Valley Elderberry Longhorn Beetle, *Desmocerus californicus dimorphus*

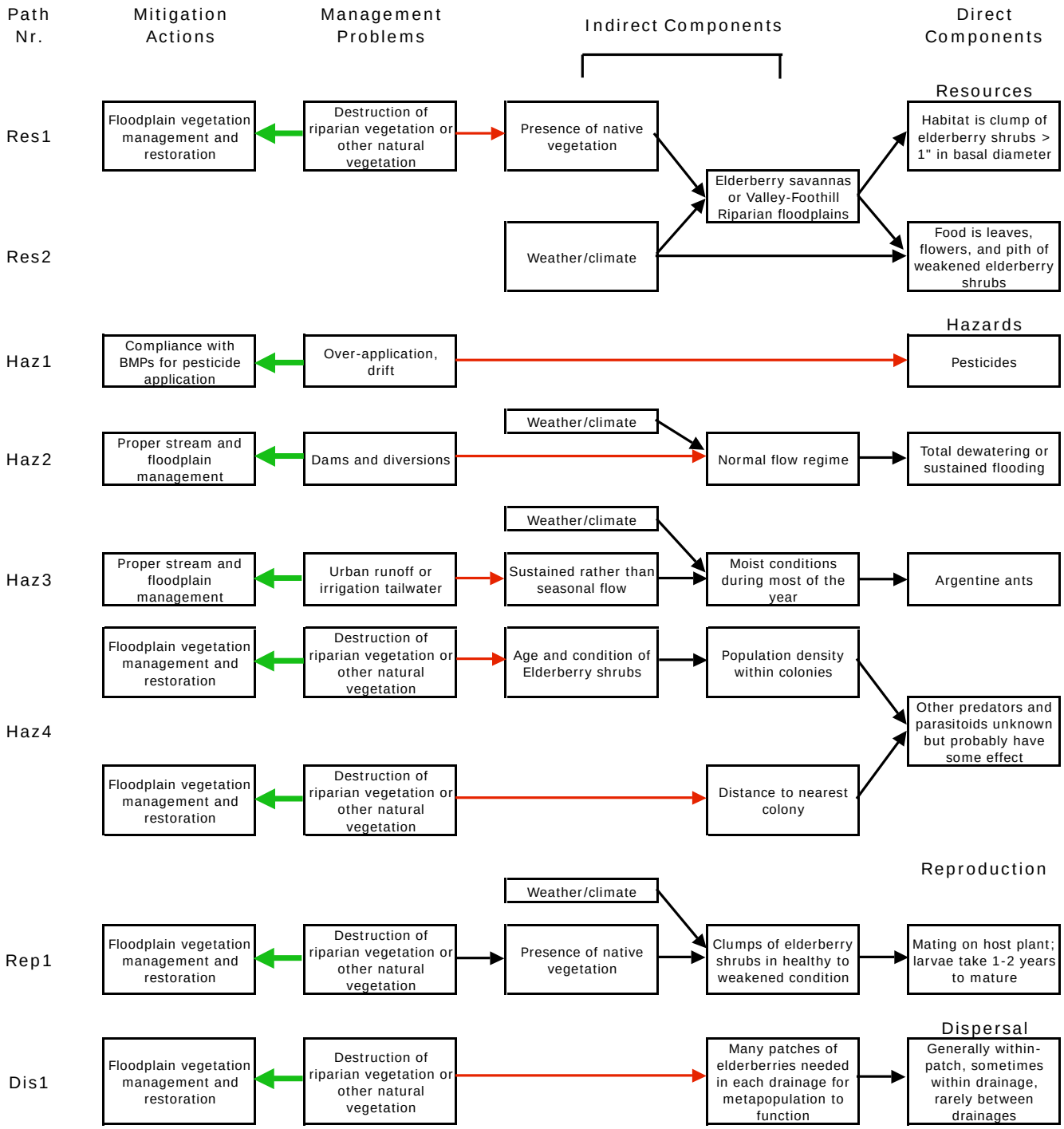


Figure 1. Envirogram. Key to abbreviations: Res = Resources; Haz = Hazards; Rep = Reproduction; Dis = Dispersal.

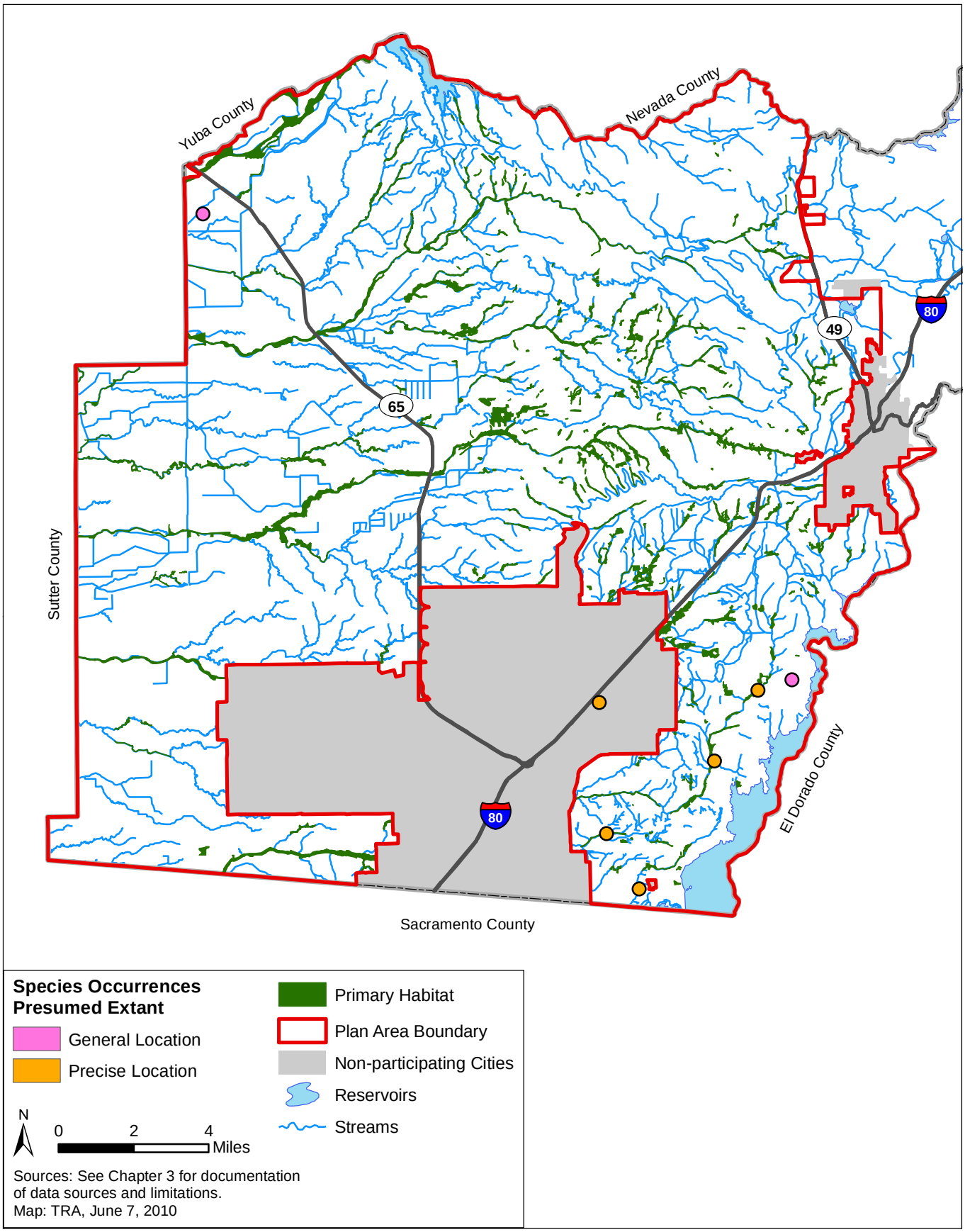
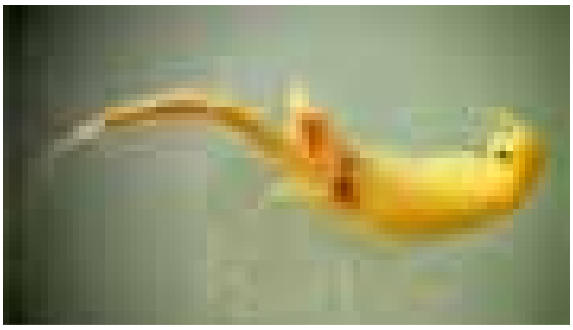


Figure 2. Valley elderberry longhorn beetle modeled habitat distribution. The habitat map present outcomes of the draft model described above. The purpose of the model is to identify areas within the Plan area where the species occurs or could occur based on known habitat requirements. Those data on which this map is based are regional in scale. This map should not be used for site planning and should be verified in the field.

Occurrence data are limited by where field surveys have been conducted; some occurrence points may be geographically inaccurate. Occurrence records are from the California Natural Diversity Database (2009).

Vernal Pool Fairy Shrimp
(*Branchinecta lynchi*)



Vernal Pool Fairy Shrimp by Dwight Harvey.
http://www.fws.gov/sacramento/es/recovery_plans/vp_recovery_plan_links.htm

Status

Federal: Threatened (USFWS 1994)

State: None

Other: G2G3/S2S3

Critical Habitat: Critical habitat designated August 6, 2003 (68 FR 46683)

Recovery Plan: Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005)

Placer Legacy Category: Class 1

Distribution

California

Vernal pool fairy shrimp (Eng et al. 1990) is endemic to California. The historical range includes annual grasslands of the Great Central Valley. Currently, the species ranges from Red Bluff in Shasta County south to Tulare County. Disjunct populations also occur on the Santa Rosa Plateau in Riverside County and in the South Coast ranges (Eriksen and Belk 1999).
Vernal pool fairy shrimp have been reported from the following California Vernal Pool Regions: Northwest Sacramento Valley, Northeast Sacramento Valley, Southeast Sacramento Valley, Solano-Colusa, Livermore, Central Coast, Carrizo, San Joaquin Valley, South Sierra Foothills, and Western Riverside County (California Department of Fish and Game 1998). The California Natural Diversity Database (2009) lists 596 occurrences of vernal pool fairy shrimp statewide.

Placer County Plan Area

Historical

The historical distribution of vernal pool fairy shrimp can only be inferred from the historical distribution of its habitat. Annual grasslands of western Placer County, particularly within the Great Valley ecoregion, probably supported a patchy distribution of vernal pool fairy shrimp.

Current

Numerous populations of vernal pool fairy shrimp occur in the Plan area, which is within the Southeastern Sacramento Valley Vernal Pool Region (USFWS 2007; California Natural Diversity Database 2009). The majority of extant populations in the Plan area occur in vernal pools of the northern hardpan and north volcanic mudflow types. These vernal pool types are common to the areas surrounding the Placer County cities of Roseville, Lincoln, and Rocklin.

Population Status & Trends

California

As of February 2010, the California Natural Diversity Database (CNDDB) listed 599 occurrences of vernal pool fairy shrimp in California (CNDDB 2010). Although vernal pool fairy shrimp are widely distributed, they are locally uncommon throughout their historical range. Where vernal pool fairy shrimp co-occur with other shrimp species, they are always outnumbered by the other species (Eriksen and Belk 1999).

Placer County Plan Area

Numerous populations of vernal pool fairy shrimp occur in the Plan area (CNDDB 2010). Several nature preserves and mitigation banks have been established in the Plan area with the partial goal of preserving habitat for vernal pool fairy shrimp. These preservation areas include Wildlands, Inc.'s, Aitken Ranch Mitigation Bank, Wildlands Mitigation Bank, and Orchard Creek Preservation Area; Eastridge Southern Wetland Preserve; Sterling Pacific Assets' Lincoln Crossing Mitigation Site; Mariner Vernal Pool Conservation Bank, managed by Westervelt Ecological Services; and the City of Roseville's Woodcreek Compensation Area (Jones & Stokes 2004, CNDDB 2010).

Natural History

The habitat requirements, ecological relationships, life history, and threats to vernal pool fairy shrimp described below are summarized in diagram form in the envirogram (Figure 1).

Habitat Requirements

Vernal pool fairy shrimp inhabit rain-filled ephemeral pools (i.e., vernal pools) that form in depressions, usually in grassland habitats (Eng et al. 1990). Pools must fill frequently and persist long enough for the species to complete its lifecycle, which takes place entirely within vernal pools. Pools occupied by vernal pool fairy shrimp often have grass or mud bottoms and clear to tea-colored water; they are often in basalt flow depression pools in unplowed grasslands. Water chemistry is key in determining fairy shrimp occurrence; alkalinity, total dissolved solids (TDS), and pH are some of the most important factors (Eriksen and Belk 1999). Vernal pool fairy shrimp inhabit alkaline pools, ephemeral drainages, pools on rock outcrops, ditches, stream oxbows, stockponds, vernal pools, vernal swales, and other seasonal wetlands. Occupied habitats range in size from rock outcrop pools as small as 1 square yard to large vernal pools up to 11 acres. The maximum potential water depth of occupied habitat ranges from 1.2 to 48 inches (Helm 1998; Eriksen and Belk 1999).

Vernal pools are characterized by a specific flora endemic to the hydrology and soil composition of the habitat. Vernal pool fairy shrimp and other fairy shrimp species have been observed in depressions filled with water that do not meet the definition of vernal pools (Helm 1998; Stone pers. comm.). Examples of non–vernal pool habitats are roadside ditches, wheel-ruts left by off-highway vehicles or other heavy equipment, and railroad toe-drains (Helm 1998). Vernal pool fairy shrimp are not found in riverine, estuarine, or other permanent waters that support fish (USFWS 1994).

Reproduction

Male vernal pool fairy shrimp visually seek out female vernal pool fairy shrimp. The male grasps the female between the last pair of phyllopods and the brood pouch with specialized second antennae. Sperm are released directly into the female's brood pouch during copulation.

Following insemination, the female releases eggs from lateral pouches into the ovisac, where the eggs are fertilized (Eriksen and Belk 1999).

Following fertilization, embryonic and cyst development begin. Embryonic development ceases when the late gastrula stage is reached. At that point, metabolism slows and a halted embryo is isolated from the environment by development of a many-layered membranous shell. The embryo and the shell comprise the cyst, or resting egg. Females carry cysts in a brood sac. Cysts are dropped to the pool bottom or remain in the female's brood sac until the female dies. Cysts are capable of withstanding heat, cold, and prolonged desiccation. When occupied pools fill with water in the same or subsequent seasons, some, but not all, of the deposited cysts may hatch. The egg bank in the soil may comprise cysts from several years of breeding. When the vernal pools fill with rainwater and the water temperature drops below 50ºF, the resting eggs hatch into small nauplii. The early stages of vernal pool fairy shrimp develop rapidly into adults, reaching maturity in as little as 18 days (Eriksen and Belk 1999).

Dispersal Patterns

Vernal pool fairy shrimp disperse locally during extremely wet years when individual pools in a complex spill into or are connected with adjacent pools. Long-distance dispersal can result from cysts being carried on the wind and on the bodies or in the guts of larger animals. Cysts, including those still in brood sacs, can pass undamaged and undigested through the digestive tracts of birds (Proctor et al. 1967 cited in Eriksen and Belk 1999); subsequent deposition of fecal matter can result in the inoculation of a new site. Cysts trapped in mud can adhere to the feet and feathers of waterfowl and the hooves and fur of grazing mammals and be transported to the dried mud of different vernal pool complexes (Eriksen and Belk 1999). Cysts may also be transported between pools in the digestive tracts of amphibian predators such as frogs and salamanders (Rogers pers. comm.).

Longevity

Vernal pool fairy shrimp can achieve reach maturity as few as 18 days after hatching. In colder water temperatures (less than 57ºF), individuals have been observed to require 41 days to mature (Helm 1998). Vernal pool fairy shrimp has the shortest maximum longevity of any fairy shrimp species observed in California: 139 days. Based on laboratory observations, Helm (1998) determined the mean longevity to be 90 days. Field observations indicate that vernal pool fairy shrimp typically persist only 10–12 weeks (Eriksen and Belk 1999; Stone pers. comm.).

Sources of Mortality

The greatest sources of mortality to vernal pool fairy shrimp are predation and heatstroke. Vernal pool fairy shrimp are unable to filter oxygen from their aquatic habitat when water temperatures remain above 70ºF. In addition, both adult fairy shrimp and diapausing cysts can be crushed by foot traffic and off-highway vehicles (Hathaway et al. 1996).

Behavior

Vernal pool fairy shrimp are omnivorous filter feeders that indiscriminately filter particles of the appropriate size from their surroundings. The diet consists of bacteria and plant and animal particles, including suspended unicellular algae and metazoans (Eriksen and Belk 1999). Adults use eleven pairs of legs, or phyllopods, for locomotion, to filter suspended food particles from the environment, and for respiration. Vernal pool fairy shrimp typically swim in a 'zig-zag' or 'figure-eight' pattern with the phyllopods oriented toward the water surface (i.e., they swim on their backs).

Movement and Migratory Patterns

The presence of vernal pool fairy shrimp adults coincides with the filling and drying pattern of the vernal pool habitats. Adult populations are typically present from mid-December through mid-March (Eriksen and Belk 1999). Resting cysts are always present in an occupied pool basin.

Ecological Relationships

Fairy shrimp is prey for migratory waterfowl, amphibians, predatory diving beetles (Coleoptera: Dytiscidae), water boatmen (Hemiptera: Corixidae), and vernal pool tadpole shrimp. Large freshwater branchiopods in California serve as an important source of protein and energy for migratory waterfowl (Eriksen and Belk 1999). Many vernal pools occur along the Pacific flyway; the use of these pools as resting and feeding grounds by migratory birds is well documented (Silveira 1998; Sterling pers. comm.).

Vernal pool fairy shrimp rarely co-occur with other fairy shrimp species, but when they are found in mixed assemblages they are never the most abundant species (USFWS 1994). The two species most likely to co-occur with vernal pool fairy shrimp are California linderiella (*Linderiella occidentalis*) and vernal pool tadpole shrimp (*Lepidurus packardi*). Only very rarely do vernal pool fairy shrimp co-occur with other *Branchinecta* species (Eriksen and Belk 1999).

Population Threats

The greatest threats to the persistence of vernal pool fairy shrimp are habitat loss and degradation resulting from urban development and agriculture. Vernal pools occur in large, flat, open grasslands that are ideal for a number of economic uses, including airports, military bases, rice and grain fields, cattle grazing, aggregate mining, and urban development.

Context for a Regional Conservation Strategy

Vernal pool fairy shrimp are known from 18 populations in the Plan area, and may also exist in additional locations that have not been surveyed. In the region, vernal pool fairy shrimp is found in vernal pool complexes north and south of the Placer County populations, including Yuba, Butte, Sutter, Sacramento, Yolo and Solano counties, among others. There is an absence of suitable habitat to the east, and thus the western Placer County populations probably represent the furthest eastward range of the species for the area. Within California, the greatest concentration of known populations occurs within the vernal pool complexes of western Placer County and Sacramento County. For conservation of vernal pool fairy shrimp within the Plan area, acquisition and conservation of vernal pool habitat and associated uplands and supporting hydrological systems is of highest priority.

Modeled Species Distribution in the Plan Area

Model Assumptions

<u>Year-round Habitat (Primary Habitat)</u>
Modeled year-round habitat for vernal pool fairy shrimp is defined by all densities of vernal pool grassland complex and seasonal wetland.

