Ohlone tiger beetle
(Cicindela ohlone)

5-Year Review:
Summary and Evaluation

Photograph by Richard A. Arnold

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

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5-YEAR REVIEW

Ohlone tiger beetle (*Cicindela ohlone)*

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 following information is summarized from the final listing rule for the species (Service 2001). The Ohlone tiger beetle is a member of the Coleopteran family Cicindelidae (tiger beetles). The species is endemic to Santa Cruz County, California, where it is known only from coastal terraces supporting patches of native grassland habitat (Freitag et al. 1993). Ohlone tiger beetle habitat is associated with either Watsonville loam or Bonnydoon soil types, both of which are characterized by shallow, pale, poorly drained clay or sandy clay soil that bakes to a hard crust by summer, after winter and spring rains cease. Adult beetles are typically found along trails or barren areas among low, sparse vegetation within the grassland habitat. Ohlone tiger beetles require these open areas for construction of larval burrows, thermoregulation, and foraging. The density of burrows decreases with increasing vegetation cover.

Ohlone tiger beetles are diurnal, predatory insects that prey on small arthropods. Adult Ohlone tiger beetles are medium-sized, elongate beetles characterized by their brilliant metallic green coloration highlighted by stripes and spots. Adults are swift and agile predators that have strong dentate mandibles (mouthparts) for capturing prey. Ohlone tiger beetle larvae are also predatory; they live in small, vertical burrows from which they lunge and seize passing invertebrate prey.

Methodology Used to Complete This Review:

This review was prepared by the Ventura Fish and Wildlife Office (VFWO), following the Region 8 guidance issued in March 2008. We used information from a recovery plan that was prepared for seven species in the Santa Cruz Mountains, including the Ohlone tiger beetle

(Service 1998). We also used 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. Personal communications with experts were our primary source of information used to update the species' status and threats. We received no information from the public in response to our Federal Register Notice initiating this 5-year review (Service 2009). 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. 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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Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on March 25, 2009 (Service 2009).

Listing History:

Original Listing
FR Notice: 66 FR 50340
Date of Final Listing Rule: October 3, 2001
Entity Listed: *Cicindela ohlone*
Classification: Endangered

Associated Rulemakings
No other rules have been published for this species.

State Listing
Insects are not listable entities under the State of California's Endangered Species Act.

Review History: There have been no status reviews since the listing rule was published in 2001. There has been no proposed designation of critical habitat. There is no recovery plan for the species.

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for the Ohlone tiger beetle is 2 according to the Service's 2009 Recovery Data Call for Ventura Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Service 1983). This number indicates that the taxon is a species that faces a high degree of threat and has a high potential for recovery.

Recovery Plan

A recovery plan has not been prepared for the Ohlone tiger beetle since it was listed as an endangered species in 2001. However, the species was discussed in a recovery plan that was published before it was listed (Service 1998). This plan, titled "Recovery plan for insect and plant taxa from the Santa Cruz Mountains in California," encompassed the five listed plants and two listed insects that occur in the Santa Cruz Mountains as well as two unlisted, but sensitive species: the Ohlone tiger beetle and the Scotts Valley polygonum (*Polygonum hickmanii*). The Ohlone tiger beetle and Scotts Valley polygonum were species of concern to the Service and were both being considered for listing when the recovery plan was published. The two unlisted species were included with the intent of this plan forming the basis for a formal recovery plan in case the species were eventually listed. Only a minor portion of the Ohlone tiger beetle's range was included in the recovery plan. Because the Ohlone tiger beetle was not listed when the recovery plan was published, no recovery criteria were established for the species.

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, the DPS policy is not applicable, and 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 Ohlone tiger beetle is a member of the Coleopteran family Cicindelidae (tiger beetles), which includes over 2,000 species worldwide and over 100 species in the United States (Pearson and Cassola 1992). Tiger beetles are diurnal, predatory insects that prey on small arthropods. Adult Ohlone tiger beetles are medium-sized (0.37 to 0.49 inch (in) (0.95 to 1.25 centimeters (cm))), elongate beetles that have a brilliant metallic green coloration highlighted by stripes and spots (Knisley and Shultz 1997). Adults are ferocious, swift, and agile predators that seize small prey with powerful sickle-shaped jaws.

Ohlone tiger beetle larvae are also predatory. They live in small, vertical or slanting burrows from which they lunge at and seize passing invertebrate prey (Essig 1926, Essig 1942, Pearson 1988). The larva grasps the prey with its strong mandibles (mouthparts) and pulls it into the burrow (Essig 1942, Pearson 1988). Tiger beetles share similar larval body forms throughout the world (Pearson and Cassola 1992). The larvae, either white, yellowish, or dusky in coloration, are grub-like and fossorial (subterranean), with a hook-like appendage on the fifth abdominal segment that anchors the larvae inside their burrows.

After mating, the Ohlone tiger beetle female excavates a hole in the soil and oviposits (lays) a single egg (Pearson 1988; Kaulbars and Freitag 1993; Hayes, pers. comm. 1998). Females of many species of *Cicindela* are extremely specific in choice of soil type for oviposition (egg laying) (Pearson 1988). It is not known at this time how many eggs the Ohlone tiger beetle female lays, but other species of *Cicindela* are known to lay between 1 and 126 eggs per female (Knisley, in litt. 2000). After the larva emerges from the egg and becomes hardened, it enlarges the chamber that contained the egg into a tunnel (Pearson 1988). Tiger beetle larvae undergo three instars (larval development stages). This period can take 1 to 4 years, but a 2-year period is the most common (Pearson 1988). Before pupation (transformation process from larva to adult), the third instar larva will plug the burrow entrance and dig a chamber. After pupation in this chamber, the adult tiger beetle will dig out of the soil and emerge. Reproduction may either begin soon after emergence or be delayed (Pearson 1988).

Tiger beetles are a well-studied taxonomic group with a large body of scientific literature; the journal *Cicindela* is devoted exclusively to tiger beetles. Scientists have studied the diversity and ecological specialization of tiger beetles, and amateur collectors have long been attracted by their bright coloration and swift movements. Tiger beetle species occur in many different habitats, including riparian habitats, beaches, dunes, woodlands, grasslands, and other open areas (Pearson 1988, Knisley and Hill 1992). A common habitat component appears to be open, sunny areas for hunting and thermoregulation (an adaptive behavior to use sunlight or shade to regulate body temperature) (Knisley et al. 1990, Knisley and Hill 1992). Individual species of tiger beetle are generally highly habitat-specific because of oviposition and larval sensitivity to soil moisture, composition, and temperature (Pearson 1988, Pearson and Cassola 1992, Kaulbars and Freitag 1993).

