California Freshwater Shrimp
(Syncaris pacifica)

5-Year Review:
Summary and Evaluation

Photo: Larry Serpa

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

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5-YEAR REVIEW

California freshwater shrimp (*Syncaris pacifica*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

The California freshwater shrimp (*Syncaris pacifica*) is a decapod crustacean of the family Atyidae and is believed to be the only extant species of the genus. They are generally less than 50 millimeters (2.17 inches) (Eng 1981) in postorbital length (from eye orbit to tip of tail). Females are generally larger than males by the time they reach sexual maturity, at the end of the second summer. Juveniles and males typically appear translucent to nearly transparent while mature females are often brown with a tan dorsal stripe. They are found in low elevation, low gradient, freshwater, perennial streams in Marin, Napa, and Sonoma counties, California. During the winter, habitat includes shallow margins of stream pools containing undercut banks and exposed living fine-root material that provide shelter and refuge from high water velocities associated with winter storm events. During the summer months, California freshwater shrimp are often associated with submerged leafy branches. It is believed both winter and summer habitat components need to be found in close proximity in order for this species to persist for prolonged periods.

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO), following the Region 8 guidance issued in March 2008. We used information from the Recovery Plan for the California Freshwater Shrimp (Service 1998), the 2007 5-year status review (Service 2007), survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database (CNDDB) maintained by the California Department of Fish and Game (CDFG). Personal communications with experts, published literature, biological

assessments, and government agency reports were the primary sources of information used to update the species' status and threats. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Lead Field Office: Josh Hull, Recovery Division Chief, Sacramento Fish and Wildlife Office; (916) 414-6600.

Federal Register (FR) Notice Citation Announcing Initiation of This Review:

A notice announcing the initiation of the 5-year review of this taxon and the opening of a 60-day comment period to receive information from the public was published in the Federal Register (Service 2011). We did not receive any comments from the public specific to the California freshwater shrimp.

Listing History:

Original Listing:

FR Notice: Federal Register 53:43884-43889
Date of Final Listing Rule: October 31, 1988
Entity Listed: California freshwater shrimp (*Syncaris pacifica)*
Classification: Endangered

State Listing:

Syncaris pacifica was listed as endangered by the State of California on October 2, 1980.

Associated Rulemakings: None.

Review History:

A 5-year review was conducted for the California freshwater shrimp dated December 2007 (Service 2007), at which time no change in the species status was recommended.

Recovery Priority Number at Start of 5-Year Review:

The recovery priority number for the California freshwater shrimp is 8C according to the Service's 2010 Recovery Data Call for the Sacramento Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates this taxon is a species, faces a moderate degree of threat, has a high potential for recovery, and there is, or may be, some degree of conflict between recovery efforts and economic development.

Recovery Plan or Outline:

Name of Plan or Outline: Recovery Plan for the California Freshwater Shrimp (*Syncaris pacifica* Holmes 1895)

Date Issued: July 1998

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy:

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. This definition of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. Because the species under review is an invertebrate and the DPS policy is not applicable, the application of the DPS policy to the species' listing is not addressed further in this review.

Information on the Species and its Status:

Species Biology and Life History: The California freshwater shrimp is a decapod crustacean of the family Atyidae and is presumably the only extant species of the genus (Hedgpeth 1968). In addition to *Syncaris pacifica*, one other species has been placed in the genus, *S. pasadenae*. The last recorded collection of *S. pasadenae* was in 1933 from San Bernardino County, California. Due to the loss of habitat from urban and water development activities in southern California, the species is probably extinct (Hedgpeth 1968). The California freshwater shrimp is readily distinguished from other shrimp species that occur in California by the family characteristics of terminal tufts of setae (hair-like structures) on the chelae (claws) of the first and second pereiopods (walking legs) (Hedgpeth 1975). In addition, they have a supraorbital spine (small spine on the carapace (backshield) above the eye), a long-slender rostrum, and exopods (oar like outer branches of the thoracid legs) on all pereiopods except the last pair. They are generally less than 50 millimeters (2.17 inches) (Eng 1981) in postorbital length. Females are generally larger than males by the time they become sexually mature at the end of the second summer. Based on specimens collected in October, Eng (1981) described females ranging between 32 to 45 millimeters (1.3 to 1.8 inches) in length, whereas males ranged from 29 to 39 millimeters (1.2 to 1.5 inches) in length. Coloration is quite variable, with males and juvenile females being

translucent to nearly transparent, while mature females can be brown with a tan dorsal stripe. They have small surface and internal chromatophores (pigment-containing and light-reflecting cells) clustered in a pattern to help disrupt their body outline and to maximize the illusion that they are submerged, decaying vegetation.

The reproductive ecology of the California freshwater shrimp has not been formally described. Reproduction seems to occur once a year. Based on the reproductive physiology and behavior of other marine and freshwater shrimps, the male probably transfers and fixes a sperm sac to the female immediately after her last molt, before autumn. Courtship and mating behavior have not been described. The timing of mating has been deduced from the presence of egg bearing females starting in September (Born 1968; Eng 1981). By November, Serpa (1991) noticed that most adult females in Huichica Creek bear eggs. Adult females produce relatively few eggs, generally, 50 to 120 (Hedgpeth 1968; Eng 1981). The eggs adhere to the pleopods (swimming legs on the abdomen) where they are protected and cared for during the winter incubation. Young are released in May or early June and are approximately 6 millimeters (0.24 inch) in length (Eng 1981). No information is available on the percentage of larvae that reach reproductive maturity.