Rationale

Vernal pool fairy shrimp inhabits vernal pools that form in depressions, usually in grassland habitats. Pools must fill frequently and persist long enough for this species to complete its

lifecycle, which takes place entirely within vernal pools. Not all mapped vernal pools and vernal pool grassland complexes have pools that provide suitable habitat features for vernal pool fairy shrimp; the level of detail necessary to identify microhabitat features (e.g., size and depth of pools, water chemistry) suitable for vernal pool fairy shrimp are not captured in the GIS land-cover data. Therefore, modeled habitat may overestimate suitable habitat available for vernal pool fairy shrimp.

Model Results

Figure 2 shows the modeled habitat for vernal pool fairy shrimp in the Plan area. Modeled habitat occurs in the western portion of the Plan area, below 200 feet elevation. The documented occurrences of vernal pool fairy shrimp corresponds well with modeled habitat.

References

California Department of Fish and Game. 1998. California vernal pool assessment, preliminary report. May. Available: http://maphost.dfg.ca.gov/wetlands/vp_asses_rept/index.htm. Accessed: January 15, 2003.

California Natural Diversity Database. 2010. RareFind , Version 3.1.0. (February, 2010). Sacramento, CA: California Department of Fish and Game.

Eng, L. L, D. Belk, and C. H. Eriksen. 1990. Californian anostraca: distribution, habitat, and status. Journal of Crustacean Biology 10(2):247-277.

Eriksen, C. H., and D. Belk. 1999. *Fairy shrimps of California's puddles, pools, and playas*. Eureka, CA: Mad River Press.

Hathaway, S. A., D. P. Sheehan, and M. A. Simovich. 1996. Vulnerability of branchiopod cysts to crushing. *Journal of Crustacean Biology*. 16(3):448–452.

Helm, B. 1998. The biogeography of eight large branchiopods endemic to California. Pages 124–139 in C. W. Witham, E. Bauder, D. Belk, W. Ferren, and R. Ornduff (eds.), *Ecology, conservation, and management of vernal pool ecosystems – proceedings from a 1996 conference*. Sacramento, CA: California Native Plant Society.

Jones and Stokes. 2004. Placer County Natural Resources Report: A scientific assessment of watersheds, ecosystems and species of the Phase 1 planning area. Sacramento, California. 259 pages.

Silveira, J. G. 1998. Avian uses of vernal pools and implications for conservation practice. Pages 92–106 in C. W. Witham, E. Bauder, D. Belk, W. Ferren, and R. Ornduff (eds.), *Ecology, conservation, and management of vernal pool ecosystems – proceedings from a 1996 conference*. Sacramento, CA: California Native Plant Society.

U.S. Fish and Wildlife Service (USFWS). 1994. Federal Register Final Rule; determination of endangered status for the Conservancy fairy shrimp, longhorn fiary shrimp and the vernal pool tadpole shrimp; and threatened status for the vernal pool fairy shrimp. 59 FR 48136.

U.S. Fish and Wildlife Service. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, Oregon. xxvi +606 pages.

U.S. Fish and Wildlife Service. 2007.Vernal Pool Fairy Shrimp (*Branchinecta lynchi*) 5 year review: Summary and Evaluation. Sacramento, California. 74 pages.

Personal Communications

Rogers, D. C. Invertebrate Ecologist. EcoAnalysts, Inc. December 2002 – telephone conversation.

Sterling, John. Wildlife Biologist. Jones & Stokes. January 2003 – meeting.

Stone, Patrick. Invertebrate Ecologist. Jones & Stokes. 1999–2002. Field surveys.

Envirogram Narrative

Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)

The envirogram was created based on the information provided in this species account. The envirogram is a tool to depict and organize the most important ecological factors that affect a population or group of populations of a particular species. The envirogram consists of Direct Components – components of the environment that directly affect a species' chances to survive and reproduce, and several webs comprised of distal factors (i.e., Indirect Components, Management Problems, and Mitigation Actions) that act in sequence to affect the Direct Components. The Direct Components consist of four major categories: resources, hazards, reproduction, and dispersal. Each of these is subdivided as necessary.

The webs identify the underlying ecological processes or human actions that influence each Direct Component. Distal factors in the web activate proximate components. Each of these pathways in the web are constructed from right to left, with Indirect Components immediately to the left of Direct Components directly affecting the Direct Component, and secondary Indirect Components affecting primary Indirect Components. Management Problems can directly affect the Indirect Components, and Mitigation Actions provide solutions to remedy the Management Problems.

<u>Resources</u>
Res1: Vernal pool fairy shrimp are most commonly found in vernal pools and other seasonally inundated waters with grass or mud bottoms that last long enough for them to complete their life cycle (>3-5 weeks). Such waters are usually associated with natural hydrologic conditions; waters that have been modified by leveling, disking, deep ripping, and other types of drainage alterations are generally not suitable, and such water bodies must be restored to their natural hydrologic conditions. Adequate rainfall, a function of weather and climate, is necessary to fill the pools to the appropriate depth, and the structural complexity of the pool and its water quality and chemistry also influence its suitability for vernal pool fairy shrimp.

Res2: Vernal pool fairy shrimp feed on bacteria and plant and animal particles. Abundant and diverse prey species depend on the structural complexity of the pool and its water quality and chemistry, which in turn are influenced by the soils and geological formations in which the pool occurs as well as by hydrologic conditions and the amount and timing of rainfall.

<u>Hazards</u>
Haz1: Vernal pool fairy shrimp are killed by water temperatures >70°F, which can occur during periods of unseasonable heat. (A warming climate with an increasing frequency of extreme weather events could result in increasing problems of this kind in the future).

Haz2: Changes in pool chemistry and turbidity can be detrimental to vernal pool fairy shrimp. These changes can result from modifications to pool hydrology as a result of drainage alteration and from surface disturbances caused by excessive livestock grazing or recreational use. They also can result from trash dumping or runoff from various sources. Restoration of the original hydrologic conditions and close management of grazing, recreation, runoff, and dumping are necessary to preserve appropriate conditions for this species. This is best achieved by managing vernal pool complexes primarily for biodiversity conservation.

Haz3: Crushing of cysts in dry pools result from surface disturbances such as livestock grazing and ORV, foot, or equestrian traffic. Adults can be crushed by cattle in shallow pools that are

drying out. Management primarily for biodiversity conservation is the best mitigation for these hazards.

Haz4: The abundance of natural invertebrate predators such as insects and tadpole shrimp depends on the hydrologic, physical, and chemical conditions in a pool. Excessive disturbance can create conditions that create unnaturally high densities of these predators.

Haz5: Natural vertebrate predators of vernal pool fairy shrimp include waterfowl and native amphibians. The presence of these species depends upon the characteristics of the individual pool and the pool complex, which in turn are determined by the degree of fragmentation of the complex and the characteristics of the surrounding area. Fragmentation and location of the pool complex may result in abnormally high or low densities of these predators in certain pools, which could be a benefit or a disaster to a vernal pool fairy shrimp population.

Haz6: If pool complexes are located near farms and irrigation structures, introduced predators such as bullfrogs and fish could be introduced into a pool, which would inevitably result in local extirpations. Large, unfragmented pool complexes, located well away from farm ponds and irrigation ditches and managed primarily for biodiversity conservation are the best management option to control these hazards.

Reproduction

Rep1: Successful reproduction by vernal pool fairy shrimp depends on finding mates, which is largely dependent upon the turbidity of the water and the numbers of individuals in a pool. Both of these factors are related to the hydrologic, physical, and chemical conditions in the pool. Any alteration to the hydrology of the pool or pool complex can make conditions unsuitable for reproduction. Restoring the original hydrology and managing a pool complex primarily for biodiversity conservation is the best way to preserve the conditions needed for reproduction.

Dispersal

Dis1: Adults can disperse from pool to pool during periods of flooding caused by abundant rainfall, provided that there are appropriate pools to disperse to. Such dispersal is not very likely in small or highly fragmented vernal pool complexes.

Dis2: Cysts can be transported by the wind from dry pools; successful dispersal depends on wind speed and direction.

Dis3: Cysts also can be transported in the guts of waterfowl or amphibians. Success in this mode of dispersal depends on where the cysts are deposited. The chances of a cyst arriving in a suitable location are enhanced considerably in a large, unfragmented pool complex. Dis1 and 3 are facilitated by establishing large reserve areas and managing them primarily for biodiversity conservation.

Dis4: Cysts possibly may be transported by livestock, attached to mud on their hooves. This event would depend on livestock being in the right place at the right time and in densities that are not likely to result in excessive surface disturbance. Adaptive grazing management within a reserve must consider all these factors.

Vernal Pool Fairy Shrimp, *Branchinecta lynchi* (page 1)

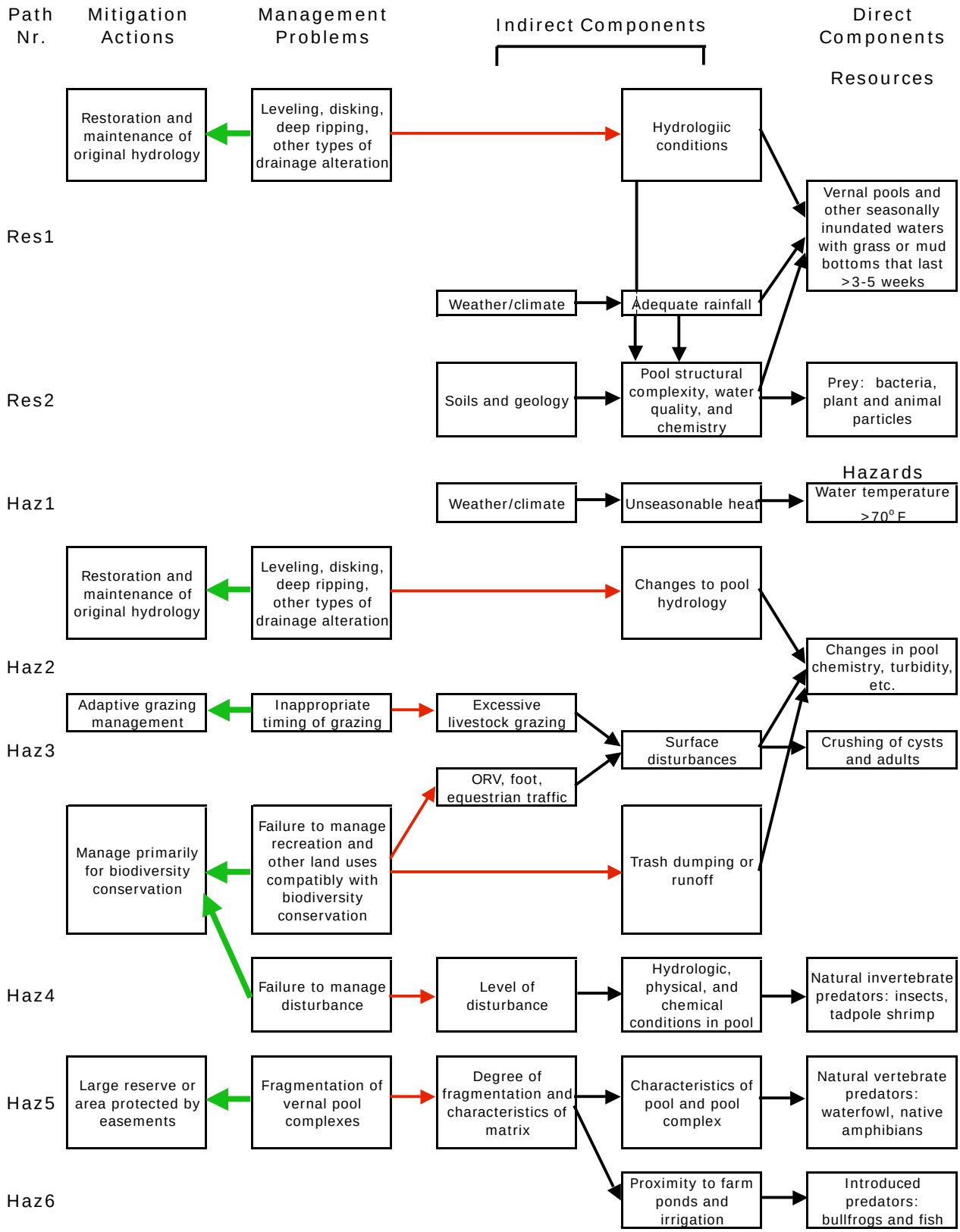
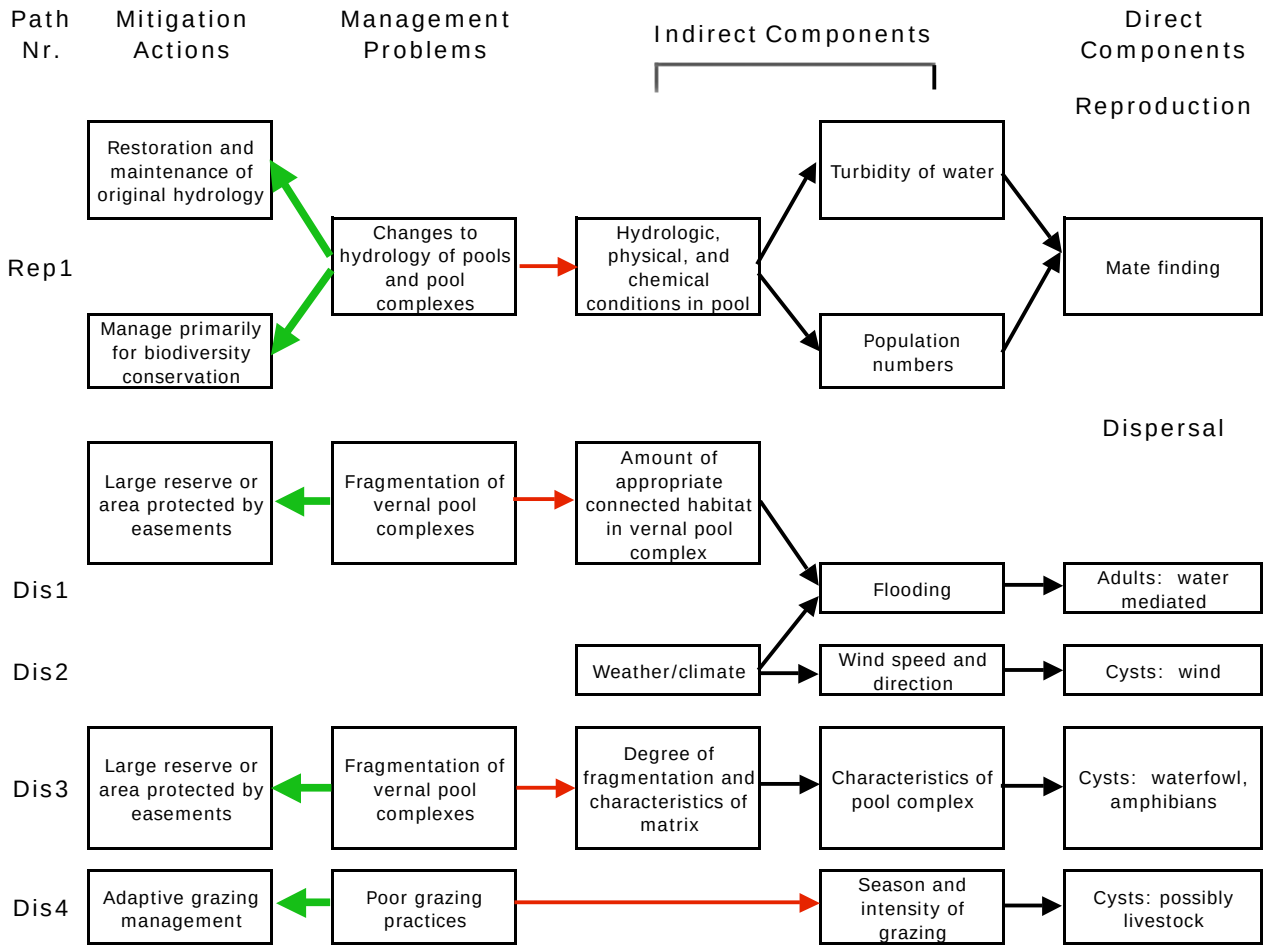


Figure 1. Envirogram. Key to abbreviations: Res = Resources; Haz = Hazards; Rep = Reproduction; Dis = Dispersal.

Vernal Pool Fairy Shrimp, *Branchinecta lynchi* (page 2)



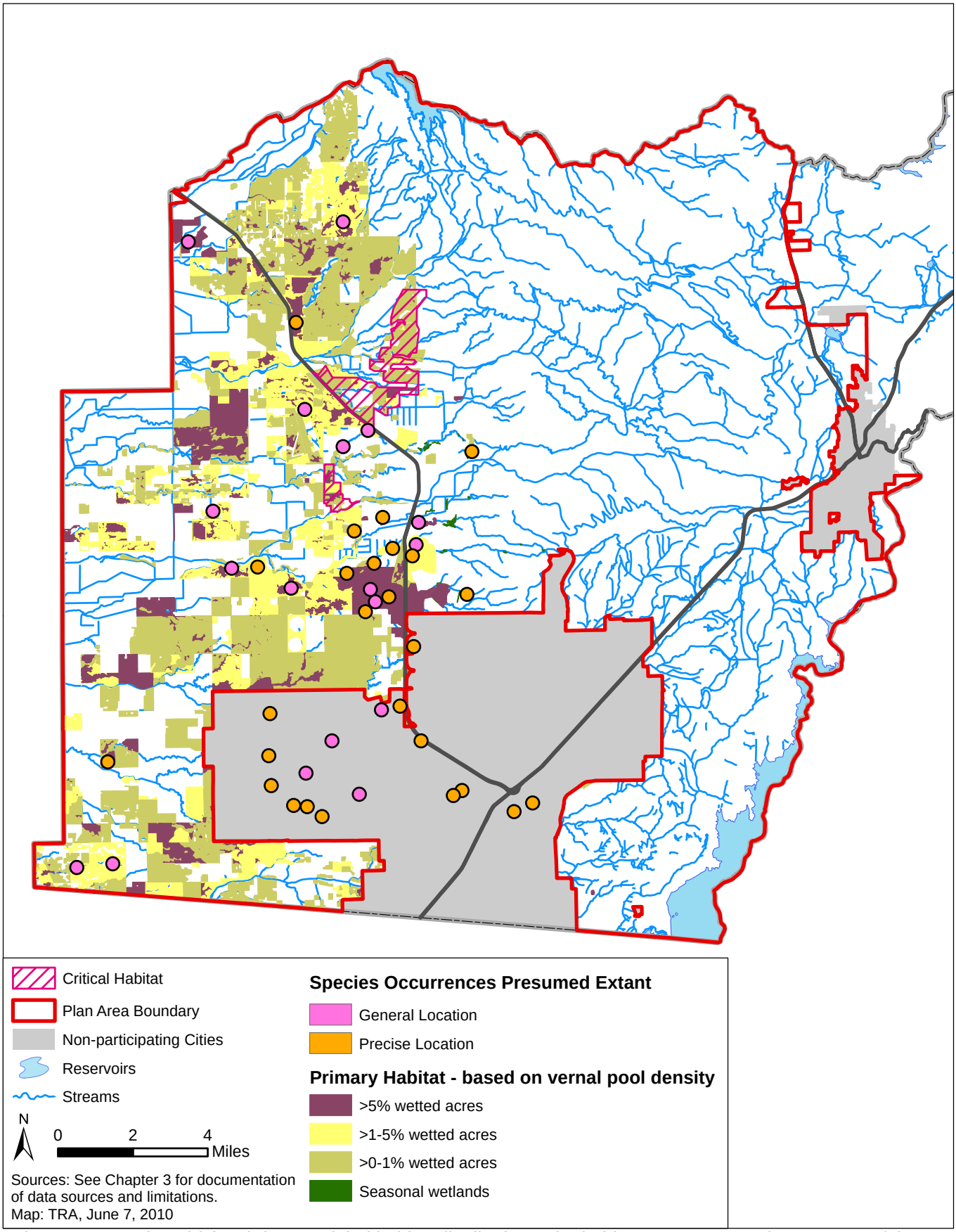


Figure 2. Vernal pool fairy shrimp modeled habitat distribution. The habitat map presents the outcome of the draft model described above. The purpose of the model is to identify areas within the Plan area where the species occurs or could occur based on known habitat requirements. Those data on which this map is based are regional in scale. This map should not be used for site planning and should be verified in the field. Occurrence data are limited by where field surveys have been conducted; some occurrence points may be geographically inaccurate. Occurrence records are from the California Natural Diversity Database (2010).