The Ohlone tiger beetle is endemic to Santa Cruz County, California, where it is known only from coastal terraces supporting remnant patches of native grassland habitat. Specimens of this species were first collected northwest of the city of Santa Cruz, California, in 1987, and were first described in 1993 (Freitag et al. 1993). Two principal distinguishing features of the Ohlone tiger beetle are its disjunct distribution and its early seasonal adult activity period. The Ohlone tiger beetle is most closely related to the *purpurea* species group of tiger beetles, which occurs throughout the continental United States. The Ohlone tiger beetle represents the southernmost taxon of this group in the Pacific Coast region; its distribution is allopatric (geographically separated) to those of similar species (Freitag et al. 1993). While other tiger beetle species, such as *Cicindela purpurea*, are active during spring, summer, or early fall (Nagano 1982, Freitag et al. 1993), the Ohlone tiger beetle is active from late January to early April (Freitag et al. 1993).

Ohlone tiger beetle burrows, measuring 0.16 to 0.23 in (0.41 to 0.58 cm) in diameter, are found in the same habitat areas occupied by adult Ohlone tiger beetles (Kavanaugh, pers. comm. 1997; Cheap, in litt. 1997). The surface openings of these burrows are circular and flat with no dirt piles or mounds surrounding the circumference. These burrows are similar to larval burrows belonging to other tiger beetle species. The substrate at burrow sites tends to be shallow (approximately 4 to 12 in (1 to 3 cm)) Watsonville loam or Bonnydoon soil type, characterized by poorly drained clay or sandy clay over bedrock of Santa Cruz Mudstone (Freitag et al. 1993). The surface layer is typically a hard crust baked in late spring and early summer after the winter and spring rains cease. Both adult and larval Ohlone tiger beetles are found where grasses are low and sparse enough to leave bare ground. Trails and trampled areas appear to be especially attractive to the Ohlone tiger beetle. These soil conditions appear to be critical for oviposition, burrow creation, and the burrow environmental conditions necessary for larval Ohlone tiger beetles.

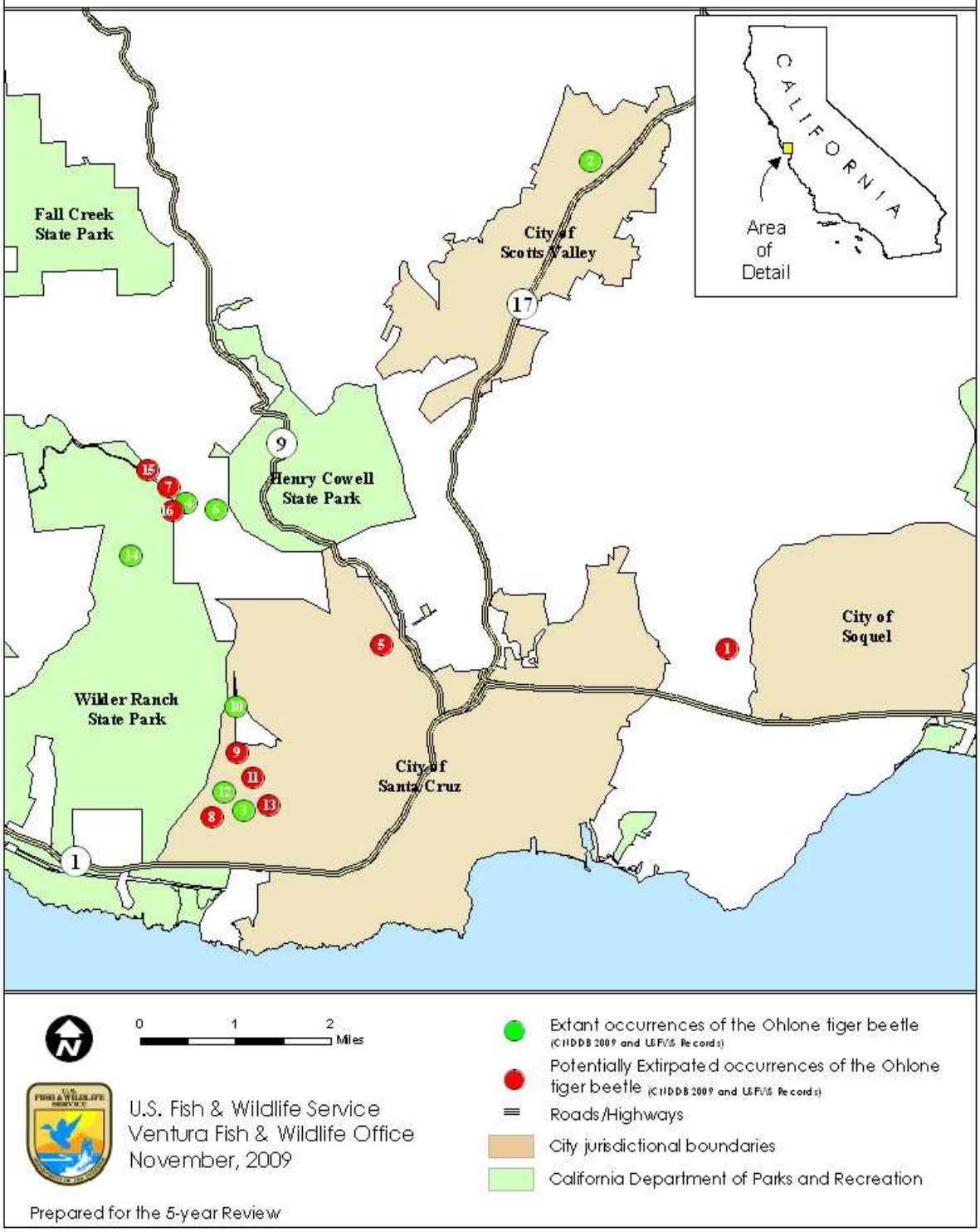
Spatial Distribution

The historic range of the Ohlone tiger beetle cannot be precisely assessed because the species was only recently discovered, and no historic specimens or records are available. The earliest specimen recorded was collected from a site northwest of the city of Santa Cruz in 1987 (Freitag et al. 1993). Based on available information on topography, substrates, soils, and vegetation, it is likely that suitable habitat for the Ohlone tiger beetle was more extensive and continuous prior to the increase in urban development and agriculture. Historically, potentially suitable habitat may have extended from southwestern San Mateo County to northwestern Monterey County, California (Freitag et al. 1993). However, we have no evidence or data indicating that this species occurred beyond the present known occupied areas of Santa Cruz County.

