

**MOVEMENT PATTERNS AND HABITAT USE
BY CALIFORNIA RED-LEGGED FROGS
ON VANDENBERG AIR FORCE BASE,
SANTA BARBARA COUNTY, CALIFORNIA**



December 2004

Susan V. Christopher
University of California, Santa Barbara

Prepared for
Vandenberg Air Force Base, California

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Project Number XUMUOS-101604
MORD Number OSMORD04630110

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PREFACE

This document is the last in a series resulting from a cooperative research project between the U.S. Department of the Air Force, the U.S. Geological Survey, and the University of California, Santa Barbara (1996 - 2004). Funding was provided by the U.S. Air Force and the U.S. Geological Survey contributed research equipment, materials and training. All handling of California red-legged frogs was authorized under U.S. Fish and Wildlife Service Endangered Species Subpermit BRDPBS-2, and California Department of Fish and Game Scientific Collecting Permit Numbers 803050-01, 803053-01 and 803087-05.

I am grateful to the many people who assisted in the field with this study, including Rebecca Doubledee, Mark Raffetto, Dr. Norman Scott, Jr., and Steve Collie. For obtaining financial and logistical support for this project, I thank Nancy Francine. I am appreciative of GIS assistance provided by Kevin Goetz and Jeff LeNay.

Suggested citation: Christopher. S. V. 2004. Movement patterns and habitat use by California red-legged frogs at Vandenberg Air Force Base, Santa Barbara County, California. December 2004. University of California, Santa Barbara with the cooperation of U.S. Geological Survey. Prepared for 30 CES/CEVPN, Vandenberg Air Force Base, California. Project Number XUMUOS-101604.

SUMMARY

Data on a species' habitat use and dispersal are difficult to generalize over a broad geographic range due to site-specific differences, and conservation planning strategies for threatened or endangered species require an understanding of these characteristics. I studied California red-legged frog movement patterns and habitat use at two wetland complexes on Vandenberg Air Force Base, Santa Barbara County, California using radio tracking and drift fence/pitfall traps. I investigated: 1) dispersal from aquatic sites and interpond movements, 2) selection of upland and pond microhabitats, 3) characteristics of movements including distances traversed and home range size, and 4) how the timing of rainfall and seasonality affect frog movements. I detailed land use planning recommendations based on the results of these and other studies.

Among adult frogs that were tracked over a period encompassing the breeding season, 23% of females and 38% of males moved to a different pond during the peak breeding period and then returned to their original ponds following that period. When one pond dried down in summer, all of the radio-tagged frogs moved to an adjacent pond, which retained water sufficiently deep to inundate emergent vegetation. Metamorphs dispersed away from breeding sites shortly following transformation. During nights of peak metamorph dispersal, the estimated number in upland habitats near each pond was >200 individuals.

Frogs selected cattail stands while in ponds and avoided deep water when those areas lacked emergent vegetation. Frogs tended to be within emergent vegetation during the day, and moved to the edge of the stands at night. Frogs occupied mature willows while far from water for extended periods of time. Dispersing frogs showed a preference for mesic swales at one site but not at the other site. Xeric sand dunes with steep slopes were not a barrier to dispersal even during dry environmental conditions.

Pond-inhabiting frogs in this study generally did not move far from water and were found on land in only a small percentage of observations. The longest distance a frog was from water was 43 m, and most of land observations were within 5 m of water. Females were more likely than males to occupy upland habitats. Long-distance movements were more common for radio-tagged male than female frogs. Size of habitat use areas did not differ between males and females.

Interpond movements during the breeding season, use of upland areas, long-distance (> 5 m) movements away from aquatic sites, and peaks of metamorph dispersal were positively correlated with the occurrence of rainfall. Metamorphs began dispersing from breeding sites as much as 3 months prior to

the start of winter rains even when environmental conditions were dry. Metamorphs were uncommon in upland traps in late-winter/early-spring despite the occurrence of rainfall. The maximum and mean distances that frogs moved was not influenced by precipitation because frogs moved around within ponds irrespective of rainfall or season.

Aquatic sites with potential or known California red-legged frog habitat should be protected with buffer zones of at least 100 m from the high water line. There was no clear evidence for the use of dispersal corridors in this or other studies, therefore virtually all undeveloped areas could be dispersal habitat. Habitat restoration or enhancement efforts should strive to establish dense shoreline and emergent vegetation of various types, with some patches of open water, and dense cover by sedge, tall grasses, herbs, willows, shrubs and blackberry thickets to 100 m from the water's edge. The best sites should have several aquatic habitats less than 350 m apart of different depths and hydroperiods. More study is needed on juveniles during the stage following metamorph dispersal from ponds until they return to breed at 2 or 3 years of age.

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1.0 INTRODUCTION

A primary aspect of a species' natural history is how it interacts with its environment. Habitat use by animals can be due to active resource selection or passively persisting in certain habitats, but ultimately is a result of natural selection on survival and reproductive rates in various habitats (Southwood 1977). A species' dispersal characteristics determine the limits for which it can access suitable habitat patches. Understanding the habitat use and dispersal characteristics of threatened or endangered species is essential for the development of conservation planning strategies (Semlitsch 2002, Bulger et al. 2003).

The California red-legged frog (*Rana aurora draytonii*) is a federally threatened amphibian species that remains widespread in California's central coast (U.S. Fish and Wildlife Service 1996, 2002). It is usually found near permanent or semi-permanent freshwater habitats, but individuals are known to move into upland habitats following early-winter rainstorms (Stebbins 1966). Radio tracking studies have provided information on habitat use and breeding migration patterns (Rathbun et al. 1993, Bulger et al. 2003), however, it is difficult to generalize these data over a broad geographic range due to site-specific differences.

This document details California red-legged frog movement patterns and habitat use at two sites on Vandenberg Air Force Base (VAFB), Santa Barbara County, California. Radio tracking was used to study adult frogs at the Waterfowl Natural Resources Area. Juveniles and metamorphs (recently-metamorphosed frogs) are too small to carry the transmitters currently available, and drift fence/pitfall trap arrays were used to study their dispersal into upland areas at San Antonio Terrace. I investigated: 1) dispersal from aquatic sites and

interpond movements, 2) selection of upland and pond microhabitats, 3) characteristics of movements including distances traversed and home range size, and 4) how the timing of rainfall and seasonality affect frog movements.

1.1 Study Sites

1.1.1 Waterfowl Natural Resources Area

The “Waterfowl Ponds” are located 4 km east of the Pacific Ocean and 270 m north of the Santa Ynez River within the river’s floodplain (Figure 1). Of fifteen basins that were originally built as part of a wastewater treatment plant 4 were rehabilitated to provide waterfowl habitat (Figure 2; see McElligott 1989, Christopher 2000). Wells on the site usually produce sufficient water to maintain year-round standing water at Ponds 4 and 5. Pond 2 has had standing water persist for several months during winters with higher than normal rainfall, but in most years has shallow water lasting only a few weeks. Pond 1 usually maintains standing water throughout the year but is shallow in summer. Water levels drop quickly when the well pumps malfunction, as was the case during this study when Pond 4 dried down in the summer of 1997. Water levels at Pond 4 rose at least 20 cm during the 1997/1998 El Niño winter but increased only slightly at Pond 5. Maximum water depths were 1.4 m (1.6 during El Niño) at Pond 4 and 1.2 m at Pond 5. Water quality parameters measured at the Waterfowl Ponds were within normal ranges, although Pond 5 (also called 4805) tended to have low dissolved oxygen and Pond 4 (4804) had high turbidity levels (Christopher 2004).

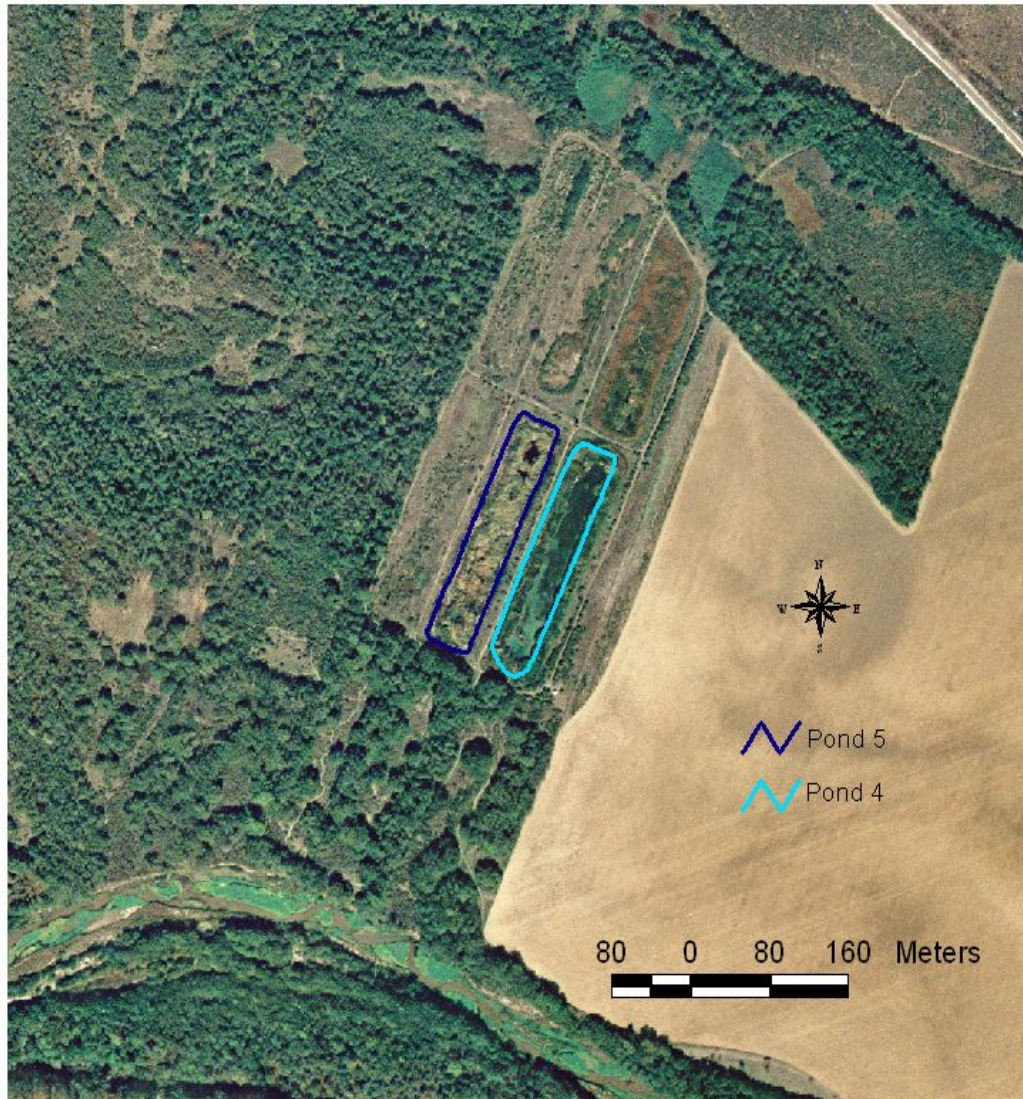


Figure 1. Overview of Waterfowl Ponds Natural Resources Area. Terra Road is in the northeast corner, and the Santa Ynez River is along the south edge.

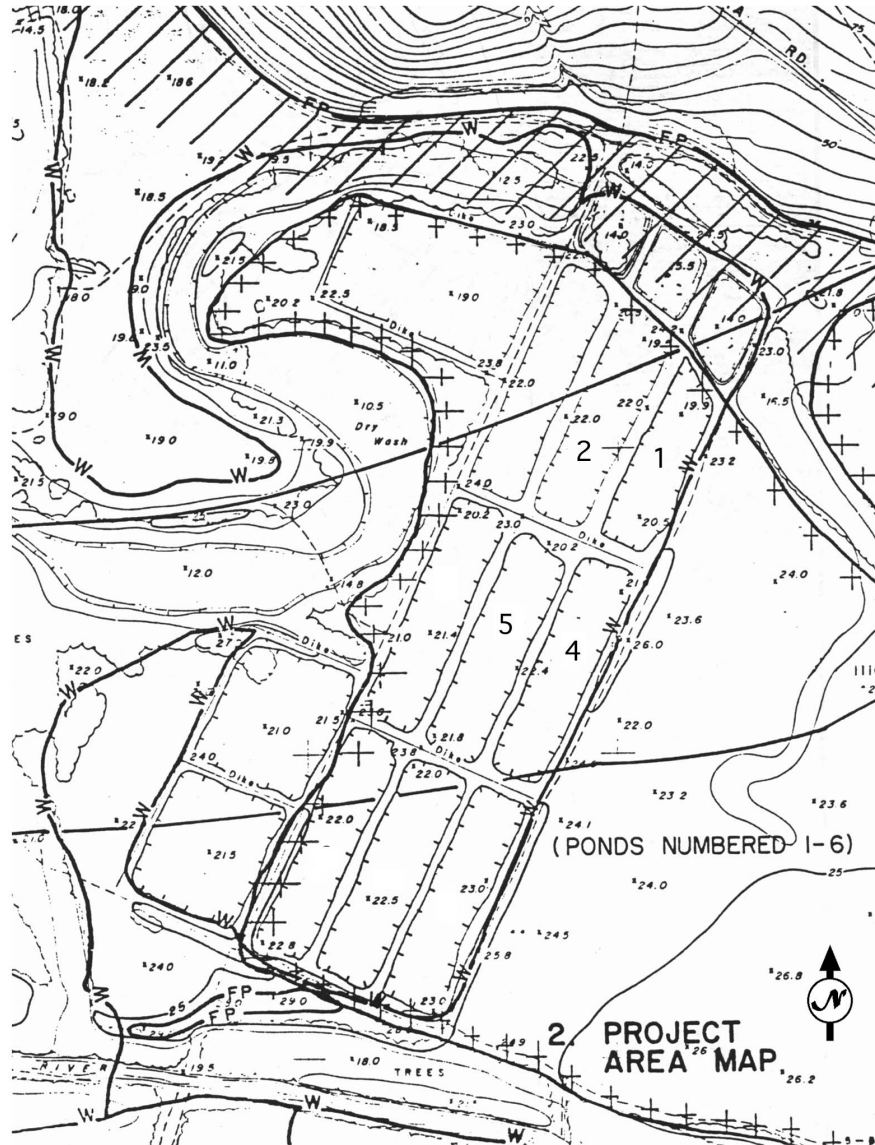


Figure 2. Site map of the Waterfowl Natural Resources Area ("Waterfowl Ponds") adapted from McElligott (1989). Frogs were captured from Ponds 4 and 5 (numbered above) for radio-tracking studies.

The Waterfowl Ponds are palustrine emergent wetlands (Ferren et al. 1996). Ponds 1 and 5 were mostly filled in by dense cattails (*Typha* sp.). In contrast, Pond 4 retained open water in the center and had a mosaic of stands of cattail, bulrush (*Scirpus* sp.), and sedge (*Carex* sp.) around its perimeter. Young willows (*Salix* sp.) were present around the upper margins of Ponds 2 and 5. The vegetation adjacent to the ponds was coyote brush (*Baccharus pilularis*), nettle (*Urtica* sp.), thistle (*Cirsium* sp.), California blackberry (*Rubus vitifolius*), grasses, and various herbaceous plants. Vegetation became increasingly more dense within and surrounding the ponds over the course of this study. Mowed trails surrounded the pond basins. Mature willows were present on three sides of the site, and apparently have naturally regenerated following the closure of the wastewater treatment plant. An agricultural field that is used for growing hay and cattle grazing is located to the east of the site (Figure 1). A drainage with mature willows is located between the Waterfowl Ponds and Terra Road, and held water approximately 1 m deep for several weeks during the 1997-1998 winter. Additional detail on the Waterfowl Ponds study site is given in Christopher (2000).

1.1.2 San Antonio Terrace

San Antonio Terrace is an area of stabilized dunes south of Shuman Creek and north of San Antonio Creek (Figure 3). The substrate is wind-deposited quartzitic marine sand, which is oriented in northwest to southeast dune ridges and intervening swales (U.S. Department of Agriculture 1972). Rising sea levels over geologic time have caused the landward migration of the San Antonio Terrace dune system and the formation of swales (Ferren et al. 1996). Dune swales are low areas between the ridges of dunes, and have surface water when

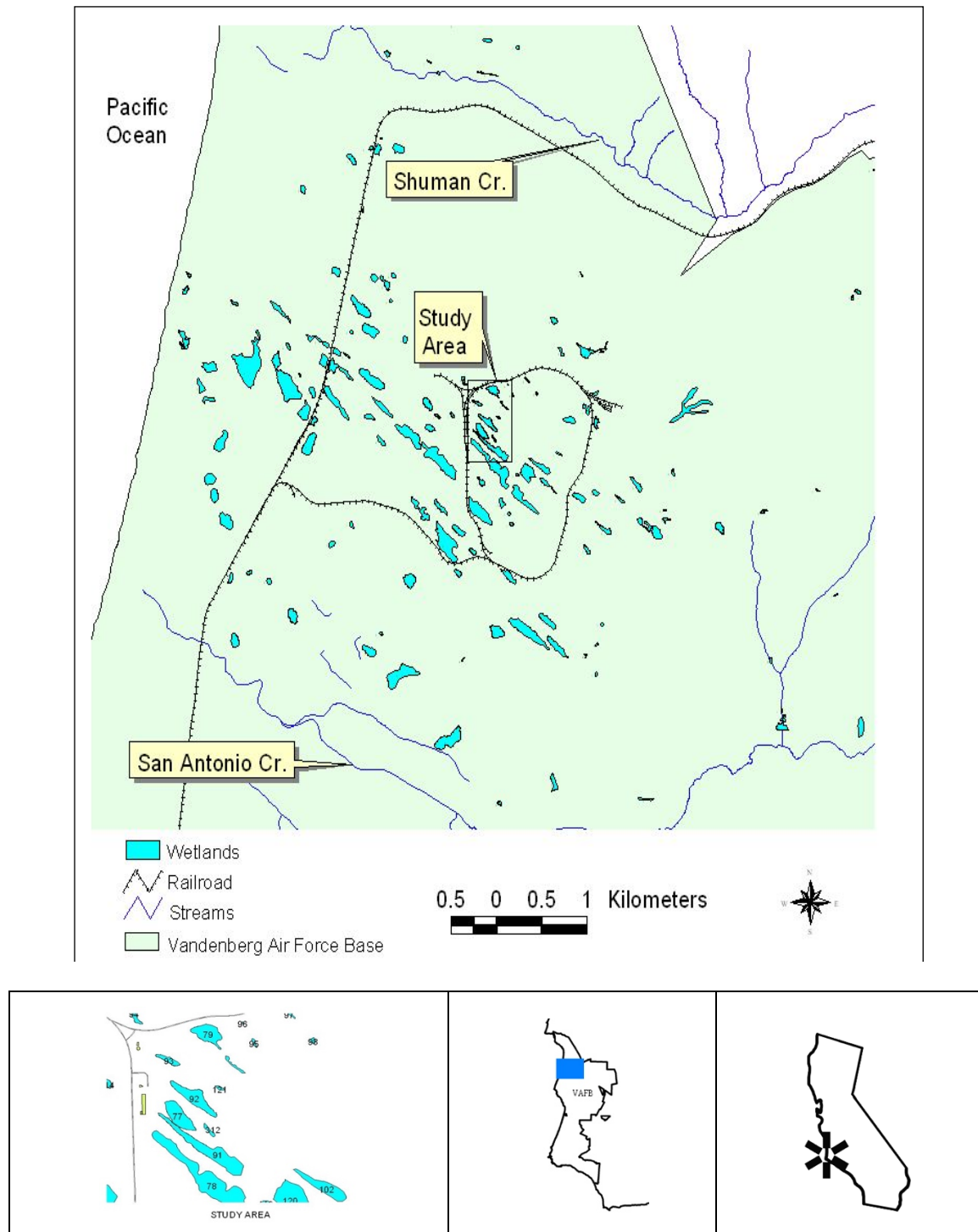


Figure 3. San Antonio Terrace lies between Shuman and San Antonio Creeks on Vandenberg Air Force Base (top). Pitfall trapping was conducted at sites 77 and 79, and mark-recapture studies were conducted at sites 77, 79, 91 and 92 (bottom left).

in contact with the water table (Ferren et al. 1996). Swales tend to have a higher percentage of organic matter in the soil than the dunes, and are vegetated by palustrine wetland plants and/or riparian woodland. The dune ridges are vegetated by coastal sage scrub and dune grass that stabilize the loose sand. A few areas are unvegetated and have active sand dunes.

The water source of the dune swale wetlands is groundwater overlaying the shale and mudstone of the Orcutt formation in the San Antonio Creek groundwater basin (Tetra Tech 1996). Ponds usually fill to annual maximum levels a few months following the cessation of winter rains (personal observation). After a few consecutive years with at least average rainfall there are many swales that hold water continuously throughout the year, but during droughts there are only a few wetlands with permanent water (Human 1990; Christopher, In Preparation). Overdraft of the San Antonio Creek groundwater basin apparently has lowered the water table and decreased the frequency of standing water in the wetlands (see Mallory 1980, Ferren et al. 1996).

