SPECIES STATUS ASSESSMENT REPORT FOR THE CASEY'S JUNE BEETLE (*Dinacoma caseyi*)

Photo Credit: USFWS

U. S. Fish and Wildlife Service
Pacific Southwest Region
Carlsbad Fish and Wildlife Office
Version 1.0
March 2025

ACKNOWLEDGEMENTS

This document was prepared by the U.S. Fish and Wildlife Service's Carlsbad Field Office. Additionally, valuable peer reviews of a draft of this document were provided by Dan Malcolm and Michael Wilcox. We would also like to recognize Kendall H. Osborne for his feedback on early drafts and his support in furthering our understanding of Casey's June beetle and its ecology. We appreciate their comments, which resulted in a more robust status assessment and final report.

Primary Contributors

- Julie Simonsen - Carlsbad Field Office, Fish and Wildlife Biologist – primary author
- Bradd Bridges – Carlsbad Field Office, Listing and Recovery Division Supervisor
- Noelle Ronan – Palm Springs Field Office, Fish and Wildlife Biologist

Contributors and Agency Reviewers

- Daniel Malcolm-Agua Caliente Band of Cahuilla Indians, Director of Planning
- Michael Wilcox-WSP Consulting, Biologist
- Kendall H. Osborne-Osborne Biological Consulting, Entomologist

Recommended Citation:

U.S. Fish and Wildlife Service. 2025. Species status assessment report for Casey's June beetle (*Dinacoma caseyi*), Version 1.0. March 2025. U.S. Fish and Wildlife Service. Pacific Southwest Region. Carlsbad Fish and Wildlife Office.

EXECUTIVE SUMMARY

We, the U.S. Fish and Wildlife Service (Service), developed this Species Status Assessment (SSA) report for Casey's June beetle (*Dinacoma caseyi*) to gather the best scientific and commercial information available on the species. This SSA Report is intended to provide the biological and ecological information for determining a recovery strategy for the beetle including defining downlisting and delisting criteria.

Casey's June beetle was listed as endangered under the Endangered Species Act in 2011. It is a narrow endemic scarab beetle known only from the alluvial fans of the Coachella Valley in the vicinity of Palm Springs, California. Pronounced sexual dimorphism is evident between the smaller, white-colored males and the larger, brown, wingless females. Most of the species' life cycle is spent underground until it molts into an adult to breed between late March and May. The species' lifespan is thought to be approximately 1 year with adults persisting for approximately 3 days (Harju 2021, p. 15). Adult activity is crepuscular with large numbers of individuals emerging from the ground as early as an hour before sunset (Hovore 2003, p. 3; Ronan et al. 2024, p. 50), which is believed to be a means of avoiding predation and heat stress (La Rue 2016, p. 22). Casey's June beetle has egg, larval, pupal, and adult life stages and all are subterranean except for breeding and male dispersal. During the immature life-stages, the beetle feeds on detritus and rootlets.

Casey's June beetle requires that individual habitat and population demographic needs be met for the core population in the Palm Canyon Wash floodplain to be resilient. Casey's June beetle habitat is typically associated with broad, gently sloping, depositional surfaces that form at the base of the Santa Rosa and San Jacinto Mountains (Bates and Jackson 1987, p. 52). The species habitat needs are closely tied to the dynamics of the alluvial fan ecosystem including: 1) input of water to support vegetation; 2) periodic (flood-based) erosion/deposition of sediment and layering of detritus (an important food resource); 3) moist, abiotic conditions for immature stages of the beetle; and 4) dispersal of individuals, including the flightless female beetles. To reproduce successfully, Casey's June beetle needs appropriate habitat and climate conditions, habitat connectivity, and sufficient abundance.

To evaluate the biological status of Casey's June beetle both currently and into the future, we assessed a range of conditions to allow us to consider the species' resiliency, redundancy, and representation. We evaluated how threats such as habitat loss and fragmentation from development, altered hydrology from flood control structures and maintenance, soil disturbance from recreation activities, and the effects of climate change (e.g., drought, increased temperatures, prolonged drought, extreme precipitation events and increased risk of wildfire) influence the species' future viability. Habitat loss and fragmentation is the highest magnitude threat currently due to direct habitat loss, artificial nighttime lighting of areas relatively near beetle habitat (that can pull reproductive males way from suitable habitat where females occur), and reductions in ecosystem connectivity due to artificial structures and habitat fragmentation. As a result, or consequence of development in the floodplain, flood control structures have concentrated flood flows into smaller areas and removed areas from the floodplain over the last

70 years. The beetle has persisted in some areas under these conditions but current increases in extreme precipitation events and subsequent flood control maintenance activities are increasing the frequency of disturbance of existing and potential habitat. Relatedly, altered hydrology is considered a moderate threat. Additional climate change effects including drought, increased temperatures, and increased risk of wildfire are also moderate threats. Over the last extended drought, abundance was lower likely through a combination of decreased soil moisture and reduced vegetation cover potentially creating lower quality habitat for the immature stages of the beetle, though we lack abundance data prior to this event. The increased risk and frequency of wildfire is expected to increase the disturbance frequency particularly because fire events in the associated watersheds are often followed by extreme precipitation events and flooding in wash habitat. These moderate and high magnitude threats have combined effects on the beetle that are projected to increase in the future.

The future scenarios evaluated in this SSA report are summarized below and were analyzed in one population within the Palm Canyon Wash floodplain.

- Scenario 1 – a continuation of current threats under the RCP4.5 climate scenario (2040-2069).
- Scenario 2 – an increase in the magnitude of current threats under the RCP8.5 climate scenario (2070-2100).
- Scenario 3 – a continuation of current threats under the RCP4.5 climate scenario with the implementation of increased conservation activities (2070-2100).

The viability of Casey's June beetle depends on maintaining a resilient population over time, having sufficient redundancy to withstand catastrophic events, and sufficient representation to adapt to a changing environment. The species has unique life history and ecological factors that confer both higher and lower adaptive capacity. Casey's June beetle evolved under arid desert conditions and demonstrated a tolerance to the range of environmental extremes and temperature increases observed over the recent past. It is a narrow endemic associated with desert alluvial fans across approximately 1,989 ac (805 ha)[1] of currently available suitable habitat, which confers lower representation. But the species' current distribution includes habitat niches that are important to maintain representation including a range of suitable alluvial soils, vegetation type, vegetation cover, elevation, slope, and aspects that could help mitigate short term changes in environmental conditions. It is an insect with short (~1 year) generation time improving its ability to adapt to progressive changes in its environment. The species has a relatively broad diet niche including detritus and rootlets from a varied number of plant species and is not believed to be tied to an obligate host plant. Behaviorally, immature stages of the beetle are expected to move to some degree within the sediment column to forage on detritus and rootlets and to find

[1] There is an approximate 4-acre discrepancy in the acreage of modeled suitable habitat (1,989 ac; 805 ha) and the acreage conserved (1,993 ac; 807 ha) due to numerous, small overlapping polygons in the GIS database that could not be resolved.

appropriate soil moisture conditions, potentially offsetting the impacts of increasing temperatures and aridity. Although most of these behavioral and ecological characteristics contribute toward higher representation, there is also some evidence of the effects of small population size and lower heterozygosity which could limit the species' evolutionary potential to adapt. As narrow endemic there is not likely to be suitable habitat outside of its current or historical range; and even if suitable habitat were present the beetle is not likely to be able to disperse outside of its current range. Therefore, we consider Casey's June beetle to have sufficient representation to adapt to the range of environmental conditions experienced over the recent past, but the species has limited adaptive capacity to persist in place under more extreme conditions or shift in space beyond average dispersal rates to overcome more rapid or extreme variability.

Based on our future scenario projections, we forecast that Casey's June beetle will continue to occupy much of its current distribution in Scenario 1 and Scenario 3. There is an increasing probability that upland terraces will not provide suitable habitat, and that abundance will be reduced as conditions become more arid toward the end of the century. However, a portion of the habitat loss may be offset by increased conservation activities under Scenario 3, such that we expect Casey's June beetle will have moderate resiliency, and sufficient redundancy and representation to maintain a viable population in the Palm Canyon Wash floodplain. Under a future scenario of increased threats (Scenario 2), we forecast greater reductions in available habitat and abundance due to development, more arid conditions, and more frequent disturbance events that together limit recovery of vegetation and suitable habitat. The available habitat is expected to be patchier with reduced connectivity, which limits reproductive potential. As a result, population resiliency is projected to be low to moderate in 2070-2100 under Scenario 2, with greater reduction in redundancy and representation, such that the species' viability in the future is limited.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 - INTRODUCTION

1.1 Species Overview

Casey's June beetle is a narrow endemic scarab beetle known only from the alluvial fans east of the Santa Rosa and San Jacinto Mountains of the Coachella Valley in the vicinity of Palm Springs, California. It is known from an elevation range of 335 feet [ft; 102 meters (m)] to 580 ft (177 m). The species is between 0.56 to 0.70 inches [in; 1.4 to 1.8 centimeters (cm)] long (Evans and Hogue 2006, p. 111), with dusty brown or whitish coloring, and brown and cream longitudinal stripes on the elytra (wing covers and back) (Blaisdell 1930, p. 55; Bruyea 2006, p. 3). Pronounced sexual dimorphism is evident between the smaller, white-colored males and the larger, brown, wingless females. Most of its life cycle is spent underground until it molts into an adult to breed in spring. The species' lifespan is thought to be approximately 1 year based on excavation of plant root zones during the breeding season (Hovore 2003, p. 3) and emergence holes and the absence of larvae or pupae (La Rue 2004, in litt.), with adults persisting for approximately 3 days (Harju 2021, p. 15). However, observation of Casey's June beetle larvae maintained in controlled captive conditions that did not molt during the breeding season suggests the possibility of a larval lifespan greater than 1 year (Osborne 2022, pers. comm.). Casey's June beetle larvae and pupae were found between 2 and 9.5 ft (0.6 and 2.9 m) of the surface (Ronan 2024, p. 105). Subpopulations of males generally occur across the species' range; however, relative abundance of males varies widely with habitat quality. Distribution of the flightless females is unknown, but males may concentrate in those areas that support females, with dispersal and genetic mixing attributed to males.