At the time of the 2001 final listing rule, the Ohlone tiger beetle was known from four narrow geographic areas within Santa Cruz County. Although the Ohlone tiger beetle was described as occurring across four geographic areas at the time of listing, the Service now believes that it is most appropriate to consider these as five distinct geographic areas. One occurrence to the north of the city of Santa Cruz (Occurrence 5, Figure 1) is isolated, both by distance and habitat fragmentation, from the occurrences to the west of the city of Santa Cruz, and is now considered to be a separate geographic area. The five currently recognized geographic areas are: west of the city of Soquel, within the city of Scotts Valley, west of the city of Santa Cruz, north of the city of Santa Cruz, and northwest of the city of Santa Cruz. At the time of listing, the Ohlone tiger beetle was known from 11 properties representing 16 occurrences (Figure 1). An occurrence is defined as a discrete location of continuous coastal terrace prairie habitat currently or historically occupied by Ohlone tiger beetles. A single parcel can have more than one occurrence, if the occupied habitat is separated by inappropriate habitat. It is not known to what extent Ohlone tiger beetles may disperse between occurrences. Population dynamics of the Ohlone tiger beetle are poorly understood. It is thought that neighboring occurrences may function each as single populations or combined as a metapopulation (Arnold, pers. comm. 2009).

The historic or current abundance of individuals in the four geographic areas is unknown. However, the Ohlone tiger beetle was known to occur on less than 5 acres (2 hectares) of land in each of these four areas (Hayes, pers. comm. 1995; Sculley, pers. obs. 1999, 2000). No

Figure 1. Distribution of the Ohlone tiger beetle (*Cicindela ohlone*), Santa Cruz County, California



Prepared for the 5-year Review

additional occurrences of Ohlone tiger beetle have been discovered since the 2001 final listing rule.

Although standardized population monitoring is not conducted at all occurrences, anecdotal observations have been recorded annually at all known Ohlone tiger beetle occurrences since the time of listing (Arnold, pers. comm. 2009). Site occupancy is defined as the presence of adult and larval Ohlone tiger beetles. The presence of adult beetles in the absence of larval burrows may suggest a dispersing group of beetles rather than occupied habitat. An occurrence is considered to be potentially extirpated if there are no adult or larval Ohlone tiger beetles located within a single year. These occurrences may remain viable and could be reestablished by dispersing beetles if the appropriate habitat remains. Although we classify occurrences as potentially extirpated if no adult or larval beetles have been observed in a year, there is potential that these occurrences may remain occupied by Ohlone tiger beetles. Because Ohlone tiger beetles are cryptic when found away from bare ground (Cooper, pers. obs. 2009), presence of adults may be missed during anecdotal surveys for the species.

The 5 geographic areas encompassing the 16 historic and current Ohlone tiger beetle occurrences and their current status are described below (Figure 1):

West of the City of Soquel. The Ohlone tiger beetle was known from one parcel of private property (Occurrence 1, Figure 1). The last year that Ohlone tiger beetles were observed at this location was in 2008; no beetles were observed during multiple visits in 2009 (Arnold, pers. comm. 2009). Although additional research is needed, Ohlone tiger beetles are potentially extirpated from this geographic area (see Factor A in the Five-Factor Analysis section).

City of Scotts Valley. The Ohlone tiger beetle is known to occur at one parcel owned by the City of Scotts Valley (Occurrence 2, Figure 1). This property is currently managed by The Land Trust of Santa Cruz County for the benefit of the Ohlone tiger beetle as well as the federally endangered Scotts Valley spineflower (*Chorizanthe pungens* var. *hartwegii*). Ohlone tiger beetles have been observed at this occurrence every year since 2003; these surveys have been conducted as a component of a long term-management plan that was initiated in 2003 (WRA 2009).

North of the City of Santa Cruz. The Ohlone tiger beetle was known from one parcel owned by the City of Santa Cruz within this geographic area (Occurrence 5, Figure 1). The City maintains this property as an open space preserve; however, no management specific to the Ohlone tiger beetle is conducted in this area. No Ohlone tiger beetles have been observed at this area since 2004 (Arnold, pers. comm. 2009). Therefore, Ohlone tiger beetles are potentially extirpated from this geographic area (see Factor A in the Five-Factors Analysis section).

West of the City of Santa Cruz. At the time of the final listing rule, the Ohlone tiger beetle was known from seven occurrences at five parcels. These properties are contiguous as well, although Ohlone tiger beetles may be isolated on each property because habitat for the beetle is not continuous between parcels. The potential for beetle movement between sites is not known.

Occurrences 3 and 11 (Figure 1)

One property is owned by the City of Santa Cruz and historically supported two separate occurrences of the Ohlone tiger beetle. Only Occurrence 11 was still occupied in 2009; beetles were last documented at Occurrence 3 in 2005 (Arnold, pers. comm. 2009). Occurrence 3 is thought to be potentially extirpated at this time.

Occurrence 10 (Figure 1)

The University of California, Santa Cruz (University) owns a second parcel, which supports a single occurrence of the Ohlone tiger beetle. Active Ohlone tiger beetle larval burrows were observed at this area in 2009 (Arnold, pers. comm. 2009).

Occurrences 8, 9, 12, and 13 (Figure 1)

The three other parcels located west of the city of Santa Cruz are under private ownership. The easternmost of these three private parcels historically supported a single occurrence of Ohlone tiger beetle (Occurrence 13, Figure 1); no beetles have been observed at this property since 2004, and are therefore thought to be potentially extirpated from this parcel (see Factor A in the Five-Factors Analysis section) (Arnold, in litt. 2006).

The centrally located private parcel historically supported two occurrences of the Ohlone tiger beetle (Occurrences 9 and 12, Figure 1). One of these two occurrences was eliminated when the land was converted to a vineyard in 1998 (see Factor A in the Five-Factors Analysis section) (Hayes, in litt. 1999); Ohlone tiger beetle larval burrows were observed at the second occurrence during surveys in 2009 (Arnold, pers. comm. 2009).

The westernmost of the private parcels historically supported a single occurrence (Occurrence 8, Figure 1). The status of this occurrence is currently in question because no Ohlone tiger beetles have been observed at this occurrence since 2007 (Arnold, in litt. 2009).

