BEFORE THE SECRETARY OF THE INTERIOR

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PETITION TO LIST THE SAN JOAQUIN TIGER BEETLE *CICINDELA TRANQUEBARICA JOAQUINENSIS* Knisley and Haines 2007 AS AN ENDANGERED SPECIES UNDER THE U.S. ENDANGERED SPECIES ACT AND CONCURRENTLY DESIGNATE CRITICAL HABITAT

CENTER FOR BIOLOGICAL DIVERSITY

December 9, 2024

NOTICE OF PETITION

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Submitted this 9th day of December, 2024

Pursuant to Section 4(b) of the Endangered Species Act (ESA), 16 U.S.C. § 1533(b); § 553(e) of the Administrative Procedure Act (APA), 5 U.S.C. § 553(e); and 50 C.F.R. § 424.14(a), the Center for Biological Diversity hereby petitions the Secretary of the Interior, through the U.S. Fish and Wildlife Service (FWS or Service), to list the San Joaquin tiger beetle (*Cicindela tranquebarica joaquinensis*) as endangered throughout its range. This beetle is at risk of extinction in the foreseeable future. However, should the Service decide not to protect this subspecies as endangered, then we also request consideration for listing as threatened.

Petitioners also request that FWS designate critical habitat concurrently with the listing, as required by 16 U.S.C. § 1533(b)(6)(C) and 50 CFR § 424.12, and pursuant to the APA (5 U.S.C. § 553).

FWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on FWS. Specifically, the Service must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). FWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id*.

The Center for Biological Diversity (Center) is a non-profit environmental organization dedicated to the protection of native species, their habitats, and climate they need to survive through science, policy, law, and creative media. The Center has over 1.7 million members and online activists that support the organization's mission. The Center submits this petition on its own behalf and on behalf of its supporters, members and staff who share an interest in protecting the San Joaquin tiger beetle and its habitat.

Please contact me at 406-366-4872 or email me at jtyler@biologicaldiversity.org if you have any questions or need any clarification on the information presented in this petition.

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Abbreviations

CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
EIS	Environmental Impact Statement
EIR	Environmental Impact Report
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FWS	United States Fish and Wildlife Service
ITIS	Integrated Taxonomic Information System
NEPA	National Environmental Policy Act
NWR	National Wildlife Refuge
USDA	United States Department of Agriculture

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The Center would like to thank Dennis Haines, Tulare County Entomologist (retired), and Dr. Barry Knisley, Professor Emeritus at Randolph-Macon College, for providing valuable information regarding the species status and reviewing the petition.

The Center also thanks Stephanie Gad for her efforts in the initial research and writing of this petition.

Suggested Citation

Tyler J. 2024. Petition to List the San Joaquin Tiger Beetle *Cicindela Tranquebarica Joaquinensis* Knisley and Haines 2007 as an Endangered Species Under the U.S. Endangered Species Act and Concurrently Designate Critical Habitat. Center for Biological Diversity, Portland, Oregon.

Executive Summary

The San Joaquin tiger beetle (*Cicindela tranquebarica joaquinensis* Knisley and Haines 2007) is endemic to alkali sinks in the San Joaquin Valley of California. This distinct subspecies of oblique-lined tiger beetle displays a very rare, nearly immaculate, color form that was formally recognized by Knisley and Haines as a named subspecies in 2007. Alkali sinks in the San Joaquin Valley formed as a result of flooding and drying cycles that historically formed Tulare Lake and surrounding wetlands. This subspecies is adapted to tolerate flooding and drying cycles within the arid environment of the San Joaquin Valley; however, this uniquely beautiful beetle is in serious decline and at risk of extinction.

The San Joaquin tiger beetle is known to be or presumed to be extant at only four locations on private land in Madera and Kings Counties, at the Pixley National Wildlife Refuge (Tulare County), and at the Allensworth State Historic Park (Tulare County). This subspecies has become extirpated from all its historic locations. The beetle's recent observed abundance has declined at all its remaining sites, except at the newly discovered Allensworth State Historic Park site where 100 adults were found in 2024. With six remaining sites out of 23 total historic and recent sites the beetle's range has declined at least 74%, but the true decline is likely higher. The extirpation of all historic sites and apparent decline of currently known sites speaks to the severe decline of this species and the widespread destruction of its habitat.

Destruction of its alkali sink habitat is the primary cause of this species' decline and is a serious threat to its current existence. Alkali sinks, also known as playas, have suffered extreme destruction and modification due primarily to agricultural activity, including conversion to orchards with ensuing pesticide use and intensive grazing. Groundwater infiltration projects and other developments also threaten to destroy the beetle's little remaining, fragmented habitat. Overcollection could further contribute to the population decline because of the extreme rarity of the subspecies. Current management and regulation either do not exist or are inadequate at the local, state, and federal levels to protect this species and its habitat. Encroachment of invasive vegetation, pesticide contamination, small population size, and climate change also threaten the survival of the San Joaquin tiger beetle.

The San Joaquin tiger beetle warrants protection as an endangered species under the Endangered Species Act (ESA), 16 U.S.C. § 1533(a)(1). It faces multiple threats across its entire range and without ESA protection, could become extinct.

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1. Introduction

Tiger beetles are charismatic insects in the family Cicindelidae (Order: Coleoptera) that are generally predatory with iridescent bodies and intricate patterns. There are an estimated 195 tiger beetle species and subspecies in North America (Pearson & Cassola 1992 p. 380). The speciation of this group has produced morphological, physiological, and behavioral adaptations to highly specific habitat types (Pearson & Cassola 1992 p. 380) that highlight regional natural heritage.

Tiger beetles live in a wide variety of habitats such as river banks, sand dunes, mud flats, or hardwood forest floors (Pearson et al. 2005 p. 177). Adult tiger beetles prefer habitat that is open enough for them to exploit acute eyesight and comparatively greater mobility to chase down their small invertebrate prey (Pearson et al. 2005 p. 186). Larvae are lay-and-wait predators that dig burrows and also rely on acute eyesight to capture prey (Pearson et al. 2005 p. 186).

Tiger beetles are a focal group for biodiversity conservation because they are an indicator taxon. Tiger beetle species richness is highly correlated with species richness of other vertebrate and invertebrate taxa (Pearson & Cassola 1992, pp. 376-7). Tiger beetles also face many threats that drive insect and wildlife decline broadly. Specific habitat types and a high degree of regional variation make tiger beetles vulnerable to habitat loss that puts them, and many other species, at risk of local and regional extirpation. Five tiger beetles are currently protected under the ESA (Miami tiger beetle, Northeastern beach tiger beetle, Ohlone tiger beetle, Puritan tiger beetle, and Salt Creek tiger beetle).

The San Joaquin Valley is a biodiverse, desert ecosystem (Germano et al. 2011 pp. 142–145) with many endemic species. The region's low rainfall and dry-summer Mediterranean climate create conditions for desert adapted species. The plants and animals of this area have significant overlap with species of the Mojave Desert to the south. The ESA protects 11 species in the San Joaquin Valley such as San Joaquin kit foxes, blunt-nosed leopard lizards, Bakersfield cacti, Kern mallows, and palmate-bracted bird's beaks.

The oblique-lined tiger beetle, *Cicindela tranquebarica*, is one of the most diverse species of tiger beetles with more than 27 named subspecies (Knisley & Haines 2007 p. 110). Members of this species can be found across the United States, with 12 named subspecies commonly recognized including six in Southern California including *C. t. subspecies arida, inyo, sierra, vibex, viridissima*, and *joaquinensis* (Pearson et al. 2005 pp. 106–109; Knisley & Haines 2007 p. 110). The nominate subspecies *C. t. tranquebarica* can be found in a wide variety of habitats such as beaches, sand dunes, and stubble fields (Pearson et al. 2005 p. 106). However, habitat preferences are much narrower for other subspecies.