1.2 California Red-legged Frog

1.2.1 General Description

The California red-legged frog (*Rana aurora draytonii*) is named for the reddish coloration on its abdomen and undersides of the hind legs (Storer 1925, Stebbins 1985). This species is one of North America's largest ranid frogs, and individuals can exceed 135 millimeters in body length (Wright and Wright 1949). The diet of adult California red-legged frogs includes fish, aquatic and terrestrial insects, tadpoles, and small frogs (Dickerson 1906, Sanders 1950, Hayes and Tennant 1985). The frogs become reproductively mature at 2 or 3 years of age

(Jennings and Hayes 1985, Scott and Rathbun 2001) and they can live up to 10 years (Jennings et al. 1992). Breeding occurs from November through April (Storer 1925, Wright and Wright 1949, Stebbins 1985, Hayes and Jennings 1986, Christopher 1996). Larvae metamorphose after 3.5 to 7 months (Dickerson 1906, Storer 1925, Jennings and Hayes 1989), but in some cases larvae may overwinter (Fellers et al. 2001).

1.2.2 Habitat Use

California red-legged frogs inhabit streams, springs, ponds, marshes, sloughs, lakes, and reservoirs (Storer 1925, Wright and Wright 1949, McKeown 1974, Stebbins 1985, U.S. Fish and Wildlife Service 2001). These sites generally retain water through mid-summer, have emergent and/or shoreline vegetation, and water depths of at least 70 cm (Storer 1925, Wright and Wright 1949, Hayes and Jennings 1989). Breeding habitat is characterized as the vegetated margins of ponds or stream pools (Dickerson 1906, Storer 1925, Wright and Wright 1949, Jennings et al. 1992). In winter, they have been observed to occupy upland areas in Santa Cruz and San Luis Obispo Counties for as long as 60 consecutive days (Rathbun et al. 1993, Bulger et al. 2003). While in upland habitats frogs spend most of their time sheltering under cover objects, vegetation, or in small mammal burrows (Rathbun et al. 1993, Jennings and Hayes 1994, U.S. Fish and Wildlife Service 2001, Scott and Rathbun 2001, Bulger et al. 2003). It is likely that the presence of dense cover and moisture are important elements of upland or riparian habitats used by California red-legged frogs while estivating or foraging (U.S. Fish and Wildlife Service 2002).

1.2.3 Movement Patterns and Dispersal

While characterized as a species that is closely tied to semi-permanent or permanent water, California red-legged frogs can venture far from water, with most overland movements occurring during rainstorms (Storer 1925, Stebbins 1985, Rathbun et al. 1993, Bulger et al. 2003). In Santa Cruz County, Bulger et al. (2003) documented migrations between breeding habitats and sites of summer residence that were as much as 2800 m apart. However, not all individuals underwent breeding migrations. Those that occupied suitable breeding habitats year-round did not migrate (Bulger et al. 2003). Other overland movements may occur when ponds dry in summer and frogs move to other sites that still containing water (Bulger et al. 2003). They may also move substantial distances along stream channel and riparian habitats (Jennings and Hayes 1989, Rathbun et al. 1993, Bulger et al. 2003). After metamorphosis the frogs disperse away from breeding sites and apparently occupy upland sites until returning to aquatic habitats to breed (U.S. Fish and Wildlife Service 2001).

The “healthiest” California red-legged frog populations have high exchange rates of individuals among various breeding habitats (U.S. Fish and Wildlife Service 2001). Since many species of pond-breeding amphibians undergo local extinctions due to episodic recruitment and wide variations in population size, emigration from other local populations is essential for recolonization (Pechmann et al. 1991, Semlitsch 2002). While past conservation efforts for the frog emphasized the aquatic habitats used for breeding, recent data suggest upland and dispersal habitats are also critical for the persistence of this species (U.S. Fish and Wildlife Service 2001). Dispersal and habitat use characteristics are likely to vary among sites based on climatic conditions and available habitat, necessitating study in many regions.

2.0 METHODS

2.1 Waterfowl Ponds

2.1.1 Habitat Mapping

Maps of Ponds 4 and 5 were prepared showing cover by vegetation type (cattails, bulrushes or tules, sedge, willows, grass, open water lacking emergent vegetation, short annuals (= various herbaceous plants), tall annuals (= nettle, thistle, blackberry), and shrubs) and water depth (to the nearest 0.1 m). Maps included the pond basins and upland habitat 3 to 18 m away from the water's edge. Maps were initially drawn using manual methods (see Christopher 2000; Note errata - grid subsections were 4 X 4 m, not 5 X 5 m), and then were imported into the VAFB Geographic Information System (GIS).

Maps were created three times (November 1996, April 1997, and August 1997) over the study period due to changes in vegetative cover. Water depths were taken in early December 1996, and were updated for Pond 4 when water levels rose following El Niño rainstorms. Water depth measurements taken along an imaginary grid (Christopher 2000) were used to create depth contours.

2.1.2 Frog Capture, Marking and Radio Attachment

California red-legged frogs were captured at night using high-intensity focused-beam lights (Wheat Cap Lamp, Koehler Manufacturing, Marlborough, Massachusetts). Frogs were caught mainly by hand while wading, and occasionally a dip net and/or float tube were used. An attempt was made to catch every frog that was observed, and frogs were released after processing

within 15 minutes at their points of capture. Each frog was sexed, weighed and measured as in Christopher (2000). Passive integrated transponder (PIT) tags (Destron Fearing Corporation, Boulder, Colorado) were used to give a unique mark to each frog (Camper and Dixon 1988, Heyer et al. 1994). All frogs that were marked with a PIT tag also received a toe clip (Rathbun et al. 1993), and the toe tips were donated to Dr. H. Bradley Shaffer (University of California, Davis). Only frogs ≥ 73 mm snout-urostyle length (SUL) and > 30 g were used for radio tracking. An attempt was made to have 6 to 10 frogs carrying transmitters at any given time, with roughly equal numbers of males/females and those caught from Pond 4/Pond 5. Otherwise frogs were chosen haphazardly as radio tracking subjects, and the remainder was studied as detailed in Christopher (2000).

I used Holohil (Woodlawn, Ontario, Canada) model BD-2G transmitters (1.65 - 1.80 g). Radio transmitters were attached to frogs following Rathbun and Murphey (1996). Each transmitter unit including radio, battery, antenna, epoxy, and bead-chain belt weighed about 2.0 g. The receiver was a Wildlife Materials, Inc. (Carbondale, Illinois) Model TRX-1000S with a 2 element directional antenna (Telonics, Mesa, Arizona). Transmitter batteries were estimated to last 20 weeks but they often failed prematurely. Frogs were recaptured to replace transmitters when batteries neared their expected life or when they emitted an abnormal signal indicating premature failure. New frogs were captured and radio-tagged when belts were shed or faulty transmitters failed abruptly.

2.1.3 Tracking Schedule and Data Collection

The tracking period was 23 November 1996 to 9 March 1998, excluding 1 June 1997 to 20 July 1997 when no frogs with transmitters were deployed. Each tagged frog was located during daylight every 1 to 3 days. Tagged frogs were

also located at night while catching frogs to replace transmitters. To understand daily movement patterns, 7 frogs were located 5 times over a 24 hour period (approximately 10 AM, 3 PM, 8 PM, and 11 PM on 8 March 1997 and 10 AM on 9 March 1997).

The observer walked around the pond basins or waded into the water and triangulated signal strength to obtain frog locations. Based on sightings of the tagged frogs, this technique was accurate 0 to 8 m of the actual frog locations; deep water or dense vegetation tended to decrease accuracy. Pond maps with Mylar overlays were used to record frog locations in the field. Frog location data were transferred to the GIS by hand digitizing. Imprecise locations were recorded on field maps as an ellipse, and entered into the GIS as a point at the center of that ellipse. Rainfall and minimum/maximum air temperatures between tracking intervals were recorded from on-site instruments.

A total of 14 females (74 - 128 mm SUL) and 12 males (73 - 112 mm SUL) were tracked throughout the study. Contact was lost with 1 female and 1 male prior to obtaining 5 tracking observations due to failed transmitters, and these frogs were omitted from the analyses. There were 10 females and 8 males with > 20 tracking observations, and the mean number of observations per individual was 43.1 (median 41). The longest continuous length of time individuals were tracked was 6 - 7 months. The total number of tracking observations for all frogs was 1043.

2.1.4 Analyses

2.1.4.1 Short-term Distances

Distances (in m) between consecutive observation point centroids were calculated using the ArcView GIS (Version 3.2a, Environmental Systems Research Institute, Inc., Redlands, California) extension Path With Distances and Bearings (Version 3.1, Jenness Enterprises, Flagstaff, Arizona). Only data from observations separated by 1 – 3 days were used. Analyses addressed the questions: 1) Do males and females differ in the distances they move? 2) What are the maximum distances frogs moved between consecutive observations? 3) What is the influence of seasonality (breeding season and winter rainy periods) on frog movements?

2.1.4.2 Habitat Use Areas & Movement Characteristics

I calculated habitat use areas for individuals using the Modified Minimum Convex Polygon (MMCP) method, which is an estimate of the areas occupied by individuals (Harvey and Barbour 1965). Minimum convex polygons were calculated for each frog using the ArcView 3.2 extension Compiled Themes Tools (Mike DeLaune and Brian J. Torreano) with the Point 2 Polygon and Graphic 2 Shape commands. This gave a perimeter line connecting a frog's outer tracking observation points and created a polygon encompassing all of its points. When a frog's observations were clumped and the clumps were highly fragmented, MMCPs were used (Harvey and Barbour 1965). The habitat use area for each frog was computed by converting the polygons to shapefiles, and polygon area was calculated with an Add Area script (Jeff LeNay). The aim of this analysis

was to determine the home range sizes of individuals, but since individuals apparently were not tracked long enough to calculate actual home ranges (see Results), these values are referred to as areas used and should be viewed in context of the length of time frogs were tracked. Habitat use areas were compared between males and females. Movement patterns were estimated by straight lines connecting consecutive tracking observation points as detailed in Section 2.1.4.1.

2.1.4.3 Microhabitat Use

Habitat use was compared with availability to evaluate selection for particular habitat features. Habitat availability was determined from the GIS map data, and included both aquatic habitats and the terrestrial areas surrounding the ponds as described in Section 2.1.1. The area occupied by each vegetation type and each water depth class was calculated using an Add Area script (Jeff LeNay) from the pond coverages. It was assumed that the area available to each frog was the entire pond that the individual was in (or was nearest to, if it was on land), since individuals could move the length of a pond within 1 – 3 days. While some individuals moved between ponds within that length of time, adjacent ponds were not considered as available habitat until frogs actually moved into a different pond because interpond movements appeared to be restricted to certain conditions (breeding season or decline in water level).

Habitat use was determined by frog radio tracking observations. Observations that were separated by less than 24 hours were excluded because they could not be considered to be independent. Observations from frogs that moved outside of the mapped area were excluded from the vegetation analysis,

and those that moved out of the water were excluded from the water depth analysis (but are discussed in the use of upland habitats). Individuals were used as the sampling unit, and an individual's habitat use was estimated by the proportion of observations in each habitat (Kenward 1992, Aebischer et al. 1993).

Habitat use versus availability was analyzed for vegetation types (willows, grass, open water, cattails, sedge, short annuals, tall annuals, tules, shrub) and water depth classes (in 0.2 m increments, with 0 = 0.01 to 0.19 m, 0.2 = 0.2 to 0.39 m, 0.4 = 0.4 to 0.59 m ... 1.0 = 1.0 to 1.19, and ≥ 1.2). Because the proportions of an individual's habitat use or those available are non-independent, proportions were log-ratio transformed (Aebischer et al. 1993). The proportions for grass and 1.0 water depth were used as the denominators in the transformed used (y) and available (y_o) habitat compositions. Values of 0.001 were substituted for 0 values of y (Aebischer et al. 1993). In addition, water depth values ≥ 1.2 were merged to reduce or eliminate 0 values (Aebischer et al. 1993). Because there was no difference in habitat use proportions between males and females (multivariate analysis of variance; vegetation: $P = 0.89$, water depth: $P = 0.64$), data for males and females were pooled. The method used to determine whether frogs consistently used some habitats more (or less) than the availability of that habitat was a variation of the Friedman (1937) test, which describes the behavior of most of the animals (Alldredge and Ratti 1992) using the differences $d = y - y_o$.

Available habitat changed over time as the ponds filled in with vegetation and the water depth fluctuated in response to high rainfall or pump failure. Habitat use and availability data were divided into time periods representing different conditions (vegetation - Pond 4 : 23 November 1996 to 27 February 1997, 1 March to 26 July 1997, 1 September 1997 to 5 March 1998; Pond 5: 23 November 1996 to 29 January 1997, 31 January 1997 to 8 June 1997, 20 July 1997

to 9 March 1998; water depth – Pond 4: normal levels 23 November 1996 to 10 March 1997, 28 April 1997 to 26 July 1997, 27 September 1997 to 5 March 1998; high water 13 March 1997 to 26 April 1997; Pond 5: 23 November 1996 – 9 March 1998). When an individual had observations across time periods with different conditions, d was calculated for each period, weighted for the percent of observations in each period, and combined to give one value for d for each individual in both the vegetation and water depth analyses.

I performed a nonparametric analysis of variance by ranks (Kruskal-Wallis) on the values for d with the number of treatments k = the number of habitat classes – 1 (because one is lost after transformation). The null hypothesis was that the ranks of the differences in use and availability were the same for all habitats. If the test statistic was significant ($\alpha \leq 0.05$) Fisher's least significant difference pairwise multiple comparisons were used to determine which habitats differed significantly in use versus availability (Alldredge and Ratti 1992). Values showing a greater disparity between use and availability indicate stronger choice or avoidance of those habitats. All statistical analyses were performed using Systat (version 5.2.1, Evanston, Illinois).

2.2 San Antonio Terrace

2.2.1 Drift Fence/Pitfall Traps

I installed drift fence/pitfall trap arrays (Figure 4) in upland habitats around two ponds at VAFB to examine California red-legged frog dispersal from breeding habitats. Emigrating frogs would run into the drift fence, and then travel along the fence until falling into one of the pitfall traps at the end of the fence (personal observation; see Figure 4). In accordance with federal permit

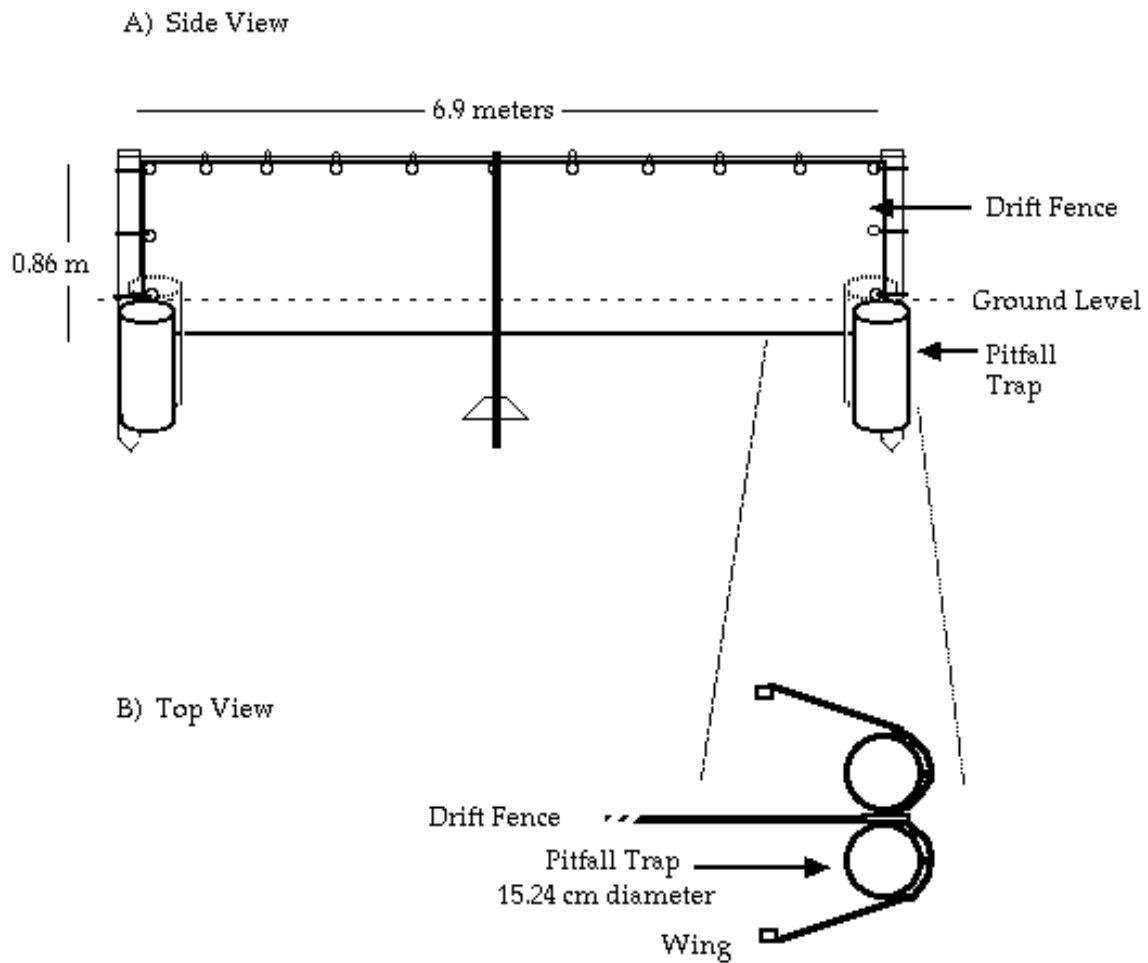


Figure 4. Drift fence/pitfall trap design used to sample California red-legged frog dispersal away from ponds showing A) side view of one array, consisting of 4 traps (wings not shown), and B) top view of 2 pitfall traps, with wings that direct frogs into the traps.

restrictions, pitfall traps were designed so that raccoons could not reach trapped frogs (diameter 15.24 cm, depth 61 cm). As a consequence of this modification, the traps may have been more effective at capturing metamorphs than adult frogs.

Drift fences were installed parallel to the perimeters of Ponds 77 and 79, and were 4.5 – 18.5 m from the water's edge (Figure 5). Array sites were chosen based on where vegetation would not need to be removed for array installation. Ponds could not be completely encircled by drift fences due to incidental capture and movement restriction of other animals, consequently, pitfall trapping sampled 12% (Pond 77) and 9% (Pond 79) of the upland perimeter through which frogs could have traveled while emigrating from the ponds. Water levels rose in summer 1998 resulting in the submergence of 3 arrays at Pond 79 and 1 at Pond 77. These arrays were reinstalled approximately 7 – 10 m from the water's edge prior to summer 1998 sampling.

Trapping was conducted during winter 1997/1998 and summer/fall 1998. For each trapping session, lids were removed from the traps at dusk and the traps were checked between 0800 and 1100 hours the following morning. Each trap received a damp sponge to prevent desiccation of amphibians and a wad of polyester fiberfill for insulation of small mammals. Lids were replaced after each trap was checked. Rainfall amounts during the time the traps were open were recorded on site. Sampling was conducted 2 - 3 times a week. Sampling nights were selected haphazardly, but sampling was attempted on each night that precipitation was predicted.

Swales tend to have more mesic conditions and higher densities of vegetation than the surrounding dunes. If frogs use corridors for dispersal, swales are expected to be suitable corridors due to their vegetative and moisture characteristics. One of the 9 drift fences at Pond 77 was constructed across the



Figure 5. Pitfall trap arrays in upland areas adjacent to two ponds on San Antonio Terrace. The arrays with the highest capture rates for California red-legged frogs are shown with call-out boxes.

bottom of a swale, as were 2 of the 7 at Pond 79. To evaluate whether frogs showed a preference for swales, capture rates in swales were compared with expected values based on the null hypothesis that within a pond each array had an equal probability of capture regardless of location.

Frogs were weighed, measured, and sexed (if mature). Metamorphs (≤ 65 mm SUL) were given a toe clip representing the pond nearest to that in which they were captured, and frogs > 65 mm SUL were given individual marks using PIT tags. After processing, frogs were returned to the water nearest the trap in which they were captured. Other vertebrates caught in the traps were recorded and released near the traps. Moribund small mammals were donated to the Museum of Systematics and Ecology and museum staff provided assistance in their identification, which was useful in identifying live small mammals in the field.

2.2.2 Pond Surveys

Frogs were hand-captured and marked during night surveys of Ponds 77, 79, 91 and 92 (Figure 3, bottom left), and from Enceladus and New North Roads during rainstorm night driving. Adult and juvenile frogs were marked with PIT tags, and metamorphs were batch toe-clipped indicating the pond in which they were captured as for those caught in the pitfall traps. Total numbers of frogs observed during the pond surveys were recorded. Thirty-five pond surveys were conducted 6 July 1997 – 25 November 1997 (Ponds 77, 79) and 18 July 1998 – 2 October 1998 (Ponds 77, 79, 91, 92) concurrent to pitfall trapping. Rain driving surveys were conducted on 7 nights in winter 1997/1998 (5 December, 9 January, 1 February, 2 February, 10 February, 5 March, 31 March), and there was one incidental road capture on 4 August 1998.

