willetti*) were found at four different arrays 9, 10, 15, and 16 (Table 1, Figure 1, and Appendix 4).

The Santa Catalina Island harvest mouse presence was ubiquitous on the island, and a large number of captures were recorded at arrays 2, 6, 10, 11, 13, and 15, which reside in either coastal sage scrub or non-native grass habitat (Table 5) most frequently in the spring (Table 6). The Santa Catalina Island harvest mouse is one of two species of native mice on Santa Catalina. It is an endemic subspecies known only from this island and two other Channel Islands, Santa Cruz and San Clemente (Schoenherr et al., 1999).

The Santa Catalina Island deer mouse is highly adaptable and can occupy nearly every dry-land habitat within its range. This is demonstrated by the presence of the Santa Catalina Island deer mouse at all 20 of our arrays (Table 1). This species was noticeably more common during the spring and winter seasons (Table 6). Deer mice occur on all eight of the Channel Islands and are also the most common mouse on the mainland. Endemic sub-species have been recognized on each of the islands (Hall, 1981). Ashley and Wills (1987) suggest that the deer mice on Santa Catalina Island are the result of two separate colonizations and that these mice have been isolated longer than the deer mice on the northern Channel Islands.

In our pitfall arrays, we captured only four Santa Catalina shrews: At arrays 9 and 10 located along the road to Empire Landing, adjacent to Valley of the Ollas, and at arrays 15 and 16 along Cottonwood Canyon (Figure 1). The CIC has extended the effort to capture these shrews by increasing the number of pitfall arrays installed in riparian habitats. Prior to our captures, the last shrew was recorded on the island in the early 1990's. The ornate shrew population on Santa Catalina Island is one of the most genetically distinct populations in the southern clade and is also one of the most endangered (Maldonado et al., 2001). Shrews have voracious appetites and high metabolic rates that restrict long distance dispersal making them unlikely candidates for colonization of an island (Schoenherr et al., 1999; Maldonado et al., 2001). It can be difficult to determine population abundance for shrews, since they are notoriously difficult to capture, except by the use of pitfall arrays (Schoenherr et al., 1999, Laakkonen, et al., 2003).

4.3 Ants

Data for ant species sampled between winter 2002 and summer 2004 revealed 20 species of ants captured at arrays 1-20 (Table 7), including five newly identified ants to Santa Catalina Island. The highly invasive Argentine ant (*Linepithema humile*) was the most numerous with 5,103 captures at 11 of the 20 arrays with 2,944 of those captures at array 15 (Table 7, Figure 3). The most widespread species was *Monomorium ergatogyna* with captures at fifteen of the twenty arrays. The greatest ant diversity was recorded at array 8, where 11 of the 20 identified ant species were captured. The highly invasive red imported fire ant (*Solenopsis invicta*) was not detected on Santa Catalina Island.

Currently 23 species of ants have been identified on Santa Catalina Island (Table 8). USGS pitfall arrays identified 20 of these 23 species. Five newly identified ants to Santa Catalina Island are *Camponotus clarithorax*, *Cyphomyrmex wheeleri*, *Formica*

subelongata, *Pheidole clementensis*, and *Temnothorax sp CA-05*. *C. clarithorax*, *P. clementensis*, and *T. sp CA-05* are endemic to California and *Solenopsis texana catalinae* is endemic to Santa Catalina Island (Table 7). *C. clarithorax* is also known from Santa Cruz Island (Wetterer et al., 2000). *Formica subelongata* is mainly confined to northern California and Oregon and the Santa Catalina Island population appears to be an isolated disjunct (Phil Ward, personal communication).

To better understand the diversity and distribution of the ants on Santa Catalina Island, we combined the results of this study with the results of two others (Sleeper, 1989; Hebard and Heller, 1999; Table 8). Research completed in 1999 identified three ant species we did not identify; *Campanotus bakeri*, *Cardiocondyla mauritanicais* (an exotic discussed in another section), and *Formica argentea* (Hebard and Heller, 1999). *C. bakeri* is thought to be an endemic to the Channel Islands (Hebard and Heller, 1999). *F. argentea* is typically in coastal regions further north, Santa Catalina Island may represent the southern extent of its range (Hebard and Heller, 1999). *Campanotus sp.* identified by Hebard and Heller (1999) as a *Campanotus* near the species *vicinus* has been identified as a new species *Campanotus CA-03* (Phil Ward, personal communication).

Argentine ants were identified at eleven arrays. At two of the arrays, 16 and 20 Argentine ants were the only species of ant detected. Native ants co-reside with Argentine ants at nine of the eleven arrays (Figure 4). At those nine arrays, the native ant species diversity is dramatically lower with an average of 3.09 species per array. Arrays without Argentine ants, average 7.44 species per array. California endemic ant species were identified at six arrays. Out of the six arrays, they are only found co-residing with Argentine ants at one array, 19.

4.4 Invertebrates

During the study period a total of two silk spinning crickets (*Cnemotettix miniatus*), and 52 Jerusalem crickets (*Stenoplmatus n.sp*. “Catalina”) were sorted and identified, and phylogenetically analyzed. The silk spinning crickets were identified at arrays 3 and 8, and the Jerusalem cricket was identified at 14 of the 20 arrays (Table 7).

With only two individual silk spinning crickets collected from arrays 3 and 8, not enough data was collected to understand the population status of this endemic cricket on Santa Catalina Island. According to Rentz and Weissman (1981), the species of silk spinning cricket is also found in Tijuana, Mexico. However, preliminary analysis of mtDNA COI sequences from specimens collected at Tijuana Estuary, San Diego County and Santa Catalina Island suggests that the Santa Catalina Island population is genetically very distinct, and that a taxonomic revision of this genus is probably warranted (Vandergast, pers. comm.)

Stenopelmatus n.sp. "Catalina", an endemic Jerusalem cricket, was collected from 70 percent of the arrays sampled at Santa Catalina Island. Preliminary phylogenetic analysis of mtDNA COI sequences from the Santa Catalina Island and mainland Jerusalem crickets places the Santa Catalina Island species in a highly supported, monophyletic clade containing other species found in southern California and Baja California. This clade is also characterized by a unique calling song characteristic; all species within this

clade exhibit sexually dimorphic drumming (Vandergast, pers comm.). Not only is the Jerusalem cricket endemic, but there is an endemic horsehair worm that only lives within the stomach of the Jerusalem cricket endemic to Santa Catalina Island. We did not see a negative impact on the Jerusalem cricket as a result of the Argentine ant. However, additional data needs to be collected to further understand the impact Argentine ants have on the invertebrates of Santa Catalina Island.

4.5 Vegetation

We defined four habitat types across the 20 pitfall arrays based on the proportion of plant indicator species present at each array. Our four habitat types included non-native grass (NNG), coastal sage scrub (CSS), oak woodland (OAK), and chaparral (CHAP) (Tables 3 and 4). Arrays previously described as maritime scrub were placed into our coastal sage scrub category due to their similarity in species composition. Since non-native grasses occurred in great abundance under oak woodland canopies and in-between coastal sage scrub plants, as well as in open fields, we needed a method that would be able to differentiate these different habitats. So, arrays that occurred in habitats with a proportion of NNG below 50% were classified into the habitat type with the next greatest proportion, if that proportion was greater than 25% (Table 3). Non-native grasslands occurred at seven arrays 1, 6, 8, 13, 14, 18, and 19. Coastal sage scrub occurred at six arrays 2, 10, 11, 15, 16, and 17. Oak woodland occurred at five arrays 5, 7, 9, 12, and 20. In addition, chaparral occurred at two arrays 3 and 4. Interestingly, the highest number of herpetofauna and small mammal captures were recorded in costal sage scrub habitat (Table 5), in which only 25% or 5 arrays were placed.

We detected six substrate types across all arrays: leaf litter, cryptogamic, moss, organic soil, sandy soil, and bare rock. Leaf litter was present at every array with the number of detection points ranging from 63 to 100. The average leaf litter depth ranged from 0.7 to 6.0 cm. The average canopy height ranged from 19.1 to 302.4 cm. Eight arrays had canopy heights under 50 cm and 12 arrays had canopy heights over 50 cm. The top three dominant plant species for each array are shown in Table 3. A complete plant list for Santa Catalina Island is found in Appendix 5.

4.6 Historical Data

We collected 1219 museum records of Santa Catalina Island herpetofauna (Table 9). Of these records, Santa Catalina Island is the only location description listed for 21% of them. The remaining records, although provide a more specific location on the island, are still largely general in their descriptions. We categorized and mapped these records into 25 generalized locations on the island to examine the distribution of these records (Table 9, Figure 5).

Of the 25 generalized locations identified, one is the island itself and three other locations: Avalon, Johnsons Landing, and Two Harbors make up 72% of all historic herpetofauna locations on Santa Catalina Island (Table 9; Figure 5). The pitfall arrays provide 20 exact locations on the island in which 681 herpetofauna records are associated. For the 1219 historic records, we found 73 unique species locations. For the pitfall data we collected, we found 80 unique species locations plus 8 additional

incidental observation totaling 88 unique species location in only 3 years (Tables 1 and 9). Together, these data provide a better understanding of the distribution of herpetofauna on the island.

5. CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

Our survey efforts resulted in additional data for 35 animal species across Santa Catalina Island. These survey efforts have generated a valuable data set, which will aid in the management to preserve the biological diversity and native wildlands on Santa Catalina Island. Included in our species detections list are 3 lizards, 4 snakes, 3 amphibians, 3 small mammals, 20 ant species, 2 invertebrate species.

5.1 Herpetofauna

The pitfall arrays detected three species of lizards, four species of snake, one species of salamander, and one frog species. While this may not represent the full extent of all species present on Santa Catalina Island, it likely includes the majority. The remainder of undetected species would require a more long-term sampling effort or the establishment of alternate survey techniques. Such survey efforts should be considered as supplemental to the pitfall sampling technique employed by this survey and might include visual encounter surveys, transect sampling, and stream surveys (Heyer et al., 1994). One of the most important aspects of this data is that it serves as baseline for future comparisons of species' presence / absence and relative abundance at established sampling locations. For comparability, future surveys should be carried out as close as possible to the protocols established under this effort. Future surveys can be designed to compare with the data collected here, in an attempt to detect trends or the extirpation of species from the island.

Concern is warranted for the two-striped garter snake which was not detected in our arrays. In addition, funnel (snake) traps should be added to the CIC's shrew pitfall arrays, which occur only in riparian areas, to help determine the complete distribution of two-striped garter snakes on the island. Visual transects of Cottonwood Creek and Reservoir and any other perennial creeks on the island should also be conducted, and every effort should be made to exclude bullfrogs from Cottonwood Reservoir. Additional targeted surveys should be considered for the arboreal salamander and the California mountain kingsnake to determine if and where they currently occur on the island.

5.2 Small Mammals

The pitfall arrays detected three small mammal species. Because small mammals were not directly targeted for this project, any future survey efforts should include multiple survey techniques.

Concern is also warranted for the Catalina Island shrew, which we detected in low numbers. This was likely due to their isolation in the few suitable riparian habitats found on the island. Because of this, these shrews will likely never occur in high abundance on the island, so the CIC's previously mentioned efforts to detect shrews should continue in

all potentially suitable habitats to serve as a baseline inventory and abundance estimates at those locations.

5.3 Ants

The ant pitfall traps detected 20 species of ants, five of which were newly identified to the island. Expansion of the ant sampling protocol should be implemented in other areas of the island to obtain a more comprehensive understanding of total ant diversity. It could also be implemented in areas of new development or habitat alteration to monitor the spread of the invasive Argentine ant.

5.4 Invertebrates

The invertebrate samples collected to date in the pitfall traps represent a baseline sample of terrestrial invertebrates across the island. We only targeted two species for identification but as more of the samples are identified, it is likely that more island endemics will be described. The CIC should have the remainder of the invertebrate samples sorted and identified to complete the invertebrate species inventory.

5.5 Historical Data

The historic herpetofauna data we examined provides valuable information on the past diversity and distribution of reptile and amphibian species on Santa Catalina Island. Because such little was known about the herpetofauna of Santa Catalina Island, the combination of historical data and our pitfall data helps even further identify the herpetofauna species present on the island and better determines their distribution and habitat preferences.

5.6 Additional Management Recommendations

Santa Catalina Island supports numerous native habitats, many of which are unique to the Channel Islands. These habitats support populations of multiple species of concern that are dependant on the stability and health of the general habitat. Although portions of Santa Catalina Island appear stable and healthy in habitat quality, other areas of the island have issues that need some type of management attention. Without active management of these populations and habitats, many may decline in the future. The baseline data collected in this report is a starting point for building a program that will not only monitor but also manage these populations and habitats. This program of monitoring and management will ensure that these species and habitats continue to thrive into the future.

Most of the island is faced with issues similar to other open space reserves in southern California. These problems include introduction and establishment of exotic species, anthropogenic disturbances, and illegal collection of natural resources.

5.6.1 Exotics

Diligent conservation efforts are critical to the preservation of native island species. Island ecosystems are notoriously fragile, because their unique evolutionary history makes them particularly vulnerable to the impacts of certain invasive alien species (Tershy et al., 2002). Thus control and elimination of exotics from Santa Catalina Island, as well as preventing others from becoming established, should be a priority.

Santa Catalina Island has a significant population of several exotic predators. Exotic predators can severely affect native island species, which have little or no mainland recruitment. The construction of reservoirs makes the establishment of exotic frog populations possible on Santa Catalina Island. We have detected bullfrogs on Santa Catalina along the dirt road adjacent to Haypress Reservoir, and they were also heard calling at other locations within the study area. Bullfrogs are not native west of the Rocky Mountains, but are thriving in areas of southern California (Stebbins, 2003). Bullfrogs are considered voracious predators, which reproduce at high rates, and adversely affect endemic populations of frogs (Porter, 1967; Hayes and Jennings, 1986). In addition, they could negatively affect the existing population of two-striped garter snakes, since they share similar habitat preferences. Another exotic frog that also has the potential to become established on the island is the African clawed frog (*Xenopus laevis*). The African clawed frog was not detected on the island; however, this highly invasive species has become established in many waterways in southern California (Touré et al., 2004). It will establish itself rapidly in a reservoir with the introduction of eggs, tadpoles, or adults that may be brought in from an outside water source. These frogs are highly aquatic and can potentially negatively impact native amphibians by the introduction of exotic pathogens and parasites (Touré et al., 2004; Kuperman et al., 2004).

Another such threat comes from the island's house and feral cat population. Cats can be observed in the town of Avalon, as well as throughout the islands interior. Cats are a problem because they are recreational predators of native lizards, small mammals, and birds (Crooks and Soulé, 1999). Feral cats have been associated with extinctions of endemic island species throughout the world (Wood et al., 2002), and therefore pose a significant problem to the conservation of biodiversity on Santa Catalina Island. Populations of herpetofauna and small mammals that are found in low abundance on the island, such as ornate shrews and two-striped garter snakes, could be heavily impacted by the predatory activities of these cats. They are also in direct competition with the imperiled Island Fox (*Urocyon littoralis*) for food. The most effective permanent way to protect island species threatened by cat predation is eradication, and subsequently prevention of cat re-introduction. However, feral cats are very difficult to eradicate (Wood et al., 2002), and are widely distributed on islands. Trapping feral cats has been used as an effective technique for their removal with trap design and placement being considered the most critical components to success (Wood et al., 2002). One barrier to feral cat removal on Santa Catalina Island is the resident human populations' sentiment towards these cats. An attempt to educate local residence about the negative impacts of feral cats on native fauna is strongly encouraged as a first step, as is encouraging residents to keep pet cats indoors. All cat owners on the island should also be encouraged, if not required, to have their pet spayed or neutered.

One of the most highly adaptable non-native island invaders is the common rat (*Rattus sp*.). We did not detect any rat species in our arrays; however, the CIC has captured rats in the island's interior. The rats' presence is of major concern, since rats are omnivorous scavengers with voracious appetites, and are capable of surviving well in most habitats. They compete for the island's limited food resources, transfer diseases to, or directly feed upon native plants, invertebrates, amphibians, reptiles, birds, and small mammals. On Anacapa Island, rats are known to feed on native lizards, and may be responsible for the present low numbers of deer mice (Erickson and Halvorson, 1990; Howald et al., 1997). Bird and reptile species tend to most affected by these exotics. Introduced rats account for an estimated 40- 60 % of all island bird and reptile extinctions world wide (Atkinson, 1985). Their proliferation on Santa Catalina Island is probably offset by the present of feral cats; however, if left unchecked, rats short breeding cycles, large litters, and fast sexual maturations, mean that they can rapidly negatively effect the island's native populations. Care should be taken to prevent rats from swimming ashore from wrecked vessels, running ashore along boat tie lines, or stowing away aboard packages arriving on the island. Only rat proof containers should be used aboard vessels transferring goods onto the island. To keep rat numbers at as low a level on the island as possible, continuous trapping should be conducted in coastal areas and canyons where rats are known to be most abundant on islands (Erickson and Halvorson, 1990; Howald et al., 1997).

Introduced Argentine ants are widespread in southern California. These ants are known to competitively displace native ant species (Suarez et al., 1998) and may negatively impact higher trophic levels. Throughout their introduced range, Argentine ants may also disrupt and reduced native arthropod communities within natural areas thus could potentially impact many species (Suarez and Case, 2002). Argentine ants appear limited by lack of moisture and have not widely invaded natural habitats (Laakkonen et al., 2001; Fisher et al., 2002).

Argentine ants were first documented on Santa Catalina Island in 1916 (Hebard and Heller, 1999). Increased moisture levels associated with irrigation, human activities and the ocean influence have facilitated the spread of Argentine ants throughout Santa Catalina Island. The eleven arrays where Argentine ants were identified are closely tied to moisture. We do expect the expansion of Argentine ants to continue on Santa Catalina Island. This raises concern for the native ant populations, especially the endemic ant species that reside on Santa Catalina Island. The further expansion of Argentine ants could be detrimental to the native and endemic ants on Santa Catalina Island.

Red imported fire ants (*Solenopsis invicta*) have not been identified on Santa Catalina Island. These ants currently occur in southern California and are known to disperse along riparian corridors; however, they are most commonly transported through soil during construction and landscaping. Because of this, red imported fire ants do pose a threat to the island. Local nurseries and any shipments of plants from the mainland should be monitored and inspected to insure this ant is not inadvertently introduced to the island.