Newly hatched young (post larvae) grow rapidly and reach 19 millimeters (0.75 inch) in length by early autumn of their first year (Eng 1981). Growth slows through the fall, winter, and early spring, and then increases through the second summer (Messer and Brumbaugh 1989). A size difference between males and females is apparent at the end of the second summer (Messer and Brumbaugh 1989). Larger female size is consistent with characteristics of other freshwater shrimp (Neilsen and Reynolds 1977). California freshwater shrimp reach sexual maturity by the end of their second summer of growth (Eng 1981).and may live longer than 3 years (Eng 1981). Sex ratios were reported in the recovery plan as having a wide variation and reported values ranging from 1.11:1 (male to female) to 1.39:1 (Service 1998). Based on capture data from six reaches of Lagunitas creek during seven years of surveys conducted from 1991 to 2000, Serpa (2002) found that the male to female sex ratios ranged from 1.3:1 to 2.6:1 and the juvenile to adult ratio ranged from 0.9:1 to 4.6:1,

Spatial Distribution: At the time the California freshwater shrimp was listed (Service 1988), 12 streams were known to support populations and four streams once known to support the populations were believed to have been extirpated (Table 1). A population was rediscovered in Stemple Creek by the time the recovery plan was issued (Service 1998). According to Hedgpeth (1968), Atascadero Creek and Laguna de Santa Rosa, two streams cited as being extirpated at the time of listing, supported small and sporadic populations that may not occur there every year, but may be a result of infrequent migrations from connecting streams. Extant populations are now known from tributaries to these two streams, Jonive Creek and Blucher Creek, respectively. Despite surveys over the past 35 years, California freshwater shrimp have not been rediscovered in Santa Rosa Creek since the 1960s and are now believed to be extirpated (B. Cox, personnel communication 2011).

The majority of recent survey information on the California freshwater shrimp is the result of independent surveys for various projects. These surveys have resulted in an increase in the number of streams known to support populations of the species, but do not represent a uniform

effort to examine the current spatial distribution throughout its range. In addition to the 17 streams noted in the recovery plan (Service 1998), the species is now known from Bud Creek (Serpa 2004), Fallon Creek, Franz Creek , Ebabias Creek, an unnamed tributary of Huichica Creek (CNDDB 2011), and Cheda Creek (Fong 2004) (Table 1). Of these new streams, Ebabias and Franz creeks are most significant because they are within watersheds that are relatively disconnected from other streams known to support the species.

Abundance: Long term population trends are only available for the Lagunitas and Olema creek populations. The number of individual California freshwater shrimp collected at six sites in Lagunitas creek increased from approximately 1,878 in 1991 to approximately 4,407 in 2000 (Serpa 2002). The increased numbers followed an increase in the amount of available habitat in 1997. Continuing changes in the stream's morphology resulted in increased water flows that have improved and/or increased habitat conditions in some areas, but worsened and/or decreased habitat in other areas. Although the species has been found in 11 additional streams since it was listed in 1988, they may be rare in some of these newly discovered streams or the additional stream is tributary to an already known population and represents only a slight increase in the distribution of the species within the watershed. For example, fewer than 10 individuals were captured in Olema Creek, all within 0.6 mile (1.0 kilometer) of its confluence with Lagunitas Creek, during surveys conducted in six of eight years from 1996 to 2004 (Martin et al. 2009), and only one shrimp was collected from Cheda Creek in 2002, and none were detected during subsequent survey efforts (Fong 2004).

Habitat or Ecosystem: The California freshwater shrimp is a true freshwater shrimp, inhabiting freshwater streams in Napa, Sonoma, and Marin counties California. The Mediterranean climate regime of this area is characterized by two distinct seasons: a rainless and relatively warm season from May to October followed by a relatively cool rainy season from November to April. Snow accumulation in watersheds inhabited by this species is low to absent, thus little water input into streams inhabited by the species is due to snow melt. As a result, water discharge on unimpounded streams is highly variable between seasons, with high stream discharges associated primarily with periods of heavy rain in the winter. It is not clear if the California freshwater shrimp depends on high winter flows to complete its lifecycle or if the species has simply adapted to survive high winter flows. In times of heavy discharge accompanying storm events, they avoid excessive flows by clinging to fine root material beneath undercut stream banks where velocities are reduced. According to B. Cox (personnel communication 2011), the amount of undercut stream banks with living fine root material that provides refugia from excessive flow during winter storm events is the primary limiting habitat feature for California freshwater shrimp. During the summer dry season, the species is often associated with submerged vegetation and vegetation that hangs into the water. During an excessively dry period, Serpa (1991) found California freshwater shrimp in Huichica Creek surviving in pools that no longer has surface flow (Serpa 1991).

California freshwater shrimp have not been found in salt or brackish water and are not known to inhabit intertidal or estuarine areas (Born 1968). Until the discovery of a population in Franz Creek at 176 meters (580 feet) elevation in 1999, none had been found above 116 meters (380 feet) elevation. They are typically found in low gradient (less than 1 percent) stream reaches, away from the main current, along the edges of 1 to 4 feet (0.3 to 1.2 meter) deep stream pools

that are structurally diverse with undercut banks, exposed adventitous root material, or overhanging vegetation (Eng 1981; Serpa 1991). Based on a study of the habitat requirements in Lagunitas and Olema creeks, the species is most likely to occur in relatively slow water current velocities, with bottom substrates dominated by sand, and moderate amounts of overhanging vegetation, emergent vegetation, and fine roots (Martin et al. 2009). The authors go on to speculate that all of these key habitat characteristics need to persist in relatively close proximity, creating a unique microhabitat (Martin et al. 2009).

Water temperatures of 7 to 16 degrees Celsius (45 to 61 degrees Fahrenheit), dissolved oxygen concentrations of 3.3 to 12.3 milligrams per liter, and pH values of 5.9 to 9.1 were reported from monitoring stations established along six different streams that support California freshwater shrimp (Messer and Brumbaugh 1989). Martin et al. (2009) note that although published information on water quality tolerance is lacking, experiments conducted with other freshwater shrimp species in the family Atyidae suggest that the relatively low minimum concentrations of dissolved oxygen they observed in Olema Creek (1.4 to 1.9 milligrams per liter), approached or exceeded concentrations causing acute mortality under laboratory conditions, and may explain the lack of California freshwater shrimp they observed in Olema Creek during their study.