3.0 RESULTS

3.1 Radio Tracking

3.1.1 Short-term Distances

Male frogs moved greater distances than females, and the longest distances were during the winter/breeding season. The mean distances moved for males ($N = 11$) was significantly greater than those for females ($N = 13$) (two-tailed independent t - test, $P = 0.05$). A few males moved at least 200 m within 3 days during the winter/breeding season. For example, Male 41035C725D had originally been tagged in Pond 5, and he moved to Pond 2 around 5 - 8 December 1997 and remained there for 1.5 months. Between 23 and 26 January 1998 he moved at least 209.3 m returning to Pond 5 (see Figure 6). The next longest distance recorded was 201.0 m (Male 4103545958; 27 - 29 January 1997), and occurred when the frog moved from the southern edge of Pond 4 to the northern part of the pond. This frog stayed in the vicinity of its new location for at least 3 weeks. These two maximum distances were recorded during intervals without precipitation.

Distance values were not affected by the occurrence of precipitation. For individuals that had > 5 distance observations in both the rain (8 December 1996 - 3 March 1997, 8 November 1997 - 9 March 1998) and the non-rain season (23 November 1996 - 8 December 1996, 3 March 1997 - 8 November 1997), there was no significant difference in the mean distances moved between the seasons for females ($N = 9$, Paired sample t - test, $P = 0.6$) or males ($N = 4$, Paired sample t - test, $P = 0.5$). Within the rain season, distance values for were not different between observation intervals in which rain fell versus when it did not for



Figure 6. Movements of frog 41035C725D, a male during breeding season, at the Waterfowl Ponds. Pond 5 is on the bottom left, and Pond 2 is shown by aerial photography taken in the summer on the top middle. Straight lines connecting consecutive tracking observation points (circles) were used to estimate movement patterns.

females ($N = 9$, ANOVA with individual frogs as covariate; $F = 2.3$, $P = 0.15$) or males ($N = 8$, ANOVA with individual frogs as covariate; $F = 0.1$, $P = 0.7$).

3.1.2 Habitat Use Areas & Movement Characteristics

Habitat use areas of radio-tagged California red-legged frogs were significantly influenced by the number of tracking observations (simple regression, $t = 12.26$, $P = 0.005$) and did not reach an asymptote (Figure 7). Therefore individuals were probably not tracked long enough to determine their actual home range sizes. Nevertheless, frogs were found to use areas up to 11,968 m² over approximately 7 months (70 observations) while moving between ponds and occupying upland habitats (Figure 8). The frog with the largest area used, Female 4103637A48, frequently moved back and forth across the pond (Figure 9). Female 410357350D remained in particular areas of Pond 5 for several weeks and then moved to different locations throughout the pond (Figure 10), resulting in a habitat use area of 5385 m² over 6 months. Other frogs remained in one end of a pond throughout the entire time they were tracked, such as Female 4103600457 who used only 1773 m² over a period of 7 months (Figure 11) and Female 41036E6A79 who used only 1020 m² despite a large number of observations ($N = 79$) (Figure 12).

Frogs remained in one place in ponds, without any detectable movement between observations, for periods up to 6 days. These stationary periods were recorded during the fall and winter (27 September to 21 February) but not during other times of year. A similar number of males and females underwent stationary periods. Stationary periods did not appear to be correlated with the presence or absence of rainfall. Frogs were within cattail stands in 6 of 7 observed stationary periods.

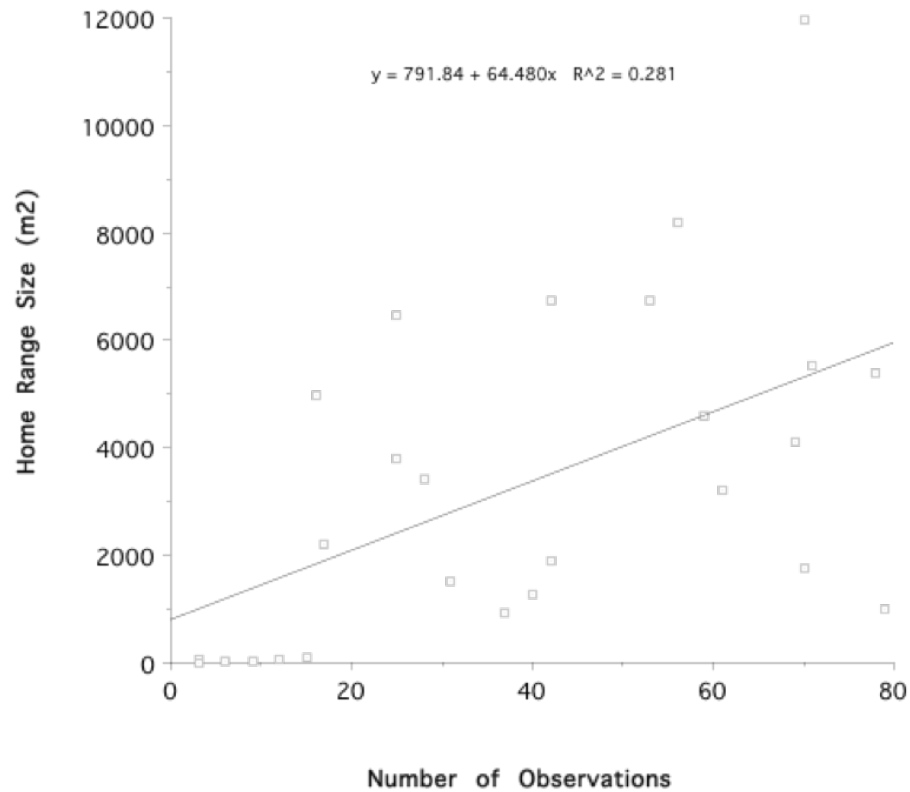


Figure 7. Home range sizes (habitat use areas) of radio tagged California red-legged frogs in relation to the the number of tracking observations per individual.

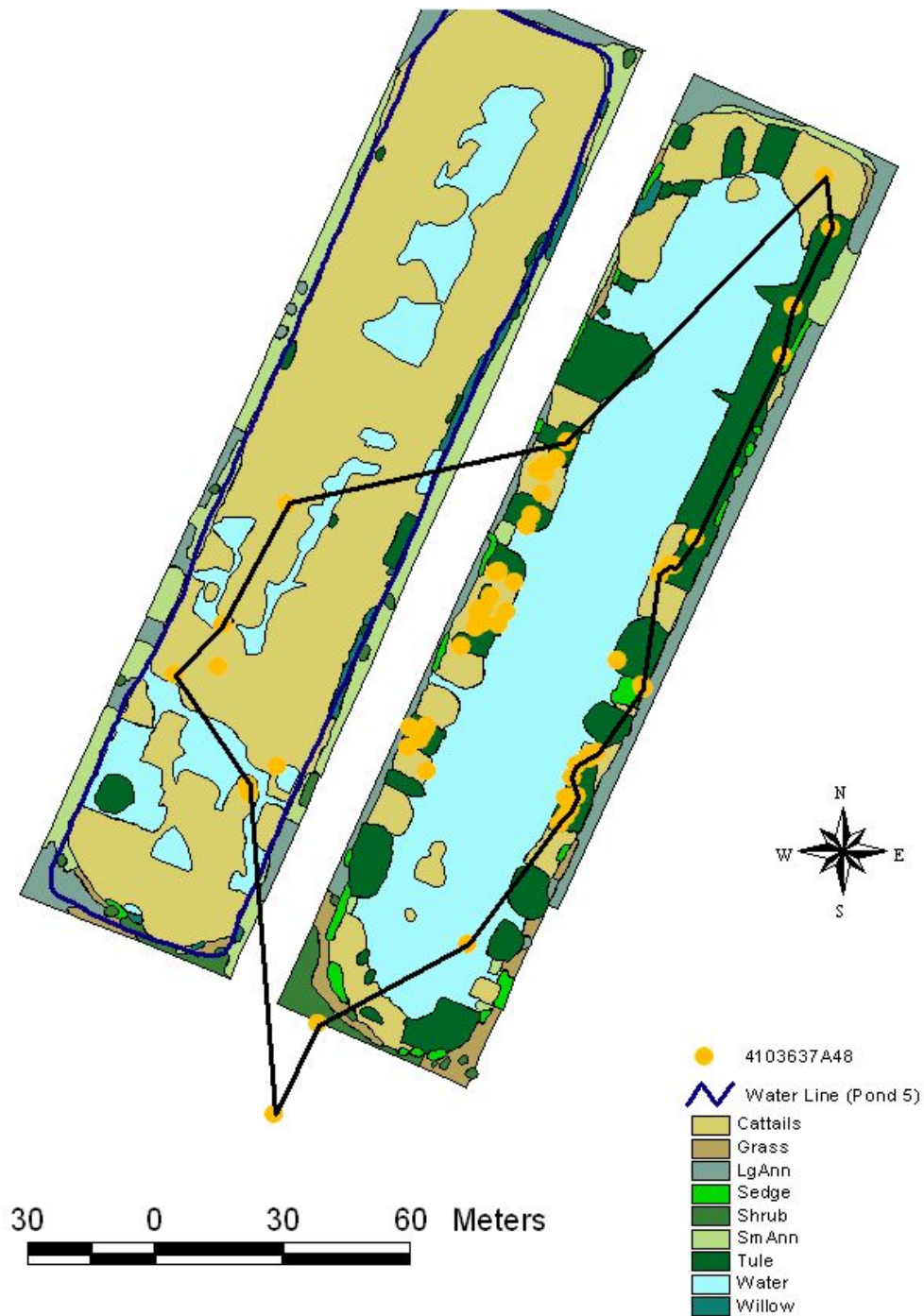


Figure 8. Female frog 4103637A48 showing 70 tracking observation points (circles) and minimum convex polygon of habitat use area.

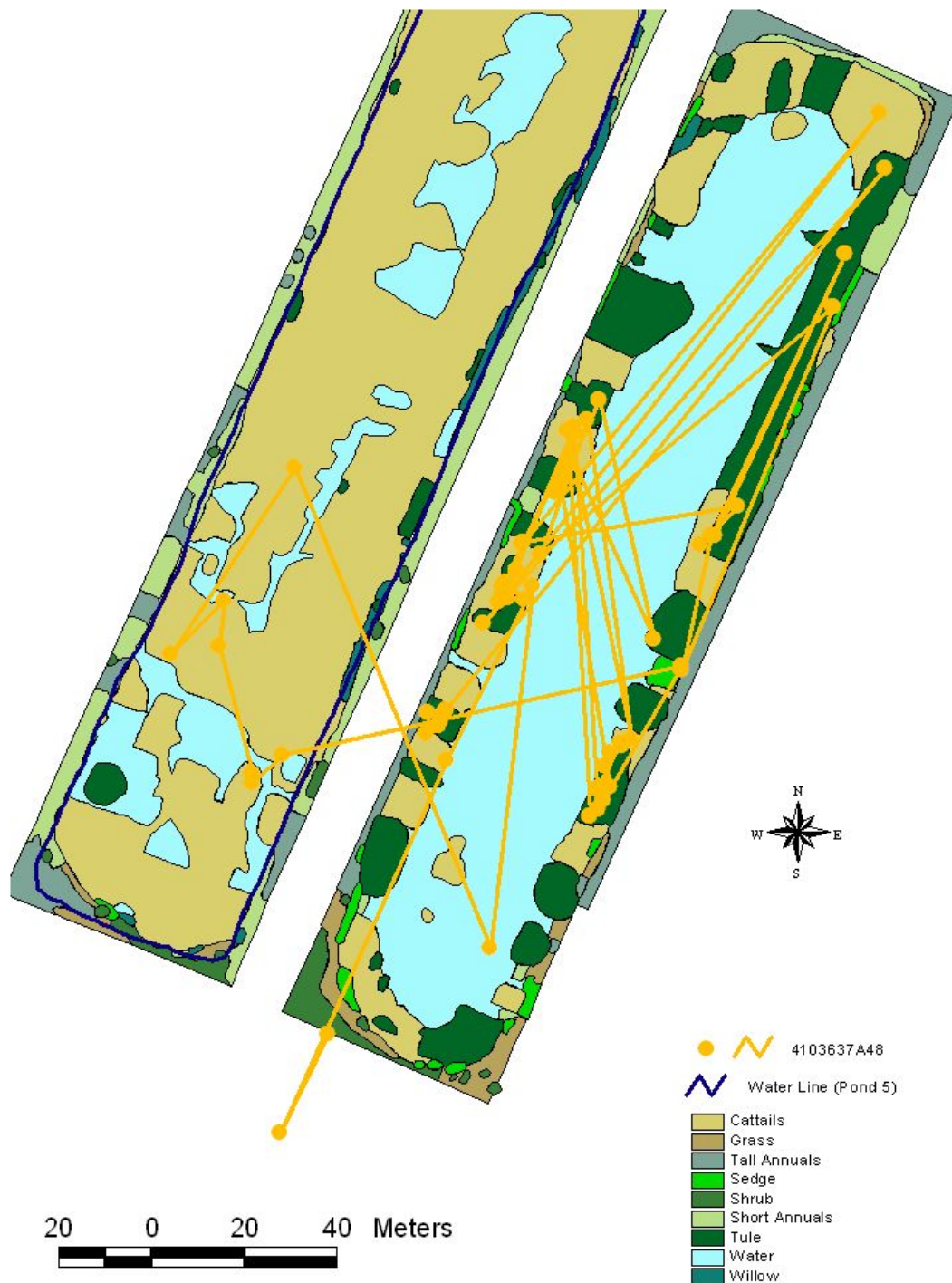


Figure 9. Female frog 4103637A48 movement patterns, estimated by straight lines connecting consecutive tracking observation points (circles). Movement from Pond 4 (right) to upland habitats, and then to Pond 5 (left) occurred when Pond 4 dried down in summer due to pump failure.

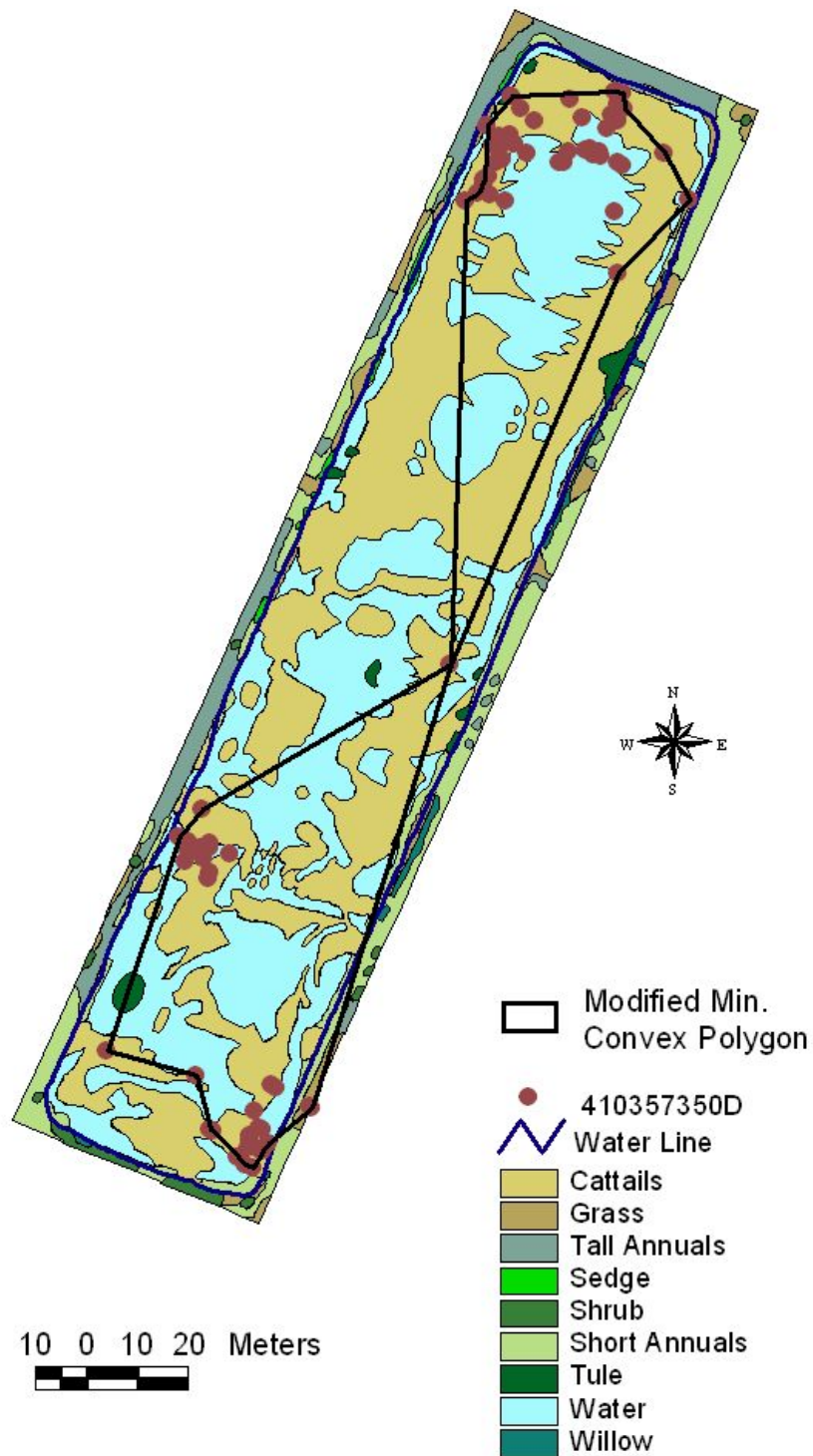


Figure 10. Female frog 410357350D in Waterfowl Pond 5 from 23 November 1996 through 22 May 1997. Tracking observation points are shown as circles, and the dark line shows the Modified Minimum Convex Polygon for this frog's habitat use area.

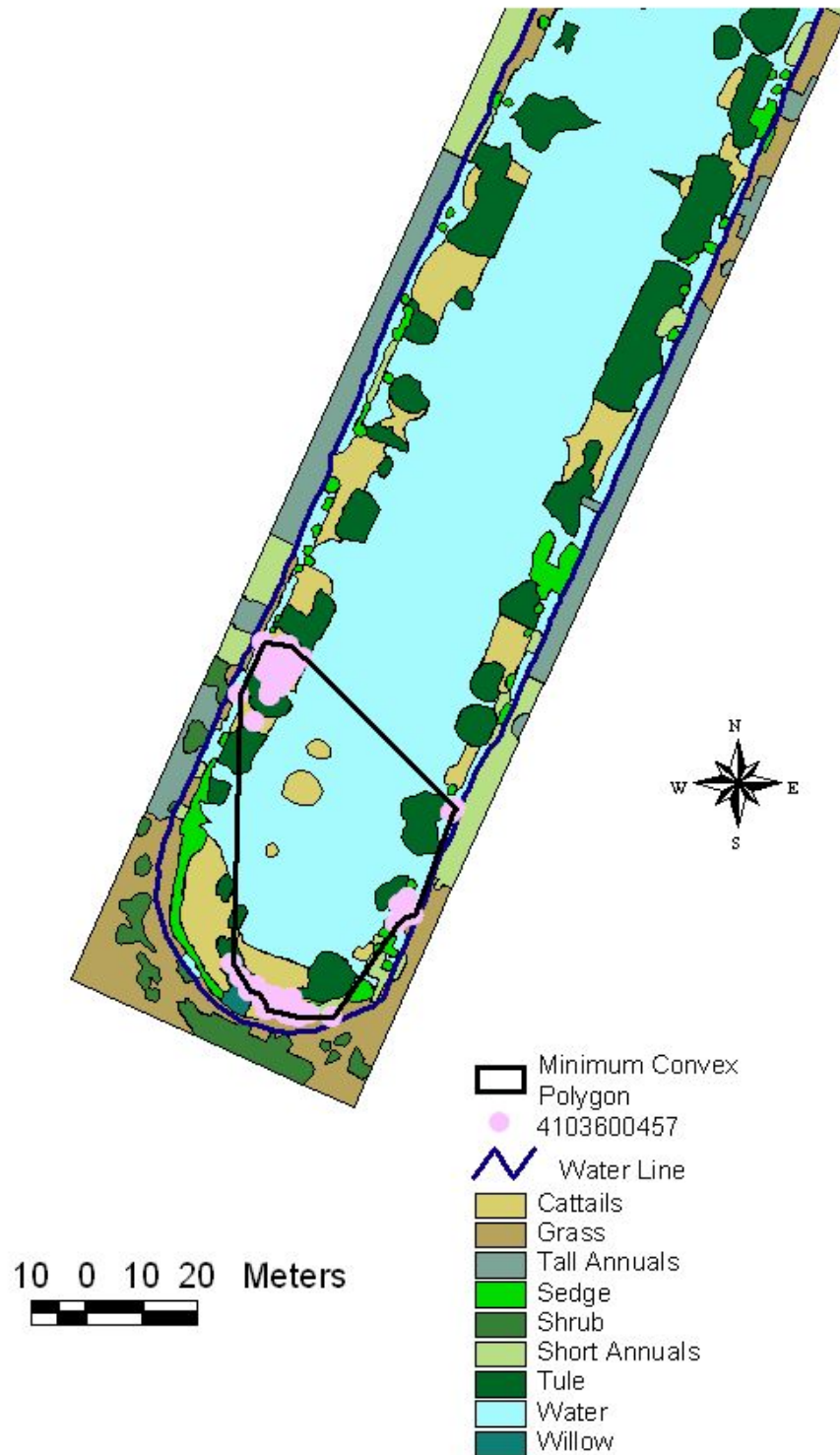


Figure 11. Female frog 4103600457 in Waterfowl Pond 4 from 14 December 1996 through 4 June 1997. Tracking observation points are shown as circles, and the dark line shows the Minimum Convex Polygon for this frog's habitat use area.