Cardiocondyla mauritanicais is an exotic ant species that was identified in one of the beach campgrounds (Hebard and Heller, 1999), but was not captured at any of our arrays.

Possibly this exotic is localized, none of the 20 USGS pitfall arrays are located in this campground area.

Control of the Argentine ants is necessary in the management of the native ants, and higher trophic levels (i.e. the Santa Catalina shrew). Also continued ant monitoring is necessary to identify any Argentine ant expansion, status of the native ants, and to monitor for the invasion of other exotic ants. If red imported fire ants are identified on the island, immediate action needs to take place to control them.

5.6.2 Anthropogenic Disturbances

Minimizing human impacts should also be a priority. Trail building in or near sensitive habitat (e.g. riparian areas), or near pitfall arrays is strongly discouraged. To prevent animal mortality, mountain biking or any type of motorized bikes should continue to be disallowed on hiking trails. Snakes are especially susceptible to mortality from vehicles. Posting signs, limiting vehicle speed and reducing the number of vehicles allowed to drive in the interior of the island would help reduce road kill fatalities. Excessive watering (irrigation) around buildings or other structures in the interior should be kept to a minimum to decrease the spread of Argentine ants throughout the island's interior.

5.6.3 Illegal Collection of Natural Resources

With plans to improve and expand the trail system within the island's interior, the collecting of natural resources will likely increase. Both plants and animals can be affected by the seemingly innocent, but continuous collecting of samples of these wildlife species. As is posted at many of the parks and reserves throughout the country, the public should be notified of the nature of the reserve and encouraged to enjoy the wildlife experience, but to leave what they encounter in place.

5.6.4 Pitfall Array Removal

All of the equipment installed for the study remains in place at the time of this report. If continued research is not foreseen, the pitfall array materials should be removed from the ground. The pitfall arrays represent a significant investment of time and effort. If it is decided to keep the pitfall arrays in the ground but there is no plan to sample them in the near future, a transfer of responsibility will need to be arranged.

Despite all these pressures, with the continuation of appropriate monitoring, land managers will have the data they need to track conservation efforts and make informed habitat management decisions, thus possibly ensuring that these species native to the island can be maintained at viable numbers within the CIC managed lands.

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Table 1. Number of herpetofauna and small mammal species captured on Santa Catalina Island per array between February 2002 and December 2004.

Common Name	*Scientific Name*	Array #																				Total	Total
Herpetofauna		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	**Captures**	**Arrays**
garden slender salamander	*Batrachoseps major*	0	0	4	0	0	1	4	4	4	1	0	1	0	0	0	0	0	0	0	3	22	8
Pacific treefrog	*Pseudacris regilla*	0	1	2	0	0	1	0	1	2	0	0	0	0	0	0	0	1	0	0	1	9	7
side-blotched lizard	*Uta stansburiana*	30	44	18	27	11	15	11	26	11	26	46	33	92	11	40	32	23	9	2	3	510	20
southern alligator lizard	*Elgaria multicarinatus*	4	3	3	2	7	8	8	2	11	5	2	2	0	1	4	4	3	7	8	7	91	19
western skink	*Eumeces skiltonianus*	3	0	2	7	3	5	3	1	0	2	0	0	0	1	0	0	0	0	0	0	27	9
common kingsnake	*Lampropeltis getulus*	0	1	1	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	5	4
gopher snake	*Pituophis catenifer*	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	4	3
southern Pacific rattlesnake	*Crotalus viridis*	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	1	0	6	6
western ringneck snake	*Diadophis punctatus*	0	0	0	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0	3	7	4
Total # of Individuals		37	50	30	36	21	31	31	34	31	36	48	36	92	14	45	36	28	16	11	18	681	
Total # of Species		3	5	6	3	3	6	7	5	6	6	2	3	1	4	3	2	4	2	3	6	80 [1]	
Small Mammals																							
Santa Catalina Island deer mouse	*Peromyscus maniculatus catalinae*	6	6	6	7	2	5	3	1	1	3	3	1	3	3	2	6	2	1	1	1	63	20
Santa Catalina Island harvest mouse	*Reithrodontomys megalotis catalinae*	3	14	2	1	3	20	0	0	6	16	14	1	17	7	19	5	5	2	9	7	151	18
Santa Catalina shrew	*Sorex ornatus willetti*	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	4	4
Total # of Individuals		9	20	8	8	5	25	3	1	8	20	17	2	20	10	22	12	7	3	10	8	218	
Total # of Species		2	2	2	2	2	2	1	1	3	3	2	2	2	2	3	3	2	2	2	2	3	

[1]Total number of unique species locations across Santa Catalina Island

Table 2. Herpetofauna species detected on Santa Catalina Island through incidental observations between February 2002 and December 2004.

Incidental Observations			
Common Name	***Scientific Name***	**Notes**	**Total**
bullfrog	*Rana catesbeiana*	Near arrays 2 and 3	1
bullfrog	*Rana catesbeiana*	Near arrays 2 and 3	1
gopher snake	*Pituophis catenifer*	Near array 16	1
southern Pacific rattlesnake	*Crotauls viridis*	Near array 18	1
southern Pacific rattlesnake	*Crotauls viridis*	Near array 15	1
southern Pacific rattlesnake	*Crotauls viridis*	Near array 9	1
southern Pacific rattlesnake	*Crotauls viridis*	Near array 7	1
southern Pacific rattlesnake	*Crotauls viridis*	Near array 20	1
		Total # of Individuals	8
		Total # of Species	3

Table 3. Vegetation transects summary data for pitfall array sites at Santa Catalina Island.

Habitat Characteristic		Array Number																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Canopy Height (cm)	Average	26.5	37.6	37.5	51.5	123.5	79.6	302.4	88.5	100.4	54.4	62.6	198.3	82.8	19.1	90.3	29.7	26.4	13.9	25.6	102.7
	Median	15.0	22.5	28.5	36.5	78.5	38.0	345.0	8.5	17.5	48.0	32.5	187.5	13.0	15.0	67.5	29.0	25.5	10.0	23.5	64.0
	Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Maximum	161.0	123.0	133.0	310.0	400.0	450.0	600.0	700.0	380.0	122.0	250.0	620.0	480.0	86.0	425.0	103.0	89.0	60.0	80.0	330.0
	StDev	33.9	35.8	40.1	62.1	122.6	113.1	166.1	182.2	138.8	30.8	66.1	189.4	142.3	16.8	103.1	23.2	22.4	13.9	18.6	101.4
Leaf Litter Depth (cm)	Average	1.0	1.2	0.7	0.8	1.9	1.6	2.2	1.7	1.0	1.5	2.1	4.1	2.3	0.8	6.0	1.8	0.8	1.0	0.8	1.8
	Median	0.5	1.0	0.5	0.5	1.0	0.5	2.0	0.5	1.0	1.0	1.0	3.0	1.0	0.5	3.0	0.5	0.5	0.5	0.5	2.0
	Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Maximum	6.0	6.0	3.0	4.0	7.0	21.0	12.0	11.0	4.0	5.0	12.0	29.0	16.0	4.0	76.0	13.0	9.0	4.0	5.0	6.0
	StDev	0.9	0.9	0.6	0.7	1.9	3.1	1.7	2.3	1.0	1.1	2.3	4.8	3.4	0.6	10.6	2.5	1.2	0.9	0.6	1.5
Substrate Type (# of points along transect)	Sandy Soil	10	6	15	16	5	28			4	1				2	3	23	6	4	1	7
	Leaf Litter	88	94	74	81	95	63	100	93	72	94	97	99	99	98	94	63	69	96	99	89
	Organic Soil						1		1			2						1			
	Cryptogamic									20								3			1
	Bare Rock	2		11	1		8		3		5	1				3	14	12			1
	Moss				2				3	4			1	1				8			2
Number of Points Along Transect, (n)		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	100	100	100
Vegetation Growth Form Structure	% Shrub	17.8%	29.2%	74.7%	74.1%	51.9%	39.5%	49.7%	22.5%	32.1%	34.0%	36.2%	42.8%	25.8%	6.0%	41.1%	95.2%	59.7%	6.6%	17.7%	55.4%
	%Grass	50.3%	60.2%	15.2%	12.3%	42.0%	59.3%	44.8%	61.7%	46.4%	41.4%	45.4%	39.7%	58.3%	59.0%	33.8%	1.9%	36.1%	74.6%	64.6%	37.2%
	%Forb	31.8%	10.5%	8.9%	12.3%	5.6%	1.2%	2.2%	15.8%	19.3%	22.7%	16.0%	8.8%	14.6%	34.3%	23.8%	2.9%	4.2%	18.9%	17.7%	4.1%
	%Other	0.0%	0.0%	1.3%	1.2%	0.6%	0.0%	3.3%	0.0%	2.1%	0.0%	1.8%	8.8%	1.3%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	3.4%
	Total Hits	157	171	79	81	162	86	181	120	140	203	163	194	151	134	151	105	119	122	147	148
Proportion of Habitat Type[1]	% Chaparral	0.0%	0.0%	55.7%	48.1%	1.2%	5.8%	0.0%	0.8%	0.0%	0.0%	1.2%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% Coastal sage scrub	6.4%	28.1%	0.0%	0.0%	23.5%	5.8%	2.2%	0.0%	2.9%	29.6%	27.6%	12.9%	6.6%	4.5%	40.4%	73.3%	58.8%	6.6%	17.7%	18.2%
	% Tree	0.0%	0.0%	12.7%	25.9%	24.7%	18.6%	47.5%	21.7%	29.3%	0.0%	6.1%	29.9%	17.2%	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%	37.2%
	% Un-classified	43.3%	9.9%	19.0%	14.8%	7.4%	38.4%	4.4%	8.3%	20.0%	28.6%	20.9%	17.5%	29.1%	33.6%	14.6%	24.8%	4.2%	20.5%	17.7%	7.4%
	% Grass	50.3%	62.0%	12.7%	11.1%	43.2%	31.4%	45.9%	69.2%	47.9%	41.9%	44.2%	39.7%	45.0%	59.7%	45.0%	1.9%	37.0%	73.0%	64.6%	37.2%
	Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

[1]Habitat types with the relative percentage for select dominant species at each pitfall array

Table 4. Habitat type at each pitfall array and the top three plant species recorded along vegetation transects on Santa Catalina Island.

