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
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5-YEAR REVIEW

Species reviewed: California freshwater shrimp (*Syncaris pacifica*)

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I. GENERAL INFORMATION

Species Overview:

The California freshwater shrimp (*Syncaris pacifica* Holmes) is a decapod crustacean of the family Atyidae. Individuals are generally less than 50 millimeters (2.17 inches) in postorbital length (from eye orbit to tip of tail) (Eng 1981). Females are generally larger than males. Based on shrimp 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. Shrimp coloration is quite variable with males being translucent to nearly transparent, with small surface and internal chromatophores (color-producing 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 upon the reproductive physiology and behavior of other marine and freshwater shrimps, the male probably transfers and fixes the sperm sac to the female shrimp 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 are bearing 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 (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). Shrimp reach sexual maturity by the end of their second summer of growth (Eng 1981). The California freshwater shrimp may live longer than 3 years (Eng 1981).

Streams inhabited by California freshwater shrimp are part of the Coast Range, a geomorphic province that lies between the Pacific Ocean on the west and the Central Valley of California on the east. Shrimp have been found only in low elevation (less than 116 meters, 380 feet) and low gradient (generally less than 1 percent) streams. Shrimp are found in reaches that are structurally diverse with undercut banks, exposed roots, overhanging woody debris, or overhanging vegetation (Eng 1981; Serpa 1991). No data are available for defining the optimum temperature and stream flow regime for the shrimp or the minimum and maximum limits it can tolerate. Shrimp-bearing streams near the town of Sonoma experience average air temperatures of

approximately 8 degrees Celsius (46 degrees Fahrenheit) in the winter to 21 degrees Celsius (70 degrees Fahrenheit) in the summer. However, water temperatures in low gradient streams, such as Stemple Creek with minimal base flow and cover, can reach 31 degrees Celsius (88 degrees Fahrenheit) during summer months and 6 degrees Celsius (43 degrees Fahrenheit) in winter months (M. Rugg, California Department of Fish and Game, unpublished data 1994). Due to the variable rainfall stream flows are markedly different throughout the year with flash flood flows in the winter to minimal or zero flows in the summer and fall months.

I.A. Methodology used to complete the review

This review was conducted by staff within the Sacramento Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service), based on information in the office files, interviews with species experts, and other pertinent literature. No 5-year reviews or other formal status reviews have been conducted since the species was listed in 1988.

I.B. Contacts

Lead Regional or Headquarters Office – Contact name(s) and phone numbers: Region 8, California and Nevada: Diane Elam, Deputy Division Chief for Listing, Recovery, and Habitat Conservation Planning, and Andy DeVolder and Jenness McBride; (916) 414-6464.

Lead Field Office – Contact name(s) and phone numbers: Sacramento Fish and Wildlife Office: Kirsten Tarp, Recovery Branch, (916) 414-6600.

I.C. Background

I.C.1. FR Notice citation announcing initiation of this review

71 FR 14538-14542, March 22, 2006
The Federal Register notice requested information from the public regarding the species' status. We received no information from the public in response to the notice.

I.C.2. Listing history

Original Listing
FR notice: 52 FR 43884-43889
Date listed: October 31, 1988
Entity listed: Species – California freshwater shrimp (*Syncaris pacifica)*
Classification: Endangered

I.C.5. Species' Recovery Priority Number at start of review

The recovery priority is 8C, indicating the species is under a moderate degree of threat and has a high potential for recovery, but also has the potential for conflicts with construction, development projects, certain agricultural practices, or other forms of economic development that impact water quality or riparian habitats.

I.C.6. Recovery Plan or Outline

Name of plan: Recovery Plan for the California Freshwater Shrimp (*Syncaris pacifica* Holmes 1895)
Date issued: Approved July 31, 1998

II. REVIEW ANALYSIS

II.A. Application of the 1996 Distinct Population Segment (DPS) policy

II.A.1. Is the species under review listed as a DPS?

___ ***Yes***
_X_ ***No***

The Endangered Species Act of 1973, as amended (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 limits listing as DPS only to vertebrate species of fish and 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.

II.B. Recovery Criteria

II.B.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

_X_ ***Yes***
___ ***No***

II.B.2. Adequacy of recovery criteria

II.B.2.a. Do the recovery criterion reflect the best available and most up-to-date information on the biology of the species and its habitat?