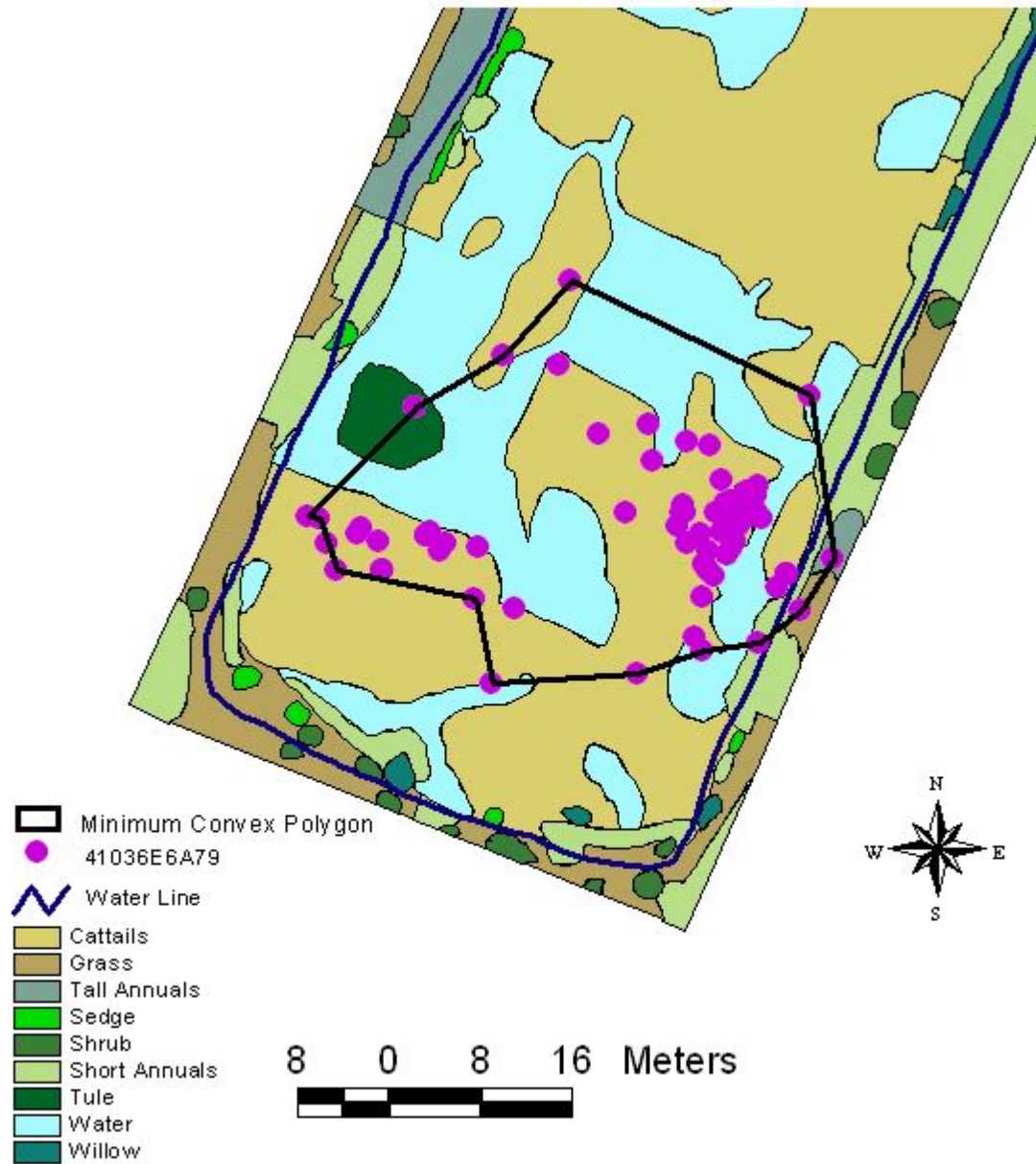


Figure 12. Female frog 41036E6A79 in Waterfowl Pond 5 from 2 December 1996 through 8 June 1997. Tracking observation points are shown as circles, and the dark line shows the Minimum Convex Polygon for this frog's habitat use area.

For frogs with > 15 tracking observations, habitat use areas did not differ between males ($N = 10$) and females ($N = 10$) (Independent t - test, $P = 0.6$). The longest straight-line distances between two points over a frog's entire tracking period were for male frogs that were tracked during the winter/breeding season (Male 4103620D55 - 366.9 m; Male 4103536F74 - 359.2 m).

3.1.3 Microhabitat Use

3.1.3.1 Upland Habitats

Only 34 of 1043 (3%) tracking observations were of frogs on land. Twenty-nine of these observations were females, and 5 were males. Thirty-two of the 34 observations were during the winter or early spring (10 December 1996 to 24 March 1997 and 11 November 1997 to 14 February 1998) and 2 observations were following the drying of the frog's resident pond before it moved to an adjacent pond (29 July 1997, 1 August 1997). Twenty-two of the 34 land observations (65%) were during or within 1 day of rainstorms. The types of vegetation used for cover while on land were: mature willows (32%), tall annuals (24%), grass (21%), short annuals (15%), sedge (6%), and shrubs (3%).

The longest distance between water and a frog on land was 43 m, and occurred on 8 December 1997 by Female 410E1C6D3B. This frog resided on land (>10 m from water) continuously from 26 November to 17 December 1997 (+/- 2 days) during first substantial storm of the year, and this was the longest length of time spent on land for any frog. This individual went on land 4 times during that winter and went into the same area of mature willows 3 of these times (Figure 13). At least 3 of the times the frog went on land were during storms (rainfall data were missing for the 4th time). This was the only frog that made

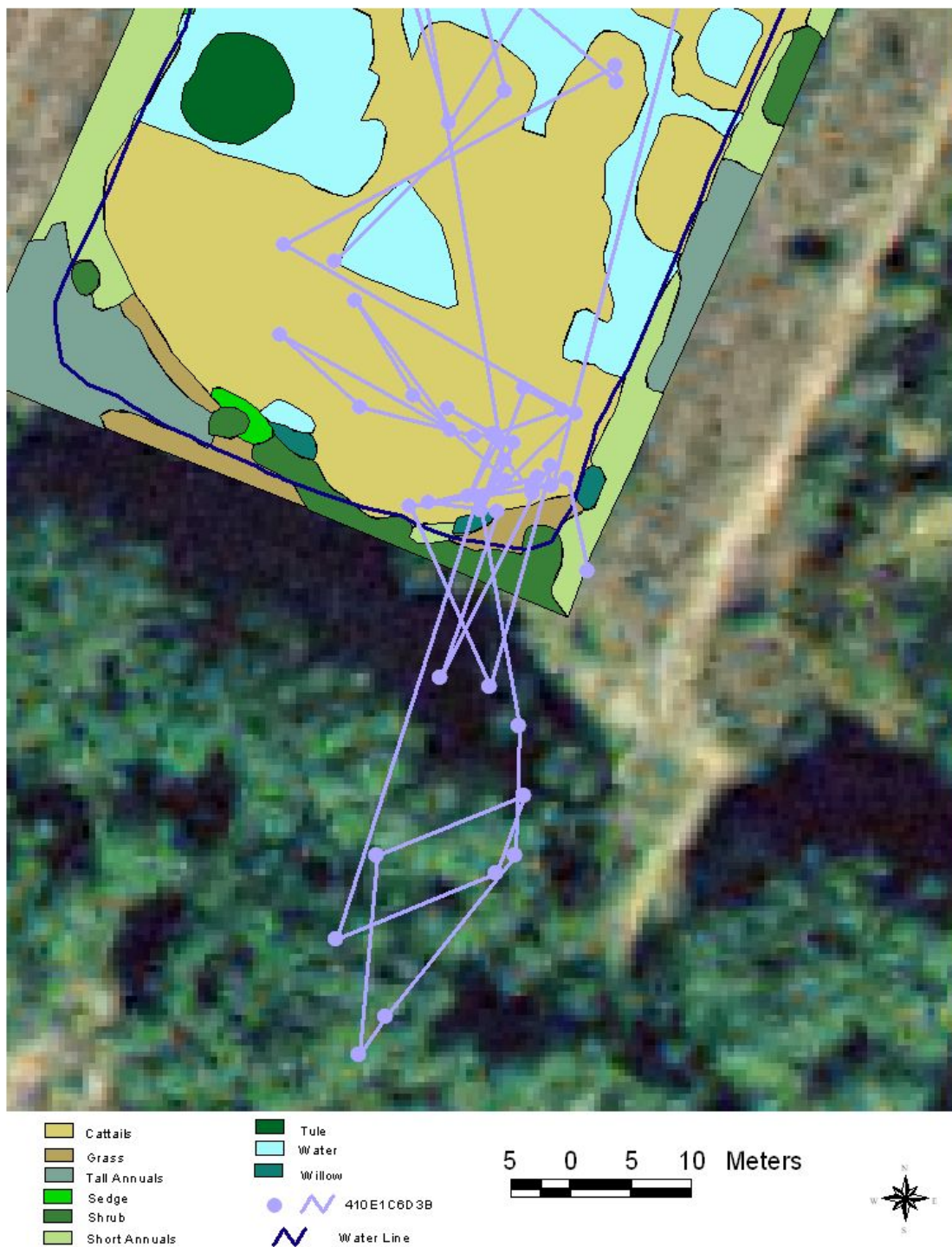


Figure 13. Female frog 410E1C6D3B in winter 1997/1998 at Waterfowl Pond 5. The dark green in the aerial photography is mature willows. Straight lines connecting consecutive tracking observation points (circles) were used to estimate movement patterns.

extensive use of upland habitats. Sixty-five percent of land observations were within 5 meters of the water.

3.1.3.2 Pond and Pond-side Habitats

Vegetation microhabitats differed significantly in the degree of selection by frogs (Kruskal-Wallis, $P = 0.0000$, $df = 7$). The cattail category was significantly different from each of the other vegetation types (Fisher least squares difference, $P < 0.01$), indicating that the strongest degree of selection for any microhabitat type was for cattails. Open water was significantly different from all other aquatic habitat types (Fisher least squares difference, $P < 0.01$), indicating strong selection against open water. The order of selection was cattails > tules > sedge > short annuals > grass > open water > tall annuals. Frogs did not use young willows or shrubs while in areas adjacent to the ponds (Table 1). They used mature willows and shrubs while outside the mapped area as described in Section 3.1.3.1, but since this analysis involved calculating available habitat those observations were omitted here.

Water depth microhabitats differed significantly in the degree of selection by frogs (Kruskal-Wallis, $P = 0.0000$, $df = 5$). Use of water depth classes 0, 0.2, 0.4, 0.6, and 0.8 m was the same, and was significantly different from ≥ 1.2 m (Fisher least squares difference, $P < 0.01$). Frogs selected against deep water, but showed no significant preference among the shallower areas. The order of selection was $0.4 > 0.2 > 0 > 0.6 > 0.8 > 1.0 > \geq 1.2$ m deep.

The distribution of tracking observation points was more evenly spaced across water depth contours at Pond 5 than at Pond 4 (Figure 14). It is likely that this pattern was a result of selection for vegetation rather than water depth

Table 1. Vegetation microhabitat use versus availability by frogs in pond and pond-side areas at the Waterfowl Ponds Natural Resource Area, Vandenberg Air Force Base, California. Use values are percent of observations (total 966) averaged across 23 radio-tagged individuals and availability values are percent cover of pond sites (Ponds 4 and 5) over time intervals (W = winter, S = spring/early summer, F = fall).

	Cattail	Tule	Open	Sedge	Grass	Short Annual	Tall Annual	Shrub	Willow
Used	71	14	2	4	2	2	1	0	0
Available									
4 - W 96/97	8	10	63	2	5	7	4	1	0
4 - S 97	11	13	55	3	9	6	0	2	0
4 - FW97/98	16	20	48	2	3	2	7	2	0
5 - W 96/97	43	1	36	0	3	10	5	1	1
5 - S 97	55	1	23	1	4	10	6	1	1
5 - FW97/98	65	1	15	0	1	10	5	1	2

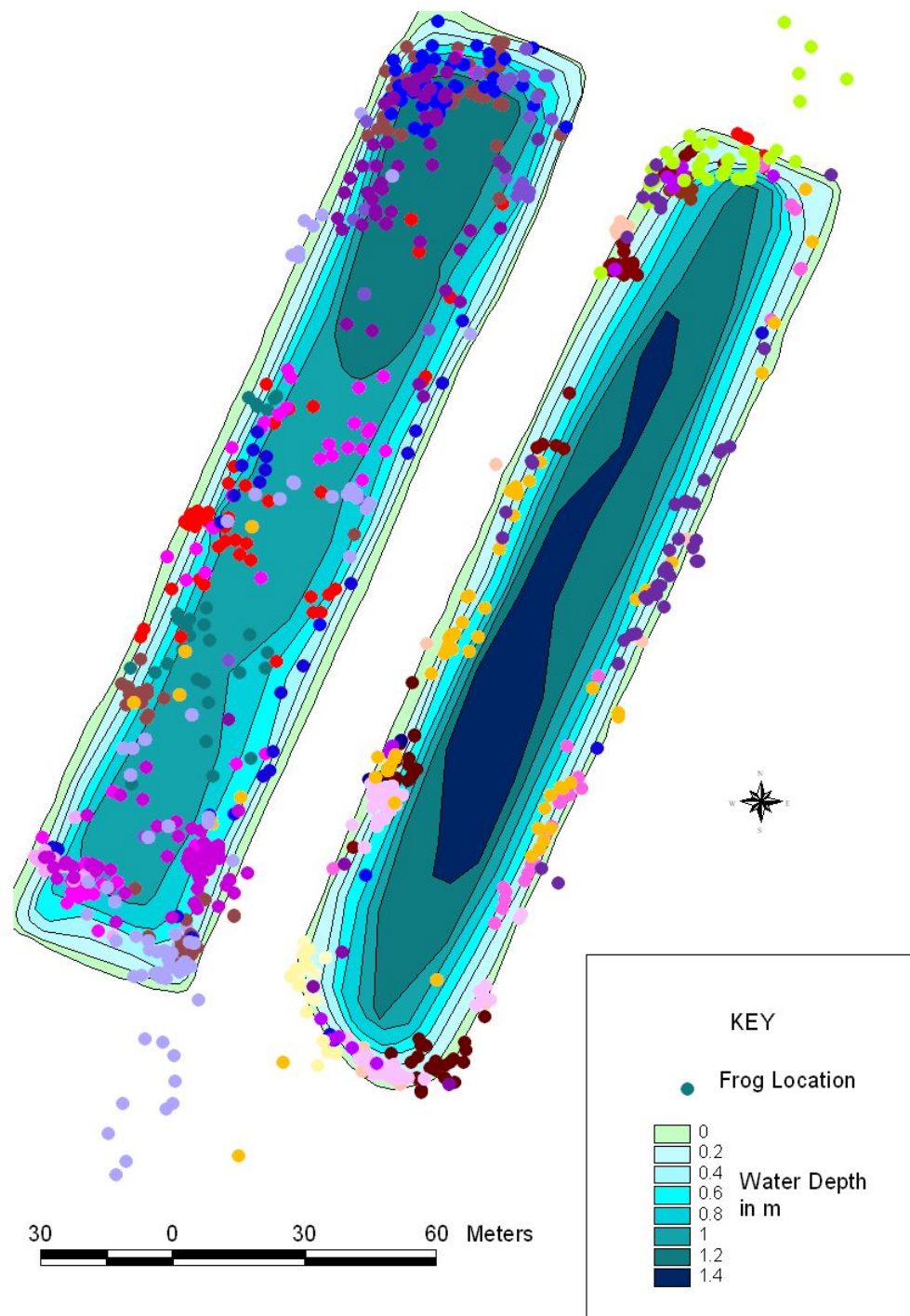


Figure 14. Distribution of all frog tracking locations across water depth contours at Ponds 4 (right) and 5 (left) at the Waterfowl Ponds.

because frog locations closely matched the extent of emergent vegetation (Figure 15).

3.1.4 Movement Between Ponds

Among female frogs that were tracked during breeding season (23 November 1996 to 31 March 1997 and 23 November 1997 to 9 March 1998) the proportions that moved to a different pond were 0 of 6 and 3 of 7, during these respective periods. For males the proportions were 1 of 4 and 2 of 4. These movements were initiated were 8 December 1997, 17 January 1997, 11 January 1998, 5 February 1998 (2 frogs – El Niño storm), and 23 February 1998 (could have been up to 5 days prior to the given dates since frogs were not tracked daily). Rainfall occurred on each of the dates that frogs moved to a different pond. The longest distance traveled in an interval of 1 to 3 days to get to a different pond was at least 188.2 m and the longest distance to return to the original pond was 209.3 m.

When Pond 4 dried down due to pump failure in late summer 1997, each of the 3 radio-tagged frogs moved to Pond 5, which still had water. These movements took place 29 July – 11 August 1997. Frogs left the pond after the water level fell below the perimeter band of emergent vegetation. One frog (Female 4103637A48) first moved into upland habitats vegetated by dense shrubs and mature willows, then went back to Pond 4 in the deepest water remaining, and finally moved to Pond 5 (Figure 9). After Pond 4 returned to normal water levels, this frog moved back to Pond 4 (on 31 August 1997). The other two frogs (1 male, 1 female) remained in Pond 5 after Pond 4 refilled.

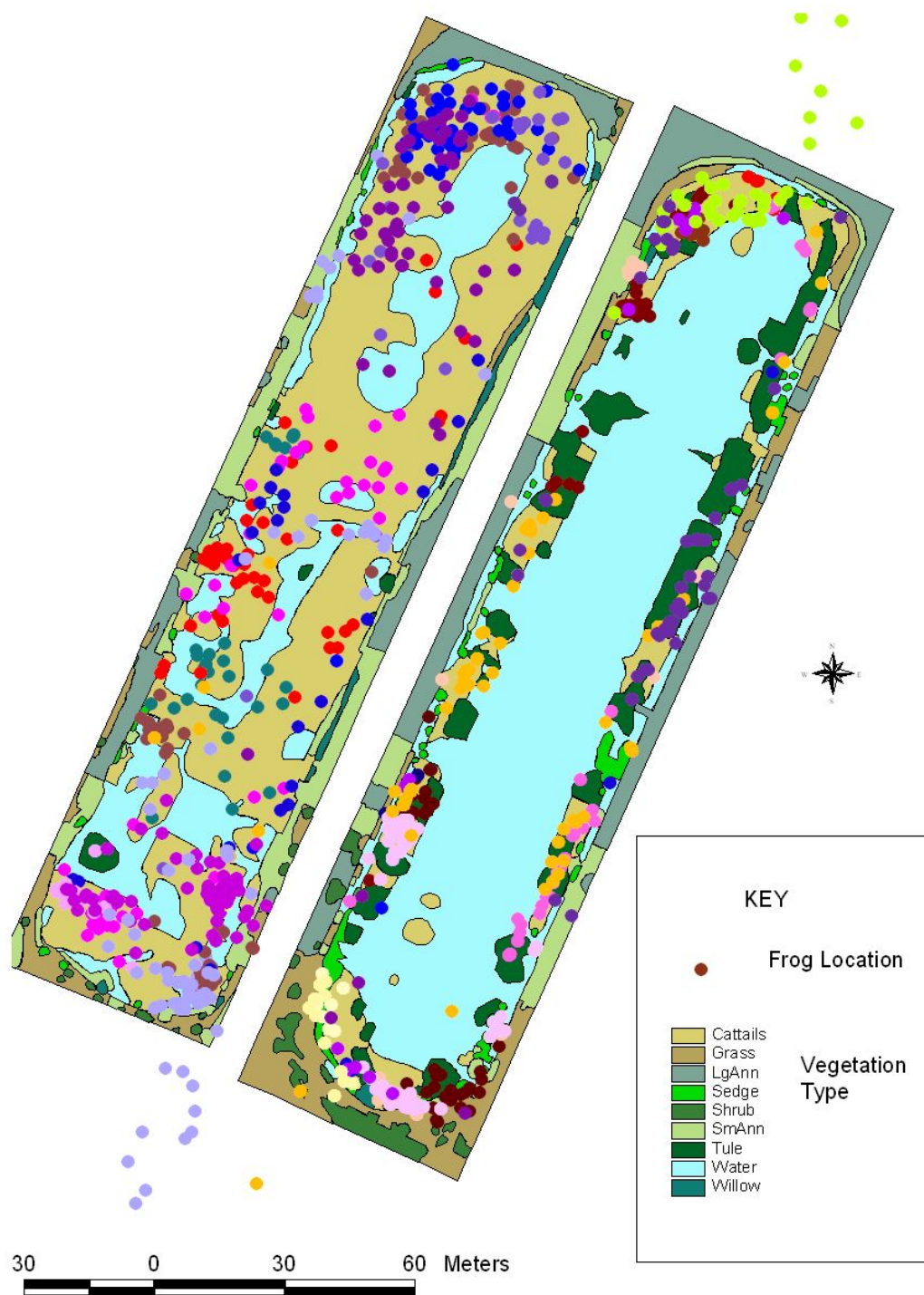


Figure 15. Distribution of all frog tracking locations at Ponds 4 (right) and 5 (left) across vegetation type.