Northwest of the City of Santa Cruz. Ohlone tiger beetles are known from two properties in this area. One property, owned by the California Department of Parks and Recreation (CDPR), supports one occurrence that was documented as occupied by Ohlone tiger beetles in 2009 (Occurrence 14, Figure 1) (Cooper, pers. obs. 2009). The other property, owned by the University, has supported up to five separate occurrences of the Ohlone tiger beetle (Occurrences 4, 6, 7, 15, and 16; Figure 1). Active Ohlone tiger beetle larval burrows were detected at only Occurrence 4 in 2009 (Arnold, pers. comm. 2009). Occurrence 6 had active adult Ohlone tiger beetles, although no larval burrows were observed (Arnold, pers. comm. 2009). No Ohlone tiger beetles have been detected at the remaining three occurrences for 5 or more years each (Arnold, pers. comm. 2009).

Abundance

Since the 2001 final listing rule, the known distribution of the Ohlone tiger beetle has decreased from 5 geographic areas with 16 occurrences to 3 geographic areas with 7 occurrences. Because the Ohlone tiger beetle was only recently discovered, little is known about the abundance of the species. At the time of the 2001 final listing rule, there were no formal studies conducted to quantify Ohlone tiger beetle abundance. Since the listing, range-wide population monitoring was initiated at all occurrences where access was available. However, in some cases monitoring was conducted as anecdotal presence/absence surveys rather than population counts.

When the Ohlone tiger beetle was listed in 2001, no abundance data were available for the population at Occurrence 2, near the city of Scotts Valley. However, annual population monitoring was initiated at the occurrence starting in 2003 (Figure 2, WRA 2009); this long-term monitoring has resulted in the most complete abundance data for any of the Ohlone tiger beetle occurrences. The number of adult Ohlone tiger beetles observed has decreased substantially since 2003, from a high of 372 adults counted in 2003 to 116 adults in 2008. Although the number of larval burrows has fluctuated considerably, the number of burrows counted in 2008 (583 burrows counted) was higher than the total counted in 2003 (556 burrows counted) and substantially higher than the low in 2005 (167 burrows counted). Occurrence 2 is also the only occurrence where the sex ratio of Ohlone tiger beetles has been documented. During the period 2003-2008, the average sex ratio was 1.6:1 male to female (WRA 2003, 2005, 2006, 2007, 2008, 2009).

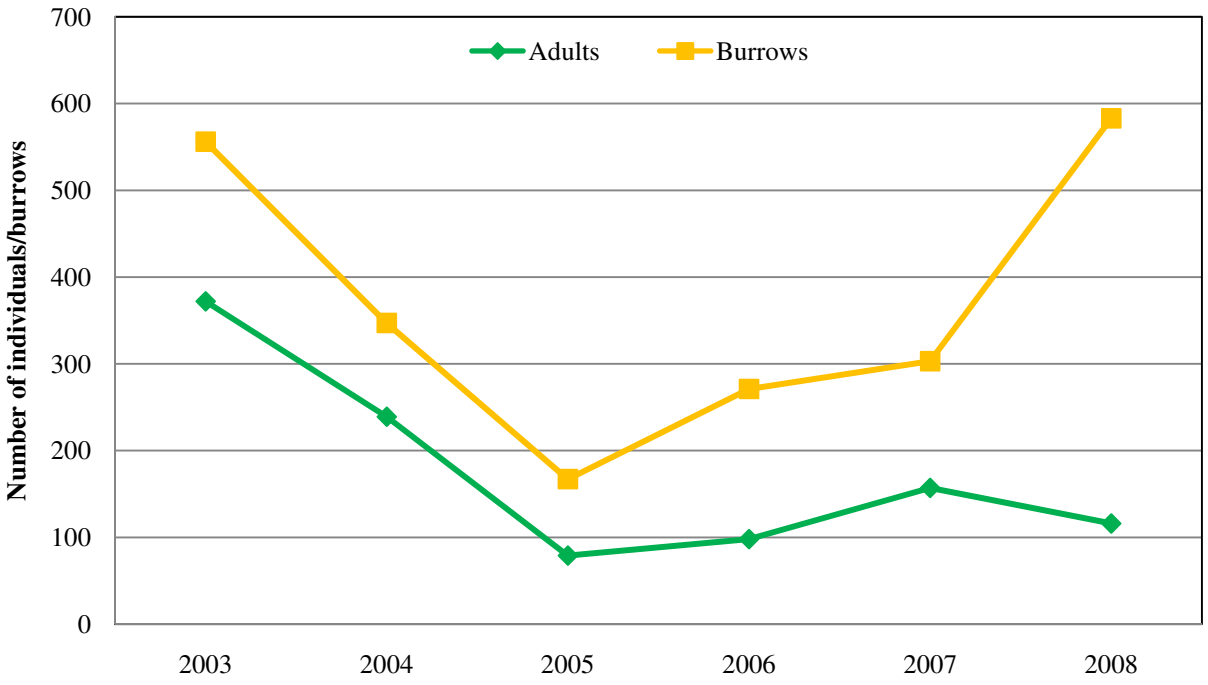


Figure 2. Ohlone tiger beetle adult and larval burrow counts at Occurrence 2, near the city of Scotts Valley, 2003-2008 (WRA 2009). Prepared for the 5-year review, August 2009.

No consistent population monitoring has been conducted at the other Ohlone tiger beetle occurrences. Formal surveys have been conducted at some occurrences, but not on an annual basis, while anecdotal observations have been recorded at several other occurrences. In general, these surveys and observations suggest that the population trends documented at Occurrence 2 are representative for the species throughout the range (Hayes, in litt. 2006). Ohlone tiger beetle numbers across all occurrences were high in 2003, and declined in 2004 and 2005 (Hayes, in litt. 2006). The declines observed in 2004 and 2005 resulted in Ohlone tiger beetles being potentially extirpated from occurrences that were smaller and more heavily impacted by habitat degradation (see Factor A in the Five-Factors Analysis section).

Habitat or Ecosystem

Ohlone tiger beetles are found in association with coastal terrace prairies, which are often characterized by the presence of California oatgrass (*Danthonia californica*) and purple needlegrass (*Stipa pulchra*). The substrate is shallow, pale, poorly drained clay or sandy clay soil that bakes to a hard crust by summer, after winter and spring rains cease (Freitag et al. 1993). Ohlone tiger beetle habitat is associated with either Watsonville loam or Bonnydoon soil types in Santa Cruz County (Casale and Oster, pers. comm. 1997).