Table 1-1. Taxonomical classification of Casey's June beetle.

Kingdom	Phylum	Class	Order	Family	Genus	Species
Animalia	Arthropoda	Insecta	Coleoptera	Scarabaeidae	Dinacoma	caseyi

1.2 Federal Listing Status

In 2011, Casey's June beetle (*Dinacoma caseyi*) was listed as endangered under the Endangered Species Act of 1973 (USFWS 2011, pp. 58954–58997*)*. As part of the final rule, the Service designated approximately 587 acres [ac; 237 hectares (ha)] of critical habitat for the beetle in Riverside County. In 2013, a Recovery Outline for the species was prepared which outlined important recovery actions (USFWS 2013, entire).

1.3 State Listing Status

Casey's June beetle is not listed by the State of California.

CHAPTER 2 - METHODOLOGY AND DATA SOURCE

This document draws the best available scientific information from resources such as primary peer-reviewed literature, reports submitted to the Service and other public agencies, species occurrence information in Geographic Information Systems (GIS) databases, and expert experience and observations. It is preceded by, and draws upon analyses presented in, other Service documents including the listing document (USFWS 2011, pp. 58954–58998), the 2013 Recovery Plan Outline (USFWS 2013, entire), and the 2021 5-year review (USFWS 2021, entire). Finally, we coordinated with our Federal, State, and local partners, including researchers and experts involved in field investigations. We consider the information we obtained to be the most current scientific conservation status information available for the species. In the future, should additional information become available, and the need arise, we will revise this document to reflect the most current information available.

All occurrence data and museum specimens were assessed in a GIS framework and in coordination with species experts for accuracy and duplicates removed to provide an accurate assessment of the species' historical and current distribution. Our literature review and data solicitation resulted in new occurrence information that expanded the north and westerly extent of the species' known distribution. Current conditions and factors influencing vulnerability were characterized for future threat projections including a review of development projects and conservation mechanisms. Throughout our analysis, when data was lacking for key life history parameters, we used generalization from the Scarabaeidae family to make inferences for *Dinacoma caseyi*, when applicable.

2.1 SSA Framework

The SSA analytical framework (Figure 2-1; USFWS 2016, entire) is designed to assess a species' current biological condition and its projected capability of persisting into the future (Smith et al. 2018, entire). Building on the best of our current analytical processes and the latest scientific information in conservation biology, this framework integrates analyses that are common to all Endangered Species Act (Act) functions, eliminates duplicative and costly processes, and allows us to strategically focus on our core mission of conserving, protecting, and enhancing fish, wildlife, and plant resources. The document is temporally structured, generally walking the reader through what is known from past data, how data inform current species' status, and what potential changes to this status may occur in the future based on data and models. The future condition analysis includes the potential conditions that the species or its habitat may face and discusses probable scenarios if those conditions come to fruition. The scenarios include consideration of the sources most likely to impact the species at the population or rangewide scales in the future, including potential synergistic effects.

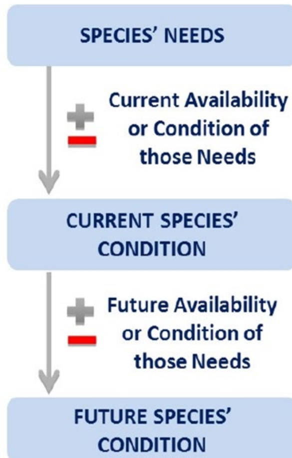


Figure 2-1. The stepwise process for assessing a species' status, as envisioned by the Services' SSA Framework (USFWS 2016, p. 6).

For the purpose of this assessment, we generally define species' viability as the ability of the species to sustain populations in the natural ecosystem beyond a biologically meaningful timeframe. Casey's June beetle has an assumed life span of 1 year and each flight season reflects the conditions and corresponding reproduction from the following year; therefore, a biologically meaningful timeframe to observe effects to the species, such as population growth trends, population extirpation, and habitat colonization events is between 30 and 80 years. We will use these timeframes for future model forecasts that are available for stressors identified in this assessment. These forecasts include some unknown level of uncertainty.

Using the SSA framework (Figure 2-1), we consider what the species needs to maintain viability by characterizing the status of the species in terms of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 301–302; Wolf et al. 2015, entire). We begin the SSA with an understanding of the species' unique life history, and from that evaluate a species' resource needs or biological requirements at the scales of individuals, populations, and species using the principles of resilience, redundancy, and representation. In general, these three concepts (or analogous ones) apply at the population and species levels and are explained that way below for simplicity and clarity as we introduce them. Throughout the rest of the document, we will use "resilience" as a population-level term, and "redundancy" and "representation" as species-level terms to avoid confusion. The 3 Rs are defined as follows:

- Resiliency is the ability of a species to withstand environmental stochasticity (normal, year-to-year variations in environmental conditions such as temperature, rainfall), periodic disturbances within the normal range of variation (fire, floods, storms), and demographic stochasticity (normal variation in demographic rates such as mortality and fecundity) (Redford et al. 2011, p. 40). Simply stated, resiliency is the ability of a species to bounce back and sustain populations through the natural range of favorable and unfavorable conditions. We can best gauge resiliency by evaluating population level characteristics such as: demography (abundance and the components of population growth rate -- survival, reproduction, and migration), genetic health (effective population size and heterozygosity), connectivity (gene flow and population rescue), and habitat quantity, quality, configuration, and heterogeneity. Also, for species prone to spatial synchrony (regionally correlated fluctuations among populations), distance between populations and degree of spatial heterogeneity (diversity of habitat types or microclimates) are also important considerations.

- Redundancy is the ability of a species to withstand catastrophes. Catastrophes are stochastic events that are expected to lead to population collapse regardless of population heath and for which adaptation is unlikely (Mangel and Tier 1993, p. 1083). We can best gauge redundancy by analyzing the number, distribution, and condition of populations relative to the scale of anticipated species-relevant catastrophic events. The analysis entails assessing the cumulative risk of catastrophes occurring over time. Redundancy can be analyzed at a population or regional scale, or for narrow-ranged species, at the species level.

- Representation is the ability of a species to adapt to both near-term and long-term changes in its physical (climate conditions, habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments. This ability to adapt to new environments-- referred to as adaptive capacity--is essential for viability, as species need to continually adapt to their continuously changing environments (Nicotra et al. 2015, p. 1269). Species adapt to novel changes in their environment by either [1] moving to new, suitable environments or [2] by altering their physical or behavioral traits (phenotypes) to match the new environmental conditions through either plasticity or genetic change (Nicotra et al. 2015, p. 1270; Beever et al. 2016, p. 132). The latter (evolution) occurs via the evolutionary processes of natural selection, gene flow, mutations, and genetic drift (Crandall et al. 2000, pp. 290–291; Zackay 2007, p. 1; Sgró et al. 2010, p. 327). We can best gauge representation by examining the breadth of genetic, phenotypic, and ecological diversity found within a species and its ability to disperse and colonize new areas. In assessing the breadth of variation, it is important to consider both larger-scale variation (such as morphological, behavioral, or life history differences which might exist across the range and environmental or ecological variation across the range), and smaller-scale variation (which might include measures of interpopulation genetic diversity). In assessing the dispersal ability, it is important to evaluate the ability and likelihood of the species to track suitable habitat and climate over time. Lastly, to evaluate the evolutionary processes that contribute to and maintain adaptive capacity, it is important to assess [1] natural levels and patterns of gene flow, [2] degree of ecological diversity occupied, and [3] effective population size. In our species status assessments, we assess all three facets to the best of our ability based on available data.

In summary, the SSA is a scientific review of the best information available, including scientific literature and discussions with experts, related to the biology and conservation status of the Casey's June beetle.

CHAPTER 3 - SPECIES BACKGROUND AND ECOLOGY

3.1 Physical Description

Casey's June beetle is classified within the family Scarabaeidae, as such it is characterized by a broad body and fanned, plate-like antennae. Casey's June beetle was first described in 1930 by Blaisdell (Blaisdell 1930, pp. 174–176) based on male specimens. The species measures 0.56 to 0.70 in (1.4 to 1.8 cm) long (Evans and Hougue 2006, p. 111), with dusty brown or whitish coloring and brown and cream longitudinal stripes on the elytra (wing covers) (Bruyea 2006, p. 3). Based on other species in the subfamily, adult size is presumed to be tied to resources amassed during the larval growth phase and is thought to be correlated with longevity (La Rue 2016, p. 24). The species displays an accentuated sexual dimorphism with females characterized by an enlarged abdomen, reduced legs, and antennae, and metathoracic wing reduction (reduction in flight wing size in adults) and venation (Figure 3-1). Females are flightless which is believed to be an adaption for resource limited environments. Muscle production for flight is energetically costly, flightlessness allows for the allocation of more resources to reproduction, resulting in higher overall fecundity and quicker development to sexual maturity (La Rue 2016, p. 26).