3.1.5 Movements Over 24 Hour Periods

Frogs occupied areas over 24 hour periods ranging from 1.02 to 21.68 m² (mean 10.9 m²), which were 0.06 to 1.6% of the area that these individuals used when tracked over extended periods. Frogs moved little or not at all between the 10 AM and 2 PM observations. During the evening and night frogs moved around within stands of emergent vegetation, or crossed open water to other stands of emergent vegetation (Figure 16). Several frogs moved to the edge of vegetation at night, and occupied areas near the center of the dense vegetation during the day (Figure 16).

3.2 San Antonio Terrace

3.2.1 Dispersal and Upland Habitat Use

Metamorphs began emigrating from ponds shortly after metamorphosis, as much as 3 months prior to capturing adults in upland areas (Figure 17B). Metamorphs used upland areas even when environmental conditions were dry. Adult frogs, in contrast, were captured only during rain events (Figure 17). In fall 1998, metamorph dispersal peaked at both ponds during the first rain event of the season in which 10 mm precipitation fell at night (Figure 17B). Metamorph dispersal became less common as the winter progressed, even when there was substantial rainfall (Figure 17A).

During pond surveys the greatest number of individual metamorphs seen per night was in August/September 1997, with 112 at Pond 77 and 282 at Pond 79 (Table 2). After the first rains of the season (early November) the number of metamorphs seen in ponds dropped dramatically (Table 2). Concurrently, pitfall

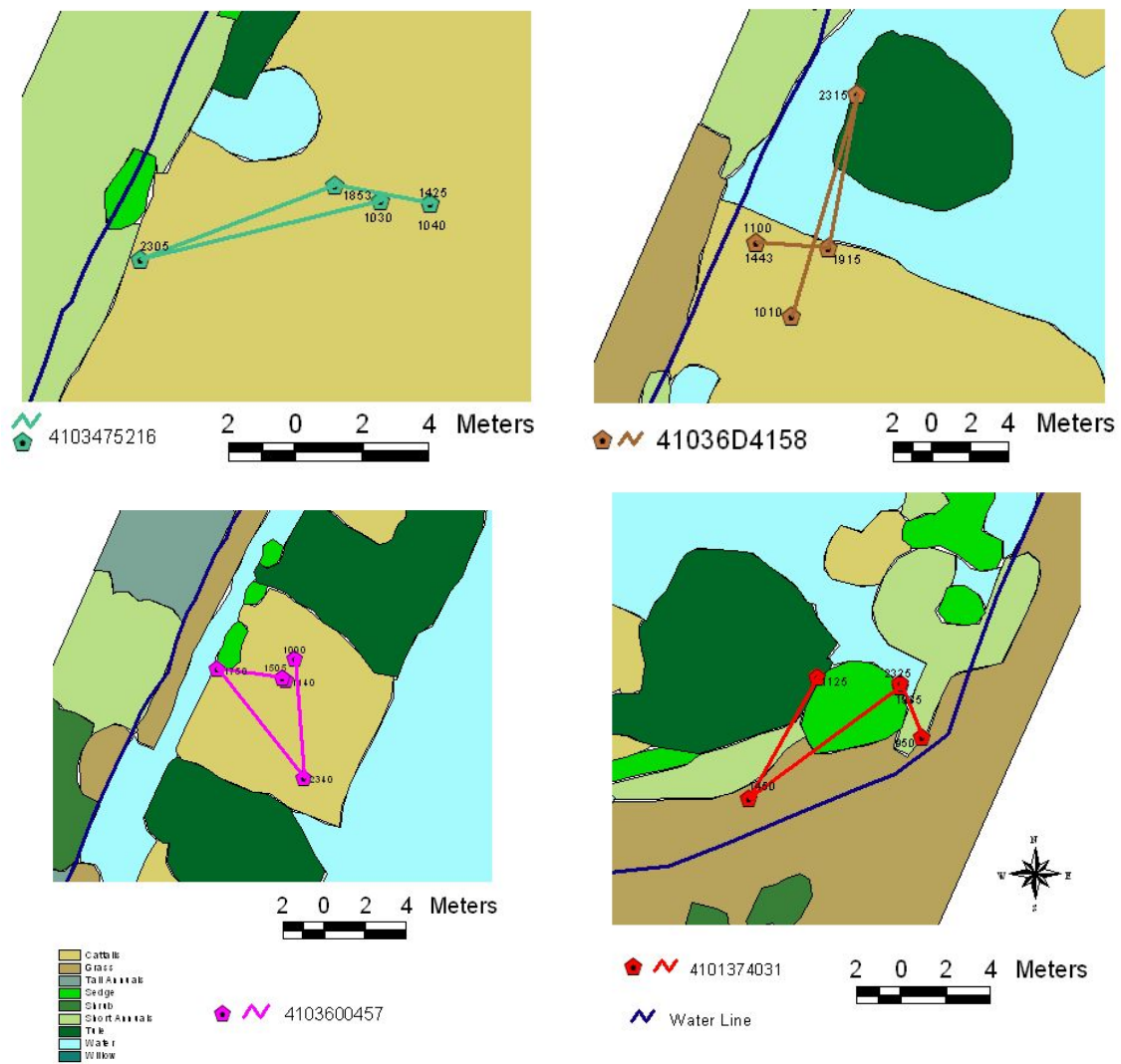
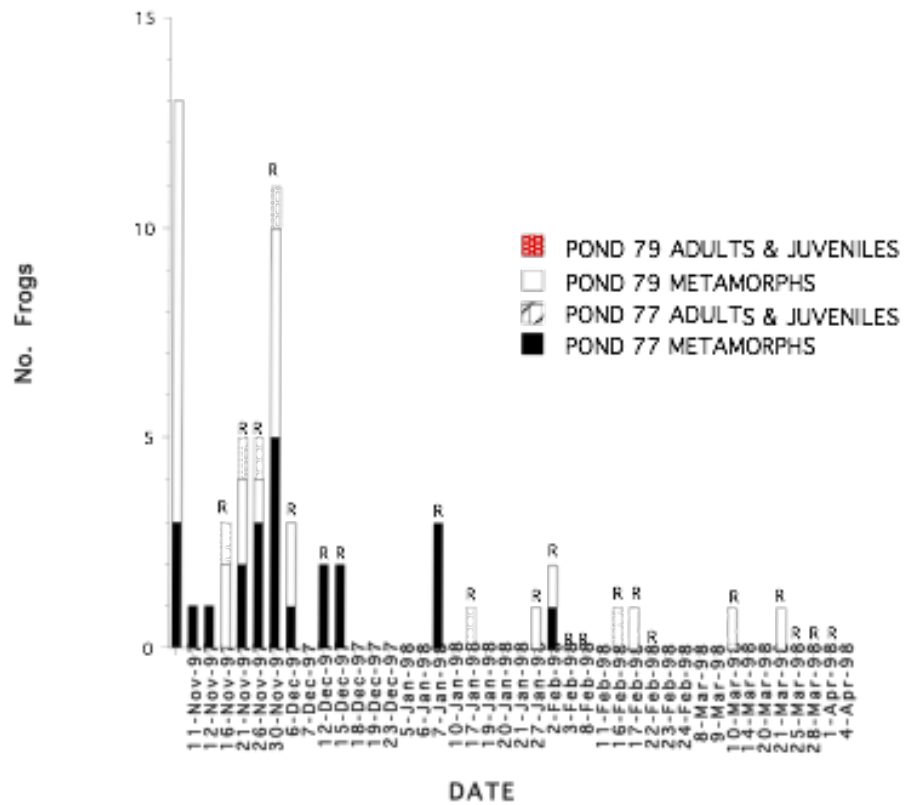


Figure 16. Movements of 4 radio-tagged frogs over 24 hours. Numbers are observation times of each frog location.

A) Winter 1997/1998:



B) Summer/Fall 1998:

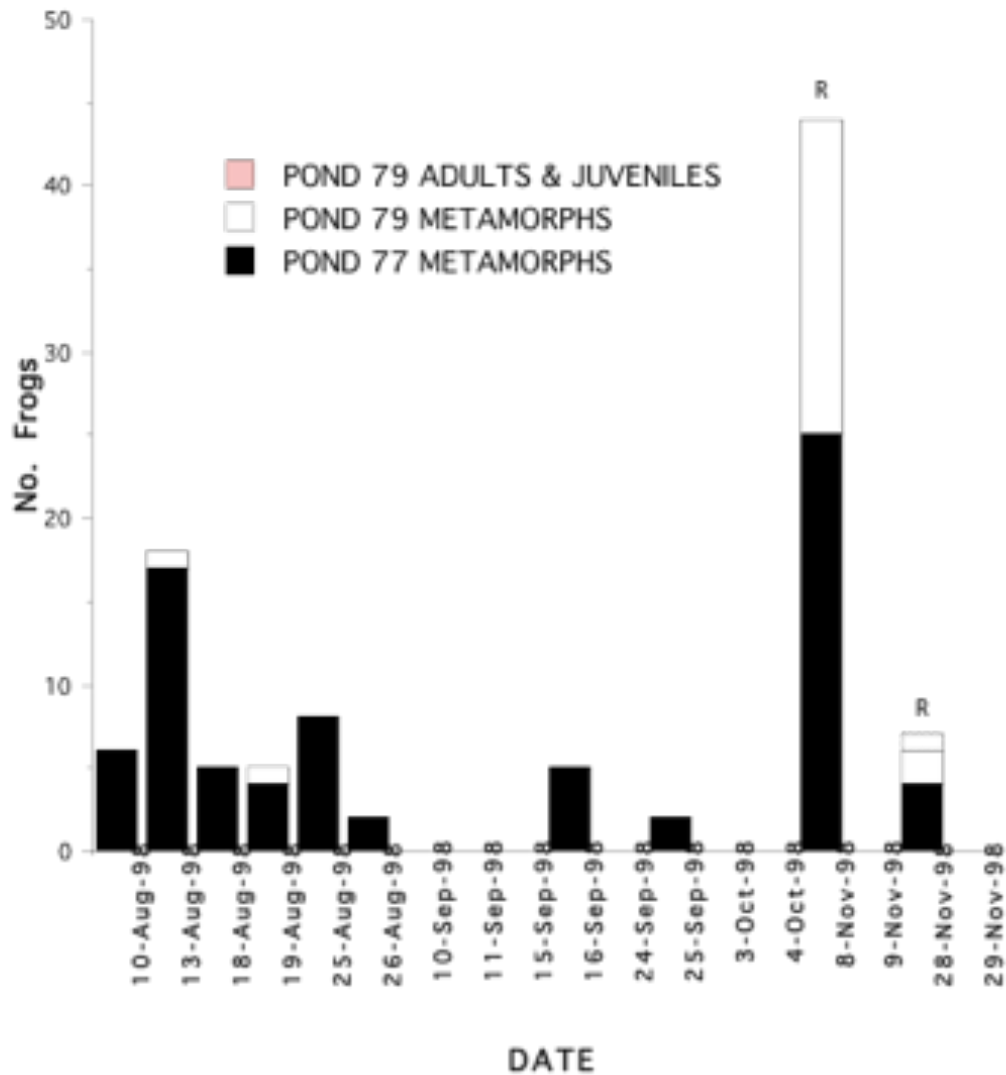


Figure 17. Total pitfall trap captures of California red-legged frogs at San Antonio Terrace in A) winter 1997/1998 and B) summer/fall 1998 for 9 arrays at Pond 77 and 7 arrays at Pond 79. Shown are the dates that traps were open overnight. Rainfall > 1 mm during the time traps were open is indicated by "R". Metamorphs were ≤ 65 mm and adults/juveniles > 65 mm snout-urostyle length.

Table 2. Number of frogs (AJ = adults + juveniles, M = metamorphs) seen during pond surveys of Pond 77 (A) and Pond 79 (B) at San Antonio Terrace concurrent to the pitfall trapping study.

A) Pond 77:

	16 Aug 1997	13 Sep 1997	19 Sep 1997	23 Sep 1997	7 Dec 1997	6 Jun 1998	29 Jun 1998	4 Aug 1998	11 Aug 1998	19 Aug 1998	26 Aug 1998	11 Sep 1998	15 Sep 1998	23 Sep 1998	2 Oct 1998
AJ	8	MD	MD	MD	3	4	3	1	1	1	0	0	0	0	1
M	27	103	96	112	0	0	0	2	13	5	4	19	2	1	2

MD = Missing data

B) Pond 79:

	6 Jul 1997	25 Jul 1997	8 Aug 1997	11 Aug 1997	15 Aug 1997	31 Aug 1997	10 Sep 1997	25 Nov 1997	29 Jun 1998	18 Jul 1998	4 Aug 1998	11 Aug 1998	19 Aug 1998	26 Aug 1998	11 Sep 1998	15 Sep 1998	23 Sep 1998	2 Oct 1998
AJ	4	6	5	5	5	7	0	0	5	2	18	2	4	2	3	3	4	3
M	13	21	56	69	255	282	257	4	0	23	5	4	2	3	8	9	15	13

trap captures of metamorphs peaked (Figure 17A). Numbers of metamorphs seen during pond surveys were much lower in 1998 than 1997 (Table 2). However, 1998 pitfall trap capture rates of metamorphs greatly exceeded those from 1997. The high number of metamorphs caught in August 1998 suggests that metamorphs dispersed into upland sites immediately after metamorphosis in that year, and consequently low numbers remained in ponds. Unfortunately, pitfall traps had not yet been installed in August 1997. After January/February, metamorphs were rarely caught in pitfall traps (Figure 17A).

At Pond 77, there were more captures in swales (26) than expected (11) under the null hypothesis of no preference for use of swales versus dune habitats. At Pond 79, there was no difference in swale capture rates from expectations based on random frog movement (14 captures in swales; 14 captures expected under the null hypothesis). The greatest total numbers of captures of any array were 26 captures at Array 5, Pond 77 (in swale) and 12 captures at Array 7, Pond 79 (see Figure 5).

Metamorphs dispersing from Pond 79 in summer/fall 1998 tended to be larger than those from winter 1997/1998 and from Pond 77 (Table 3). Numbers of metamorphs seen during pond surveys were generally lower in summer/fall 1998 at Pond 79, which may indicate there had been reduced levels of tadpole competition resulting in larger metamorphs.

3.2.2 Capture/Recapture Rates

A total of 150 pitfall trap captures were made of metamorphs (102 from Pond 77, 48 from Pond 79), and 9 adults over 59 trap nights. Of the adults captured, 2 males were captured at Pond 77, and 2 males and 5 females were from Pond 79. None of the frogs > 65 mm SUL were considered juveniles; the

Table 3. Size (snout-urostyle length in mm) of California red-legged frog metamorphs dispersing from ponds that were caught in pitfall traps at San Antonio Terrace, Vandenberg Air Force Base.

Pond	Winter 1997/1998		Summer/Fall 1998	
	Range (Median)	<i>n</i>	Range (Median)	<i>n</i>
77	35 - 64 (39)	21	30 - 54 (38)	77
79	36 - 51 (41)	21	40 - 65 (50)	23

two smallest non-metamorph frogs (77 and 87 mm SUL) had the enlarged nuptial pads characteristic of males. The largest number of captures per night was on 8 November 1998 with 25 metamorphs at Pond 77 and 19 at Pond 79. Since pitfall trap arrays sampled only 12 and 9% of the upland areas around these ponds, the actual numbers of metamorphs using upland habitats on this date could have been as many as 208 (Pond 77) and 211 (Pond 79) at these sites. There were only 4 recaptures in the pitfall traps, and all were metamorphs that were at the pond of initial capture.

There were 357 hand captures of metamorphs and 138 hand captures of adult and juvenile frogs over 46 pond and 7 road surveys. Nineteen captures of adults/juveniles were recaptures, representing 13 different individuals that were caught more than once (4 frogs were captured 3 times, 1 was captured 4 times). Among recaptured adults/juveniles, 2 were first captured in May/November 1997 and recaptured summer 1998. The rest were recaptured in the same season in which they were originally marked. Only 1 was recaptured in a pond other than that in which it had originally been caught - an adult female that was originally caught in Pond 77 in May 1997 and was recaptured three times in Pond 91 in late summer 1998. None of the 5 adults caught on the roads near these ponds were later recaptured. The greatest number of individual metamorphs captured and marked per pond in one season was 185 at Pond 79 in Fall 1997. Sixteen metamorphs were recaptured in ponds after having been marked (initial captures either in the pitfall traps or hand-captured), and 0 had moved to a different pond.

3.2.3 Other Species

Other species caught in the pitfall traps were Pacific treefrog (*Pseudacris regilla*), western fence lizard (*Sceloporus occidentalis*), common garter snake (*Thamnophis sirtalis*), western terrestrial garter snake (*T. elegans*), western skink (*Eumeces skiltonianus*), side-blotched lizard (*Uta stansburiana*), southern alligator lizard (*Elgaria multicarinatus*), California vole (*Microtus californicus*), deer mice (*Peromyscus* sp.), shrews (*Sorex* sp.), western harvest mouse (*Reithrodontomys megalotis*), Botta's pocket gopher (*Thomomys bottae*), California pocket mouse (*Perognathus= Chaetodipus californicus*), and agile kangaroo rat (*Dipodomys agilis*). The complete list of capture data is given in Appendix A.

4.0 Discussion

4.1 Dispersal and Movement Characteristics

Evidence presented here indicates that adult California red-legged frogs moved between aquatic sites on VAFB, highlighting the importance of this age class to dispersal. Among adult frogs that were tracked over a period encompassing the breeding season, 23% of females and 38% of males moved to a different pond during the peak breeding period and then returned to their original ponds following that period. In Santa Cruz County, Bulger et al. (2003) estimated 11 – 22% of adult California red-legged frogs migrated to and from breeding sites annually. Despite the large number of marked frogs in the San Antonio Terrace study (138 adults/juveniles, and almost 500 metamorphs caught in ponds and pitfall traps), only one recapture was made in a pond other than the site of original capture. This recaptured frog was a female that was recaptured in

an adjacent pond that was about 100 m away from the site of original capture. Apparently there are large frog population sizes on San Antonio Terrace, and documenting interpond movements using mark-recapture techniques is not as efficient as radio tracking.

Interpond movement also occurred in response to pond drying. When Pond 4 dried down below the perimeter band of emergent vegetation, all 3 of the radio-tagged frogs moved to Pond 5, which retained water sufficiently deep to inundate emergent vegetation. In Santa Cruz County, each of 9 frogs that were in a drying pond went to other sites that contained water (Bulger et al. 2003). Alvarez (2004) found California red-legged frogs in deep cracks in the dried mud of pond bottoms after ponds dried in summer.

Long-distance movements were more common for radio-tagged male than female frogs and they moved the longest distances during the winter/breeding season. In contrast, habitat use areas did not differ between males and females. There was wide variation in the size of areas used among individuals who were tracked for similar lengths of time. Some individuals remained in one end of a pond for as long as 7 months, while others ranged widely around the study site. Even though frogs had emigrated to the Waterfowl Ponds after the site was rehabilitated, radio-tagged frogs did not leave the site during this study. When frogs (especially females) use limited areas over extended periods it would appear that habitat conditions must be favorable.

This study documented metamorphs dispersing away from breeding sites shortly following transformation. In other studies of interpond movements of amphibians, metamorphs were more important than adults to dispersal (Breden 1987; Sinch 1992, 1997). No metamorphs were recaptured at a pond other than that of their site of original capture in the San Antonio Terrace study. However, metamorphs were not followed through the juvenile stage until they reached

sexual maturity at 2 to 3 years of age (Jennings and Hayes 1985, Scott and Rathbun 2001) and would need to return to aquatic sites to breed. Although it was not possible to determine what proportion return to natal ponds to breed versus those that disperse to other sites, it is likely that overland movements of metamorphs are important for dispersal in this species.

4.2 Upland Habitat Use

Radio-tagged frogs in this study generally did not move far from water and were found on land in only a small percentage of observations (3%). The longest distance a frog was from water was 43 m, and most (65%) of land observations were within 5 m of water. During the winter rain season frogs occupied pond-side vegetation for short periods of time (less than 1 week), and mature willows for slightly longer periods (maximum 21 +/- 2 days). One frog temporarily used upland habitats (shrubs, mature willows) after a pond dried up in the late summer. Females were more likely (85% of observations) than males to occupy upland habitats.

Radio-tagged California red-legged frogs in Santa Cruz County moved to and from aquatic sites that were up to 2800 m apart and covered distances to 3200 m in one season (Bulger et al. 2003). These frogs apparently underwent breeding migrations because their sites of summer residence were not suitable breeding habitats. Frogs may not have moved long distances at Vandenberg since the sites studied were suitable for breeding. Frogs that underwent long migrations in other studies occupied upland areas for as long as 60 consecutive days and non-migrating frogs stayed in upland areas 20 to 30 days (Rathbun et al. 1993, Bulger et al. 2003). Frogs in Santa Cruz County also occupied terrestrial habitats following summer rainstorms for periods up to 22 days and went as far

as 130 m from water (Bulger et al. 2003). In San Luis Obispo County, radio-tagged frogs stayed within 51 m of water (Rathbun et al. 1993, Scott and Rathbun 2001). An important difference was that I studied frogs occupying ponds, whereas many of the other study sites were streams (Rathbun et al. 1993, Scott and Rathbun 2001, Bulger et al. 2003). Frogs inhabiting stream sites may move into upland or riparian habitats in winter to avoid high flow rates and flooding. The reason for temporary occupation of upland sites without migrating by frogs normally residing in ponds remains poorly understood. Since their main defense against predators is to jump into deep water, they would appear to be especially vulnerable on land. It is possible their exploitation of terrestrial food resources balances increased predation risk on land.