Array Number	Habitat Type[1]				Dominate Plant Species[2]		
	NNG	CSS	OAK	CHAP	1	2	3
1	X				BRDI2	FIGA	NAPU4
2		X			BRDI2	ARCA11	BRHO2
3				X	ADFA	QUPA6	NAPU4
4				X	ADFA	QUPA6	BRDI2
5			X		BRDI2	QUPA6	RHIN2
6	X				PRMI3	PHAQ	QUPA6
7			X		QUPA6	BRDI2	BRDI3
8	X				BRDI2	QUPA6	ERODI
9			X		BRDI2	QUPA6	NAPU4
10		X			BRDI2	ARCA11	MELIL
11		X			BRDI2	RHIN2	NAPU4
12			X		BRDI2	QUPA6	RHIN2
13	X				BRDI2	QUPA6	GAVE3
14	X				BRDI2	HEFA	ISME5
15		X			ENCA	BRNI	AVENA
16		X			ENCA	OPLI3	LYCA
17		X			ARCA11	BRMAR	NAPU4
18	X				BRDI2	BRHO2	BEMA4
19	X				BRDI2	ARCA11	HEFA
20			X		QUPA6	BRDI2	ARCA11
Totals	7	6	5	2			

[1]Habitat types include: Non-native grasslands (NNG), coastal sage scrub (CSS), oak woodland (OAK), and chaparral (CHAP)

[2]Plant species codes can be found in Appendix 5

Table 5. Relative abundance of herpetofauna and small mammals on Santa Catalina Island.

Common Name	*Scientific Name*	Relative Abundance[1]				
		Habitat Type[2]				Total
Herpetofauna		**NNG**	**CSS**	**OAK**	**CHAP**	
garden slender salamander	*Batrachoseps major*	0.006	0.001	0.019	0.016	0.009
Pacific treefrog	*Pseudacris regilla*	0.002	0.003	0.005	0.008	0.004
side-blotched lizard	*Uta stansburiana*	0.206	0.275	0.108	0.176	0.199
southern alligator lizard	*Elgaria multicarinatus*	0.033	0.027	0.055	0.020	0.036
western skink	*Eumeces skiltonianus*	0.011	0.003	0.009	0.035	0.011
common kingsnake	*Lampropeltis getulus*	0.000	0.003	0.003	0.004	0.002
gopher snake	*Pituophis catenifer*	0.000	0.001	0.005	0.000	0.002
southern Pacific rattlesnake	*Crotalus viridis*	0.002	0.004	0.002	0.000	0.002
western ringneck snake	*Diadophis punctatus*	0.001	0.000	0.009	0.000	0.003
Total Relative Abundance per Habitat Type		0.262	0.319	0.214	0.258	
Total # of Species		9	8	9	6	9
Total # of Arrays		7	6	5	2	20
Small Mammals						
Santa Catalina Island deer mouse	*Peromyscus maniculatus catalinae*	0.022	0.029	0.013	0.051	0.025
Santa Catalina Island harvest mouse	*Reithrodontomys megalotis catalinae*	0.065	0.095	0.027	0.012	0.059
Santa Catalina shrew	*Sorex ornatus willetti*	0.003	0.000	0.002	0.000	0.002
Total Relative Abundance per Habitat Type		0.090	0.124	0.041	0.063	
Total # of Species		3	2	3	2	3
Total # of Arrays		7	6	5	2	20

[1]Relative abundance = Total number of captures / (number of arrays x number of days sampled)

[2]Habitat type: NNG (non-native grass), CHAP (chaparral), OAK (oak woodland), and CSS (coastal sage scrub)

Table 6. Herpetofauna and small mammal captures per season between February 2002 and December 2004 on Santa Catalina Island.

Common Name	***Scientific Name***	**Season**				
Herpetofauna		**Spring**	**Summer**	**Fall**	**Winter**	**Total**
garden slender salamander	*Batrachoseps major*	2	0	2	18	22
Pacific treefrog	*Pseudacris regilla*	4	0	1	4	9
side-blotched lizard	*Uta stansburiana*	128	130	93	159	510
southern alligator lizard	*Elgaria multicarinatus*	42	23	10	16	91
western skink	*Eumeces skiltonianus*	11	10	3	3	27
common kingsnake	*Lampropeltis getulus*	2	1	2	0	5
gopher snake	*Pituophis catenifer*	1	1	1	1	4
southern Pacific rattlesnake	*Crotalus viridis*	2	2	1	1	6
western ringneck snake	*Diadophis punctatus*	3	3	0	1	7
Total # of Species		195	170	113	203	681
Small Mammals						
Santa Catalina Island deer mouse	*Peromyscus maniculatus catalinae*	23	9	9	22	63
Santa Catalina Island harvest mouse	*Reithrodontomys megalotis catalinae*	57	21	38	35	151
Santa Catalina shrew	*Sorex ornatus willetti*	2	0	0	2	4
Total # of Species		82	30	47	59	218
Number of Sample Days		35	30	35	28	128

Table 7. Ant and focal invertebrate species captured at pitfall arrays on Santa Catalina Island between winter 2002 and summer 2004 (includes winter 2002, 2003, 2004 and summer 2002, 2003 and 2004).

Ants		**Array #**																				**Total Captures**	**Total Arrays**
Subfamily																							
Species Name	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**		
Dolichoderinae																							
Linepithema humile[1]	Argentine ant	0	0	2	82	125	0	0	0	0	0	332	0	0	265	2944	119	578	28	28	600	5103	11
Tapinoma sessile	oderous house ant	0	0	0	0	0	35	0	0	0	0	0	2	3	0	0	0	0	0	0	0	40	3
Formicinae																							
Brachymyrmex depilis		0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Camponotus clarithorax	carpenter ant	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Camponotus sp. CA-03	carpenter ant	5	0	4	1	0	11	16	11	12	10	0	30	10	0	0	0	0	0	0	0	110	10
Formica subelongata	wood ant	6	2	0	0	0	19	16	1	4	0	0	0	0	0	0	0	0	0	0	0	48	6
Prenolepis imparis	winter ant	0	0	0	4	36	2	13	3	21	0	0	0	0	0	0	0	0	0	0	0	79	6
Myrmicinae																							
Aphaenogaster patruelis		2	15	0	0	0	27	4	0	0	0	0	0	0	0	0	0	0	1	0	0	49	5
Crematogaster californica	acrobat ant	3	0	0	17	0	0	6	0	9	42	0	16	4	0	0	0	0	0	0	0	97	7
Crematogaster coarctata	acrobat ant	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1
Crematogaster marioni	acrobat ant	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	1
Cyphomyrmex wheeleri	fungus-growing ant	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	7	1
Messor andrei	harvester ant	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
Monomorium ergatogyna		37	50	3	18	3	31	9	21	10	29	0	16	33		12	0	0	2	20	0	294	15
Pheidole clementensis		7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	11	3
Pheidole hyatti		458	301	0	0	0	143	58	1291	84	79	0	205	134	2	0	0	0	0	0	0	2755	10
Solenopsis molesta	thief ant	0	1	0	0	0	0	2	1	1	9	0	4	1	0	1	0	0	0	0	0	20	8
Solenopsis texana catalinae[2,3]		0	0	0	0	0	0	0	4	0	3	0	1	0	0	0	0	0	0	0	0	8	3
Temnothorax andrei		2	0	1	2	2	0	2	1	7	0	2	2	0	0	0	0	1	8	2	0	32	12
Temnothorax sp CA-05[3]		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Total # of Individuals		523	372	10	131	166	269	126	1342	148	172	334	280	185	267	2957	119	579	39	51	600	8670	
Total # of Species		9	6	4	7	4	8	9	11	8	6	2	10	6	2	3	1	2	4	4	1	20	
Invertebrates																							
Species Name	**Common Name**																						
Cnemotettix miniatus	silk spinning cricket	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Stenopelmatus n.sp "Catalina"	Jerusalem cricket	0	1	0	1	3	1	9	0	7	3	0	7	4	2	8	1	1	0	0	4	52	14
Total # of Individuals		0	1	1	1	3	1	9	1	7	3	0	7	4	2	8	1	1	0	0	4	54	
Total # of Species		0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	2	

[1] Highly invasive species

[2] Species endimic to Santa Catalina Island

[3] Species in the process of being verified

Table 8. Ant species identified on Santa Catalina Island.