Adult Ohlone tiger beetles are found more often on level or nearly level slopes along trails (e.g., foot paths, dirt roads, and bicycle paths) that are adjacent to or near remnant patches of native grassland on coastal terraces. Adults will also utilize barren areas among low or sparse vegetation within the grassland. Ohlone tiger beetles require these open areas for construction of larval burrows, thermoregulation, and foraging (Knisley, in litt. 2000; Sculley, pers. obs. 2000). The density of larval burrows decreases with increasing vegetation cover (Hayes, in litt. 1997). When disturbed, adults will fly to more densely vegetated areas (Freitag et al. 1993). Oviposition by females and subsequent larval development also occur in this coastal prairie habitat (i.e., open areas among native vegetation) (Kavanaugh, pers. comm. 1997; Cheap, in litt. 1997).

The extent of potentially suitable habitat for the Ohlone tiger beetle is estimated at 200 to 300 acres (81 to 121 hectares) in Santa Cruz County, California (Freitag et al. 1993). The area of habitat currently occupied by active Ohlone tiger beetle larval burrows is estimated to be less than 10 acres (4 hectares) (Arnold, pers. comm. 2009).

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

The degradation and destruction of habitat was identified as the primary threat to the Ohlone tiger beetle in the 2001 final listing rule (Service 2001). Loss of habitat is the principal threat to insect species worldwide because of their close associations with, and dependence on, specific

habitats (Pyle et al. 1981). The effects of habitat destruction and modification on tiger beetle species have been documented by Knisley and Hill (1992) and Nagano (1982). The Ohlone tiger beetle is restricted to remnant patches of native grassland on coastal terraces where low and sparse vegetation provide space for foraging, reproduction, and thermoregulation, and support a prey base of other invertebrate species. The poorly drained clay or sandy clay substrate of the coastal terraces provides the soil moisture, composition, and temperature conditions necessary for oviposition and larval development (Pearson 1988, Kaulbars and Freitag 1993).

The habitat of the Ohlone tiger beetle is threatened with destruction resulting from urban development or with modification by invasive nonnative vegetation across all of the species' occurrences. Disturbance of the substrate, and removal or elimination of vegetation by urban development, kills or injures individuals and precludes others from feeding, sheltering, or reproducing. Historically, potentially suitable habitat is believed to have extended from southwestern San Mateo County to northwestern Monterey County, California (Freitag et al. 1993). Most of this habitat has been modified or destroyed by human actions such as urbanization and agriculture (Freitag et al. 1993).

Freitag et al. (1993) estimated that about 15,000 to 20,000 acres (6,070 to 8,094 hectares) of native grassland remain in Santa Cruz County, but not more than 200 to 300 acres (81 to 121 hectares) contain the proper combination of substrate, slope, and exposure (bare areas between patches of grasses) to be considered suitable habitat for the Ohlone tiger beetle. Nearly all suitable habitat is located within or adjacent to urbanized areas in the coastal mid-county area of Santa Cruz. Much of the City of Santa Cruz and its adjacent towns were built on these marine terrace grassland habitats (Freitag et al. 1993). Within suitable habitat, the beetle occupies only sparsely vegetated areas and bare areas, which are artifacts of trails, grazing, or other disturbance activities.

Four of the nine occurrences that are classified as potentially extirpated since 2001 were located on privately owned land (Occurrences 1, 8, 9, and 13). The five other occurrences classified as potentially extirpated were on open space land owned by the University (Occurrences 7, 15, and 16) or the City of Santa Cruz (Occurrences 5 and 11). Of the seven currently extant occurrences, three are located on preserve or park land owned by local cities (Occurrences 2 and 3) or by CDPR (Occurrence 14). Three current occurrences are located on land owned by the University (Occurrences 4, 6, and 10). Only one of the remaining Ohlone tiger beetle occurrences (Occurrence 12) is located on private property.

Two Ohlone tiger beetle occurrences have been potentially extirpated since the 2001 final listing rule as a result of impacts directly caused by development. Both of these occurrences were on private property west of the city of Santa Cruz. At Occurrence 8 (Figure 1), Ohlone tiger beetle habitat has been altered by activities related to the development of a horse ranch on the property resulting in the potential extirpation of Ohlone tiger beetles from this occurrence (Arnold 2009). At Occurrence 9 (Figure 1), the property owners tilled up a large percentage of the area occupied by the Ohlone tiger beetle in preparation for converting from livestock grazing to a vineyard (Hayes, in litt. 1999). At the time of listing, the effects of this action on the Ohlone tiger beetle were unknown. Since that time, no Ohlone tiger beetles have been observed at the occurrence and the population is now considered to have been extirpated (Arnold, pers. comm. 2009). The

one remaining occurrence on private property is threatened by the potential for future development activities on the land. The other six remaining Ohlone tiger beetle occurrences are located on open space preserves and park lands, and therefore are afforded protection from the threat of development.

Other land management practices also threaten Ohlone tiger beetle sites throughout the species range. Heavy vehicular traffic in areas with extensive use of public trails, such as on lands owned by the University, the City of Santa Cruz, and CDPR, may create soil compaction and rutting, damaging potential oviposition sites. Populations of another tiger beetle species found in the northeastern United States, *Cicindela dorsalis dorsalis*, were extirpated in several localities that were subjected to heavy recreational use (i.e., heavy pedestrian foot traffic and vehicular use) but survived at other sites that had received little or no recreational disturbance (Knisley and Hill 1992). Six of the seven remaining Ohlone tiger beetle occurrences are located on open space or park areas accessible to the public. Ohlone tiger beetles at these six occurrences are at risk of the threat of traffic or trail use potentially resulting in crushing or otherwise injuring or killing adult or larval beetles.

In addition to the development and land management threats to the Ohlone tiger beetle, the invasion of nonnative plants threatens the little coastal terrace prairie habitat that remains for this species. All occurrences of the Ohlone tiger beetle are threatened by nonnative plants, including areas that are protected from development. These nonnative plants are aggressive invaders that convert open, sunny grasslands required by Ohlone tiger beetles to habitat dominated by a more closed, shady overstory (Knisley and Arnold 2004). Without these open, sunny areas, the Ohlone tiger beetle cannot forage and oviposit. In addition to shading these areas used by the beetle, the nonnative vegetation fills in the open spaces among the low or sparse vegetation creating an unsuitable, densely vegetated habitat. Nonnative vegetation may also affect the numbers and diversity of the beetle's prey, predators, and parasites (see Factor C of this section). Increased vegetation encroachment is the primary factor attributed to the extirpation of several populations of other *Cicindela* species (e.g., *C. abdominalis* and *C. debilis*) (Knisley and Hill 1992). Nonnative plants, including French broom (*Cytisus monspessulanus*), velvet grass (*Holcus* spp.), filaree (*Erodium* spp.), and *Eucalyptus* spp. are encroaching into grassland habitats and out-competing native grassland vegetation (Morgan, in litt. 1992; Hayes, in litt. 1997; Sculley, pers. obs. 1999, 2000). Nonnative grasses, such as bromes (*Bromus* spp.) and oats (*Avena* spp.), can rapidly invade California grasslands, which has resulted in the loss of over 98 percent of California's native grasslands (Noss et al. 1995, Lulow 2006). In Santa Cruz County, nonnative grasses have resulted in habitat alteration to rare coastal terrace prairie habitat (Ford, pers. comm. 2009).