During nights of peak metamorph dispersal, the estimated number in upland habitats near each pond was >200 individuals. It is not known where metamorphs reside after they dispersed into upland habitats since none were captured in the traps in late-winter. The juvenile stage, following metamorph dispersal to upland sites until sexual maturity, remains poorly understood. Juveniles are seldom seen in aquatic sites during this stage (personal observation, Bulger et al. 2003), and none were captured in pitfall traps in this study. Study of green frogs (*Rana clamitans*) also documented dispersal from aquatic natal sites shortly after metamorphosis and few returning to aquatic sites the following summer prior to sexual maturity (Schroeder 1976).

4.3 Microhabitat Selection

Radio-tagged frogs selected cattail stands while in ponds, and mature willows while on land. Frogs avoided deep water when those areas lacked emergent vegetation. Frogs tended to be within cattail stands during the day,

and moved to the edge of the stands at night. In a study of California red-legged frog microhabitat selection in a northern California marsh, Cook (1997) also found that frogs were found mainly in areas with emergent vegetation (spikerush and smartweed), and they avoided deep water when vegetation was lacking. In coastal streams and lagoons in San Luis Obispo County, frogs were associated with cattails, sedges, rushes, willows and blackberry and they avoided vegetation types that generally grow to lower heights (Rathbun et al. 1993, Scott and Rathbun 2001). In other studies of upland habitat use, California red-legged frogs were found to shelter under shrubs (blackberry, poison oak, willow, coyote brush), leaf litter, herbs, German ivy, nettles, downed trees or logs, rootballs rocks, and in small mammal burrows (Rathbun et al. 1993, Jennings and Hayes 1994, U.S. Fish and Wildlife Service 2001, Scott and Rathbun 2001, Bulger et al. 2003).

Use of dispersal corridors remains unclear. Dispersing frogs on San Antonio Terrace showed a preference for swales at one pond but not at the other pond. Xeric sand dunes with steep slopes were not a barrier to dispersal even during dry environmental conditions. Dispersal habitats or corridors at the Waterfowl Ponds were difficult to study because the ponds were so close together and none of the tagged frogs left the site. However, since the two frogs that moved the greatest distance from water went into mature willows, and one of these moved into this area several times, riparian woodland may be an important habitat during dispersal. Migrating frog in Santa Cruz County showed no tendency to follow watercourses or other features that may be thought of as dispersal corridors, and they showed no avoidance of steep slopes or any type of land use present in the study area (Bulger et al. 2003). When undertaking long-distance movements, frogs moved in approximately straight lines without regard to topography, vegetation type, or riparian corridors and

utilized upland habitats that were up to 500 m from a water source (Bulger et al. 2003). In studies of other amphibian species, corridor use for immigration to or emigration from breeding ponds has not been detected (Stenhouse 1985, Dodd and Cade 1998).

4.4 Influence of Rainfall On Frog Movements

Some frog movements were influenced by the occurrence of rainfall, but rain was not necessary for frogs to occupy upland habitats. Radio-tagged frogs that moved to a different pond during the breeding season initiated movements during periods with rain. All of the adult frogs caught in upland areas at San Antonio Terrace were from nights that it had rained. Except for movements away from drying ponds, all (32) tracking observations of frogs on land occurred in winter after the start of the rainy season (November through February). Sixty-five percent of these observations were within 1 day of rainstorms. In addition, long-distance (> 5 m) movements away from aquatic sites showed a tendency to be during or following substantial rainstorms.

Pitfall trap captures of metamorphs peaked during the first storm of the season, however, metamorph dispersal away from ponds began as much as 3 months prior to the onset of the rain season. Metamorphs were uncommon in traps in late-winter/early-spring despite the occurrence of rainfall. Precipitation did not affect the maximum or mean distances that radio-tagged frogs moved because frogs moved around within ponds irrespective of rainfall.

5.0 Management Recommendations

5.1 Buffer Zones

Any aquatic site that has potential or known California red-legged frog habitat should be protected with buffer zones of at least 100 m from the high water line, consistent with the conclusions of Bulger et al. (2003). Radio-tagged frogs in this study remained within 44 m of water, and most in other studies remained within 60 m of water (Rathbun et al. 1993, Bulger et al. 2003).

However, since some individuals may move considerably farther, protection of natural vegetation in a 100 m buffer is a reasonable compromise.

While adults mainly use upland sites during early-winter rains, they may also be present in upland areas following pond drying, during unseasonal summer storms, or during post-breeding migrations (see Bulger et al. 2003). Metamorphs can be common in upland areas surrounding breeding ponds beginning in July and August. Therefore, if any activities are proposed to take place in buffer zones, the best time to avoid take of frogs in these areas is May and June as long as there is no precipitation and aquatic sites retain water inundating emergent vegetation.

5.2 Dispersal Corridors

There was no clear evidence for the use of dispersal corridors in this or other studies, therefore virtually all undeveloped areas could be California red-legged frog dispersal habitat. Dispersing frogs on San Antonio Terrace moved through dry steep sand dunes as well as through mesic swales. At the Waterfowl Ponds, frogs occupied mature willows while far from water, and

while none occupied the agricultural field, there is no reason to believe they would not move across agricultural areas (see Bulger et al. 2003).

Planning for conservation of frog dispersal corridors should begin with the identification of all potentially suitable aquatic habitats within at least 3000 m of a project site. These sites should be mapped along with suitable upland sites that frogs may shelter in and any potential barriers to dispersal already in existence (such as freeways, walls, or solid fences in contact with the ground). Since migrating frogs tended to move in straight lines between aquatic sites (Bulger et al. 2003) and they may move along watercourses, modeling potential dispersal corridors would involve connecting all potential aquatic and riparian sites with straight lines that are at least 600-700 m wide (Bulger et al. 2003). The second level of investigation to pinpoint dispersal areas actually used could employ radio tracking, drift fences/pitfall trap arrays, or thread trailing studies.

5.3 Habitat Restoration or Enhancement

Facilitating dense shoreline and emergent vegetation of various types should be the focus of any habitat restoration or enhancement effort for the California red-legged frog. In this study frogs selected cattails while in aquatic habitats. Frogs were also found in tules (=bulrushes), especially when under water during the day. Visual observations suggest that cattails provide better resting places for frogs while feeding and may be better sites for the attachment of egg masses than are tules (see also Cook 1997). This is because cattails provide more horizontal structure at the water surface (through root masses that detach from the substrate and rise to the surface, and bent leaves) whereas tules tend to be mostly vertical. The presence of some open water also appears to favor this species, as some frogs that were tracked over 24 hour periods moved from within

dense patches of emergent vegetation that they used during the day to the edges of these patches at night.

Dense cover by sedge, tall grasses, herbs, and willows within 5 m of the water's edge also appears to be important since frogs moved short distances away from water and sheltered in these vegetation types. Mature willows, shrubs and blackberry thickets should be established to 100 m from the water's edge.

The best situation for long-term red-legged frog establishment is the existence of several aquatic sites less than 350 m apart. Aquatic sites should be of different depths and hydroperiods, with most retaining water throughout the summer of dry years. Shallow aquatic sites may facilitate populations because recruitment of metamorphs is often greater at shallow marshes than at deep ponds with steep shorelines.

5.4 Future Studies

Little is known about juvenile California red-legged frogs during the stage following metamorph dispersal from ponds until they return to breed at 2 or 3 years of age. Since they are not common in aquatic sites during this time, it is assumed that they occupy terrestrial habitats, but this remains unstudied.

More study is needed to determine the relative contributions of metamorphs, juveniles, and adults to metapopulation persistence. Since dispersing frogs can have a rescue effect on extirpated populations, a broader understanding of the dynamics of interpond movements is need for landscape level conservation plans.

6.0 Literature Cited

- Aebischer, N. J., P. A. Robertson, and R. E. Kenward. 1993. Compositional analysis of habitat use from animal radio-tracking data. *Ecology* 74:1313-1325.
- Allredge, J. R., and J. T. Ratti. 1992. Further comparison of some statistical techniques for analysis of resource selection. *Journal of Wildlife Management* 56:1-9.
- Alvarez, J. A. 2004. *Rana aurora draytonii* (California red-legged frog). Microhabitat. *Herpetological Review* 35:162.
- Arthur, S. M., B. F. J. Manly, L. L. McDonald, and G. W. Garner. 1996. Assessing habitat selection when availability changes. *Ecology* 77:215-227.
- Breden, F. 1987. The effect of post-metamorphic dispersal on the population genetic structure of Fowler's toad, *Bufo woodhousei fowleri*. *Copeia* 1987:386-395.
- Bulger, J. B., N. J. Scott, and R. B. Seymour. 2003. Terrestrial activity and conservation of adult California red-legged frogs *Rana aurora draytonii* in coastal forests and grasslands. *Biological Conservation* 110:85-95.
- Camper, J. D., and J. R. Dixon. 1988. Evaluation of a microchip marking system for amphibians and reptiles. Texas Parks and Wildlife Department, Austin, Texas. 22 pp.
- Christopher, S. V. 1996. Reptiles and amphibians of Vandenberg Air Force Base, Santa Barbara County, California 1995: A focus on sensitive aquatic species. Prepared for CES/CEVN Natural Resources, Vandenberg Air Force Base, California and National Biological Service (now USGS), California Science Center (now WERC), San Simeon, California. Department of Ecology, Evolution, and Marine Biology and the Museum of Systematics and Ecology, University of California, Santa Barbara. Military Interdepartmental Purchase Request No. NP4051. Museum of Systematics and Ecology Report No. 4. 203+ pp.
- Christopher, S. V. 2000. Natural history and ecology of the California red-legged frog and bullfrog at the Waterfowl Ponds, Vandenberg Air Force Base, California. 12 November 2000. Prepared for 30 CES/CEV, Vandenberg Air Force Base, California. Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, and Santa Barbara Museum of Natural History, Santa Barbara, California, with the cooperation of U.S.G.S. Biological Resources Division, Piedras Blancas Research Station, San Simeon, California. Project Number XUMU-987503. 83 + vi pp.

- Christopher, S. V. 2004. Water quality at California red-legged frog breeding sites on Vandenberg Air Force Base, California. June 2004. Prepared for 30 CES/CEVPN Natural Resources, Vandenberg Air Force Base, California. University of California, Santa Barbara. 36 pp. + app.
- Christopher, S. V. In preparation. Distribution and abundance of California red-legged frogs on Vandenberg Air Force Base: Responses to El Niño and drought conditions. Prepared for 30 CES/CEV, Vandenberg Air Force Base, California. Santa Barbara Museum of Natural History. Project Number XUMU-017501.
- Cook, D. 1997. Microhabitat use and reproductive success of the California red-legged frog (*Rana aurora draytonii*) and bullfrog (*Rana catesbeiana*) in an ephemeral marsh. M. A. Thesis, Sonoma State University. 23 pp. + appendices.
- Dickerson, M. C. 1906. The frog book. Dover Publications, Inc., New York. 253 pp.
- Dodd, C. K., Jr., and B. S. Cade. 1998. Movement patterns and the conservation of amphibians breeding in small, temporary wetlands. *Conservation Biology* 12:331-339.
- Fellers, G. M., A. E. Launer, G. Rathbun, S. Bobzien, J. Alvarez, D. Sterner, R. B. Seymour, and M. Westphal. 2001. Overwintering tadpoles in the California red-legged frog (*Rana aurora draytonii*). *Herpetological Review* 32:156-157.
- Ferren, W. R., Jr., P. L. Fiedler, and R. A. Leidy. 1996. Wetlands of the central and southern California coast and coastal watersheds: a methodology for their classification and description. University of California, Santa Barbara with San Francisco State University and the U.S. Environmental Protection Agency. Prepared for U.S. Environmental Protection Agency, Region IX, San Francisco, California.
- Friedman, M. 1937. The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association* 32:675-701.
- Harvey, M. J., and R. W. Barbour. 1965. Home range of *Microtus ochrogaster* as determined by a Modified Minimum Area method. *Journal of Mammalogy* 46:398-402.
- Hayes, M. P., and M. R. Jennings. 1986. Decline of ranid frog species in western North America: are bullfrogs (*Rana catesbeiana*) responsible? *Journal of Herpetology* 20:490-509.

- Hayes, M. P., and M. R. Jennings. 1989. Habitat correlates of the distribution of the California red-legged frog (*Rana aurora draytonii*) and the foothill yellow-legged frog (*Rana boylei*): implications for management. Pages 144-158 in R. E. Szaro, K. E. Severson and D. R. Patton, technical coordinators. Management of amphibians, reptiles and small mammals in North America. July 19-21, 1988 - Flagstaff, Arizona. USDA General Technical Report RM-166:1-458.
- Hayes, M. P., and M. R. Tennant. 1985. Diet and feeding behavior of the California red-legged frog, *Rana aurora draytonii* (Ranidae). Southwestern Naturalist 30:601-605.
- Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D. C.
- Human, V. L. 1990. Biological resources of San Antonio Terrace, Vandenberg Air Force Base, California. Unpublished. 158 pp.
- Jennings, M. R., and M. P. Hayes. 1985. Pre-1900 overharvest of California red-legged frogs (*Rana aurora draytonii*): the inducement for bullfrog (*Rana catesbeiana*) introduction. Herpetologica 41:94-103.
- Jennings, M. R., and M. P. Hayes. 1989. Final report on the status of the California red-legged frog (*Rana aurora draytonii*) in the Pescadero Marsh Natural Preserve. Prepared for the California Department of Parks and Recreation with the California Academy of Sciences. Contract No. 4-823-9018. Unpublished. 56 pp.
- Jennings, M. R., and M. P. Hayes. 1994. Amphibian and reptile species of special concern in California. 1 November 1994. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California. Contract Number 8023. 255 pp.
- Jennings, M. R., M. P. Hayes, and D. C. Holland. 1992. A petition to the U. S. Fish and Wildlife Service to place the California red-legged frog (*Rana aurora draytonii*) and the western pond turtle (*Clemmys marmorata*) on the list of endangered and threatened wildlife and plants. Submitted to the U. S. Department of the Interior, Fish and Wildlife Service. Unpublished. 24 pp.
- Kenward, R. E. 1992. Quantity versus quality: programmed collection and analysis of radio-tracking data. Pages 231-246 in I.G. Priede and S. M. Swift, editors. Wildlife telemetry: remote monitoring and tracking of animals. Ellis Horwood, New York, New York.
- Mallory, M. J. 1980. Potential effects of increased ground-water pumpage on Barka Slough, San Antonio Creek Valley, Santa Barbara County, California. U. S. Geological Survey, Water Resources Division, Menlo Park, California. AD/A-099 019. 15 pp.

- McElligott, M. J. 1989. Waterfowl habitat enhancement, Vandenberg Air Force Base, California. U. S. Air Force, Vandenberg Air Force Base, California. 12 pp.
- McKeown, M. S. 1974. Check-list of amphibians and reptiles of Santa Barbara County, California. Santa Barbara Museum of Natural History, Santa Barbara, California. Occasional Paper Number 9. 11 pp.
- Pechmann, J. H. K., D. E. Scott, R. D. Semlitsch, J. P. Caldwell, L. J. Vitt and J. W. Gibbons. 1991. Declining amphibian populations: the problem of separating human impacts from natural fluctuations. *Science* 253:892-895.
- Rathbun, G. B., M. R. Jennings, T. G. Murphey, and N. R. Siepel. 1993. Status and ecology of sensitive aquatic vertebrates in lower San Simeon and Pico Creeks, San Luis Obispo County, California. Final Report under Cooperative Agreement 14-16-0009-91-1909 between U. S. Fish and Wildlife Service and California Department of Parks and Recreation. Publication number PB-93-230779, National Technical Information Service, Springfield, Virginia. ix + 103 pp.
- Rathbun, G. B., and T. G. Murphey. 1996. A waistband for attaching radio transmitters to ranid frogs. *Herpetological Review* 27:187-189.
- Sanders, R. M. 1950. A herpetological survey of Ventura County, California. M.S. Thesis, Stanford University, Stanford, California. 128 pp.
- Schroeder, E. E. 1976. Dispersal and movement of newly transformed green frogs, *Rana clamitans*. *American Midland Naturalist* 95:471-474.
- Scott, N. J., Jr., and G. B. Rathbun. 2001. Biology of the aquatic vertebrates of coastal San Luis Obispo County, California: a study of the effects of highway bridge construction. Final report prepared for the California Department of Transportation, San Luis Obispo, California. Piedras Blancas Field Station, Western Ecology Research Center, U. S. Geological Survey, San Simeon, California.
- Semlitsch, R. D. 2002. Critical elements for biologically based recovery plans of aquatic-breeding amphibians. *Conservation Biology* 16:619-629.
- Sinsch, U. 1992. Structure and dynamic of a natterjack toad metapopulation (*Bufo calamita*). *Oecologia* 90:489-499.
- Sinsch, U. 1997. Postmetamorphic dispersal and recruitment of first breeders in a *Bufo calamita* metapopulation. *Oecologia* 112:42-47.
- Southwood, T.R.E. 1977. Habitat, the template for ecological strategies? *Journal of Animal Ecology* 46:337-365.
- Stebbins, R. C. 1966. A field guide to western reptiles and amphibians. Houghton Mifflin, Boston, Massachusetts.
- Stebbins, R. C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston, Massachusetts. 336 pp.

- Stenhouse, S. L. 1985. Migration, orientation, and homing in *Ambystoma maculatum*. *Copeia* 1985:631-637.
- Storer, T. I. 1925. A synopsis of the amphibia of California. University of California Publications in Zoology 27:1-342.
- Tetra Tech. 1996. Installation Restoration Program (IRP), Phase I Site Characterization Summary (SCS), Informal Technical Information Report (ITIR), Site 16 - Mod III Lake, Operable Unit 4 Remedial Investigation/Feasibility Study (RI/FS), Vandenberg Air Force Base, California. Prepared for Air Force Space Command, Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. March 1996. Prepared by Tetra Tech, Inc., Santa Barbara, California. USAF Contract No. F33615-90-D0-4006. 95 pp.
- U.S. Department of Agriculture. 1972. Soil survey of northern Santa Barbara area, California. July 1972. Soil Conservation Service, USDA, in cooperation with University of California Agricultural Experiment Station.
- U.S. Fish and Wildlife Service. 1996. Endangered and threatened wildlife and plants; determination of threatened status for the California red-legged frog. Federal Register 61:25813-25833.
- U.S. Fish and Wildlife Service. 2001. Endangered and threatened wildlife and plants; final determinations of critical habitat for the California red-legged frog. Federal Register 66:14626-14674.
- U.S. Fish and Wildlife Service. 2002. Recovery plan for the California red-legged frog (*Rana aurora draytonii*). U. S. Fish and Wildlife Service, Portland, Oregon. viii + 173.
- Wright, A. H., and A. A. Wright. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Company, Ithaca, New York. 640 pp.

Appendix A

Pitfall Trapping Data

KEY

Rain – Precipitation recorded on site.

Date – On the morning traps were checked.

Trap No. – 77 or 79 is the pond, -# is the array, and letters represent one of four traps per array.

Species – “-” is nothing caught in any trap on that date.

R? – “N” = new frog, “Y” = yes, recaptured frog.

PIT/Clip – Pit tag number or toe clip code.

Length – Snout-urostyle length in mm.

Mass – in g.

Sex – “M” = male, “F” = female, “U” = unknown.