___ ***Yes***
_X_ ***No***

At the time the recovery plan was finalized, the California freshwater shrimp (shrimp) was known from 17 streams (Service 1998). The species is now known from 23 streams, including six new streams: "Bud Creek" (Sonoma County) (L. Serpa, The Nature Conservancy, pers. comm. 2006b), Fallon Creek (Marin County) (California Department of Fish and Game 2006), Franz Creek (Sonoma County) (Martin and Wicksten 2004; Serpa 2002), Ebabias Creek (Sonoma County) (B. Cox, California Department of Fish and Game, pers comm. 2006), Cheda Creek (Marin County) (Fong 2004), and an unnamed tributary of Huichica Creek (Napa County)

(L. Serpa, The Nature Conservancy, pers. comm. 2006b). In addition, there is a new unconfirmed record in the Napa River near the confluence of Sulphur Creek, approximately 8.5 miles south of the existing record at the confluence of the Napa River with Garnett Creek (Natural Resources Management 2006). The existing recovery criteria do not address the role of any shrimp localities discovered after publication of the 1998 Recovery Plan in the recovery of the species.

Preliminary genetic analysis, based on individuals from eight streams, suggests genetic variation occurs between populations within drainage units (K. Roe, Iowa State University, pers. comm. 2006). These data may indicate a need to revise recovery criteria if further genetic analysis reveals these differences to be significant.

The adequacy of existing recovery criteria is discussed in section II.B.3 below.

II.B.2.b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

_X_ ***Yes***.
____ ***No***.

II.B.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors* are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.

The Recovery Plan provides recovery criteria that implicitly address the four listing factors noted in the final rule to list the species: destruction, modification, or curtailment of habitat or range (factor 1), disease or predation (factor 3), inadequacy of existing regulatory mechanisms (factor 4), and other man-made or natural factors affecting its continued existence (factor 5). Factor 2, overutilization for commercial, recreational, scientific, or education purposes, was not included as a threat in the listing rule and is not addressed in the 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 1, 3, 4, and 5.

* 1)Present or threatened destruction, modification or curtailment of its habitat or range;
2) Overutilization for commercial, recreational, scientific, or educational purposes;
3) Disease or predation;
4) Inadequacy of existing regulatory mechanisms;
5) Other natural or manmade factors affecting its continued existence.

The development and implementation of watershed plans (similar to delisting criterion 1) does not address the suitability of these plans to provide adequate protection for the shrimp. Watershed plans without goals specific to protecting and enhancing shrimp habitat may not afford the species the presumed level of protection that having watershed plans implies. Additionally, the goal of developing watershed plans does not identify the party responsible for developing them, funding sources, or a mechanism for enforcement.

To date, several watershed management and/or enhancement plans have been developed, primarily by local Resource Conservation Districts (RCD). Watershed plans exist for the Tomales Bay Watershed (including Lagunitas Creek, Olema Creek, Walker Creek, Keys Creek, and Stemple Creek) (Tomales Bay Watershed Council 2003), Laguna de Santa Rosa (including Santa Rosa and Blucher Creeks) (Honton and Sears 2006), Sonoma Creek (including Yulupa Creek) (Southern Sonoma County RCD, 2004), the northern Napa River (including Garnett Creek) (Koehler 2002), and Huichica Creek (L. Sharp, Napa County RCD, per. comm. 2006).

Watershed plans have not been developed for Salmon Creek, Green Valley Creek (including Atascadero, Jonive, and Redwood Creeks) (L. Hulette, Gold Ridge RCD, per. comm. 2006), or Austin Creek (including East Austin Creek) (S. Cantor, Sotoyome RCD, per. comm. 2006).

The development of watershed plans for several shrimp streams represents significant progress in the fulfillment of this recovery criterion. However, even though the above watershed plans have been developed, there is no mechanism for determining what level of implementation, if any, has occurred. Additionally, none of the watershed plans were developed in conjunction with the Service or reviewed by the Service and may not include measures that benefit the shrimp.

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 1, 3, 4, and 5.

Approximately seven miles of Lagunitas Creek flows through the 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 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, drainage unit 1, is the only 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 recovery plan was finalized.

Downlisting Criterion #3: "The abundance of California freshwater shrimp approaches carrying capacity in each of 17 streams." This criterion implicitly addresses factors 1, 3, and 5.

Carrying capacity was not defined in the recovery plan. 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 area can vary depending on several factors including environmental conditions, food supply, and water supply. In addition, "approaching carrying capacity" is not defined.

At this time, there are insufficient data available to calculate K for any population of shrimp in any stream. The Service is not aware of any plans to conduct surveys in an effort to determine K or other long term population trends.