Since the 2001 final listing rule, habitat degradation caused by the invasion of nonnative grasses and forbs has been a factor at eight of the nine occurrences where Ohlone tiger beetles have been potentially extirpated. Ohlone tiger beetles have been potentially extirpated from two of the five geographic areas as a result of habitat degradation primarily caused by the lack of a habitat management program (Occurrences 1 and 5). Habitat degradation continues to be a threat to all remaining Ohlone tiger beetle occurrences. Without management efforts to reduce and control encroachment by nonnative plants, the Ohlone tiger beetle will likely continue to decline and the

risk of extinction will increase. Without active habitat management, increased growth of nonnative vegetation can severely reduce the availability of bare or sparsely vegetated ground.

Efforts are underway to reduce the spread of nonnative plants and control them where they already occur. Five of the occurrences that are still occupied by the Ohlone tiger beetle are actively managed for the benefit of the beetle, and the other two occurrences benefit indirectly from land use activities. The University conducts controlled burns in habitat for the Ohlone tiger beetle on its property northwest of the city of Santa Cruz (Occurrences 4 and 6; Figure 1). These burns are conducted for fire-training exercises and to restore native vegetation to this grassland (UCSC 1992; Knisley and Arnold 2004; Arnold, pers. comm. 2009). In a novel form of habitat management, bicycle traffic is managed through controlled access to trails at the property owned by CDPR west of the city of Santa Cruz (Occurrence 14, Figure 1) (Arnold, pers. comm. 2009). Although bicycle and foot traffic can result in crushing of adult and larval Ohlone tiger beetles (see Factor E of this section), the activity also maintains the open patches of bare ground that the Ohlone tiger beetle depends on for foraging, thermoregulation, and oviposition. Through controlled trail access, CDPR is able to manage the extent and timing of foot and bicycle traffic to maintain appropriate habitat while at the same time limiting the risk to adult and larval Ohlone tiger beetles.

Grazing is the most common form of habitat management and appears to be historically correlated with Ohlone tiger beetle occurrences. Grazing regimes, when conducted with the appropriate timing, frequency, and intensity, can effectively maintain native species of grasses and herbs in grasslands (Ford 2009a, 2009b; Arnold, pers. comm. 2009). Horse grazing is used to actively manage habitat at Occurrence 2 near the city of Scotts Valley; monitoring to determine the effects of these actions on the Ohlone tiger beetle is ongoing (WRA 2009). Grazing currently occurs on several parcels of land located west of the city of Santa Cruz which are occupied by the Ohlone tiger beetle (Occurrences 3, 10 and 12; Figure 1).

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

At the time of listing, unrestricted collecting was considered a threat to the species. Tiger beetle specimens are highly sought by amateur collectors (Nagano, pers. comm. 1993), and members of the genus *Cicindela* may be the subject of more intense collecting and study than any other single insect genus. The original petitioner for the Ohlone tiger beetle has been contacted by several people from such places as France, Wisconsin, and California, looking for Ohlone tiger beetle specimens they can add to their private collections, as well as those asking where the colonies are located with the intent to collect the species (Morgan, pers. comm. 1998). We are aware of at least one individual who collected specimens of the Ohlone tiger beetle from the type locality after the species was described in a scientific journal (Sumlin, in litt. 2000). Removal of even a few females from a small population could reduce the persistence of the population over time (Knisley, in litt. 2000).

The Ohlone tiger beetle is not likely to be used as a model organism for general research projects because it is a rare and limited species. It may be the subject of studies intended to improve understanding of the species' ecology and to improve management strategies for its

conservation. Although such studies would directly benefit the recovery of the Ohlone tiger beetle, they may contribute cumulatively to other threats to the species.

The relative level of threat posed by the potential for unrestricted collecting has not changed since the 2001 final listing rule (Service 2001). The threat remains and is the reason for maintaining nonspecific descriptions of site locations in this document and others published by the Service.

FACTOR C: Disease or Predation

At the time of listing, predation and parasitism were considered to be threats to the Ohlone tiger beetle.

No diseases are known to threaten the Ohlone tiger beetle. However, the Ohlone tiger beetle may be affected by any of several predators and parasites known to prey upon, and afflict, other tiger beetle species. In general, parasites are considered to be more detrimental than predators to populations of tiger beetles (Nagano 1982, Pearson 1988). Known tiger beetle parasites include ant-like wasps of the family Typhiidae, especially the genera *Mathoca, Karlissa*, and *Pterombrus*, and the Bombyliid flies of the genus *Anthrax* (Nagano 1982, Pearson 1988). These insect parasites are distributed worldwide and specialize on tiger beetle larvae. Some species of tiger beetles from Arizona sustain larval parasitism rates of 20 to 60 percent (Knisley, in litt. 2000). Known tiger beetle predators include birds, shrews (Soricidae), raccoons (*Procyon lotor*), lizards (Lacertilia), toads (Bufonidae), ants (Formicidae), robber flies (Asilidae), and dragonflies (Anisoptera) (Lavigne 1972, Nagano 1982, Pearson 1988).

Predators and parasites play important roles in the natural dynamics of populations and ecosystems. Although the magnitude of predation and parasitism on the Ohlone tiger beetle is not known, their effect will likely increase as the species continues to decline.

There is no change in the relative level of threat caused by parasites or predators since the 2001 final listing rule.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

Inadequacy of existing regulatory mechanisms was identified as a threat to the Ohlone tiger beetle in the 2001 final listing rule.

The Ohlone tiger beetle is not listed under the California Endangered Species Act, which does not allow for the listing of invertebrate species, and therefore receives no protection from this act.