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
LITTLE	12-Nov-97	77-2B	MOUSE	-	-	-	-	-
LITTLE	12-Nov-97	77-2D	H. REGILLA	-	-	JUV	-	F
LITTLE	12-Nov-97	77-5B	R. AURORA	N	LR2	40	5.5	U
LITTLE	12-Nov-97	77-6D	H. REGILLA	-	-	JUV	-	F
LITTLE	12-Nov-97	77-7C	H. REGILLA	-	-	JUV	-	F
LITTLE	12-Nov-97	77-7C	H. REGILLA	-	-	JUV	-	F
LITTLE	12-Nov-97	77-9C	H. REGILLA	-	-	MET	-	-
0	16-Nov-97	77-2B	POCKET MOUSE	-	-	-	-	-
0	16-Nov-97	77-2C	H. REGILLA	-	-	JUV	-	F
0	16-Nov-97	77-2C	H. REGILLA	-	-	MET	-	-
0	16-Nov-97	77-3A	H. REGILLA	-	-	ADULT	-	M
0	16-Nov-97	77-6B	R. AURORA	N	LR2	45	7.5	U
0	16-Nov-97	77-6D	H. REGILLA	-	-	JUV	-	F
DAY 12 MM	21-Nov-97	77-3D	H. REGILLA	-	-	ADULT	-	M
NIGHT 0	21-Nov-97	77-9C	H. REGILLA	-	-	JUV	-	F
	21-Nov-97	79-1A	R. AURORA	N	LR1	44	6.0	U
	21-Nov-97	79-1C	R. AURORA	N	LR1	39	4.5	U
	21-Nov-97	79-2D	H. REGILLA	-	-	JUV	-	F
	21-Nov-97	79-3D	R. AURORA	N	LR1	45	8.0	U
	21-Nov-97	79-4D	R. AURORA	N	LR1	40	4.5	U
	21-Nov-97	79-4D	R. AURORA	N	LR1	41	5.5	U
	21-Nov-97	79-5A	H. REGILLA	-	-	ADULT	-	M
	21-Nov-97	79-5C	R. AURORA	N	LR1	40	4.5	U
	21-Nov-97	79-6A	R. AURORA	N	410D69521C	97	69.0	F
	21-Nov-97	79-7C	R. AURORA	N	LR1	38	4.5	U
	21-Nov-97	79-7C	H. REGILLA	-	-	META	-	-
	21-Nov-97	79-6A	H. REGILLA	-	-	META	-	-
DAY 0	26-Nov-97	77-2A	R. AURORA	N	LR2	43	6.0	U
NIGHT - MOD	26-Nov-97	77-2A	R. AURORA	N	LR2	38	4.5	U
	26-Nov-97	79-1C	R. AURORA	N	LR1	45	7.0	U
	26-Nov-97	79-5A	R. AURORA	N	LR1	40	5.5	U
	26-Nov-97	79-5C	R. AURORA	N	410D5D7939	102	82	M
	26-Nov-97	79-6B	SHREW	-	-	-	-	-
DAY 0	30-Nov-97	77-1D	SHREW	-	-	-	-	-
NIGHT 33MM	30-Nov-97	77-3A	R. AURORA	N	LR2	36	4.5	U
	30-Nov-97	77-5A	CALIFORNIA VOLE	-	-	-	-	-
	30-Nov-97	77-5B	R. AURORA	N	LR2	35	4.5	U
	30-Nov-97	77-9D	R. AURORA	N	LR2 (LR3 DEFORMED)	39	5	U
	30-Nov-97	79-1B	CALIFORNIA VOLE	-	-	-	-	-
	30-Nov-97	79-3C	R. AURORA	N	410D5A1B08	95	73	M

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	30-Nov-97	79-4A	CALIFORNIA VOLE	-	-	-	-	-
	30-Nov-97	79-6A	R. AURORA	Y	LR1	45	5.5	U
DAY 0 MM	6-Dec-97	77-1A	R. AURORA	N	LR2	40	5.5	U
NIGHT 8 MM	6-Dec-97	77-5B	R. AURORA	Y	LR2	39	4.5	U
	6-Dec-97	77-5B	R. AURORA	N	LR2	37	4.5	U
	6-Dec-97	77-6D	R. AURORA	N	LR2	39	4.5	U
	6-Dec-97	77-7B	R. AURORA	N	LR2	40	5.5	U
	6-Dec-97	77-7D	CALIFORNIA VOLE	-	-	-	-	-
	6-Dec-97	79-1B	R. AURORA	N	LR1	51	10.5	U
	6-Dec-97	79-3B	R. AURORA	N	LR1	42	5.0	U
	6-Dec-97	79-3A	PEROMYSCUS	-	-	-	-	-
	6-Dec-97	79-5D	R. AURORA	N	LR1	39	4.5	U
	6-Dec-97	79-6A	R. AURORA	Y	LR1	40	5.0	U
	6-Dec-97	79-6A	R. AURORA	N	LR1	43	5.5	U
	6-Dec-97	79-7A	R. AURORA	N	LR1	43	5.5	U
	6-Dec-97	79-7D	R. AURORA	N	410D731534	112	122.0	F
DAY & NIGHT	7-Dec-97	77-3C	R. AURORA	Y	LR2 (LR3 DEFORMED)	39	4.0	U
1 MM	7-Dec-97	77-4A	PEROMYSCUS	-	-	-	-	-
	7-Dec-97	79-1B	R. AURORA	N	LR1	40	5.5	U
	7-Dec-97	79-3B	R. AURORA	N	LR1	36	4.0	U
	7-Dec-97	79-7B	PEROMYSCUS	-	-	-	-	-
0	12-Dec-97	77-9B	PEROMYSCUS	-	-	-	-	-
	12-Dec-97	79-6B	PEROMYSCUS	-	-	-	-	-
DAY & NIGHT	15-Dec-97	77-8D	R. AURORA	N	410E1D3C0B	64	86.0	M
2 MM	15-Dec-97	77-5B	R. AURORA	N	LR2	41	6.5	U
	15-Dec-97	79-1B	PEROMYSCUS	-	-	-	-	-
DAY & NIGHT	18-Dec-97	77-1A	R. AURORA	N	LR2	35	3.5	U
16 MM	18-Dec-97	77-2A	R. AURORA	N	LR2	38	5.0	U
(MOST DAY)	18-Dec-97	77-3C	PEROMYSCUS	-	-	-	-	-
	18-Dec-97	77-3C	PEROMYSCUS	-	-	-	-	-
	18-Dec-97	77-4D	PEROMYSCUS	-	-	-	-	-
	18-Dec-97	77-5A	PEROMYSCUS	-	-	-	-	-
NIGHT TRACE	19-Dec-97	77-8C	SHREW	-	-	-	-	-
0	23-Dec-97	77-6C	PEROMYSCUS	-	-	-	-	M
NIGHT TRACE	5-Jan-98	79-1B	H. REGILLA	-	-	-	-	-
	5-Jan-98	79-6D	PEROMYSCUS	-	-	-	-	-
	5-Jan-98	79-6B	PEROMYSCUS	-	-	-	-	-
0	6-Jan-98	77-6B	H. REGILLA	-	-	-	-	M
0	7-Jan-98	-	-	-	-	-	-	-
DAY & NIGHT	10-Jan-98	77-1C	R. AURORA	N	LR2	47	7.5	U

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
7 MM	10-Jan-98	77-1D	CAL. VOLE	-	-	-	-	-
	10-Jan-98	77-2A	W. HARVEST MOUSE?	-	-	-	-	-
	10-Jan-98	77-3B	R. AURORA	N	LR2	39	4.5	U
	10-Jan-98	77-6A	PEROMYSCUS	-	-	-	-	M
	10-Jan-98	77-6D	H. REGILLA	-	-	-	-	-
	10-Jan-98	77-7C	R. AURORA	N	LR2	39	4.5	U
	10-Jan-98	77-7D	H. REGILLA	-	-	-	-	F
	10-Jan-98	77-7C	PEROMYSCUS	-	-	-	-	-
	10-Jan-98	79-1D	H. REGILLA	-	-	-	-	F
0	17-Jan-98	77-5B	H. REGILLA	-	-	-	-	F
	17-Jan-98	77-5B	H. REGILLA	-	-	-	-	F
	17-Jan-98	77-5B	H. REGILLA	-	-	-	-	M
NIGHT 12 MM	19-Jan-98	77-1A	W. HARVEST MOUSE?	-	-	-	-	-
	19-Jan-98	77-6D	H. REGILLA	-	-	-	-	F
	19-Jan-98	77-9B	H. REGILLA	-	-	-	-	M
	19-Jan-98	79-3A	PEROMYSCUS	-	-	-	-	-
	19-Jan-98	79-5B	R. AURORA	N	410D64047A	93	69.5	F
	19-Jan-98	79-5C	PEROMYSCUS	-	-	-	-	-
	19-Jan-98	79-7B	H. REGILLA	-	-	-	-	F
0	20-Jan-98	79-1D	PEROMYSCUS	-	-	-	-	-
0	21-Jan-98	79-1B	PEROMYSCUS	-	-	-	-	F
0	27-Jan-98	77-5B	H. REGILLA	-	-	-	-	-
	27-Jan-98	77-6D	PEROMYSCUS	-	-	-	-	-
	27-Jan-98	79-1C	PEROMYSCUS	-	-	-	-	-
DAY & NIGHT	2-Feb-98	77-1D	PEROMYSCUS	-	-	-	-	-
55 MM	2-Feb-98	77-4A	PEROMYSCUS	-	-	-	-	-
	2-Feb-98	79-5A	CAL. VOLE	-	-	-	-	-
	2-Feb-98	79-6B	SHREW	-	-	-	-	-
	2-Feb-98	79-6D	CAL. VOLE	-	-	-	-	-
	2-Feb-98	79-7B	R. AURORA	N	LR1	40	5.5	U
DAY & NIGHT	3-Feb-98	79-1A	R. AURORA	N	LR1	45	7.5	U
40 MM	3-Feb-98	77-2B	CAL. VOLE	-	-	-	-	-
	3-Feb-98	77-4A	R. AURORA	N	LR2	36	4.0	U
	3-Feb-98	77-6D	H. REGILLA	-	-	-	-	M
	3-Feb-98	77-6D	POCKET GOPHER	-	-	-	-	-
DAY 24 MM	8-Feb-98	77-4B	H. REGILLA	-	-	-	-	F
	8-Feb-98	77-6C	H. REGILLA	-	-	-	-	F
	8-Feb-98	77-8A	H. REGILLA	-	-	-	-	M
	8-Feb-98	79-2D	H. REGILLA	-	-	-	-	M
	8-Feb-98	79-5B	H. REGILLA	-	-	-	-	M

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
NIGHT 1 MM	11-Feb-98	77-8A	H. REGILLA	-	-	-	-	F
	11-Feb-98	77-6D	PEROMYSCUS	-	-	-	-	-
	11-Feb-98	77-6D	PEROMYSCUS	-	-	-	-	-
0	16-Feb-98	-	-	-	-	-	-	-
DAY & NIGHT	17-Feb-98	77-2A	H. REGILLA	-	-	-	-	M
32 MM	17-Feb-98	77-2D	SHREW	-	-	-	-	-
(MOST NIGHT)	17-Feb-98	77-4D	H. REGILLA	-	-	-	-	F
	17-Feb-98	77-8D	PEROMYSCUS	-	-	-	-	-
	17-Feb-98	79-5A	CAL. VOLE	-	-	-	-	-
	17-Feb-98	79-5C	H. REGILLA	-	-	-	-	F
	17-Feb-98	79-6A	R. AURORA	N	410E1C3D3C	96	76.0	F
	17-Feb-98	79-7B	H. REGILLA	-	-	-	-	F
28 MM	22-Feb-98	77-3C	SHREW	-	-	-	-	-
MOST NIGHT	22-Feb-98	77-4A	PEROMYSCUS	-	-	-	-	-
	22-Feb-98	77-5A	CAL. VOLE	-	-	-	-	-
	22-Feb-98	77-5A	CAL. VOLE	-	-	-	-	-
	22-Feb-98	77-6C	R. AURORA	N	410D751648	87	45.0	M
	22-Feb-98	77-8A	CAL. VOLE	-	-	-	-	-
	22-Feb-98	77-9C	CAL. VOLE	-	-	-	-	-
	22-Feb-98	79-1B	CAL. VOLE	-	-	-	-	-
	22-Feb-98	79-1D	H. REGILLA	-	-	-	-	F
	22-Feb-98	79-2A	H. REGILLA	-	-	-	-	F
	22-Feb-98	79-2B	H. REGILLA	-	-	-	-	F
	22-Feb-98	79-2D	CAL. VOLE	-	-	-	-	-
	22-Feb-98	79-3A	PEROMYSCUS	-	-	-	-	-
	22-Feb-98	79-3B	CAL. VOLE	-	-	-	-	-
	22-Feb-98	79-3C	H. REGILLA	-	-	-	-	F
	22-Feb-98	79-3C	H. REGILLA	-	-	-	-	F
	22-Feb-98	79-5C	CAL. VOLE	-	-	-	-	-
22 MM	23-Feb-98	77-5A	PEROMYSCUS	-	-	-	-	-
MOSTLY DAY	23-Feb-98	77-9C	SCELOPORUS OCCIDENTALIS	-	-	-	-	F
	23-Feb-98	79-2A	PEROMYSCUS	-	-	-	-	-
	23-Feb-98	79-2C	PEROMYSCUS	-	-	-	-	-
	23-Feb-98	79-3C	H. REGILLA	-	-	-	-	F
	23-Feb-98	79-4A	SHREW	-	-	-	-	-
0	24-Feb-98	79-2A	PEROMYSCUS	-	-	-	-	-
	24-Feb-98	79-3A	PEROMYSCUS	-	-	-	-	-
	24-Feb-98	77-5A	PEROMYSCUS	-	-	-	-	-
0	8-Mar-98	77-1D	SCELOPORUS OCCIDENTALIS	-	-	-	-	M
	8-Mar-98	77-7A	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	8-Mar-98	77-9B	PEROMYSCUS	-	-	-	-	-
	8-Mar-98	79-4B	PEROMYSCUS	-	-	-	-	-
	8-Mar-98	79-4D	PEROMYSCUS	-	-	-	-	-
	8-Mar-98	79-6B	THAMNOPHIS SIRTALIS	-	-	-	-	-
0	9-Mar-98	79-2D	THAMNOPHIS SIRTALIS	-	-	-	-	-
	9-Mar-98	79-3C	EUMECES SKILTONIANUS	-	-	-	-	-
	9-Mar-98	77-7C	PEROMYSCUS	-	-	-	-	-
0	10-Mar-98	77-3A	PEROMYSCUS	-	-	-	-	-
	10-Mar-98	77-6D	UN-ID RODENT	-	-	-	-	-
	10-Mar-98	79-3A	CALIFORNIA VOLE	-	-	-	-	-
	10-Mar-98	79-5A	PEROMYSCUS	-	-	-	-	-
	10-Mar-98	79-6A	SCELOPORUS OCCIDENTALIS	-	-	-	-	F
NIGHT 1 MM	14-Mar-98	79-1B	CAL. VOLE	-	-	-	-	-
	14-Mar-98	79-2B	CAL. VOLE	-	-	-	-	-
	14-Mar-98	79-6C	SHREW	-	-	-	-	-
	14-Mar-98	77-1B	CAL. VOLE	-	-	-	-	-
	14-Mar-98	77-1D	SHREW	-	-	-	-	-
	14-Mar-98	77-4C	R. AURORA	N	410E0A6805	77	36.5	M
	14-Mar-98	77-4C	PEROMYSCUS	-	-	-	-	-
	14-Mar-98	77-5A	PEROMYSCUS	-	-	-	-	-
	14-Mar-98	77-5A	PEROMYSCUS	-	-	-	-	-
0	20-Mar-98	79-3D	CAL. VOLE	-	-	-	-	-
	20-Mar-98	79-4B	PEROMYSCUS	-	-	-	-	-
	20-Mar-98	79-5B	SCELOPORUS OCCIDENTALIS	-	-	-	-	J
	20-Mar-98	79-6D	PEROMYSCUS	-	-	-	-	-
	20-Mar-98	77-2A	SHREW	-	-	-	-	-
	20-Mar-98	77-6C	SCELOPORUS OCCIDENTALIS	-	-	-	-	M
	20-Mar-98	77-9B	PEROMYSCUS	-	-	-	-	-
0	21-Mar-98	79-6B	SCELOPORUS OCCIDENTALIS	-	-	-	-	M
	21-Mar-98	77-9A	PEROMYSCUS	-	-	-	-	-
DAY & NIGHT	25-Mar-98	79-1B	R. AURORA	N	LR1	46	9.0	U
47.5 MM	25-Mar-98	79-1D	H. REGILLA	-	-	-	-	F
	25-Mar-98	79-1D	PEROMYSCUS	-	-	-	-	-
	25-Mar-98	79-2A	CAL. VOLE	-	-	-	-	-
	25-Mar-98	79-3A	SHREW	-	-	-	-	-
	25-Mar-98	79-5A	H. REGILLA	-	-	-	-	F
	25-Mar-98	79-6B	PEROMYSCUS	-	-	-	-	-
	25-Mar-98	79-6D	PEROMYSCUS	-	-	-	-	-
	25-Mar-98	77-1D	CAL. VOLE	-	-	-	-	-
	25-Mar-98	77-2A	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	25-Mar-98	77-2A	PEROMYSCUS	-	-	-	-	-
	25-Mar-98	77-2C	CAL. VOLE	-	-	-	-	-
	25-Mar-98	77-5A	SHREW	-	-	-	-	-
	25-Mar-98	77-6A	H. REGILLA	-	-	-	-	F
	25-Mar-98	77-6D	PEROMYSCUS	-	-	-	-	-
	25-Mar-98	77-6D	PEROMYSCUS	-	-	-	-	-
	25-Mar-98	77-7C	CAL. VOLE	-	-	-	-	-
	25-Mar-98	77-8C	SHREW	-	-	-	-	-
20 MM	28-Mar-98	77-2A	CAL. VOLE	-	-	-	-	-
MOSTLY NIGHT	28-Mar-98	77-2C	PEROMYSCUS	-	-	-	-	-
	28-Mar-98	77-8C	PEROMYSCUS	-	-	-	-	-
	28-Mar-98	77-9A	H. REGILLA	-	-	-	-	M
	28-Mar-98	79-3D	PEROMYSCUS	-	-	-	-	-
	28-Mar-98	79-6B	T. ELEGANS	-	-	-	-	-
	28-Mar-98	79-7B	H. REGILLA	-	-	-	-	F
22 MM	1-Apr-98	77-3B	CAL. VOLE	-	-	-	-	-
NIGHT & DAY	1-Apr-98	77-3D	CAL. VOLE	-	-	-	-	-
	1-Apr-98	77-3D	CAL. VOLE	-	-	-	-	-
	1-Apr-98	77-6B	CAL. VOLE	-	-	-	-	-
	1-Apr-98	77-6B	PEROMYSCUS	-	-	-	-	-
	1-Apr-98	77-7A	PEROMYSCUS	-	-	-	-	-
	1-Apr-98	77-8A	H. REGILLA	-	-	-	-	M
	1-Apr-98	79-1B	CAL. VOLE	-	-	-	-	-
	1-Apr-98	79-1B	CAL. VOLE	-	-	-	-	-
	1-Apr-98	79-1B	CAL. VOLE	-	-	-	-	-
	1-Apr-98	79-1C	CAL. VOLE	-	-	-	-	-
	1-Apr-98	79-5B	CAL. VOLE	-	-	-	-	-
	1-Apr-98	79-5D	CAL. VOLE	-	-	-	-	-
	1-Apr-98	79-6A	CAL. VOLE	-	-	-	-	-
	1-Apr-98	79-7D	CAL. VOLE	-	-	-	-	-
11 MM	4-Apr-98	77-1A	PEROMYSCUS	-	-	-	-	-
DAY	4-Apr-98	77-1C	CAL. VOLE	-	-	-	-	-
	4-Apr-98	77-3C	CAL. VOLE	-	-	-	-	-
	4-Apr-98	77-3C	CAL. VOLE	-	-	-	-	-
	4-Apr-98	79-2A	CAL. VOLE	-	-	-	-	-
	4-Apr-98	79-2C	CAL. VOLE	-	-	-	-	-
	4-Apr-98	79-3A	CAL. VOLE	-	-	-	-	-
	4-Apr-98	79-3A	CAL. VOLE	-	-	-	-	-
	4-Apr-98	79-3B	CAL. VOLE	-	-	-	-	-
	4-Apr-98	79-5D	CAL. VOLE	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	4-Apr-98	79-6B	CAL. VOLE	-	-	-	-	-
	4-Apr-98	79-6C	PEROMYSCUS	-	-	-	-	-
0	10-Aug-98	77-1D	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	77-2B	REITHRODONTOMYS	-	-	-	-	-
	10-Aug-98	77-3A	R. AURORA	N	LR2	38	5.5	U
	10-Aug-98	77-3A	R. AURORA	N	LR2	38	6.5	U
	10-Aug-98	77-3D	R. AURORA	N	LR2	33	3.0	U
	10-Aug-98	77-3C	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	77-5A	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	77-6B	SCELOPORUS	-	-	HATCHLING	-	-
	10-Aug-98	77-7A	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	77-7A	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	77-8B	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	77-8C	R. AURORA	N	LR2	34	3.0	U
	10-Aug-98	77-8C	R. AURORA	N	LR2	33	3.0	U
	10-Aug-98	77-9A	R. AURORA	N	LR2	48	9.0	U
	10-Aug-98	77-9D	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	77-9D	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-1A	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-1B	PEROGNATHUS	-	-	-	-	-
	10-Aug-98	79-1C	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-1D	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-2A	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-2A	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-2B	CAL. VOLE	-	-	-	-	-
	10-Aug-98	79-2C	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-2C	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-2D	CAL. VOLE	-	-	-	-	-
	10-Aug-98	79-3D	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-3D	PEROGNATHUS	-	-	-	-	-
	10-Aug-98	79-4C	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-4D	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-5D	PEROMYSCUS	-	-	-	-	-
	10-Aug-98	79-6B	T. ELEGANS	-	-	-	-	-
0	13-Aug-98	77-1A	PEROGNATHUS	-	-	-	-	-
	13-Aug-98	77-1D	PEROMYSCUS	-	-	-	-	-
	13-Aug-98	77-2B	PEROMYSCUS	-	-	-	-	-
	13-Aug-98	77-2C	R. AURORA	N	LR2	44	7.5	U
	13-Aug-98	77-2C	R. AURORA	N	LR2	44	7.5	U
	13-Aug-98	77-3D	R. AURORA	N	LR4	35	4.5	U