Figure 3-1. Photograph of a Casey's June beetle mating pair illustrating sexual dimorphism.[2]

3.2 Taxonomy

The genus *Dinacoma* and approximately 90 other genera constitute the New World members of the subfamily Melolonthinae (e.g., May beetles, June beetles, and chafers) of the scarab beetle

[2] *Photograph provided by Guy Bruyea.*

family (Scarabaeidae) (Smith and Evans 2005, entire). Until recently, *Dinacoma caseyi* Blaisdell, and *Dinacoma marginata* (Casey) were the only described taxa in the genus *Dinacoma*. In 2020, phylogenomic analysis of *Dinacoma* found divergence consistent with the existence of three species-level taxa: *D. caseyi*, *D. marginata*, and a third, new species, *D. sanfelipe* sp. *nov*., occurring in the San Felipe Valley in San Diego County, California (Gillett et al. 2020, entire). Several additional species in southern California and northern Baja California, Mexico are currently being investigated.

3.3 Life History

Limited information is available regarding the life history of Casey's June beetle. There have been no published scientific studies on the species' life history, population size, population distribution, or individual movement. However, the Service funded and conducted recent research to inform our understanding of the species' ecology that is included in the description below, including new information on specific triggers for adult emergence. In the absence of species-specific information, the life history is generalized for beetles with some specific lab generated data available for a related species, *Hypothyce mixta* (Melolonthinae), where indicated (Barfield Gibson 1975, pp. 251–256; Coca-Abia 2000, p. 20).

Casey's June beetle emerges as an adult between late March and early April and the adult flight season can extend as long as mid-July. Abundance peaks in late April and early May (Julian day 100-140) and aligns with the 50 percent full waxing moon during that period (Harju 2021, p. 6). Yearly beetle activity may be depressed, delayed, or concentrated over a shorter period if weather conditions are cooler and/or wetter than average conditions; but the flight season is unlikely to shift toward the summer months (Hovore 1995, p. 2). Male Casey's June beetles are attracted to artificial list sources and have been documented at streetlights, parking lot lights, porch lights, pool lights and head lights. As a result, survey captures are depressed during full moons that decrease the trapping effectiveness of black light traps. Daytime temperatures of at least 90ºF (32ºC) are indicative of initial beetle activity.

Adult activity is crepuscular with individuals emerging from the ground as early as an hour before sunset and male activity has been documented up to 3 hours after sunset (Hovore 2003, p. 3; Ronan et al. 2024, p. 50); crepuscular activity is believed to be a means of avoiding predation and heat stress in desert beetles (La Rue 2016, p. 22). Males flying in an area are attracted to female pheromones (Cornett 2022, p. 5; Ronan et al. 2024, p. 15), sometimes even prior to complete emergence of the female from the ground (Duff 1990, p. 3; Anderson 2012, p. 1). The males fly swiftly over the ground, sometimes in an apparent pattern, searching for females. Males are reported to fly back and forth or crawl on the ground where a female beetle has been detected (Duff 1990, p. 3). After detecting a female, males land and crawl a short distance on the ground to where the female beetle has been detected to mate. Males may mate with more than one female (La Rue 2008, pers. comm.). Based on mark-recapture data from a long-term monitoring site (sentinel site) surveyed every 1 to 3 days (depending on the year), adult beetles are presumed to live approximately 3 days (Harju 2021, p. 8). Based on observed wear of the white scales on the elytra and abdomen, males burrow into the ground again each night and/or take shelter within vegetation or leaf litter (Ronan et al. 2024, p. 33). Adults are not known to feed and rely on stored fat reserves (Hovore 1995, p. 2).

Females emerge from the ground over the same period as male emergence, remaining at or near the end of their burrows. Females may turn downward and extend the tip of their abdomen upward, presumably exuding a pheromone that the males use to find them. Females are always recorded on the ground and are considered flightless (Duff 1990, p. 4; Hovore 1995, p. 7; Hovore 2003, p. 3), emerging only briefly around sunset to mate. After mating, the female retreats down her emergence hole or digs a new burrow and is believed to deposit eggs within damp sediment within approximately 8 in (20 cm) of the soil surface (La Rue 2004, pers. comm.). Ten eggs were deposited by a gravid female under laboratory conditions (Ronan et al. 2024, p. 99). Dissection of a mated female confirmed the size and shape of eggs observed. Brood size is expected to vary with environmental conditions and larval food resources (La Rue 2008, pers. comm.; Osborne, 2024, pers. comm.). A related species, *Hypothyce mixta*, was observed to lay an average of 19 eggs per female with oviposition occurring between one- and six-days following copulation and an average incubation time of 20 days (Barfield and Gibson 1975, p. 254). Damp sediment is believed to provide consistent temperature and humidity that prevents desiccation of the

Figure 3-2. Diagram of Casey's June beetle's life cycle.[3]

[3] *Photos courtesy of Kenneth H. Osborne (egg and larvae), Noelle Ronan (wash habitat), Philip Clevinger (adult emergence), Guy Bruyea (breeding).*

immature stages of the beetle (e.g., eggs, larvae, and pupae). Females are rarely seen, approximately 0 to 7 incidental observations of females per year during male surveys (Wood 2020, p. 27; Wood 2021, pp. 2-3, 65; Ronan et al. 2024, p. 97) at least in part due to their flightless and cryptic nature, and the short time they spend above ground. Systematic female-specific surveys have not been conducted, and field information is based only on the limited anecdotal observations.

Casey's June beetle has egg, larval, pupal, and adult life stages and all are subterranean except for breeding and male dispersal. The immature life-stages of Casey's June beetle have not been well-studied. The life cycle described assumes that females are active over the same time period as males and includes generalized development times for scarab beetles. Therefore, eggs laid between April and June and are presumed to hatch into larvae within approximately 3 to 4 weeks (La Rue 2004, pers. comm.) The species persists as a larva for approximately 11 months, with pupation occurring 3 to 8 weeks before adult emergence (Figure 3-2 and 3-3; La Rue 2004, pers. comm.). It has been assumed that the life cycle is approximately 1 year, based on the absence of larvae near the ground surface during the adult flight season (Figure 3-2; Hovore 1995, p. 6; La Rue 2004, pers. comm.). However, observation of Casey's June beetle larvae maintained in controlled captive conditions did not molt during the breeding season suggesting the possibility of a larval lifespan greater than 1 year, but further research is required (Osborne 2024, pers. comm.). Casey's June beetle larvae and pupae were found within 2 and 9.5 ft (0.6 and 2.9 m) of the surface during soil excavation (Ronan et al. 2024, p. 105). Excavations of adult emergence burrows revealed pupal exuviae (casings) at depths ranging from approximately 4 to 12 in (10 to 30.5 cm; Hovore 1995, p. 6; Osborne 2024, pers. comm.).

The subterranean larvae feeding ecology is not well understood, though other species in the family Scarabaeidae are known to feed on detritus or plant rootlets. Under laboratory conditions, Casey's June beetle larvae were found to feed on detritus and rotten wood (Ronan et al. 2024, p. 106). There is no data to support a preference for a particular species of host plant (Hovore 2003, p. 2; La Rue 2006, pers. comm.; Hawks 2010, pers. comm.). There is also no evidence of adults feeding and they are presumed to rely on reserves amassed during larval development, like other beetles within the Melolonthinae (Barfield and Gibson 1975, p. 253; Hovore 1995, p. 2; La Rue 2016, p. 24).

Table 3-1. Casey's June beetle phenology chart for an assumed 1-year life cycle.

<table>
<tr><th>Life Stage</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>June</th><th>July</th><th>Aug</th><th>Sept</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Adult</td><td></td><td></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Egg</td><td></td><td></td><td></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Larvae</td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td></tr>
<tr><td>Pupae</td><td></td><td></td><td style="background:#c4d79b"></td><td style="background:#c4d79b"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

3.4 Habitat

Casey’s June beetle is a narrow-endemic species associated with historical alluvial fans and bajadas (compound alluvial fans) at the base of the Santa Rosa and San Jacinto Mountains in the southwestern Coachella Valley of the Colorado Desert. The species only occurs on the desert floor and is known from an elevation range of 335 ft (102 m) to 580 ft (177 m). As a result, the species habitat is closely tied to this dynamic ecosystem including alluvial soils, seasonal hydrological inputs from the surrounding mountainous watershed, and native and nonnative desert wash and desert scrub vegetation. Our current knowledge of Casey’s June beetle habitat is primarily based on the correlation of extant records with known, mapped environmental features within the beetle’s limited distribution in Palm Springs, California (e.g. Palm Canyon Wash and Tahquitz Creek), including climate, hydrology, soil type, and vegetation. The species has some tolerance to human disturbance and has been found on golf courses, fill slopes, and in ornamental landscaping.