The California Environmental Quality Act (CEQA) requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. When a project with potential impacts on the Ohlone tiger beetle is reviewed, the species would be considered endangered under section 15380 of CEQA because it is federally listed. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project

or to decide that overriding considerations make mitigation infeasible (CEQA Sec. 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of listed endangered species or their habitat. Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

Occupied habitat of a federally listed species, occurring within the coastal zone, is considered an "environmentally sensitive area" under the California Coastal Act (section 30107.5). The California Coastal Act requires that environmentally sensitive habitat areas "shall be protected against any significant disruption of habitat values" (section 30241). Therefore, the California Coastal Act can provide protection to Ohlone tiger beetles in those cases where they would be affected by a proposed project requiring a coastal development permit. Only the occurrences within the geographic area west of the city of Santa Cruz (Occurrences 3, 8, 9, 10, 11, 12, and 13; Figure 1) are within the coastal zone. The California Coastal Act would not provide benefits to those Ohlone tiger beetles occurring outside the coastal zone or those affected by ongoing activities.

The Ohlone tiger beetle is listed as endangered under the Federal Endangered Species Act of 1973, as amended (Act). The Act and its implementing regulations provide substantial benefits to the Ohlone tiger beetle by requiring consultation between the Service and other Federal agencies on the effects of Federal projects, to ensure that they are not likely to jeopardize the continued existence of the species. However, the Ohlone tiger beetle does not occur on Federal lands. To date, the only Federal consultations that have been conducted regarding the Ohlone tiger beetle have been intra-Service consultations to analyze the effects of projects funded through the Service's Partners Program and the effects of the issuance of the incidental take permit associated with the Santa Cruz Gardens HCP.

The Act and its implementing regulations provide benefits to the Ohlone tiger beetle through the habitat conservation planning process, by requiring non-Federal entities that seek a permit to take Ohlone tiger beetles to minimize and mitigate for such take. The Ohlone tiger beetle population northwest of the city of Soquel is included in the HCP for a residential development that is planned for the area; the measures included in this HCP should benefit the Ohlone tiger beetle and its habitats at the site. The incidental take permit for this HCP was issued in August 2009, so the habitat management component of the plan has not yet been initiated.

It is unlikely that these restoration, minimization, mitigation, and avoidance measures would continue to be implemented if the Ohlone tiger beetle were not listed under the Act. The species' status as endangered under the Act also ensures its consideration under other Federal and State acts, as discussed above. If the Ohlone tiger beetle were not listed under the Act, land use and development projects on public and private lands would likely be implemented without consideration of the species' needs, resulting in accelerated losses of habitat and decreases in populations.

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

At the time of the 2001 final listing rule, stochastic events, recreational activities, and the use of pesticides were identified as threats to the Ohlone tiger beetle.

Stochasticity

Demographic stochasticity refers to random variability in survival and/or reproduction among individuals within a population (Shaffer 1981). Random variability in survival or reproduction can have a significant impact on population viability for populations that are small, have low fecundity, and are short-lived. In small populations, reduced reproduction or die-offs of a certain age-class will have a significant effect on the whole population. Individuals vary naturally in their ability to produce viable offspring; for example, a particular male may be sterile or a female may produce fewer eggs than average. Although of only minor consequence to large populations, this randomly occurring variation in individuals becomes an important issue for small populations.

The occurrences of the Ohlone tiger beetle are isolated and restricted to relatively small patches of habitat. A direct correlation exists between increased extinction rates with the reduction of available habitat area and increased distances between small populations (Gilpin 1987). Small or localized populations are particularly susceptible to catastrophic events (Shaffer 1981, Shaffer 1987, Meffe and Carroll 1997, Primack 1998). This conservation biology model suggests that the isolated populations of the Ohlone tiger beetle may be more vulnerable to local extinction from random genetic and demographic events or environmental catastrophes. Effects of small habitat patches and isolated populations on other species of tiger beetles have been documented. In the eastern United States, several small populations of *Cicindela dorsalis* became extinct at sites where no obvious change in habitat occurred. These extinctions were presumably due to factors related to small population sizes (Knisely, in litt. 2000).

Genetic stochasticity results from the changes in gene frequencies caused by the founder effect, random fixation, or inbreeding bottlenecks (Shaffer 1981). Founder effect is the loss of genetic variation when a new population is established by a very small number of individuals. Random fixation refers to when some portion of gene loci is fixed at a selectively unfavorable allele (a different form of a gene) because the intensity of selection is insufficient to overcome random genetic drift. Random genetic drift (the occurrence of random changes in the gene frequencies of small isolated populations) happens when alleles are transmitted from one generation to the next, because only a fraction of all possible genetic combinations are represented in individuals that survive to become breeding adults. A bottleneck is an evolutionary event in which a significant percentage of a population is killed or prevented from breeding.

In small populations, such as those documented at the remaining Ohlone tiger beetle occurrences, these factors may reduce the amount of genetic diversity retained within populations and may increase the chance that deleterious recessive genes are expressed. Loss of diversity could limit the species' ability to adapt to environmental changes and contributes to inbreeding depression (i.e., loss of reproductive fitness and vigor). Deleterious recessive genes could reduce the viability and reproductive success of individuals. Isolation of the seven remaining occurrences preventing any natural genetic exchange will lead to a decrease in genetic diversity.

Although some species of tiger beetles are known to disperse over sizable distances (Pearson 1988), species from the *purpurea* group of the genus *Cicindela* typically do not disperse widely,

usually only 40 to 60 feet (12.2 to 18.3 meters) (Pearson, pers. comm. 1997). The dispersal capabilities of Ohlone tiger beetles are unknown; however, because the Ohlone tiger beetle belongs to the *purpurea* group, its dispersal distance is most likely short. Even if the Ohlone tiger beetle is able to disperse greater distances than other *Cicindela* beetles, the likelihood of successful emigration or colonization is greatly reduced by the small size of suitable habitat patches and the unavailability of even marginal habitat among the extensive urban development in the region.

Environmental stochasticity is the variation in birth and death rates from one season to the next in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981). Drought or predation in combination with a low population year could result in extinction. The origin of the environmental stochastic event can be natural or human-caused. The Ohlone tiger beetle has demonstrated a vulnerability to environmental stochastic events and will likely continue to be vulnerable to the same threat in the future. The Ohlone tiger beetle site near Scotts Valley has experienced widely fluctuating population numbers between 2003 and 2008 (WRA 2009). These fluctuations appear to have been driven by variations in both the timing and extent of winter and spring precipitation. These changes in environmental conditions resulted in a 79 percent decline in the Ohlone tiger beetle population from 2003 to 2005 (WRA 2006). An extended period of unfavorable environmental conditions could potentially threaten any of the remaining seven Ohlone tiger beetle populations with extinction.