Vernal Pool Tadpole Shrimp
(*Lepidurus packardi*)

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Status

Federal: Endangered (59 Federal Register [FR] 48136, September 19, 1994)

State: None

Other: G2G3/S2S3

Recovery Plan: Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005)

Placer Legacy Category: Class 1

Distribution

California

Vernal pool tadpole shrimp (*Lepidurus packardi* Simon, 1886) is endemic to the Central Valley of California (USFWS 1994; Helm 1998; Rogers 2001). Rogers (2001) determined that specimens from southern Oregon and the California Central Valley that were originally described as *L. packardi* were, in fact, *Lepidurus cryptus*, a recently described species of tadpole shrimp.

The historical range of vernal pool tadpole shrimp in California includes annual grasslands of the Great Central Valley. Today the species has a patchy distribution from Shasta County in the north to Tulare County in the south, with disjunct populations occurring in Alameda and Contra Costa Counties (USFWS 2007; California Natural Diversity Database 2009).

Vernal pool tadpole shrimp have been reported from the following California Vernal Pool Regions: Northwest Sacramento, Northeast Sacramento, Southeast Sacramento, Solano-Colusa, San Joaquin Valley, South Sierra Foothill, and Central Coast (USFWS 2007). The California Natural Diversity Database (California Natural Diversity Database) (2009) lists 249 occurrences of vernal pool tadpole fairy shrimp in California.

Placer County Plan Area

Historical

The historical distribution of vernal pool tadpole shrimp can only be inferred from the historical distribution of its habitat. Annual grasslands of western Placer County, particularly within the Great Valley ecoregion, probably supported a patchy distribution of vernal pool tadpole shrimp (Rogers pers. comm.).

Current

There are three known populations of vernal pool tadpole shrimp in the Plan area. The first is located on the U.S. Air Force Lincoln Communications Facility where, in 1996, at least four

vernal pools of a 236-pool complex support vernal pool tadpole shrimp (36 pools were surveyed). The second is on the Woodcreek Oaks Mitigation Site between Kasenburg Creek and the south branch of Pleasant Grove Creek; adults were observed in one pool on this site in 1995. The third population is on the West Placer School District property, between Markham Ravine and Auburn Ravine. In 2006, twenty shrimp were observed on the site's 9.38 acres of naturally occurring wetlands and swales (California Natural Diversity Database 2009).

Population Status & Trends

California

As of February 2010, the California Natural Diversity Database (CNDDB) listed 249 occurrences of vernal pool tadpole shrimp in California. Although vernal pool tadpole shrimp is widely distributed in California, it is now locally uncommon throughout the historical range (Helm 1998; Eriksen and Belk 1999).

Placer County Plan Area

The CNDDB lists three occurrences of vernal pool tadpole shrimp within the Plan area (CNDDB 2010). Several nature preserves and mitigation banks have been established in the Plan area with the partial goal of preserving habitat for vernal pool tadpole shrimp. These preservation areas include Wildlands, Inc.'s, Aitken Ranch Mitigation Bank, Wildlands Mitigation Bank, and Orchard Creek Preservation Area; Eastridge Southern Wetland Preserve; Sterling Pacific Assets' Lincoln Crossing Mitigation Site; and the City of Roseville's Woodcreek Compensation Area (Jones & Stokes 2004, California Natural Diversity Database 2009).

Natural History

The habitat requirements, ecological relationships, life history, and threats to vernal pool tadpole shrimp described below are summarized in diagram form in the envirogram (Figure 1).

Habitat Requirements

Vernal pool tadpole shrimp occur in a variety of natural and artificial seasonally inundated habitats. They require seasonally aquatic habitats that are wet for at least seven weeks and dry in summer (Gallagher 1996). Helm (1998) observed vernal pool tadpole shrimp occurring in vernal pools (natural, artificial, and constructed), seasonal wetlands (natural and artificial), alkaline pools, clay flats, vernal swales, stockponds, railroad right-of-way pools, roadside ditches, and road rut pools resulting from vehicular activity. Occupied pools and wetlands typically have highly turbid waters or aquatic vegetation that may provide shelter from predators (USFWS 1994; Stone pers. comm.).

Reproduction

Vernal pool tadpole shrimp are bisexual. Diapausing cysts (eggs) occurring in the dry pool bottom hatch within 3 weeks of inundation (Ahl 1991). The hatched neonate is a metanauplius that undergoes several molts, each gaining additional phyllopod appendages until reaching sexual maturity. This process takes approximately 6–7 weeks depending on temperature and food availability (Ahl 1991; Gallagher 1996; Helm 1998). Reproduction occurs throughout the ponding season, when females average 0.39–0.47 inch in carapace length (Ahl 1991). Laboratory studies conducted by Ahl (1991) revealed that eggs can hatch during the same ponding event in which they were laid without intervening dehydration. The remaining unhatched cysts settle to the pool substrate and contribute to the cyst bank for subsequent wet seasons.

Dispersal Patterns

Vernal pool tadpole shrimp disperse locally during extremely wet years when individual pools in a complex spill into or are connected with adjacent pools. Long-distance dispersal can result from cysts being carried on the wind and on the bodies or in the guts of larger animals. Cysts, including those still in brood sacs, can pass undamaged and undigested through the digestive tracts of birds (Proctor et al. 1967 cited in Eriksen and Belk 1999); subsequent deposition of fecal matter can result in the inoculation of a new site. Cysts trapped in mud can adhere to the feet and feathers of waterfowl and the hooves and fur of grazing mammals and be transported to the dried mud of different vernal pool complexes (Eriksen and Belk 1999). Cysts may also be transported between pools in the digestive tracts of amphibian predators such as frogs and salamanders (Rogers pers. comm.).

Longevity

Vernal pool tadpole shrimp is considered a long-lived species. Adults are often present and reproductive until the pools dry up in the spring (USFWS 1994).

Sources of Mortality

The greatest sources of mortality to vernal pool tadpole shrimp are predation and desiccation. Tadpole shrimp are left exposed when their habitat dries up. In addition, both adult shrimp and diapausing cysts can be crushed by foot traffic and off-highway vehicles (Hathaway 1996).

Behavior

Vernal pool tadpole shrimp are filter feeders and opportunistic predators on aquatic insect larvae, segmented worms (Oligochaeta), water fleas (Cladocera), seed shrimp (Ostracoda), copepods (Copepoda), fairy shrimp (Anostraca), and other vernal pool tadpole shrimp. This species hunts by moving along the pool bottom or aquatic vegetation, stirring up the muddy substrate, and capturing prey items with its phyllopods to direct them into the feeding groove or mouth (Rogers pers. comm.). This feeding behavior and predator avoidance leads to vernal pool tadpole shrimp being most often observed at the pool bottom.

Ecological Relationships

Vernal pool tadpole shrimp are preyed on by migratory waterfowl, amphibians, predatory diving beetles (Coleoptera: Dytiscidae), water boatmen (Hemiptera: Corixidae), and other vernal pool tadpole shrimp. Large freshwater branchiopods in California serve as an important source of protein and energy for migratory waterfowl (Eriksen and Belk 1999). Many vernal pools occur along the Pacific flyway; the use of these pools as resting and feeding grounds by migratory birds is well documented (Silveria 1998; Sterling pers. comm.).

Vernal pool tadpole shrimp commonly co-occur with vernal pool fairy shrimp (*Branchinecta lynchi*), Conservancy fairy shrimp (*Branchinecta conservatio*), and California linderiella (*Linderiella occidentalis*) (Helm 1998; Stone pers. comm.).

Population Threats

The greatest threats to the persistence of vernal pool tadpole shrimp are habitat loss and degradation resulting from urban development and agriculture. Vernal pools occur in large, flat, open grasslands that are ideal for a number of economic uses including airports, military bases, rice and grain fields, cattle grazing, aggregate mining, and urban development.

Context for a Regional Conservation Strategy

Vernal pool tadpole shrimp are known from three populations in the Plan area, and may also exist in additional locations that have not been surveyed. In the region, vernal pool tadpole shrimp is found in vernal pool complexes north and south of the Placer County populations, including Yuba, Butte, Sutter, Sacramento, Yolo and Solano counties, among others. There is an absence of suitable habitat to the east, and thus the western Placer County populations probably represent the furthest eastward range of the species for the area. Within California, the greatest concentration of known populations occurs within the vernal pool complexes of Sacramento County. For conservation of vernal pool tadpole shrimp within the Plan area, acquisition and conservation of vernal pool habitat and associated uplands and supporting hydrological systems is of highest priority.

Modeled Species Distribution in the Plan Area

Model Assumptions

Year-round Habitat (Primary Habitat)

Modeled year-round habitat for vernal pool tadpole shrimp is defined by all densities of vernal pool grassland complex and seasonal wetland.

Rationale

Vernal pool tadpole shrimp inhabits vernal pools that form in depressions, usually in grassland habitats. Pools must fill frequently and persist long enough for this species to complete its lifecycle, which takes place entirely within vernal pools. Not all mapped vernal pools and vernal pool grassland complexes have pools that provide suitable habitat features for vernal pool tadpole shrimp; the level of detail necessary to identify microhabitat features (e.g., size and depth of pools, water chemistry) suitable for vernal pool tadpole shrimp are not captured in the GIS land-cover data. Therefore, modeled habitat may overestimate suitable habitat available for vernal pool tadpole shrimp.

Model Results

Figure 2 shows the modeled habitat for vernal pool tadpole shrimp in the Plan area. Modeled habitat occurs in the western portion of the Plan area, below 200 feet elevation. The documented occurrences of vernal pool tadpole shrimp falls within the modeled habitat.

References

Printed References

Ahl, J. S. B. 1991. Factors affecting contributions of the tadpole shrimp, (*Lepiduris packardi*), to its oversummering egg reserves. *Hydrobiologia* 212:137–43.

Eriksen, C. H., and D. Belk. 1999. *Fairy shrimps of California's puddles, pools, and playas*. Eureka, CA: Mad River Press.

California Department of Fish and Game. 1998. California vernal pool assessment, preliminary report. May. Available: http://maphost.dfg.ca.gov/wetlands/vp_asses_rept/index.htm. Accessed: January 15, 2003.

California Natural Diversity Database. 2010. RareFind , Version 3.1.0. (February, 2010). Sacramento, CA: California Department of Fish and Game.

Gallagher, S. P. 1996. Seasonal occurrence and habitat characteristics of some vernal pool branchiopoda in northern California, USA. *Journal of Crustacean Biology* 16(2):323–329.

Hathaway, S. A., D. P. Sheehan, and M. A. Simovich. 1996. Vulnerability of branchiopod cysts to crushing. *Journal of Crustacean Biology*. 16(3):448–452.

Helm, B. 1998. The biogeography of eight large branchiopods endemic to California. Pages 124–139 in C. W. Witham, E. Bauder, D. Belk, W. Ferren, and R. Ornduff (eds.), *Ecology, conservation, and management of vernal pool ecosystems – proceedings from a 1996 conference*. Sacramento, CA: California Native Plant Society.

Jones and Stokes. 2004. Placer County Natural Resources Report: A scientific assessment of watersheds, ecosystems and species of the Phase 1 planning area. Sacramento, California. 259 pages.

Rogers, D.C. 2001. Revision of the neartic *Lepidurus* (Notostraca). *Journal of Crustacean Biology* 21(4): 991–1006.

Silveria, J. G. 1998. Avian uses of vernal pools and implications for conservation practice. Pages 92–106 in C. W. Witham, E. Bauder, D. Belk, W. Ferren, and R. Ornduff (eds.), *Ecology, conservation, and management of vernal pool ecosystems – proceedings from a 1996 conference*. Sacramento, CA: California Native Plant Society.

U.S. Fish and Wildlife Service (USFWS). 1994. Federal register final rule; determination of endangered status for the Conservancy fairy shrimp, longhorn tadpole shrimp and threatened status for the vernal pool fairy shrimp. Federal Register Vol. 59 September 19, 1994 48136 (59 FR 48136).

_____. 2007. Vernal Pool Tadpole Shrimp (*Lepidurus packardi*) 5 year review: Summary and Evaluation. Sacramento, California. 46 pages.

_____. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, Oregon. xxvi +606 pages.

Personal Communications

Rogers, D. Christopher. Personal communication. December, 2002.

Sterling, John. Wildlife Biologist. Jones & Stokes. January 2003 – meeting.

Stone, Patrick. Invertebrate Ecologist. Jones & Stokes. 1999–2002. Field surveys.

Envirogram Narrative

Vernal Pool Tadpole Shrimp (*Lepidurus packardii*)

The envirogram was created based on the information provided in this species account. The envirogram is a tool to depict and organize the most important ecological factors that affect a population or group of populations of a particular species. The envirogram consists of Direct Components – components of the environment that directly affect a species' chances to survive and reproduce, and several webs comprised of distal factors (i.e., Indirect Components, Management Problems, and Mitigation Actions) that act in sequence to affect the Direct Components. The Direct Components consist of four major categories: resources, hazards, reproduction, and dispersal. Each of these is subdivided as necessary.

The webs identify the underlying ecological processes or human actions that influence each Direct Component. Distal factors in the web activate proximate components. Each of these pathways in the web are constructed from right to left, with Indirect Components immediately to the left of Direct Components directly affecting the Direct Component, and secondary Indirect Components affecting primary Indirect Components. Management Problems can directly affect the Indirect Components, and Mitigation Actions provide solutions to remedy the Management Problems.

<u>Resources</u>
Res1: Vernal pool tadpole shrimp is found in vernal pools and seasonal wetlands that last long enough for it to complete its life cycle (at least 6-7 weeks) and dry up in summer. Such waters are often but not necessarily associated with natural hydrologic conditions; waters that have been modified by leveling, disking, deep ripping, and other types of drainage alterations often are not suitable. Altered water bodies should be restored to their natural hydrologic conditions if they are to support this species. Adequate rainfall, a function of weather and climate, is necessary to fill the pools to the appropriate depth, and the structural complexity of the pool and its water quality and chemistry also influence its suitability for the vernal pool tadpole shrimp.

Res2**:** Vernal pool tadpole shrimp feeds on small invertebrates such as insect larvae, worms and other crustaceans. Abundant and diverse prey species depend on the structural complexity of the pool and its water quality and chemistry, which in turn are influenced by the soils and geological formations in which the pool occurs as well as by hydrologic conditions and the amount and timing of rainfall.

Res3**:** Vernal pool tadpole shrimp requires pools with high turbidity or dense vegetation, probably to protect them from vertebrate predators.

<u>Hazards</u>
Haz1: Vernal pool tadpole shrimp are killed by premature desiccation of the pool, which can result from too little rainfall or unseasonable heat. (A warming climate with an increasing frequency of extreme weather events could create more problems in this regard in the future). Premature desiccation also can result from changes to pool hydrology, discussed in Res1 above.

Haz2: Crushing of cysts in dry pools result from surface disturbances such as livestock grazing and ORV, foot, or equestrian traffic. Adults also may be crushed by livestock in shallow pools that are drying out. Management primarily for biodiversity conservation is the best mitigation for these hazards.

Haz3: Changes in pool chemistry and turbidity can be detrimental to vernal pool tadpole shrimp. These changes can result from modifications to pool hydrology as a result of drainage alteration and from surface disturbances caused by excessive livestock grazing or recreational use. They also can result from trash dumping or runoff from various sources. Restoration of the original hydrologic conditions and close management of grazing, recreation, runoff, and dumping are necessary to preserve appropriate conditions for this species. This is best achieved by managing vernal pool complexes primarily for biodiversity conservation.

Haz4: The abundance of natural invertebrate predators such as insects and other tadpole shrimp depends on the hydrologic, physical, and chemical conditions in a pool. Excessive disturbance can create conditions that result in unnaturally low or high densities of these predators, either to the benefit or detriment of the vernal pool tadpole shrimp population.

Haz5: Natural vertebrate predators of vernal pool tadpole shrimp include waterfowl and native amphibians. The presence of these species depends upon the characteristics of the individual pool and the pool complex, which in turn are determined by the degree of fragmentation of the complex and the characteristics of the surrounding area. Fragmentation and location of the pool complex may result in abnormally low or high densities of these predators in certain pools, which could be an advantage or a disaster to a vernal pool tadpole shrimp population.

Haz6: If pool complexes are located near farms and irrigation structures, introduced predators such as bullfrogs and fish could be introduced into a pool, which would inevitably result in local extirpations. Large, unfragmented pool complexes, located well away from farm ponds or irrigation ditches and managed primarily for biodiversity conservation are the best management option to control these hazards.

Reproduction

Rep1: Successful reproduction of vernal pool tadpole shrimp depends on finding mates, which is largely dependent upon the turbidity of the water and the numbers of individuals in a pool. Both of these factors are related to the hydrologic, physical, and chemical conditions in the pool. Any alteration to the hydrology of the pool or pool complex can make conditions unsuitable for reproduction. Restoring the original hydrology and managing a pool complex primarily for biodiversity conservation is the best way to preserve the conditions needed for reproduction.

Dispersal

Dis1: Adults can disperse from pool to pool during periods of flooding caused by abundant rainfall, provided that there are appropriate pools to disperse to. Such dispersal is not very likely in small or highly fragmented vernal pool complexes.

Dis2: Cysts can be transported by the wind from dry pools; successful dispersal depends on wind speed and direction.

Dis3: Cysts also can be transported in the guts of waterfowl or amphibians. Success in this mode of dispersal depends on where the cysts are deposited. The chances of a cyst arriving in a suitable location are enhanced considerably in a large, unfragmented pool complex. Dis1 and Dis3 are facilitated by establishing large reserve areas and managing them primarily for biodiversity conservation.

Dis4: Cysts may be transported by livestock, attached to mud on their hooves. Successful dispersal in this manner would depend on livestock moving from pool to pool just as they were drying out. Because high densities of livestock are likely to result in excessive surface

disturbance, adaptive grazing management within a reserve must consider all the costs and benefits of using livestock as dispersal agents.