The San Joaquin tiger beetle (*C. t. joaquinensis*) has a very narrow habitat preference, having only been observed in the alkali sinks, also known as playas, of the San Joaquin Valley (Knisley & Haines 2007 p. 122). In the San Joaquin Valley, conversion to agriculture or other land uses destroys open sandy habitat that, once converted, no longer supports tiger beetle populations. Open areas of bare soil that are near water are particularly vulnerable to conversion to agriculture. In the Central Valley, groundwater depletion can also make habitat no longer suitable for tiger beetles. This species faces the threat of extreme habitat modification from agricultural activities, groundwater infiltration protects, solar energy development, pesticide exposure, invasive plant species, small population size, and climate change. Over-collection and lack of regulatory mechanism are additional threats contributing to its rapid decline. In the face of such peril, the now exceptionally rare San Joaquin tiger beetle deserves prompt ESA and its imperiled habitat prompt critical habitat protection. Without ESA protection, this species will likely go extinct, and we will lose this important part of the natural heritage of California's Central Valley forever.

2. Description and Natural History

2.1. Taxonomy

The San Joaquin tiger beetle or *Cicindela tranquebarica joaquinensis* is a subspecies of oblique-lined tiger beetle (*Cicindela tranquebarica*) (Table 1). Knisley and Haines described this subspecies in 2007 based on analysis of historic specimens and field surveys (Knisley & Haines 2007 entire). The San Joaquin tiger beetle and *Cicindela tranquebarica joaquinensis* are both recognized as valid taxa within the Integrated Taxonomic Information System (ITIS) (ITIS 2023 entire). Of the 12 generally accepted subspecies designations of oblique-lined tiger beetle, *C. t. joaquinensis* is most closely related to *C. t. vibex* that also occurs in the San Joaquin Valley (Knisley & Haines 2007 p. 109). *C. t. joaquinensis* is distinguished from *C. t. vibex* by, among other morphological features, very reduced elytra maculation pattern. Additionally, *C. t. joaquinensis* is restricted to alkali sink habitats while *C. t. vibex* inhabits a wider range of riparian habitats (Knisley & Haines 2010 pp. 4-5).

Table 1. Taxonomy of *Cicindela tranquebarica joaquinensis*

Kingdom	*Animalia*
Phylum	*Arthropoda*
Subphylum	*Hexapoda*
Class	*Insecta*
Order	*Coleoptera*
Family	*Carabidae*
Genus	*Cicindela*
Species	*tranquebarica*
Subspecies	*joaquinensis*

2.2. Physical Description

Adult San Joaquin tiger beetles are robust, metallic green beetles with large eyes and large, black mandibles. Adult females are larger than males with a mean length of 12.6 mm (range 11.8 mm to 13.2 mm). Adult males average 11.8 mm in length (range 11.2 mm to 12.2 mm). The head and thorax are metallic green while the abdomen, specifically the elytra (hardened outer wing), is metallic green with slight metallic blue with a small apical lunule maculation (Knisley & Haines

2007 p. 112). Knisley and Haines described the subspecies based on the holotype male collected in Kings County near the town of Guernsey (Knisley & Haines 2007 p. 114). The more detailed description of the holotype can be found in Knisley and Haines (2007 pp. 112-115).

Larvae of this subspecies have not been formally described. Tiger beetle larvae are generally grub-like with white membranous outer covering, a highly sclerotized head with six small eyes and large mandibles (Pearson et al. 2005 p. 8).

The maculation pattern on the elytra is often diagnostic for tiger beetles. Oblique-lined tiger beetles have a variety of maculation patterns (shown in Figure 1). The least developed maculation pattern (Figure 1H) is the typical pattern for nearly all of the specimens of the San Joaquin tiger beetle. Pattern C is typical of *C. t. vibex* that is also found in the San Joaquin Valley (Knisley & Haines 2010, p. 6). Knisley and Haines found that some individuals from the western edge of the San Joaquin Valley displayed patterns B or C where they likely intergrade with *C. t. vibex* (Knisley & Haines 2007 p. 115). These are from older collections and not found in the Knisley and Haines study and thus are believed to have been extirpated from this area.

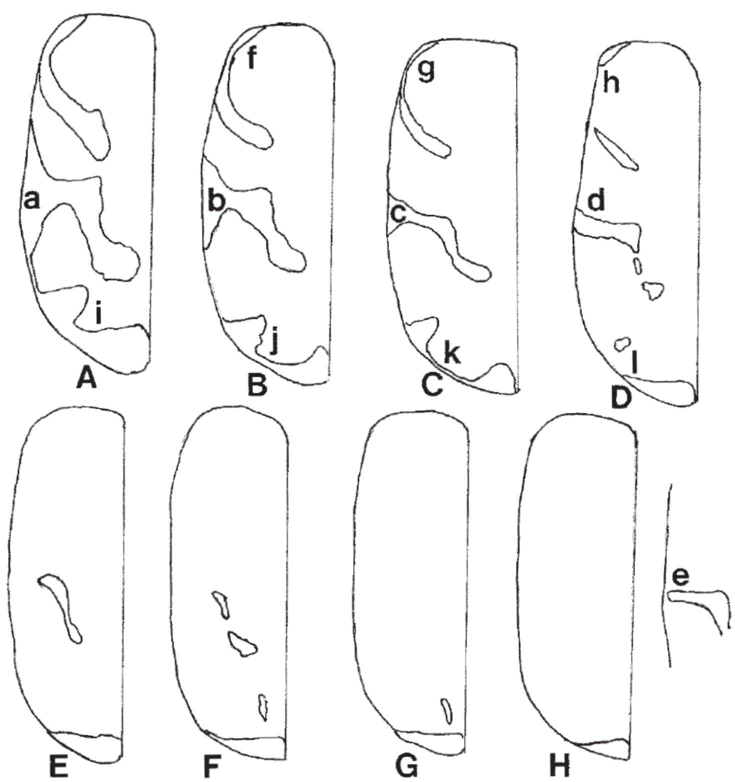

Figure 1. Oblique-lined tiger beetle maculation patterns. Patterns are arranged from most developed maculation (A) to least developed maculation patterns (H). Illustrations show the variation in the width of the base of the middle band (a-e), the amount of attachment of the humeral lunule (f-h), and variation of the apical lunule (i-l). (Figure taken from Knisley & Haines 2007 p. 112).

The San Joaquin tiger beetle also differs from other subspecies regarding three other features. First, San Joaquin tiger beetles have no microserrations on the posterior edge of the elytra, unlike all other California subspecies (Knisley & Haines 2010 p. 5). This characteristic has been used to separate various species of tiger beetles in taxonomic keys (Pearson et al. 2006 cited in Knisley & Haines 2010 p. 5). Second, the setae, or large hairs, on the ventral surface of the metasternum and metapisternum are long and wavy on *C. t. joaquinensis* but short and straight in *C. t. vibex* (Knisley & Haines 2010 p. 5). Third, the notch on the apical sternite of the male is a wide shallow "V" in *C. t. joaquinensis* but a deep parallel sided "U" in *C. t. vibex* (Knisley & Haines 2010 p. 5).

2.3. Life Cycle and Behavior

San Joaquin tiger beetle are holometabolous, meaning they undergo complete metamorphosis and have distinct egg, larva, pupa, and adult life stages. San Joaquin tiger beetles typically have an annual life cycle, but individuals can extend development time up to two years under adverse environmental conditions (Knisley & Haines 2010 p. 19). Typical, annual life stage seasonality (shown in Figure 2) begins when adults emerge from underground winter hibernation in late February to mid-March to mate and oviposit (Knisley & Haines 2010 p. 20). After hatching, the first instar (growth stage) larvae hatch beginning in March and lasting through early May (Knisley & Haines 2010 p. 20). Larvae progress through second instar by early summer and into a third instar by mid-summer (Knisley & Haines 2010 p. 20). Pupation typically occurs in late summer and early fall (Knisley & Haines 2010 p. 20). Adults emerge and are active starting in September and can extend into early December dependent on rainfall and other weather conditions (Knisley & Haines 2010 p. 20). At the end of the fall, adults dig burrows to overwinter. Larvae that do not reach pupation in the fall overwinter in their burrows and reemerge in the spring. Late oviposition, late hatching, reduced feeding, drought, or other factors result in a two-year life cycle (Knisley & Haines 2010 p. 19).