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 and implicitly addresses factors 1, 3, 4, and 5.

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 1 and 3.

To date, the only substantive long-term sampling effort has been on Lagunitas Creek. Within Lagunitas Creek, 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, 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.

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 1, 3 and 5.

As mentioned above, the Service is not aware of any information regarding K for any of the streams occupied by the shrimp. See also section II.C.1.a., below.

II.C. Updated Information and Current Species Status

II.C.1. Biology and Habitat

II.C.1.a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Long-term population trends are only available for the Lagunitas Creek population. The number of individual shrimp collected at six sites in Lagunitas creek increased from approximately 1,878 in 1991 to approximately 4,407 in 2000 (Serpa 2002). The increase 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.

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). Data from Serpa (2002) calculated sex ratios for the Lagunitas population between 1997 and 2000, resulting in male to female ratios between 1.32:1 and 2.57:1.

The Service is not aware of any information regarding sex ratios with respect to their affect on population size and stability or whether the ratios reported by Serpa (2002) are typical for the species or genus.

II.C.1.b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Preliminary genetic analysis on approximately 12 individuals (L. Serpa, The Nature Conservancy, per. comm. 2006a) from eight streams indicates populations can be divided into distinct groups based on genetic similarities from mitochondrial DNA (K. Roe, Iowa State University, per. comm. 2006); these tentative data suggest genetic variation between populations may not correspond to the drainage units identified in the recovery plan. The drainage units identified in the recovery plan were originally developed in an effort to maximize genetic diversity.

II.C.1.c. Taxonomic classification or changes in nomenclature:

A recent review 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 *Syncaris pacifica* and the presumed extinct *Syncaris 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).

II.C.1.d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.):

The majority of recent survey information on the shrimp is the result of independent surveys for various projects. The surveys have resulted in an increase in the number of streams known to contain populations of the shrimp, but do not represent a uniform effort to examine the species' 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" (Sonoma County) (L. Serpa, The Nature Conservancy, pers. comm. 2006b), Fallon Creek (Marin County) (California Department of Fish and Game 2006), Franz Creek (Sonoma County) (Martin and Wicksten 2004; Serpa 2002), Ebabias Creek (Sonoma County) (B. Cox, California Department of Fish and Game, pers comm. 2006), Cheda Creek (Marin County) (Fong 2004), an unnamed tributary of Huichica Creek (Napa County) (L. Serpa, The Nature Conservancy, pers. comm. 2006b), and an additional location on the Napa River in Napa County (C. Malan, Institute for Conservation Advocacy, per. comm. 2006; Natural Resources Management 2006).

II.C.1.e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

An ongoing study by the National Park Service and the U.S. Geological Survey is examining the habitat requirements of *Syncaris pacifica* in Lagunitas and Olema creeks (D. Fong, Biologist, Golden Gate Recreation Area, per comm. 2006). Preliminary results from this study indicated that shrimp were primarily located in glides (a stretch of clam slow-flowing water in a river or stream) characterized with overhanging vegetation, submerged root wads, sandy substrates, and low water velocities (Saiki 2006).

II.C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

II.C.2.a. Present or threatened destruction, modification, or curtailment of its habitat or range:

When the shrimp was listed as endangered in 1988 (52 FR 43884-43889), we identified agricultural activities, residential development, water pollution, water diversions, recreation activities (summer dams), chemicals, and channelization as threats to its habitat. Additional threats were noted in the recovery plan and included gravel mining, water development, urban runoff, flood control, and bank protection. All these threats are still significant threats to the species.

Agricultural activities such as grazing and dairy operations may destroy suitable habitat through the removal of riparian vegetation, adverse bank and channel changes, decreased water quality (runoff from feed lots, vineyards, etc.), increased sediment loads, change in runoff characteristics, and increased water temperatures. Grazing activities 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. According to the Natural Resource Conservation Service (NRCS), current riparian habitat along Stemple Creek, Estero Creek, and their tributaries totals approximately 30 percent (NRCS 2007). 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 thread 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.

The construction of summer dams (temporary dams constructed for recreational activities such as swimming and fishing during the summer) adversely affects shrimp in several ways, including: (1) crushing individuals due to construction; (2) inundating habitat; (3) serving as a barrier to movement; and (4) altering flow patterns (Service 2003). Impoundments raise the elevation of the inundation zone, drowning the roots of riparian vegetation not adapted to periods of long 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 interstitial 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, 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, North Section Chief, Corps, per. comm. 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 can alters 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.