Vernal Pool Tadpole Shrimp, *Lepidurus packardii* (page1)

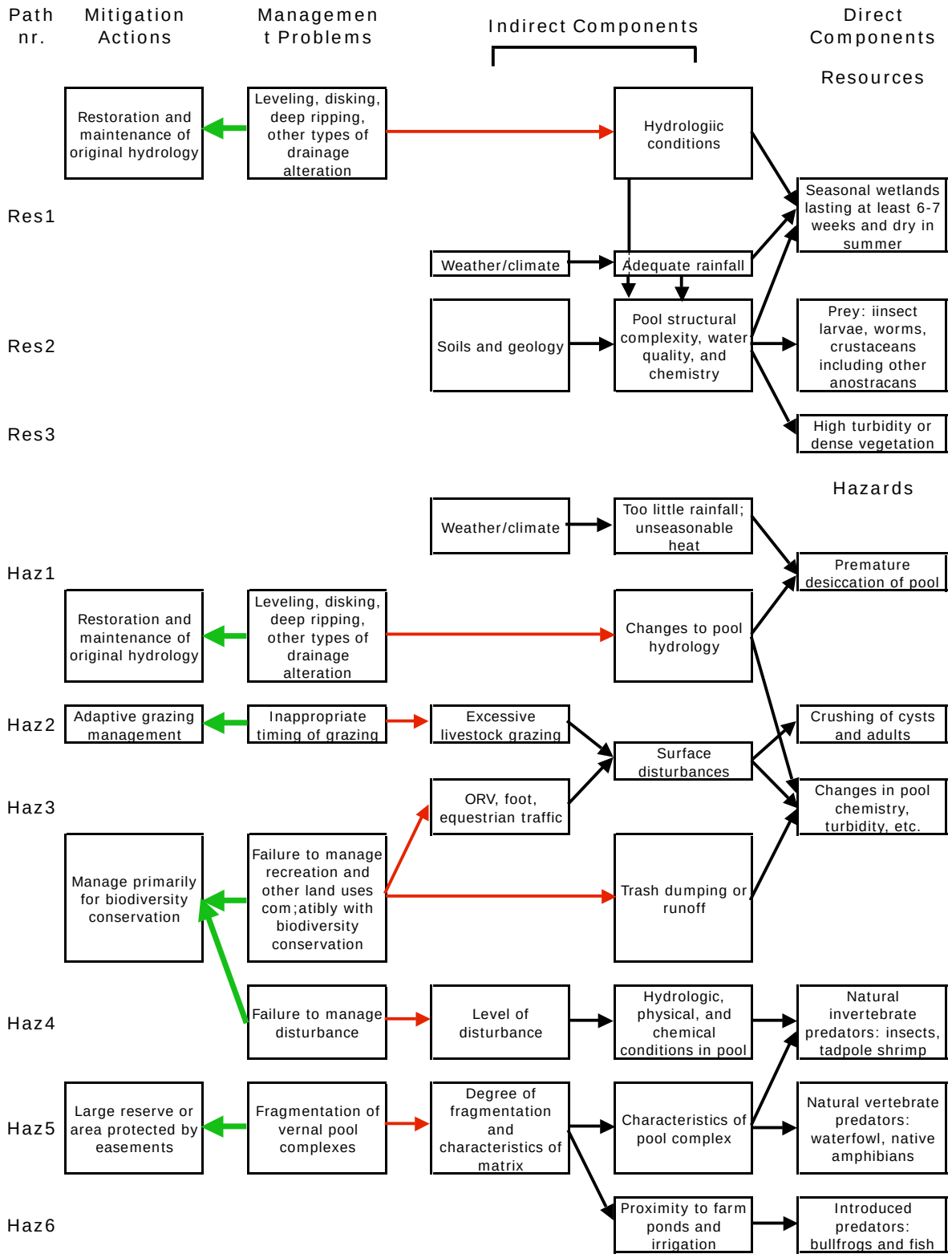
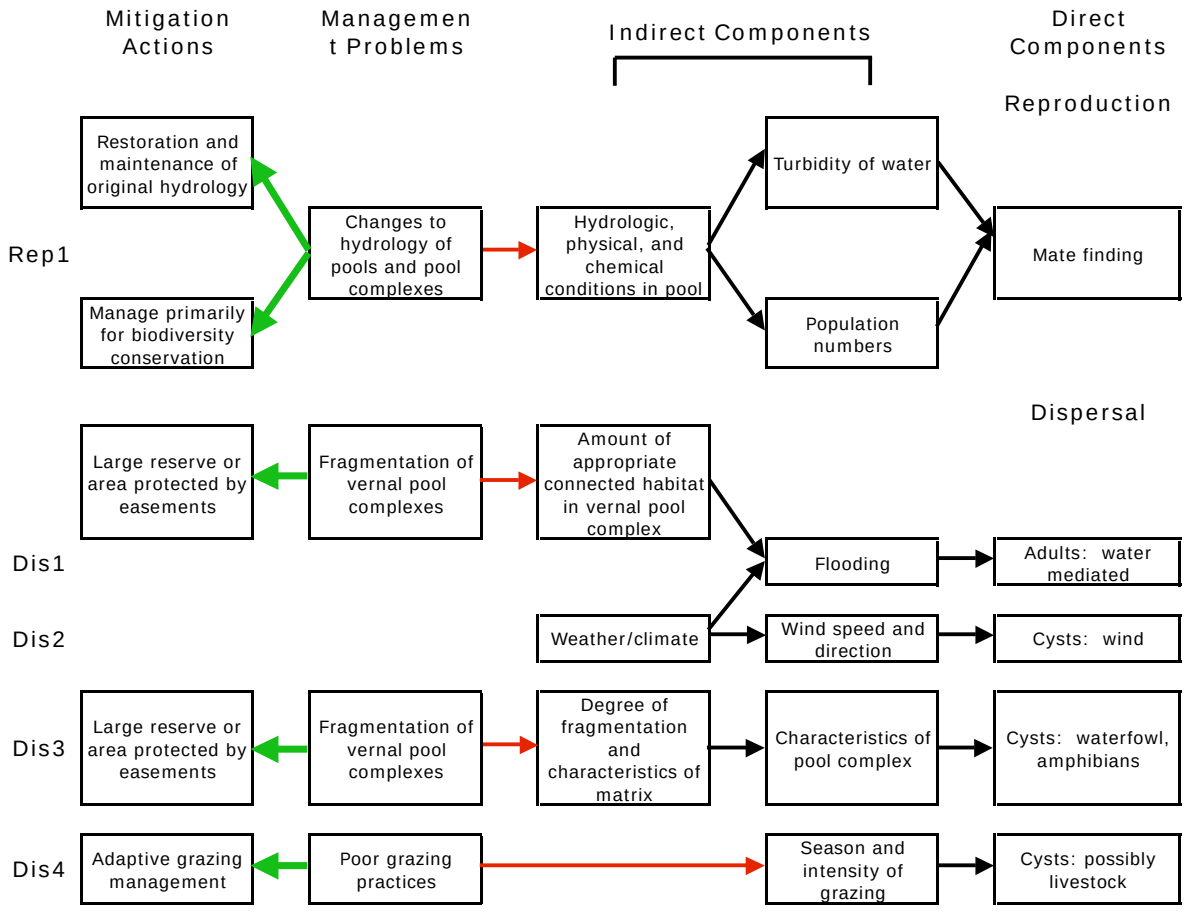


Figure 1. Envirogram. Key to abbreviations: Res = Resources; Haz = Hazards; Rep = Reproduction; Dis = Dispersal.

Vernal Pool Tadpole Shrimp, *Lepidurus packardii* (page 2)



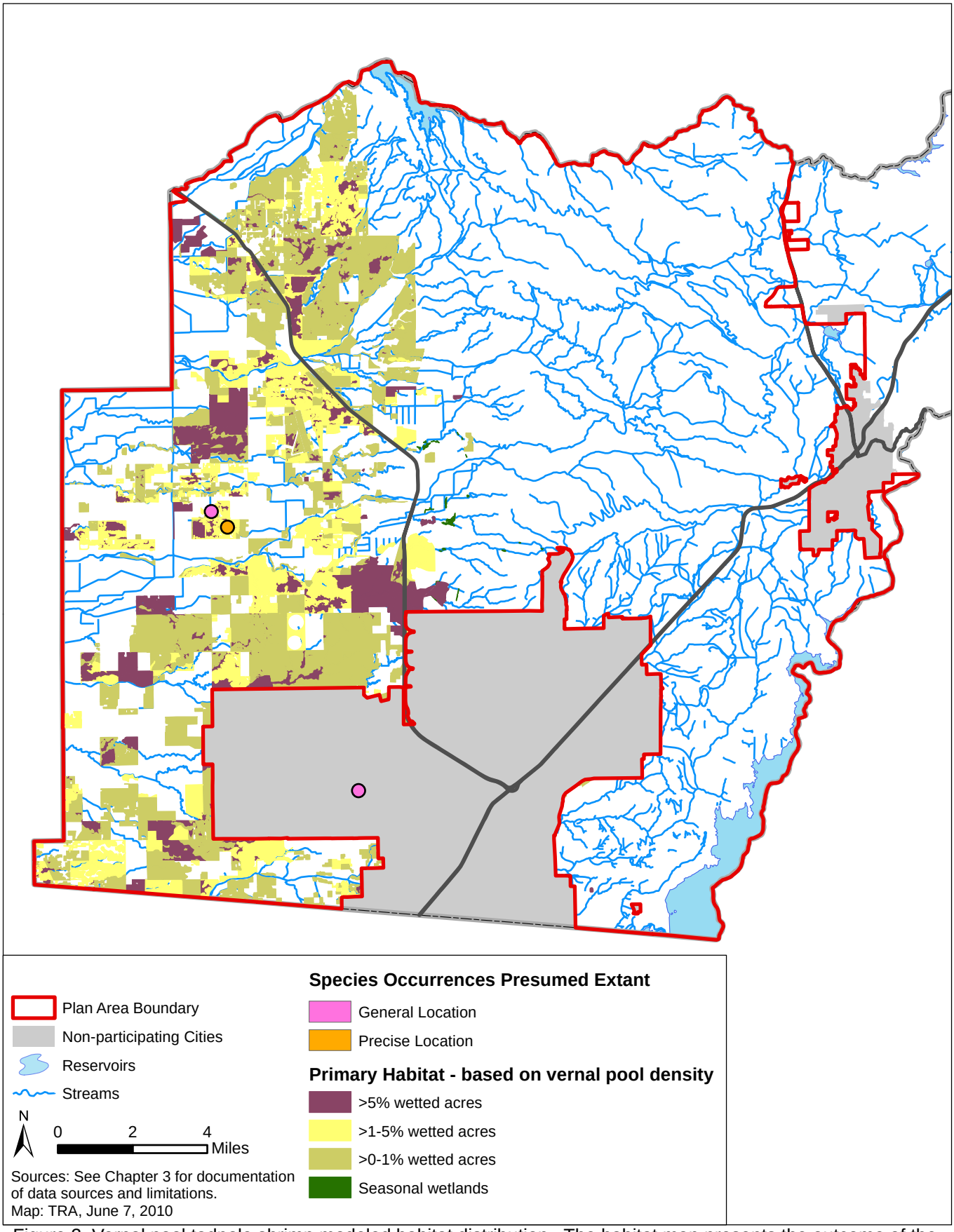


Figure 2. Vernal pool tadpole shrimp modeled habitat distribution. The habitat map presents the outcome of the draft model described above. The purpose of the model is to identify areas within the Plan area where the species occurs or could occur based on known habitat requirements. Those data on which this map is based are regional in scale. This map should not be used for site planning and should be verified in the field. Occurrence data are limited by where field surveys have been conducted; some occurrence points may be geographically inaccurate. Occurrence records are from the California Natural Diversity Database (2010).

Western Spadefoot Toad
(*Spea hammondii*)

© David Rosen

Status

Federal: None

State: Species of Special Concern

Other: G3

Recovery Plan: Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005).

Placer Legacy Category: Class 3

Distribution

North America

The spadefoot toad historically ranged from the vicinity of Redding in Shasta County southward to Mesa de San Carlos in northwestern Baja California (Stebbins 1985).

California

Western spadefoot toad has been recorded from the vicinity of Redding in Shasta County south into Baja California (Stebbins 1985). It has been observed in seventeen counties either in or bordering the Central Valley. On the eastern edge of the Central Valley it has been found from Redding in Shasta County south to Kern County. On the western edge of the valley it has been recorded from Orland in Glenn County to Corral Hollow on the Alameda and San Joaquin County borders in the south (Jennings and Hayes 1994; Barry 2000; California Natural Diversity Database 2010). Their coastal populations occur in the Salinas River basin (Monterey, San Benito, and San Luis Obispo counties); on the Carrizo Plain (San Luis Obispo County); and in the foothills northeast of Point Conception (Santa Barbara County). Southern California populations have been found in the Los Angeles basin, in the interior valleys of Riverside and northern San Diego Counties, and on the coastal plains of Orange and San Diego Counties (Storer 1925; Stebbins 1985; Jennings and Hayes 1994; California Natural Diversity Database 2010).

Placer County Plan Area

Historical

There are no data on the historical distribution of western spadefoot in Placer County. However, western spadefoot historically ranged throughout the Central Valley, likely including western Placer County (Jennings and Hayes 1994).

Current

Western spadefoot occur in the western portion of the Plan area along the interface of the Central Valley and Sierra Nevada foothills. However, the species is probably uncommon in the

county; the few recorded occurrences, which are from the Roseville area, are summarized below.

- In 1990 more than 30 metamorphs were observed in a drying intermittent drainage near the intersection of Woodcreek Oaks Boulevard and Pleasant Grove Boulevard in western Roseville (California Natural Diversity Database 2010).
- In 1991 several tadpoles were observed in an intermittent tributary of Kaseberg Creek and adjacent vernal pools in Roseville (California Natural Diversity Database 2010).
- In 1993, one adult was observed crossing Phillip Road 1.5 mile west of the junction with Fiddyment Road (California Natural Diversity Database 2010).
- In 1994, five tadpoles were observed in vernal pools near Taylor Road in Roseville (California Natural Diversity Database 2010).
- There is a reported record west of Roseville near Fiddyment Road in a small intermittent drainage (Placer Legacy Scientific Working Group undated).
- In 2004, one pool was observed to support western spadefoot in an unnamed tributary to Pleasant Grove Creek north of Philip Road (California Natural Diversity Database 2010).

Population Status & Trends

North America

Populations of western spadefoot toad have not been studied outside of California.

California

Limited available data indicate that western spadefoot populations are sometimes large and may include aggregations of up to 1,000 chorusing males (Stebbins 1951; Jennings and Hayes 1994). Spadefoot may be more likely to survive to metamorphosis than most other pond-breeding anurans because spadefoot metamorphoses quickly and its natural predators are scarce (Barry 2000). However, Feaver (1971) found that even though western spadefoot metamorphoses rapidly, more than 70% of larvae died because their ponds dried too quickly.

Western spadefoot has been extirpated from many historically occupied sites within the Central Valley (Jennings and Hayes 1994; Fisher and Shaffer 1996) and throughout most of the lowlands in southern California (Stebbins 1985). Western spadefoot toads have suffered a severe decline in the Sacramento Valley, and a reduced density of populations in the eastern San Joaquin Valley (Fisher and Shaffer 1996). According to Jennings and Hayes (1994), more than 80% of the habitat once occupied by western spadefoot south of Santa Barbara and Kern Counties has been lost to urban and agricultural development. More than 30% of western spadefoot habitat north of that region has been lost, primarily to agricultural development. Although the decline in southern California is clearly documented, the decline in northern California is much less clear. Previously undocumented populations may yet be discovered that could fill distribution gaps in the species' known range; a recent example is the 1992 discovery of a Glenn County population (Fisher cited in Barry 2000).

Placer County Plan Area

Detailed population studies have not been conducted in Placer County.

Natural History

The habitat requirements, ecological relationships, life history, and threats to western spadefoot toad described below are summarized in diagram form in the envirogram (Figure 1).

Habitat Requirements

Western spadefoot toad requires two distinct habitat components to meet its life history requirements: 1) terrestrial, upland habitats for feeding and constructing burrows for dry-season dormancy, and 2) wetland habitats for reproduction (USFWS 2005). Western spadefoot toad is primarily terrestrial, and can be found in dry grassland habitat. Although spadefoot populations primarily occur in grassland settings, they are occasionally found in valley-foothill woodlands (Zeiner et al. 1988). It is frequently assumed that spadefoot requires loose soils for subsurface dormancy (Jennings and Hayes 1994); however, there is some evidence that spadefoot may also use rodent burrows (Stebbins 1951; Barry 2000). Also, most sites that support western spadefoot are moderately to heavily grazed (Morey pers. comm.).

Western spadefoot requires seasonal wetlands for reproduction and metamorphosis. Western spadefoot breeds in seasonal wetlands such as vernal pool complexes typically near extensive areas of friable (but not usually sandy) soil (Storer 1925; Stebbins 1951; Barry 2000). Western spadefoot can also be found in creeks, drainages, and stock ponds (USFWS 2005; Westphal pers. comm.); however, it appears that vernal pools and other temporary wetlands may be optimal for breeding due to the absence or reduced abundance of native and nonnative predators, many of which require more permanent water sources (USFWS 2005). Little is known about the distance that western spadefoot ranges from aquatic resources for dispersal and aestivation; however, current research suggests that average habitat utilization falls within 1,207 feet of aquatic habitats (Semlitsch and Brodie 2003; USFWS 2005). The specific physical attributes that make such wetlands and adjacent uplands suitable for spadefoot are not well known, but suitable ponds must exhibit sufficient depth and surface area to persist at least several weeks (Stebbins 1951; Feaver 1971; Jennings and Hayes 1994; Morey 1998).

Several aspects of the life history of western spadefoot are unknown, including the parameters that define suitable habitat and the behavior of metamorphs following pool drying. Perhaps the most significant data gaps involve the species' metapopulation structure (i.e., the distribution of populations relative to one another); movement requirements; and the effect of habitat fragmentation on metapopulation structure and viability (Jennings and Hayes 1994; Morey pers. comm.). This information is important for understanding the amount and distribution of habitat necessary to sustain long-term persistence of this species (Jennings and Hayes 1994). Although the spatial requirements of western spadefoot are unknown, it has been postulated that populations are more likely to persist in large complexes of vernal pools than in small, isolated pools. In general, small or isolated occurrences of most organisms are more likely to experience random local extirpation as a result of adverse genetic effects, natural disturbances, or demographic stochasticity (e.g., random variation in birth and death rates) (Goodman 1987; Hanski and Gilpin 1997).

Reproduction

Adult western spadefoot spends most of the year in self-excavated underground retreats and mammal burrows (Jennings and Hayes 1994; USFWS 2005). It emerges during heavy rains in autumn and winter and spawn in seasonal wetlands, such as vernal pools, in late winter or early spring (Storer 1925; Stebbins 1951). Spawning cues are believed to include the onset of heavy, warmer winter rains of subtropical origin; the filling of vernal pools with rainwater; and the increase of ambient temperatures (Feaver 1971; Jennings and Hayes 1994; Morey 1998; Barry

2000). During dry years, spawning pools may not fill, and western spadefoot may not reproduce. Eggs hatch in less than a week and larvae metamorphose in 30–80 days; the period to metamorphosis apparently depends on the duration of pool depth that is sufficient to support larvae, and possibly on pool temperatures (Feaver 1971; Morey 1998).