Subfamily *Scientific Name*	Common Name	Ant Species Identifed Sleeper 1989	Hebard and Heller 1999	USGS 2002-2004	
Dolichoderinae					
Linepithema humile	Argentine ant	X	X	X	
Tapinoma sessile	oderous house ant		X	X	
Formicinae					
Brachymyrmex depilis			X	X	
Camponotus clarithorax	carpenter ant			X	
Camponotus bakeri	carpenter ant	X	X		
Camponotus sp CA-03 [1]	carpenter ant	X	X	X	
Formica argentea	wood ant		X		
Formica subelongata	wood ant			X	
Prenolepis imparis	winter ant		X	X	
Myrmicinae					
Aphaenogaster patruelis		X	X	X	
Cardiocondyla mauritanicais			X		
Crematogaster californica	acrobat ant		X	X	
Crematogaster coarctata	acrobat ant	X		X	
Crematogaster marioni	acrobat ant			X	
Cyphomyrmex wheeleri	fungi-growing ant		X	X	
Messor andrei	harvester ant	X	X	X	
Monomorium ergatogyna		X	X	X	
Pheidole clementensis				X	
Pheidole hyatti		X	X	X	
Solenopsis molesta	theif ant	X	X	X	**Total Number of Ants Identified on Santa Catalina Island**
Solenopsis texana catalinae		X	X	X	
Temnothorax andrei			X	X	
Temnothorax sp CA-05				X	
Total Species		10	17	20	23

[1]Species name has changed across the three studies

Table 9. Historical records for Santa Catalina Island herpetofauna.

Common Name	*Scientific Name*	Location																									Total Captures	Total Locations
Herpetofauna		Airport	Avalon	Ben Weston Beach	Big Springs Canyon	Black Jack Mnt.	Cabrillo Harbor	Camp Cactus	Deer Valley Reservoir	Echo Lake	Emerald Bay	Fisherman Cove	Fourth of July Cove	Gallagher Beach	Haypress Reservior	Howland Landing	Johnsons Landing	Little Harbor	Middle Canyon	Renton Mine	Santa Catalina Island	Silver Canyon	Toyon Bay	Two Harbors	Whites Cove	Willow Canyon		
arboreal salamander	*Aneides lugubris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
garden slender salamander	*Batrachoseps major*	0	57	0	1	4	0	0	9	6	0	28	3	0	0	4	62	10	47	0	82	0	10	74	7	0	404	15
bullfrog	*Rana catesbeiana*	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1
Pacific treefrog	*Pseudacris regilla*	0	81	0	9	0	0	0	0	2	12	0	0	0	0	4	26	2	7	0	15	0	0	24	2	0	184	11
side-blotched lizard	*Uta stansburiana*	0	115	2	6	2	0	0	0	6	0	4	0	24	0	12	83	16	40	0	49	4	0	37	22	0	422	15
southern alligator lizard	*Elgaria multicarinatus*	1	18	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	70	2	2	5	8	12	122	11
western skink	*Eumeces skiltonianus*	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	0	0	0	0	13	5
common kingsnake	*Lampropeltis getulus*	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	4	0	0	1	0	0	12	5
gopher snake	*Pituophis catenifer*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	2	0	0	7	2
southern Pacific rattlesnake	*Crotalus viridis*	0	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	32	0	0	0	0	0	39	4
two-striped garter snake	*Thamnophis hammondii*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	2
western ringneck snake	*Diadophis punctatus*	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	2	0	0	10	2
Total # of Individuals		2	287	3	16	6	1	1	9	14	12	32	3	24	2	20	179	28	102	1	259	10	12	145	39	12	1219	
Total # of Species		2	8	2	3	2	1	1	1	3	1	2	1	1	1	3	4	3	7	1	10	3	2	6	4	1	73[1]	
Percent of records at each location		0%	24%	0%	1%	0%	0%	0%	1%	1%	1%	3%	0%	2%	0%	2%	15%	2%	8%	0%	21%	1%	1%	12%	3%	1%	100%	

[1]Total number of unique species locations across Santa Catalina Island

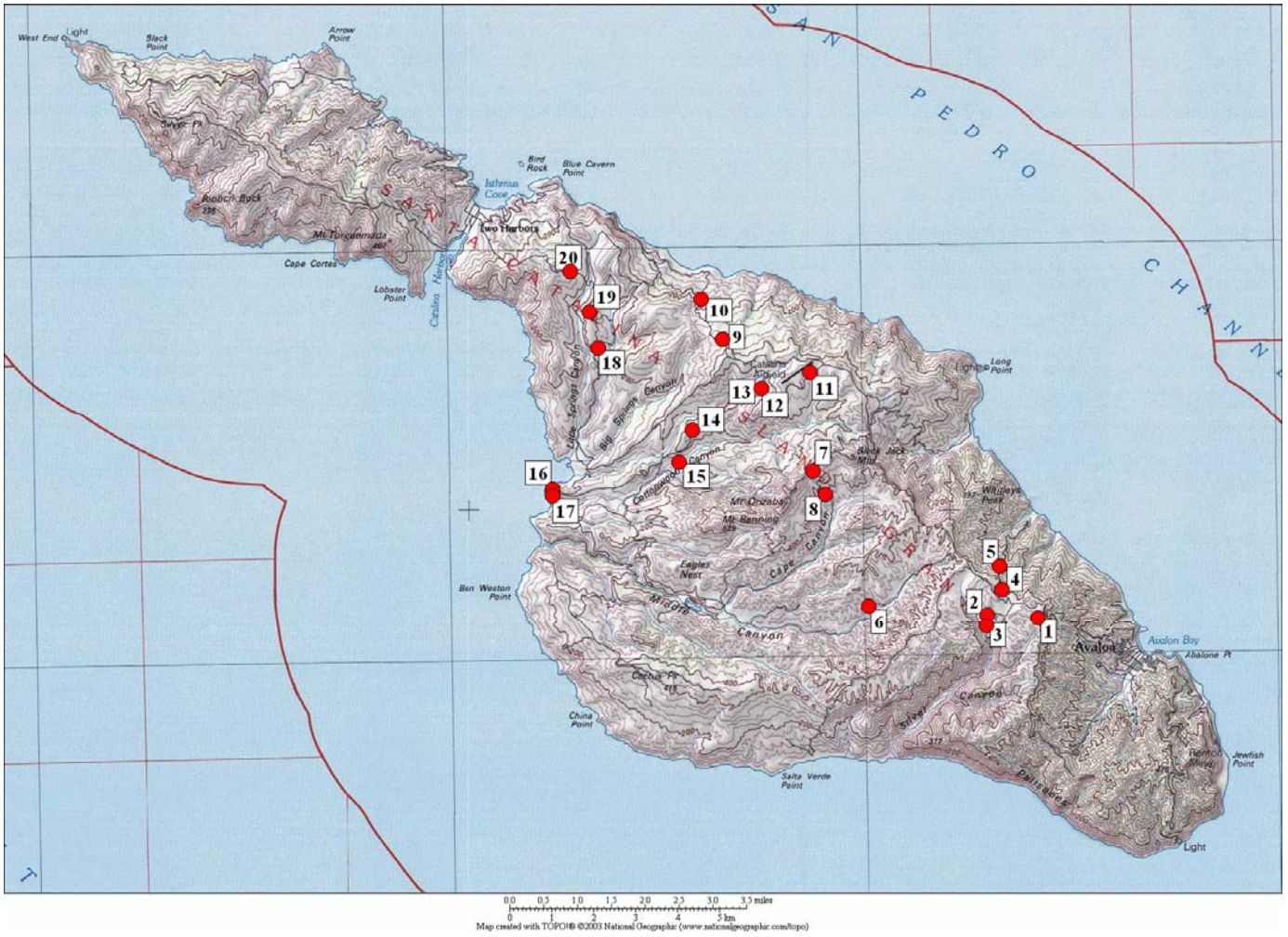

Figure 1. Location of pitfall arrays on Santa Catalina Island**.** Note arrays 12 and 13 occur within close proximity and therefore are represented by a single point.