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	13-Aug-98	77-4C	R. AURORA	N	LR2	34	3.5	U
	13-Aug-98	77-4C	R. AURORA	N	LR2	34	3.0	U
	13-Aug-98	77-4D	R. AURORA	N	LR4	40	6.5	U
	13-Aug-98	77-5A	R. AURORA	N	LR2	33	3.5	U
	13-Aug-98	77-5A	R. AURORA	N	LR2	33	3.5	U
	13-Aug-98	77-5A	R. AURORA	N	LR2	32	3.0	U
	13-Aug-98	77-5C	R. AURORA	N	LR2	34	3.0	U
	13-Aug-98	77-5C	R. AURORA	N	LR2	35	4.0	U
	13-Aug-98	77-5C	R. AURORA	N	LR2	36	4.0	U
	13-Aug-98	77-5D	R. AURORA	N	LR4	36	4.5	U
	13-Aug-98	77-5D	R. AURORA	N	LR4	50	9.5	U
	13-Aug-98	77-6B	S. OCCIDENTALIS	-	-	HATCHLING	-	-
	13-Aug-98	77-6B	PEROMYSCUS	-	-	-	-	-
	13-Aug-98	77-6D	PEROGNATHUS	-	-	-	-	-
	13-Aug-98	77-6C	R. AURORA	LR2	LR2	35	3.5	U
	13-Aug-98	77-8A	H. REGILLA	-	-	META	-	-
	13-Aug-98	77-8C	R. AURORA	N	LR2	34	3.5	U
	13-Aug-98	77-8D	R. AURORA	N	LR2	39	6.0	U
	13-Aug-98	77-8D	PEROMYSCUS	-	-	-	-	-
	13-Aug-98	79-1C	DIPODOMYS AGILIS	-	-	-	-	-
	13-Aug-98	79-4A	PEROMYSCUS	-	-	-	-	-
	13-Aug-98	79-5A	EUMECES	-	-	-	-	-
	13-Aug-98	79-7D	R. AURORA	N	LR1	50	12.0	U
	13-Aug-98	79-6B	PEROMYSCUS	-	-	-	-	-
	13-Aug-98	79-5C	PEROMYSCUS	-	-	-	-	-
	13-Aug-98	79-5C	PEROMYSCUS	-	-	-	-	-
0	18-Aug-98	77-1B	R. AURORA	N	LR2	34	3.5	U
	18-Aug-98	77-2A	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	77-3A	R. AURORA	N	LR2	33	3.5	U
	18-Aug-98	77-3B	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	77-3D	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	77-4B	R. AURORA	N	LR2	32	2.5	U
	18-Aug-98	77-4C	R. AURORA	U	NO-GOT AWAY	.(33)	.(3.5)	U
	18-Aug-98	77-5A	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	77-7A	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	77-8C	R. AURORA	N	LR2	30	2.0	U
	18-Aug-98	79-1D	DIPODOMYS AGILIS	-	-	-	-	-
	18-Aug-98	79-2A	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	79-3B	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	79-6A	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	18-Aug-98	79-6C	S. OCCIDENTALIS	-	-	-	-	-
	18-Aug-98	79-6D	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	79-7D	PEROMYSCUS	-	-	-	-	-
	18-Aug-98	79-7D	PEROMYSCUS	-	-	-	-	-
0	19-Aug-98	77-3A	R. AURORA	N	LR2	33	3.0	U
	19-Aug-98	77-3B	R. AURORA	N	LR4	41	5.5	U
	19-Aug-98	77-3C	T. ELEGANS	-	IN TRAP WHEN OPENED	-	-	-
	19-Aug-98	77-5A	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	77-5A	R. AURORA	N	LR2	43	7.0	U
	19-Aug-98	77-7A	R. AURORA	N	LR2	38	4.0	U
	19-Aug-98	77-7B	H. REGILLA	-	-	META	-	-
	19-Aug-98	77-7C	T. ELEGANS	-	IN TRAP WHEN OPENED	-	-	-
	19-Aug-98	77-8B	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	79-1A	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	79-1B	DIPODOMYS AGILIS	-	-	-	-	-
	19-Aug-98	79-3A	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	79-3B	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	79-3D	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	79-4C	R. AURORA	N	LR1	41	7.5	U
	19-Aug-98	79-4D	S. OCCIDENTALIS	-	-	HATCHLING	-	-
	19-Aug-98	79-5D	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	79-5D	PEROMYSCUS	-	-	-	-	-
	19-Aug-98	79-7D	PEROMYSCUS	-	-	-	-	-
0	25-Aug-98	77-1D	T. SIRTALIS	-	IN TRAP WHEN OPENED	HATCHLING	-	-
	25-Aug-98	77-1D	T. SIRTALIS	-	IN TRAP WHEN OPENED	HATCHLING	-	-
	25-Aug-98	77-3B	R. AURORA	N	LR4	34	3.5	U
	25-Aug-98	77-3B	R. AURORA	N	LR4	37	5.0	U
	25-Aug-98	77-5A	R. AURORA	N	LR2	34	3.0	U
	25-Aug-98	77-5B	R. AURORA	N	LR2	34	3.0	U
	25-Aug-98	77-5B	R. AURORA	N	LR2	33	3.0	U
	25-Aug-98	77-5B	R. AURORA	N	LR2 - TAIL BUD	34	4.0	U
	25-Aug-98	77-5C	R. AURORA	N	LR2	36	3.5	U
	25-Aug-98	77-7A	PEROMYSCUS	-	-	-	-	-
	25-Aug-98	77-7C	R. AURORA	N	LR2	38	4.5	U
	25-Aug-98	77-7D	PEROMYSCUS	-	-	-	-	-
	25-Aug-98	77-9C	T. SIRTALIS	-	-	HATCHLING	-	-
	25-Aug-98	77-9C	S. OCCIDENTALIS	-	-	HATCHLING	-	-
	25-Aug-98	79-1C	PEROMYSCUS	-	-	-	-	-
	25-Aug-98	79-2B	PEROMYSCUS	-	-	-	-	-
	25-Aug-98	79-3D	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	25-Aug-98	79-7D	PEROMYSCUS	-	-	-	-	-
0	26-Aug-98	77-3B	PEROMYSCUS	-	-	-	-	-
	26-Aug-98	77-3A	CAL. VOLE	-	-	-	-	-
	26-Aug-98	77-4A	R. AURORA	N	LR2	30	2.0	U
	26-Aug-98	77-6A	PEROMYSCUS	-	-	-	-	-
	26-Aug-98	77-8C	R. AURORA	N	LR2	32	2.5	U
	26-Aug-98	79-4D	PEROMYSCUS	-	-	-	-	-
	26-Aug-98	79-5A	PEROGNATHUS	-	-	-	-	-
	26-Aug-98	79-6B	PEROGNATHUS	-	-	-	-	-
DAMP, COLD	10-Sep-98	77-1A	PEROMYSCUS	-	-	-	-	-
NIGHT	10-Sep-98	77-2C	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-2D	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-3A	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-3A	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-3D	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-5A	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-6B	PEROGNATHUS	-	-	-	-	-
	10-Sep-98	77-7D	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-7D	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	77-9B	CAL. VOLE	-	-	-	-	-
	10-Sep-98	79-1B	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	79-2A	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	79-3A	H. REGILLA	-	-	-	-	-
	10-Sep-98	79-4C	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	79-4D	S. OCCIDENTALIS	-	-	ADULT	-	-
	10-Sep-98	79-5C	S. OCCIDENTALIS	-	-	HATCHLING	-	-
	10-Sep-98	79-6B	PEROMYSCUS	-	-	-	-	-
	10-Sep-98	79-6D	DIPODOMYS AGILIS	-	-	-	-	-
	10-Sep-98	79-7D	T. ELEGANS	-	-	HATCHLING	-	-
WARM, STILL,	11-Sep-98	77-2C	PEROMYSCUS	-	-	-	-	-
FOG	11-Sep-98	77-2D	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	77-3A	CAL. VOLE	-	-	-	-	-
	11-Sep-98	77-4B	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	77-4C	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	77-5C	CAL. VOLE	-	-	-	-	-
	11-Sep-98	77-8A	CAL. VOLE	-	-	-	-	-
	11-Sep-98	77-9B	CAL. VOLE	-	-	-	-	-
	11-Sep-98	77-9C	S. OCCIDENTALIS	-	-	HATCHLING	-	-
	11-Sep-98	79-1A	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	11-Sep-98	79-1A	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	79-2A	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	79-3A	H. REGILLA	-	-	-	-	-
	11-Sep-98	79-3D	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	79-4A	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	79-4B	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	79-4B	PEROMYSCUS	-	-	-	-	-
	11-Sep-98	79-4D	PEROMYSCUS	-	-	ADULT	-	-
	11-Sep-98	79-4D	S. OCCIDENTALIS	-	-	-	-	-
	11-Sep-98	79-6D	PEROGNATHUS	-	-	-	-	-
DRIZZLING	15-Sep-98	77-1B	PEROGNATHUS	-	-	HATCHLING	-	-
WARM, STILL	15-Sep-98	77-2A	S. OCCIDENTALIS	-	-	-	-	-
	15-Sep-98	77-4A	PEROGNATHUS	-	-	-	-	-
	15-Sep-98	77-5B	PEROMYSCUS	-	-	-	-	-
	15-Sep-98	77-6D	PEROMYSCUS	-	-	-	-	-
	15-Sep-98	77-7D	PEROMYSCUS	-	-	-	-	-
	15-Sep-98	79-1A	DIPODOMYS AGILIS	-	-	-	-	-
	15-Sep-98	79-3D	H. REGILLA	-	-	-	-	-
	15-Sep-98	79-4C	PEROMYSCUS	-	-	-	-	-
	15-Sep-98	79-6D	PEROGNATHUS	-	-	-	-	-
	15-Sep-98	79-7B	PEROMYSCUS	-	-	-	-	-
0	16-Sep-98	77-1B	CAL. VOLE	-	-	-	-	-
	16-Sep-98	77-2C	R. AURORA	N	LR2	32	3.0	U
	16-Sep-98	77-3A	R. AURORA	N	LR2	38	5.5	U
	16-Sep-98	77-3B	R. AURORA	N	LR4	37	5.0	U
	16-Sep-98	77-3A	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	77-4A	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	77-6B	PEROGNATHUS	-	-	-	-	-
	16-Sep-98	77-6D	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	77-7C	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	77-8B	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	77-8A	R. AURORA	N	LR2	53	11.3	U
	16-Sep-98	77-8A	R. AURORA	N	LR2	39	5.0	U
	16-Sep-98	79-1B	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	79-3D	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	79-4D	DIPODOMYS AGILIS	-	-	-	-	-
	16-Sep-98	79-4D	PEROMYSCUS	-	-	-	-	-
	16-Sep-98	79-4B	PEROGNATHUS	-	-	-	-	-
	16-Sep-98	79-6C	PEROMYSCUS	-	-	-	-	-
0	24-Sep-98	77-5A	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	24-Sep-98	77-5C	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	77-5D	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	77-6A	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	77-7B	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	77-7C	PEROGNATHUS	-	-	-	-	-
	24-Sep-98	77-8B	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	77-8B	PEROGNATHUS	-	-	-	-	-
	24-Sep-98	77-8B	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	77-8D	PEROGNATHUS	-	-	-	-	-
	24-Sep-98	79-1C	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-2B	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-2B	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-2B	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-2C	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-2D	SHREW	-	-	-	-	-
	24-Sep-98	79-3B	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-4D	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-6D	PEROMYSCUS	-	-	-	-	-
	24-Sep-98	79-7B	PEROMYSCUS	-	-	-	-	-
0	25-Sep-98	77-3A	R. AURORA	N	LR2	52	12.5	U
	25-Sep-98	77-4B	S. OCCIDENTALIS	-	-	HATCHLING	-	-
	25-Sep-98	77-4C	PEROGNATHUS	-	-	-	-	-
	25-Sep-98	77-4C	R. AURORA	N	LR2	33	3.0	U
	25-Sep-98	77-5B	PEROGNATHUS	-	-	-	-	-
	25-Sep-98	77-5D	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	77-7D	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	77-8A	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	77-8B	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	77-9B	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	79-1B	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	79-2D	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	79-4B	SHREW	-	-	-	-	-
	25-Sep-98	79-5B	PEROGNATHUS	-	-	-	-	-
	25-Sep-98	79-5D	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	79-6B	PEROGNATHUS	-	-	-	-	-
	25-Sep-98	79-7B	PEROMYSCUS	-	-	-	-	-
	25-Sep-98	79-7B	PEROMYSCUS	-	-	-	-	-
0	3-Oct-98	77-1D	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	77-3A	PEROGNATHUS	-	-	-	-	-
	3-Oct-98	77-3C	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	3-Oct-98	77-5B	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	77-5B	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	77-5C	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	77-6A	S. OCCIDENTALIS	-	-	-	-	-
	3-Oct-98	77-6C	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	77-7B	PEROGNATHUS	-	-	-	-	-
	3-Oct-98	77-8A	CAL. VOLE	-	-	-	-	-
	3-Oct-98	79-1B	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	79-2C	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	79-2D	PEROMYSCUS	-	-	-	-	-
	3-Oct-98	79-3C	H. REGILLA	-	-	-	-	-
	3-Oct-98	79-4D	S. OCCIDENTALIS	-	-	-	-	-
	3-Oct-98	79-6D	DIPODOMYS AGILIS	-	-	-	-	-
	3-Oct-98	79-7D	PEROMYSCUS	-	-	-	-	-
0	4-Oct-98	77-1D	PEROMYSCUS	-	-	-	-	-
	4-Oct-98	77-5A	PEROGNATHUS	-	-	-	-	-
	4-Oct-98	77-8A	PEROMYSCUS	-	-	-	-	-
	4-Oct-98	77-8B	PEROMYSCUS	-	-	-	-	-
	4-Oct-98	79-1B	PEROMYSCUS	-	-	-	-	-
	4-Oct-98	79-2D	PEROMYSCUS	-	-	-	-	-
	4-Oct-98	79-3A	PEROGNATHUS	-	-	-	-	-
	4-Oct-98	79-3B	H. REGILLA	-	-	-	-	-
	4-Oct-98	79-6B	PEROMYSCUS	-	-	-	-	-
	4-Oct-98	79-6D	PEROMYSCUS	-	-	-	-	-
10 MM RAIN	8-Nov-98	77-1A	R. AURORA	N	LR2	50	9.0	U
NIGHT	8-Nov-98	77-1D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-2A	R. AURORA	N	LR2	45	6.0	U
	8-Nov-98	77-2A	H. REGILLA	-	-	META	-	-
	8-Nov-98	77-2B	R. AURORA	N	LR4	50	8.5	U
	8-Nov-98	77-2B	R. AURORA	N	LR4	44	7.0	U
	8-Nov-98	77-2B	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-2C	R. AURORA	N	LR2	48	9.0	U
	8-Nov-98	77-3B	S. OCCIDENTALIS	-	-	-	-	-
	8-Nov-98	77-3D	CAL. VOLE	-	-	-	-	-
	8-Nov-98	77-3C	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-4A	CAL. VOLE	-	-	-	-	-
	8-Nov-98	77-4B	R. AURORA	N	LR4	52	10.5	U
	8-Nov-98	77-4B	R. AURORA	N	LR4	43	5.5	U
	8-Nov-98	77-5B	CAL. VOLE	-	-	-	-	-
	8-Nov-98	77-5B	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	8-Nov-98	77-5B	R. AURORA	N	LR2	35	3.5	U
	8-Nov-98	77-5B	R. AURORA	N	LR2	49	9.0	U
	8-Nov-98	77-5C	R. AURORA	N	LR2	32	2.5	U
	8-Nov-98	77-5D	R. AURORA	N	LR2	38	4.5	U
	8-Nov-98	77-5D	R. AURORA	N	LR2	45	7.5	U
	8-Nov-98	77-5D	R. AURORA	N	LR2	40	4.5	U
	8-Nov-98	77-6B	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-6D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-6D	R. AURORA	N	LR2	36	4.0	U
	8-Nov-98	77-6D	R. AURORA	N	LR2	54	12.0	U
	8-Nov-98	77-7B	R. AURORA	N	LR2	54	13.0	U
	8-Nov-98	77-7B	R. AURORA	N	LR2	45	7.5	U
	8-Nov-98	77-7C	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-7C	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-7C	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-7D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	77-8C	R. AURORA	N	LR2	51	8.5	U
	8-Nov-98	77-8D	R. AURORA	N	LR2	51	9.0	U
	8-Nov-98	77-8D	R. AURORA	N	LR2	49	8.5	U
	8-Nov-98	77-8D	R. AURORA	N	LR2	45	7.5	U
	8-Nov-98	77-8D	H. REGILLA	-	-	META	-	-
	8-Nov-98	77-9B	R. AURORA	N	LR2	44	7.0	U
	8-Nov-98	77-9C	R. AURORA	N	LR2	47	7.0	U
	8-Nov-98	77-9C	R. AURORA	N	LR2	52	10.5	U
	8-Nov-98	77-9C	R. AURORA	N	LR2	44	6.5	U
	8-Nov-98	79-1A	R. AURORA	N	LR1	51	11.0	U
	8-Nov-98	79-1A	R. AURORA	N	LR1	40	5.5	U
	8-Nov-98	79-1A	R. AURORA	N	LR1	49	8.5	U
	8-Nov-98	79-1A	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-1B	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-1B	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-1D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-1C	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-1C	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-2B	R. AURORA	N	LR1	51	10.0	U
	8-Nov-98	79-2D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-2C	R. AURORA	N	LR1	48	8.0	U
	8-Nov-98	79-3B	R. AURORA	N	LR1	46	8.5	U
	8-Nov-98	79-3B	R. AURORA	N	LR1	47	8.5	U
	8-Nov-98	79-3B	R. AURORA	N	LR1	40	4.5	U

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	8-Nov-98	79-3D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-3D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-3C	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-4A	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-4A	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-4D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-4C	UTA STANSBURIANA	-	-	-	-	-
	8-Nov-98	79-5A	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-5B	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-5B	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-5D	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-5C	R. AURORA	N	LR1	58	15.5	U
	8-Nov-98	79-6A	R. AURORA	N	LR1	65	17.5	U
	8-Nov-98	79-6A	R. AURORA	N	LR1	52	9.5	U
	8-Nov-98	79-6A	R. AURORA	N	LR1	53	10.0	U
	8-Nov-98	79-6B	PEROMYSCUS	-	-	-	-	-
	8-Nov-98	79-6B	CAL. VOLE	-	-	-	-	-
	8-Nov-98	79-6C	R. AURORA	N	LR1	60	16.5	U
	8-Nov-98	79-7A	R. AURORA	N	LR1	54	11.0	U
	8-Nov-98	79-7A	R. AURORA	N	LR1	43	6.0	U
	8-Nov-98	79-7A	R. AURORA	N	LR1	44	6.0	U
	8-Nov-98	79-7C	R. AURORA	N	LR1	56	13.0	U
	8-Nov-98	79-7C	R. AURORA	N	LR1	52	9.5	U
	8-Nov-98	79-7C	R. AURORA	N	LR1	50	10.0	U
	8-Nov-98	79-7C	PEROMYSCUS	-	-	-	-	-
TRACE	9-Nov-98	77-6B	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	77-6B	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	77-6B	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	77-6B	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	77-6D	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	77-8B	DIPODOMYS AGILIS	-	-	-	-	-
	9-Nov-98	77-8B	PEROGNATHUS	-	-	-	-	-
	9-Nov-98	77-9A	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	77-9D	S. OCCIDENTALIS	-	-	-	-	-
	9-Nov-98	79-2B	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	79-5B	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	79-5B	S. OCCIDENTALIS	-	-	-	-	-
	9-Nov-98	79-6B	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	79-6C	PEROMYSCUS	-	-	-	-	-
	9-Nov-98	79-7B	PEROMYSCUS	-	-	-	-	-

PITFALL TRAPPING

RAIN	DATE	TRAP NO.	SPECIES	R?	PIT/CLIP	LENGTH	MASS	SEX
	9-Nov-98	79-7B	S. OCCIDENTALIS	-	-	-	-	-
55 MM NIGHT	28-Nov-98	77-5B	R. AURORA	N	LR2	42	6.0	U
(LATE) COLD	28-Nov-98	77-7B	R. AURORA	N	LR2	50	10.0	U
	28-Nov-98	77-7C	PEROMYSCUS	-	-	-	-	-
	28-Nov-98	77-8B	R. AURORA	N	LR2	51	10.5	U
	28-Nov-98	77-8B	R. AURORA	N	LR2	44	7.0	U
	28-Nov-98	79-1C	R. AURORA	N	LR1	64	24.0	U
	28-Nov-98	79-3A	PEROMYSCUS	-	-	-	-	-
	28-Nov-98	79-5C	R. AURORA	N	410D537143	127	219.0	F
	28-Nov-98	79-7C	R. AURORA	N	LR1	47	9.0	U
0	29-Nov-98	77-3A	CAL. VOLE	-	-	-	-	-
	29-Nov-98	77-4B	PEROMYSCUS	-	-	-	-	-
	29-Nov-98	77-4D	CAL. VOLE	-	-	-	-	-
	29-Nov-98	77-7A	PEROMYSCUS	-	-	-	-	-
	29-Nov-98	77-9C	PEROMYSCUS	-	-	-	-	-
	29-Nov-98	79-4B	PEROMYSCUS	-	-	-	-	-
	29-Nov-98	79-7B	PEROMYSCUS	-	-	-	-	-