Dispersal Patterns

There are no available data on movement patterns or colonization abilities of adult western spadefoot (Jennings and Hayes 1994). Following metamorphosis, western spadefoot disperse after spending a few hours or days near the pond margins (Zeiner et al. 1988). Little is known about the behavior of metamorphs once they leave the pool. They may use a variety of underground retreats, such as burrows and desiccation cracks in the dried pond bottom (as has been reported for *S. intermontanus*) (Barry 2000), as well as seeking cover under surface objects such as boards and decomposing cow dung (Zeiner et al. 1988).

Longevity

No published information regarding the longevity of western spadefoot is available.

Sources of Mortality

Because spadefoot occurs primarily in seasonal wetlands and has a short breeding cycle (approximately 30 days), aquatic predators are few, especially for adult spadefoot. California tiger salamanders (*Ambystoma californiense*), garter snakes (*Thamnophis* sp.), great blue herons (*Ardea alba*), and raccoons (*Procyon lotor*) are probably the most important predators of larval and postmetamorphic western spadefoot (Childs 1953; Feaver 1971).

In a study of amphibian reproduction in 30 vernal pools in Madera County, Feaver (1971) reported a mortality rate of 81% for larval spadefoot populations, 10% of which he attributed due to *Ambystoma* larvae while the remainder was due to pools drying before metamorphosis was completed. Because vernal pools are seasonal, they do not support predatory species such as bullfrogs, bass, and crayfish (except for stocked mosquitofish and transient bullfrogs). Other potential sources of mortality are described in *Population Threats* below.

Behavior

Western spadefoot is rarely found above ground except following relatively warm ($\geq$50–55ºF) rains. It may emerge from burrows in any month between October and April if sufficient rain has fallen to stimulate surface activity; however, the cues that induce surface activity remain poorly understood (Jennings and Hayes 1994)

Adult western spadefoot consumes a variety of invertebrates, including various insects and annelids (worms and leeches), mostly during the short time they are active on the surface (Morey and Guinn 1992). Larvae filter-feed on smaller materials in the water column and scrape larger organisms such as algae (McCready pers. comm.). However, spadefoot larvae are opportunistic feeders and will take advantage of dead larvae if present in the pool (McCready pers. comm.). Western spadefoot larvae are not known to be as cannibalistic as either southern spadefoot (*S. muliplicata*) or plains spadefoot (*S. bombifrons*), both of which are dimorphic, occurring in both omnivorous and carnivorous morphs (Pomeroy 1981; McCready pers. comm.).

Movement and Migratory Patterns

During dry periods, spadefoot toad constructs and occupies burrows that may be up to 3 feet in depth (Ruibal et al. 1969). Individuals may remain in these burrows for 8 to 9 months. Spadefoot toads emerge from burrows to forage and breed following rains in the winter and

spring. The factors that stimulate emergence are not well understood. Sound or vibration from rain striking the ground appears to be the primary emergence cue used by spadefoot toads, and even the vibrations of a motor can cause toads to emerge (Dimmitt and Ruibal 1980). Spadefoot toads may move closer to the surface prior to precipitation and may even emerge to forage on nights with adequate humidity.

Most surface activity is nocturnal. Even when exposed to artificial light, spadefoot toad will immediately move away or begin burrowing underground (Ruibal et al. 1969). Surface activity has been observed in all months from October to May (Morey 1988).

During the day, spadefoot toad digs and occupies relatively shallow burrows 0.5 to 2 inches in depth (Ruibal et al. 1969), and may even use small mammal burrows.

It is assumed that corridors to enhance connectivity between populations are essential for the conservation of metapopulations. However, little is known regarding the distance that western spadefoot toad may range from aquatic resources for dispersal and aestivation; current research suggests that average habitat utilization by amphibians falls within 1,207 feet of aquatic habitats (Semlitsch and Brodie 2003).

Ecological Relationships

Because it spends most of the year below ground, adult spadefoot is able to avoid most predators. However, dense populations of tadpoles may be heavily preyed upon by wading birds, raccoons, or garter snakes. Introduced predators such as mosquitofish, other fish species, and bullfrogs (*Rana catesbeiana*) are found in more permanent water habitats than those that typically provide suitable habitat for western spadefoot.

Population Threats

Loss of vernal pool habitat from agricultural and urban development is likely the most significant threat to western spadefoot. Jennings and Hayes (1994) noted the loss of more than 80% of occupied habitat in southern California and more than 30% in northern California and they noted severe declines east of Sacramento, Fresno, and Bakersfield. McCready (pers. comm.) found a significant decline in the number of adult spadefoot over a 20-year period (1960s through 1980s) in Sacramento County, near Sunrise Boulevard, State Route 16, Grant Line Road, and Douglas Road. Urban development along with increased traffic has increased in this area since his original survey work in the late 60s and early 70s.

In addition to habitat loss, habitat fragmentation by urban development, agricultural conversion, and road construction is also likely to threaten western spadefoot populations. The migratory and spatial requirements of western spadefoot are not well understood (Morey pers. comm.), but it is likely that development and land conversion result in smaller and more isolated populations by removing habitat and imposing barriers to movement. Also, vehicle-related mortality on roads may be an important threat to western spadefoot populations in areas where occupied vernal pools are adjacent to roads and potential movement and dispersal corridors.

Context for a Regional Conservation Strategy

There are six recorded occurrences of western spadefoot in western Placer County, and the species is considered present, but uncommon, in the Plan area. The only neighboring county to Placer in which the species has been recorded is Sacramento County. There are a handful of records north of Placer County including Butte and Yolo counties, although the majority of California's populations are in or adjacent to the Central Valley south of Placer, in coastal ranges south of Monterey, and in Southern California. For conservation of western spadefoot

within the Plan area, conservation or acquisition of seasonal wetlands (such as vernal pools) and associated grassland habitat is of highest priority.

Modeled Species Distribution in the Plan Area

Model Assumptions

Breeding Habitat (Primary Habitat)
Modeled breeding habitat for western spadefoot is defined as vernal pool complex, seasonal wetlands, fresh emergent wetlands, riverine (intermittent and small tributaries), stock ponds, and valley foothill riparian.

Upland and Movement Habitat (Secondary Habitat)
Modeled upland and movement habitat for western spadefoot toad is defined as annual grassland and pasture, vernal pool complex uplands (i.e., upland grassland between vernal pools), valley foothill riparian, and all woodland habitats within one mile of modeled breeding habitat.

Rationale

Western spadefoot toads require seasonal wetlands (including off-channel seasonal pools in valley foothill riparian) and intermittent streams and drainages for reproduction and metamorphosis. They have been observed in a variety of permanent wetlands such as rivers, stock ponds, and fresh emergent wetlands; however, it appears that vernal pools and other temporary wetlands may be optimal for breeding due to the absence or reduced abundance of native and nonnative predators, many of which require more permanent water sources (USFWS 2005). Therefore, some permanent bodies of water may not be used for breeding, or provide lower quality breeding habitat, and likely reflect an overestimate of modeled breeding habitat.

Western spadefoot toads use upland habitats for foraging, movement, and aestivation. Although little is known about the distance that western spadefoot toads range from breeding habitat, a distance of 1 mile is consistent with movement distances for other amphibians in the region. For example, California tiger salamanders have been found up to 1.3 mile from breeding ponds (USFWS 2004). Grasslands are considered more optimal upland habitats than woodlands; therefore, much woodland habitat included in the model may not be occupied and is an overestimate of habitat occupied by western spadefoot.

Model Results

Figure 2 shows the modeled potential habitat for western spadefoot toad within the Plan area. Primary habitat is distributed mostly in the western portion of the Plan area, composed primarily of vernal pools. Much of the eastern portion of the Plan area supports secondary habitat, with most primary habitat limited to riverine systems.

References

Barry, S. J. 2000. Western Spadefoot (Pelobatidae: *Scaphiopus (Spe*a) *hammondi*i). Unpublished report on the biology, status, and distribution of western spadefoot toads in South Sacramento County. Submitted to Jones & Stokes.

California Natural Diversity Database. 2010. RareFind, Version 3.1.0 (Jun2 2010). Sacramento, CA: California Department of Fish and Game.

Childs, H. E. 1953. Selection by predation on albino and normal spadefoot toads. *Evolution* 7:228–233.

Dimmitt, M. A., and R. Ruibal. 1980. Environmental correlates of emergence in spadefoot toads. *Journal of Herpetology 14*(1):21-29.

Feaver, P. E. 1971. Breeding pool selection and larval mortality of three California amphibians: *Ambystoma tigrinum californiense* Gray, *Hyla regilla* Baird and Girard, and *Scaphiopus hammondii* Girard. M.A. thesis, Fresno State College, Fresno, CA.

Fisher, R. N., and H. B. Shaffer. 1996. The decline of amphibians in California's Great Central Valley. Conservation Biology 10(5):1387-1397.

Goodman, D. 1987. The demography of chance extinction. Pages 11–34 in M. E. Soulé (ed), *Viable populations for conservation*. Cambridge, UK: Cambridge University Press.

Hanski, I., and M. E. Gilpin (eds.). 1997. *Metapopulation biology: ecology, genetics, and evolution*. San Diego, CA: Academic Press.

Jennings, M. R., and M. Hayes. 1994. *Amphibian and reptile species of special concern in California*. Sacramento. California Department of Fish and Game.

Morey, S. 1998. Pool duration influences age and body mass at metamorphosis in the western spadefoot toad: implications for vernal pool conservation. In Witham, C. W. (ed.), *Ecology, conservation, and management of vernal pool ecosystems*. Sacramento, CA: California Native Plant Society.

Morey, S. R. 1988. Western spadefoot Scaphiopus hammondi. Pages 56-57 in: D. C. Zeiner, W. F. Laudenslayer, Jr., and K. E. Mayer, editors. California's wildlife. Volume 1. Amphibians and reptiles. *California Statewide Wildlife Habitat Relationships System, California* Department of Fish and Game, Sacramento, California.

Morey, S., and D. Guinn. 1992. Activity patterns, food habits, and changing abundance in a community of vernal pool amphibians. In Williams, D. F., S. Byrne, and T. A. Rado, (eds.), *Endangered and sensitive species of the San Joaquin Valley, California*. Sacramento, CA: California Energy Commission.

Placer Legacy Scientific Working Group. Undated. Western spadefoot (*Scaphiopus hammondi*). Phase 1 Species List – Draft Species Accounts. Available at: http://www.placerdata.org/bioresources/species/western_spadefoot.html

Pomeroy, L. V. 1981. Developmental polymorphism in the tadpoles of the spadefoot toad *Scaphiopus multiplicatus*. Ph.D. dissertation, University of California, Riverside.

Ruibal, R., L. Tevis, Jr., and V. Roig. 1969. The terrestrial ecology of the spadefoot toad Scaphiopus hammondii. *Copeia 1969*:571-584.

Semlitsch, R. D. and J. R. Brodie. 2003. Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles. *Conservation Biology* 17(5):1219-1228.

Stebbins, R. C. 1951. *Amphibians of western North America*. Berkeley, CA: University of California Press.

_____. 1985. *A field guide to western reptiles and amphibians*. Boston, MA: Houghton Mifflin Co.

Storer, T. I. 1925. *A synopsis of the amphibia of California*. University of California Publications in Zoology 27:1–343.

U.S. Fish and Wildlife Service. 2004. Endangered and Threatened Wildlife and Plants; Proposed Designation of Critical Habitat for the Santa Barbara County Distinct Population Segment of the California Tiger Salamander. Proposed Rule. Federal Register 69(14): 3064-3094.

U.S. Fish and Wildlife Service (USFWS). 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Portland, Oregon.

Zeiner, D. C., W. F. Laudenslayer, Jr., and K. E. Mayer (eds.). 1988. *California's wildlife*. Volume I: *Reptiles*. California Statewide Wildlife Habitat Relationships System. Sacramento, CA: California Department of Fish and Game.

Personal Communications

McCready, Alan. Herpetologist. 1993–2001 – Numerous telephone conversations and memoranda.

Morey, Steve. Biologist. U.S. Fish and Wildlife biologist. Mapped data of western spadefoot toad occurrences in Sacramento County.

Westphal, Mike. Biologist. California Department of Parks and Recreation. March 27, 1999 – meeting.

Envirogram Narrative

Western Spadefoot Toad (*Spea hammondii*)

The envirogram was created based on the information provided in this species account. The envirogram is a tool to help depict and organize the most important ecological factors that affect a population or group of populations of a particular species. The envirogram consists of Direct Components – components of the environment that directly affect a species' chances to survive and reproduce, and several webs comprised of distal factors (i.e., Indirect Components, Management Problems, and Mitigation Actions) that act in sequence to affect the Direct Components. The Direct Components consist of four major categories: resources, hazards, reproduction, and dispersal. Each of these is subdivided as necessary.

The webs identify the underlying ecological processes or human actions that influence each Direct Component. Distal factors in the web activate proximate components. Each of these pathways in the web are constructed from right to left, with Indirect Components immediately to the left of Direct Components directly affecting the Direct Component, and secondary Indirect Components affecting primary Indirect Components. Management Problems can directly affect the Indirect Components, and Mitigation Actions provide solutions to remedy the Management Problems.

<u>Resources</u>
Res1: Western spadefoot toad uses seasonal wetlands such as vernal pools for breeding habitat. Such pools usually are associated with natural hydrologic conditions; if the pools have been modified by leveling, disking, deep ripping, or other types of drainage alterations, they usually are not suitable. Modified vernal pools should be restored to their natural hydrologic conditions if they are to support successful reproduction in this species.

Res2: Individual pools used for breeding must persist for several weeks so the eggs can hatch and the larvae can develop to the metamorph stage. Adequate rainfall is necessary to fill the pools to the level where they will not dry up prematurely.

Res3: Western spadefoot larvae (tadpoles) feed on algae and organic detritus. The abundance and diversity of these food sources depend on pool structural complexity, water quality, and water chemistry, the amount and timing of rainfall, and the hydrologic regime of the pool.

Res4: Adult habitat for the western spadefoot consists of grazed grasslands or oak woodlands with friable soil or rodent burrows. These conditions depend on the proper soils and underlying geology, the presence of burrowing rodents such as ground squirrels and pocket gophers, and livestock grazing. If the intensity of grazing is inadequate to produce stubble of the appropriate height for spadefoot foraging and dispersal or if rodents are eliminated by control measures, habitat becomes unsuitable. A whole-ecosystem approach to management, including adaptive grazing management, is the best mitigation strategy.

Prey for adults and metamorphs consists of a variety of small invertebrates, which normally depend on a healthy grassland or understory ecosystem. If pesticide applications reduce invertebrate populations severely, western spadefoot populations are very likely to be affected negatively. A whole-ecosystem approach to management should minimize this threat.

Hazards

Haz1: The major threat to larvae is the premature drying of the breeding pool. This can result either from too little rainfall or from changes to pool hydrology resulting from various types of drainage alterations. The restoration and maintenance of the original pool hydrology can help minimize this threat.

Haz2: Another major hazard to larvae and to metamorphs is predation by a variety of birds, reptiles, amphibians, and mammals. The intensity of predation depends on the characteristics of the pool complex; highly fragmented pool complexes near urban and agricultural areas provide many opportunities for predators to be successful. Large reserve areas located away from subdivisions and farms are the best mitigation.

Haz3: The major hazards for adults are barriers that impede their movement and vehicle-related mortality. The proximity to roads and development and the degree of fragmentation generally determine the extent of vehicle-related mortality. Large reserve areas located away from urban areas minimize this problem.

Reproduction

Rep1: Spawning starts at the onset of warm winter rains, so the amount and timing of rainfall is critical to reproduction.

Rep2: The breeding pool must remain filled for 5-12 weeks after spawning for successful metamorphosis. This depends on the amount and timing of rainfall as well as the hydrologic regime of the breeding pool. If pool hydrology has been altered, the original hydrologic regime must be restored.

Dispersal

Dis1: Metamorphs must disperse from the breeding pool to adjacent grassland. This requires appropriate dispersal habitat, which is minimized in highly fragmented and disturbed situations.

Dis2: Adults must disperse from their underground retreats to the breeding pool and back again. Large vernal pool complexes that are not fragmented or highly disturbed provide such habitat.

Western Spadefoot, *Spea hammondii* (page 1)

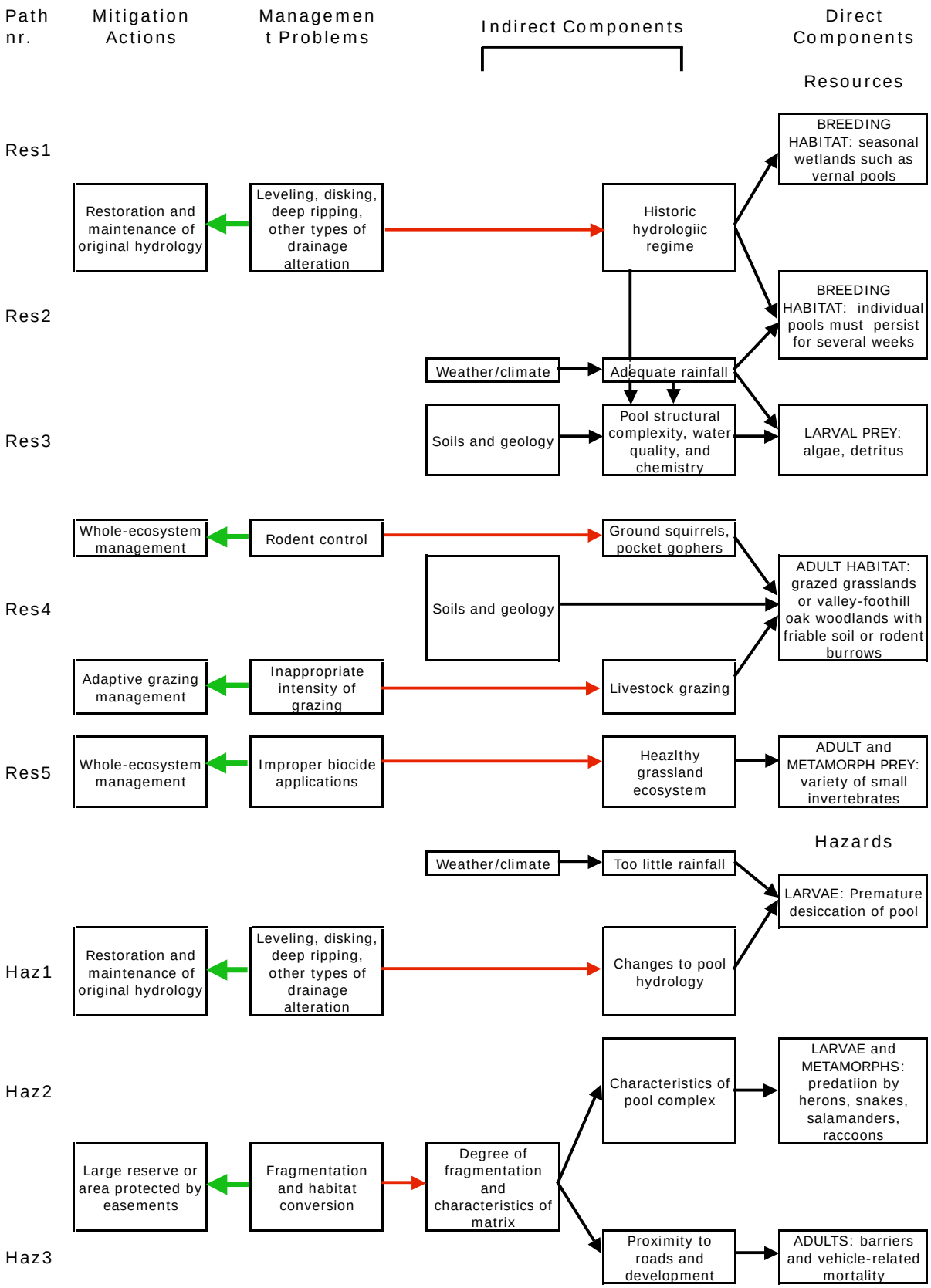
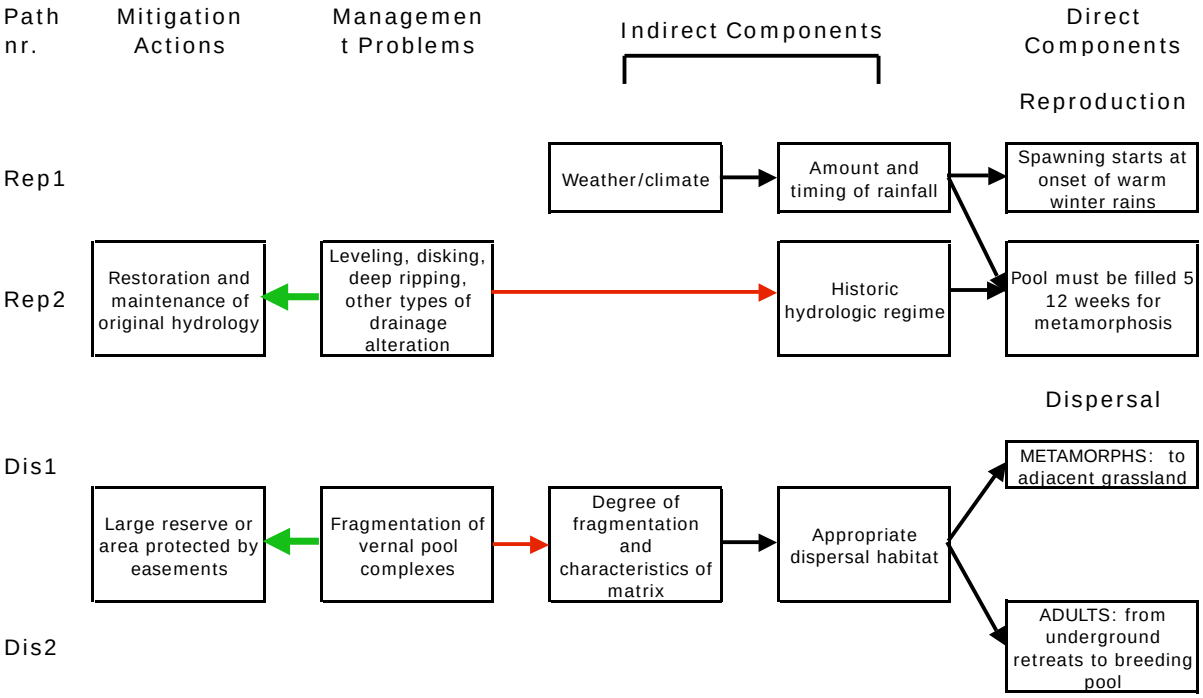