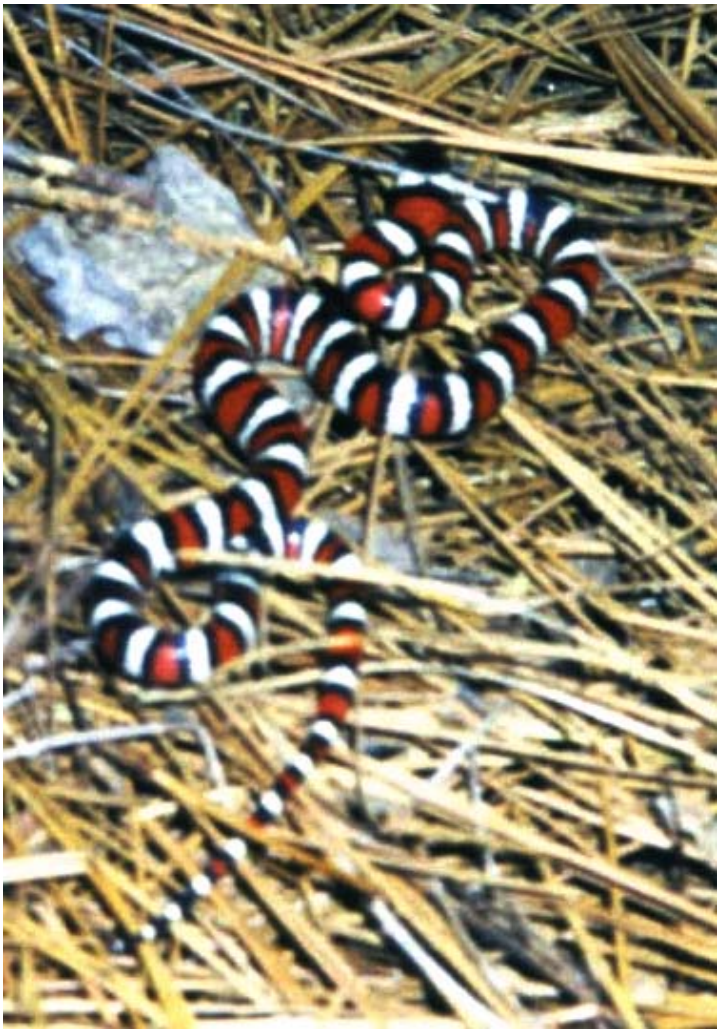

Figure 2. California mountain kingsnake (*Lampropeltis zonata*) photograph taken from Black Jack Campground in 1999 by Scott Panzer.

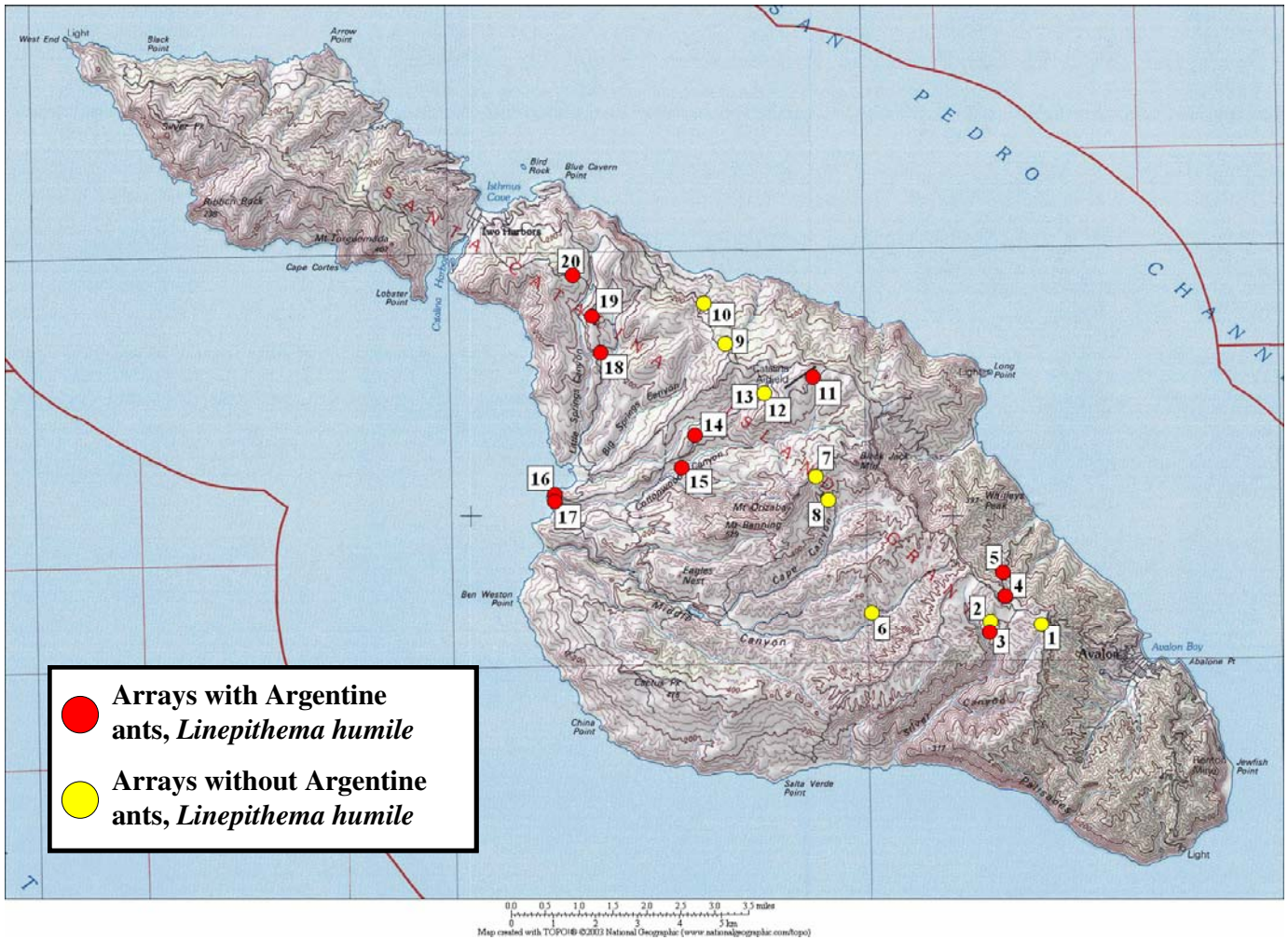

Figure 3. Location of Argentine ants (*Linepithema humile*) at pitfall arrays on Santa Catalina Island. Note arrays 12 and 13 are represented by a single point since they occur within close proximity and both arrays are without Argentine ants.

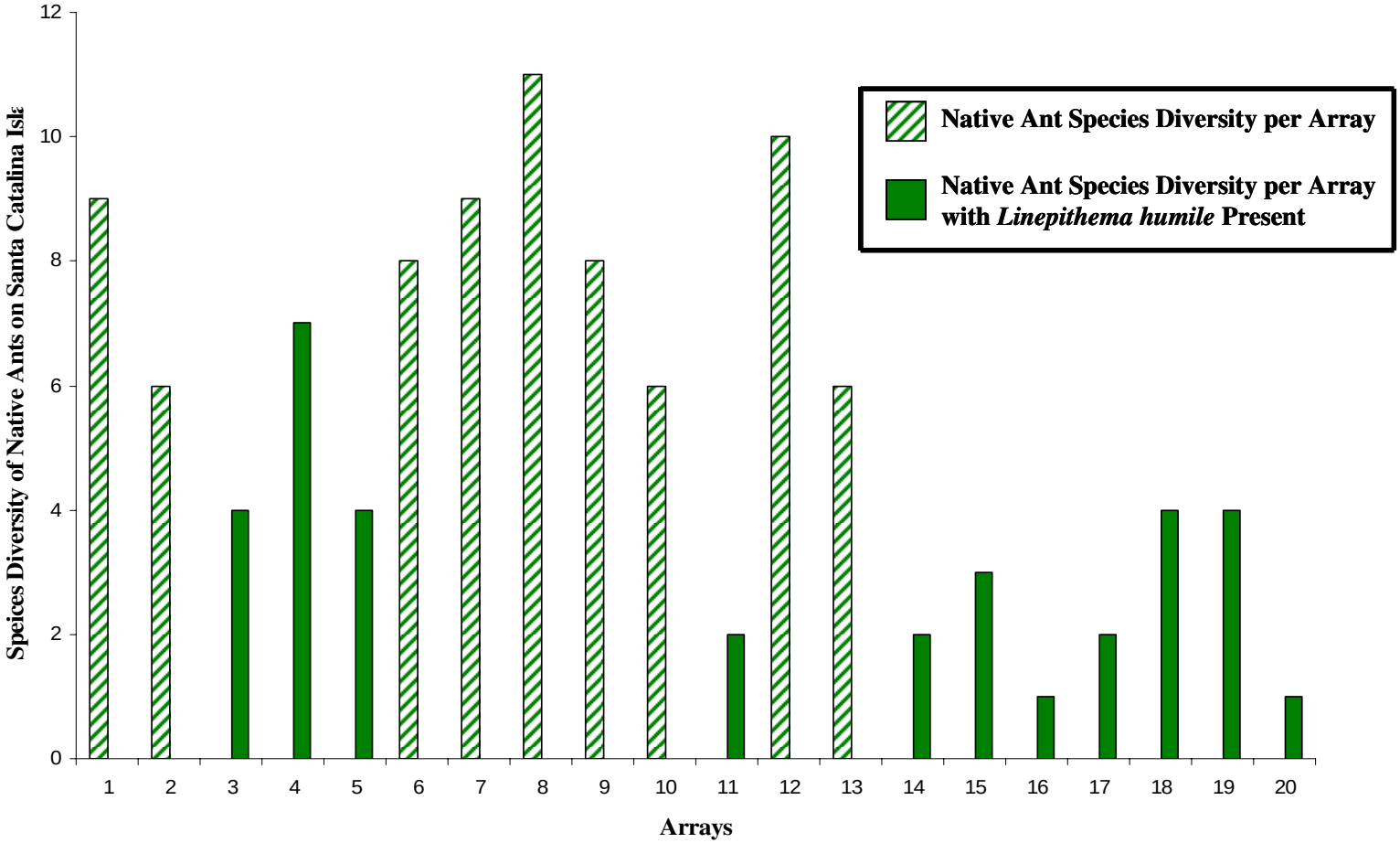

Figure 4. Native ant species diversity with and without the presence of the Argentine ant (*Linepithema humile)* on Santa Catalina Island.