3.4.1 Climate

Casey’s June beetle is known in the vicinity of Palm Springs, California. Temperatures range from an average low of 42ºF (5.6ºC) in the winter to a high of 108ºF (42.2ºC) in the summer (WRCC 2024, unpaginated). Adult emergence is typically tied to increasing daytime temperatures beginning in late March, with a higher probability of emergence as late afternoon/evening temperatures approach 86ºF (30ºC; Harju 2021, p. 9). Rainfall in the region is low; average rainfall between 1906 and 2016 was 5.5 in (14 cm; WRCC 2021, unpaginated). In the last 20 years, drought conditions have been the norm with 12 of 20 years (60 percent) below the annual average rainfall (Figure 3-4).

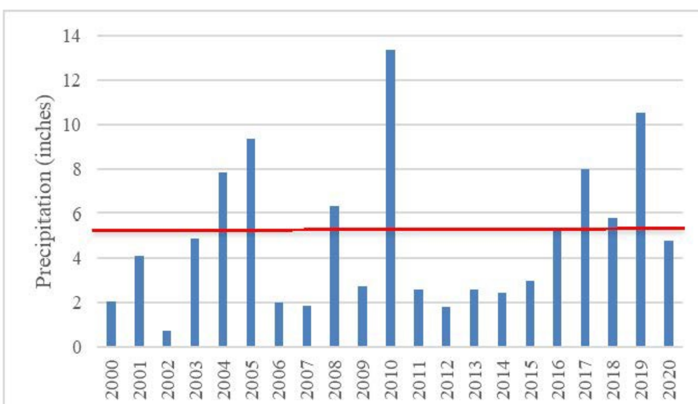


Figure 3-3. Annual precipitation from 2000 to 2020.[4]

[4] Average annual precipitation of 5.5 in (14 cm) is indicated by a red, horizontal line (WRCC 2021).

Measurable rainfall (greater than 0.5 in [1.3 cm] a month) typically occurs between December and March. Extreme rainfall events, of approximately 3 in (7.6 cm) or greater in a day, have also been recorded during this period. Two extreme rainfall events have occurred in the last 5 years in August 2023 (2.6 in; 6.7 cm) and February 2019 (3 in; 7.6 cm) resulting in major flooding that exceeded the height of the levee system in Palm Canyon Wash at South Gene Autry bridge. These large magnitude events are historically rare, occurring just 8 times in the last 100 years; but three time in the last decade provide evidence for increased climatic variability (WRCC 2024, unpaginated). Large flood events can be disruptive to the beetle's habitat when erosion results in scouring and removal of sediment. Portions of Palm Canyon Wash are often scoured during large rain events with vegetation and large amounts of sediment deposited downstream (**see section 6.2- Altered Hydrology**). However, the species has persisted in the wash with the associated flood control structures despite concentrated flows, higher peak flows, and increased velocities, compared to the broad alluvial fans where the species historically occurred.

The region is subject to strong winds and the beetle evolved under these conditions. However, high wind may inhibit the flight of male beetles based on reductions in capture probability (Ronan et al. 2024, p. 51). Wind direction and speed at the Palm Spring airport is less than 8 miles per hour [mph; 13 kilometers per hour (kmph)] most of the year with occasional gusts between 23 and 28 mph (37 and 45 kmph), on average. Wind speeds above 5 mph (8 kmph) are believed to deter beetle flight (USFWS 2016, p. 2). Between the months of April and July wind speeds can range from 8 to as much as 25 mph (13 to 40 kmph) but come from the northwest and are largely blocked by the San Jacinto Mountains (Windfinder 2021, unpaginated). The remainder of the year the winds come from the north and most of the beetles' range is unprotected. However, during this period all life stages are subterranean and unaffected by wind speed.

3.4.2 Hydrology

Casey's June beetle habitat is typically associated with broad, gently sloping, depositional surfaces that form at the base of the Santa Rosa and San Jacinto Mountains in the dry Coachella Valley region by the overlapping or converging of individual alluvial fans (bajada) (Bates and Jackson 1987, p. 52). As a result of natural rainfall and erosion patterns, alluvial fans historically included sandy, dry washes with meandering channels that contained ephemeral flows and dry upland areas associated with soil deposition. The benefits of this hydrological regime to the ecology of Casey's June beetle are not well understood but likely include: 1) input of water to support vegetation; 2) periodic (flood-based) erosion deposition of sediment and layering of detritus, an important food resource; 3) moist, abiotic conditions for immature stages of the beetle; and 4) dispersal of individuals, including the flightless female beetles.

Casey's June beetle and its habitat likely depends upon the natural flood flow regimes describe above to maintain habitat functions in the long-term. Currently, Casey's June beetle habitat is largely constrained within flood control structures that concentrate flows rather than disperse flows across a broader alluvial floodplain. Palm Canyon Wash and Tahquitz Creek are largely channelized including riprap, cement levees, and drop structures that focus and contain flows. As a result, higher magnitude events and greater flow velocities are more common and often scour the channel resulting in removal of sediment that are deposited downstream (Figure 3-5). These peak flow events are presumed to transport Casey's June beetle from locations within the wash, depending on the timing and magnitude of the flood flow, stream dynamics and vegetation cover, and potentially relocate them downstream, with some unknown degree of mortality. As a result, abundance is expected to decrease during these events potentially resulting in local extirpations, with the potential for subsequent recolonization from adjacent, occupied beetle habitat. Hovore reported that Casey's June beetle is typically not known from recently scoured areas of the wash or where there are signs of severe erosion (Hovore 2003, p. 2). However, recent information has shown the beetle to occupy areas that were scoured during previous flood events (Ronan et al. 2024, p. 119). In addition, to sediment transport and scouring, flood control structures may lower the water table which can cause soil moisture depths to increase.

3.4.3 Alluvial Soils

Dinacoma species are ecologically associated with alluvial sediments (La Rue 2006, pers. comm.). Based on correlations with recent records, Casey's June beetle is most associated with well-drained, alluvial soils with an apparent preference to coarse alluvium found in Carsitas soil (50 percent), particularly Carsitas gravelly sand, with pockets of cobbly Riverwash (24.6 percent) and Fluvents (3.1 percent). To a lesser degree, the species may also occur in finer textured Myoma soils (16 percent) formed because of sand blown from recent alluvium and Coachella soil series (3.1 percent) is derived from igneous rocks associated with lacustrine basins. Alluvial soils are characterized by the presence of a water table from 1.5 to 4 ft (0.5 to 1.2 m) below the surface, indicative of the importance of natural hydrology (Knecht et al. 1980, p. 2). Within occupied habitat on the upland terrace[5], depth to moist soil was between 4 and 8 in (10 and 20 cm) with permanently damp soils noted at a depth of 24 in (60 cm) and 35 in (90 cm) of the soil surface (Hovore 1995, p. 5). Soil moisture is expected to be higher in the wash, though the depth to moist soil can increase due to channelization of waterways. Alluvial soils tend to be alkaline with low organic content and organic content tends to decrease with depth. The eastern limits of the historical species' range occurs within the limits of historical Lake Cahuilla and the resulting deep sand is thought to retain moisture at depth (La Rue 2008, pers. comm.). Fluvents are atypical from the other natural soil series in that they are typically found on the levee banks of the flood control channels (Knecht et al. 1980, p. 16). On alluvial terraces and where they occur within washes, these soils show light braiding and some organic deposition, but typically do not receive scouring surface flows (Hovore 2003, p. 2). These preferred soils provide a medium for reproduction, egg laying, development of immature stages, moisture to maintain

[5] These measurements include the only available data on soil moisture and were taken within occupied habitat on an upland terrace southeast of Bogart Trail and South Palm Canyon Drive (between Palm Canyon Wash and an unnamed creek flowing from the west). This data is not indicative of soil moisture in the wash that is expected to be closer to the surface, though site specific data is lacking.

subterranean stages, and food sources primarily in the form of detritus. Soils that are highly modified, compacted, or too isolated for females to recolonize by crawling along the soil surface are not likely to support persistent occupancy, though they have been observed in modified habitats as noted above.

3.4.4 Vegetation

Casey's June beetle occurs in native desert scrub and desert wash (riparian) vegetation located on desert alluvial fans and bajadas at the base of the Santa Rosa and San Jacinto Mountains. The current cover and composition of these communities varies depending on whether natural hydrological processes are intact. Upland terraces tend toward desert scrub and the desert wash vegetation community generally occurs along and within the active channel and wash. The cover and dominant species vary depending on the magnitude of the last flood event (Dudek 2019, p. 11) and the degree to which the vegetation has recovered. After flood events, large sections of the wash are often barren or contain less than 10 percent vegetative cover. When the desert wash vegetation is present, *Chilopsis linearis* (desert willow) and *Psorthamnus* sp. (smoketree) can form patches with closed canopies. In areas exposed to relatively permanent water due to runoff or irrigation, nonnative *Tamarix* sp. (salt cedar) and *Tamarix aphylla* (Athel tamarisk) may dominate; but both species can also co-occur among native vegetation (Dudek 2019, pp. 7–8). Large portions of the historical alluvial fans are excluded from natural flows by flood control structures, referred to as upland terraces throughout the rest of this document. As a result, they are dominated by urban development and upland desert scrub species such as *Larrea tridentata* (creosote bush) and *Ambrosia salsola* (cheeseweed) (Dudek 2019, pp. 6–8). Native vegetation is an important habitat characteristic, though individuals and emergence holes have been observed near nonnative vegetation as well, including *Tamarix* sp., *Washingtonia robusta* (Mexican fan palms), *Nerium oleander* (oleander), and *Olea europaea* (olive) (USFWS 2011, p. 58955).

