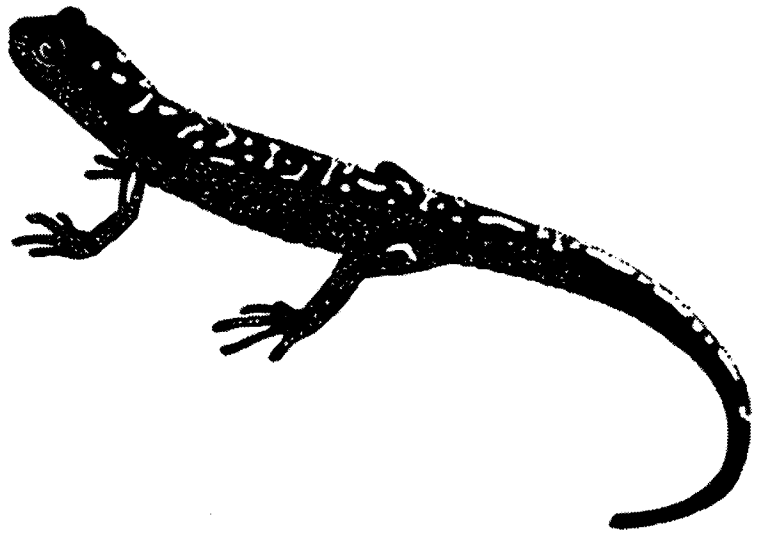
U.S. Fish & Wildlife Service

Draft Revised Recovery Plan for the Santa Cruz Long-toed Salamander



SANTA CRUZ LONG-TOED SALAMANDER

(*Ambystoma macrodactylum croceum*)

DRAFT

REVISED RECOVERY PLAN

(Original Approved September 28, 1977)

(Revised December 23, 1985)

(Second Revision April 1999)

Region 1

U.S. Fish and Wildlife Service

911 NE 11th Avenue

Portland, OR 97232-4181

Revision Approved: XXXXXXX

Manager, California/Nevada Operations Office,

Region 1, U.S. Fish and Wildlife Service

Date: _____

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Literature citation of this document should read as follows:

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ACKNOWLEDGMENTS

This recovery plan was prepared by Grace S. McLaughlin of the U.S. Fish and Wildlife Service (Service), with input from Mark R. Jennings (U.S. Geological Survey, Biological Resources Division), Catherine McCalvin (Service), Stephen B. Ruth (Science Research and Consulting Services), Erin Fernandez (Service), David Dixon (California Department of Parks and Recreation), Steve Maki (Monterey County Planning Department), and Constance Rutherford (Service).

EXECUTIVE SUMMARY

Current Status: The Santa Cruz long-toed salamander is federally listed as endangered. It is currently known from three population clusters (metapopulations) in coastal areas of central California's Santa Cruz and Monterey Counties.

Habitat Requirements and Limiting Factors: This salamander inhabits temporary ponds for breeding and adjacent upland scrub and woodland areas during the nonbreeding season. These ponds and adjacent scrub and woodland habitats are restricted naturally to relatively few areas along the central coast of California. Direct habitat loss due to agriculture, urbanization, and road construction is the main cause for this salamander's decline. Other known threats include pollution, siltation, and declining water quality in breeding ponds due to nearby development and agricultural activities; loss of nonbreeding habitat and food resources due to the spread of exotic plants; predation by introduced fishes, bullfrogs, and tiger salamanders; and parasites.

Recovery Priority: 3 on a scale of 1 to 18. The priority is based on its being a subspecies (rather than a full species) with a high degree of threat and high recovery potential.

Recovery Objectives: 1) Reclassify from endangered to threatened status. 2) Delist.

Recovery Criteria: The Santa Cruz long-toed salamander may be reclassified to threatened status when breeding and upland habitats are conserved, maintained, and/or restored so that self-sustaining populations or subpopulations are supported for a minimum of 20 years at the following complexes: Valencia-Seascape, Larkins Valley, Ellicott-Buena Vista, and McClusky Slough. Each habitat complex must include at least two functional breeding ponds, adequate upland scrub or woodland habitats within migration distance for the salamanders, and protected corridors (if necessary) connecting ponds to upland habitats. The Santa Cruz long-toed salamander may be considered for delisting when the above criteria are met, with the added stipulation that there shall be at least three functional breeding ponds in each complex, and at least two additional subpopulations and their habitats are protected and managed as discussed above. At least one additional population or subpopulation shall be in Monterey County. Due to this salamander's limited distribution, relatively small population sizes, and the dynamic

nature of its habitats, all populations or subpopulations warrant protection and appropriate management. A self-sustaining population is defined as a population exhibiting an approximately equal adult sex ratio and successful breeding and recruitment, as evidenced by an age structure indicative of a stable or growing population.

Actions Needed:

1. Perpetuate self-sustaining populations of breeding Santa Cruz long-toed salamanders at Valencia-Seascape, Larkins Valley, Ellicott-Buena Vista, and McClusky Slough complexes by managing pond and upland habitats for this salamander, reducing human-related mortality, and monitoring populations.
2. Conduct surveys in the general area of each complex to locate additional breeding sites and upland habitat areas. Identify parcels that would be appropriate for conservation agreements or easements, acquisition, or other management actions.
3. Assess the distribution and population status of Santa Cruz long-toed salamanders at other known sites and at new locations found through the Task 2 surveys. Plan and implement appropriate management strategies and actions.
4. Conduct research on which to base management of Santa Cruz long-toed salamander habitats and populations.
5. Continue and expand the public education and information programs used by the California Department of Fish and Game and the Service, which have been effective.

Total Cost of Recovery (minimum): $6,519,000

Costs, in thousands of dollars:

Year	Minimum Costs: ($000's)
1999	957.5
2000	571.5
2001	517
2002	325
2003	284
2004 – 2018	3,864

Date of Recovery: If recovery criteria are met, reclassification to threatened status could be initiated in 2018.

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PART I: INTRODUCTION

Brief Overview

The Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*) was originally discovered on December 2, 1954 at Valencia Lagoon, Rio del Mar, Santa Cruz County, California (Russell and Anderson 1956; Figure 1). In 1955, this breeding pond was reduced in size by highway construction along California State Highway 1 (Robert C. Stebbins, University of California at Berkeley, unpublished field notes, 1955). Subsequent surveys in the southern part of Santa Cruz County found only one other breeding site, at Ellicott Slough, in 1956 (Anderson 1967; Figure 1). Herpetologists, who believed this to be the extent of the Santa Cruz long-toed salamander's range, recommended that the two known habitats be protected from housing developments (Grobman 1955; Ferguson 1963). Despite this recommendation, public agencies remained generally unaware of the salamander's existence and its distribution. When the California Department of Transportation (Caltrans) converted California State Highway 1 to a freeway in 1969, it eliminated the Valencia Lagoon breeding pond (Bury and Ruth 1972). During the same period, the only other known breeding pond, at Ellicott Slough, was threatened by a proposed mobile home park (Ferguson 1963), for which developers obtained permits in 1970 (Ruth 1974, 1988a). Threats such as these, along with the inherently limited distribution of the Santa Crux long-toed salamander, resulted in its listing as an endangered species by the U.S. Fish and Wildlife Service (32 FR 4001, 11 March 1967) and the California Fish and Game Commission (21 May 1971) (Bury 1972; Bury and Ruth 1972). The original recovery plan was prepared by the Santa Cruz Long-Toed Salamander Recovery Team and approved by the Service in 1977 (Service 1977). In response to the discovery of additional populations, a revised recovery plan was prepared, and it was approved in 1985 (Service 1986). It has been revised to incorporate important new information on the status and distribution of Santa Cruz long-toed salamanders and their habitats, and to apply recent advances in metapopulation theory[1] and dynamics to the management of the populations and subpopulations.

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[1] Metapopulations are groups of (sub)populations that are genetically interconnected through occasional exchange of animals. While individual populations may go extinct, a metapopulation is likely to persist through colonization/recolonization events that establish new populations.

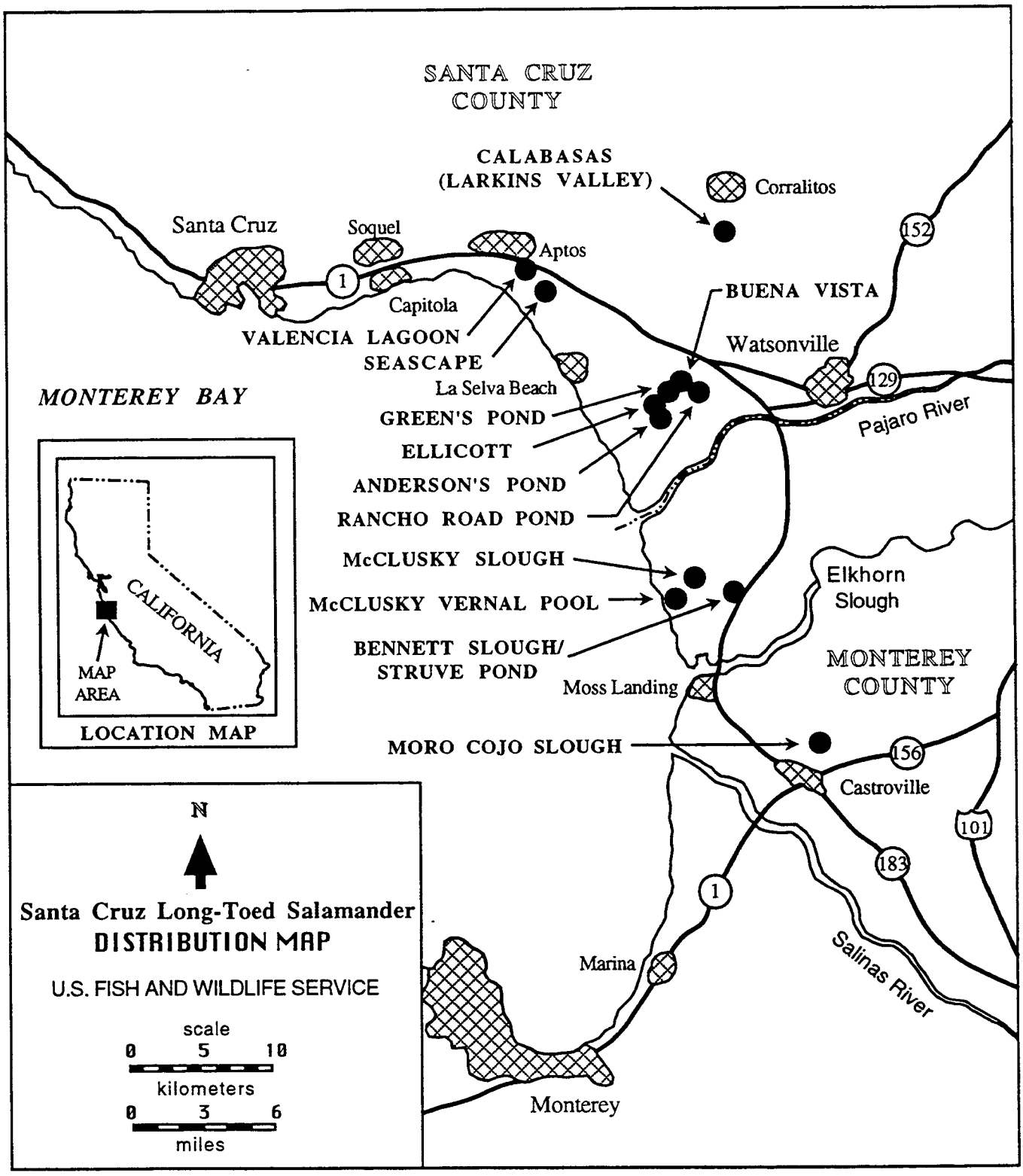

Figure 1. Current known distribution of the Santa Cruz long-toed salamander in Santa Cruz and Monterey counties, California.

Ten additional breeding sites for Santa Cruz long-toed salamanders have been identified in Santa Cruz and Monterey Counties since it was listed (Santa Cruz County/northern metapopulation — Seascape Pond, Calabasas Pond, Buena Vista Pond, Green's Pond, Anderson's Pond, and Rancho Road Pond; Monterey County/central metapopulation — McClusky Slough, McClusky vernal pool, and Bennett Slough/Struve Pond; and Monterey County/southern metapopulation — Moro Cojo Slough; Figure 1). In addition, this salamander has been seen along several roads near the Calabasas Pond site and at the Elkhorn Slough National Estuarine Research Institute's Visitors Center. Of the 12 known sites, 7 have been documented to support breeding efforts in the last 5 years (Seascape Pond, Calabasas Pond, Ellicott Slough, Buena Vista Pond, Rancho Road Pond, McClusky Slough, and McClusky vernal pool). Of the 5 other sites, 3 have experienced habitat degradation that has precluded breeding by this salamander (Valencia Lagoon and Bennett Slough/Struve Pond) and 2 have not been surveyed for at least 5 years (Green's and Anderson's Ponds in the Ellicott/Buena Vista complex, and Moro Cojo Slough) (principal references are: Patricia Anderson, California Dept. of Fish and Game, pers. comm. 1998; Jennings 1995; Steve Miller, *in litt.*, 1996; Reed 1979; Ruth 1988a, 1988b; Stephen B. Ruth, Science Research and Consulting Services, Marina, Calif., *in litt.*, 1988, pers. comm. 1997; Talent and Talent 1980; details, including references by site, are provided in the Distribution and Population Status section, page 10).

Actions are being taken to protect, restore, and manage the Santa Cruz long-toed salamander and its habitat. These actions include habitat acquisition, conservation easements, and the development and implementation of habitat management plans, habitat conservation plans, and watershed management plans. The details are presented in the Conservation Measures section of this plan.

Actions undertaken at the Ellicott site (including Ellicott Pond, Ellicott Slough National Wildlife Refuge, and California Department of Fish and Game Salamander Ecological Reserve) appear to have slowed further degradation of the breeding pond and are improving the upland habitat, while actions implemented at Valencia Lagoon have not been sufficient to ensure the continued breeding and recruitment of this salamander. At other sites, planning and implementation of management actions has been so recent that it is premature to assess the results. This revised recovery plan identifies ongoing and

potential threats to Santa Cruz long-toed salamander and its habitats, conservation measures that have been implemented, and actions necessary for its recovery.

Description and Taxonomy

The Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*) is a small dark-colored salamander of the family Ambystomatidae (Figure 2). The adults have an average snout-to-vent length of 42 to 71 millimeters (1.7 to 2.8 inches), with an average total length of 105 to 150 millimeters (4.2 to 6.0 inches). They weigh approximately 3.0 to 9.8 grams (0.1 to 0.4 ounce). This subspecies differs from subspecies *A. m. macrodactylum* by its dull orange or metallic yellow dorsal markings (a series of discrete, irregular patches on its "back" side), and by greatly reduced dorsal head markings of small scattered dots, which are often absent, anterior to (in front of) the eyes (Ferguson 1961; Stebbins 1966, 1985). The ventral ("stomach") surface is sooty black. The vomerine teeth (located on the roof of the mouth) form a continuous or broken row. Differences in biochemistry (Sage 1978), physiology, and life history traits (Anderson 1960, 1967, 1968a, 1968b, 1972a, 1972b, 1972c) support the separation of *A. m. croceum* as a distinct species. However, until a more thorough investigation of the genetics of the species is conducted and a revision of the taxonomy published in a peer-reviewed journal, Santa Cruz long-toed salamanders will continue to be considered a subspecies of long-toed salamander (*A. macrodactylum*).

Life History and Ecology

The Santa Cruz long-toed salamander spends a substantial portion of its life underground in small mammal burrows. Examples of the small mammal burrows include mice (*Peromyscus* spp.), California voles (*Microtus californicus*), Botta pocket gophers (*Thomomys bottae*), and California moles (*Scapanus latimanus*). This salamander is also found among the root systems of plants in upland chaparral and woodland areas of coast live oak (*Quercus agrifolia)* or Monterey pine (*Pinus radiata*), and in strips of riparian vegetation such as arroyo willows (*Salix lasiolepis*), cattails (*Typha* spp.), and bulrush (*Scirpus* spp.). These areas are desirable because they are protected from heat and the drying rays of the sun (Reed 1979, 1981). The soils associated with these plant communities are usually sandy loams formed on old dune deposits, marine terraces, or alluvium deposits (Cook 1978, Bowman and Estrada 1980).

Figure 2. Adult (actual size) Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*). Reproduced from photograph taken at Buena Vista by Mark R. Jennings.

Santa Cruz long-toed salamanders usually breed in shallow, ephemeral freshwater ponds. The ponds at the Valencia, Seascape, Calabasas, Buena Vista, Green's, and Rancho Road sites are human-made or modified. The extent of the upland habitat used by salamanders adjacent to the ponds varies from a narrow ring of riparian vegetation on the perimeter of the pond, to extensive riparian vegetation adjacent to the ponds, and oak woodlands and chaparral as far as 1.6 kilometers (1.0 mile) or more from the ponds (Ruth and Tollestrup 1973). Although no adult salamanders have been found more than about 1 kilometer (0.6 mile; straight line distance) from a breeding site where they were originally marked (Reed 1979), the studies may not have been designed appropriately to determine the extent of salamander movements and habitat use away from the breeding ponds.

The distance between known breeding and estivation[2] locations varies from site to site and apparently depends on soil type, slope, aspect, vegetation structure and composition, and the size of the breeding pond. During studies at Valencia Lagoon and the Ellicott site, up to 90 percent of the adults were captured within 125 meters (400 feet) of the breeding pond and subsequently not caught in more distant trap lines (Reed 1979, 1980, 1981). Conversely, Ruth (1988b) found that significant numbers (22 percent) of Seascape Pond's adult salamanders were migrating more than 250 meters (800 feet) through grasslands to reach suitable nonbreeding habitat in oak woodlands. Ruth (1994) has indicated in more recent reports that Santa Cruz long-toed salamanders may be migrating more than 300 meters (960 feet) between breeding ponds and upland habitats. The few records of unmarked juvenile and adult salamanders found more than 1.6 kilometers (1.0 mile) from the nearest known breeding site may represent individuals from as yet unknown breeding sites. Alternatively, they may be dispersed individuals that found suitable upland habitat in which to survive (at least during years of above-average rainfall) but may not be part of any regular salamander breeding population. Such wide-ranging movements of a few salamanders in each subpopulation probably ensure the colonization of nearby breeding habitats.