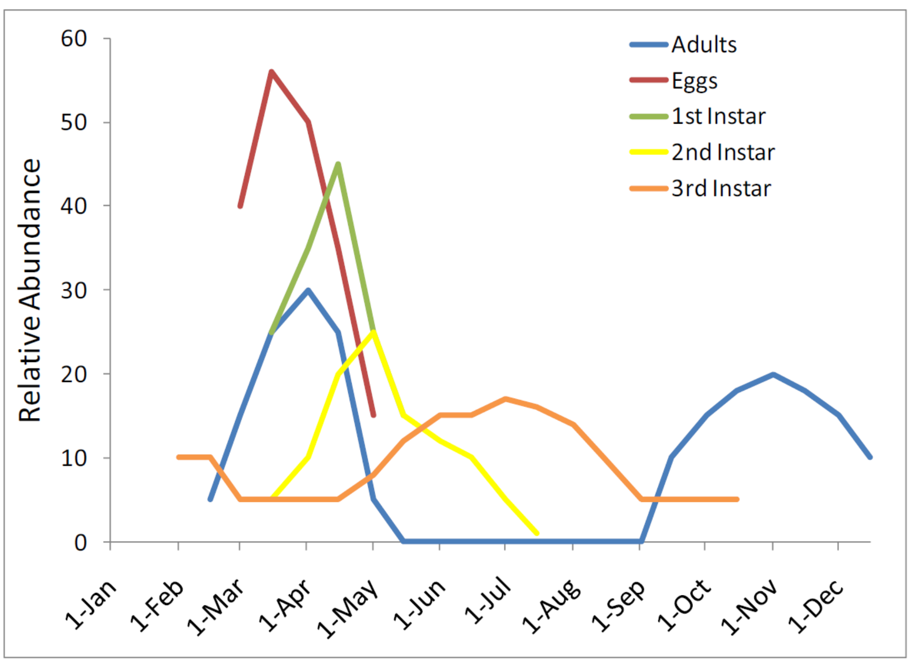

Figure 2. Emergence time and seasonality of egg, larvae, and adult stages of the San Joaquin tiger beetle. Figure taken from Knisley and Haines (2010 p. 20).

Adults of the San Joaquin tiger beetle, like most other tiger beetles, are diurnal predators that hunt other small invertebrates during the day and take cover at night. Adults have acute vision that allows them to chase down and capture prey with their large mandibles. Adults are most active around the edges of the alkali sinks and other patches of damp soil when there is standing water in the sink areas (Knisley & Haines 2010 p. 20). Few or none are found during extended dry periods. Adults are less common and usually solitary in smaller bare patches scattered between vegetated areas (Knisley & Haines 2010 p. 9). Usually, one to four individuals occur within each open patch (Knisley & Haines 2010 p. 9).

Larval tiger beetles are burrow dwelling, lay-and-wait predators that usually occur in the same microhabitats as adults. Larvae can often be found in small clusters of 2-8 larval burrows near the edges of alkali sinks (Knisley & Haines 2010 p. 20). Sink edges and areas of consistently damp soil are the preferred sites for oviposition (Knisley & Haines 2010 p. 20). The larvae use their mandibles to seize small arthropods that come within a few centimeters of their burrow (Pearson et al. 2005 p. 9).

Adult and larval activity is weather and rainfall dependent. Tiger beetles spend time in the open sun attempting to reach a high enough body temperature to efficiently capture prey (Dreisig 1980 p. 383). During spring and fall, adults are most abundant on warm, sunny days. Sunny weather that follows sufficient rainfall that creates standing water in the alkali sinks triggers adult and larval emergence likely coinciding with greater prey availability (Knisley & Haines 2010 p. 19). During cold or cloudy days in the spring or fall adults and larvae can dig burrows and remain inactive for extended periods (Knisley & Haines 2010 p. 19).

2.4. Habitat Description

The San Joaquin tiger beetle is restricted to valley sink scrub alkali meadow habitat and bare alkali sinks that formed along the northeastern edge of the historic Tulare Lake as well as in the floodplains of the San Joaquin River and other tributaries in the southern Central Valley (Knisley & Haines 2007 pp. 123-125) (see Figure 3 for example habitat). This habitat type is formed at the bottom of alluvial fans in areas of poor drainage that flood periodically forming ephemeral pools that dry in the summer and subsequently leave behind salty, alkaline deposits (FWS 1998 p. 4).

Adults are active in areas of damp soil that exist across the open areas of the sinks as well as on the edges near vegetation (Knisley & Haines 2010 p. 20). The damp edges of the sinks tend to provide the microhabitat that supports the greatest activity and are the typical sites that adults choose for oviposition (Knisley& Haines 2010 p. 20). The alkali sinks are of variable sizes ranging from $40m^2$ to $300m^2$ with a mix of low growing forbs and shrubs on the margins and sparse vegetation in the interior (Knisley & Haines 2010 p. 11). Soils are typically sandy loam constituting 70-80% medium to fine sands and 20-30% silt to very fine sands (Knisley & Haines 2010 p. 19). Historic and contemporary flooding and drying cycles of these areas cause soil salinity and alkalinity to increases over time in these sinks leaving bare patches with little vegetation. The sink scrub alkali meadow plant community consists generally of halophytes including a mix of shrubs (*Sueda moquinii*, *Frankenia salina*, *Allenrolfea occidentale*, and *Haplopappus acradenius*), forbs (*Atriplex spp. Hemizonia pungens, Lasthenia spp.*, *Lepidium* *spp*. and *Spergularia spp*.), saltgrass (*Distichlis spicata*), and other annual grasses (*Bromus spp*., *Vulpia spp*. and *Hordeum spp*.) (Knisley & Haines 2010 p. 11).

Figure 3. Example of habitat for the San Joaquin tiger beetle. Photo by Jess Tyler, taken March 2023.

3. Population Distribution and Status

Oblique-lined tiger beetles have historically been found throughout California's San Joaquin Valley. Knisley and Haines named *Cicindela tranquebarica joaquinensis* in 2007 after reanalysis of historical tiger beetle observations from the San Joaquin Valley. Historic tiger beetle records, collected mostly from the 1920s – 1940s, show tiger beetles present in five counties in the San Joaquin Valley with two specimens from Madera County, twenty from Fresno County, thirty-five from Tulare County, six from Stanislaus, and what was described as "many" from Kern County (Knisley & Haines 2010 p. 5).

Prior to its formal description, Knisley and Haines surveyed over 60 sites in the San Joaquin Valley between 2002 and 2006 including many historic tiger beetle locations (Knisley & Haines 2010 p. 4). Surveyed sites were mostly sandy floodplains as this is the habitat type most typical of the oblique-lined tiger beetle (Knisley & Haines 2010 p. 4). Most of the historic sites had been destroyed for agriculture or other development and few had any tiger beetle activity (Knisley &

Haines 2010 p. 4). None of the historic sites for the San Joaquin tiger beetle are currently occupied (Knisley & Haines 2010 pp. 5-7). However, in 2005, new populations were found near Earlimart at the Pixley National Wildlife Refuge (NWR) and near Guernsey (Knisley & Haines 2010 p. 4) that are still presumed extant as of 2023 (Table 2). By 2007, this species was known to be extant in four sites in the San Joaquin Valley, three within a 10 km^2 area of Kings County (referred to as the Guernsey site) and one in Tulare County at the Pixley National Wildlife Refuge (Knisley & Haines 2007 p. 122).

Surveys from 2008-2010 expanded to include over 100 sites including historic and potential sites. Based on extant populations near Guernsey and at the Pixley National Wildlife Refuge, satellite imagery was used to identify additional alkali sink habitat as potential sites within Fresno, Kings, Madera, and Tulare counties (Knisley & Haines 2010 p. 7). These surveys identified three additional sites in Madera County with appropriate habitat (see Table 2). The Madera Ranch site was confirmed to have individuals present based on previous surveys of this area for San Joaquin kit fox that incidentally produced observations of San Joaquin tiger beetles (Haines March 2023 pers. comm.). The New Stone Ranch and Road 9 site were confirmed to have individuals present based on roadside surveys (Haines March 2023 pers. comm.). The Madera County sites have not been resurveyed recently due to lack of access.