Changes in Taxonomic Classification or Nomenclature: Holmes (1895) first described the California freshwater shrimp and placed the species in the genus *Miersia*. Subsequently, *Miersia* was removed from the family Atyidae and Holmes (1900) erected the genus *Syncaris* (as cited in Messer and Brumbaugh 1989). A review of the genus *Syncaris* by Martin and Wicksten (2004) redescribed the freshwater Atyid shrimp group in California to which *Syncaris pacifica* belongs. The redescription primarily focused on the lack of detailed descriptions for both *S. pacifica* and *S. pasadenae*. Martin and Wicksten (2004) provided a detailed morphological description of both *S. pacifica* and *S. pasadenae*. However, the review did not result in a change in the taxonomy of either species, but recommended the retention of their current taxonomy based on morphological differences (Martin and Wicksten 2004).

Genetics: Preliminary genetic analysis on approximately 12 individuals (L. Serpa, personnel communication 2006) from eight streams indicates populations can be divided into distinct groups based on genetic similarities from mitochondrial DNA (K. Roe, personnel communication 2006); these tentative data suggest genetic variation between populations may not correspond to the drainage units identified in the recovery plan.

Species-specific Research and/or Grant-supported Activities: We are only aware of one species-specific research paper that has been published since the last 5-year review was conducted for this species, Martin et al. (2009). Martin et al. (2009) randomly sampled reaches (glides, pools, and riffles) of Lagunitas and Olema creeks to compare physiochemical, morphometry, and sediment sizes. The results of their study found that California freshwater shrimp were most numerous in glide (64%), then pools (31%), and lastly in riffles (5%). Important habitat variables included submerged portions of streambank vegetation (overhanging vegetation, emergent vegetation, and fine roots), low water current velocity, and sandy substrate.

A number of restoration projects undertaken by the Bay Institute, through the Students and Teachers Restoring a Watershed (STRAW) program, have been implemented on Stemple Creek since 1993; these projects have focused on removing nonnative vegetation, planting native species, erecting livestock exclusion fencing, and installing cattle bridges (L. Rogers, communication 2006). According to Martin et al. (2009), by 1999 California freshwater shrimp had re-colonized a reach of Stemple Creek even though Hedgpeth (1975) suggested the creek was too severely altered to be rehabilitated. The STRAW project has completed more than 185 projects along over 50,000 linear feet of stream bank. The Service's Partners for Fish and Wildlife Program has provided some funding for these restoration efforts; in these instances contracts for continued management of the properties for the benefit of wildlife are in place, but the contracts will eventually expire and do not represent long term protection (D. Strait, personnel communication 2006).

Five-Factor Analysis:

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range:

At the time the California freshwater shrimp was listed (Service 1988), we identified livestock, agricultural activities and development, residential development, water pollution, heavy earthmoving equipment, water diversions, temporary summer dams and associated chemical purification of impounded water, siltation from poor soil conservation practices, silvicultural practices, and flood control and channelization as threats to California freshwater shrimp habitat. In the recovery plan, we also identified gravel mining, water development, and urban runoff as threats (Service 1998). The 2007 5-year status review (Service 2007) included all of the threats defined above and did not identify any additional Factor A threats. At this time, all of the above mentioned threats continue to threaten the species. In addition to these threats, salmonid habitat restoration represents a temporary threat to the species.

Livestock Grazing: Incompatible grazing and dairy operations currently represent significant threats to the species. Grazing activities may destroy California freshwater shrimp habitat through the removal of riparian vegetation, adverse bank and channel changes, decreased water quality due to runoff from manure lots, increased sediment loads, change in runoff characteristics, and increased water temperatures due to a reduced riparian canopy. When livestock are not excluded from riparian areas, grazing animals typically concentrate along watercourses, particularly during the summer when the creek and adjacent riparian areas offer the livestock water and palatable forage. Extended foraging along the creek results in the loss of vegetation, trampled stream banks, and increased stream bank erosion. In addition, runoff from manure lots following storms and direct inputs increase nutrient levels and result in high production of algae. Algal blooms cause oxygen supersaturation during the day and result in oxygen depletion at night because of respiration and decomposition (Goldman and Horne 1983). Ammonia is also a threat as a result of grazing and dairy operations, which are sources of nitrogenous wastes. Ammonia is present in an un-ionized form (NH_3) and an ionized form

(NH_4+) and both forms result in mortality of aquatic organisms. For example, the 1998 California Water Quality Assessment Report published by the California State Water Resources Control Board lists 17 miles of Stemple Creek as an impaired water body (Natural Resource Conservation Service 2002). The assessment report identifies runoff from pasture lands and manure lagoons as the sources of consolidation of ammonia and the reason for low dissolved oxygen levels. In addition, there is little or no riparian vegetation along 70 percent of Stemple Creek due to clearing, cultivation, and year-round heavy grazing, resulting in stream bank erosion (Natural Resource Conservation Service 2002). As noted in Martin el al. (2009), dissolved oxygen concentration in Olema Creek may occasionally be too low for high survival of California freshwater shrimp and suggest the differences in water quality they observed between Lagunitas and Olema creeks is related to land-use practices; whereby grazing is not allowed in most of the Lagunitas Creek watershed and is allowed in the Olema Creek watershed.