Casey's June beetle does not appear to rely on a particular host plant species to complete its lifecycle, though research is limited. The beetle is believed to share habitat characteristics of other subterranean beetles in the family Scarabaeidae, including: the use of detritus, organic matter, and fine plant roots as a larval food source. Additionally, annual plants and grasses co-occur with these shrubs that contribute to surface litter and the plant rootlets likely provide an additional food source (La Rue, pers. comm.). The accumulation of leaf duff contributes to surface litter and subsurface detritus as flood events transport vegetation and sediment forming buried organic detritus downstream. Annual average male capture numbers were found to be positively correlated with plant species richness near the trap location, regardless of if the species were native or naturalized (i.e., nonnative) (Harju 2022, p. 14). Further study is required to determine if cover or specific plant species are correlated with male captures. (Hovore 1995, p. 5).

Figure 3-4. Photograph of Casey's June beetle habitat within Palm Canyon Wash.

Although Casey's June beetle distribution has not been correlated with the distribution of a specific plant host, proximity of observed emergence holes to native desert vegetation indicates some of these plants may be important as a direct or indirect food source (Table 3-1; Hovore 2003, p. 3; La Rue 2004, pers. comm.; Ronan et al. 2024, p. 87). Our understanding of vegetation associations is informed by Service-led annual research on the Casey's June beetle conducted from 2015 to 2020. Four of the main activities undertaken with the Service's work included collection of environmental and climatic data, delineation of vegetation boundaries, counting and marking the numbers of flying male Casey's June beetles caught in black light traps, and counting the number of potential Casey's June beetle emergence holes at the end of the flight season, in an effort to correlate beetle presence and relative abundance with climatic conditions and ecological phenomena. (Ronan et al. 2024, p. 92) A summary of the dominant vegetation within survey plots and emergence holes is shown in Table 3-2 below (Ronan et al. 2024, p. 90).

Based on preliminary results, emergence holes are more prevalent in habitat dominated by desert willow. Two to three times more emergence holes were recorded in this vegetation type relative to its distribution throughout the survey area; however, desert willows tend to co-occur with compacted soils where emergence holes are more visible (Table 3-1). Although we cannot draw conclusions about the direct association of desert willow and Casey's June beetle abundance, we believe this plant species to play an important role in the hydrological and disturbance dynamics of beetle habitat. Desert willow trees provide structure both above and below the ground surface, which is hypothesized to reduce water velocities, trap plant material that form the detritus that immature stages feed upon and stabilize the soil in the immediate area. Desert willow trees also help to maintain soil moisture by bringing water toward the surface through their roots that can extend beyond the region of damp soil, more than 3 ft (0.9 m) deep, and the canopy shades the surrounding ground surface. Vegetation, alluvial soils, moisture inputs, and climatic conditions contribute to the nutritional and physiological requirements of Casey's June beetle. As described above, current evidence supports the hypothesis that Casey's June beetle larvae do not require a particular species of host plants for feeding (USFWS 2011, p. 58955). While the food source for subterranean Casey's June beetle larvae is unknown, other species of June beetles are known to eat plant rootlets, organic detritus, and fungus material (Hovore 2003, p. 2; La Rue 2004, pers. comm.; Hill and O'Malley 2010, p. 277). Under laboratory conditions, Casey's June beetle larvae were found to feed on detritus and rotten wood (Ronan et al. 2024, p. 102).

Table 3-2. Casey's June beetle vegetation associations based on the percent of emergence holes located near each dominant plant species.[6]

Dominant Plant Species	Survey Area (percent)	2015 (percent)	2016 (percent)	2017 (percent)
Ambrosia salsola (cheesebush)	30.9	1.4	6.3	8.7
Chilopsis linearis (desert willow)	20.9	92.5	81.7	52.9
Larrea tridentata (creosote)	5.8	0.0	0.1	0.0
Psorthamnus sp. (smoke tree)	5.3	2.5	1.4	1.0
Tamarix sp. (tamarisk)	1.2	0.3	5.5	0.1
Disturbed	4.5	2.6	2.3	1.0
Un-vegetated	1.6	0.2	0.7	1.7
Urban Landscape	29.9	0.0	0.1	0.0
Not Mapped	0.3	1.6	34.8	0.3

CHAPTER 4 – HISTORICAL ABUNDANCE AND DISTRIBUTION

4.1 Historical Range

Casey's June beetle is part of a genus of beetles that has naturally restricted ranges (La Rue 2006, pers. comm.). Casey's June beetle is adapted to specialized habitat and soil types found in the alluvial fans, bajadas and river wash areas of the Santa Rosa and San Jacinto Mountains. The historical range is defined as the probable species' distribution prior to development of the Coachella Valley in Riverside County, California (Figure 4-1). We do not know the exact historical population footprint of Casey's June beetle due to the generality and paucity of location descriptions from early collection records (USFWS 2006, p. 44962; USFWS 2011, p. 58956). However, museum specimen records indicate the historical range can be described from the City of Palm Springs south and east to the community of Indian Wells. Casey's June beetle was first collected in the City of Palm Springs in 1916 and was later described by Blaisdell (Blaisdell 1930, pp. 174–176). Most locality information on Casey's June beetle collection

[6] Data is summarized for the total percent cover of each dominant plant species within the survey area and the corresponding percentage of emergence holes found in that plant community. Data is preliminary and has not been adjusted for varying percentages of compacted soils where emergence holes are visible, within survey plots.

specimens often specifies Palm Springs or a nearby feature (e.g., Palm Canyon and Tahquitz creek; (Duff 1990, pp. 2–3) or simply Riverside County (Duff 1990, p. 2; O'Brian 2007, p.1.

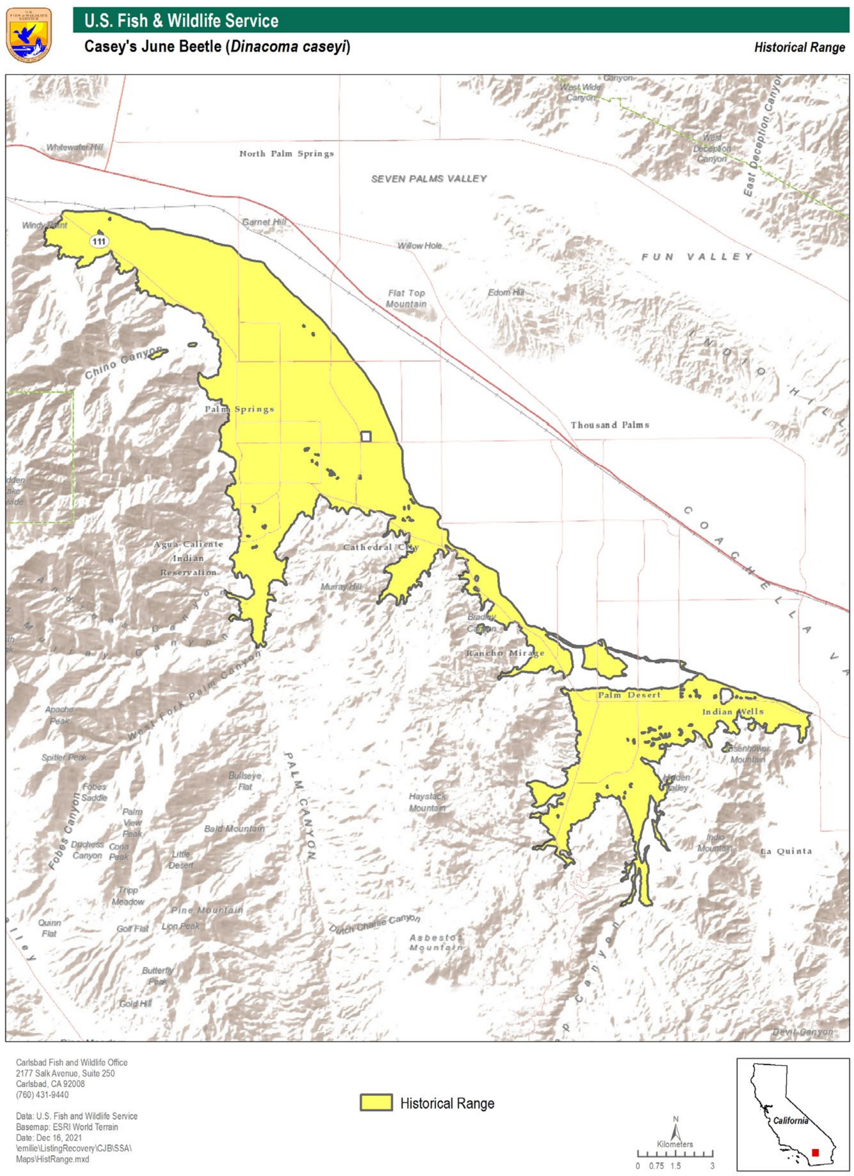


Figure 4-1. Map of Casey's June beetle historical distribution.[7]

[7] Based on a habitat suitability model incorporating the distribution of historical records, alluvial fans, and preferred soils. Current distribution is illustrated on Figure 7-1.

Ratcliff 2007, p. 1; Wall 2007, p.1). The historical range possibly extended from Chino Canyon floodplain or Snow Creek, draining south to Indian Wells; there are no records north of Palm Springs and thorough survey efforts throughout the potential historical range have been limited (Hovore 1995, p. 4). The core of the current population in Palm Canyon was first discovered in the 1980s. Other early collection records identify Palm Desert near Highway 111 and Highway 74 (Duff 1990, p. 3), and Indian Wells (two specimens in the Los Angeles County Natural History Museum from 1953) in the western Coachella Valley, east of the San Jacinto Mountains.