Figure 1. Envirogram. Key to abbreviations: Res = Resources; Haz = Hazards; Rep = Reproduction; Dis = Dispersal.

Western Spadefoot, *Scaphiopus hammondii* (page 2)



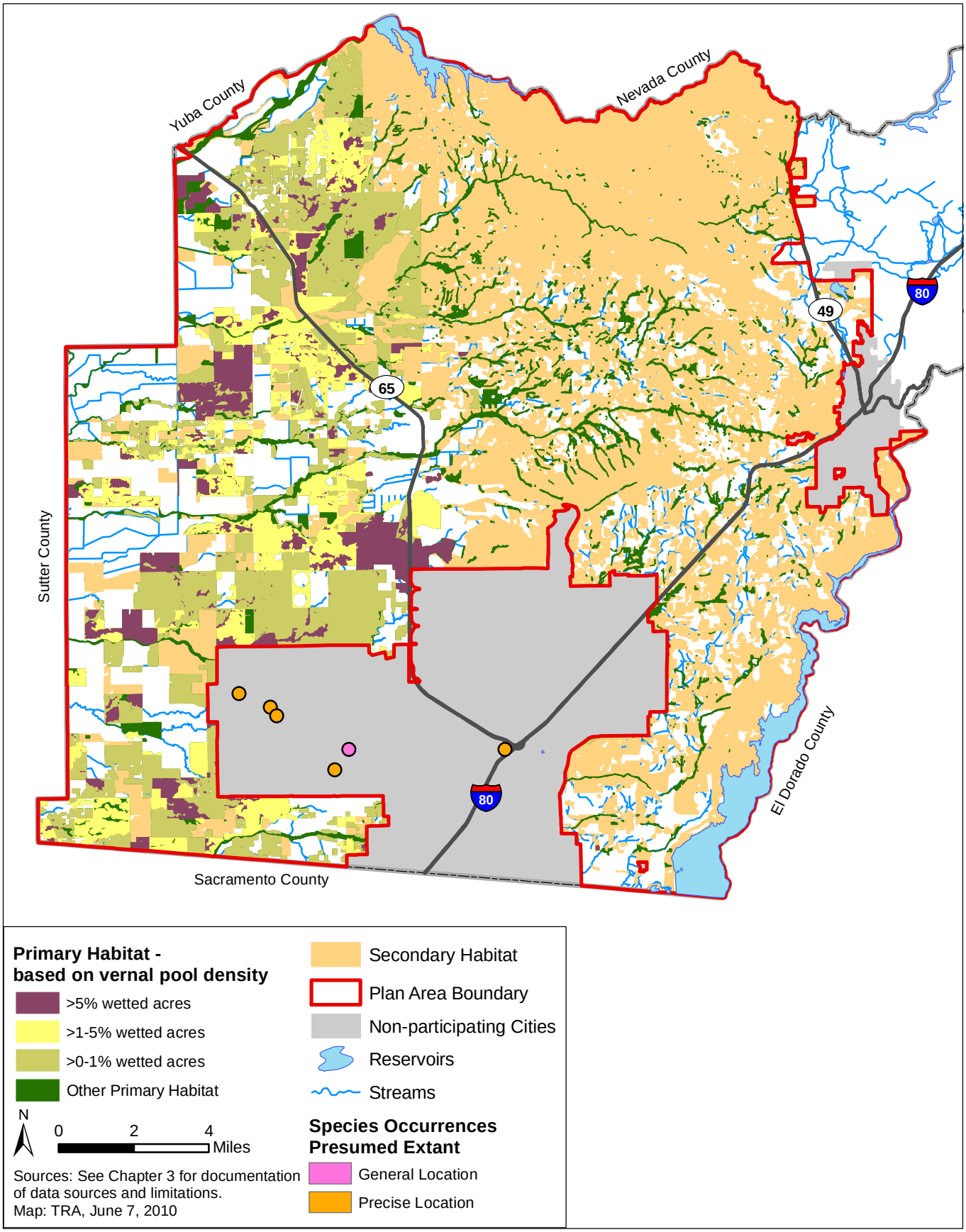


Figure 2. Western spadefoot modeled habitat distribution. The habitat map present outcomes of the draft model described above. The purpose of the model is to identify areas within the Plan area where the species occurs or could occur based on known habitat requirements. Those data on which this map is based are regional in scale. This map should not be used for site planning and should be verified in the field.

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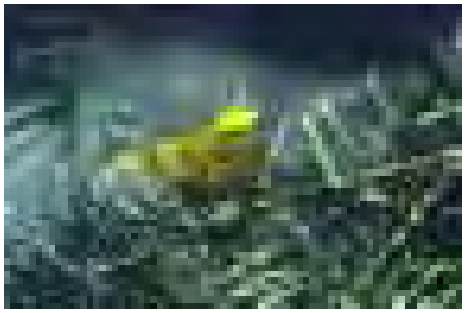
Yellow Warbler

(*Dendroica petechia*)



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Status

Federal: None

State: Bird Species of Special Concern, Priority 2

Other: California Partners in Flight: high-priority riparian obligate species (Evans 1997)

Recovery Plan: None

Placer Legacy Category: Class 3

Distribution

North America

Yellow warbler of the "yellow" group of subspecies breeds from the northern limits of the boreal forest in Alaska and Canada throughout most of the upper two-thirds of the continental United States. The breeding range also extends along the Pacific coast into Baja California, and there is a disjunct breeding population in the Sierra Madre Occidental of Mexico (Lowther et. al. 1999)

Yellow warbler winters from the coasts along northern Mexico south to northern South America (Lowther et. al. 1999).

California

Yellow warbler occurs primarily as a summer resident and migrant from late March through early October; breeding from April through July (Dunn and Garrett 1997). A few yellow warblers remain to winter in lowlands in southern California (Garrett and Dunn 1981). Yellow warbler currently occupies much of its former breeding range, except in the Central Valley, where it has declined close to extirpation (Heath 2008).

Placer County Plan Area

Historical

There is no specific historical information on the breeding status of yellow warbler within the Plan area; however, yellow warbler was reported to nest throughout the lowlands of California, including the Central Valley, in the early to mid-twentieth century (Dawson 1923; Grinnell and Miller 1944).

Current

There is no documented information on the current breeding status of yellow warbler in the Plan area, though it likely no longer breeds in the Central Valley portion of the Plan area (Pandolfino pers. comm.). Yellow warbler may nest in the riparian habitats in the foothill region of the Plan area (Williams 1996), but this has apparently not been confirmed. A singing male was detected on July 1, 2009 (A. Gabbe, pers. comm.), however, in the valley foothill riparian woodlands along Coon Creek on the Taylor Ranch Preserve**.** Yellow warbler is a common spring and fall

migrant in the riparian corridors and other migration stopover sites (Webb 2009; Easterla pers. comm.).

Population Status & Trends

North America

Yellow warbler is common throughout much of its breeding range (Dunn and Garrett 1997). Breeding bird survey results indicate a stable North American population between 1966 and 2005 (Sauer et al. 2005).

California

Historically, yellow warbler was a common breeder in lowland riparian habitats throughout California (Dawson 1923; Grinnell and Miller 1944). However, it has been largely extirpated from riparian areas in the Central Valley, as well as from lowland portions of southwestern California along the coastal plain (Heath 2008; Garrett and Dunn 1981). By 1973, yellow warbler had disappeared as a breeding species along the Feather and lower Sacramento rivers, and it was detected at only four of 20 sites along the upper Sacramento River (Gaines 1974).

Placer County Plan Area

Yellow warbler is not known to have nested on the Central Valley floor in western Placer County in recent years (Williams 1996), and no nesting pairs were detected during intensive riparian bird surveys during 1998 and 1999 in nearby Yolo, Sacramento, Sutter, and Colusa counties (PRBO unpubl. data, T. Manolis in litt., cited in Heath 2008). Early descriptions of the species' breeding range in California described most lowland areas including the Central Valley (Dawson 1923; Grinnell and Miller 1944). It is difficult to assess the extent of the historic abundance and consequent population decline because there are no quantitative data of confirmed breeding populations in the Central Valley (Heath 2008). However, with extensive riparian loss and the addition of brown-headed cowbird brood parasitism during the twentieth century, it is reasonable to assume that local yellow warbler populations have experienced steep declines or have been extirpated in the Central Valley section of the Plan area.

Natural History

The habitat requirements, ecological relationships, life history, and threats to yellow warbler described below are summarized in diagram form in the envirogram (Figure 1).

Habitat Requirements

In Colorado, Knopf and Sedgwick (1992) found that distance between willows (high density) was the best indicator of yellow warbler density and nest placement. They also found that the warblers selected nest sites based on nest concealment rather than on characteristics (e.g., vigor and structure) of individual shrubs.

In California, yellow warbler nests primarily in riparian habitats (Grinnell and Miller 1944), but in some montane areas it also nests in a variety of shrub habitats (e.g., manzanita, ceanothus) far removed from water (Grinnell et al. 1930; Beedy and Granholm 1985; Gaines 1992). Yellow warbler occasionally nests in the shrubby understory of mixed-conifer forests (Grinnell et al. 1930; Beedy and Granholm 1985; Gaines 1992).

Migrants prefer edges to the interior of forests and broad-leaf trees to conifers. They can be found in a variety of habitats, including riparian, oak woodland, and suburban parks and gardens (Dunn and Garrett 1997).

Reproduction

Females lay four to five eggs and incubate them for 11–13 days. Both parents feed young at the nest until the young fledge at 8–10 days. The daily survival rates for eggs/young in nests are 94–99% (Lowther et. al. 1999).

Dispersal Patterns

There is no information regarding dispersal of young or adults from breeding sites. There are data that show a strong tendency for breeding and wintering site fidelity with individuals returning in successive years (Lowther et. al. 1999).

Longevity

Survival rates for adults are difficult to measure; however, 53% of banded adults returned from their wintering grounds to their previous breeding locations. This is a conservative estimate of survivorship, because it presumes that nonreturning birds died rather than relocated to a different breeding area. The oldest known yellow warbler reached 8 years 11 months (Lowther et. al. 1999).

Sources of Mortality

There are few data on predation of adults; however, long-tailed weasel (*Mustela frenata*) is a known predator. Nest predation by squirrels, snakes, jays, foxes, American crow (*Corvus branchrynchos*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), and domestic cat (*Felis domesticus*) has been documented (Lowther et. al. 1999).

Behavior

Yellow warbler is highly territorial on both breeding and wintering grounds. Breeding territories in Utah averaged 0.35 acre, and winter territories in southern Mexico averaged 1.24 acre. Extra-pair copulation has been documented, so at least some males visit rival territories (Lowther et. al. 1999). Apparently, territory size has not been estimated in Central Valley riparian areas. Manolis (1973) reported a density of 13 territorial males/square mile (four singing males on the study plot) in a disturbed riparian woodland west of Chico, Butte County. This was in contrast to none found by Gaines (1973) during a concurrent study in a riparian woodland north of Glenn along the Sacramento River. Grinnell et al. (1930) reported eight singing males on a 10-acre island in the Sacramento River near Red Bluff; this report may pertain to migrants because the early May observation date was within the peak migration period. Yellow warbler populations may increase dramatically with the elimination of cattle grazing in willow riparian habitats (Taylor and Littlefield 1986).

Yellow warbler feeds primarily on arthropods and rarely on wild fruit. A study of stomach samples of 98 yellow warbler from California found that its diet comprised 30% bees, wasps, and ants; 18% caterpillars; 19% bugs (Hemiptera); 16% beetles; 9% flies; and the balance of other arthropods and fruit (Beale 1907). Yellow warbler actively gleans insects from leaves and occasionally sallies to capture flying insects. Males often forage higher in trees than females (Lowther et. al. 1999). A study of foraging behavior in eastern songbirds showed that yellow warbler are very adaptable, allowing them to respond to local or changing environmental conditions in search of prey (Petit et al. 1990).

Movement and Migratory Patterns

Yellow warbler migrates to the neotropics annually. Spring migration in central California takes place from early April until late May, while fall migration begins in late July and lasts until mid-October (Dunn and Garret 1997).

Ecological Relationships

Yellow warbler often forms flocks during migration and will also join mixed-species flocks with other warblers, vireos, and flycatchers. Territorial birds are highly aggressive towards other bird species and will often initiate chasing, especially near the nest or on winter territories. Nest parasitism by brown-headed cowbirds can severely affect individual breeding attempts; however, there is little evidence that brood parasitism by brown-headed cowbird has caused population declines (except for certain populations, e.g., West Indies) (Lowther et. al. 1999).

Population Threats

Loss, fragmentation, and degradation of riparian habitat are the major factors contributing to the historic decline in the Central Valley (Gaines 1974, Heath 2008). Intense grazing by cattle, especially where willow growth is removed or reduced, can severely degrade habitat. These threats still exist and may impede any recolonizaton attempts in the Central Valley.

Context for a Regional Conservation Strategy

Yellow warbler is a common spring and fall migrant in riparian corridors and other migration stopover sites in the Plan area. The species may nest in the riparian habitats of the Plan area foothill region, but this has not been confirmed, though a singing male was observed on July 1, 2009 in the riparian forest along Coon Creek in the Taylor Ranch Preserve. In the region, the California Natural Diversity Database (2009) shows occurrences only in eastern Placer, Nevada and Sierra counties. Yellow warbler was at one time a common breeder in lowland riparian habitat in the region, but has been largely extirpated from the Central Valley. In the state, yellow warbler still occupies much of its historic breeding range. Yellow warbler nests primarily in riparian habitats and migrants can be found in a variety of habitats, including riparian, oak woodland, and suburban parks and gardens.

Modeled Species Distribution in the Plan Area

Model Assumptions

<u>Nesting Habitat (Primary Habitat)</u>
Modeled nesting habitat for yellow warbler is defined as valley foothill riparian in the foothills (> 200 feet elevation) and oak-foothill pine woodland.

<u>Foraging and Movement Habitat (Secondary Habitat)</u>
Modeled foraging and movement habitat for yellow warbler is defined by the following land-cover types (at all elevations in the Plan area): mixed oak woodland, blue oak woodland, interior live oak woodland, valley oak woodland, oak foothill pine woodland, oak woodland savanna, valley foothill riparian, orchard, rural residential, rural residential forested, urban/suburban, urban golf courses, urban parks, urban riparian, eucalyptus woodland, and urban woodland.

Rationale

Yellow warblers are no longer known to nest on the Valley floor in western Placer County. Yellow warblers may nest in riparian and to a lesser, extent oak-foothill pine woodlands in the foothill region of the Plan area. Yellow warblers occasionally nest in the shrubby understory of mixed conifer forests.

Yellow warblers are common spring and fall migrants in riparian habitats and woodland areas at all elevations in the Plan area. This habitat is used primarily by yellow warblers that stopover in the Plan area during spring and fall migration, though it includes foraging and movement habitat for individuals that nest in the Plan area (i.e., in valley foothill riparian).

Model Results

Figure 2 shows the modeled potential habitat for yellow warbler within the Plan area. Nesting habitat is restricted to riparian and oak-foothill pine habitats in the eastern portion of the Plan area. Modeled secondary habitat in the western portion of the Plan area is more likely to be used as migratory stopover habitat.

References

Printed References

Beale, F. 1907. Birds of California in relation to the fruit industry, Part 1. Washington, DC: U.S. Department of Agriculture Biological Survey Bulletin No. 30.

Beedy, E. C., and S. L. Granholm. 1985. *Discovering Sierra birds*. Yosemite National Park, CA: Yosemite Natural History Association and Sequoia Natural History Association.

California Natural Diversity Database. 2009. RareFind , Version 3.1.0. (May 30, 2009). Sacramento, CA: California Department of Fish and Game.

Dawson, W. L. 1923. The birds of California. Volume 1. San Diego, Los Angeles, San Francisco: South Moulton Company.

Dunn, J., and K. Garrett. 1997. *A field guide to the warblers of North America*. Boston and New York: Houghton Mifflin.

Evans, D. 1997. Filling out flight plan: conservation goals for California's riparian obligate bird species. *Flight Log (Newsletter of California Partners-in-Flight)* 5:2–3.

Gaines, D. 1973. Breeding bird census: floodplain riparian forest. *American Birds* 27:995.

Gaines, D. 1974. A new look at the nesting riparian avifauna of the Sacramento Valley, California. *Western Birds* 5:61–80.