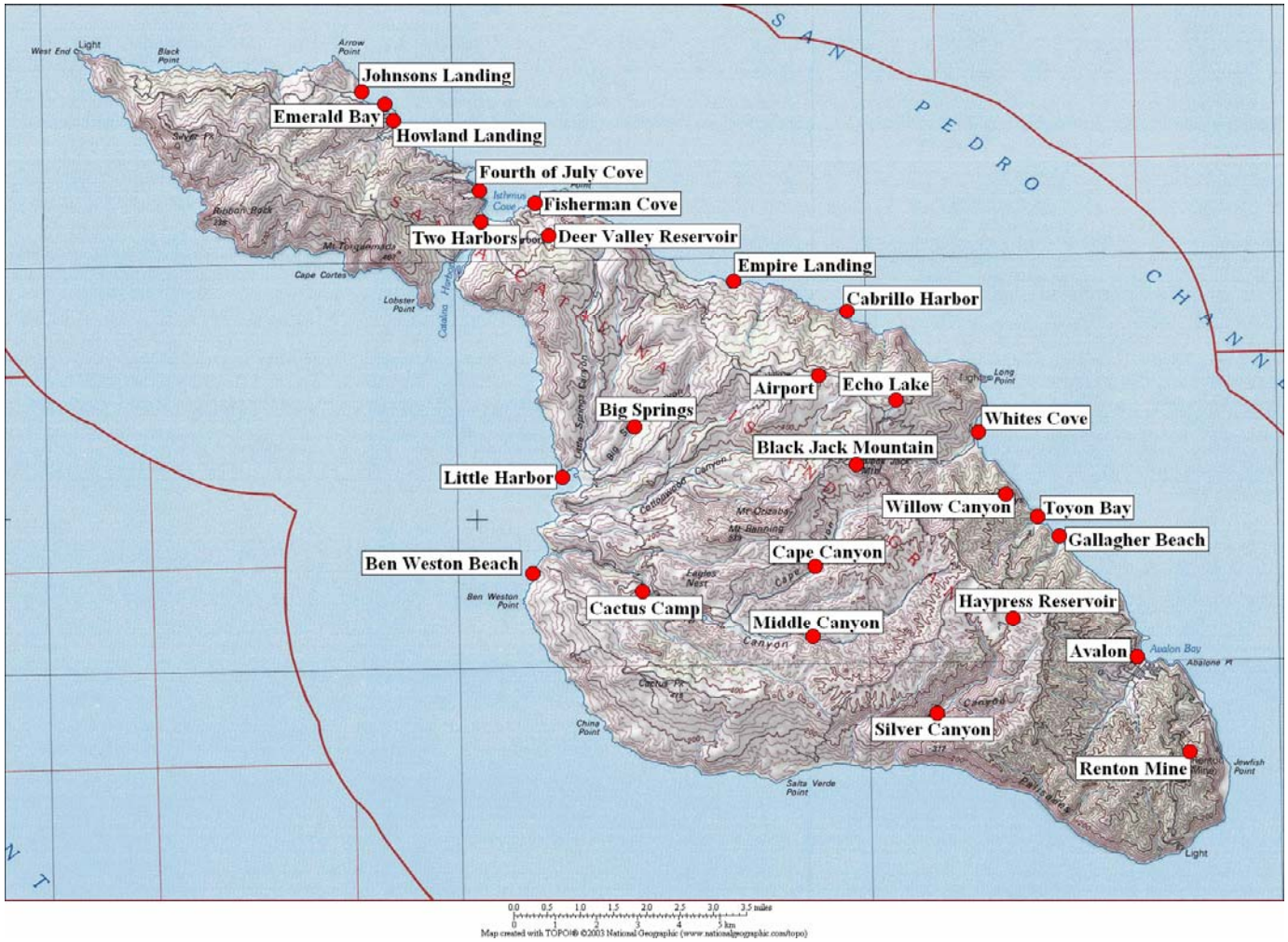

Figure 5. General locations of herpetofauna records on Santa Catalina Island from museums.

Appendix 1. Coordinates of pitfall arrays on Santa Catalina Island.

USGS Pitfall Array Number	Latitude[1]	Longitude[1]	Elevation (m)[2]	Associated CIC Land Bird Monitoring Point
1	33.35108	118.35285	458	51
2	33.35157	118.36586	433	56
3	33.34919	118.36586	414	56
4	33.35709	118.36199	407	52
5	33.36221	118.36256	317	53
6	33.35338	118.39660	262	32
7	33.38317	118.41092	472	34
8	33.37804	118.40788	347	33
9	33.41205	118.43466	351	6
10	33.42099	118.44016	164	4
11	33.40477	118.41190	460	7
12	33.40317	118.42457	388	9
13	33.40325	118.42501	377	9
14	33.39215	118.44243	226	10
15	33.38520	118.44581	126	N/A
16	33.37911	118.47865	79	N/A
17	33.37770	118.47877	47	N/A
18	33.41012	118.46689	165	39
19	33.41806	118.46920	227	76
20	33.42712	118.47398	233	43

[1]All coordinates recorded in WGS84 (decimal.degrees)

[2]Derived using Topo!® Version 3.4.3

Appendix 2. Photos of herpetofauna pitfall arrays on Santa Catalina Island.


Array 1


Array 2


Array 3


Array 4


Array 5


Array 6

Appendix 2 (continued).


Array 7


Array 8


Array 9


Array 10


Array 11


Array 12

Appendix 2 (continued).


Array 13


Array 14


Array 15


Array 16


Array 17


Array 18

Appendix 2 (continued).

Array 19

Array 20

Appendix 3. Summary of sampling dates for pitfall arrays on Santa Catalina Island between February 2002 and December 2004.

Sample Period	Start Date	End Date	Number of Days Sampled
1	26-Feb-2002	1-Mar-2002	4
2	19-Mar-2002	22-Mar-2002	4
3	16-Apr-2002	19-Apr-2002	4
4	14-May-2002	17-May-2002	4
5	18-Jun-2002	21-Jun-2002	4
6	16-Jul-2002	19-Jul-2002	4
7	27-Aug-2002	30-Aug-2002	4
8	1-Oct-2002	4-Oct-2002	4
9	29-Oct-2002	1-Nov-2002	4
10	19-Nov-2002	22-Nov-2002	4
11	28-Jan-2003	31-Jan-2003	4
12 [1]	6-Mar-2003	9-Mar-2003	4
13	19-Mar-2003	22-Mar-2003	4
14	22-Apr-2003	25-Apr-2003	4
15	20-May-2003	23-May-2003	4
16	24-Jun-2003	27-Jun-2003	4
17	22-Jul-2003	25-Jul-2003	4
18	26-Aug-2003	29-Aug-2003	4
19	23-Sep-2003	26-Sep-2003	4
20	28-Oct-2003	31-Oct-2003	4
21	16-Nov-2003	19-Nov-2003	4
22	13-Jan-2004	16-Jan-2004	4
23	10-Feb-2004	13-Feb-2004	4
24	14-Mar-2004	17-Mar-2004	4
25	13-Apr-2004	16-Apr-2004	4
26	18-May-2004	21-May-2004	4
27	15-Jun-2004	18-Jun-2004	4
28	20-Jul-2004	23-Jul-2004	4
29	17-Aug-2004	20-Aug-2004	4
30	21-Sep-2004	24-Sep-2004	4
31 [1]	1-Nov-2004	5-Nov-2004	4
32 [1]	29-Nov-2004	3-Dec-2004	4
Total Sampling Days/Array			**128**

[1] Sample period was delayed due to rain

Appendix 4. Representative photos of species from herpetofauna pitfall arrays on Santa Catalina Island.

Herpetofauna:

Garden slender salamander
Batrachoseps major

Pacific treefrog
Pseudacris regilla

Side-blotched lizard
Uta stansburiana

Southern alligator lizard
Elgaria multicarinatus

Western skink
Eumeces skiltonianus

Western ringneck snake
Diadophis punctatus

Appendix 4 (continued).

Common kingsnake
Lampropeltis getulus

Gopher snake
Pituophis catenifer

Southern Pacific rattlesnake
Crotalus viridis

Santa Catalina Island deer mouse
Peromyscus maniculatus catalinae

Santa Catalina shrew
Sorex ornatus willetti

Santa Catalina Island harvest mouse
Reithrodontomys megalotis catalinae

Appendix 5. Plant species codes used in the description of plant communities associated with pitfall arrays on Santa Catalina Island (Sawyer and Keeler-Wolf, 1995).