Peak adult counts from 2008-2010 at the Guernsey and Pixley NWR sites showed consistent presence but indicate declining population abundance (Figure 4, Table 2). Based on previous surveys, the Guernsey sites has had the largest population (Knisley & Haines 2010 p. 11), however peak adult counts decreased from more than 150 in 2006 to only 35 in 2010 (Table 2). The Pixley NWR site experienced a significant decline in adult number from 2008-2010 after a combination of drought and overgrazing largely stripped the vegetation at Pixley NWR (Knisley & Haines 2010 p. 13) (Figure 5).

Follow-up surveys of the known occupied sites confirmed three extant sites (Knisley et al. 2014 pp. 102, 122) the Guernsey site, the Pixley NWR, and the New Stone Ranch. However, a large part of the Guernsey site was entirely destroyed, plowed and converted to a pistachio orchard (Haines March 2023 pers. comm.) The Pixley NWR sites remained intact but observed population abundance has declined. The Madera County sites that could, or previously supported a population, are inaccessible and are of unknown status (Knisley et al. 2014 p. 122).

In 2023, Knisley and Haines surveyed five known or potentially occupied sites and confirmed the beetle's presence at the remaining undestroyed portion of the Guernsey site, but the beetle was not found at the Pixley NWR (Table 2) (Haines March 2023 pers. comm.). The Central Valley had an exceptionally cool and wet spring and may have contributed to a lack of observations. The two known occupied and three potential sites remained intact (unplowed) and have otherwise not been destroyed (Haines March 2023 pers. comm.). The Pixley National Wildlife Refuge and Guernsey sites were surveyed twice and for approximately 30 minutes each time (Haines March 2023 pers. comm.). Sites referred to as Road 9, New Stone Ranch, and Madera Ranch are inaccessible, private property so surveys were only conducted as possible from county roads (Haines 2023 pers. comm). The three Madera County sites also remained in their current state as cattle ranches (unplowed) and remain as potentially occupied sites of the San Joaquin tiger beetle (Haines 2023 pers. comm).

In the spring of 2024, a new population with an estimate of as many as 100 adults was found within a small section of Colonel Allensworth State Historic Park (J. Shetterly April 2024 pers. comm.).

Figure 4. Peak adult San Joaquin tiger beetle adult counts across three sites. Data from Knisley and Haines (2010 p. 11).
*There is no data point for the Guernesy site from 2008 (see Table 2). Data for this year was imputed as the average of the other four points for this location.

Table 2. Survey information of presently or presumed occupied sites of the San Joaquin tiger beetle within the San Joaquin Valley, California. Data from Knisley and Haines (2010 p. 11). NS=Not Surveyed.

Site Name	**County**	**Manager**	**Size (acres)**	**Peak Adult Count**						
				2006	**2007**	**2008**	**2009**	**2010**	**2023**	**2024**
Pixley NWR	Tulare	USFWS	195	35	--	--	28	15	Surveyed Absent	--
Allensworth State Historic Park	Tulare	CA State Parks	18	--	--	--	--	--	--	100
Guernsey	Kings	Private	247	150+	25	--	60+	35	Surveyed Present	--
Road 9	Madera	Private	69	--	--	1	0	0	--	--
Madera Ranch*	Madera	Private	1334	--	--	--	--	--	--	--
New Stone Ranch	Madera	Private	340	--	--	75+	36	26	--	--

*The Madera Ranch was confirmed to have a population of the San Joaquin tiger beetle based on surveys done for a 2011 environmental assessment for the Madera Irrigation District Water Supply Enhancement Project (see section 4.4.2).

4. Current and Potential Threats

FWS is required to list a species under the ESA if it is in danger of extinction or threatened by possible extinction in all or a significant portion of its range. In making such a determination, FWS must analyze the species' status considering five threat factors:

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms;
(E) other natural or manmade factors affecting its continued existence.

16 U.S.C. § 1533(a)(1)(A)-(E); 50 C.F.R. § 424.11(c)(1)-(5).

4.1. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

The San Joaquin tiger beetle is associated with alkali sink scrub and alkali meadow habitat in the San Joaquin Valley that has almost entirely been destroyed or highly altered for agriculture and human land uses. Less than 5% of the San Joaquin Valley floor is undeveloped for agriculture or urban areas, with significant portions of the remaining undeveloped land used for other purposes that also degrade the Valley floor ecosystem (FWS 1998 p. 1). While there is no estimate of the percentage of sink scrub habitat remaining in the San Joaquin Valley, any remaining alkali sink habitat exists in small fragments. The San Joaquin tiger beetle's known, occupied habitat, except for the Allensworth site, is unprotected and is high risk of conversion to other uses (Knisley 2014 p.122).

4.1.1. Row Crop and Orchard Agricultural Conversion and Altered Water Flow

Conversion of alkali sink habitat to row crops and orchards along with the concurrent disruption of water flow are the primary factors causing loss of suitable habitat for the San Joaquin tiger beetle (Knisley & Haines 2007 p. 109). The beetle is adapted to specific soil types and vegetation communities and is unable to adapt to survive in converted crop fields. Knisley and Haines's surveys of recently tilled alkali meadow habitat showed no evidence of this subspecies (Knisley & Haines 2007 p. 124). The beetle's immobile larvae are unable to escape the impacts of tillage and are likely all killed during tillage and the small, fragmented populations of the beetle are unable to recolonize plowed fields. Even if suitable habitat exists in fields the altered hydrology and agrochemicals present in the fields make cropland and orchards inhospitable for the San Joaquin tiger beetle (Knisley & Haines 2007 p. 124).

One of the few remaining occupied sites, a large former alkali sink habitat near Guernsey, was destroyed after being tilled and converted to pistachio orchards between 2010-2012 (Haines

March 2023 pers. comm.). Three sites where these beetles were found prior to 2007 have been similarly converted to other agricultural uses and no longer with beetles (Knisley & Haines 2010 p. 12)

Once tilled and planted, row crops and orchards rely heavily on agrochemicals including pesticides that are designed to kill insects and other pests. Currently occupied sites are surrounded by agriculture and pesticide drift or runoff could easily reach the beetles and their habitat. Only a small fraction of highly toxic pesticides reach their intended target with the excess toxins drifting off-field in the air, washing off the field via runoff, blowing off the field on contaminated dust, or seeping into groundwater (see section 4.5.2 for further detail on the off-field movement of pesticides and their toxic effects). Only small concentrations of toxic pesticides are required to directly harm and kill San Joaquin tiger beetles or harm their prey.

Cropland in the San Joaquin Valley requires a highly regulated water distribution network and reliance on groundwater pumping for irrigation that alters the hydrology in the region and degrades the beetle's habitat. The San Joaquin tiger beetle is adapted to periodic flooding and standing water, but natural flood regimes are completely disrupted in the Valley. Controlled flooding to protect crops reduces flooding as a periodic disturbance that maintains alkali sinks and soil moisture. The irrigated cropland in the San Joaquin Valley is also highly dependent on groundwater pumping. Subsurface soil moisture is important to larval survival (Knisley & Haines 2007 p. 111) and intensive groundwater pumping lowers the water table further reducing surface and subsurface soil moisture. Reduced soil moisture also likely reduces the abundance of small invertebrate prey that adults and larvae need.

4.1.2. Livestock Grazing

Livestock grazing is a chronic stressor to San Joaquin tiger beetles. Animal grazing, whether by large mammals or insects such as grasshoppers, has always been present in the San Joaquin Valley and is part of the natural disturbance cycles. However, cattle grazing in this desert ecosystem has increased the intensity of grazing disturbance that has short-term, negative impacts to tiger beetle's alkali sink habitat. In the short-term, heavy, hooved animals trample and destroy larval burrows within alkali sinks (Knisley & Haines 2007 p. 124). Trampling increases when there are more animals and can be especially detrimental around salt licks near alkali sinks because animals tend to spend more time around them (Knisley & Haines 2007 p. 124). Spring and fall rains also create pools that are important for maintaining soil moisture for emerging larvae, but cattle are attracted to drink from the pooled water that results in further trampling (Knisley 2007, p.124). During the wet periods, the alkaline soils become very soft because of general lack of vegetation that can maintain soil structure. Animals can drive their hooves deeper into the soft soils and increase the damage to larval burrows (Knisley & Haines 2007 p. 124).