Adult Santa Cruz long-toed salamanders leave their upland chaparral and woodland summer retreats at the onset of the rainy season in mid- to late-November or December, and begin their annual nocturnal migration to the breeding ponds (Anderson 1960). They

[2] estivation is summer inactivity

often forage for invertebrates on the soil surface — primarily isopods, but also beetles, slugs and earthworms (Anderson 1968b). Adult Santa Cruz long-toed salamanders migrate primarily on nights of rain, mist, or heavy fog (Anderson 1960, 1967; Ruth and Tollestrup 1973; Reed 1979, 1981). They arrive at the breeding ponds from November through March, with most arrivals occurring in January and February (Anderson 1967, Reed 1979, Ruth 1988b). Peak breeding occurs during January and February because earlier rains are usually insufficient to fill the breeding ponds (Anderson 1967). Adults may skip breeding for one or more years if little or no surface water is present (Russell and Anderson 1956). Males usually migrate to pond sites 1 to 2 weeks before the females (Reed 1979, 1981; Ruth 1988a), although they may move up to 6 weeks earlier depending on rainfall patterns (Ruth and Tollestrup 1973). As female salamanders enter the pond, they pair with males, court, and breed (Anderson 1961, 1967; Reed 1979, 1981). Males apparently remain in ponds twice as long (1 to 5 weeks) as females (Ruth 1988a) and may successfully breed with more than one female each season (Reed 1981). Sex ratios of sampled populations vary depending on site, time of year, and distance from the pond. However, most studies using standard mark-recapture methods have found sex ratios of one to two males per female at the breeding sites, with more females found farther from the ponds (0.6 males per female) (Reed 1981; Ruth 1988b, 1994).

Female Santa Cruz long-toed salamanders have specialized and selective egg-laying habits. Eggs are laid singly on submerged stalks of spikerush (*Eleocharis* spp.) or other vegetation about 2 to 3 centimeters (1 inch) apart (Anderson 1960, 1967). Unattached and clustered eggs have also been observed (Reed 1981). Each female lays about 300 (range 215 to 411) eggs per year (Anderson 1967).

After courtship and egg laying, most adult Santa Cruz long-toed salamanders leave the pond in March or April and return to the same general upland areas where they spent the previous summer, often foraging while en route. Some adults may remain in the vicinity of the breeding site for a year or more before returning to more distant terrestrial retreats (Ruth 1988b). The eggs and larvae are unattended by the adults.

Eggs usually hatch after 15 to 30 days into the aquatic larval stage (Reed 1979, 1981; Ruth 1988a); the actual development time depends on water temperature (Anderson 1972b). The larvae, which subsist largely on aquatic invertebrates such as mosquito

larvae and worms, as well as larval amphibians (e.g., Pacific treefrogs [*Hyla regilla*] and salamander larvae) (Anderson 1968b), remain in the pond environment for 90 to 145 days until they reach about 32 millimeters (1.3 inches) snout to vent length (Anderson 1960). However, the body size at initiation of metamorphosis is variable, ranging from 26 to 48 millimeters (1.0 to 1.8 inches) snout to vent length (Anderson 1967, Reed 1981, Ruth 1988b). Metamorphosis may extend from early May to mid-August, but all of the larvae may metamorphose in a relatively short period of time if the pond environment becomes unsuitable (Anderson 1967; Ruth and Tollestrup 1973; Reed 1979, 1981; Ruth 1988a).

A complex of factors determines the timing of metamorphosis in ambystomatid salamanders (salamanders that belong to the family Ambystomidae; Wilbur and Collins 1973, Wilbur 1976, Smith-Gill and Berven 1979, Werner 1986). In the closely-related mole salamander *(A. talpoideum)*, metamorphosis can be induced in the laboratory by starvation, water pollution, increased water temperatures, or drying of the aquatic habitat (Shoop 1960). If water quality remains suitable, remaining in the pond for a longer period of time may be advantageous to the larvae. A larger body size at metamorphosis increases resistance to desiccation, makes the individual less vulnerable to predation, and increases the size range of food items that can be eaten (Werner 1986).

As the ponds begin to dry, juvenile Santa Cruz long-toed salamanders move at night and may seek refuge underground, in litter at the pond site, or in adjacent willow stands (Anderson 1967; Reed 1979, 1981). However, Andoli (1995) and Jennings (1995) found that most juvenile Santa Cruz long-toed salamanders moved at least 30 to 60 meters (100 to 200 feet) from the breeding pond during the initial migration phase. In their studies, migration was associated with unusual heavy rains in mid-June. During the next rainy season, the juveniles disperse farther away from the pond, not returning until they reach sexual maturity at 2 to 3 years (Ruth 1988a). Anderson (1967) reported minimum adult size (snout to vent length) as 52 millimeters (2.1 inches) for females and 46 millimeters (1.8 inches) for males. Reed (1981) reported minimum adult size as 42 millimeters (1.7 inches), and Ruth (1994) reported minimum adult size of 52 millimeters (2.1 inches). Few data exist regarding dispersal movements of juveniles, foraging ecology, habitat use, or movements of adult salamanders during the nonbreeding season.

Santa Cruz long-toed salamanders apparently are long-lived creatures, possibly living for

a decade or more. An adult Santa Cruz long-toed salamander confiscated by law enforcement officials was kept in captivity for more than 8 years until its death (S. B. Ruth, *in litt.*, 1998). Adults of the closely related southern long-toed salamander (*A. m. sigillatum*) have lived more than 6 years in captivity (Snider and Bowler 1992), and the eastern long-toed salamander (*A. m. krausei*) have been known to survive 10 years in the wild (Russell et al. 1995).

Santa Cruz long-toed salamanders are vulnerable to several predators. Eggs and larvae may be preyed upon by mosquitofish (*Gambusia affinis*) and crayfish (*Procambarus* spp.). These introduced species have also been implicated in the declines of other amphibian species (Blyth 1994, Axelsson *et al.* 1997, Gillespie and Hero in preparation). Larvae are also eaten by adult Santa Cruz long-toed salamanders, California tiger salamanders (*A. californiense*) (Blau 1972), predacious aquatic insects, and a few bird species including mallard ducks (*Anas platyrhynchos*) (Mark R. Jennings, U.S. Geological Survey, Biological Resources Division, pers. obs.). Larvae and juveniles probably are preyed upon by herons (*Ardea herodias, Butorides striatus, Egretta* spp.), grebes (*Podilymbus podiceps*, *Podiceps* spp.), and kingfishers (*Ceryle alcyon*). Predators of juvenile Santa Cruz long-toed salamanders include introduced opossums (*Didelphis virginiana*), striped skunks (*Mephitis mephitis*), and ringneck snakes (*Diadophis punctatus*) (Reed 1979). Adults and juveniles also can be preyed upon by raccoons (*Procyon lotor*). Larvae, juveniles, and adults are prey to California tiger salamanders, coast garter snakes (*Thamnophis atratus*), western terrestrial garter snakes (*T. elegans*), and common garter snakes (*T. sirtalis*) (Ruth 1988a). Predation of adult salamanders by birds is minimized by the availability of sufficient cover and by the adults' secretive, primarily nocturnal activities. Burrowing mammals such as California moles apparently avoid Santa Cruz long-toed salamanders because of toxic skin secretions (Anderson 1963).

Larval Santa Cruz long-toed salamanders are parasitized by a digenetic trematode (flatworm, fluke; Family Plagiorchiidae) that can cause the creation of extra limbs as well as other limb deformities. In 1986 and 1987, 39 percent of the larval and juvenile salamanders and 72 percent of the larval Pacific tree frogs at Seascape Pond had limb abnormalities caused by massive infestations of trematodes, compared to less than 5 percent of the adult salamanders and less than 3 percent of the adult treefrogs captured

(Sessions and Ruth 1990). Heavily-infested larval salamanders may be unlikely to survive to metamorphosis because of an increased risk to predation by garter snakes and other predators in which the trematode's life cycle presumably is completed. Given their habitats and life history traits, larval, juvenile, and adult Santa Cruz long-toed salamanders probably harbor a number of internal parasites.

Distribution and Population Status

The Santa Cruz long-toed salamander is a relict form of a species that probably was widespread throughout much of California during and immediately after the last Pleistocene ice advance, 10,000 to 12,000 years ago (Ruth and Tollestrup 1973). Scientists believe that during climatic changes and drying conditions in California following the end of the Pleistocene epoch (Stebbins 1949, Raven and Axelrod 1978), a population of the ancestral salamander species became isolated in the area of present-day Santa Cruz, California, about 840 kilometers (520 miles) south of the nearest coastal population of the long-toed salamander and about 240 kilometers (150 miles) southwest of the nearest Sierra Nevada population (Russell and Anderson 1956). In adapting to the very different conditions, far from the main range of long-toed salamanders, the Santa Cruz population evolved during the last several thousand years into a distinct subspecies.

The Santa Cruz area is geologically active, so the dynamic processes of pond, lagoon, and slough formation have ensured the availability of alternate breeding sites. Because breeding ponds are ephemeral, they vary greatly in size and duration of persistence from year to year, and may not fill at all during periods of subnormal rainfall. However, breeding ponds are likely enough to fill at least once over a period of 5 to 10 years to ensure successful recruitment into Santa Cruz long-toed salamander populations, and the populations' survival over many generations. Eventually, all suitable breeding ponds will silt in and new ones will be created by geologic processes or, as in more recent times, by human activities. This creates a dynamic mosaic in space and time of suitable breeding and nonbreeding habitats for the salamander throughout its limited range (Ruth 1988a).

Suitable upland habitats were formerly more widespread, and corridors for dispersing and migrating salamanders may have existed that allowed for genetic exchange over most of the range of the species. Anthropogenic changes (including agricultural, industrial and

urban developments, highways, and railroads) have reduced the habitat available to Santa Cruz long-toed salamanders and tended to isolate the subpopulations. Such changes also have altered the natural dynamics of pond formation and maintenance, as well as altering migration corridors and the accessibility of alternate breeding sites. However, human activities, including pond construction and road building, may have increased the number of ponds suitable for breeding. If sufficient uplands are available to support nonbreeding activities, and migration corridors allowing access to the ponds are available, the habitat available to the species may have been increased with a consequent increase in the range of the species or in the number of individuals in some subpopulations.

Based on the available survey data, the Santa Cruz long-toed salamander's distribution appears to consist of three metapopulations, each with one or more subpopulations, inhabiting one or more ponds or sloughs and the surrounding upland habitats. The metapopulations originally may have been separated by unsuitable habitat consisting of large rivers and sloughs, or extensive areas of coastal scrub and grasslands. Today, the Pajaro River and Elkhorn Slough act as barriers between metapopulations, as do extensive areas of agriculture. The subpopulations within the complexes (the ponds and upland habitats that harbor subpopulations — see Table 1) are focused around individual breeding ponds or clusters of ponds. Areas of suitable riparian and woodland vegetation between ponds within complexes allow Santa Cruz long-toed salamanders to move between ponds and to locate new ponds as they became available. However, much of this habitat has been lost to agriculture, urbanization, and highway construction.

The northern or Santa Cruz County metapopulation (consisting of four currently recognized subpopulations) appears to be restricted to the area bounded by Valencia Creek on the north, Corralitos Creek on the east, the Pajaro River on the south, and the Pacific Ocean on the west. The central or McClusky Slough metapopulation is found in the region between the Pajaro River and Elkhorn Slough, and the southern or Moro Cojo metapopulation is located between Elkhorn Slough and the Salinas River. In the central and southern metapopulations, the known breeding sites are very close to each other, so these metapopulations cannot be subdivided into distinct subpopulations, based on current knowledge of salamander movements. Further surveys in suitable habitats may find new subpopulations or metapopulations.

It is important to maintain connectivity between breeding ponds within subpopulation ranges and between adjacent subpopulations. If one or more breeding aggregations within a subpopulation, or subpopulations, becomes extirpated due to a catastrophic event, then individuals from nearby aggregations or subpopulations can recolonize the site when suitable habitat becomes available, or colonize any new habitats that are created. The cycle of continuous extinction and recolonization events in suitable habitats is a common theme for ambystomatid salamanders (Shaffer et al. 1993).

Rather than discussing each individual breeding pond or location where Santa Cruz long-toed salamanders have been identified, the plan discusses subpopulations and the core areas they inhabit as complexes within the metapopulations, as shown below.

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Table 1. Subpopulation complexes.

Northern or Santa Cruz metapopulation	
Valencia-Seascape complex	Valencia Lagoon and Seascape Pond, the intervening habitat in Cuesta Canyon/Bush Gulch (Willow Canyon property), and surrounding upland habitats
Larkins Valley complex	Calabasas Pond and associated uplands in Larkins Valley, other ponds and associated uplands that may support Santa Cruz long-toed salamanders.
Ellicott-Buena Vista complex	Ellicott Pond, Buena Vista Pond, Rancho Road Pond, Anderson's Pond, Green's Pond, and surrounding uplands. Other ponds in the area may be breeding sites.
Pleasant Valley-Corralitos complex	Merk Road Pond, Corralitos Creek drainage, is a possible breeding site.
Central or McClusky metapopulation	
McClusky Slough complex	McClusky Slough, McClusky vernal pool (adjacent to Zmudowski State Beach), and Bennett Slough/Struve Pond and surrounding uplands
Southern or Moro Cojo metapopulation	
	Freshwater reaches of upper Moro Cojo Slough and surrounding uplands

The following section describes each complex and provides available information on the historic and current status of the complex's populations or subpopulations.

- Northern or Santa Cruz Metapopulation
  - Valencia-Seascape Complex

When this salamander was discovered in 1954, its only known breeding site was at Valencia Lagoon (also referred to as Rio Del Mar), a 0.46-hectare (1.1-acre) freshwater lagoon (Russell and Anderson 1956) (Figure 3). According to Ruth and Tollestrup (1973), Anderson initially estimated the population at 5,000 to 10,000

individuals. The site has undergone considerable alteration since its discovery, including draining of the lagoon in 1969 (see following section — Reasons for Declines and Current Threats, p. 25). Following the construction of a mitigation pond, studies estimated that 500 to 1,000 adults were breeding at that pond and otherwise using the lagoon site and undeveloped lots directly to the west (Ruth and Tollestrup 1973, Tollestrup 1974). Further studies quantified the upland habitat available for adult and juvenile Santa Cruz long-toed salamanders and estimated the adult population at approximately 2,580 individuals in 1978 and 1,350 individuals in 1979 (Reed 1979, 1981). Due to repeated habitat alterations, there has been essentially no reproduction at Valencia Lagoon since 1978 (Ruth 1988a, *in litt.*, 1995); one egg and one larva were found in 1997 (Bryan Mori, biological consultant, *in litt.*, 1998).

When Santa Cruz long-toed salamanders were found at the Seascape Pond site in 1974 (Figure 3), it consisted of a small (1.3 hectare / 3.2 acres), steep-sided breeding pond surrounded by a narrow band of arroyo willows, grasslands, and coastal scrub (Reed 1979, Ruth 1988a, 1988b). The artificial pond is situated at the northern end of a valley almost completely surrounded by grass-covered ridges. Oak (*Quercus* spp.) woodlands lie beyond the ridges to the east and south, a distance of more than 1.6 kilometers (1.0 mile) from the breeding pond. The population probably was established when Santa Cruz long-toed salamanders colonized the artificial pond sometime after it was created at the head of Uplands Valley in the early part of the century (Reed 1979, Ruth 1988b). Although only small numbers of larvae were found in 1974 and 1978, the population was estimated to be composed of at least 1,700 adults and 3,200 juveniles in 1986–87. In the intervening years, removal of cattle from the site and a breach in the dam, which reduced the surface area to 1.3

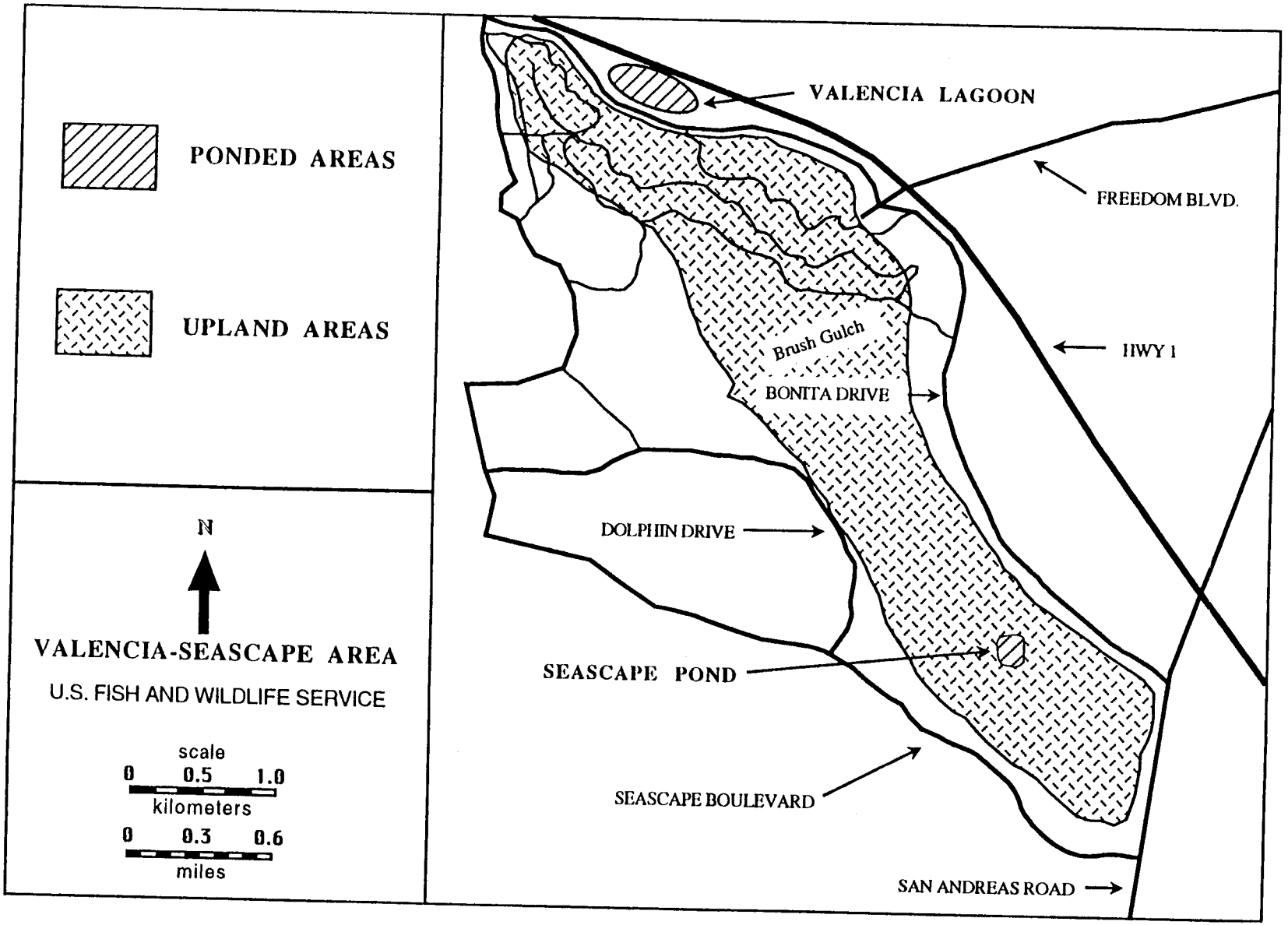

Figure 3. Distribution of the Santa Cruz long-toed salamander in the Valencia-Seascape Complex, Santa Cruz County, California.

hectares (3.2 acres), made the site temporarily more suitable for Santa Cruz long-toed salamander reproduction and survival (Ruth 1988b). Continued erosion has since reduced the maximum surface area and depth of the pond, decreasing the suitability of the site. The population has persisted, with successful reproduction through 1995, although the population's size is unknown because the site has not been surveyed formally since 1987 (S. B. Ruth, pers. comm. 1997).