Since the 2001 final listing rule, nine Ohlone tiger beetle occurrences have been lost, including two of the five geographic areas in which the beetle was found. The remaining seven occurrences are restricted to three geographic areas. This further reduction in number of occurrences and species range increases the threat of stochastic events on the Ohlone tiger beetle.

Recreational Activities in Ohlone tiger beetle habitat

Some recreational uses of Ohlone tiger beetle habitat (i.e., off-highway vehicular use or mountain biking) may pose a threat to the Ohlone tiger beetle. The Ohlone tiger beetle requires open ground to maneuver, take prey, and lay eggs. Beetles use the hard-packed bicycle trails for foraging, thermoregulation, and laying their eggs (Morgan, pers. comm. 1998). Although controlled recreational uses may help maintain the open spaces that Ohlone tiger beetles depend on (see Factor A in this section), bicycle traffic has been observed to result in the crushing of individual beetles at the occurrences located on University property, northwest of the city of Santa Cruz (Morgan, in litt. 1993). Similar mortality has been observed in the species' habitat west of the city of Santa Cruz (Morgan, in litt. 1993) and may occur in other Ohlone tiger beetle populations. In addition, bicycle and foot traffic could potentially collapse larval tunnels and crush the larvae. The significance of such mortality for population viability is not known at this time, but is considered a potential threat to the Ohlone tiger beetle, particularly if bicycle traffic through the habitat increases. Ohlone tiger beetles were potentially extirpated from one of the five geographic areas, west of the city of Soquel, in part as a result of substantial impacts caused by uncontrolled recreational uses. Children dug out the primary location of Ohlone tiger beetle burrows at the only occurrence in this geographic area (Occurrence 1) to build ramps for jumping bicycles (Arnold, pers. comm. 2009). Ohlone tiger beetles persisted at the site, although

in reduced numbers and in a smaller area, until the remaining habitat became unsuitable due to degradation caused by encroachment of nonnative plants (see Factor A of this section).

Six of the seven remaining Ohlone tiger beetle occurrences are located on open space or park areas that are accessible to the public. These six occurrences are all at risk to the threat of traffic or trail use potentially resulting in crushing or otherwise injuring or killing adult or larval Ohlone tiger beetles.

Pesticides

Pesticides could pose a threat to the Ohlone tiger beetle. The effects of insecticides on other tiger beetle species are referenced by Nagano (1982). Local land owners may use pesticides to control targeted invertebrate species around their homes and gardens. These pesticides may drift aerially or be transported by water runoff into Ohlone tiger beetle habitat where they may kill nontargeted organisms including the Ohlone tiger beetle or its prey species. As urban development increases near or in Ohlone tiger beetle habitat, negative impacts from pesticides may become more frequent. The significance of pesticide effects is not known at this time, but the Service continues to recognize them as a substantial potential threat to the species.

III. RECOVERY CRITERIA

There is no approved final recovery plan for the Ohlone tiger beetle, and therefore there are no established recovery criteria. However, recovery actions that will benefit the species are listed in the Recommendations section.

IV. SYNTHESIS

At the time of listing in 2001, 16 occurrences of the Ohlone tiger beetle were known from 5 geographic areas; since listing, 9 occurrences have been potentially extirpated, a decline of 56 percent, and the 7 remaining occurrences are distributed in only 3 geographic areas. Threats to the Ohlone tiger beetle, including habitat fragmentation and destruction due to urban development, habitat degradation due to invasion of nonnative plants, potential threats due to collection, pesticides, and recreational use of habitat, and vulnerability to random local extirpations continue to imperil the continued existence of this species. In particular, encroachment by nonnative plants has become a much more serious threat since the species was listed. Much of the habitat of this species is suitable for development and is unprotected from these threats. This species remains in danger of extinction ‘‘throughout all or a significant portion of its range’’ (section 3(6) of the Act) and, therefore, meets the Act’s definition of endangered. Because of the high potential for these threats, if realized, to result in the extinction of the Ohlone tiger beetle, we recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

_____ Downlist to Threatened
_____ Uplist to Endangered
_____ Delist (indicate reason for delisting according to 50 CFR 424.11):
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ No Change

New Recovery Priority Number and Brief Rationale: Recommend that Recovery Priority Number remains unchanged, at 2.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. We recommend that a Recovery Plan be developed for the Ohlone tiger beetle.

   Development of a recovery plan is required by the Act unless development of a plan would not promote species conservation. In the case of the Ohlone tiger beetle, a recovery plan would provide a description of site specific actions necessary for the conservation and survival of the species. Since the time of listing, 9 of the 16 Ohlone tiger beetle occurrences have been potentially extirpated, in part due to the lack of site specific management strategies.

2. We recommend that research be conducted to determine habitat management practices that can be used by landowners to benefit the Ohlone tiger beetle.

   Habitat management is necessary to maintain the open patches of bare ground required by the Ohlone tiger beetle for foraging, thermoregulation, and oviposition. Without this management, the habitat degrades until it is no longer suitable for the Ohlone tiger beetle. Although some occurrences are actively managed for the benefit of the Ohlone tiger beetle, there is not a consistent management strategy for the species throughout its range. However, the management strategies that are currently being employed are not consistent from one site to another; there is currently no accepted standard for habitat management to benefit the Ohlone tiger beetle. There are also several sites at which no beetle habitat management occurs. At many of these sites the property owners are anxious to begin planning for Ohlone tiger beetle habitat management, but have been delayed by the high costs of research to determine the appropriate management plans. Without a management strategy informed by research, management planning will be delayed, or inappropriate management, including no management, will continue, thus seriously reducing the beetle's chances of recovery.

3. We recommend establishing a uniform, range-wide monitoring program for the Ohlone tiger beetle.

Assessment of the status of this species is difficult without a well-developed, long-term monitoring plan. It is recommended that this plan be developed. Several sites have been monitored for presence and absence over the years. However, this does not allow for statistically-sound quantification of trends in population size across the species' range. This is due to varying degrees of sampling effort across the species range and variation in sampling protocol. To this end, we recommend that a long-term monitoring plan be developed dictating that: 1) sites are sampled in a common fashion throughout the species' range where possible, or at least sampled in such a way that comparisons can be made among sites based on catch per unit effort; and 2) a hierarchical sampling scheme be developed that dictates sampling in each recovery unit, sub-unit and locality at specific intervals. Standardized reporting forms should be developed to ensure consistency of environmental data and reporting detail.

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

Ohlone tiger beetle (*Cicindela ohlone*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

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

Review Conducted By: Douglass Cooper

FIELD OFFICE APPROVAL:

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

Approve _____ Date 11/13/09