Other endemic tiger beetles have been shown to be negatively impacted by livestock grazing. In Idaho, 76%-80% of larvae of *C. arenicola* that were trampled by cattle never reopened their burrows compared to 14% of undisturbed burrows (Bauer 1991 p. 230), while in Missouri, an endemic form of *C. circumpicta johnsonii* was nearly extirpated because of cattle grazing (Brown & MacRae 2003 cited in Knisley 2011 p. 51). Grazing is also explicitly mentioned as a threat to the survival of the endangered Salt Creek tiger beetle in FWS's 2005 proposed listing rule for the species (FWS 2005a p. 5108).

Livestock grazing occurs on all currently occupied sites of the San Joaquin tiger beetle except at the Allensworth site. The severity of grazing impacts depends on the number of animals and timing of grazing. The combination of drought and heavy grazing has resulted in over grazed and desiccated conditions at the Pixley NWR (Figure 5 from Knisley 2011 p. 51). The Pixley NWR has had grazing animals for decades but has no explicit management to conserve alkali sinks. Cattle at Pixley NWR graze from November to April (FWS 2005b p. 72) which are the wettest times of the year and may have greater impacts than grazing during the summer. Populations of the San Joaquin tiger beetle are not currently monitored at the refuge, yet Knisley and Haine's surveys of the refuge showed lower numbers of the beetle at the Pixley NWR than at the Guernsey site despite their geographic proximity and similar area (Table 2). Overgrazing at the Pixley NWR may have contributed to lack of observations during the 2023 survey (Knisley July 2024 pers. comm.). The Guernsey site has some evidence of grazing, but it appears to be less intensive than at Pixley NWR (pers. obs.). Knisley argues that, comparing the Pixley NWR to other known locations, sites with more limited grazing cattle grazing improved the beetle population by limiting trampling while also removing vegetation (Knisley 2011 pp. 50–51). Grazing intensity at the Road 9 site, the New Stone Ranch, and the Madera Ranch is unknown, but is assumed to be typical for the area.

Figure 5. Photograph of Tulare Co. site at the Pixley NWR in 2008 after a drought and heavy cattle grazing. Photograph from Knisley and Haines (2010 p. 51).

4.1.3. Groundwater Infiltration Projects

Groundwater infiltration projects are likely to become more common in the San Joaquin Valley and have the potential to kill San Joaquin tiger beetles by inundating their habitat for periods longer than the beetles can survive. Unsustainable groundwater withdrawal to support agriculture in the arid San Joaquin Valley has led to county and state initiatives to implement groundwater infiltration projects to promote the recharge of groundwater. For example, the Madera Irrigation District Water Supply Enhancement Project proposed and implemented a project on a known occupied area of the San Joaquin tiger beetle that flooded one section of the Madera Ranch and likely drowned tiger beetles in the flooded area (Bureau of Reclamation 2011 pp. 3-58–59). Infiltration projects like this flood certain areas at a higher volume and potentially for longer periods than historic, natural flooding regimes. Tiger beetles can withstand inundation as long as three weeks (Pearson 1988 p. 136), but cannot survive continual or prolonged inundation.

4.1.4. Solar Energy Production

Solar energy production is a relatively new land use in the Central Valley. While solar energy production is needed and vital for a green energy transition, if projects are not thoughtfully sited and implemented appropriately, they could destroy or degrade habitat, including for the San Joaquin tiger beetle. California's incentives and initiatives to increase renewable energy production have increased open land conversion to solar farms. These solar energy projects typically install ground-mounted panels that can cover large areas. Solar projects can have negative, neutral, or positive effects depending on the habitat needs of wildlife. For example, pollinating insects have been shown to inhabit solar farm environments if there is sufficient flowering plants underneath the panels and no or little pesticide is used (Blaydes et al. 2021 pp. 4–8). On the other hand, large solar facilities in the Mojave Desert are generally considered detrimental to fragile desert ecosystems (Parker et al. 2018 p. 8; Grodsky & Hernandez 2020 p. 1037; Grodsky et al. 2021 p. 5). The San Joaquin Valley is an arid, desert environment and impacts to wildlife similar to those seen in the Mojave Desert ecosystems are likely if considerations for the needs of the beetle are not included in site development. Installation of a new solar farm on unplowed alkali sink habitat could result in large disturbance of soil that could harm tiger beetles and larvae during construction. If a population was to survive construction, disturbance from ongoing maintenance including mowing, and panel cleaning could also trample larval burrows and maintenance herbicide application could introduce toxins to the soil. Herbicides such as 2,4-D in formulated products can have direct, toxic effects to beetles (Freydier & Lundgren 2016 p. 5). Additionally, a lack of disturbance that maintains bare soil favors invasive grasses that reduce larval sites and hunting areas for the tiger beetle. Furthermore, there are no studies that have confirmed the coexistence of tiger beetles in the areas underneath solar panels.

4.2. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

San Joaquin tiger beetles are highly vulnerable to overcollection because of their very limited population size and rarity. Tiger beetles may be among the most intensively collected genera (FWS 2000 p. 6955). Collectors and naturalists take rare, adult tiger beetles for a variety of purposes including scientific research and commercial sale. The collection and sale of rare insects has increased in recent decades and the rarity of a species can increase its value among collectors (FWS 2000 p. 6955). One of the original researchers of this species has received inquiries from individuals seeking to collect the San Joaquin tiger beetle since it was first described in 2007 (Haines March 2023 pers. comm.). Overutilization can result in population declines if collectors take high percentages of a small population, especially if collection occurs before oviposition (Knisley et al. 2014 p. 138). Other factors such as easy access to habitat, the absence of nearby populations, and the concentration of adults in open habitats can elevate the risk to this vulnerable species. Both living and dead tiger beetles of many species can be purchased online, with rare species being more sought after and thus more vulnerable to extirpation.

4.3. Disease or Predation

Petitioners are not aware that any populations of the San Joaquin tiger beetle are threatened by disease. However, disease has been implicated in the decline of other imperiled invertebrate species such as the ESA-listed rusty-patched bumble bee (Szymanski et al. 2016 pp. 40–43). In bumble bees, disease is known to spillover from domesticated honey bees and bumble bees to wild populations (Colla et al. 2006 p. 464). It is possible that diseases from coleopteran pests in nearby almond and pistachio orchards could spill over to wild beetles. At least two beetles are considered pests to almond and pistachio crops: the ten-lined June beetles (*Polyphila sobrina*) and a sap beetle (*Caprophilus truncates*) (University of California, Agriculture and Natural Resources 2024 pp. 1–4). To control these beetle (or other insect) pests, growers may introduce insecticides and also biocontrols including bacteria, entomopathogenic fungi, or viruses (Abd-Alla et al. 2020 p. 277; Sanchez 2020 p. 1). Biocontrols could spread via spores or dust from nearby orchards and harm San Joaquin tiger beetles. Whether endemic or introduced, disease and biocontrols can exacerbate existing threats making each population less resilient to current and future stressors.

Predation is also not known to detrimentally impact the San Joaquin tiger beetle. Tiger beetles do have some natural predators including birds, racoons, shrews, lizards, toads, robber flies, and dragonflies (Pearson et al. 2005 p. 183). Predatory animals are important parts of the local ecosystems and generally do not reduce prey populations to localized extirpation. Several parasitoids also are known to use tiger beetles larvae as hosts including wasps of the family Typhiidae and the Bombyliid flies of the genus *Anthrax* (Pearson 1988 p. 136). The severity of the impact from predators and parasites is unclear but could reduce the resilience of the San Joaquin tiger beetle to other current and future stressors.

4.4. Inadequacy of Existing Regulatory Mechanisms

4.4.1. International, National, and State Wildlife Protection Laws

International

NatureServe, an international network and authoritative source of biodiversity information, identifies the San Joaquin tiger beetle with a rank of G5T1 meaning the subspecies is critically imperiled on a global scale, and S1 meaning the subspecies is critically imperiled within

California (NatureServe 2023 p. 1). The NatureServe ranking has not been updated since 2005, and rankings are informational only and do not represent protected status at any governmental level.