Upland habitats suitable for nonbreeding activities, such as summering habitat and dispersal corridors have been affected by urbanization, road construction, invasion of exotic plant species, off road vehicle use, and other human activities (Ruth 1994). The Cuesta Canyon/Bush Gulch area (also known as Willow Canyon) between Valencia Lagoon and Seascape Pond may be the primary migration or dispersal corridor between the two ponds. A low-lying area at the junction of Bush Gulch and Cuesta Canyon has held water for several months, even at the end of a long term drought (Ruth 1994), and may provide an accessory breeding site for the complex. Approximately 100 Santa Cruz long-toed salamanders were estimated to use the area in 1986–87 (Ruth 1989), and 100 to 200 individuals in 1991–92 (Ruth 1994).

◆ Larkins Valley Complex

Larkins Valley lies in the upper Harkins Slough watershed. Santa Cruz long-toed salamanders have been found at various locations along several roads in the area (California Natural Diversity Database, unpubl. records) and one breeding site (Calabasas Pond) has been located (S. B. Ruth, *in litt.*, 1989). It is possible that several more ponds in the area also are used for breeding.

The Larkins Valley site is about 2.3 kilometers (1.4 miles) west of Seascape Pond and 3.6 kilometers (1.2 miles) north of the Ellicott site. It includes Calabasas Pond, an artificial pond covering about 0.4 to 0.5 hectare (1.0 to 1.5 acres), and probably more than 100 hectares (250 acres) of upland habitat (Figure 4).

Although there has been some alteration of the area due to livestock grazing, limited agriculture, road construction, and individual house construction, upland habitats within 1 kilometer (0.6 mile) of the breeding pond have been altered less than at most of the other known sites. The upland habitats are primarily coastal scrub, which may

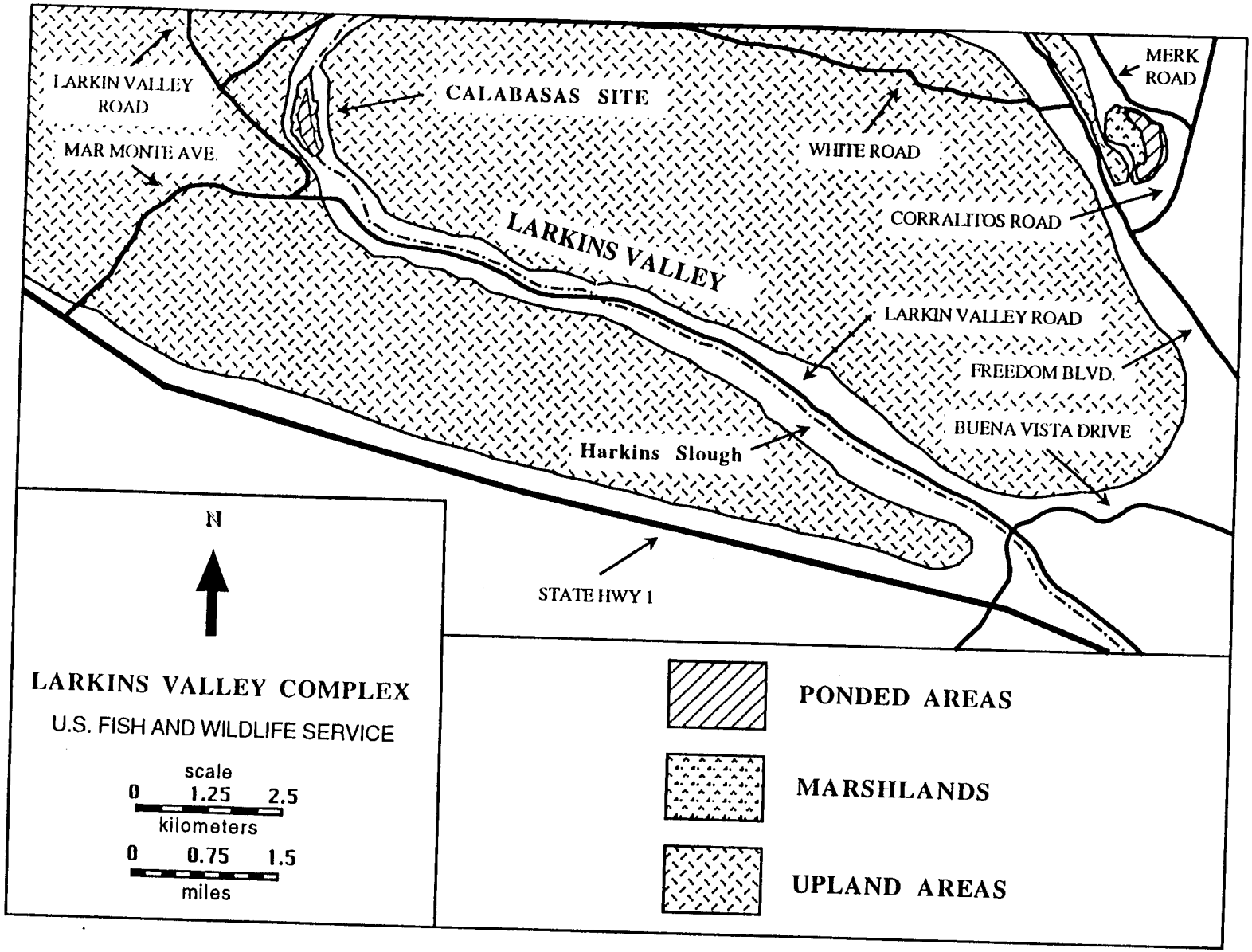

Figure 4 Distribution of the Santa Cruz long-toed salamander in Larkins Valley, Santa Cruz County, California.

not be optimal nonbreeding habitat for this salamander. The current size and status of the salamander subpopulation are unknown as no formal surveys have been conducted. Reproduction was documented in 1989, 1993, and 1995; larvae were reported to be abundant in 1989 and 1995 (S. B. Ruth, *in litt.*, 1989, 1993, 1996).

◆ Ellicott Slough-Buena Vista Complex

The Ellicott Slough-Buena Vista Complex (Figure 5) includes five ponds in the Ellicott Slough and Gallighan Slough watersheds that have been used as breeding habitat by Santa Cruz long-toed salamanders. The ponds are known as Ellicott Pond, Anderson's Pond, Green's Pond, Buena Vista Pond and Rancho Road Pond. Anderson's and Green's Ponds have not been sampled in more than 20 years, but breeding activity has been documented at the other sites in the vicinity since 1993. The area also has numerous farm ponds that may support breeding salamanders.

The second breeding site to be discovered for the Santa Cruz long-toed salamander was found in 1956 at an ephemeral pond in the Ellicott Slough watershed, approximately 6.4 kilometers (4.0 miles) south-southeast of Valencia Lagoon and 0.8 kilometer (0.5 mile) northwest of the defunct Ellicott Railroad Station (Anderson 1967). During the years Anderson studied the species at the Ellicott site (1956–1960), the pond reached a maximum size of approximately 0.4 hectare (1 acre). In 1972, Marlow calculated the pond's size to be approximately 1.9 hectares (4.7 acres) and estimated the Santa Cruz long-toed salamander population at 8,000 to10,000 individuals, based on limited sampling during which more than 3,900 individual salamanders were captured. Regular monitoring has documented the presence of adult and juvenile salamanders in 1992, 1994, 1995, 1996, 1997, and 1998 (Service, *in litt.*, 1995, 1996; Mori, *in litt.*, 1996; Miller, *in litt.*, 1997, 1998; Erin Fernandez, U.S. Fish and Wildlife Service, pers. comm. 1998). This breeding aggregation appears to be stable at the present time.

Green's Pond, a small (1 hectare; 2.5 acre) farm pond, is located approximately 0.5 kilometer (0.3 mile) west of Ellicott Pond in the Ellicott Slough watershed. Although breeding was documented at the pond in the 1970's (Reed 1979; S. B. Ruth, *in litt.*, 1988) and in 1989 (S. B. Ruth, *in litt.*, 1989), no surveys have been conducted since then.

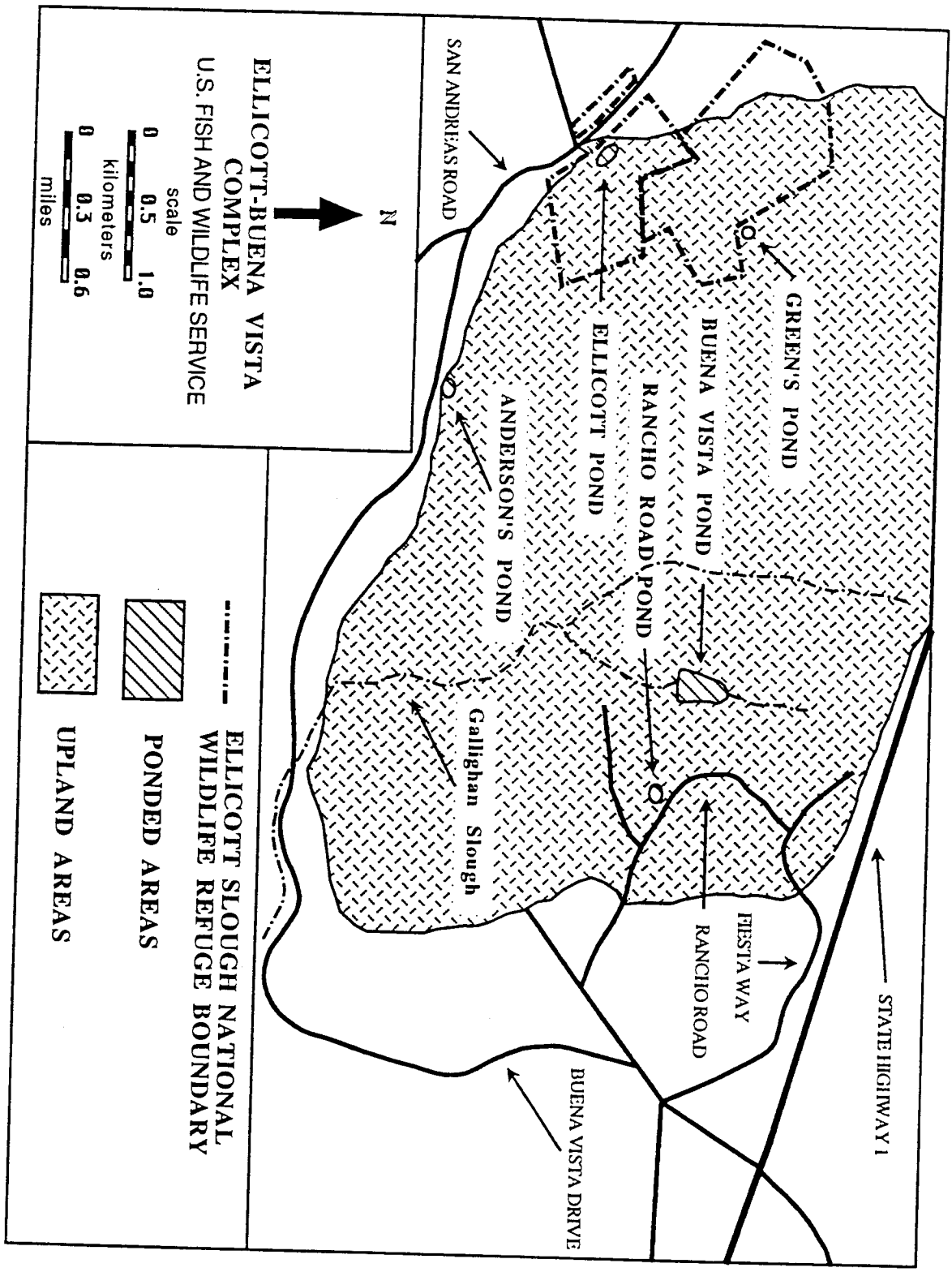

Figure 5. Distribution of the Santa Cruz long-toed salamander in the Ellicott-Buena Vista Complex, Santa Cruz County, California.

Anderson's Pond is along Buena Vista Drive in the Gallighan Slough watershed, and is about 1 kilometer (0.6 mile) southwest of Ellicott Pond and Green's Pond. The Anderson's Pond site supported breeding salamanders in the 1950's and 1960's, but surveys have not been conducted since then (S. B. Ruth, pers. comm. 1998).

The Buena Vista Pond, in the Gallighan Slough watershed, is about 1.4 kilometers (0.8 mile) west of Ellicott Pond and 1.2 kilometers (0.7 mile) north of Anderson's Pond. The pond apparently was created during the 1940's. Santa Cruz long-toed salamanders were first found here in 1992 (S. B. Ruth, *in litt.*, 1993), and larvae were abundant when observed in 1993 (S. B. Ruth, *in litt.*,1996). It may support several hundred adults based on trapping studies conducted during 1995 (Jennings 1995). The pond covers approximately 2 hectares (5 acres) with about 9.3 hectares (23 acres) of surrounding uplands (pine-oak woodlands and coastal scrub) (Figure 5). The pine-oak woodlands are located on the west and north sides of the pond, and there is a band of willows to the south and southwest, along the dam face. The breeding pond also contains a small mat of tules (*Scirpus* spp.).

Larval Santa Cruz long-toed salamanders were found in 1996 in a small pond along Rancho Road (Dana Bland, biological consultant, pers. comm. 1998) (Figure 5). There is contiguous upland habitat (oak woodland) between this pond and the Buena Vista pond, 0.4 kilometer (0.25 mile) to the southwest. No population surveys have been conducted at the site.

- Pleasant Valley/Corralitos Complex

  Santa Cruz long-toed salamanders also have been found along Merk Road near its intersection with Corralitos Road in the Corralitos Creek drainage (Steve Miller, *in litt.*, 1996; Figure 4). The sightings were adjacent to a ponded area in a tributary to Corralitos Creek. Because the sightings are 3.4 kilometers (2.1 miles) from the nearest confirmed breeding site (Calabasas Pond), it is likely that they represent an eastward range extension for the species and a new subpopulation that needs to be protected.

- Central or McClusky Metapopulation/McClusky Slough Complex

  The McClusky Slough Complex consists of McClusky Slough, McClusky vernal

pool, and Bennett Slough/Struve Pond and the surrounding upland habitats in Monterey County. The McClusky Slough location consists of several semipermanent and ephemeral ponds, adjacent wetlands, and riparian vegetation covering approximately 40 hectares (100 acres) and extending approximately 2 kilometers (1.2 miles) from the dunes of Zmudowski State Beach north of Giberson Road, nearly to Struve Road. The slough is surrounded almost completely by agricultural fields (Figure 6). Dense stands of cattails, tules and scattered willows were present when the salamanders were first found (Talent and Talent 1980). Today, some ponds are completely surrounded by dense willow stands. The current size and status of the McClusky Slough population are unknown. The site has been checked only occasionally for Santa Cruz long-toed salamanders and their larvae since 1978; larvae were last observed in June of 1989 (S. B. Ruth, in litt. 1989). No formal population surveys for the salamander have been conducted, although habitat management plans that have been or are being developed include provisions for monitoring salamander populations (e.g., Resource Conservation District of Monterey County and Natural Resources Conservation Service 1997).

Santa Cruz long-toed salamanders were discovered in 1993 in McClusky vernal pool, a 2 hectare (5 acre) ephemeral pond near the southern end of Zmudowski State Beach (Figure 6). The pond is approximately 0.4 kilometers (0.2 mile) south of the westernmost arm of McClusky Slough and 1.1 kilometers (0.7 mile) north of the western arm of Bennett Slough, to which it is connected by a drainage canal. The surrounding 2 hectares (5 acres) of upland habitat is considered atypical due to the lack of oak-woodland and coastal scrub plant communities. To the west of the site are sand dunes and to east are agricultural fields, which may originally have been riparian or scrub habitat. No formal population surveys have been conducted at the site.