Summer Dams: The construction of summer dams (temporary dams constructed for recreational activities such as swimming and fishing during the summer) adversely affects California freshwater shrimp in several ways, including: (1) crushing individuals due to construction; (2) inundating habitat; (3) serving as a barrier to movement; (4) altering flow patterns (Service 2003), and 5) increasing sedimentation and siltation downstream when dams are washed out during high winter flows. Impoundments raise the elevation of the inundation zone, drowning the roots of riparian vegetation not adapted to periods of prolonged inundation, and likely reduce riparian vegetation in the area. Lack of riparian vegetation harms shrimp by reducing habitat complexity, increasing the potential for bank scour, reducing detritus production, and eliminating high flow refugia. In a 1985 public notice on summer dams, the U.S. Army Corps of Engineers (Corps) determined that water velocities upstream of dams are reduced and suspended sediments settle out. Gravel and soil then fill pools, glides, and the spaces between cobbles and boulders by as much as 6 inches (Corps 1985), which reduces foraging areas and cover and increase predation.

The Murray Dam Commission (MDC) submitted an application to the Corps in 1998 for a five-year permit to construct a summer dam on Austin Creek in Sonoma County, California. The proposed summer dam would have been located approximately five miles from the confluence of Austin Creek and the Russian River. The Corps denied the MDC's permit, but the MDC appealed the determination. The South Pacific Division of the Corps concluded the appeal had merit and remanded the application to the San Francisco Corps District for additional review. The Corps reinitiated consultation with the Service on the proposed summer dam in 2000 and the Service issued a biological opinion on the project in 2002. However, according to the Corps, the permit was not authorized and no new information is available regarding the status of this permit application (P. Straub, personnel communication 2006).

The Service has objected to the construction of summer dams in the Austin Creek watershed since 1985. In 1990, the Service issued a biological opinion in relation to the existing summer dam program to the Cazadero Dam Committee and recommended a moratorium on all dams in the creek (Service 2003). Included in the project description was a commitment from the Corps to reduce the number of dams each year, with no more dams authorized after 1995. The Murray dam has been constructed illegally at least once (and possibly twice) since the expiration of the 1990 permit (Service 2003).

Gravel Mining: Gravel mining can alter natural channel geomorphology (Collins and Dunne 1990). In addition, long term gravel mining on point bars and inside bends restricts the development of vegetation, which can remove habitat in new areas of mining and preclude the establishment of vegetation in areas that experience repeated disturbance as a result of gravel mining. To date, no specific studies have been conducted to determine the extent of the affects of gravel mining on populations of the shrimp.

Salmonid Habitat Restoration: Over the past several years, the Service has issued several biological opinions authorizing incidental take of California freshwater shrimp for projects designed to restore salmonid habitat. These projects often focus on increasing in-stream habitat complexity for juvenile salmonids through the input of large woody debris structures. Installing large woody debris often involves dewatering the stream and anchoring the woody debris to the stream bed and/or bank. If the habitat requirements of the California freshwater shrimp are not properly taken into consideration, the installation of these structures can alter or destroy California freshwater shrimp undercut bank habitat and dewatering the stream results in a temporary loss of habitat. Due to the lack of adventitious roots, the installation of large woody debris structures should not be considered self-mitigating for the loss of undercut stream banks, because large woody debris does not provide the California freshwater shrimp with refugia from high velocity stream flows associated with winter storm events (B. Cox, personnel communication 2011). According to B. Cox (personnel communication 2011), California freshwater shrimp habitat has not been successfully created and it would likely take a decade or more for areas properly restored to form undercut stream banks with mats of living fine root material capable of providing high flow winter refugia habitat for the species.

Water Development Activities: Water developments, such as impoundments that are intended to reduce flooding, provide for recreation, and provide water for municipalities would result in similar affects to the shrimp as summer dams. However, the affects from these activities would be long term. The Marin Municipal Water District has developed several water storage and diversion facilities on Lagunitas Creek and Nicasio Creek, a major tributary (Smith 1986). The construction of two reservoirs, Kent Lake and Nicasio Reservoir, likely resulted in a significant loss of California freshwater shrimp habitat upstream of the dams. In addition, water storage facilities serve as continual sources of introduced fishes, and operations of storage facilities tend to eliminate normal high discharges that can flush introduced sunfish from the system. Operation of these facilities changes natural hydrology and sediment transport within Lagunitas Creek. During drought years, natural reductions in flow combined with water exports could result in losses to shrimp populations, therefore, scheduled water releases from reservoirs and minimum flows must be maintained. Smith (1986) also notes that occasional high winter flows are necessary to maintain undercut banks and pools and that fluctuating summer flows could be detrimental to California freshwater shrimp populations.

Groundwater pumping and water diversions for the purpose of vineyard and other agricultural irrigation and for the purpose of frost protection represent a moderate threat. The proximity of vineyard and orchard blocks to many watersheds inhabited by California freshwater shrimp allows for easy access to surface diversions and has been found to result in instantaneous reductions in flow during the frost protection season. During a spring frost, multiple landowners may divert water from a single watercourse causing a rapid decrease in stream flow. These

diversions may strand California freshwater shrimp in pools. Groundwater pumping may reduce base flows and reduce the extent of riparian habitat. The effects of water diversion and groundwater pumping are greatly increased by drought or below normal seasonal rainfall.

Residential Development: Residential development was defined as a threat at the time of listing due to encroachment on stream banks and increasing the need for flood control activities and bank stabilization. According to Hedgpeth (1968), the population in Santa Rosa Creek at the City of Santa Rosa was extirpated by an urban renewal project which converted the stream into a large square culvert that now runs beneath the city. Although urban development is known to have resulted in the direct destruction of habitat and was listed as a threat at the time of listing, we are unaware of the direct loss of California freshwater shrimp habitat from new urban development over the past several decades. However, the development of residential streamside parcels, which increases the need for flood protection and bank stabilization and increases runoff from household non-point source pollutants (see pollutants), still occurs and remains a moderate threat to the species.

Pollutants: Urban development creates impervious surfaces that increase the amount of runoff from non-point source pollutants as well as increased sedimentation. The sources of pollutants vary, ranging from runoff from housing developments, golf courses, as well as the disposal of paints, petroleum products (i.e., automotive fluids), and household cleaning agents into storm drains. Hedgpeth (1975) cited spillage of chlorinated swimming pool waters as a major problem in shrimp streams. The acute and sublethal effect of these pollutants on shrimp populations is not known. Continued urban development is expected to result in decreased stream water quality.