The San Joaquin tiger beetle is not protected under the Committee for the International Trade of Endangered Species or any other international wildlife protection treaty or law.

National Regulation and Incidental Protection from Other ESA Listed Species

Neither the San Joaquin tiger beetle nor the oblique-lined tiger beetle are currently protected under the Federal Endangered Species Act. FWS recognized this species as in need of protection in 1994 by designating it a category two candidate species for listing (FWS 1994 p. 59014). Candidate status is an inadequate regulatory mechanism since candidate species receive no statutory protection (FWS 1994 p. 59014). In 1996, the FWS discontinued the practice of maintaining a category two candidate species list and instead reassigned these species as "species of concern," which does not provide any formal protections.

Protections for other ESA listed species in the San Joaquin Valley are insufficient for the protection of the San Joaquin tiger beetle. The ESA protects 14 other species in the San Joaquin Valley (FWS 1998 pp. 2–3) 11 of which are covered under the Recovery Plan for Upland Species of the San Joaquin Valley and three recently listed species. The currently protected species of the San Joaquin Valley occupy various ecological niches and provide protection at several areas. The Recovery Plan for Upland Species of the San Joaquin Valley presents important information about where protected species are located and it makes recommendations for protecting species listed or that could be listed under the ESA. However, Recovery Plans and Recovery Implementation Strategies represent guidance documents and are not regulations. A recovery plan for species in similar habitats is not a regulatory mechanism nor is it sufficient to protect the San Joaquin tiger beetle.

The palmate-bracted bird's beak (*Cordylanthus palmatus*) is a protected plant species that is found in alkali sink habitat (FWS 1998 p. 33) and is the only protected species in the Valley that is specifically found only in sink scrub alkali meadow habitat. There are eight known populations of this plant with two populations potentially in the range of the San Joaquin tiger beetle at the Alkali Sink Ecological Reserve and the nearby Mendota Wildlife Area (FWS 2023 p. 2). Neither of these sites have known populations of the San Joaquin tiger beetle so their protections are not relevant. Other ecological preserves such as the Kerman Ecological Reserve, the Semitropic Ecological Reserve, and the Kern NWR also protect suitable alkali sink scrub habitat, but additional survey is needed to confirm if the San Joaquin tiger beetle is present in these areas (Knisley & Haines 2010 pp. 17-18). Currently, the San Joaquin tiger beetle is not protected under any habitat conservation plan for any ESA listed species.

California

The San Joaquin tiger beetle is on the California Department of Fish and Wildlife's "Special Animals" list (California Natural Diversity Database 2023 p. 40) and is identified as a Species of Greatest Conservation Need in the State Wildlife Action Plan (California Department of Fish and

Wildlife (CDFW) 2015 Appendix C). Both lists identify all animals tracked by the California Natural Diversity Database regardless of their protected status and are for informational purposes and do not represent legal protections. The San Joaquin tiger beetle has no legal protection in California because it is not listed under the California Endangered Species Act (CESA). No county or city in the species range has developed regulations that specifically protect or incidentally protect the San Joaquin tiger beetle. No CESA-only protected species are known to co-occur with the San Joaquin tiger beetle.

Pixley National Wildlife Refuge

The Pixley NWR does offer some protection for the beetle from the threat of development, but not enough to constitute an adequate regulatory mechnism. The Pixley NWR provides habitat for several ESA listed species including Tipton kangaroo rats, blunt-nosed leopard lizards, and San Joaquin kit foxes as well as for other species of concern and many migratory birds. Unfortunately, the Pixley NWR does not consider or mention the San Joquin tiger beetle in its comprehensive conservation plan and the refuge is not managed in a way that intentionally conserves the beetle's habitat. Ongoing cattle grazing likely has a negative impact on the beetle by introducing invasive species and trampling of alkali sinks (see section 4.1.2.). Flooding is controlled at the refuge and regular flooding of alkali sinks is no longer allowed which can facilitate the spread of invasive grasses, contribute to desiccation of soils, and reduce prey abundance (see above section 4.1 and subsections). Any incidental protections for the San Joaquin tiger beetle at the Pixley NWR protect only the population there and have no impact on populations on private land.

4.4.2. National Environmental Policy Act and California Environmental Quality Act

The National Environmental Policy Act (NEPA) requires federal agencies to assess environmental effects of proposed actions prior to making decisions. NEPA requires federal agencies to prepare Environmental Impact Statements (EISs) that assess environmental impacts of proposed projects and alternatives. NEPA does not compel federal agencies to protect sensitive species, therefore, NEPA alone is inadequate to protect the San Joaquin tiger beetle from projects that could destroy or adversely modify the beetle's habitat.

The California Environmental Quality Act (CEQA) requires state and local agencies to identify significant environmental impacts of their actions and avoid or mitigate them. Under CEQA agencies are required to prepare Environmental Impact Reports (EIRs) to provide full public disclosure of the environmental impacts of a proposed project.

Some EISs and EIRs for projects in the San Joaquin Valley have considered the implications of harm to the San Joaquin tiger beetle but have not protected its populations. For example, in 2011 the Bureau of Reclamation finalized an EIS for the Madera Irrigation District Water Supply Enhancement Project, a water banking project on the Madera Ranch. The San Joaquin tiger beetle is known to occupy the Madera Ranch and the EIS states that individuals in approximately 10% of the potential habitat would be harmed during construction and through maintenance activities (Bureau of Reclamation 2011 pp. 3-58–59). Overall, no special mitigations were implemented for this project to protect the tiger beetle, and no additional habitat was protected.

4.4.3. Pesticide Regulations

Current regulatory mechanisms to protect vulnerable, non-target insects against pesticide threats are ineffective. The Environmental Protection Agency (EPA) licenses the sale and use of all pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA, 7 U.S.C. § 136 et seq). FIFRA directs EPA to register a pesticide only upon determining that "when used in accordance with widespread and commonly recognized practice it will not generally cause unreasonable adverse effects on the environment" (7 U.S.C § 136a(c)(5)(D)). The EPA conducts a cost-benefit analysis in undergoing this assessment and the use of this method has continued to allow numerous highly toxic pesticides, like neonicotinoid insecticides, to be used across the country. FIFRA does not compel the EPA to take any action to prevent the extinction of any species. The cost-benefit analysis under FIFRA permits the EPA to condemn a species to extinction if the benefits of the use of a pesticide are considered to outweigh the cost of potentially eradicating a species. Thus, pesticide regulation under FIFRA is not precautionary and does not provide an adequate regulatory mechanism for protecting the San Joaquin tiger beetle.

EPA's risk assessments of toxicity to all terrestrial invertebrates are based on toxicity to the honey bee as a surrogate and may underestimate toxicity or exposure to tiger beetles. Pesticide toxicity to insects exists on a spectrum where pesticide toxicity is variable across insect taxa. The honey bee is sensitive to many pesticides, but based on comparisons of toxicity across other bee species the honey bee is not a protective standard for all bees (Shahmohamadloo et al. 2024 p. 5) nor is it protective for all terrestrial invertebrates. Reliance on the honey bee as a surrogate has critical limitations that may underestimate toxicity and routes of exposure for tiger beetles. For example, the honey bee does not spend any of its life cycle in the soil while a tiger beetle spends all of its life either on the surface or burrowed in soil. Honey bees live in large hives that can number in the thousands of individuals so impacts to some individuals is buffered at the colony level. Individual honey bees live on nectar and pollen. The San Joaquin tiger beetle is an entirely solitary predator that lives on a diet of smaller invertebrates. Habitat, diet, and life history are completely different between a tiger beetle and a honey bee. A pesticide risk assessment to tiger beetles specifically would reach different risk conclusions than one done with the honey bee.

Furthermore, EPA has only engaged in ESA Section 7 consultation efforts with FWS regarding pesticide registration for ~30 pesticides that are in various stages of the informal consultation process. For the pesticides that EPA has commenced consultation for, EPA has released draft, and in some cases final, Biological Evaluations on the risk to listed species and requested formal consultation. These Biological Evaluations are only the first step in the consultation process. Biological Evaluations may be inaccurate for multiple reasons including from reliance on inaccurate usage data, inaccurate species range maps, faulty exposure assumptions, and a lack of species life history knowledge. These Biological Evaluations require action from the experts at FWS through Biological Opinions that describe specific non-discretionary protective measures and thresholds issued concurrently with Section 9 take coverage to translate to on-the-ground conservation benefits. The FWS has completed very few pesticides biological opinions for individual pesticides, and there is no programmatic Biological Opinion in place to protect San Juaquin tiger beetles.