When Santa Cruz long-toed salamanders were found at Bennett Slough in 1974, the site consisted of an 8 hectare (20 acre) breeding pond (Struve Pond) connected by a drainage pipe southwest across California State Highway 1 to a 3 hectare (7.5 acre) portion of Bennett Slough (Figure 6). Salamanders apparently were restricted to the riparian areas adjacent to the wetlands, as the surrounding area was composed of saltwater marsh and agricultural fields (Talent and Talent 1980). Both larval and

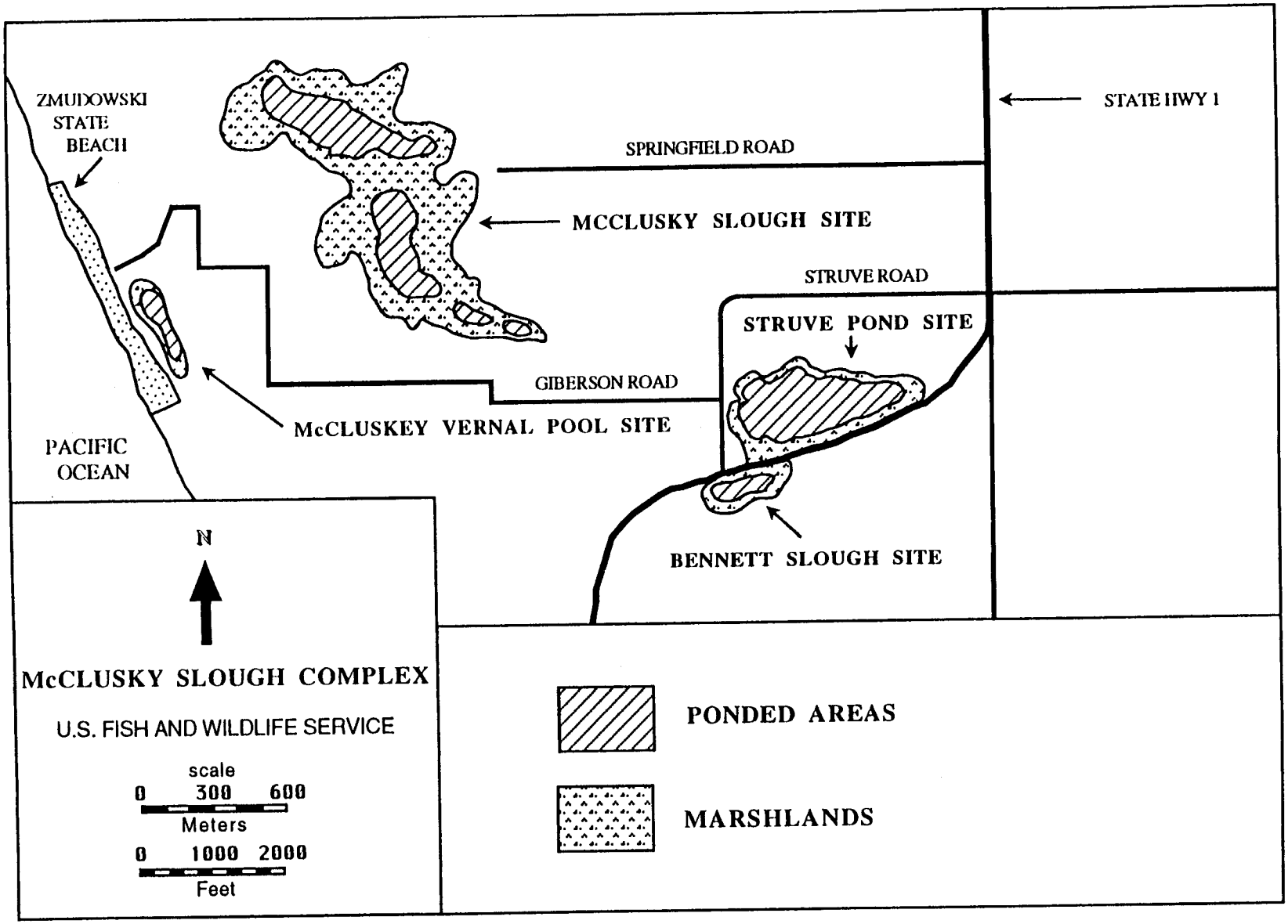

Figure 6. Distribution of the Santa Cruz long-toed salamander in the McClusky Slough Complex, Monterey County, California.

adult salamanders were found in Bennett Slough and Struve Pond, and when examined during 1973–74, the population consisted of hundreds of adults (Talent and Talent 1980, Ruth 1988a).

Bennett Slough was originally a fully tidal slough, but tidal action was altered as early as the 1850's by the construction of railways and roads, including Jetty Road and Highway 1. Significant freshening of the waters may not have occurred until a bridge over Bennett Slough was replaced with a culvert in the 1930's, and a channel through salt ponds in Elkhorn Slough was diked in the 1940's (Coats 1990). Santa Cruz long-toed salamanders may not have bred in the slough and adjacent ponds until the 1950's or later. Breaching of the salt pond dike in 1982 (Rainey 1985a) and replacement of the single culvert under Jetty Road with six culverts after the 1989 Loma Prieta earthquake (Coats 1990) has restored tidal action to Bennett Slough and Struve Road Pond. The increasing salinity has killed the freshwater marsh-associated vegetation and made the pond unsuitable for salamander breeding. The most recent survey of the site located no adults or larvae (Rainey 1985a, b). Although there is no information on the current size and status of the Bennett Slough/Struve Pond subpopulation, it is likely to have been extirpated.

- Southern or Moro Cojo Metapopulation/Moro Cojo Slough Complex

  Moro Cojo Slough lies south of Elkhorn Slough and Dolan Road in Monterey County. Santa Cruz long-toed salamanders have been found at two locations in Moro Cojo Slough (Reed 1979). A few adult and juvenile Santa Cruz long-toed salamanders also were found near some sewage disposal ponds east of Castroville Boulevard, but the breeding site is unknown (ABA 1990). The size and status of the Moro Cojo Slough population are currently unknown. At the time of discovery, the Moro Cojo Northeast location comprised an area of about 12 ha (30 ac) (Figure 7). The breeding site contained tule mats and was ringed with an extensive stand of willows. The surrounding uplands consisted of grasslands with scattered oaks and an extensive stand of willows at the eastern boundary of the slough (Reed 1979). Ruth (*in litt.*, 1989) reported that the site was heavily overgrazed and that the upstream habitat had been cut over and trenched. Much of the uplands to the southwest and northwest of the slough has been converted to trailer parks and agricultural fields. The slough

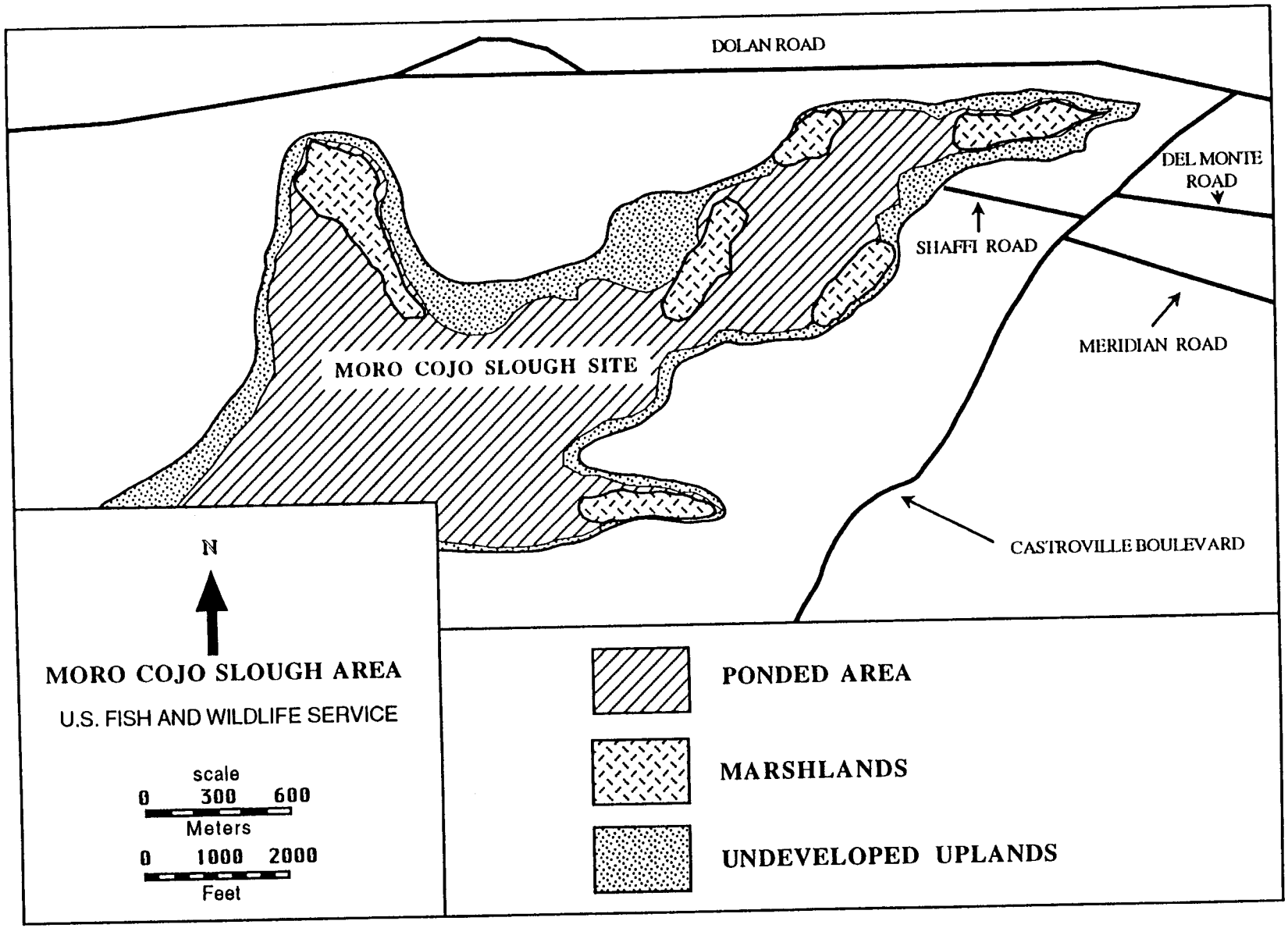

Figure 7. Distribution of the Santa Cruz long-toed salamander at Moro Cojo Slough, Monterey County, California.

downstream from the site (to the west) has been channelized (Reed 1979). No formal population surveys for salamanders have been conducted.

New breeding sites for the Santa Cruz long-toed salamander are likely to be discovered, given the amount of unsurveyed privately-owned habitat in the region and reports of salamanders in this area by local residents (S. B. Ruth, *in litt.* 1996). East of Highway 1 in Santa Cruz County, surveys should focus on the area between Freedom Boulevard and White Road, the Pleasant Valley and the Merk Road drainages, along Calabasas Road, and Larkins Valley down to Buena Vista Road. West of the highway, the area between San Andreas Road and Mar Monte Drive, north of the Mar Monte exit, should be surveyed, as well as the area to the north of the Ellicott Slough and Buena Vista sites. In Monterey County, surveys should be conducted in the Elkhorn Slough drainage, particularly in the upper reaches of Moro Cojo Slough and the area along Elkhorn Road to the east of the Elkhorn Slough National Estuarine Research Reserve. Topographic maps that were revised in 1993 and 1994 (Moss Landing, Prunedale, Soquel, and Watsonville West) show dozens of small ponds in this region, many of them constructed during the past 25 years.

Reasons for Declines and Current Threats

Climate changes and geologic activity in California over the last 10,000 to 12,000 years have led to a restricted and patchy distribution of habitat suitable for Santa Cruz long-toed salamanders, resulting in a naturally restricted distribution of the subspecies. The disjunct distribution of the subpopulations has made the Santa Cruz long-toed salamander especially susceptible to population declines resulting from both human-associated and natural factors. The factors include habitat loss and degradation, collection, predation by introduced and native organisms, infestations of parasites, geologic processes, and weather conditions. In Santa Cruz County, the primary threats have been road construction and urbanization. In the past, agriculture conducted at relatively low intensity apparently did not severely reduce the subpopulation sizes nor the extent or quality of available habitat. Today in Monterey County, the primary causes for decline are extensive and intensive agricultural practices and urbanization. The reasons for declines of the subpopulations and current threats (Table 2) at each of the complexes are discussed below.

Table 2. Threats to the stability and persistence of Santa Cruz long-toed salamanders.

Complex	Threats — past (□) and present (■)				
	Crops	Grazing	Urbanization	Exotic animals	Exotic plants
Santa Cruz County					
Valencia-Seascape	□	□	□■	□	
Larkins Valley	□	□	■		■
Ellicott-Buena Vista	□■		□■		□■
Corralitos	□■	? [past]	■	■	■
Monterey County					
McClusky	□■				
Moro Cojo	□■	□■	□■	□■	

◆ Valencia-Seascape Complex

Before the Santa Cruz long-toed salamander was discovered in 1954, Valencia Lagoon had been farmed when seasonally dry. Less than a year after the discovery, the only known breeding pond at Valencia Lagoon was reduced by one-third to one-half of its original 0.46 hectare (1.1 acre) size by highway construction along California State Highway 1 (Robert C. Stebbins, University of California at Berkeley, unpublished field notes, 1955). In 1968, widening and conversion of Highway 1 to a freeway began in the region, and in 1969 the remaining lagoon was drained (Bury 1972, Bury and Ruth 1972).

Upon learning that they had destroyed the breeding pond of an endangered species, Caltrans constructed an artificial pond at the site during the summer of 1970, as mitigation for the Highway 1 project. A second pond was constructed at the same site in the spring of 1972 in order to increase breeding habitat until a larger pond could be built on site. The mitigation ponds enabled the Santa Cruz long-toed salamander to survive and reproduce at Valencia Lagoon and in an adjacent storm drainage channel,

but at a much lower and more vulnerable population level than in the previous natural lagoon system (Ruth and Tollestrup 1973, Ruth 1974, Tollestrup 1974, Reed 1979). Bullfrogs (*Rana catesbeiana*), which eat ambystomatid salamanders (Morey and Guinn 1992), were using the ponds in 1972 and 1973, but were removed as they were found (Ruth and Tollestrup 1973).

In 1978, Caltrans replaced the two existing ponds with a larger artificial breeding pond (Service 1979, Ruth 1988a; Figure 8). They also installed metal flashing around part of the breeding pond to prevent salamanders from entering the storm drain and other areas not intended to be salamander habitat. This effort was not successful, and the salamanders used the drainage channel for breeding. This accessory breeding habitat was destroyed when Caltrans cleared and dredged the channel in 1986 (Ruth 1988a). By the late 1980's, it was apparent to biologists with the California Department of Fish and Game and the Service, as well as to Caltrans, that the large mitigation breeding pond was not working as originally envisioned. No Santa Cruz long-toed salamanders have been observed in this pond since it was constructed, except for one egg and one recently-hatched larva found by Mori (*in litt.* 1998) — which does not constitute a successful breeding season. The pond is probably too deep and choked with aquatic vegetation to be suitable for salamander reproduction (Ruth 1988a, *in litt.* 1995; Anderson, *in litt.* 1997).

Residential development on the oak-covered hillside adjacent to Valencia Lagoon destroyed some habitat and degraded the rest. Barriers such as fences and walls have blocked salamander access to portions of some undeveloped parcels. Roads through the development altered the hydrologic regime and are a source of mortality (Reed 1979, Ruth 1988a). Heavy floods in 1982 deposited a large amount of silt into the mitigation pond and flood control structures (California Dept. of Fish and Game, *in litt.* 1982). Poor water quality due to runoff from the residential area and the highway may affect salamander reproduction and survival.

Methoprene, an insect growth regulator, has been used at Valencia Lagoon and other ponds to control mosquito populations. Although methoprene did not cause increased mortality of gray treefrog (*Hyla versicolor*) tadpoles (Sparling and Lowe 1998), it has been implicated in reduced survival rates and the development of malformations in

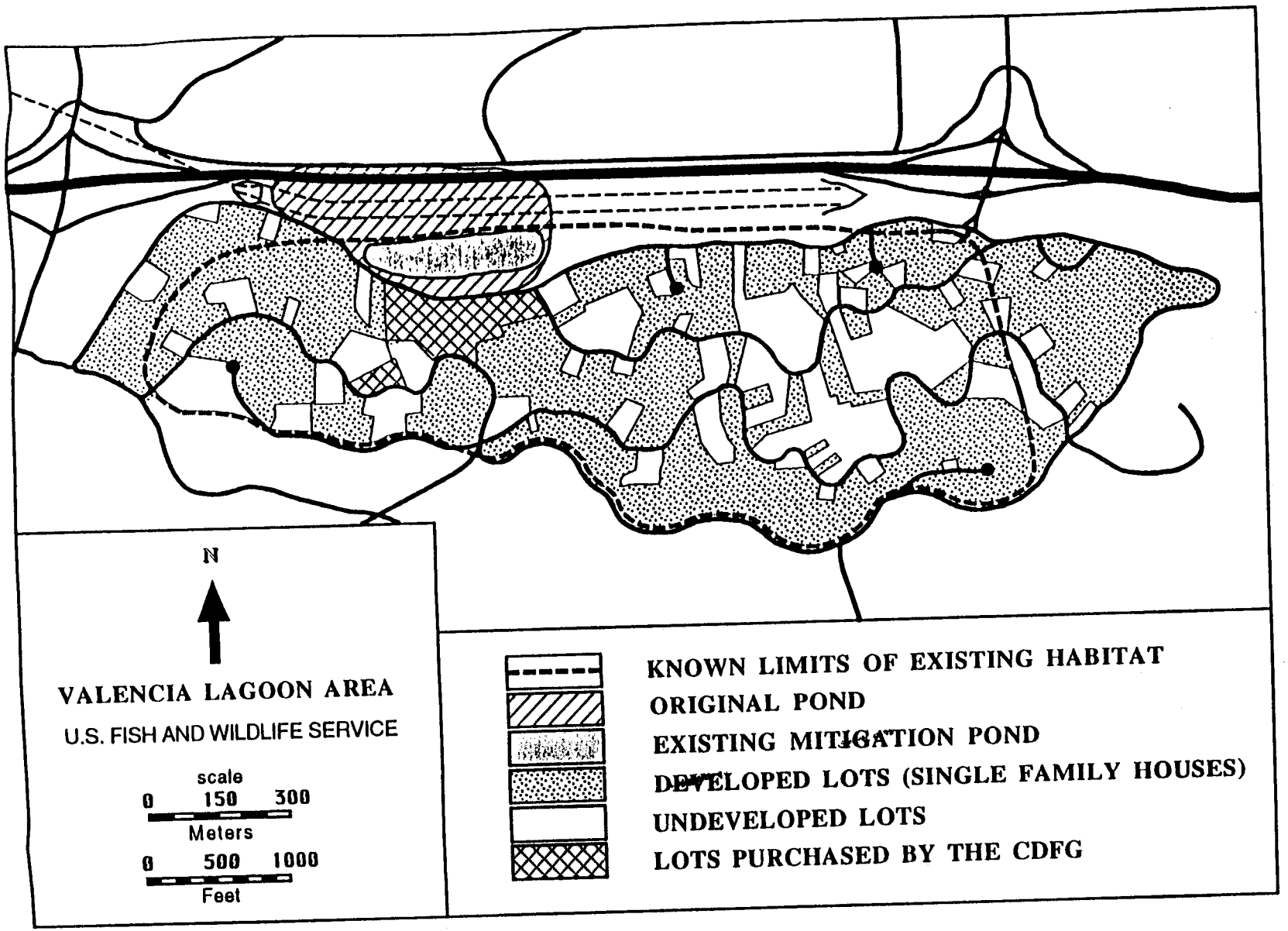

Figure 8. Land use and California Department of Fish and Game (CDFG) land purchases at Valencia Lagoon (adapted from from Reed 1979).

northern leopard frogs (*Rana pipiens*) (Ankley *et al.* 1998), and with malformations in southern leopard frogs (*R. utricularia*) (Sparling 1998). Blumberg *et al.* (1998) also correlated exposure to methoprene with delayed metamorphosis and high mortality rates in northern leopard and mink (*R. septentrionalis*) frogs. Other insecticides (e.g., temephos) have caused reductions in the growth rates of gray treefrog tadpoles and increased mortality rates in green frog (*R. clamitans*) tadpoles (Sparling and Lowe 1998), and increased mortality rates in southern leopard frogs (Sparling 1998).