A habitat suitability model (USFWS GIS 2021, unpaginated) was used to estimate the historical and current range of Casey's June beetle based on alluvial fans, alluvial soils, and hydrological features (approximately 30,691 ac; 12,420 ha; Appendix A, **see section 7.1 for Current Range**). The model may overestimate the historical range as the area of known occurrences is substantially smaller. The historical range is more broadly defined compared to previous estimates and extends to the northwest and southeast of occupied habitat (Figure 4-1). The northern and western limit is believed to be constrained by wind conditions that increase soil evaporation and inhibit male activity during the breeding season. The San Jacinto Mountains serves as a windbreak for winds coming from the west and northwest. The Whitewater River is considered the northern and eastern limit as it defines a significant hydrological input and aeolian sands tend to dominate the central part of the valley to the north and east of the river. The historical range model was limited to the valley floor and a maximum elevation of approximately 750 ft (229 m). The potential historical range, while far greater than the current known population distribution, is nonetheless restricted geographically.

4.2 Historical Abundance

We do not have information on the historical abundance of Casey's June beetle prior to listing because systematic surveys for abundance were not conducted. We believe that the seasonal timing and duration of beetle activity is similar to current conditions. We believe that there was also substantial spatial variability. Locally, males are believed to be abundant at high quality sites during optimal environmental conditions, while in low density areas or under poor- and low-quality habitat conditions beetles can be difficult to detect. Less is known about the abundance of females. Though they are observed less frequently, we expect that the sex ratio is 50:50 based on other beetle species (Osborne 2024, pers. comm.).

CHAPTER 5 - RESOURCE NEEDS

In this section, we synthesize the information from the preceding sections to highlight the resource needs for Casey's June beetle (Figure 5-1). For individuals to complete their life cycle the beetle requires specific habitat needs including desert vegetation with an open canopy, alluvial soils, and natural hydrology. To maintain resiliency, populations require sufficient habitat quality and quantity to support a population of an appropriate size and adequate reproduction to ensure sufficient abundance the following year. Reproduction and future abundance are also dependent on dispersal to ensure successful breeding attempts and to maintain gene flow. The resource needs are cumulative such that the habitat needs must be met for individuals to survive and reproduce. The demographic needs of a population must be met to ensure population resiliency and contribute toward the species' overall viability. Sustaining Casey's June beetle into the future will depend on having a broadly distributed, large population across of range of ecological conditions to withstand annual variations in environmental conditions (resiliency), catastrophic events (redundancy), and to adapt to changing conditions (representation).

5.1 Individual Needs

For individuals to complete their life cycle, Casey's June beetle requires the dynamic processes and structure associated with alluvial fans including desert vegetation with an open canopy, alluvial soils, and natural hydrology (Figure 5-1). Although the association with alluvial fans and the habitat needs described below are well established, we lack information on the precise quality and quantity of these resources needed by Casey's June beetle, particularly for the subterranean, immature stages of the beetle that have not be well studied.

5.1.1 Desert Vegetation with an Open Canopy

Casey's June beetle is associated with native riparian and desert scrub vegetation located on alluvial fans and desert washes. This habitat is characterized by a scattered assemblages of trees and shrubs with an open canopy. The open canopy provides space for adult male beetles to fly in search of females and fulfill normal life history activities. Breeding success depends on a male's ability to detect pheromones emitted by females and the male's ability to maneuver to and remain in contact with the pheromone plume. Vegetation, in combination with alluvial soils, hydrology, and climate contribute to the nutritional and physiological requirements of immature stages of Casey's June beetle. Beetle larvae likely feed on plant rootlets, fungus, organic matter, and detritus below ground. Vegetation in the form of leaf litter, dead or otherwise dislodged plant material from the surrounding watershed is washed downstream during flood events and contributes organic matter into the alluvial system, which is layered between sediment deposits. The above and below ground structure of vegetation, particularly trees, helps to reduce flow velocities allowing organic material, sediment, and potentially beetle individuals to be deposited during flood events. Organic material collects on vegetation forming drift lines that are buried during subsequent events to form detritus. These processes are expected to contribute to increased organic material near the base of trees, such as desert willow; but the presence and quantity of organic matter in the soil around trees has not been specifically evaluated. Tree and shrub roots also pull water from deep in the soil and likely increase the water balance near the surface, which helps meet the soil moisture requirements of immature stages of the beetle. Individual shrubs also provide the subterranean space required for egg-laying and larval development and provide protection from anthropogenic soil disturbance, though these developmental needs are also believed to be met in the interstitial space between shrubs. Highly manipulated, nonnative ornamental landscaping does not serve the same ecological function as native or minimally disturbed habitat, though the species will utilize nonnative vegetation as well (e.g., golf courses).

5.1.2 Alluvial Soils

The majority of Casey's June beetle's lifespan takes place underground. Soils provide the physical space and structure to support all life stages. Eggs are laid fairly close to the surface, larvae move throughout the soil column to feed on rootlets and detritus, and eventually pupate, all over a roughly 51-week period after which they emerge as adults. Females emerge at the soil surface to mate and then retreat to their burrow to lay eggs. Alluvial soils provide habitat structure, facilitate the maintenance of soil moisture, and provide some protection against surface disturbances. Alluvial soils are evidence of the dynamic process of alluvial fans and the watershed wide erosion and flood events that Casey's June beetle relies on and is memorialized in the region-specific alluvial soil types that occupy the alluvial fans at the base of the mountains. The Carsitas soil series, Riverwash and Fluvents (soils that line the levee and flood control structures) are most strongly correlated with Casey's June beetle and are believed to provide the highest quality habitat followed by the Myoma and Coachella soils series that tend to be more aeolian and lacustrine derived, respectively. Soils that are exposed to the natural hydrological cycles of scouring and periodic (flood-based) erosion deposition tend to have a significant sand component, with minimal cobbles that facilitates burrowing. The high proportion of sand and overall large particle size allows for percolation, while maintaining moisture at depth. Maintenance of soil moisture is believed to be critical for the development of immature stages, decomposition of organic material, and is required to support native and nonnative vegetation.

5.1.3 Natural Hydrology

Casey's June beetle is adapted to the natural hydrology of alluvial fans that relies on processes that occur throughout the entire watershed. The watersheds that flow into alluvial fans contribute rainfall, and to a lesser degree snow melt, that supports vegetation both throughout the watershed and on the alluvial fan. Stream flow also maintains soil moisture to support the immature stages of Casey's June beetle life history. Sufficient precipitation is required to create the large flow events that transport organic material and sediment into the alluvial fan, which are critical for depositing the layers of organic debris and detritus that the immature stages feed upon. Like other subterranean scarab beetles, Casey's June beetle is believed to prefer the interface between surface soil and damp subsoil. Moisture in the soil layer prevents desiccation of larvae and eggs and helps maintain a constant temperature. Casey's June beetle is dependent on the natural hydrological cycle and disturbance regime that it evolved with that allows vegetation to reestablish. However, the magnitude and frequency of hydrological events required to maintain the Casey's June beetle population is not well understood, as well as the appropriate frequency of flood events and the potential impacts associated with concentrating flows in a levee system.

5.2 Population Needs

Populations require sufficient amounts of available habitat of sufficient quality to provide resiliency, based on the individual needs described above. For a population to be resilient it also needs sufficient population numbers, a stable or increasing growth rate, and habitat connectivity to withstand stochastic variability in habitat, climate, and demographic conditions. For the Casey's June beetle population to be resilient and able to withstand fluctuations in environmental conditions, it requires sufficient reproduction and survival to support stable or increasing abundance year to year and dispersal of individuals to maintain adequate levels of reproduction and gene flow (Figure 5-1). These demographic factors are influenced by the presence and availability of sufficient habitat resources, as described above.

5.2.1 Abundance and Reproduction

Casey's June beetle requires a population of sufficient abundance to be maintained over time with stable or increasing population growth. Sufficient abundance is achieved through survival of immature stages to adulthood and successful breeding and reproduction to support the next generation. Because Casey's June beetle is believed to live for only one year, it is important that abundance remains sufficiently high such that reduced survival or reproduction due to annual variability in food resources or abiotic conditions does not put the persistence of the population at risk. There must also be adequate survival at all life stages to support an abundant adult population. Sufficient individuals, particularly females, must occur within the population, to ensure an adequate number of successful mating encounters to support the reproduction necessary to maintain an adequate population size into the next generation. We currently lack a population estimate and therefore an understanding of the appropriate abundance or number of males and females required to maintain a resilient population.

5.2.2 Dispersal and Habitat Connectivity

Dispersal is necessary to improve the probability of breeding encounters, reproductive success, and gene flow necessary to maintain adaptive capacity. Dispersal of Casey's June beetle is limited by the flightlessness and reduced terrestrial movements of females. Male dispersal is critical, particularly for females that are isolated or occur in fragmented habitat. Male dispersal capacity has not been well characterized. It is not clear to what extent contiguous habitat connectivity is required. Male beetles have been documented to traverse urban environments because they are attracted to artificial light sources (e.g. streetlights). The distance that they can travel through developed environments to isolated habitat patches is unknown and there is concern that developed areas may be population sinks. In the absence of habitat connectivity, proximity to suitable habitat is likely required within the average distance traveled by a male per evening. Dispersal of both sexes also potentially occurs during flood events within hydrologically connected habitats allowing for gene flow, migration, and colonization of unoccupied habitat. However, it is not clear if hydrological processes tend to favor clustered relocation of individuals or if it could contribute to the isolation of females, provided individuals survive relocation during flood events.