Water development, 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 presence of two reservoirs (Kent Lake and Nicasio Reservoir) effectively precludes the use of former stream 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.

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.

Installation of bank protection generally requires a U.S. Army Corps of Engineers section 404 permit. Review of bank protection projects in areas containing shrimp and suitable habitat 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 that has shrimp populations. 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.

Since 1998, the Service has issued 13 biological opinions under section 7 of the Endangered Species Act (Act) authorizing a combined incidental take for the shrimp in the form of 1,048 linear feet and 3.05 acres of shrimp habitat. The biological opinions for these projects have included a total of 548 linear feet combined with 5.49 acres of habitat restoration and/or protection to compensate for effects to the shrimp. However, not all projects that result in habitat loss and take of the shrimp are consulted on under section 7. Recently, at least one illegally constructed water diversion near the City of Olema may have affected the shrimp. The project was constructed in the fall of 2006 and spring of 2007. The construction of the water diversion channel into Olema Creek included removal of riparian vegetation along the banks of Olema Creek, which may have resulted in water quality degradation (such as increased sedimentation and higher temperatures) as well as removal of foraging and sheltering habitat for the shrimp. The project was constructed without consultation with the Service (or any other regulatory agency).

The development of watershed plans for many shrimp streams represents an important effort in protecting and restoring habitat for this species, but many restoration activities for these plans have yet to be implemented. Continuing habitat loss and degradation as a result of the above actions, combined with the lack of development and implementation of watershed protection plans, represents one of the primary threats to this species.

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, The Bay Institute, per. comm. 2006). To date, the STRAW project has completed approximately 185 projects restoring 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, Fish and Wildlife biologist, Service, per. comm. 2006).

II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:

Historically, this factor was not a threat for the shrimp and was not identified as such in the final listing rule (52 FR 43884-43889). The Service is not aware of any new information that would indicate a change in the imminence of this threat factor.

II.C.2.c. Disease or predation:

When the shrimp was listed as endangered in 1988 (52 FR 43884-43889), we identified predation by fish as a significant threat (see below). Threats from predatory fish include both native and non-native introduced fish. Disease was not identified as a threat in the listing rule or the recovery plan. Predation by non-native fish is still a significant threat.

According to Rudnick *et al*. (2000), the Chinese Mitten Crab (*Eriocheir sinensis*) is established in tributaries flowing to San Pablo Bay and may prey on the shrimp. Heib (2004) stated mitten crab abundance peaked in 1998-1999, but that current population trends indicate low numbers of the crab. If crab numbers increase substantially, predation pressure on the shrimp may increase.

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 shrimp's current 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*) prey on the shrimp (Saiki 2006)

II.C.2.d. Inadequacy of existing regulatory mechanisms:

When the shrimp was listed as endangered in 1988 (52 FR 43884-43889), we identified inadequacy of existing regulatory mechanisms as a threat to the species. This is still an ongoing threat to the species.

<u>State Protections</u>

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 Federal Endangered Species 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 the 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 the shrimp. Since its listing, the Service has analyzed the potential effects of many projects on the shrimp under section 7(a)(2) of

the Act, which requires Federal agencies to consult with the Service prior to authorizing, funding, or otherwise carrying out activities that may affect listed species. While projects that are likely to result in adverse effects often include minimization measures, the Service is limited to requesting minor modifications in the project description. In instances where some incidental take is unavoidable, the Service requires that additional measures be taken by the project proponents to compensate for adverse affects to the species. Compensation measures for these effects can be included in biological opinions; however, due to the number of projects that have been permitted since the listing of the species in 1988, examination of the completion and success of any existing or future compensation will require significantly more resources and time than are currently available for this review.

Incidental take permits, pursuant to Section 10(a)(1)(B) of the Endangered Species Act, may be issued for projects without a Federal nexus. A non-Federal applicant may obtain a permit with Service approval of a Habitat Conservation Plan (HCP) that details measures to minimize and mitigate the potential impacts of the project to federally listed species to the maximum extent practicable. However, to date no HCPs have been prepared that include the shrimp as a covered species.