Code [1]	Family	*ScientificName*	CommonName	Native to CA [2]
MENO2	Aizoaceae	*Mesembryanthemum nodiflorum*	slender-leaved iceplant	N
MALA6	Anacardiaceae	*Malosma laurina*	laurel sumac	Y
RHIN2	Anacardiaceae	*Rhus integrifolia*	lemonadeberry	Y
TODI	Anacardiaceae	*Toxicodendron diversilobum*	poison-oak	N
DAPU3	Apiaceae	*Daucus pusillus*	american wild carrot	Y
FOVU	Apiaceae	*Foeniculum vulgare*	sweet fennel	N
SANIC	Apiaceae	*Sanicula sp.*	sanicle	Y
ACMI2	Asteraceae	*Achillea millefolium*	yarrow, milfoil	Y
AMPS	Asteraceae	*Ambrosia psilostachya*	ragweed	Y
AMPU3	Asteraceae	*Amblyopappus pusillus*	pineapple weed,dwarf coastweed	Y
ANCO2	Asteraceae	*Anthemis cotula*	mayweed, stinkweed, dog-fennel	N
ARCA11	Asteraceae	*Artemisia californica*	California sagebrush	Y
ARDO3	Asteraceae	*Artemisia douglasiana*	mugwort	Y
BAPI	Asteraceae	*Baccharis pilularis*	coyote bush	Y
BASA4	Asteraceae	*Baccharis salicifolia*	mulefat	Y
CEME2	Asteraceae	*Centaurea melitensis*	tocalote, star-thistle	N
CIOC	Asteraceae	*Cirsium occidentale*	western thistle	Y
ENCA	Asteraceae	*Encelia californica*	California encelia	Y
FICA2	Asteraceae	*Filago californica*	California filago/cottonrose	Y
FIGA	Asteraceae	*Filago gallica*	herba impia, narrow-leaf filago	N
GNST	Asteraceae	*Gnaphalium stramineum*	cotton-batting plant	Y
HASQ2	Asteraceae	*Hazardia squarrosa*	saw-toothed goldenbush	Y
HEFA	Asteraceae	*Deinandra fasciculata*	fascicled tarweed	Y
HYGL2	Asteraceae	*Hypochaeris glabra*	smooth cat's-ear	N
ISME5	Asteraceae	*Isocoma menziesii*	goldenbush	Y
LEFI11	Asteraceae	*Lessingia filaginifolia*	California-aster, cudweed, sand aster	Y
MAGR3	Asteraceae	*Madia gracilis*	slender/grassy tarweed	Y
SOOL	Asteraceae	*Sonchus oleraceus*	common sow thistle	N
STEPH	Asteraceae	*Stephanomeria sp.*	stephanomeria	N
URLI5	Asteraceae	*Uropappus lindleyi*	silver puffs	Y
XASP2	Asteraceae	*Xanthium spinosum*	spiny cocklebur	Y
XAST	Asteraceae	*Xanthium strumarium*	cocklebur	Y
BRNI	Brassicaceae	*Brassica nigra*	black mustard	N
OPLI3	Cactaceae	*Opuntia littoralis*	coast prickly-pear	Y
OPPR	Cactaceae	*Opuntia prolifera*	coast cholla	Y
ISAR	Capparaceae	*Isomeris arborea*	bladderpod	Y
LONIC	Caprifoliaceae	*Lonicera sp.*	honeysuckle	SS
SIAN2	Caryophyllaceae	*Silene antirrhina*	sleepy catchfly/silene	Y
SIGA	Caryophyllaceae	*Silene gallica*	common catchfly	N
ATSE	Chenopodiaceae	*Atriplex semibaccata*	australian saltbush	N
BEMA4	Chenopodiaceae	*Beta vulgaris ssp. macrocarpa*	wild beet	N
SATR12	Chenopodiaceae	*Salsola tragus*	russian thistle, tumbleweed	N
DUHA	Crassulaceae	*Dudleya hassei*	bright green (Catalina) dudleya	Y
DUVI	Crassulaceae	*Dudleya virens*	bright green dudleya, green liveforever	Y
DW	Crassulaceae		dead wood	N/A
SCIRP	Cyperaceae	*Scirpus sp.*	bulrush	SS
ARCA21	Ericaceae	*Arctostaphylos catalinae*	Santa Catalina Island manzanita	Y
ERSE3	Euphorbiaceae	*Eremocarpus setigerus*	turkey mullein, dove weed	Y
ASTRA	Fabaceae	*Astragalus sp.*	locoweed, milkvetch	Y
GELI5	Fabaceae	*Genista linifolia*	mediterranean broom	N
LATI	Fabaceae	*Lathyrus tingitanus*	tangier pea	N
LODED	Fabaceae	*Lotus dendroideus var. dendroideus*	island broom	Y
LOHA2	Fabaceae	*Lotus hamatus*	grab lotus, san diego bird's-foot trefoil	Y
LOTUS	Fabaceae	*Lotus sp.*	lotus, trefoil	SS
LUPIN	Fabaceae	*Lupinus sp.*	lupine	Y
MELIL	Fabaceae	*Melilotus sp.*	sweetclover	N
MEPO3	Fabaceae	*Medicago polymorpha*	California burclover	N
TRIFO	Fabaceae	*Trifolium sp.*	clover	N
QUPA6	Fagaceae	*Quercus pacifica*	Channel Island scrub oak	Y
ERODI	Geraniaceae	*Erodium sp.*	storksbill/filaree	SS
PHACE	Hydrophyllaceae	*Phacelia sp.*	phacelia	Y
JUNCU	Juncaceae	*Juncus sp.*	rush	Y
MAVU	Lamiaceae	*Marrubium vulgare*	horehound	N
SAAP2	Lamiaceae	*Salvia apiana*	white sage	Y

[1]Plant codes from USDA Natural Resources Conservation Service Plants Database (http://plants.usda.gov)

Appendix 5 (continued)**.**

Code [1]	Family	*ScientificName*	CommonName	Native to CA[2]
SAME3	Lamiaceae	*Salvia mellifera*	black sage	Y
BLCR	Liliaceae	*Bloomeria crocea*	common goldenstar	Y
CALOC	Liliaceae	*Calochortus sp.*	mariposa lily	Y
DICA14	Liliaceae	*Dichelostemma capitatum*	blue dicks	Y
MICA6	Nyctaginaceae	*Mirabilis californica*	wishbone bush	Y
CLARK	Onagraceae	*Clarkia sp.*	clarkia	Y
PLER3	Plantaginaceae	*Plantago erecta*	dotseed plantain	Y
PLOV	Plantaginaceae	*Plantago ovata*	woolly plantain	Y
ARDO4	Poaceae	*Arundo donax*	giant reed	N
AVENA	Poaceae	*Avena sp.*	wild oats	N
BRDI2	Poaceae	*Brachypodium distachyon*	purple false brome	N
BRDI3	Poaceae	*Bromus diandrus*	ripgut grass	N
BRHO2	Poaceae	*Bromus hordeaceus*	soft (chess) brome	N
BRMAR	Poaceae	*Bromus madritensis ssp. rubens*	red brome, foxtail chess	N
CYDA	Poaceae	*Cynodon dactylon*	bermuda grass	N
DISP	Poaceae	*Distichlis spicata*	saltgrass	Y
ELGL	Poaceae	*Elymus glaucus*	blue wildrye	Y
GAVE3	Poaceae	*Gastridium ventricosum*	nit grass	N
HORDE	Poaceae	*Hordeum sp.*	barley	SS
LAAU	Poaceae	*Lamarckia aurea*	golden-top grass	N
LECO12	Poaceae	*Leymus condensatus*	giant wildrye	Y
LOPE	Poaceae	*Lolium perenne*	perennial ryegrass	N
MEIM	Poaceae	*Melica imperfecta*	smallflower/coast range melic	Y
NAPU4	Poaceae	*Nassella pulchra*	purple needlegrass	Y
PHAQ	Poaceae	*Phalaris aquatica*	harding grass	N
PIMI3	Poaceae	*Piptatherum miliaceum*	smilo grass	N
VUMY	Poaceae	*Vulpia myuros*	fescue	N
NAVAR	Polemoniaceae	*Navarretia sp.*	skunkweed/pincushionplant	Y
ERGIG	Polygonaceae	*Eriogonum giganteum var. giganteum*	Santa Catalina Island buckwheat, St. Catherine's lace	Y
RUCR	Polygonaceae	*Rumex crispus*	curly dock	N
DOCLI	Primulaceae	*Dodecatheon clevelandii ssp. insulare*	(padre's) shooting star	Y
PEAN2	Pteridaceae	*Pellaea andromedifolia*	coffee fern/cliff-brake	Y
CLLI2	Ranunculaceae	*Clematis ligusticifolia*	virgin's bower, yerba de chiva, western white clematis	Y
RHPI	Rhamnaceae	*Rhamnus pirifolia*	island redberry	Y
ADFA	Rosaceae	*Adenostoma fasciculatum*	chamise	Y
CEBE3	Rosaceae	*Cercocarpus betuloides var. betuloides*	birch-leaf mountain-mahogany	Y
HEAR5	Rosaceae	*Heteromeles arbutifolia*	toyon, christmas berry	Y
PRILL	Rosaceae	*Prunus ilicifolia ssp. lyonii*	Catalina cherry	Y
GALIU	Rubiaceae	*Galium sp.*	bedstraw	SS
SALIX	Salicaceae	*Salix sp.*	willow	SS
ANNUS	Scrophulariaceae	*Antirrhinum nuttallianum ssp. subsessile*	Nuttall's snapdragon	Y
MIAU	Scrophulariaceae	*Mimulus aurantiacus*	coast monkeyflower	Y
LYCA	Solanaceae	*Lycium californicum*	California box/desert thorn	Y
VELA	Verbenaceae	*Verbena lasiostachys*	robust vervain	Y

[1]Plant codes from USDA Natural Resources Conservation Service Plants Database (http://plants.usda.gov)

[2]Native to CA includes: native (Y), non-native (N), and species specific (ss)