The San Juaquin tiger beetled is not protected by an adequate existing regulatory mechanisms.

4.5. Other Natural or Manmade Factors Affecting Its Continued Existence

4.5.1. Invasive Species Encroachment

Natural plant succession and the spread of invasive plants can eliminate the bare ground that the San Joaquin tiger beetle needs to hunt and lay its eggs (Knisley & Haines 2007 p.124). Many invasive, non-native, plant species have become established across the San Joaquin Valley where they can outcompete native plant species and exploit bare patches. The primary invasive species threatening San Joaquin tiger beetle habitat are: Mediterranean grasses (*Bromus diandrus*, *B. madritensis rubens*, *B. hordeaceus*, and *Hordeum murinum leporinum*), as well as several annual forbs (*Bassia hyssopifolia*, *Erodium* spp., *Malva parvifolia*, and *Melilotus indica*) (Knisley & Haines 2007 p. 124).

Alkali sinks tend to have highly saline soil where halophytes, plants adapted to saline soil conditions, grow better than other species. The alkali sinks are formed by repeated flooding and drying that raises the alkalinity of the soils, however, changes in hydrology from agriculture and general aridification has resulted in less frequent flooding. Standing water from floods naturally restricts the growth of certain plant species while also leaving behind salt deposits when the pools dry. Less frequent flooding means that non-halophyte plants are better able to establish in alkali sinks that are becoming less saline over time.

Vegetation encroachment is considered a threat to and a cause of decline of other tiger beetles including *C. abdominalis* (Knisley & Hill 1992 cited in Knisley 2007 p. 124), *C. ohlone* (Knisley unpublished studies cited in Knisley & Haines 2007 p. 124), and *C. debilis* (Knisley & Shultz 1997 cited in Knisley & Haines 2007 p. 124). The San Joaquin tiger beetle is likely similarly impacted by encroachment (Knisley & Haines 2007 p.124).

4.5.2. Pesticides

Pesticides pose a clear and present danger to the San Joaquin tiger beetle as all known occupied locations are surrounded by intensive agriculture. Cropland surrounding the San Joaquin tiger beetle occupied habitat is likely to result in acute and chronic exposure to the beetle from a toxic cocktail of pesticides. No studies have evaluated the impact of pesticides to the San Joaquin tiger beetle, however research on pesticide impacts to other beetles and insects indicate that many pesticides used in agriculture around the occupied areas can or will have acute and chronic impacts to the San Joaquin tiger beetle.

Overall, farmland is becoming more toxic to insects as total applied pesticide toxicity has increased for terrestrial invertebrates from 2002-2015 despite lower volumes of pesticides being applied (Schulz et al. 2021 p. 2). The acute toxic loading of the environment from insecticides has increased 48-fold for oral toxicity and by a factor of four for contact toxicity from 1992-2014 (DiBartolomeis et al. 2019 pp. 11–12). This increase is primarily from the increased use of neonicotinoid insecticides (DiBartolomeis et al. 2019 p. 18).

Almond and pistachio production is very common in the area and hundreds of pesticide active ingredients are labeled for use on these orchard crops including many highly toxic insecticides. Both crops have a large number of insect and arachnid pests as well as fungal and other diseases that are often treated with pesticides (University of California, Agriculture and Natural Resources 2024 pp. 1–4). Producers also use herbicides to clear unwanted understory vegetation. Coleopteran pests of almond and pistachio include the carpophilus beetle (*Carpophilus truncatus*) and the ten-lined June beetle (*Polyphylla decemlineata*) (University of California, Agriculture and Natural Resources 2024 p. 2). Any insecticide exposure used to treat insect pests is likely to adversely affect and may jeopardize the survival of the San Joaquin tiger beetle. Fungicide and herbicides used in the fields also have the potential to likely adversely affect and jeopardize this species even if their acute lethal toxicity is lower. Due to the large number of potential pesticides and combinations of pesticides potentially present on or near the tiger beetle habitat, the impacts of specific active ingredients is an overview but not the full analysis that FWS should undertake in assessing the threats pesticides pose to this species, especially from the hundreds of pesticides that can be used in the San Joaquin tiger beetle's habitat.

Routes of Exposure

The San Joaquin tiger beetle can be exposed to pesticides via several routes of exposure including through drift, blowing dust, contaminated prey, and contaminated surface and groundwater. Pesticides are also likely to produce indirect impacts such as through a reduction in prey or a reduction in vegetation.

Drift of aerosolized particles via ground boom application or application from airplane can also result in direct exposure. Many pesticides are applied in the spring and early summer to suppress pest populations before they cause damage, but spring is also when adults are actively ovipositing. Pesticides can drift through the air for hundreds of feet and potentially miles depending on application method and environmental conditions (EPA 2023 pp. 19–23). Volatile pesticides stay airborne longer. Some populations of the tiger beetle are directly across a road from orchards where drift could easily reach them.

Other direct exposure includes from contaminated soil and water. The San Joaquin tiger beetle spends its entire life in contact with soil and may be exposed to chronic low-levels doses of pesticides that are likely to impact behavior, reproduction, and overall health. Only a small portion of any applied pesticide contacts the target pest and overspray settles onto the soil surface where it remains until it degrades. Contaminated soil from fields can then become airborne and is a significant source of particulate matter in the San Joaquin Valley that is known to spread toxic pesticides (Ayres et al. 2022 pp. 15–16). The hot, dry summers of the San Joaquin Valley and the bare soil that is maintained in orchards creates conditions for dust to blow away from the treated fields. Mechanical tillage, especially of dry soil, also releases large amounts of dust into the air that can drift significant distances depending on wind conditions and could easily drift into occupied beetle habitat. Due to the high toxicity of neonicotinoid insecticides only small amounts of dust contaminated with neonicotinoids are needed to cause acute or chronic toxicity. Uncontrolled flood waters may also become contaminated and runoff from treated fields into tiger beetle habitat. Additionally, many pesticides are known to contaminate groundwater as they leach into the soil after irrigatation or after rains. The San Joaquin tiger beetle relies on shallow groundwater to maintain soil moisture that may become contaminated. Wells in the San Joaquin Valley are known to be contaminated with pesticides (Burow et al. 2008 p. 249).

San Joaquin tiger beetles can experience secondary exposed to pesticides through the ingestion of contaminated prey. Both larvae and adults primarily consume small invertebrates that live in vegetation or in the soil. Invertebrate prey items may take up residual pesticides through consumption of contaminated leaf matter and through their contact with the soil. These pesticide residues are then transferred to the tiger beetles. Both larvae and adult beetles consume most of their water through their prey so may have limited ability to consume uncontaminated water. Prey populations may also be reduced if they are exposed to levels of pesticides that reduce their reproduction.

Pesticides of Particular Concern

The group of pesticides of greatest concern are the class of insecticides known as neonicotinoids. These systemic insecticides are present in all parts of a plant, are highly persistent, and very highly toxic to insects. Neonicotinoids include the most used insecticide imidacloprid as well as clothianidin, thiamethoxam, acetamiprid, dinotefuran, and sulfoxaflor. Neonicotinoids mode of action is to interfere with the acetylcholine receptors in the insect brain that causes the nervous system to stop functioning leading to paralysis and death (EPA 2017 p. 11).