A viable aggregation of Santa Cruz long-toed salamanders at Valencia Lagoon is unlikely to persist under existing conditions. Even if the pond can be reconfigured successfully, there is no assurance that enough adult salamanders remain in the vicinity to establish a healthy population (numerically and genetically). The upland habitat between the Seascape Pond and Valencia Lagoon may be too extensive or too degraded to permit sufficient migration or dispersal from Seascape Pond to adequately repopulate the Valencia site. Although reestablishment of a breeding aggregation at Valencia may be possible by translocating individuals from Seascape, the remaining upland habitat may not be of sufficient extent or quality to maintain a breeding aggregation over the long term.

The Seascape Pond site is being developed. The project is expected to destroy about 12 hectares (30 acres) of mostly lower-quality upland habitat, and to temporarily disturb about 2 hectares (5 acres) of upland habitat. The breeding pond and most of the adjacent upland habitats will not be affected adversely. Threats at the Seascape Pond site include invasion of the uplands by pampas grass (*Cortaderia selloana*) and other exotic plants, siltation of the breeding pond due to past grazing practices and off road vehicle use, lowered water levels due to erosion of the breeding pond dam, and choking of the breeding pond by cattails and other emergent aquatic vegetation (Zentner and Schonholtz, *in litt.* 1984; Ruth 1988b). High rates of trematode infestations have been noted in larval salamanders at Seascape Pond and may significantly affect larval survival in some years (Sessions and Ruth 1990). In the past, mosquitofish were planted in the pond, but they have not been observed recently, and bullfrogs were eliminated in the mid-1980's (Ruth 1988b). Because this small breeding pond is almost entirely surrounded by low grass-covered ridges with only a

narrow band of willows adjacent to the pond, many of the salamanders may have to migrate up to 1 kilometer (0.6 mile) to reach oak-woodland habitats, possibly exposing them to increased predation by opossums and raccoons.

- Larkins Valley Complex

  The subpopulation in Larkins Valley is affected by urban development, limited agriculture, and vehicular traffic. A small greenhouse operation in the upper portion of the drainage does not appear to threaten the subpopulation, nor does the light grazing that occasionally occurs near the pond. The salamanders breeding at Calabasas Pond are threatened by the breaching of the earthen dam. Although efforts by the Department of Fish and Game have succeeded in at least temporarily halting further erosion (P. Anderson, pers. comm. 1998), a more permanent solution is needed. Although some parcels surrounding the pond have been developed, this has caused relatively little permanent habitat loss. Most of the land, including the parcel on which the pond is located, remains relatively undisturbed.

- Ellicott-Buena Vista Complex

  Survival of the Ellicott population of Santa Cruz long-toed salamanders was threatened in 1970 when the owner of the breeding site and much of the upland habitat applied to Santa Cruz County to re-zone the tract, including the pond itself, for a trailer park (Bury and Ruth 1972). Off road vehicle activity near the pond destroyed vegetation and caused siltation of the pond, reducing its value as a breeding site. The loss of native vegetation hastened the invasion of exotic plant species during the late 1960's and early 1970's, including pampas grass, crystalline iceplant (*Mesembryanthemum crystallinum*) and blue gum eucalyptus (*Eucalyptus globulus*), which reduced the quality of the upland habitat for salamanders (Ruth 1988a). Few native invertebrates are found in dense stands of exotic plant species (Miller 1944, Nagano *et al.* 1981, Bury 1985). Some species of ice plant can cause increased salt concentrations in the soil (Kloot 1983), which could affect the water balance of salamanders, other amphibians, and the invertebrates on which they prey upon. Populations of small mammals also may be reduced by the loss of habitat, thus reducing the number and extent of burrow systems available to Santa Cruz long-toed salamanders.

Green's Pond, to the east of Ellicott Pond, was planted with mosquitofish and other aquatic predators, and by 1994 it had been modified, apparently to provide recreational opportunities, including fishing, for its owners (S. B. Ruth, *in litt.* 1996).

Threats to the Anderson's Pond breeding aggregation have not been evaluated.

At Buena Vista Pond, the salamanders are on private land that experienced minimal use during the past 25 years, although currently the pond is threatened by siltation from a nearby hillside that is eroding due to past off road vehicle activity. A golf course and associated development proposed for the area probably would destroy some upland habitat, and degrade the breeding pond and remaining upland habitat due to siltation and runoff from upslope golf course greens. Monterey pine was introduced into this area and has become naturalized, covering about 17 percent of the property. Its effects on Santa Cruz long-toed salamanders are unknown. Blue gum and other eucalyptus (*Eucalyptus* spp.) are present and probably have a negative effect on the salamanders' invertebrate prey base. French broom (*Genista monspessulana*), pampas grass, and crystalline iceplant are also established in disturbed areas and may have negative effects on salamander habitat.

The area surrounding the Rancho Road breeding site has several conservation problems. Development of single housing units has been proposed. Many local landowners clear the underbrush on their lots. The pond receives poor quality water from road runoff, and the riparian vegetation is regularly trimmed by the County (D. Bland, pers. comm. 1998), further reducing the amount of habitat available for the Santa Cruz long-toed salamander.

- McClusky Slough Complex

  Except for the ponds and immediate riparian zone of McClusky Slough, the surrounding area is used for intensive agriculture and associated housing and outbuildings (Talent and Talent 1980). Portions of the area were being used as a dump and there has been some encroachment on margins of the slough for agriculture (Ruth 1988a). Landowners have periodically cleared vegetation for agricultural and hunting purposes during extended droughts (Steven Maki, Monterey County Planning Department, pers. comm. 1998). The clearing probably reduced population levels and

delayed recovery of the population's size when normal rainfall resumed, but apparently did not extirpate the population. Pesticide use for agricultural and mosquito control purposes remains a concern. The lowering of the water table for agriculture may permit enough saltwater intrusion (Daniel Mountjoy, U.S. Natural Resources Conservation Service, pers. comm. 1998) to make the slough unsuitable for breeding. Threats from introduced aquatic species have not been assessed.

Past agricultural practices around the McClusky vernal pool adjacent to Zmudowski State Beach reduced the suitability of the upland habitats for use by the Santa Cruz long-toed salamander. The pond may be affected by salt water intrusion and agricultural runoff (David Dixon, California Department of Parks and Recreation, pers. comm. 1998).

The primary threat at the Bennett Slough/Struve Road Pond site — increasing salinity — was discussed in the section on population status on page 23. Most of the willows surrounding the pond have died due to the increased salinity. Agricultural practices extending to the edge of wetlands on the north side of the slough have degraded or eliminated upland habitat for any remaining salamanders, and chemical runoff and siltation into the ponds may also be problems. If tidal gates or other mechanisms are installed to reduce the saltwater intrusion, habitat restoration and alteration of the agricultural practices will be necessary to allow reestablishment of the Santa Cruz long-toed salamander population in this portion of the McClusky Slough Complex.

- Moro Cojo Slough Complex

  Agricultural activities that channelized over half of Moro Cojo Slough and eliminated much of the adjacent upland habitat adversely affected the Santa Cruz long-toed salamander population, which remains threatened by loss of upland habitats, agricultural runoff, the introduction of mosquitofish and other exotic species, and residential development. Another threat is the introduced tiger salamander (*A. tigrinum* ssp.), which preys on other amphibians. Tiger salamanders are present near the Santa Cruz long-toed salamander breeding site in the northeastern arm (Reed 1979), and in the southeastern arm where Santa Cruz long-toed salamanders were captured (ABA 1990). In addition, parts of Moro Cojo Slough are being used as a dump by residents (M.ark R. Jennings, pers. obs.).

Conservation Measures

The Santa Cruz long-toed salamander was listed as an endangered species by the Service (32 FR 4001, 11 March 1967) and the California Fish and Game Commission (CFGC; 21 May 1971). At the time, only the Valencia Lagoon and Ellicott Slough breeding sites were known to the herpetological community and the two listing agencies.

The Santa Cruz Long-Toed Salamander Recovery Team began preparing the original Santa Cruz Long-Toed Salamander Recovery Plan in late June 1975, and submitted it to the Service in final form in July 1976. It was approved by the Service's Director on September 28, 1977 (Service 1977). Many recovery actions identified in the original recovery plan were completed, reducing some of the threats to the species. Management plans were developed and implemented at Valencia and Ellicott, population studies were carried out, land was acquired at both sites, surveys were conducted in additional localities, educational efforts were undertaken, and agreements between various agencies were finalized (Service 1986).

The conservation efforts were not sufficient to recover the population at Valencia Lagoon, nor to allow reclassification of the salamander to threatened status, so a revised recovery plan was prepared and approved on December 23, 1985 (Service 1986). The following discussion of recovery results provides task numbers[3] from the 1986 revised plan in parentheses.

While actions undertaken at the Ellicott site (111., 112., 1211., 122., 123., 131., 133., 31., 32., 33.) are restoring and enhancing that subpopulation's habitat, and thus its stability, actions intended for implementation at Valencia Lagoon (111., 112., 1211., 122., 123., 131., 132., 134.) have either not been implemented, or have failed to secure the Valencia subpopulation. The lack of recruitment at the Valencia Lagoon pond since 1978 was not addressed in the 1986 revision, nor has the situation been corrected as of 1999. Status assessments and recovery actions at sites identified in the 1986 plan (2. — Bennett, McClusky, Seascape, Moro Cojo) have not been completed satisfactorily, or are only now being undertaken. However, as detailed above and below, several new sites have been

[3] The 1985/1986 plan's task numbering format was slightly different than the present plan's format. Where the outline numbering in the present plan goes 1., 1.1., 1.1.1., the older plan's numbering went 1., 11., 111.

found and various agencies and entities are cooperating to secure habitat for the salamander and reduce the known threats.

- Valencia-Seascape Complex

  Early population studies on salamanders at Valencia Lagoon were conducted in the 1970's by University of California at Berkeley graduate students (see Ruth and Tollestrup 1973, Tollestrup 1974) with funding provided by Caltrans in 1973, and by the Service in 1974. Later population and migration studies were carried out by the California Department of Fish and Game, in cooperation with the Service, from 1977 through 1979. In concert with the salamander studies, the residual Caltrans property at Valencia Lagoon was transferred to the Department in 1979, and the Department purchased six additional lots on the hillside above Valencia Lagoon in 1981-82. Five of these lots front on Bonita Drive, forming a block of undisturbed habitat in one of the major salamander migration corridors between the breeding pond and the upslope estivation habitat. The sixth lot lies in a ravine further upslope and is also an important migration route between the pond and undeveloped lots further upslope. Since then, the Department has purchased more undeveloped lots and conservation easements on the hillside (Figure 8), and in 1982 the County of Santa Cruz formed a Santa Cruz long-toed salamander protection district with strict zoning regulations to protect the remaining privately-owned upland salamander habitat (111.). Fencing of the Valencia Lagoon core area and initial efforts to restore the breeding pond (CDFG 1975) were completed in November 1978. As noted in the threats section, the mitigation pond system has not worked and the Service, the California Department of Fish and Game, and Caltrans are cooperating to redesign the pond to restore suitable habitat for Santa Cruz long-toed salamander reproduction (112.). The metal flashing along the east side of the lagoon pond was recently replaced (123.) and will continue to require periodic maintenance.

  The Seascape Pond was sampled in 1974 and 1978 (Reed 1979) and a population study was conducted in 1986 (Ruth 1988b). Because the landowners were proposing a housing development, they entered into discussions with the Service to determine appropriate protection measures for the breeding pond and adjacent upland habitats. A Habitat Conservation Plan was developed that includes a conservation easement to the Center for Natural Lands Management. The Service approved the Plan, issuing a

section 10(a)1(B) permit in August 1997, and work has begun on site. The specific goals of the Habitat Conservation Plan with regards to the Santa Cruz long-toed salamander are to set aside sufficient upland habitat to support the breeding aggregation in perpetuity, enhance currently degraded habitat, maintain the existing breeding pond and migration corridors, and create two additional ponds (Thomas Reid Associates 1997). The Seascape property is included in a Santa Cruz County Salamander Protection Zone.

The Willow Canyon site, which probably provides a corridor for genetic exchange between Santa Cruz long-toed salamanders breeding in Valencia Lagoon and those in Seascape Pond, is currently under consideration for a housing development. The project proponents have entered into discussions with the Service to develop a Habitat Conservation Plan for the proposed project.

- Larkins Valley Complex

The entire Larkins Valley area, bounded by Calabasas Road on the east, White Road on the north, East Bel Mar Drive (west of Larkins Valley Road) on the west, and south of Winter Wind Way nearly to Dusty Trail on the south, has been designated as a Salamander Protection Zone by Santa Cruz County. Continued monitoring by California Department of Fish and Game personnel resulted in efforts to check erosion of the dam, which has enabled successful reproduction to occur at the Calabasas Pond in Larkins Valley. Concerted efforts by the Department, the Trust for Public Lands, and the Service have resulted in the acquisition of approximately 12 hectares (30 acres) in Larkins Valley, including the Calabasas Pond and some surrounding upland habitat. Additional upland habitat is in private ownership. A management plan for a 6.5-hectare (16-acre) parcel on which a single family home was built included the installation of a small accessory breeding pond, although use of this new pond by Santa Cruz long-toed salamanders has not been confirmed. Efforts are underway to identify and acquire additional parcels in the Larkins Valley for dispersal, nonbreeding, and potential breeding habitat (P. Anderson, pers. comm. 1998).

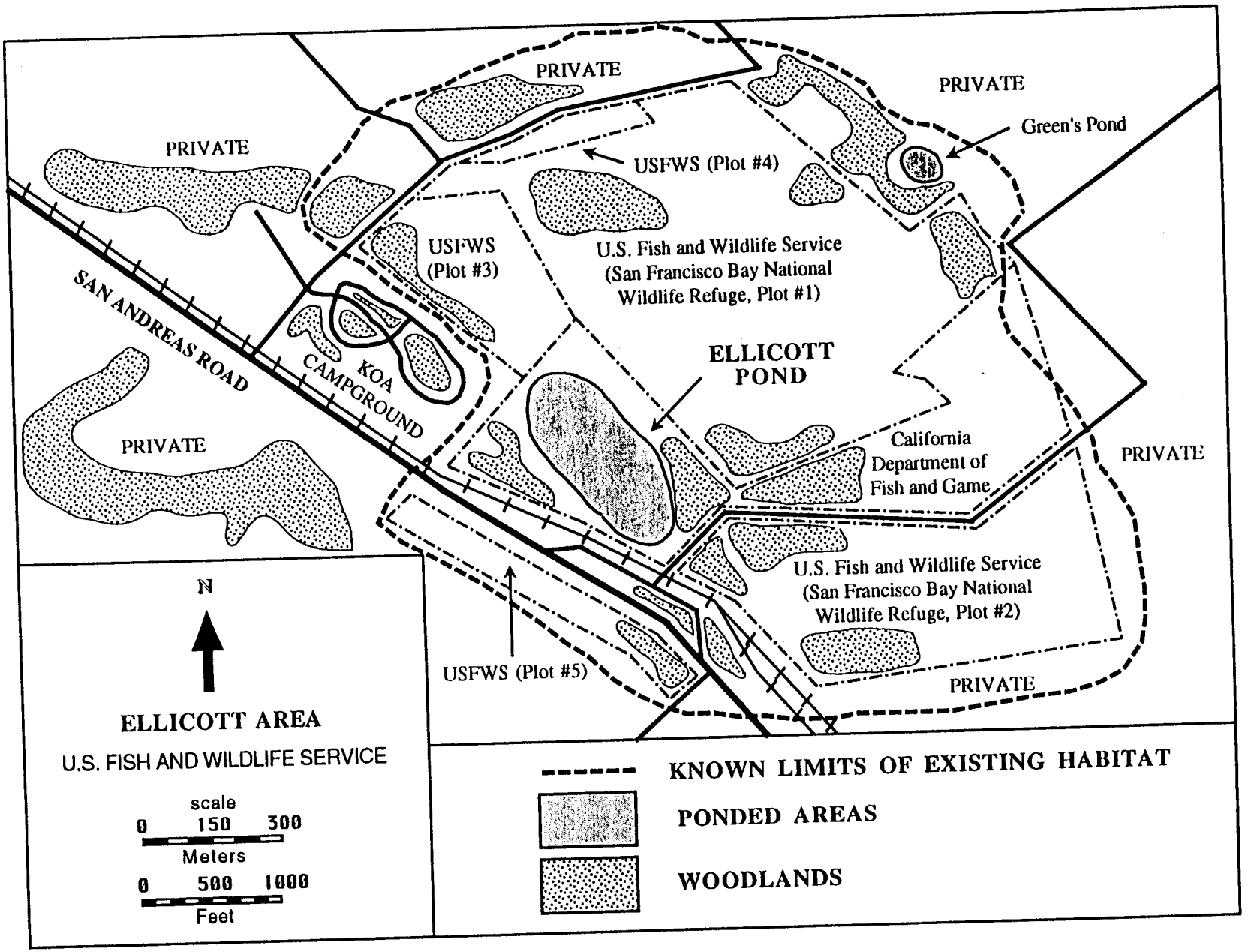

Figure 9. Land ownership at Ellicott, Santa Cruz County, California.