We are aware of two contaminants spills that have adversely affected California freshwater shrimp. According to Martin et al. (2009), a pesticide spill of Korlan 2 (used to control ectoparasites for livestock) occurred in 1993, causing a large fish kill on Olema Creek. The authors note that in addition to the pesticide spill, several factors may explain the lack of California freshwater shrimp captured in Olema Creek during their study, including channel straightening, levee construction, and grazing (Martin et al. 2009). In January 2011, 55,000 to 60,000 gallons (208,000 to 227,000 liters) of aluminum sulfate (used to purify drinking water) in a semi-solid state, was accidently released into Sonoma Creek from the Sonoma Developmental Center. The material was reported to be approximately 4 to 5 inches (10 to 13 centimeters) thick where the material entered the creek and approximately 3 inches (8 centimeters) thick for about a mile (1.6 kilometers) downstream. The material continued in patches for approximately another 2 miles (3 kilometers) downstream. The area affected by the spill is known to be inhabited by California freshwater shrimp. Aluminum sulfate results in a lower water pH, which may be detrimental to fish and invertebrates. One California freshwater shrimp individual was found dead (K. Haitt, personnel communication 2011). Due to the relatively low number of watersheds inhabited and the unlikely recolonization of a watershed if extirpated; chemical spills, although relatively rare events, represent a significant threat to the recovery of the California freshwater shrimp. The likelihood of a chemical spill affecting the species is greatest where heavily trafficked roads cross or run adjacent to streams inhabited by the species and where facilities that use hazardous chemicals occur in close proximity to streams inhabited by the species. In general, the potential for extirpation is greatest if a chemical spill were to occur high in a

watershed and during low stream flows.

Flood Control: Installation of bank protection generally requires a Corps section 404 permit. Review of bank protection projects in areas containing California freshwater shrimp allows the Service to recommend measures that can protect shrimp and their habitat. However, the Service is aware of at least one bank protection effort constructed without Corps authorization on Garnett Creek. On Garnett Creek, a subdivision placed bank protection in an area known to support California freshwater shrimp. Rock bank protection precludes the development of undercut banks and may reduce the development of riparian vegetation and woody debris. In addition, rock bank protection typically creates scour holes and bank failures upstream and downstream of the bank protection. Loss of natural banks can be expected to increase as greater numbers of developments are built along stream corridors.

Timber Harvesting At the time of listing (Service 1988), we determined that silvicultural practices may have altered hydrologic regimes and in the recovery plan (Service 1998) we determined that silvicultural practices that remove streamside vegetation have and may continue to impact California freshwater shrimp habitat. At this time, the California Department of Forestry and Fire Protection has established watercourse and lake protection regulations to ensure that timber operations do not potentially cause significant adverse site-specific and cumulative impacts to native aquatic and riparian associated species (CalFire 2010). Although the measures established in the regulations do not avoid all potential adverse effects of timber harvest operations, they significantly reduce the threat.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

At the time of listing and the issuance of the most recent 5-year review (Service 1988 and 2007), we determined this factor was not applicable to the California freshwater shrimp. The Service is not aware of any new information that would indicate overutilization for commercial, recreational, scientific, or educational purposes threaten the California freshwater shrimp.

FACTOR C: Disease or Predation

At the time of listing and the issuance of the most recent 5-year review (Service 1988 and 2007), we identified predation by native and non-native fish as a significant threat. Predation remains a threat today.

The recovery plan stated introduced fish, such as green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*Micropterus salmoides*), mosquitofish (*Gambusia affinis*), and various introduced minnows may contribute to the California freshwater shrimp's limited distribution (Eng 1981; Serpa 1991) as a result of predation. Additionally, several native fish species may also prey on the shrimp. Results from stomach content analysis from a study on habitat requirements of the shrimp in Lagunitas and Olema creeks found that prickly sculpin (*Cottus asper*) and riffle sculpin (*Cottus gulosus*) preyed on California freshwater shrimp (Saiki 2006)

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing and the issuance of the most recent 5-year review (Service 1988 and 2007), we identified inadequacy of existing regulatory mechanisms as a threat to the species. This is remains an ongoing threat to the species.

State Protections: The species was listed as endangered by the State of California in 1980. The California Endangered Species Act (CESA) includes a provision against "take" of listed species. Section 86 of the California Fish and Game Code defines "take" as to as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill. Unlike the Act, CESA does not include "harm" or "harass" in the definition of "take." Therefore, effects of a project such as increased sediment load in a stream or increased bank erosion that reduce habitat quality or quantity and result in injury, reduced reproductive success, etc., are not covered under CESA.

The California Environmental Quality Act (CEQA) (chapter 2, section 21050 *et seq.* of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects and to avoid or mitigate them where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the process through public comment. If a project may impact known populations of the shrimp, these affects would be disclosed to the Service and allow the Service an opportunity to comment on the proposed project's effects to this species. Typically, project proponents propose conservation measures to offset or minimize adverse effects to listed species. However, CEQA does not guarantee that such conservation measures will be implemented and it does not cover activities carried out by private parties, unless they require permits by state agencies.

Section 1600 of the California Fish and Game Code authorizes the California Department of Fish and Game to regulate streambed alteration. The California Department of Fish and Game (CDFG) must be notified of and approve any work that substantially diverts, alters, or obstructs the natural flow or substantially changes the bed, channel or banks of any river, stream, or lake. If an existing fish or wildlife resource may be substantially adversely affected by a project, the CDFG must submit proposals to protect the species within 60 days (Section 1602 of the California Fish and Game Code). However, if the CDFG does not respond within 60 days of notification, the applicant may proceed with the work. Mitigation under a streambed alteration agreement is entirely voluntary by a project applicant and is typically agreed upon only when compatible with mitigation required by permits issued by other agencies such as U.S. Army Corps of Engineers or the Regional Water Quality Control Boards. Therefore, this regulation on its own may not provide protection to the shrimp, especially when other agencies do not require mitigation.