We previously described upland terraces as an important habitat feature required for dispersal. Our understanding was that upland terraces function as local refugia, allowing the species to recolonize wash habitat that has undergone natural disturbance from intense flooding and scouring events (Hovore 2003, p. 9; Cornett 2004, p. 14). Palm Canyon Wash experiences periodic flooding and scouring that was thought to impact the species through direct mortality or by relocating them downstream to unsuitable habitat, potentially resulting in local extirpation. Based on the most recent flood event in 2019, all survey locations that were occupied before the flood were occupied after the event, though abundance was reduced in some areas (Figure 4-6). Based on the high magnitude of this event, there is preliminary evidence that local extirpations are not an inevitable conclusion following high magnitude flood events. Additionally, upland terraces are often separated from the historical floodplain and isolated by flood control structures, restricting the opportunities for female dispersal. Although these factors may reduce the potential importance of upland terraces in dispersal, they do provide refugia to help offset potential threats (e.g. periodic flood control maintenance) in those upland areas that contain soils, vegetation, and hydrology to support the nutritional and physiological processes essential for the species. Individuals in these refugia could be actively translocated to establish and augment subpopulations. Under these circumstances, upland terraces may become a component of the species recovery but is currently not considered a species' need.

To maintain a resilient population, Casey's June beetle requires sufficient survival and reproduction to maintain a stable population year to year. Dispersal contributes to the probability of successful reproduction and increased genetic diversity. Because it is an annual species, each population need must be met at a minimum, albeit unknown level, each year for the population to persist.

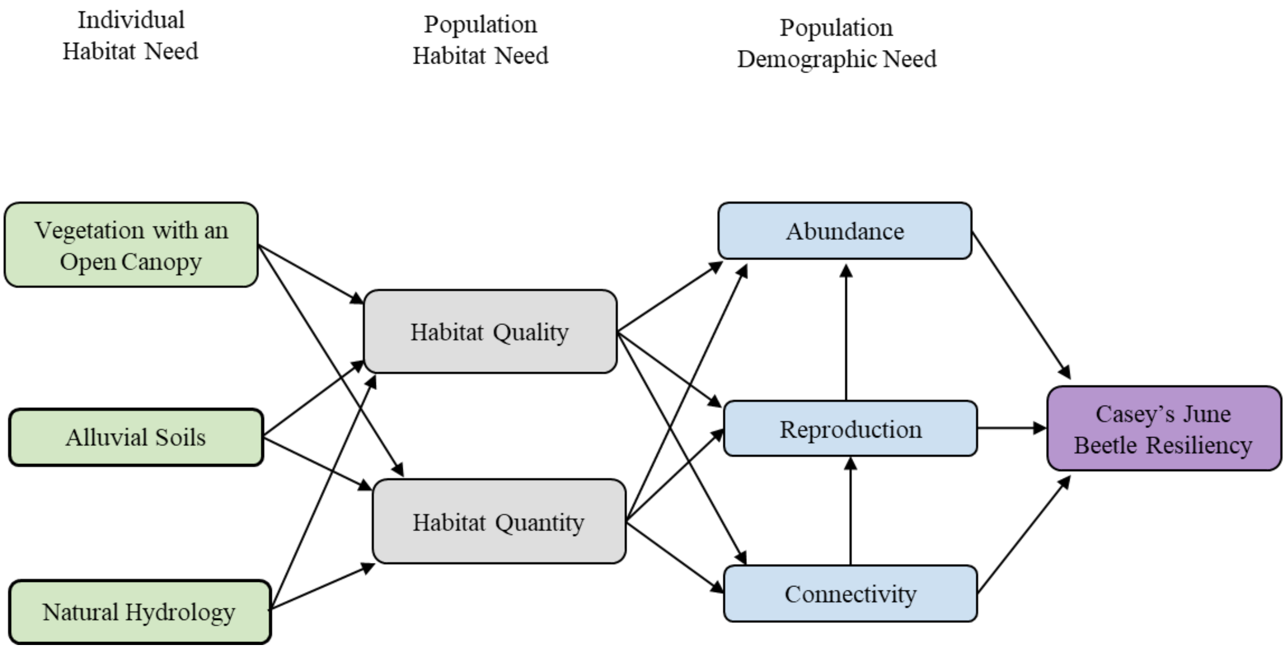


Figure 5-1. Casey's June beetle conceptual model of population resiliency

5.3 Species-level Needs

We evaluated the redundancy and representation required for Casey's June beetle viability. Multiple resilient subpopulations of sufficient abundance or one large geographically dispersed population are required for species' redundancy and to spread the risk of catastrophic events such as prolonged, multi-year drought, high magnitude flood events, or wildfire. The species' distribution should include abundant moderate to high quality habitat, with occupied habitat distributed across the range of hydrological and topographical variability. Natural hydrological functions must be maintained to support suitable habitat including one or more streams flowing into occupied habitat. Multiple hydrological features that vary in size and are fed from different portions of the watershed improves the probability that a portion of the population will receive appropriate hydrological and organic inputs in an average year and spreads the risk should a catastrophic event occur. Upland terraces could provide a refuge under certain circumstances that could be used to actively relocate beetles back to wash areas should they be locally extirpated. We do not know the population abundance necessary to maintain species' redundancy. Given recent climatic conditions, we believe that the average yearly male capture totals represent a range of sufficient abundance to ensure reproduction to support the next generation (see **section 7.3.3 Abundance**). Connectivity and dispersal between occupied habitat patches are required to maintain sufficient reproduction to support abundance and gene flow. Occupied habitat patches should occur within the median male dispersal distance range of 131 ft (40 m).

Casey's June beetle representation or adaptive capacity was evaluated to assess the species ability to adapt to changing environments. In general, species adapt to changes in their environment by altering physical or behavior traits that allow them to persist in place or they may be able to move in space to a new environment with suitable habitat conditions (Nicotra et al. 2015, p. 1270; Beever et al. 2016, p. 132; Thurman et al. 2020, entire). The ability of Casey's June beetle to "persist in place" or "shift in space" was assessed following Thurman et al. (2020), including demographic, life history, distribution, movement, evolutionary potential, ecological role, and abiotic niche attributes (Appendix B).

In general, Casey's June beetle needs at least one, large resilient population distributed across the range of potentially suitable habitat to have the redundancy and representation to withstand catastrophes and adapt to environmental change given the numerous attributes that confer lower adaptive capacity.

5.4 Summary of Species Needs

For Casey's June beetle to be viable, individuals need sufficient alluvial soils, vegetation, and hydrology to successfully feed, shelter, and reproduce. Individual survival influences abundance, reproduction, and population growth. One large or multiple resilient subpopulations contribute to species' viability through improved redundancy. Similarly, dispersal contributes to abundance by increasing the probability of successful reproduction, particularly when females occur in fragmented habitat. Dispersal and gene flow must continue to occur at an unknown rate to maintain the limited genetic variability; although we presume gene variation was historically lower because the beetle is a narrow endemic. Multiple subpopulations or one geographically dispersed population could provide sufficient representation, so the species has the ability to adapt to a changing environment.

5.5 Uncertainties

- Definitive information on the subterranean habitat requirements of the Casey's June beetle and the quality and quantity of these resources necessary to complete the life cycle of an individual and to support a population.

- Female beetle abundance, distribution, and whether they have different habitat requirements than males.

- Population abundance, trends, growth rate, and survival at the different life stages.

- Direct measure of male dispersal capability, constraints to dispersal, particularly across developed areas or degraded landscapes, degree of female dispersal, and the minimum amount of dispersal required within and among subpopulations to maintain genetic diversity under natural conditions.

- Preferred frequency and magnitude of disturbance regime in wash habitats and the species tolerance to changes in the disturbance regime, particularly as it is tied to hydrological events. It is also unclear how the flood control system potentially impacts the beetle through higher peak flows and velocities.

- The potential role of interspecific interactions such as predation and parasitism in structuring the species' distribution, abundance, and annual variability.

CHAPTER 6 - FACTORS INFLUENCING VIABILITY

This section describes the current factors influencing Casey's June beetle resiliency in terms of potential threats, stressors, and conservation measures. We use the term threat, in a general sense, to refer to actions or conditions that may be or are reasonably likely to negatively affect individuals of a species directly or impact aspects of their ecology. Threats include actions or conditions that have a direct impact on individuals, as well as those that affect individuals through alteration of their habitat or required resources. Threats may encompass the source of the action or condition, or the action or condition itself. The magnitude of a threat depends upon a population-level assessment of the scope, likelihood, immediacy, and intensity of the threat as well as potential direct or indirect impacts it may have on a species or its habitat across all life history stages. Scope is defined as the spatial extent of threat within the context of the species' range (localized, moderate, high, or pervasive). Intensity indicates the magnitude of the impact on the species (negligible, weak, moderate, strong, and severe). Likelihood describes the probability that the stressor will impact the species in the foreseeable future [not likely (0 percent), low (1-25 percent), medium (26-50 percent), high (51-75 percent) and very likely (76-100 percent)]. Immediacy refers to the time frame of the threat (ongoing, past, imminent, or future). Threats may be reduced through existing conservation mechanisms or management activities; and those mitigating measures are described below where appropriate. Below we outline the main threats currently affecting Casey's June beetle as informed by the recent past. These factors impact individual, population, and species' needs, ultimately affecting the viability of the species. The relationships between threats, sources, species' ecology, and demographic parameters are illustrated in the effects pathway (Figure 6-1).