- Ellicott-Buena Vista Complex

  Due to threats from development and other incompatible land uses, the Service and the Wildlife Conservation Board purchased the 12-hectare (30-acre) pond site and adjacent parcels (approximately 52 hectares/128 acres). The purchase secured the entire pond area and most of the surrounding habitat (Reed 1979) (Figure 9). The Service and the California Department of Fish and Game signed an agreement regarding management of the Ellicott site in 1977, which designated the Department as manager for both State and Service lands. Since then, all Service lands at the Ellicott site have been included in the State-designated Santa Cruz Long-Toed Salamander State Ecological Reserve, and the Service has been placed in charge of all on-the-ground activities.

The population at Ellicott Slough was originally studied in the early 1970's (Aaron 1972; Blau 1972; Marlow 1972, 1973) and was censused in 1977–78 under a Service contract (Reed 1979). The studies indicated that the Ellicott Slough/Ellicott site population was healthy and viable. Since then, monitoring by U.S. Fish and Wildlife Service National Wildlife Refuge personnel and others has documented migrating juvenile and adult salamanders as well as larvae in the pond (Service, *in litt.* 1996, 1997, 1998; 1211.), verifying that Santa Cruz long-toed salamanders are successfully reproducing within the reserve. At the Ellicott site during the 1980's, preliminary studies were conducted on an automatic salamander counter by California State University, Hayward (J. M. Brode, California Department of Fish and Game, pers. comm.).

Past management actions at the Ellicott site focused on controlling vehicular trespass and erosion, and removing pampas grass and eucalyptus trees (111., 13.). All lands purchased by the Service have been fenced (133.), vehicular trespass has been eliminated, and all of the erosion formerly caused by off road vehicles within the reserve property has been controlled (13.). Plans to remove more of the pampas grass and eucalyptus grove are being undertaken by the Department and the California Department of Parks and Recreation, in cooperation with the Service (131.).

Attempts were made to reduce the number of Santa Cruz long-toed salamanders killed on San Andreas Road (which crosses the preserve) by building three "salamander

tunnels" (112.). Unfortunately, the salamanders did not use the pipe-like tunnels, so a new design is being considered for installation. It is a trench covered with a slotted grate that was tested at the University of California at Davis (B. Bolster, California Department of Fish and Game, pers. comm. 1998). Hopefully, the new design will eliminate roadway mortality of salamanders along migration corridors between the breeding pond and upland habitats.

In 1992, following the extended drought of 1986–92, the Service and the California Department of Fish and Game pumped water into the breeding pond to help ensure successful reproduction (123.). In 1996, the temporary pipeline was replaced with a permanent, buried pipeline; it has not yet been used because annual rains have filled the breeding pond. A second pond, dug in 1996, may need to be deepened (E. Fernandez, pers. comm. 1998). To support the new pond, an existing well was reactivated, and a permanent pipeline was installed to use as necessary. Spikerush (*Eleocharis* spp.) was planted in the winter of 1997–98, and Pacific tree frogs used the pond that season.

At the Ellicott site, the Department and the Service have permitted public use for scientific and educational purposes (33.); the primary use has been by school groups visiting the reserve. Permission is granted through a letter of condition from the Department's Monterey Office. Compliance with reserve regulations has been excellent (32.). School field trips to the preserve are important because they provide valuable educational opportunities for young students to learn to appreciate nature first hand, and they also assist in the overall protection of the reserve and its wildlife and plants by showing the usefulness of the reserve to the local community (3.). Additionally, informational signs for visitors have been installed at the Ellicott site to explain its sensitivity and importance (31.).

Owners of the Buena Vista property funded a study at the Buena Vista site in early 1995 to determine the population status and habitat use (Andoli 1995, Jennings 1995). The project proponents entered into initial discussions with the Service to develop a Habitat Conservation Plan and obtain a section 10(a)(1)(B) permit for this development, but have not continued to move forward with that process. As an alternative to development, the site is under consideration for acquisition as a

preserve.

- McClusky Slough Complex

  The portions of McClusky Slough and the surrounding riparian areas that are in private ownership have been managed primarily to provide waterfowl habitat and hunting opportunities. This management has retained freshwater pond, marsh, and riparian areas. Ducks Unlimited, Monterey County, and the Natural Resources Conservation Service have worked with some of the landowners to develop management plans that include the Santa Cruz long-toed salamander. Other landowners have worked with the Service, Monterey County, and the National Resources Conservation Service to develop habitat management plans that focus primarily on the restoration and management of habitat for Santa Cruz long-toed salamanders and, secondarily, for California red-legged frogs (*Rana aurora draytonii*). Implementation of the plans was not completed at the time this document was prepared, so no information was available regarding the outcome of the efforts.

Forty-one acres (17 hectares) adjacent to Zmudowski State Beach, including the southern portion of the westernmost part of McClusky Slough, McClusky vernal pool and some surrounding uplands, were recently acquired by the California Department of Fish and Game. The lands will be managed by California Department of Parks and Recreation specifically for Santa Cruz long-toed salamanders, and to restore the dune habitat.

Talent and Talent (1980) conducted limited trapping surveys for salamanders in Bennett Slough/Struve Road Pond during 1973 and 1974, with funding from the California Department of Fish and Game (212.). The Nature Conservancy purchased a conservation easement at Struve Pond in 1981. Studies conducted by Rainey (1985a,b) found that the freshwater wetland habitats in Bennett Slough/Struve Pond were deteriorating due to saltwater intrusion (22.). This historically tidal wetland was a freshwater habitat for only 30 to 40 years, so further conservation actions directed at the maintenance of Santa Cruz long-toed salamander breeding habitat may not be appropriate. Management time and money may be more appropriately directed toward efforts to secure the McClusky Slough and vernal pool habitats.

- Moro Cojo Slough

  The slough and its drainage basin are included in the Natural Resources Conservation Service Elkhorn Slough Watershed Management Plan (Soil Conservation Service 1994), and the Moro Cojo Slough Watershed Rehabilitation and Management Plan (The Habitat Restoration Group 1996). The former plan's goals are to reduce erosion; reduce sediment and pesticide input to Elkhorn, McClusky and Moro Cojo Sloughs; reduce wetland losses; and reduce the further degradation of endangered species habitat. The Moro Cojo Plan's goals are to retain, enhance, and restore wetland and upland habitats; improve water quality; reduce erosion and sedimentation; increase the extent of freshwater habitats in the lower reaches of the slough; manage flood waters, and provide opportunities for public access and education.

  Some land has been transferred to The Nature Conservancy and will be managed by the Elkhorn Slough Foundation; possibilities for further land acquisitions are being investigated (Mark Silberstein, Elkhorn Slough Foundation, pers. comm. 1998). Management actions outlined in the Moro Cojo plan are being implemented by the Wetlands Institute, California State University Monterey Bay, with support from the Regional Water Quality Control Board and in cooperation with Pacific Gas and Electric and private landowners (S. Hennessy, Wetlands Institute, California State University Monterey Bay, pers. comm. 1998). Consultations and discussions between the Service and private landowners have resulted in measures to decrease the likelihood of take of the endangered salamander on project sites and measures to restore upland habitat adjacent to the slough. Cooperative efforts among the various agencies are expected to continue and expand.

Recovery Strategy

The revised recovery plan of 1986 stated that delisting of the Santa Cruz long-toed salamander could be achieved "when breeding populations are maintained with approximately equal sex ratios at or above 2,600 animals at Valencia Lagoon and 6,500 animals at Ellicott Slough for a minimum of 10 years, and at least three additional sites are secured and adequately managed to support self-maintaining populations of at least 2,600 breeding animals each with approximately equal sex ratios and recruitment equal to or exceeding mortality." Based on information gathered on the Santa Cruz long-toed salamander since 1986, it is necessary to modify the goals for those sites and include new

subpopulations whose long-term survival seems likely. The revised recovery strategy presented here focuses on:

1) perpetuating self-sustaining populations of Santa Cruz long-toed salamanders at Valencia-Seascape, Larkins Valley, Ellicott-Buena Vista, and McClusky Slough Complexes by managing pond and upland habitats, reducing human-related mortality, and monitoring populations;
2) conducting surveys in the general area of each complex to locate additional breeding sites and suitable upland habitat areas, and to identify parcels that would be appropriate for conservation agreements or easements, acquisition, or other management actions;
3) assessing the distribution and population status of Santa Cruz long-toed salamanders in the Merk Road drainage, in upper Moro Cojo Slough, and at any other new locations found through the surveys, planning and implementing appropriate management strategies and actions where appropriate;
4) supporting the management of Santa Cruz long-toed salamander habitats and populations with appropriate research; and
5) maximizing public support for conservation of this salamander through continuing and expanding a program of public education and information.

PART II. RECOVERY

Recovery Objectives

The first objective is to recover the Santa Cruz long-toed salamander sufficiently to warrant reclassification to threatened species status. The second objective is to recover the species sufficiently to warrant delisting.

Criteria for Reclassification to Threatened Status

The Santa Cruz long-toed salamander will be considered for reclassification from endangered to threatened status when the following four complexes are protected and managed such that habitat is conserved, maintained, and/or restored: Valencia-Seascape, Larkins Valley, Ellicott-Buena Vista, and McClusky Slough. Each complex must contain at least two functional breeding ponds or sites, as well as sufficient upland habitat to support self-sustaining populations (see below). These four complexes were selected because they represent two-thirds of the metapopulations and two-thirds of the known areas where Santa Cruz long-toed salamanders occur. Also, the Valencia Lagoon and Ellicott sites are already under Federal and/or State management, the entire Seascape site has an approved Habitat Conservation Plan and land has been deeded to the Center for Natural Lands Management, the known breeding site in Larkins Valley has been acquired and will be transferred to the National Wildlife Refuge System, and portions of the McClusky Slough complex have been acquired by the State or have management plans that are being implemented. There is a strong possibility that either Habitat Conservation Plans will be developed for the Buena Vista (Ellicott-Buena Vista Complex) and Bush Gulch/Cuesta Canyon (Valencia-Seascape complex) sites, or the sites will be acquired for addition to existing preserves. Cooperation among landowners, Federal and State agencies, and non-governmental organizations for the management of McClusky Slough has been increasing, and is expected to develop further. Such actions, in conjunction with specific tasks detailed below, would provide a measure of security for the northern and central metapopulations that currently does not exist.

A self-sustaining subpopulation is defined as one exhibiting an average adult sex ratio of 1:1 and either a stable age distribution (that is, not skewed toward larger, presumably older, individuals, nor strongly skewed toward smaller, presumably newly-matured animals), or evidence of a population increasing in size (that is, more small adults than

expected in a stable age distribution, without loss of older, larger individuals). Evidence of continued breeding success, metamorphosis, and recruitment of adults must be documented over a 20-year period. Twenty years should be long enough to monitor the salamander and its habitat through at least one drought cycle, and will allow sufficient time for evaluation of management actions, determination of population trends, and alteration of management actions if necessary. Each secured population must be self-maintaining — that is, not requiring any direct human assistance to reproduce successfully and maintain a stable or growing population during years of average or above average precipitation. All protected areas must provide sufficient acreage and habitat diversity to ensure that each subpopulation is capable of self-maintenance, even after adverse environmental conditions such as drought, heavy rains, or catastrophic fires. Upland scrub or woodland habitats must be adjacent to the breeding ponds or within migration distance, protected corridors for migration to nonbreeding habitat must be established and maintained where necessary, and protected corridors for dispersal to other ponds in the complex must be established and maintained. The most effective way to achieve this goal is to protect the whole drainage surrounding the breeding pond, as well as protecting and enhancing existing ponds or creating one or more new breeding ponds within 1 kilometer (0.6 mile) of currently protected or managed breeding sites.

The best-studied site is Ellicott, where information from 1998 unfortunately was inadequate to determine whether breeding was successful, or if an adjacent farmer's pumping of his fields into the pond caused a failure. Statistically valid trend data for that site do not exist. Valencia Lagoon was destroyed in 1979, but no new breeding area has been created or restored there. Management actions have begun just this year at Seascape, the Calabasas Pond acquisition is not yet complete and a complete management program has not been implemented, the Buena Vista site is not secured, and the breeding site for the Merk Road salamanders is unknown. The situation for the Monterey County populations is especially serious. The discovery of Santa Cruz long-toed salamanders in McClusky vernal pool occurred within the last few years, and that site was acquired by the State in 1998. Management planning and actions have just begun. It is not known whether the rest of McClusky Slough still supports this salamander, because there has been no monitoring or even adequate surveys for more than 10 years. Conservation measures may begin at this site soon. The only known breeding site for this salamander in Moro Cojo Slough has been heavily affected by grazing, and no sites have been

secured for that population. So, while crucial conservation work has already been accomplished, the job of ensuring this salamander's future is in many respects just beginning.

Criteria for Delisting

The Santa Cruz long-toed salamander will be considered for delisting when the reclassification criteria are met, with the added stipulation that there shall be at least three functional breeding ponds or sites in each complex (more in some complexes), and at least two additional self-sustaining populations (as described above) and their associated habitats protected with at least one located in Monterey County. The additional subpopulations should be at least 2 kilometers (1.2 miles) from currently protected sites, or otherwise be separated by barriers to migration between subpopulations. This will ensure a broad enough distribution through the landscape to reduce threats from catastrophic events, as well as maximizing the conservation of genetic diversity.

Stepdown Narrative

1. Perpetuate self-sustaining populations of Santa Cruz long-toed salamanders. Manage pond and upland habitats, reduce human-related mortality, and monitor populations at Valencia-Seascape, Larkins Valley, Ellicott-Buena Vista, and McClusky Slough complexes. These actions are focused toward achieving the first recovery objective, which is to reclassify the Santa Cruz long-toed salamander to threatened status.

1.1. Ensure that existing ponds remain, or become, functional breeding sites. If existing ponds are not capable of supporting breeding, larval development, and metamorphosis, they act as sinks, draining the population of individuals and genetic diversity. In the absence of recruitment of juvenile salamanders into a breeding population, salamander numbers will decline until the population is no longer capable of self-maintenance, either numerically or genetically.

1.1.1. Improve the Valencia Lagoon for salamander reproduction by recontouring it based on dimensions of ponds that are currently successful, managing its vegetation to provide appropriate cover, and managing runoff into it

to ensure appropriate water level and water quality. These measures should make the pond suitable for breeding.

1.1.2. Maintain the Seascape Pond at an appropriate level for successful breeding and recruitment by repairing the breach in the Seascape berm to maintain the pond at an appropriate level. The Seascape Pond may be the only functional breeding pond for the Valencia-Seascape Complex subpopulation; if so, it is essential for the survival of that subpopulation.

1.1.3. Complete the acquisition of the Calabasas Pond site in Larkins Valley, and transfer the property to the Service. This will secure a known breeding site and the associated upland habitats for this subpopulation, strengthening the protection already available under Federal, State, and County regulations. This will ensure the continued existence of this subpopulation and contribute to the stability of the northern metapopulation.

1.1.4. Maintain the Calabasas Pond at an appropriate level for successful breeding and recruitment. The breach in the pond's berm must be repaired. If the berm continues to erode, the pond will no longer hold enough water long enough to allow for the metamorphosis of larval salamanders.

1.1.5. Develop and implement a comprehensive management plan for the Calabasas Pond site, once it is acquired, that ensures continued monitoring and management of the pond and the surrounding upland habitats.

1.1.6. Continue adaptive management at Ellicott Pond. Assess the results of management actions and modify the management plan as necessary.

1.1.7. Develop conservation agreements and management plans for salamander habitat near Ellicott, working with landowners to enhance both historic and current breeding sites (Green's and Anderson's Ponds, and others) and their associated upland habitats.

1.1.8. Investigate the possibility of conserving all or some of the Buena Vista Pond site by acquiring it or by establishing a conservation easement on the property. This would enhance the chances of maintaining the known breeding site and provide for the maintenance of the Ellicott-Buena Vista Complex population if Ellicott Pond or its breeding aggregation suffers a catastrophic event and is lost.

1.1.9. Develop agreements for monitoring and managing Santa Cruz long-toed salamanders and their associated habitat at McClusky Slough in collaboration with landowners, the Natural Resources Conservation Service, Ducks Unlimited, and other parties as appropriate.

1.1.10. Develop and implement a management plan for the McClusky Slough acquisition by working with the California Department of Parks and Recreation and the California Department of Fish and Game.

1.1.11. Implement management actions at Moro Cojo Slough by working with landowners, the Watershed Institute of California State University Monterey Bay, Natural Resources Conservation Service, Monterey County Planning Department, and other parties as appropriate.

1.2. Secure and manage upland habitats to provide hydrologic integrity to the ponds and adequate cover and food for nonbreeding salamanders. If the hydrologic integrity of a system is compromised, its ponds may become unsuitable for breeding, with the consequences described in task 1.1. If upland habitats are degraded in quality or insufficient in size, mortality levels of juveniles, subadults, and adults will be too high for the local breeding aggregation or subpopulation to maintain itself. The breeding aggregation will not provide sufficient individuals to disperse to nearby ponds, compromising the viability and genetic diversity of the subpopulation.

1.2.1. Protect salamander habitat in Santa Cruz County. Work with Santa Cruz County and landowners in the Salamander Protection Zones to ensure application of the regulations and provide for the appropriate management of upland habitats. Establish conservation agreements or easements as necessary. Such activities will help maintain upland habitats in suitable condition for use by

the salamander.

1.2.1.1. Secure land upslope from Valencia Lagoon by continuing to identify and purchase appropriate undeveloped lots and conservation easements as opportunities arise. Sites between the Valencia Lagoon and Seascape Pond are the most important to investigate and acquire.

1.2.1.2. Ensure proper implementation of the Habitat Conservation Plan at Seascape Pond by maintaining adequate communication with landowners and managers, and oversight of activities at the pond. To maintain this subpopulation, it is essential that the uplands are managed properly by removing exotic vegetation and planting appropriate native species, controlling the amount and quality of runoff, controlling access to the pond and upland habitats, and other necessary actions.