The National Environmental Policy Act (NEPA) provides some protection for the 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). These mitigation actions are usually developed in coordination with the Service during section 7 consultation and are designed to provide some protection for listed species. 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 (CWA) and section 10 of the Rivers and Harbors Act, the Corps regulates the discharge of fill material (fill) 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 having hydric soils, hydrology (either sufficient flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Pursuant to 33 CFR 323.4, the Corps has exempted various farming, forestry, and maintenance activities from the regulatory requirements of section 404. Many of the irrigation and drainage canals, as well as wetlands in agricultural areas, are generally not subject to section 404 regulations. However, jurisdiction over agricultural fields is determined on a case-by-case basis and is dependent upon whether wetlands existed on the site prior to the establishment of farmed lots. Lack of regulatory authority over agricultural lands often means nonpoint source pollution (i.e., runoff with high sediment loads) enter tributary systems; this often results in a degradation of water quality, increased bank erosion, and stream channel down cutting having a detrimental effect on shrimp habitat.

In-stream activities (i.e., summer dam construction, channelization, sand and gravel removal, etc.) that would result in fill are regulated by section 404 and afford the species some protection.

If the Corps determines a project "may affect" the shrimp, they are required to consult with the Service pursuant to section 7 of the Act. However, projects that do not result in fill, or the fill is incidental to the activity, do not require a Corps permit but may still affect the shrimp (i.e., removal of cover and foraging habitat.

II.C.2.e. Other natural or manmade factors affecting its continued existence:

When the shrimp was listed as endangered in 1988 (52 FR 43884-43889), we identified environmental extremes, vandalism, and silviculture as threats. Silviculture is less of a threat today than historically and no new cases of vandalism have been reported to the Service, since 1987. Environmental extremes are still a significant threat.

Climate change was not specifically addressed in the recovery plan. However, the listing rule stated environmental extremes, specifically drought and spring floods, were a threat and could influence the stability of the shrimp populations.

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

Increases in sea levels resulting from climate change may also have significant affects on the shrimp. Sea level rise may result in higher salinities in streams with populations of shrimp. Born (1968) determined that shrimp were still 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.

Climate forecasts vary in their predicted outcomes, and range from cooler and drier to warmer and wetter (Miller *et al.* 2003; Deffenbaugh *et al*. 2005; Leung and Ghan 1999), which makes it difficult to adequately assess the affects climate change may have on populations of the shrimp. The Service is not aware of specific research into the effects climate change may have on populations of *Syncaris pacifica*.

II.D. Synthesis

There is no new information available that would suggest the threats to *Syncaris pacifica* have changed substantially since the species' listing and finalization of the recovery plan. Primary threats to the shrimp 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 (i.e., loss of riparian vegetation, runoff, water diversion, and increased sedimentation), and water development (i.e., barrier to migration, conversion of

glide to pool habitat, introduced predators, altered hydrology, and reduced stream flows). Watershed plans have been developed for a number of shrimp streams, but implementation of these plans has been sporadic and little progress has been made towards achieving the remaining recovery criteria. New surveys have revealed the shrimp's presence in six additional locations. Small-scale, site-specific surveys have confirmed additional occurrences, but these have generally been individual efforts and unrelated to other surveys.

Because there has been no apparent change in the imminence of the threats to this species, we conclude *Syncaris pacifica* continues to meet the definition of endangered.

III. RESULTS

III.A. Recommended Classification:

____ **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**

III.B. New Recovery Priority Number: N/A

No change to the species' recovery priority number is recommended, because there has been no change in the imminence of known threats, no new threats have been identified (except for the unpredictable affects of climate change), and little progress has been made towards accomplishing the recovery criteria.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

The recovery criterion addressing the development and implementation of watershed management plans does not address the adequacy of these plans with regard to the needs of the shrimp. Watershed management plans may have objectives that do not reflect the best management strategy for this species. Current watershed plans should be reviewed to determine if they provide adequate protection to the shrimp. In addition, the Service should pursue partnerships with other Federal, State, and county agencies, including local Resource Conservation District (RCD) offices, responsible for developing watershed management plans, to help ensure they provide protection for the shrimp.

The Service should consider revisiting the recovery criteria to reflect newly discovered occurrences of the shrimp.

Long term protection has not been established for the many streams with populations of shrimp. Protection of these areas, through mechanisms such as Safe Harbor Agreements, should be pursued since habitat loss is still one of the primary threats to the species.

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.

In order to determine the current distribution of the species, assess habitat conditions, and population trends (including K) range wide surveys should be initiated; this would allow the Service to adequately assess the success of many of the recovery criteria.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Syncaris pacifica*

Current Classification ___Endangered___.
Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
_X_ **No change is needed**

Review Conducted By ___Sacramento Fish and Wildlife Office staff___

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

ACTING

Approve _____ Date 1·8·08

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 1/10/08