Gaines, D. 1992. *Birds of Yosemite and the east slope*. Lee Vining, CA: Artemisia Press.

Garrett, K., and J. Dunn. 1981. *Birds of southern California*. Los Angeles, CA: Los Angeles Audubon Society.

Grinnell, J., J. Dixon, and J. Linsdale. 1930. *Vertebrate natural history of a section of northern California through the Lassen Peak region*. Berkeley, CA: University of California Press.

Grinnell, J., and A. H. Miller. 1944. *The distribution of the birds of California*. Berkeley, CA: Cooper Ornithological Club, Pacific Coast Avifauna. Number 27. Reprinted 1986. Lee Vining, CA: Artemisia Press.

Heath, S. 2008. Yellow Warbler Account. *In* California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Shuford, W. D., and Gardali, T., editors. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Knopf, F., and J. Sedgwick. 1992. An experimental study of nest-site selection by yellow warblers. *Condor* 94:734–742.

Lowther, P. E., C. Celada, N. K. Klein, C. C. Rimmer, and D. A. Spector. 1999. Yellow warbler (*Dendroica petechia*). In A. Poole and F. Gill (eds.), *The birds of North America*, No. 454. Philadelphia, PA: The Academy of Natural Sciences and Washington, DC: The American Ornithologists' Union.

Manolis, T. 1973. Breeding bird census: disturbed floodplain woodland. *American Birds* 27:994.

Petit, D., K. Petit, and L. Petit. 1990. Geographic variation in foraging ecology of North American insectivorous birds. *Studies in Avian Biology* 13:254–263.

Sauer, J. R., J. E. Hines, and J. Fallon. 2005. The North American Breeding Bird Survey, Results and Analysis 1966 - 2005. Version 6.2.2006. USGS Patuxent Wildlife Research Center, Laurel, MD.

Taylor, D., and C. Littlefield. 1986. Willow flycatcher and yellow warbler response to cattle grazing. *American Birds* 40:1169–1173.

Webb, B. Seasonal Checklist of the Birds of Placer County, California. Retrieved November 15, 2009, from http://placerbirding.com/PlacerCountyBirds.htm

Williams, B. 1996. Seasonal checklist of the birds of Placer County. Rocklin, CA: Sierra Foothills Audubon Society.

Personal Communication

Todd Easterla. December 28, 2002 – Interview during field investigations.

Ed Pandolfino. Conservation Chairman, Placer County. Sierra Foothills Audubon Society. 2009 – emails and meeting.

Aaron Gabbe, biologist, TRA Environmental Sciences, Inc. July 1, 2009.

Envirogram Narrative

Yellow Warbler (*Dendroica petechia*)

The envirogram was created based on the information provided in this species account. The envirogram is a tool to help depict and organize the most important ecological factors that affect a population or group of populations of a particular species. The envirogram consists of Direct Components – components of the environment that directly affect a species' chances to survive and reproduce, and several webs comprised of distal factors (i.e., Indirect Components, Management Problems, and Mitigation Actions) that act in sequence to affect the Direct Components. The Direct Components consist of four major categories: resources, hazards, reproduction, and dispersal. Each of these is subdivided as necessary. For example, resources are subdivided into breeding habitat and food.

The webs identify the underlying ecological processes or human actions that influence each Direct Component. Distal factors in the web activate proximate components. Each of these pathways in the web are constructed from right to left, with Indirect Components immediately to the left of Direct Components directly affecting the Direct Component, and secondary Indirect Components affecting primary Indirect Components. Management Problems can directly affect the Indirect Components, and Mitigation Actions provide solutions to remedy the Management Problems.

<u>Resources</u>
Res1: The yellow warbler requires dense shrub thickets in valley foothill riparian for nesting habitat. While habitat quality is somewhat weather-dependent, more important factors include relatively unmodified stream channels, flood plains, and flow regimes. Few streams in Placer County have these characteristics, but they can be restored.

Res2: Food items for the yellow warbler consist primarily of arthropods, but a few fruits are eaten as well. Arthropods are abundant in healthy riparian ecosystems when weather conditions are good, but the destruction and modification of riparian vegetation may change food availability. Restoration and proper management of floodplains and riparian ecosystems are logical mitigation actions to ensure a predictable food supply.

<u>Hazards</u>
Haz1: Loss of shrub understory in riparian vegetation resulting from clearing for agriculture or development and inhibition of regrowth by overgrazing are a major hazard for the yellow warbler in Placer County. Loss of riparian vegetation can be mitigated to some extent by restoration, and poor grazing practices can be corrected.

Haz2: Yellow warbler is vulnerable to nest parasitism by brown-headed cowbird. Brown-headed cowbird parasitism is related to the proximity of livestock to the yellow warbler breeding sites, habitat patch size (areas with smaller patches suffer greater levels of nest parasitism), and shrub density. Brown-headed cowbirds should be monitored and control may be considered in riparian areas when the frequency of parasitism becomes >20%.

Haz3: Nest predation by corvids, snakes, squirrels, and raccoons is also a larger problem in small patches of riparian vegetation than it is in larger patches. These predators are less common and alternate prey is more abundant in large patches. Loss of riparian vegetation intensifies predation, and restoration of riparian vegetation mitigates some of the effects of predation on the yellow warbler.

Haz4: Predation by feral and domestic cats also is a problem for yellow warbler. These predators are generally most abundant near homes and farms. Controlling feral cats and keeping pet cats inside reduces this hazard.

Reproduction

The nesting success of individual pairs of yellow warbler depends upon successful return from the wintering area, availability of nest sites and mates, and abundance of arthropods. Weather conditions affect successful migration, the state of the ecosystem on which the prey base depends, and the prey base directly. The destruction of riparian vegetation and channel and flow modifications, improper vegetation management, and improper biocide applications in adjacent fields all impact the health of riparian ecosystems. Integrated management for agricultural production and riparian health is necessary for successful reproduction in the yellow warbler.

Dispersal

Dis1: Adult yellow warblers exhibit strong site fidelity, so the persistence of patches of suitable nesting habitat is important to maintain a population. This depends to some extent on weather conditions, but more importantly on the condition of streams and associated riparian zones. Appropriate management of floodplains and riparian vegetation is critical.

Dis2: Young yellow warblers disperse, so the availability of unoccupied habitat is important. Healthy riparian zones throughout the County, resulting from floodplain and riparian restoration and appropriate flow management is necessary to achieve this.

Migration

Mig1: In winter yellow warbler migrates to the Neotropics. The weather and habitat conditions along the migratory route and in the wintering areas are critical to their survival.

Summary

Yellow warbler may not be a breeding resident of Placer County at present but it evidently has been in the past. For the species to become a breeding resident of the County again a major effort needs to be made to restore and maintain healthy riparian ecosystems through floodplain restoration and appropriate water management. Additionally, it is necessary to determine whether predation by feral cats and parasitism by brown-headed cowbird is a significant problem for the species. If so, control procedures should be implemented and their effectiveness should be determined.

Yellow warbler, *Dendroica petechia*

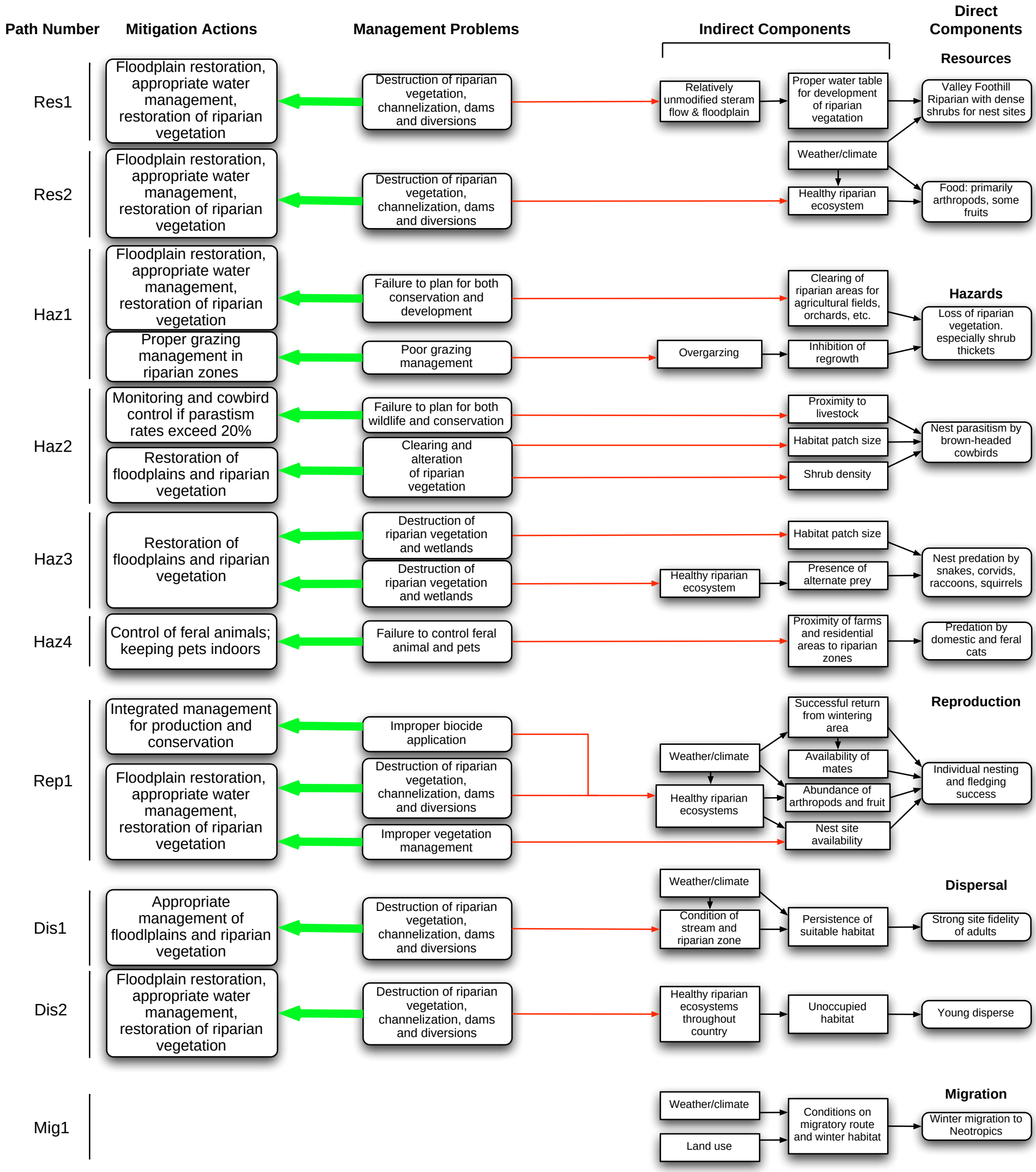

Figure 1. Envirogram. Key to abbreviations: Res = Resources; Haz = Hazards; Rep = Reproduction; Dis = Dispersal; Mig = Migration.

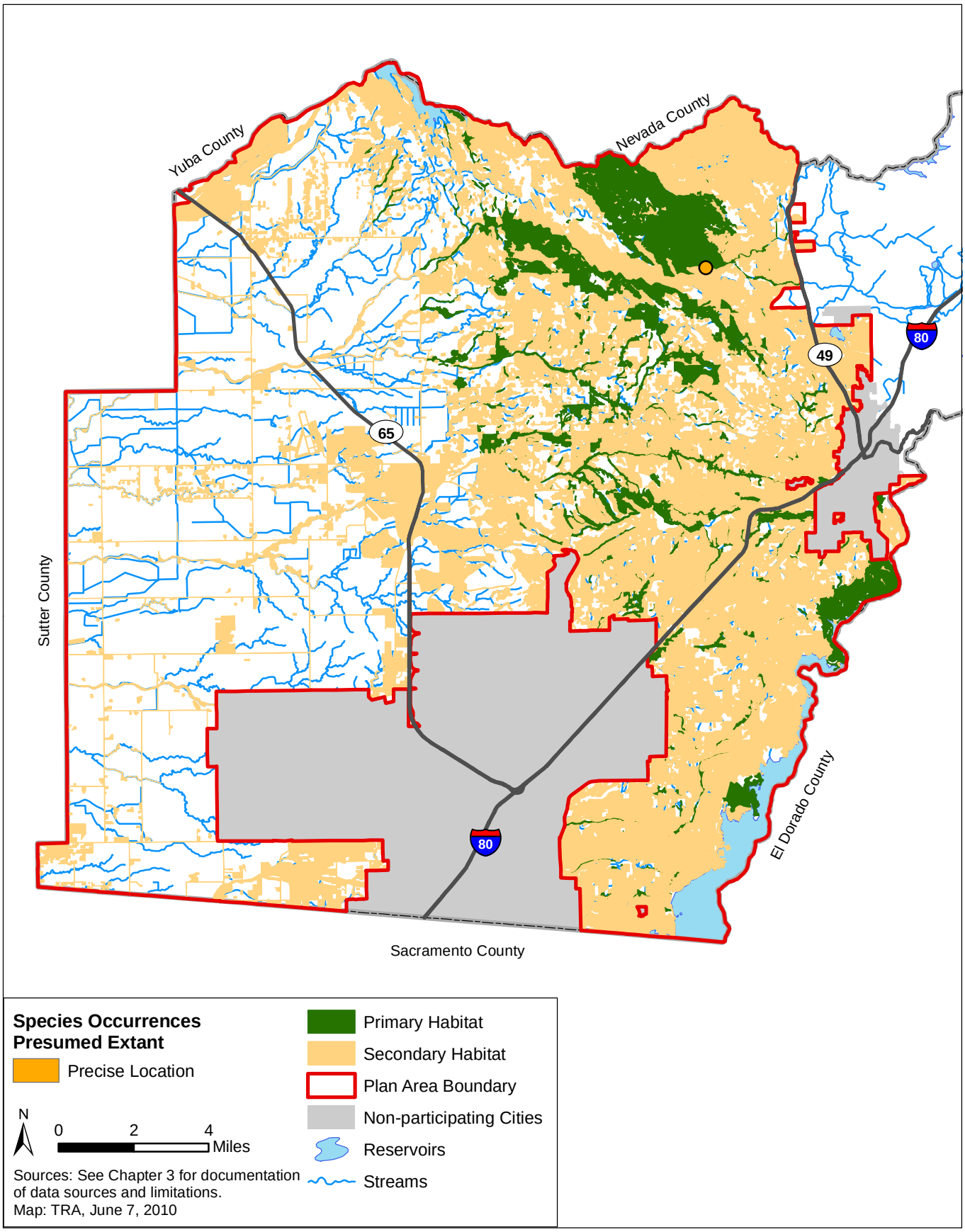

Figure 2. Yellow warbler modeled habitat distribution. The habitat map present outcomes of the draft model described above. The purpose of the model is to identify areas within the Plan area where the species occurs or could occur based on known habitat requirements. Those data on which this map is based are regional in scale. This map should not be used for site planning and should be verified in the field.
Occurrence data are limited by where field surveys have been conducted. The occurrence record is from A. Gabbe (pers. comm.).

Yellow-Breasted Chat
(Icteria virens)

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www.avesphoto.com

Status

Federal: None

State: Bird Species of Special Concern, Priority 3

Other: California Partners in Flight: high-priority riparian obligate species (Evans 1997)

Recovery Plan: None

Placer Legacy Category: Class 3

Distribution

North America

Yellow-breasted chat is a widespread summer resident of the eastern United States; it has a much more fragmented distribution in the west, where its range includes the Cascade Range; central Oregon valleys; southern Idaho; northern Nevada; and portions of California, Utah, western Colorado, and central Arizona (Eckerle and Thompson 2001).

California

Yellow-breasted chat occurs as a migrant and summer resident primarily from late March to late September (Garrett and Dunn 1981, Unitt 2004); breeds from late April through early August (Eckerle and Thompson 2001, Unitt 2004). Yellow-breasted chat breeds primarily in the northern third of the state and is currently scarce in the Central Valley and central and southern California (Comrack 2008). A significant but declining population occurs along the lower Colorado River Valley in southern California, though this population may be rebounding (Rosenberg et al. 1991; Comrack 2008).

Placer County Plan Area

Historical

There is no information available on the historical distribution of yellow-breasted chat in Placer County, but it probably occurred in foothill riparian habitats in the Plan area.

Current

There are no known populations in the Central Valley (western) portion of the Plan area (Easterla pers. comm.). Yellow-breasted chat is considered an uncommon nesting bird in foothill riparian areas within the Plan area (Webb 2009).

Population Status & Trends

North America

The North American population overall appears to have been stable from 1966 to 2005; however, these data are only moderately credible as yellow-breasted chat was detected in low abundance (<1.0 bird per route) (Sauer et al. 2005). There is little evidence of population decreases or increases over large sections of the species' range (Eckerle and Thompson 2001).

California

The southern California and Monterey County populations have declined in tandem with the destruction of much of the species' riparian habitat and increased brown-headed cowbird nest parasitism (Garrett and Dunn 1981; Roberson and Tenney 1993). Although Gaines (1974) did not consider yellow-breasted chat to be decreasing in the Sacramento Valley, the species has since been reported to be rare or absent from the lower Sacramento Valley; its statewide range had decreased by 35% during the twentieth century (Comrack 2008). Overall, populations in California appear to have been stable from 1966 to 2005; however, these data are only moderately credible as yellow-breasted chat was detected in low abundance (<1.0 bird per route) (Sauer et al. 2005).

Placer County Plan Area

There are no data on population trends in the Plan area. However, because populations in the lower Sacramento Valley have been largely extirpated (Comrack 2008), it is reasonable to assume that, concomitant with habitat loss, populations in the Plan area have also disappeared.

Natural History

The habitat requirements, ecological relationships, life history, and threats to yellow-breasted chat described below are summarized in diagram form in the envirogram (Figure 1).

Habitat Requirements

In northern and central California, yellow-breasted chat requires riparian woodland or riparian shrub thickets with dense vegetation typically comprised of Himalayan blackberry (*Rubus discolor*), wild grape (*Vitis* sp.), and/or willow (*Salix* spp.) (Grinnell et al. 1930; Grinnell and Miller 1944; Comrack 2008). Tall willows, cottonwoods, and sycamores are often used for song perches (Grinnell and Miller 1944; Dunn and Garrett 1997).

Reproduction

The breeding season generally begins in April or early May and can last until August. Males arrive on the breeding grounds shortly before females in April–late May. Little is known about pair formation and territory establishment for this species. Females initiate nest construction, which begins shortly after pair formation. Eggs are typically laid between May and July. Females lay 3-6 eggs and incubate them for 11–12 days; both parents feed the nestlings until they fledge at approximately 9 days. No data are available on the reproductive success of the California population (Eckerle and Thompson 2001).

Dispersal Patterns

Little information is available on juvenile dispersal. Banding studies in Indiana showed that many juveniles moved away from the forests where they were born. Data on postbreeding dispersal are also scarce. Data from the eastern United States indicate an extremely low fidelity to breeding sites between years, with many spatially separated breeding sub-populations linked

by movement of individuals among short-lived patches of suitable habitat (Eckerle and Thompson 2001). In southern California, however, the limited amount of available habitat may foster a higher level of breeding site fidelity (Eckerle and Thompson 2001).

Longevity

No data are available on survival rates of adults or fledglings. The oldest known individual was 8 years11 months (Eckerle and Thompson 2001).