The Clean Water Act Section 401 Water Quality Certification and/or Waste Discharge Requirements are regulated by the State of California's Regional Water Quality Control Board. Anyone proposing to conduct a project that requires a Federal permit and involves dredge or fill activities that may result in a discharge to U.S. surface waters and/or "Waters of the State" are required to obtain a Clean Water Act Section 401 Water Quality Certification and/or Waste

Discharge Requirements permit. However, if a proposed project does not require a Federal permit, but does involve dredge or fill activities that may result in a discharge to "Waters of the State", the Regional Water Quality Control Board has the option to regulate the project under its state authority (Porter-Cologne) in the form of Waste Discharge Requirements or Waiver of Waste Discharge Requirements. However, since this is not a requirement, this regulation may not afford the shrimp protection.

Federal Protections: The Act is the primary Federal law providing protection for this species. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize adverse affects to listed species associated with a project. In addition to section 7(a)(2) of the Act, incidental take of listed animal species can be authorized for activities carried out by non-Federal agencies through section 10(a)(1)(B) of the Act. Section 10(a)(1)(B) requires non-Federal applicants to submit a conservation plan specifying the impact which will likely result from the take and what steps the applicant will take to minimize and mitigate such impacts.

The National Environmental Policy Act (NEPA) provides some protection for the California freshwater shrimp. For activities undertaken, authorized, or funded by Federal agencies, NEPA requires the project be analyzed for potential impacts to the human environment prior to implementation (42 U.S.C. 4371 *et seq*.). In instances where that analysis reveals significant environmental effects, the Federal agency must propose mitigations that could offset those effects (40 CFR 1502.16). However, NEPA does not require that adverse impacts be fully mitigated, therefore some impacts could still occur. Additionally, NEPA is only required for projects with a Federal nexus, and therefore, actions taken by private landowners are not required to comply with this law.

Under section 404 of the Clean Water Act, the Corps regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term "wetland" refers to areas meeting the Corps' criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands).

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

When the California freshwater shrimp was listed and the last 5-year review was conducted (Service 1988), we identified environmental extremes, vandalism and silviculture as factor E threats (see Factor A for threats analysis of silvicultural practices). In addition to these threats, the last 5-year status review included climate change as a threat. For several populations of the species, small population size could be a threat. No new cases of vandalism have been reported to the Service since 1987.

Climate Change and Environmental Extremes: Although climate change was not specifically addressed in the recovery plan, the listing rule stated that environmental extremes, specifically drought and spring floods, were threats and could influence the stability of California freshwater shrimp populations. Climate change forecasts vary in their predicted outcomes, and range from cooler and drier to warmer and wetter (Leung and Ghan 1999; Miller *et al.* 2003; Deffenbaugh *et al*. 2005), which makes it difficult to adequately assess the effects climate change may have on California freshwater shrimp populations.

Reduced precipitation (drought) and increased temperatures could have two compounding effects on the California freshwater shrimp. First, reduced rainfall and increased temperatures would result in lower stream flows through reduced runoff and increased evaporation, thereby increasing the likelihood that stream segments dry out during the summer months; this could result in local extirpations and further isolate populations of the shrimp. The listing rule stated natural events (such as drought) devastate populations of the California freshwater shrimp because the current loss of habitat makes it difficult for this species to repopulate affected areas. A second, but compounding factor would be an increase in water demand for household and agricultural purposes, which could further reduce stream flows and increase the likelihood that stream segments harboring the species dry out.

According to Cayan et al. (2009), under medium to medium-high emissions scenarios, mean sea level along the California coast will rise from 1.0 to 1.4 meters by the year 2100. Sea level rise may result in higher salinities in the lower reaches of streams with populations of California freshwater shrimp. This increase in salinity is likely to reduce the overall amount of habitat available to the species since they have not been found in salt or brackish water and are not known to inhabit intertidal or estuarine areas (Born 1968). Under laboratory conditions, Born (1968) determined that shrimp were able to osmoregulate (balance internal fluids) at salinities less than 17 parts per thousand (ppt). However, Hedgpeth (1968), who also observed shrimp surviving at 16 and 17 ppt for up to 13 days, found that mortality occurred after seven hours at higher salinities.

Small Population Size: Several populations of California freshwater shrimp are threatened by small population size. This threat is greatest for the species in isolated watersheds where immigration and emigration is improbable. For example, as the result of severe drought, the entire Huichica Creek population consisted of approximately 500 individuals in 1983, including adults and juveniles (Serpa 1991). Small populations may be subject to inbreeding depression and genetic drift, and also to chance extinction from stochastic environmental and demographic incidents (Gilpin and Soulé 1986; Goodman 1987; Shaffer 1987).

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently,

and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed (or since the most recent 5-year review) by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

At the time the recovery plan was finalized, the California freshwater shrimp was known from 17 streams (Service 1998). The species is now known from 23 streams (Table 1). The existing recovery criteria do not address the recovery role of California freshwater shrimp populations discovered after the issuance of the 1998 Recovery Plan.

Downlisting Criterion #1. "A watershed plan has been prepared and implemented for Lagunitas Creek (including Olema Creek), Walker Creek (including Keys Creek), Stemple Creek, Salmon Creek, Austin Creek (including East Austin Creek), Green Valley Creek (including Atascadero, Jonive, and Redwood Creeks), Laguna de Santa Rosa (including Santa Rosa and Blucher Creeks), Sonoma Creek (including Yulupa Creek), Napa River (including Garnett Creek), and Huichica Creek." This criterion implicitly addresses factors A, C, D, and E.