1.2.1.3. Rehabilitate upland habitat surrounding Seascape Pond to provide enough habitat of suitable quality to support nonbreeding activities.

1.2.1.4. Ensure Salamander Protection Zone regulations are enforced appropriately in the Larkins Valley/Calabasas area. Work with landowners and appropriate agencies.

1.2.1.5. Implement upland habitat restoration and management actions at the Calabasas site. This will help control the spread of exotic species and ensure enough upland habitat of sufficient quality to support nonbreeding activities.

1.2.1.6. Continue upland habitat restoration at the Ellicott site. This is necessary to prevent excessive silt deposition into the pond and to provide adequate cover and food for nonbreeding salamanders.

1.2.2. Work with Willow Canyon Enterprises to develop and implement an adequate Habitat Conservation Plan that includes removal of exotic vegetation, revegetation with appropriate native species, and control of erosion and runoff. The Bush Gulch/Cuesta Canyon drainage probably serves as a migration and dispersal corridor between Seascape Pond and Valencia Lagoon, and may provide a route for migrating salamanders to naturally reestablish the Valencia Lagoon breeding aggregation, if that pond can be restored to functional status.

1.2.3. Restore recently-acquired upland habitat adjacent to McClusky vernal pool and McClusky Slough. Remove exotic vegetation and revegetate with appropriate native species to provide habitat for nonbreeding salamanders.

1.2.4. Develop management plans for the McClusky Slough upland habitats, working with Natural Resources Conservation Service, Ducks Unlimited, landowners, and other appropriate parties.

1.2.5. Investigate additional McClusky Slough land protection. Additional acquisitions of land or conservation easements around McClusky Slough may be feasible.

1.2.6. Investigate additional Moro Cojo Slough land protection. Additional acquisitions of land or conservation easements around Moro Cojo Slough may be feasible.

1.3. Establish additional ponds or restore existing ponds in each complex. Establishing and maintaining at least two functional breeding sites in each complex will provide a "safety net" in the event that one of the ponds remains or becomes nonfunctional as a breeding site, hopefully ensuring that a sufficient number of Santa Cruz long-toed salamanders and an appropriate level of genetic diversity remains to allow for the persistence of the subpopulation.

1.3.1. Establish a new pond on the Seascape site with appropriate contours and vegetation. Monitor the pond to assess its utility as a breeding site. This will provide some security if the original pond fails to continue as a functional

breeding pond.

1.3.2. Establish a new breeding pond at the Bush Gulch/Cuesta Canyon site. This could allow the Valencia-Seascape subpopulation to grow and would provide a source for recolonization of Valencia Lagoon/Pond that is closer than Seascape Pond.

1.3.3. Monitor and manage the new accessory pond in Larkins Valley below the Calabasas Pond. Monitor the pond for breeding and recruitment. Manage the vegetation and recontour the pond, if the monitoring shows it is needed.

1.3.4. Assess the feasibility of establishing an additional pond(s) in Larkins Valley or tributary drainages.

1.3.5. Monitor the new pond at Ellicott Preserve for breeding activity and recruitment. Manage water levels and vegetation as appropriate.

1.3.6. Investigate the potential for enhancing or establishing a pond in the drainage to the west of the Buena Vista site. If a Habitat Conservation Plan is developed for the Buena Vista Pond site or the site is acquired, investigate the possibility that salamanders breed in an existing pond or the potential for establishing a pond in the drainage to the west of the current pond.

1.4. Reduce human-related mortality. Because human-related mortality factors, including road construction, agriculture and urbanization, have been identified as the major threats to the Santa Cruz long-toed salamander's survival, it is important to minimize mortality from those factors.

1.4.1. Prevent losses to the populations by encouraging appropriate actions by public agencies that are responsible for deterring illegal activities such as draining wetlands, clearing underbrush, and releasing exotic aquatic species in breeding ponds. Additionally, public agencies such as the Natural Resources Conservation Service can promote conservation actions, for example with the Elkhorn Slough and Moro Cojo Watershed Management Plans, where the

National Resources Conservation Service and cooperators are working to slow erosion and discharge of contaminants to the sloughs. Depending on the situation, the Natural Resources Conservation Service is advocating the return of pasture and cropland to wetlands, reducing grazing pressures, using organic farming methods, having greater setbacks from slough edges, planting native shrubs and trees, and other actions. These actions should benefit the Santa Cruz long-toed salamander as well as many other species. While recovery plans are intended to cover tasks that potential participants would *not* do as part of their normal duties, it is worth emphasizing that because breeding and nonbreeding habitats for this salamander are so limited, considerable good can be accomplished within the scope of "normal duties."

1.4.2. Extend Salamander Protection Zones in Santa Cruz County to include the Bush Gulch/Cuesta Canyon area, the Buena Vista Pond and Rancho Road Pond areas, and any areas around newly discovered breeding sites.

1.4.3. Investigate whether Salamander Protection Zones in Monterey County are needed, and if so, possible. If current mechanisms are inadequate to address the needs of the salamanders in Monterey County, establishment of Salamander Protection Zones and regulations may help maintain and recover the Santa Cruz long-toed salamander.

1.4.4. Evaluate roadkills and installing salamander tunnels as feasible. Tunnels have been used in Europe and New England to reduce road mortality of toads and salamanders, and experiments have been conducted in California (page 38). This task assumes success in developing functional tunnel designs.

1.4.4.1. Evaluate the roads around Valencia Lagoon and in the residential area above it to determine if and where tunnels are appropriate. Install tunnels as feasible.

1.4.4.2. Install salamander tunnels at Seascape as specified in the Habitat Conservation Plan to allow salamanders safer access to the breeding ponds and upland habitats.

1.4.4.3. Determine appropriate sites in and around the Willow Canyon development (Bush Gulch/Cuesta Canyon) for installation of tunnels to permit migration and dispersal between Valencia Lagoon and Seascape Pond. Install tunnels as feasible.

1.4.4.4. Identify areas of heavy roadkill in the Larkins Valley area. Install tunnels as needed and as feasible.

1.4.4.5. Replace nonfunctional tunnels at Ellicott Preserve with functional design. Install tunnels as feasible.

1.4.4.6. Evaluate roads near Buena Vista Pond and Rancho Road Pond for salamander mortality and assess the need for and feasibility of tunnels. Install tunnels as feasible.

1.4.4.7. Evaluate roads in the upper reaches of the Moro Cojo Slough watershed for mortality and assess the feasibility of tunnels. Install tunnels as feasible.

1.4.5. Control use of sites by domestic animals as necessary, and reduce populations of raccoons, opossums, and skunks if they are artificially large due to access to pet and livestock feed or garbage.

1.4.6. Protect Santa Cruz long-toed salamander habitat from effects of pesticides, herbicides, fertilizers, petroleum products, and other chemicals. Evaluate new information on the effects of these chemicals on amphibians and their prey base. Make recommendations for the use of such chemicals in and near Santa Cruz long-toed salamander habitat and work with appropriate agencies to implement adequate regulations and management practices to protect the salamanders.

1.5. Determine and monitor population status. Effects of management actions can be evaluated only through continued monitoring that leads to knowing each subpopulation's or metapopulation's status. Based on this knowledge, needed

changes can be identified, adverse conditions can be detected and corrected, and causal agents can be identified. This is particularly true when situations arise that require emergency action.

1.5.1. Monitor and census salamanders during the breeding migrations. The breeding migrations are the only time when a large proportion of the population is active and focused in a relatively small area, allowing for the assessment of the population size and age structure.

1.5.2. Monitor egg and larval development in the ponds and juvenile emigration from the ponds to determine the functionality of the ponds, assess threats and determine if emergency actions (such as artificially augmenting water levels or removal of exotic predators) are necessary.

2. Conduct surveys and identify habitat for protection.

Conduct surveys in the general area of each complex to locate additional breeding sites and upland habitat areas. Survey areas that appear to support suitable breeding and upland habitat, based on maps, aerial photos, and visual reconnaissance. This will help focus survey efforts on the most likely sites to harbor Santa Cruz long-toed salamanders. Identify parcels that would be appropriate for conservation agreements or easements, acquisition, or other management actions. Protection and management of additional breeding and upland habitats would buffer this salamander against abrupt losses of subpopulations or a metapopulation due to catastrophic events, whether natural or human-related, or against gradual losses due to habitat destruction and degradation. These tasks are focused toward achieving both recovery objectives — reclassification to threatened status and delisting.

2.1. Survey areas in Santa Cruz County.

2.1.1. Valencia-Seascape complex — survey the area between San Andreas Road and Robak Drive north of the Mar Monte exit. One pond shown on the 1994 revision of the USGS Watsonville West quad may provide suitable breeding habitat, and other ponds may exist in the area.

2.1.2. Larkins Valley/Calabasas Road area — the need for surveys is indicated by the 1994 revision of the USGS Watsonville West quad, which shows numerous ponds that may provide suitable breeding habitat.

2.1.2.1. Survey the area designated as Salamander Protection Zone (approximately bounded by Calabasas Road on the east, White Road on the north, East Bel Mar Drive and west of Larkins Valley Road on the west, and Winter Wind Way and Dusty Trail on the South).

2.1.2.2. Survey the area between Freedom Boulevard and White Road from Highway 1 to Pleasant Valley.

2.1.2.3. Survey the Larkins Valley/Harkins Slough area downstream from the Salamander Protection Zone to Buena Vista Drive between Highway 1 and Calabasas Road.

2.1.3. Survey the area north of the Ellicott site and Buena Vista Pond to San Andreas Road and Robak Road, and the area to the south to Buena Vista Drive. As with the areas above, several ponds are shown on the 1994 revision of the USGS Watsonville West quad that may provide suitable breeding habitat.

2.1.4. Survey the Merk Road drainage and Pleasant Valley to determine Santa Cruz long-toed salamander breeding sites and assess threats in those drainages.

2.2. Survey areas in Monterey County.

2.2.1. Survey the inner dune face from the Pajaro River to the Salinas River to detect ponds similar to McClusky vernal pool that may currently or potentially provide salamander breeding habitat.

2.2.2. Survey upper Moro Cojo Slough drainages, particularly between Dolan Road and Castroville Boulevard on the north and Tembladero Slough on the south.

2.2.3. Survey the area along Elkhorn Road to the east of the Elkhorn Slough National Estuarine Research Reserve.

2.2.4. Survey the upper reaches of Elkhorn Slough.

3. Assess distribution and population status in the Merk Road (Santa Cruz County) and upper Moro Cojo (Monterey County) areas, and implement appropriate management.

Before appropriate management strategies and actions can be planned and implemented, the distribution and status of Santa Cruz long-toed salamanders must be determined in the Merk Road drainage and in upper Moro Cojo Slough, and at any new locations found through the surveys conducted under Task 2. This task is focused toward accomplishing the second recovery objective — delisting this salamander.

3.1. Locate breeding sites and assess threats for the Merk Road and Moro Cojo Slough salamander populations and any new locations found in surveys conducted as part of Task 2.

3.2. Determine relative numbers of adults at breeding sites and assess threats by conducting migration monitoring and trapping studies.

3.3. Monitor egg and larval survival at breeding sites.

3.4. Determine the location and extent of upland habitat used by Santa Cruz long-toed salamanders in the Merk Road drainage and in upper Moro Cojo Slough, and at any new locations found through the surveys conducted under Task 2.

3.5. Institute management actions as necessary to protect any new site. Work with the appropriate agencies and non-governmental organizations to achieve protection.

4. Conduct research applicable to the management of the Santa Cruz long-toed salamander and its habitats.

Adequately designed and implemented research applicable to the management of Santa

Cruz long-toed salamander habitats and populations is essential to evaluate methods and develop appropriate strategies for habitat management and population assessment/management.

4.1. Conduct research applicable to habitat management.

4.1.1. Determine the effects of methoprene (an insect growth regulator used to control mosquito larvae) on larval salamanders and their habitats. Local mosquito abatement districts often rely upon this method of mosquito control and in the past used it in known salamander breeding ponds at Valencia Lagoon, Ellicott, and Seascape. The manufacturer of the hormone claims it is nontoxic to salamander larvae, but recent evidence implicates it as a factor in amphibian malformations. Also, its effect on the salamander's prey base has not been addressed.

4.1.2. Determine the effects of mosquitofish/larval salamander interactions. Mosquitofish are non-native predators that are presumed to have contributed to the decline and extinction of certain native amphibians in California by consuming their eggs and larvae. Because the local mosquito abatement districts consider mosquitofish to be an important method for controlling mosquito larvae, effects of mosquitofish predation on larval Santa Cruz long-toed salamanders must be understood.

4.1.3. Determine how far juveniles disperse from their breeding pond. Data on juvenile salamander dispersal distances are needed to determine how much and what type of habitat must be protected, and at what distance it must be from the breeding pond.

4.1.4. Determine how much upland habitat is needed by nonbreeding Santa Cruz long-toed salamanders. This must be known in order to protect appropriate and sufficient upland habitats.

4.1.5. Determine pond characteristics.

4.1.5.1. Determine the areal extent and depth profiles of ponds, temperatures, dissolved oxygen levels, pH, and other water quality parameters as appropriate at critical life history points (arrival of adults at ponds, egg laying, hatching, initiation of metamorphosis, completion of metamorphosis) and throughout the larval development phase.

4.1.5.2. Determine the species composition of the plant cover, its extent, and use of the cover by adults, larvae, and juveniles.

4.1.6. Determine the life cycle of the trematode found at the Valencia-Seascape Complex, whether it is at any other sites, the magnitude of the effects on the Santa Cruz long-toed salamander population, and if the infestations are a threat to any known breeding aggregations. The trematode's life cycle must be fully understood to determine whether control is possible and, if so, what control measures are appropriate.

4.2. Conduct research applicable to population management.

4.2.1. Conduct a comparative marking study in conjunction with monitoring programs or on captive animals. Determine the most efficient method for mark-recapture studies by comparing the use of toe clipping, passive integrated transponder (PIT) tagging, dorsal pattern recognition, and injectable elastomers. Although toe-clipping has long been used, the toes grow back very quickly, so the method is of limited or no use in determining adult survival from year to year or the age at which sexual maturity is reached. However, toe-clipping yields tissue that can be used for genetic analysis and age determination. The tissue analysis methods are relatively new, especially the age-determination techniques, and are not yet widely used. PIT tags and elastomers may be retained long enough to determine year-to-year survival and age of sexual maturity. Use of both PIT and elastomer techniques requires handling the salamanders for the insertion phase and again to determine whether the individual has been implanted. Another potential marker for mark-recapture studies is dorsal patterns. Dorsal patterns

may change as the juvenile salamanders grow into and through subadult stages, and the time at which the patterns become stable is currently unknown. If that could be determined, a rapid population assessment technique might be developed using still or video photography and computer analysis of the patterns.

4.2.2. Conduct a long-term population dynamics study (at least 10 years) in conjunction with the monitoring efforts. Understanding the natural fluctuations in population parameters (sex ratios, number of adults breeding, egg production rates, egg and larval survival, etc.) is essential to understanding and assessing how management actions affect the survival and recovery of the species. This study should be conducted at a minimum of two locations (e.g., Ellicott Slough and McClusky Slough) in order to assess variation within a given year and between habitats. If more locations are studied, additional information would be obtained, and extrapolation of the results to additional sites would be more justifiable.

4.2.3. Determine population age structure using stained bone sections from toe clippings obtained in monitoring programs and marking studies (Russell et al. 1995). Simultaneously, a correlative study using snout to vent measurements can be conducted to determine which method is more appropriate for evaluating age structure. Assessing the age structure of a population can provide evidence of reproductive failures or abnormally high adult mortality, and allow appropriate management actions to be implemented.

4.2.4. Determine genetic structure within and among metapopulations using toe clippings obtained from monitoring programs and marking studies. The results can be used to determine the source of founder individuals if re-establishment of any breeding aggregation becomes necessary (for example, at Valencia Lagoon, if the pond is appropriately reconfigured but not enough salamanders migrate to it to establish a healthy breeding aggregation).

4.2.5. Develop protocols to assess population status.

4.2.5.1. Assess the utility and efficiency of using coverboards to determine the status and size of Santa Cruz long-toed salamander breeding populations by conducting a well-designed study. The present method of live-trapping juvenile and adult salamanders with pit traps is an excellent way to obtain data on population size and age structure, but it is expensive and time consuming. It also disrupts the animals' behaviors.

4.2.5.2. Test the utility and efficiency of using an underwater viewing apparatus to assess larval densities and habitat use. Such a method should be less disruptive to the animals and their habitat than dipnetting or seining, and poses less risk of injury to larvae.

5. Conduct public education and information programs.

Programs of conservation education and public information sponsored by the California Department of Fish and Game and the Service have been effective in protecting the Santa Cruz long-toed salamander and should be continued and expanded.

5.1. Continue to provide information to all interested parties on a timely basis. Descriptive leaflets and small pamphlets prepared for visitors to the Ellicott Slough Ecological Reserve and National Wildlife Refuge should continue to be available. Similar pamphlets should be made available for any other sites that allow public access.

5.2. Continue the program for controlled public access to the Ellicott site. Public use at the Ellicott site has been effectively controlled by requiring all visitors to obtain a letter of condition prior to each visit. This policy should continue.

5.3. Install postings and informational signs around protected areas to educate the public. Existing informational signs at Valencia Lagoon and the Ellicott site inform visitors about the sensitivity and importance of the protected areas. These signs should be posted and maintained at all sites that are open to the public or accessible to the residents of surrounding developments.

5.4. Continue the interpretive program at the Ellicott site and expand to other sites as feasible. Although a major interpretive program for the Santa Cruz long-toed salamander has not been established, visitors to the Ellicott site have been provided with information on the Santa Cruz long-toed salamander and shown the area during their visits. This program should continue to provide worthwhile benefits at a relatively low cost. Consideration should also be given to using volunteers to conduct guided tours through the area.

PART III. LITERATURE CITED

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PART IV. IMPLEMENTATION SCHEDULE

The schedule that follows (Table 3) summarizes the actions and their estimated costs for the Santa Cruz long-toed salamander draft revised recovery program. It is a guide to meet the objectives of this recovery plan as elaborated in the narrative section of the plan (Part II). This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of this salamander and protect its habitat. Because the schedule estimates the monetary needs for all parties involved in the salamander's recovery, it covers the entire estimated cost of recovery.