Sources of Mortality

There is no information on sources of mortality in the western United States. Potential nest predators include western scrub jay (*Aphelocoma californica*), snakes, and mammals such as raccoon (*Procyon lotor*), rats, and squirrels.

Behavior

In the eastern United States, yellow-breasted chat territory sizes ranged from 0.86–4.32 acres. Studies in the eastern United States found that effectiveness of territory defense decreased with increasing densities of males in a given area (Eckerle and Thompson 2001). There are no published data on territory sizes of yellow-breasted chat in California. Laymon (1984) estimated densities of 44–60 pairs/square mile in riparian woodland on Dog Island along the Sacramento River near Red Bluff, Tehama County.

Yellow-breasted chat eats a variety of arthropods, including beetles and weevils, true bugs, ants, bees, caterpillars, and spiders; it forages in dense thickets, gleaning off leaves and twigs. It also eats fruit, especially blackberries (*Rubus* sp.), elderberries (*Sambucus* sp.), and wild grapes (*Vitis* sp.) (Eckerle and Thompson 2001).

It does not join mixed-species flocks, even during postbreeding dispersal, migration, or on its wintering grounds where many migrant species join mixed-species flocks (Rappole and Warner 1980).

Movement and Migratory Patterns

Yellow-breasted chat migrates annually between breeding grounds in North America and wintering grounds in Mexico and Central America. For populations that breed in southern California, spring migration from the wintering grounds lasts from mid-April to late May; fall migration from the breeding grounds lasts from mid-July to mid-September (Dunn and Garrett 1997).

Ecological Relationships

Yellow-breasted chat is highly susceptible to brood parasitism by brown-headed cowbird (Eckerle and Thompson 2001). Nest parasitism by brown-headed cowbird can affect individual breeding attempts, though yellow-breasted chat nestlings appear able to compete and survive with brown-headed cowbird nestlings and still fledge from the nest (Eckerle and Thompson 2001). There is little direct evidence that brood parasitism by brown-headed cowbird has caused population declines, though yellow-breasted chat became numerous on Camp Pendleton, San Diego County and at the Prado Basin, Riverside County, with intensive brown-headed cowbird trapping (P. Unitt pers. comm., L. Hays pers. comm., both cited in Comrack 2008).

Population Threats

The loss and degradation of riparian woodland with dense understory is a continuing threat to the Central Valley population of yellow-breasted chat, as is brown-headed cowbird brood

parasitism. Grazing that degrades suitable habitat has been implicated in local population declines (Sedgwick and Knopf 1987).

Context for a Regional Conservation Strategy

Yellow-breasted chat is an uncommon nesting bird in foothill riparian areas within the Plan area, although occurrences in Placer County have not been recorded in the California Natural Diversity Database (2009). In addition, the California Natural Diversity Database shows no occurrences of yellow-breasted chat in the Placer County region. Records of yellow-breasted chat are concentrated in southern California, with only a few scattered occurrences in the upper half of the state. However, the species is known to breed primarily in the northern third of the state and thus true occurrences may be underrepresented. Yellow-breasted chat requires riparian woodland or riparian shrub thickets with dense vegetation typically comprised of Himalayan blackberry, wild grape, and/or willow.

Modeled Species Distribution in the Plan Area

Model Assumptions

Nesting, Foraging, and Movement Habitat (Primary Habitat)

Modeled nesting, foraging, and movement habitat for yellow-breasted chat is defined as valley foothill riparian in the foothills (> 200 feet elevation).

Rationale

There are no known populations in the Valley portion of the Plan area. Yellow-breasted chats are considered uncommon nesting birds in the Plan area. They require dense understory vegetation in riparian woodlands. Foraging and movement habitat overlap with nesting habitat, so the model does not distinguish between primary and secondary habitat.

Model Results

Figure 2 shows the modeled potential habitat for yellow-breasted chat within the Plan area. Potential primary habitat for yellow-breasted chat is located in the riparian habitats in the eastern portion of the Plan area.

References

Printed References

California Natural Diversity Database. 2009. RareFind , Version 3.1.0. (May 30, 2009). Sacramento, CA: California Department of Fish and Game.

Comrack, L. 2008. Yellow Warbler Account. *In* California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Shuford, W. D., and Gardali, T., editors. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Dunn, J., and K. Garrett. 1997. *A field guide to the warblers of North America*. Boston and New York: Houghton Mifflin.

Eckerle, K. P., and C. F. Thompson. 2001. Yellow-breasted chat (*Icteria virens*). In A. Poole and F. Gill (eds.), *The birds of North America*, No. 575. Philadelphia, PA: The Academy of Natural Sciences and Washington, DC: The American Ornithologists' Union.

Evans, D. 1997. Filling out flight plan: conservation goals for California's riparian obligate bird species. *Flight Log* (Newsletter of California Partners-in-Flight) 5:2–3.

Gaines, D. 1974. A new look at the nesting riparian avifauna of the Sacramento Valley, California. *Western Birds* 5:61–80.

Garrett, K., and J. Dunn. 1981. *Birds of southern California*. Los Angeles, CA: Los Angeles Audubon Society.

Grinnell, J., J. Dixon, and J. Linsdale. 1930. *Vertebrate natural history of a section of northern California through the Lassen Peak region*. Berkeley, CA: University of California Press.

Grinnell, J., and A. H. Miller. 1944. *The distribution of the birds of California*. Berkeley, CA: Cooper Ornithological Club, Pacific Coast Avifauna. Number 27. Reprinted 1986. Lee Vining, CA: Artemisia Press.

Laymon, S. 1984. Riparian bird community structure and dynamics: Dog Island, Red Bluff, California. In R. Warner and K. Hendrix (eds.), *California riparian systems: ecology, conservation and productive management*. Berkeley, Los Angeles, London: University of California Press.

Rappole, J., and D. Warner. 1980. Ecological aspects of migrant bird behavior in Veracruz, Mexico. In A. Keast and E. Morton (eds.), *Migrant birds in the neotropics: ecology, behavior, distribution, and conservation*. Washington, DC: Smithsonian Institution Press.

Roberson, D. and C. Tenney (eds.). 1993. Atlas of the breeding birds of Monterey County, California. Monterey, CA: Monterey Peninsula Audubon Society.

Rosenberg, K. V., R. D. Ohmart, W. C. Hunter, and B. W. Anderson. 1991. *The birds of the lower Colorado River*. Tucson, AZ: University of Arizona Press.

Sauer, J. R., J. E. Hines, and J. Fallon. 2005. The North American Breeding Bird Survey, Results and Analysis 1966 - 2005. Version 6.2.2006. USGS Patuxent Wildlife Research Center, Laurel, MD

Sedgwick, J., and F. Knopf. 1987. Breeding bird response to cattle grazing of a cottonwood bottomland. *Journal of Wildlife Management* 51:230–237.

Unitt, P. 2004. San Diego County bird atlas. Proc. San Diego Soc. Nat. Hist. 39.

Webb, B. Seasonal Checklist of the Birds of Placer County, California. Retrieved November 15, 2009, from http://placerbirding.com/PlacerCountyBirds.htm

Personal Communication

Todd Easterla. December 28, 2002 – Interview during field investigations.

Envirogram Narrative

Yellow-breasted Chat (*Icteria virens*)

The envirogram was created based on the information provided in this species account. The envirogram is a tool to help depict and organize the most important ecological factors that affect a population or group of populations of a particular species. The envirogram consists of Direct Components – components of the environment that directly affect a species' chances to survive and reproduce, and several webs comprised of distal factors (i.e., Indirect Components, Management Problems, and Mitigation Actions) that act in sequence to affect the Direct Components. The Direct Components consist of four major categories: resources, hazards, reproduction, and dispersal. Each of these is subdivided as necessary. For example, resources are subdivided into breeding habitat and food.

The webs identify the underlying ecological processes or human actions that influence each Direct Component. Distal factors in the web activate proximate components. Each of these pathways in the web are constructed from right to left, with Indirect Components immediately to the left of Direct Components directly affecting the Direct Component, and secondary Indirect Components affecting primary Indirect Components. Management Problems can directly affect the Indirect Components, and Mitigation Actions provide solutions to remedy the Management Problems.

<u>Resources</u>
Res1: The yellow-breasted chat requires valley foothill riparian with well-developed under- and mid-story vegetation layers for nest sites and tall trees in a scattered overstory for song perches. These conditions require the proper water table for the development of riparian vegetation. While the state of the water table is somewhat weather-dependent, more important factors include relatively unmodified floodplains and flow regimes. Few streams in Placer County have these characteristics, but they can be restored.

Res2: Food items for the yellow-breasted chat include a variety of arthropods and berries. These food items are abundant in healthy riparian ecosystems when weather conditions are good, but the destruction and modification of riparian vegetation may have diminished food availability for the chat. Restoration of riparian ecosystems is a logical mitigation.

<u>Hazards</u>
Haz1: Loss of riparian vegetation due to clearing for agriculture, development, and water management in the form of dams, diversions, flood control levees, and channelization is probably the biggest hazard confronting the chat in Placer County. Poor planning in the past can be mitigated to some extent by restoration of riparian zones and floodplains by implementing appropriate water management.

Haz2: Disturbance of nests by livestock during late spring and summer is another hazard to yellow-breasted chat. Livestock grazing must occur in riparian zones at the proper time and intensity to mitigate this hazard.

Haz3: Yellow-breasted chat is vulnerable to nest parasitism by brown-headed cowbird. Brown-headed cowbird parasitism is related to habitat patch size; areas with smaller patches (i.e. greater habitat fragmentation) suffer greater levels of nest parasitism. Brown-headed cowbird parasitism also is related to the proximity of livestock to the chats' breeding sites. Control of

brown-headed cowbirds may be considered in riparian areas near farms and ranches if rates of parasitism exceed 20%.

Haz4: Nest predation by corvids, snakes, squirrels, and raccoons is also a larger problem in small patches of riparian vegetation than it is in larger patches. These predators are less common and alternate prey is more abundant in large patches. Loss of riparian vegetation intensifies predation, and restoration of riparian vegetation mitigates some of the effects of predation on yellow-breasted chat.

Reproduction

The nesting success of individual pairs depends upon successful return from the wintering area, availability of nest sites and mates, and abundance of arthropods and fruit. Weather conditions affect successful migration, the state of the ecosystem on which the prey base depends, and the prey base directly. The destruction of riparian vegetation and channel and flow modifications, improper vegetation management, and improper pesticide applications in adjacent fields all impact the health of riparian ecosystems. Integrated management for agricultural production and riparian health is necessary for successful reproduction in the yellow-breasted chat.

Dispersal

Dis1: Yellow-breasted chat apparently exhibits little site fidelity except where breeding habitat is extremely limited. Because the birds are not dispersal limited, restoring healthy riparian ecosystems throughout the planning area should result in increased yellow-breasted chat populations.

Migration

Mig1: In winter, the yellow-breasted chat migrates to Mexico and Central America. The weather and habitat conditions along their migratory route and in their wintering areas are critical to the yellow-breasted chat's survival. These issues are beyond the County's direct control.

Summary

The restoration of healthy riparian ecosystems is necessary for the recovery of yellow-breasted chat in Placer County. Such ecosystems have large patches of vegetation containing several layers, a diversity of arthropods and fruit, and brown-headed cowbirds and predatory "edge species" are not abundant. The restoration of healthy riparian vegetation requires the restoration of a functional floodplain that in turn requires different management of water storage and diversion structures. Integrated management for both agricultural production and biodiversity conservation in riparian zones should be implemented.

Yellow-breasted chat, *Icteria virens*

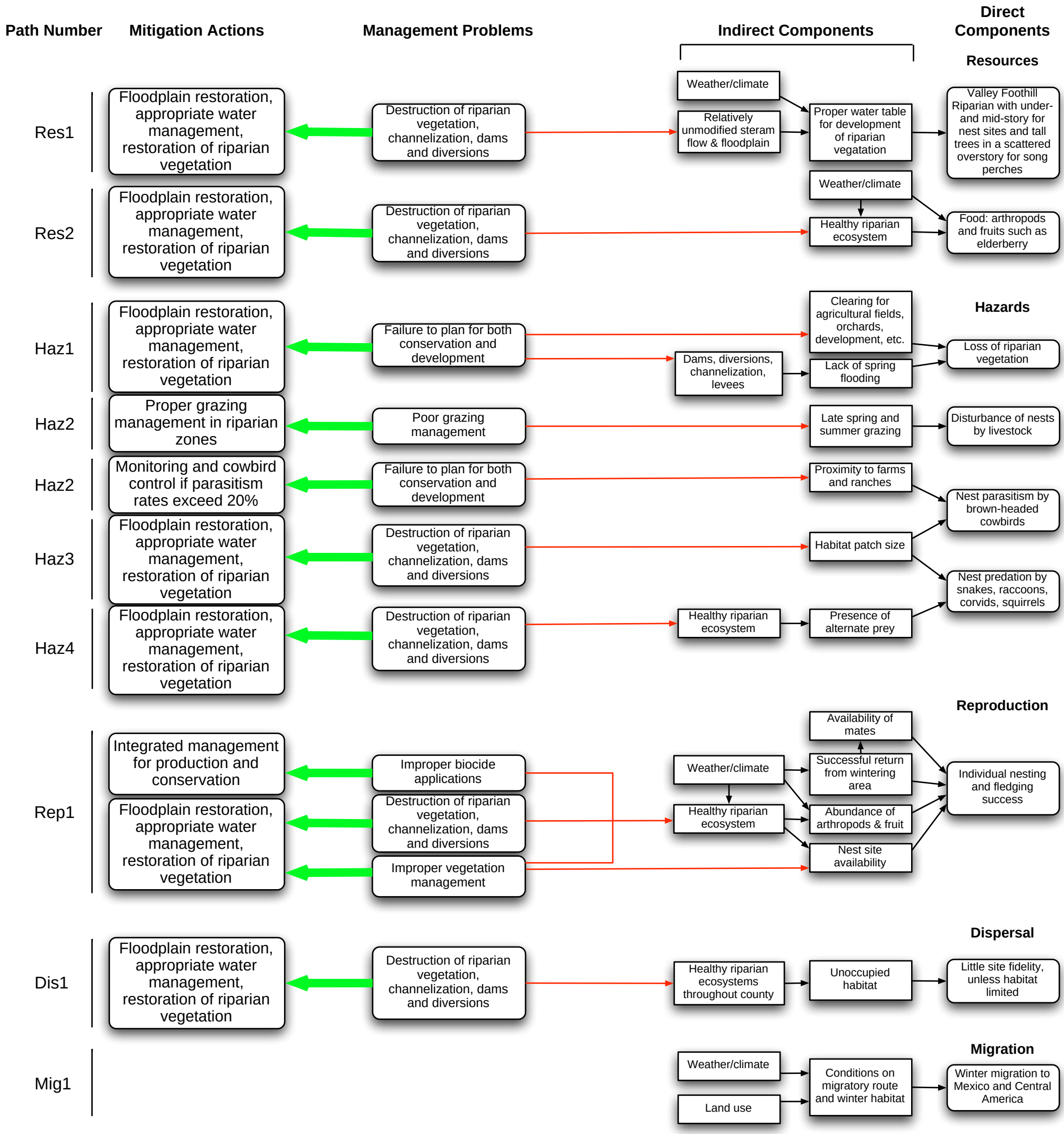

Figure 1. Envirogram. Key to abbreviations: Res = Resources; Haz = Hazards; Rep = Reproduction; Dis = Dispersal; Mig = Migration.

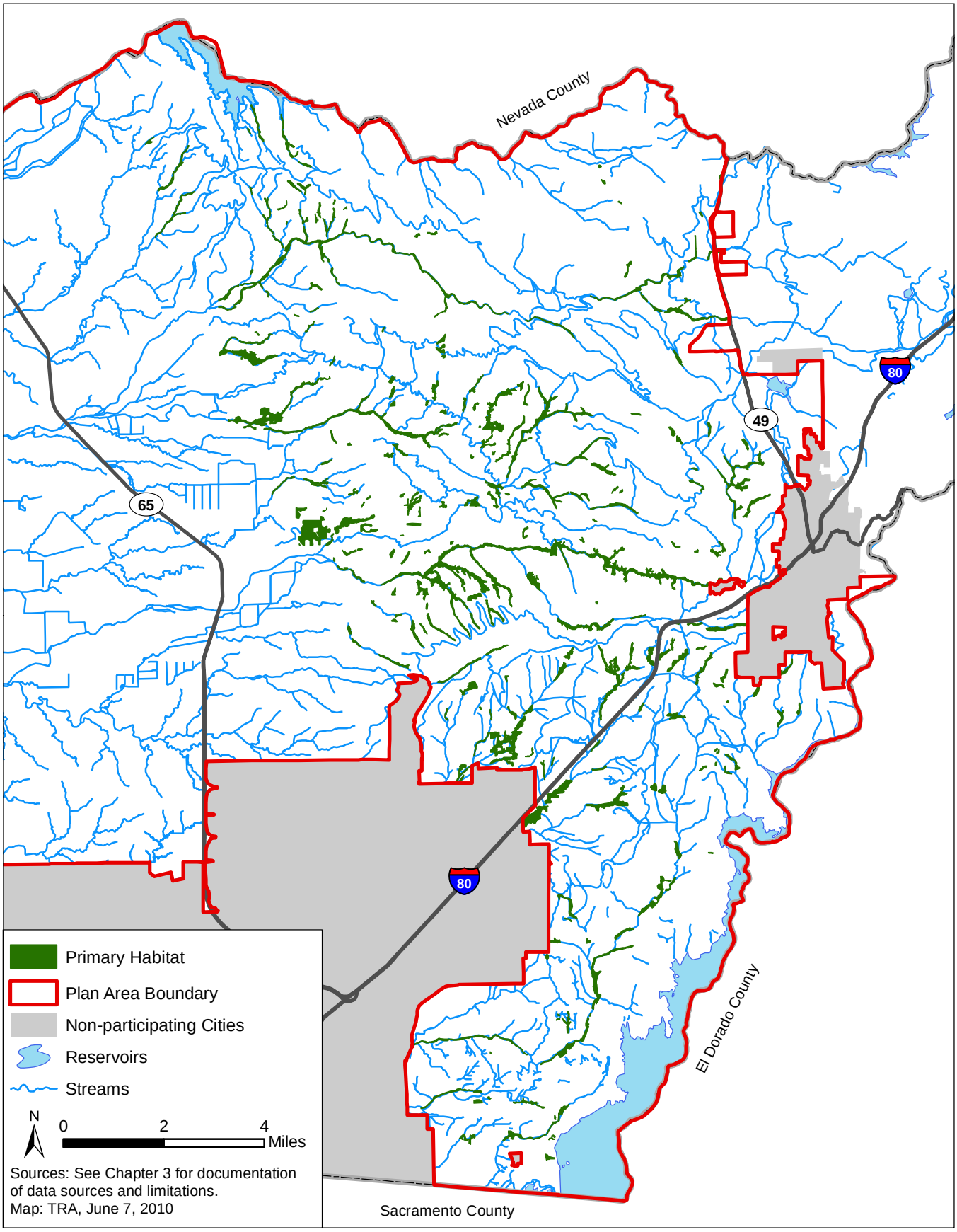

Figure 2. Yellow-breasted chat modeled habitat distribution. The habitat map present outcomes of the draft model described above. The purpose of the model is to identify areas within the Plan area where the species occurs or could occur based on known habitat requirements. Those data on which this map is based are regional in scale. This map should not be used for site planning and should be verified in the field.