Is Criterion Still Valid: Yes. Formal watershed assessments, watershed enhancement programs, and watershed management plans have been conducted or developed, primarily by local Resource Conservation Districts (RDC) and watershed councils, for most of the watersheds that support California freshwater shrimp. The primary purpose of these plans is to increase water quality for humans and salmonids. To accomplish this, these plans and programs most often promote riparian habitat restoration, reduced sedimentation from roads and other sources, and environmentally friendly grazing practices. Although many of these plans and programs do not specifically propose or implement recovery actions for the California freshwater shrimp and have not been reviewed by the Service, many of them acknowledge the presence of this species within the watershed and describe its habitat requirements. The implementation of the vast majority of the goals of these plans and programs will, over several decades, result in improved habitat quality and quantity for the California freshwater shrimp.

To date, watershed management and/or enhancement plans have been developed for all streams known to be inhabited by the California freshwater shrimp, except Austin, East Austin, and Franz Creeks: Lagunitas, Olema, and Cheda creeks (Tomales Bay Watershed Council 2003), Walkerand Keys creeks (Prununske Chatham, Inc. 2001),Stemple and Fallon creeks (Prununske Chatham, Inc. 1994), Santa Rosa and Blucher creeks (Honton and Sears 2006), Salmon Creek (Prununske Chatham, Inc. and Gold Ridge RCD 2010), Sonoma and Yulupa creeks) (McKee et al. 2000), the northern Napa River and Garnett Creek (Koehler 2002), Huichica Creek (Koehler and Edwards 2009), Ebabias Creek (Gold Ridge RCD 2007), and Green Valley, Atascadero, Jonive, and Redwood creeks (Gold Ridge RCD 2010). Although watershed management plans

have not been developed, watershed assessments have been conducted for Austin and East Austin creeks (Laurel Marcus and Associates 2005) and Franz Creek (Laurel Marcus and Associates 2004). These watershed assessments include recommendations for future restoration efforts to enhance and improve water quality, riparian vegetation, and salmonid habitat.

The development of watershed plans for all but three streams inhabited by California freshwater shrimp represents significant progress in the fulfillment of this recovery criterion. However, even though the above watershed plans have been developed, landowner participation is voluntary and there are no mechanisms for determining what level of implementation, if any, has or will occur. Additionally, none of the watershed plans were developed in conjunction with the Service or reviewed by the Service and may not include the level of threats reduction necessary to delist or downlist the species.

Downlisting Criterion #2. "Long term protection is assured for at least one shrimp stream in each of the four drainage units." This criterion implicitly addresses factors A, C, D, and E.

Is Criterion Still Valid Yes. Approximately seven miles of Lagunitas Creek flows through Samuel P. Taylor State Park (managed by the California Department of Parks and Recreation) and the Golden Gate National Recreation Area (managed by the National Park Service) (Service 1998). A small portion of Salmon Creek flows through lands managed by the Sonoma County Department of Parks and Recreation (Watson School Historic Park) (Service 1998). The Austin Creek State Recreation Area is immediately upstream of several known California freshwater shrimp populations on East Austin Creek (Service 1998). A small portion of Sonoma Creek flows through land owned by the State Land Commission. To date, Lagunitas Creek is the only California freshwater shrimp stream that is assured significant long term protection because it is on public lands. The Service is not aware of any other progress towards attaining this criterion since the last 5-year review was conducted.

Downlisting Criterion #3. "The abundance of California freshwater shrimp approaches carrying capacity in each of 17 streams." This criterion implicitly addresses factors A, C, and E.

Is Criterion Still Valid No. Carrying capacity (K) has been defined differently by different authors. Lampert and Sommer (1997) define K as "the upper limit of population density in a given ecosystem." Others have discussed K as the maximum number of individuals an area can support. The K-value of a given stream is a function of numerous environmental factors, including habitat quality, quantity, and availability, predation pressure, food supply, and hydrologic regime. While the intent of maximizing the number of California freshwater shrimp that each of 17 streams is capable of supporting is valid, K is not a fixed value and is subject to change as environmental conditions change. However, if the threats to the species were adequately reduced or managed and habitat quality, quantity, and availability were maximized, the K-value of each stream would also be maximized. As such, to reach a maximum carrying capacity, specific criterion need to be defined to determine when the threats to the species have been adequately reduced or managed and when habitat quality, quantity, and availability have been optimized.

Delisting Criterion #1. "A watershed plan has been prepared and implemented for Lagunitas Creek (including Olema Creek), Walker Creek (including Keys Creek), Stemple Creek, Salmon Creek, Austin Creek (including East Austin Creek), Green Valley Creek (including Atascadero, Jonive, and Redwood Creeks), Laguna de Santa Rosa (including Santa Rosa and Blucher Creeks), Sonoma Creek (including Yulupa Creek), Napa River (including Garnett Creek), and Huichica Creek." This criterion is the same as Downlisting Criterion #1.

Delisting Criterion #2. "Long term protection is assured for at least one shrimp stream in each of the four drainage units." This criterion is the same as Downlisting Criterion #2.

Delisting Criterion #3. "Shrimp-bearing streams having fewer than 8 kilometers (5 miles) of potential shrimp habitat have shrimp distributed in all potential habitat; those with more than 8 kilometers (5 miles) of potential shrimp habitat, have shrimp distributed over 8 kilometers (5 miles) or more." This criterion implicitly addresses factors A and C.