For each recovery task, the first agency listed is the lead agency.

Definitions and Acronyms Used in Table 3:

Priorities in the first column of the implementation schedule are:

1 An action that *must* be taken to prevent extinction or to prevent the salamander from declining irreversibly in the *foreseeable* future.

2 An action that must be taken to prevent a significant decline in the salamander's population/habitat quality, or to prevent some other significant negative impact short of extinction.

3 All other actions necessary to provide for full recovery of the salamander.

Key to Acronyms:

BRD	–	Biological Resources Division, U.S. Geological Survey
Caltrans	–	California Department of Transportation
CDA	–	California Department of Agriculture
CDFG	–	California Department of Fish and Game
CDPR	–	California Department of Parks and Recreation
CNLM	–	Center for Natural Lands Management
DU	–	Ducks Unlimited
EPA	–	Environmental Protection Agency
LO	–	Landowners
MCMAD	–	Monterey County Mosquito Abatement District
MCPD	–	Monterey County Planning Department

NRCS	–	Natural Resources Conservation Service
SCCPD	–	Santa Cruz County Planning Department
SCMAD	–	Santa Cruz County Mosquito Abatement District
TBD	–	To Be Determined
TNC	–	The Nature Conservancy
TPL	–	Trust for Public Lands
USFWS	–	U.S. Fish and Wildlife Service
WCE	–	Willow Canyon Enterprises, Inc.
WI/CSUMB	–	Wetlands Institute, California State University Monterey Bay

Table 3. Implementation Schedule for the Santa Cruz Long-toed Salamander Draft Revised Recovery Plan.

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
	Need 1: Manage pond and upland habitats, reduce human-related mortality, and monitor populations.										
1	1.1.3	Complete acquisition of Calabasas site and transfer to USFWS	1	WCB	**250**	250	0	0	0	0	0
				USFWS	**10**	10	0	0	0	0	0
2	1.1.1	Improve the Valencia Lagoon	1	CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				Caltrans	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.1.2	Repair the breach in the Seascape berm, maintain berm and pond	Continuous	CNLM	**173**	47	5	5	5.5	5.5	105
2	1.1.4	Maintain the Calabasas pond at an appropriate level by maintaining and repairing the berm	Continuous	USFWS	**138.5**	12.5	5	5	5.5	5.5	105
				CDFG	**67.5**	2.5	2.5	2.5	3	3	54
2	1.1.5	Develop a management plan for the Calabasas acquisition and update it as appropriate.	Continuous	USFWS	**62.5**	10	5	2	2	2.5	41
				CDFG	**27**	2	2	1	1	1	20
2	1.1.6	Continue adaptive management of Ellicott Pond	Ongoing	USFWS	**134.5**	5	5	5.5	5.5	5.5	108
				CDFG	**134.5**	5	5	5.5	5.5	5.5	108
2	1.1.7	Develop conservation agreements and management plans for salamander habitat near Ellicott	5	USFWS	**26.5**	5	5	5.5	5.5	5.5	0
				SCCPD	**26.5**	5	5	5.5	5.5	5.5	0
2	1.1.8	Investigate acquisition possibilities for the Buena Vista site	3	USFWS	**TBD**	TBD	TBD	TBD	0	0	0
				TPL	**TBD**	TBD	TBD	TBD	0	0	0
				CDFG	**TBD**	TBD	TBD	TBD	0	0	0

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
2	1.1.9	Develop agreements with private landowners for management of salamander habitat in McClusky Slough	3	NRCS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				DU	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.1.10	Develop and implement a management plan for the McClusky acquisition	3	CDPR	**152.5**	20	15	5	5	5.5	102
				CDFG	**55**	5	3	2	2	2	41
				USFWS	**55**	5	3	2	2	2	41
2	1.1.11	Implement management actions at Moro Cojo Slough	3	WI/CSUMB	**195**	65	65	65	0	0	0
2	1.2.1.1	Secure land upslope from Valencia Lagoon through conservation easements and/or purchase	3	SCCPD	**TBD**	TBD	TBD	TBD	0	0	TBD
				CDFG	**TBD**	TBD	TBD	TBD	0	0	TBD
				USFWS	**TBD**	TBD	TBD	TBD	0	0	TBD
2	1.2.1.2	Ensure proper implementation of the Seascape Habitat Conservation Plan	Ongoing	CNLM	**142.5**	15	10	5	5	5.5	102
				USFWS	**134.5**	5	5	5.5	5.5	5.5	108
2	1.2.1.3	Rehabilitate upland habitat surrounding Seascape Pond	Ongoing	CNLM	**58.5**	5	5	5	2	2	39.5
2	1.2.1.4	Ensure Salamander Protection Zone regulations are enforced in Larkins Valley/Calabasas area.	Ongoing	SCCPD	**134.5**	5	5	5.5	5.5	5.5	108
				USFWS	**27**	1	1	1	1	1	22
2	1.2.1.5	Implement upland habitat restoration and management at Calabasas	Continuous	USFWS	**266**	15	10	10.5	10.5	11	209
				CDFG	**71.5**	5	2.5	2.5	2.5	3	56

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 – 2018
2	1.2.1.6	Continue upland habitat restoration and management at Ellicott	Ongoing	USFWS	**386.5**	72	12.5	13	13	14	262
				CDFG	**67.5**	2.5	2.5	2.5	3	3	54
				CDPR	**214.5**	8	8	8.5	8.5	9	172.5
				CDFFP	**67.5**	2.5	2.5	2.5	3	3	54
2	1.2.2	Develop and implement an adequate Habitat Conservation Plan at Willow Canyon	5	WCE	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.2.3	Restore upland habitat at the McClusky acquisition	5	CDPR	**85**	20	20	15	15	15	0
				CDFG	**35**	10	10	5	5	5	0
				USFWS	**19**	5	5	3	3	3	0
2	1.2.4	Develop management plans for privately owned McClusky Slough uplands	3	LO	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				NRCS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				DU	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.3.1	Establish a new pond at Seascape	1	CNLM	**72**	15	10	2	2	2	41
2	1.3.2	Establish a new breeding pond at Bush Gulch/Cuesta Canyon	1	WCE	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.3.3	Monitor and manage the new pond in Larkins Valley	Ongoing	CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.3.4	Assess the feasibility of establishing additional ponds in Larkins Valley	3	CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
2	1.3.5	Manage and monitor the new pond at Ellicott Preserve	Ongoing	USFWS	**298.5**	35	30	10	10	10.5	203
				CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.4.1	Prevent losses to the populations by encouraging appropriate actions by public agencies	Ongoing	USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				MCPD	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				SCCPD	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
2	1.4.4.2	Install salamander tunnels at Seascape as specified in the Habitat Conservation Plan	1	CNLM	**49**	24	1	1	1	1	21
2	1.4.4.7	Evaluate roadkills near Moro Cojo and assess the feasibility of tunnels	3	TNC	**3**	0	0	1	1	1	0
				MCPD	**3**	0	0	1	1	1	0
2	1.5.1	Monitor and census adult salamanders during the breeding migrations	Ongoing	USFWS	**161**	6	6	6.5	6.5	7	129
				CDFG	**107**	4	4	4	4.5	4.5	86
				CDPR	**54**	2	2	2	2.5	2.5	43
				CNLM	**54**	2	2	2	2.5	2.5	43
				TNC	**54**	2	2	2	2.5	2.5	43
2	1.5.2	Monitor egg and larval development	Ongoing	USFWS	**107**	4	4	4	4.5	4.5	86
				CDFG	**54**	2	2	2	2.5	2.5	43
				CDPR	**54**	2	2	2	2.5	2.5	43
				CNLM	**54**	2	2	2	2.5	2.5	43
				ESF/TNC	**107**	4	4	4	4.5	4.5	86

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
3	1.2.5	Investigate additional protection around McClusky Slough	3	CDFG	**TBD**	TBD	TBD	TBD	0	0	0
				TPL	**TBD**	TBD	TBD	TBD	0	0	0
				ESF/TNC	**TBD**	TBD	TBD	TBD	0	0	0
				USFWS	**TBD**	TBD	TBD	TBD	0	0	0
3	1.2.6	Investigate additional land protection around Moro Cojo Slough	3	CDFG	**TBD**	TBD	TBD	TBD	0	0	0
				TPL	**TBD**	TBD	TBD	TBD	0	0	0
				ESF/TNC	**TBD**	TBD	TBD	TBD	0	0	0
				USFWS	**TBD**	TBD	TBD	TBD	0	0	0
3	1.3.6	Investigate the potential for establishing a pond in the drainage to the west of the Buena Vista site	1	CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
3	1.4.2	Extend Salamander Protection Zones in Santa Cruz County	as needed	SCCPD	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
3	1.4.3	Investigate establishing Salamander Protection Zones in Monterey County	2	MCPD	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
3	1.4.4.1	Evaluate roadkills near Valencia Lagoon to determine if and where tunnels are appropriate	TBD	CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
3	1.4.4.3	Determine appropriate sites at the Willow Canyon development for installation of tunnels	1	WCE	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
3	1.4.4.4	Investigate roadkill in Larkins Valley and install tunnels if needed	3	CDFG	**3**	1	1	1	0	0	0

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
3	1.4.4.5	Replace non-functional tunnels at Ellicott with a functional design	1	CDFG	**6**	6	0	0	0	0	0
3	1.4.4.6	Evaluate roads near Buena Vista and Rancho Road Ponds for mortality, assess the need for tunnels and install if needed	3	CDFG	**3**	0	1	1	1	0	0
3	1.4.5	Control site use by domestic animals and control racoons, opossums, and skunks as appropriate	Ongoing	USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				CDPR	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				TNC/ESF	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				NRCS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
3	1.4.6	Protect Santa Cruz long toed salamander habitat from effects of pesticides, herbicides, fertilizers, petroleum products, and other chemicals	Continuous	CDA	**24**	5	1	1	1	1	15
				BRD	**24**	5	1	1	1	1	15
				EPA	**24**	5	1	1	1	1	15
		Need 1 Subtotal Cost (Minimum):			**4533**	**746**	**300.5**	**246.5**	**184.5**	**188.5**	**2867**
Need 2: Identify additional populations and suitable habitat throughout the range of the Santa Cruz long-toed salamander.											
2	2.1.4	Survey the Merk Road and Pleasant Valley drainages.	2	USFWS	**2**	1	1	0	0	0	0
				SCCPD	**2**	1	1	0	0	0	0
				CDFG	**2**	1	1	0	0	0	0

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
2	2.2.2	Survey upper Moro Cojo Slough drainages	2	TNC/ESF	4	2	2	0	0	0	0
				WI/CSUMB	2	1	1	0	0	0	0
				MCCPD	4	2	2	0	0	0	0
				CDFG	4	2	2	0	0	0	0
2	2.2.3	Survey east of Elkhorn Slough National Estuarine Research Reserve	2	BRD	4	2	2	0	0	0	0
				TNC/ESF	4	2	2	0	0	0	0
				USFWS	4	2	2	0	0	0	0
2	2.2.4	Survey the upper reaches of Elkhorn Slough	2	TNC/ESF	4	0	2	2	0	0	0
				MCCPD	4	0	2	2	0	0	0
				CDFG	4	0	2	2	0	0	0
3	2.1.1	Survey in the vicinity of Valencia-Seascape	1	USFWS	0.5	0.5	0	0	0	0	0
				SCCPD	0.5	0.5	0	0	0	0	0
				CDFG	0.5	0.5	0	0	0	0	0
3	2.1.2.1	Survey the Salamander Protection Zone in the Larkins Valley/Calabasas area.	2	USFWS	2	1	1	0	0	0	0
				SCCPD	2	1	1	0	0	0	0
				CDFG	2	1	1	0	0	0	0
3	2.1.2.2	Survey north of the Salamander Protection Zone in the Larkins Valley/Calabasas area.	2	USFWS	2	0	1	1	0	0	0
				SCCPD	2	0	1	1	0	0	0
				CDFG	2	0	1	1	0	0	0

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
3	2.1.2.3	Survey south of the Salamander Protection Zone in the Larkins Valley/Calabasas area.	2	USFWS	**2**	0	0	1	1	0	0
				SCCPD	**2**	0	0	1	1	0	0
				CDFG	**2**	0	0	1	1	0	0
3	2.1.3	Survey in the vicinity of Ellicott-Buena Vista complex	2	USFWS	**2**	0	0	1	1	0	0
				SCCPD	**2**	0	0	1	1	0	0
				CDFG	**2**	0	0	1	1	0	0
3	2.2.1	Survey the inner dune face from the Pajaro River to the Salinas River	2	CDFG	**1**	0	0.5	0.5	0	0	0
				CDPR	**1**	0	0.5	0.5	0	0	0
				USFWS	**1**	0	0.5	0.5	0	0	0
				MCCPD	**1**	0	0.5	0.5	0	0	0
		Need 2 Subtotal Cost (Minimum):			**73.5**	**20.5**	**30**	**17**	**6**	**0**	**0**
		Need 3: Assess the distribution and population status of poorly documented and new breeding aggregations and subpopulations.									
2	3.1	Locate breeding sites and assess threats for Merk Road, Moro Cojo, and new breeding aggregations or subpopulations	2	CDFG	**24**	0	0	6	6	6	6
				USFWS	**8**	0	0	2	2	2	2
2	3.2	Conduct migration monitoring and trapping studies at the above sites	6	TBD	**60**	0	0	10	10	10	30
2	3.3	Monitor egg and larval survival at the above breeding sites	6	CDFG	**36**	0	0	6	6	6	18
				USFWS	**12**	0	0	2	2	2	6

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
2	3.4	Determine the location and extent of upland habitat at the above sites	3	CDFG	**18**	0	0	6	6	6	0
				USFWS	**6**	0	0	2	2	2	0
2	3.5	Institute management actions as necessary to protect any new sites	5	CDFG	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
				USFWS	**TBD**	TBD	TBD	TBD	TBD	TBD	TBD
		Need 3 Subtotal Cost (Minimum):			**164**	**0**	**0**	**34**	**34**	**34**	**62**
		Need 4: Conduct research applicable to the management of Santa Cruz long-toed salamander and its habitats									
2	4.1.1	Determine the effects of insect growth regulators on Santa Cruz long-toed salamander and their prey base	3	SCMAD	**13**	5	5	3	0	0	0
				MCMAD	**13**	5	5	3	0	0	0
				BRD	**25**	10	10	5	0	0	0
2	4.1.2	Determine the effects of mosquitofish on Santa Cruz long-toed salamander	3	SCMAD	**9**	3	3	3	0	0	0
				MCMAD	**9**	3	3	3	0	0	0
				BRD	**15**	5	5	5	0	0	0
2	4.1.3	Determine juvenile dispersal distances	3	USFWS	**30**	10	10	10	0	0	0
				BRD	**30**	10	10	10	0	0	0
				CDFG	**15**	5	5	5	0	0	0
2	4.1.4	Determine how much upland habitat is needed by nonbreeding Santa Cruz long-toed salamanders	3	USFWS	**30**	10	10	10	0	0	0
				BRD	**30**	10	10	10	0	0	0
				CDFG	**15**	5	5	5	0	0	0
2	4.1.5.1	Determine physical and chemical characteristics of ponds	3	BRD	**30**	10	10	10	0	0	0
				USFWS	**15**	5	5	5	0	0	0
				CDFG	**15**	5	5	5	0	0	0

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
2	4.1.5.2	Determine biotic attributes of ponds	3	BRD	**15**	5	5	5	0	0	0
				USFWS	**15**	5	5	5	0	0	0
				CDFG	**15**	5	5	5	0	0	0
2	4.2.1	Conduct a comparative marking study	3	USFWS	**15**	0	5	5	5	0	0
				CDFG	**15**	0	5	5	5	0	0
				BRD	**30**	0	10	10	10	0	0
2	4.2.2	Conduct a long-term population dynamics study	10	BRD	**78.5**	15	10	5	5	5.5	38
				CDFG	**73.5**	15	10	5	5	5.5	33
3	4.1.6	Determine the life cycle of the trematode at Valencia-Seascape	5	USFWS	**20**	0	10	10	0	0	0
3	4.2.3	Determine population age structure using stained bone sections	5	BRD	**25**	5	5	5	5	5	0
3	4.2.4	Determine genetic structure within and between metapopulations	3	BRD	**45**	0	20	15	10	0	0
3	4.2.5.1	Assess the utility and efficiency of using coverboards as a monitoring tool	3	USFWS	**15**	0	5	5	5	0	0
3	4.2.5.2	Test the utility and efficiency of using underwater viewing apparatus to assess larval densities and habitat use	3	USFWS	**15**	0	5	5	5	0	0
		Need 4 Subtotal Cost (Minimum):			**671**	**151**	**201**	**177**	**55**	**16**	**71**

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates, thousands of dollars for first 5 fiscal years. 1999	2000	2001	2002	2003	Cost Estimate 2001 - 2018
	Need 5: Develop information and education programs.										
3	5.1	Continue to provide information to all interested parties.	ongoing	USFWS	**67.5**	2.5	2.5	2.5	3	3	54
				CDFG	**67.5**	2.5	2.5	2.5	3	3	54
3	5.2	Continue program for controlled public access to the Ellicott site	ongoing	USFWS	**67.5**	2.5	2.5	2.5	3	3	54
3	5.3	Install signs around protected areas	ongoing	USFWS	**134.5**	5	5	5.5	5.5	5.5	108
				CDFG	**67.5**	2.5	2.5	2.5	3	3	54
				CDPR	**67.5**	2.5	2.5	2.5	3	3	54
				CNLM	**67.5**	2.5	2.5	2.5	3	3	54
3	5.4	Continue interpretive program at Ellicott and expand to other sites as feasible	ongoing	USFWS	**134.5**	5	5	5.5	5.5	5.5	108
				CDFG	**134.5**	5	5	5.5	5.5	5.5	108
				CDPR	**134.5**	5	5	5.5	5.5	5.5	108
				TNC	**134.5**	5	5	5.5	5.5	5.5	108
		Need 5 Subtotal Cost (Minimum):			**1077.5**	**40**	**40**	**42.5**	**45.5**	**45.5**	**864**
		TOTAL COST (Minimum):			**6519**	**957.5**	**571.5**	**517**	**325**	**284**	**3864**