Neonicotinoids are very highly toxic to insects (EPA 2020 p. 24) based on toxicity to the honey bee. Neonicotinoids are toxic even at low levels and toxicity has been shown to increase with increased exposure time (Sánchez-Bayo & Tennekes 2020 p. 13). Neonicotinoid toxicity to tiger beetles is largely unknown and the tiger beetle has a completely different life history compared to the honey bee that may result in higher toxicity to tiger beetles (as noted in section 4.4.3). One available study on *Cicindela circumpicta* showed that this tiger beetle was three times more sensitive to the neonicotinoid imidacloprid compared to insect pollinators (Svehla et al. 2023 pp. 194–196). Additional studies of neonicotinoid toxicity to beetles and predatory insects show there is clear evidence of harm. For example, toxicity studies of beneficial predatory insects in crop systems such as lady beetles (Coleoptera:Coccinellidae) show that the neonicotinoid clothianidin is highly toxic to predatory lady beetles (Jiang et al. 2018 p. 211). Lady beetles, if not exposed at a lethal level, can experience reduced lifespan and fecundity after exposure to neonicotinoids (Pisa et al. 2021 p. 11763).

While neonicotinoid use is ubiquitous in orchards and poses unique risks due to them being systemic and highly persistent, they are far from the only insecticides used. All insecticide use poses grave threats to San Joaquin tiger beetles.

Insecticides are not the only pesticides that are likely present in adjacent almond or pistachio orchards. Fungicides are regularly used in these orchards and several fungicides are known to have reproductive and other sublethal effects to rove beetles (Samsøe-Petersen 1995 p. 149). Among the most commonly used fungicides, chlorothalonil, when applied to Japanese beetles reduced the survival of first-instar larvae and impaired detoxifying enzymes (Obear et al. 2016 p. 972).

Herbicides are also commonly used in orchards to manage unwanted vegetation, and many herbicides have lethal or sublethal impacts to insects. For example, a 2,4-D formulated product had similar toxicity to lady beetles as an insecticide product with an LC_{90} at 13% of the label rate (Freydier & Lundgren 2016 p. 5). Toxicity from single pesticide active ingredients is also not the only concern. The EPA does not look at the impacts of pesticide synergy or so-called "inert" ingredients in pesticide formulas. The toxicity of 2,4-D was shown to be driven by the inactive ingredients in the formulated product (Freydier & Lundgren 2016 p. 5).

Pesticide Impacts to Other Listed Insects

Pesticide exposure is a common threat across listed insects, especially those near agricultural or urban areas. The endangered Salt Creek tiger beetle recovery plan identifies pesticide exposure as a threat to the species (FWS 2016 p. 2–8). The Ohlone tiger beetle is also impacted by pesticides from urban areas through drift and runoff (FWS 2000 p. 6957). A survey of critical habitat for the endangered prairie butterflies Dakota skipper and Poweshiek skipperling, shows that even protected areas are exposed to pesticides that drift in from adjacent cropland (Runquist et al. 2024 p. 542).

EPA has only engaged in ESA Section 7 consultations with FWS regarding the registration of ~30 pesticides out of the ~1,100 active ingredients currently registered for use. As a result, EPA and FWS know only a small extent of the potential harms from pesticides to listed species. EPA has recently acknowledged in Biological Evaluations for 32 pesticide active ingredients that other listed tiger beetles are likely adversely affected by at least 15 pesticides and are potentially jeopardized by the continued use of multiple insecticides (Table 3). Of those pesticides assessed, seven pesticides, including six neonicotinoids and one herbicide, potentially jeopardize the continued existence of the Salt Creek tiger beetle (Table 3).

Table 3. Summary of EPA's Biological Evaluation findings for pesticide impacts to listed tiger beetles. As of 5/2024.

Common Name	Percent Likely Adversely Affect	Number of Preliminary Jeopardy Determinations	Number of Preliminary Adverse Modification Determinations
Miami tiger beetle	50%	2 Acetamiprid and Sulfoxaflor	0
northeastern beach tiger beetle	53%	3 Clothianidin, Imidacloprid, and Thiamethoxam	0
Ohlone tiger beetle	50%	2 Acetamiprid and Dinotefuran	0
Puritan tiger beetle	50%	0	0
Salt Creek tiger beetle	53%	7 Acetamiprid, Clothianidin, Dinotefuran, Glufosinate-P,	7 Acetamiprid, Clothianidin, Dinotefuran, Glufosinate-P,

		Imidacloprid, Sulfoxaflor, Thiamethoxam	Imidacloprid, Sulfoxaflor, Thiamethoxam

4.5.3. Small Populations and Allee Effects

The San Joaquin tiger beetle is known to exist in only small populations in isolated habitat fragments. Small population size can lead to lack of genetic diversity, inbreeding depression, the Allee effect, and related impacts in tiger beetles (Knisley et al. 2014 p. 138). Little information exists on population density or population size at the currently occupied sites and the minimum viable population size or minimum occupied area is unclear. For comparison, the Recovery Plan for the Salt Creek tiger beetle states that the minimum viable population size is 500-1000 individuals (FWS 2016 pp. 2–11). Given that the surveys for the species have produced a high count of ~150 individuals, it is unlikely that any of the current populations of the San Joaquin tiger beetle are viable compared to a viable population size of 500-1000 individuals, highlighting the urgent need for protection and recovery actions.

4.5.4. Climate Change

Aridification in California's Central Valley is likely to decrease soil moisture in ways that will negatively impact the San Joaquin tiger beetle. The San Joaquin Valley is considered a desert (Germano et al. 2011 p. 145) (BSk under the Köppen climate classification) (USDA Hardiness zone 9a) that experiences hot, dry summers and cool, wet winters. Visalia, a representative city in the area, receives 262.1 mm (10.3 in) of rain per year on average with most precipitation coming from November to April (NOAA 2024 p. 2). While the San Joaquin tiger beetle is adapted to a hot and dry climate, the Southwest is expected to become hotter and dryer as a result of anthropogenic climate change (Gonzalez et al. 2018 pp. 1104–1106). The fourth national climate assessment shows that the average temperature in the Southwest has already increased 0.9°C from 1901-2016 (Gonzalez et al. 2018 p. 1108).

Changes in precipitation patterns may include decreased winter precipitation and snowpack that are projected to lower groundwater recharge levels across the western United States and by an estimated 5% in the Central Valley by 2100 (Meixner et al. 2016 p. 133). Increased temperatures and decreased precipitation decrease groundwater recharge rates and are likely to increase the severity and duration of droughts across the region (Gonzalez et al. 2018 p. 1109). Greater evapotranspiration from plants lowers soil moisture at a faster rate under increased temperatures caused by climate change (Gonzalez et al. 2018 p. 1109). Increased evapotranspiration means that crops and orchards in the area will require even more water to survive and produce during the growing season which will require even more groundwater pumping that will lower the groundwater further. The increased evapotranspiration of San Joaquin Valley soils will not be compensated by increases in flooding because flooding is very controlled in the San Joaquin Valley. Flooding is now much less frequent and lasts for shorter amounts of time, further reducing the amount of water that infiltrates into the soil.

Hotter, dryer summers and especially dryer winters are likely to harm the beetle if declining precipitation reaches a point where the soils do not retain enough moisture for larvae to survive or it reduces prey abundance.

5. Request for Critical Habitat Designation

Critical habitat is an extremely effective and important component of the ESA, without which the San Joaquin tiger beetle's chance for survival significantly diminishes. Petitioner requests that the Service propose all currently occupied areas as critical habitat for the beetle concurrent with its listing as endangered under the ESA. Critical habitat as defined by Section 3 of the ESA is: (i) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) the specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species (16 U.S.C. § 1532(5)).

6. Conclusion

The San Joaquin tiger beetle is in dire need of protection under the Endangered Species Act to insure its continued survival. This rare, highly localized subspecies has become extirpated from all historically known sites and is declining in abundance at all currently occupied sites except one newly discovered site that has only been surveyed once. The beetle faces multiple threats that can destroy or degrade its habitat. Human land use change threatens to eliminate populations of this tiger beetle primarily through the conversion of its alkali sink habitat to almond and pistachio orchards. Invasive species, pesticides, climate change, over collection, and small population size also present clear threats to this species. The beetle's populations on public or private land offer limited or no protection and no protections for other ESA-listed species adequately protect the San Joaquin tiger beetle in its current habitat areas. Regulations for development, pesticide use, or water use in the Valley do not provide adequate protection. Gaining protection under the ESA is the best chance for this beetle to avoid wholesale habitat destruction, poisoning from pesticides, or the drying up of its habitat. This species was only described in 2007 and without ESA protection this beautiful species will fade away forever.

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