Is Criterion Still Valid No. To date, the only substantive long term sampling effort has been on Lagunitas Creek. Within Lagunitas Creek, California freshwater shrimp are known from an eight mile reach, from Shafter Bridge to just downstream of the Galleager Bridge U.S. Geological Survey (USGS) gage (Serpa 2002). However, California freshwater shrimp have not been observed in the immediate vicinity of Shafter Bridge since 1991. The Service is not aware of any additional information regarding this criterion. This recovery criterion is not valid because "potential habitat" has not been defined and is ambiguous and because this recovery criterion is inherently easier to achieve for smaller streams or streams that provide less habitat. The favorable habitat conditions of this species are naturally sporadically distributed along streams. As such, it would be improbable for a stream to provide contiguous habitat along 8 miles of the stream. For many of the streams occupied by the species, all "potential habitat" is occupied. The distribution of California freshwater shrimp within a given stream is primarily limited by habitat availability. Thus, one could argue that this recovery criterion is and has been achieved for all streams occupied by the species; although the intent of this criterion, to increase the distribution of the species, has not been met.

Delisting Criterion #4. "Populations of shrimp maintain stable populations approaching carrying capacity for at least 10 years in each of 17 streams." This criterion implicitly addresses factors A, C and E.

Is Criterion Still Valid No. See analysis of carrying capacity for downlisting criterion #3. In addition, we are not aware of any comprehensive surveys of any of the 17 streams, except Lagunitas Creek.

Synthesis:

Although the known distribution of the California freshwater shrimp has expanded from 12 streams to 23 streams since the species was listed, eight of the eleven newly discovered streams do not represent new populations, but rather the discovery California freshwater shrimp in tributaries to already known populations. In addition, the stability of the species in a few occupied streams is questionable. There is no new information available that would suggest the

threats to California freshwater shrimp have changed substantially since listing, the finalization of the recovery plan, or the last 5-year review. Primary threats to the species continue to be degradation and loss of habitat as a result of increased urbanization (i.e., water diversion, urban runoff, loss of riparian vegetation, and bank stabilization), agricultural development and inappropriate grazing practices (i.e., loss of riparian vegetation, reduced water quality from manure runoff, water diversion, and increased sedimentation), pollutants and contaminants, and water development (i.e., barriers to migration, conversion of glide to pool habitat, introduced predators, altered hydrology, and reduced stream flows). Only one stream is currently protected, Lagunitas Creek, and no progress has been made at protecting any additional streams inhabited by the species. Watershed plans have been developed for a number of shrimp streams and the implementation of these plans, although not guaranteed and participation is voluntary, is likely to result in increased habitat quality and quantity. However, due to the time required for a stable undercut stream bank with adventitious living root material to form, it will likely be decades before the beneficial effects of these plans are realized. Because there has been no apparent change in the imminence of the threats to this species, we conclude the California freshwater shrimp continues to meet the definition of endangered.

IV. RESULTS

Recommended Listing Action:

___ Downlist to Threatened
___ Uplist to Endangered
___ Delist (indicate reasons for delisting per 50 CFR 424.11):
    ___ *Extinction*
    ___ *Recovery*
    ___ *Original data for classification in error*
_X_ No change is needed

New Recovery Priority Number and Brief Rationale:

Currently, the recovery priority number for this species is 8C. A recovery priority number of 8C is for a taxon that is species. However, because *Syncaris pacifica* is the only extant species within the genus *Syncaris*, we recommend changing the species recovery priority number from 8C to 7C. A recovery priority number of 7C is for a taxon of a monotypic genus that faces a medium degree of threat, has a high potential for recovery, and there is, or may be, some degree of conflict between recovery efforts and economic development. No other changes to the species' recovery priority number are recommended, because there has been no change in the imminence of known threats.

V. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1) The recovery plan divided shrimp populations into four drainage units in an effort to preserve potential genetic variability (Service 1998); however, the only genetic analysis to date indicates potential variability within drainage units. Therefore, further genetic analysis should be conducted to determine if significant differences exist within and/or

between drainage units. Depending on the results on any future genetic analysis, recovery criteria may need to be updated.

2) Conduct a habitat assessment of Santa Rosa Creek to determine if there is sufficient habitat to support a reintroduced population.

3) A monitoring and survey program should be developed to determine the current distribution of the species, assess habitat conditions, and population trends range wide.

4) Identify areas where restoration actions could improve habitat quality and quantity.

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Table 1. California freshwater shrimp (*Syncaris pacifica*) streams with occurrence records (1 = Present).

Stream Name	County	Tributary to:	Service (1988)	Service (1998)	Current
Atascadero	Sonoma		Extirpated	?	NA
Big Austin	Sonoma		1	1	1
Blucher	Sonoma	Laguna de Santa Rosa	1	1	1
"Bud Creek"	Sonoma	Blucher/Laguna de Santa Rosa	NA	NA	1
Cheda	Marin	Lagunitas	NA	NA	1
East Austin	Sonoma	Big Austin	1	1	1
Ebabias	Sonoma		NA	NA	1
Fallon	Marin	Stemple	NA	NA	1
Franz	Sonoma		NA	NA	1
Garnett	Napa	Napa	NA	1	1
Green Valley	Sonoma		1	1	1
Huichica	Napa	Napa	1	1	1
Tributary to Huichica	Napa	Huichica/Napa	NA	NA	1
Jonive	Sonoma	Atascadero	1	1	1
Keys	Marin	Walker	NA	1	1
Laguna de Santa Rosa	Sonoma		Extirpated	NA	NA
Lagunitas	Marin		1	1	1
Napa	Napa		1	1	1
Olema	Marin	Lagunitas	NA	1	1
Redwood	Sonoma	Jonive/Atascadero	NA	1	1
Salmon	Sonoma		1	1	1
Santa Rosa	Sonoma	Laguna de Santa Rosa	Extirpated	Extirpated	Extirpated
Sonoma	Sonoma		1	1	1
Stemple	Marin		Extirpated	1	1
Walker	Marin		1	1	1
Yulupa	Sonoma	Sonoma	1	1	1
Total			**12**	**17**	**23**

U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW

California freshwater shrimp (*Syncaris pacifica*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Review Conducted By: Ben Solvesky, Sacramento Fish and Wildlife Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 8 Sept 2011