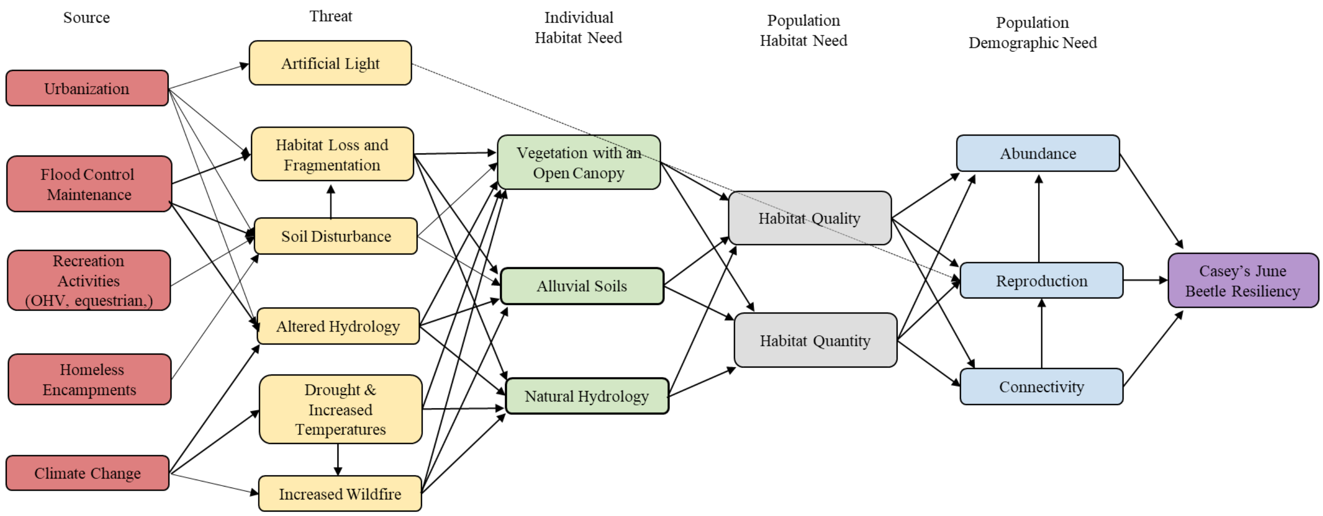


Figure 6-1. Casey's June beetle conceptual model illustrating the factors that contribute to population resiliency.[8]

The 2011 listing rule and 2013 Recovery Outline discussed potential threats to Casey's June beetle from: (1) destruction, modification, and fragmentation of habitat; (2) loss of individuals due to soil disturbance; (3) increased intensity and frequency of catastrophic flood events; (4) environmental effects resulting from climate change; and (5) loss of individuals due to attraction to artificial light sources (USFWS 2011, p. 58956-58959; USFWS 2013, p. 8). In the 2021 5-year review we described that these threats were on-going. For purposes of this analysis, we discuss threats to the beetle due to habitat loss and fragmentation, altered hydrology, soil disturbance, artificial light sources, drought and increased temperatures, and wildfire, which act both individually and in combination often with amplified effects.

6.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation is an imminent, high magnitude threat to Casey's June beetle occurring because of urbanization and new flood control structures (Figure 6-2). At listing, our analysis indicated that over 97 percent of Casey's June beetle historical distribution had been converted to development or rendered unsuitable by the impacts of adjacent development (USFWS 2011, p. 58956). The population of the City of Palm Springs increased by 10 percent (42,805 to 47,100) between 2000 and 2016 (SCAG 2020, p. 39). The City of Palm Springs is predicted to grow by an additional 30 percent by 2045 (61,600). The current growth rate has increased development pressure on properties zoned for residential and commercial use which

[8] The conceptual model includes the relationship between sources, threats, habitat needs, and demographic needs. The population habitat needs are combined in a habitat suitability model to describe the quality and quantity of suitable habitat to assess current and future conditions.

encroaches upon Casey's June beetle habitat. In addition to direct habitat loss which can result in the mortality of individuals at all life stages, urbanization and new flood control structures also indirectly impacts both habitat and demographic needs. The degradation of adjacent habitat through edge effects, including altered hydrology due to impervious surfaces or water diversion structures, and introduced nonnative plant species can change the water balance creating conditions that are either too dry or too moist to support immature stages of the beetle and may reduce survival and abundance. Additionally, artificial lighting associated with development may disrupt breeding behavior reducing reproduction and potentially resulting in population sinks (discussed in more detail in **section 6.4 Artificial Light Sources**); and individual mortality is expected to be higher along roadways that bisect habitat.

Although most of the habitat loss occurred prior to the species being listed, Casey's June beetle habitat in Palm Springs has been increasingly fragmented by development in recent years. Continued fragmentation of already limited, remnant habitat compromises the ability of the species to disperse, establish new subpopulations, augment declining subpopulations, and can isolate segments of a subpopulation increasing the chance of extirpation. Casey's June beetle is especially impacted by smaller-scale habitat fragmentation because females are flightless and unable to move between fragmented habitat patches. Male beetles can move between fragmented habitat patches and are largely responsible for genetic mixing on a population scale. However, it is not clear what degree of fragmentation or distance from suitable habitat males can successfully traverse to find females in isolated habitat patches, particularly if buildings and other obstacles to dispersal are present. Fragmented patches that no longer support female Casey's June beetles may be attractive to male beetles because of artificial light sources and act as population sinks.

However, dispersed, low impact development has been shown to be compatible with the Casey's June beetle. The Smoke Tree Ranch Habitat Conservation Plan (HCP) covers a gated community adjacent to Palm Canyon Wash, which is occupied by Casey's June beetle (USFWS 2013, p. 7). Portions of Smoke Tree Ranch were protected under a conservation easement prior to the listing of Casey's June beetle and the beetle has been recorded from the property for decades. The beetle population has persisted within the development likely due to the large open space areas with appropriate soils, relatively undisturbed vegetation, and an irrigation regime that may support immature stages of the beetle (USFWS 2021, p. 5). The HCP covers existing uses (e.g., artificial light and pools), on-going maintenance, and low-intensity recreational activities, and provides for 126.8 ac (51.3 ha) of preserved Casey's June beetle habitat, including an established conservation easement and endowment.

Since 2011, we issued four Biological Opinions (formal Section 7 consultations), two Habitat Conservation Plans (HCPs; Section 10 consultations), and two Not Likely to Adversely Affect determinations (informal Section 7 consultations, for temporary impacts) for the beetle authorizing modification of 37.1 ac (15.0 ha) of suitable habitat including transportation, infrastructure, and residential development projects (Appendix C). Recently, transportation and infrastructure projects have been implemented in such a way as to minimize impacts, often resulting in only temporary habitat impacts, and are therefore not anticipated to contribute to substantial future impacts. We use this information and future population growth projections to estimate the acreage of suitable habitat that may be impacted per decade in our future condition analysis. In addition, a programmatic biological opinion was issued to the Riverside County Flood Control and Water Conservation District (District) for up to 185 ac (75 ha) of temporary impacts due to flood control system maintenance in Palm Canyon Wash and Tahquitz Creek and 28 ac (11.3 ha) for levee repair in Palm Canyon Wash, in addition to other smaller, maintenance activities. Typical project impacts are much smaller than the maximum acreage authorized, and the programmatic biological opinion includes measures to avoid, minimize and mitigate impacts. Of the approximately 1,989 ac (805 ha) of remaining extant suitable habitat, approximately 41 percent (819 ac; 331 ha) is zoned for development and subject to varying degrees of habitat destruction and modification (see **section 7.1- Current Distribution**).

Casey June beetle receives some degree of habitat protection and indirect conservation benefits through the Agua Caliente Band of Cahuilla Indians Tribal Habitat Conservation Plan (THCP; Helix 2010, entire), though the beetle is not a covered species under either of these plans. Several of the covered species under the THCP have overlapping ranges and habitat requirements as the beetle. Therefore, the regulatory protection and conservation for these species are expected to provide added benefits to Casey's June beetle. Additionally, wetland and riparian areas are provided some protections under the existing tribal conservation programs including management of nonnative vegetation, minimization of trail impacts and erosion, restriction of recreational activities and habitat restoration (Helix 2010, pp. 2–8). The THCP designates much of the southern portion of the species' distribution and the watershed surrounding the species range as a Tribal Reserve dedicated for the preservation of open space and cultural resources (Malcolm 2023, pers. comm.). The remaining habitat in the southern portion of the species' distribution is zoned Rural Residential (up to 1 unit per 20 acres) and is expected to remain largely undeveloped. The Valley Floor Planning Area within the THCP requires a mitigation fee to acquire conservation land that is expected to equate to a 1:4 conservation ratio across the THCP plan area. The Plan Area occurs within the species' range, but future acquisitions may not be located within suitable beetle habitat. The CVMSHCP includes

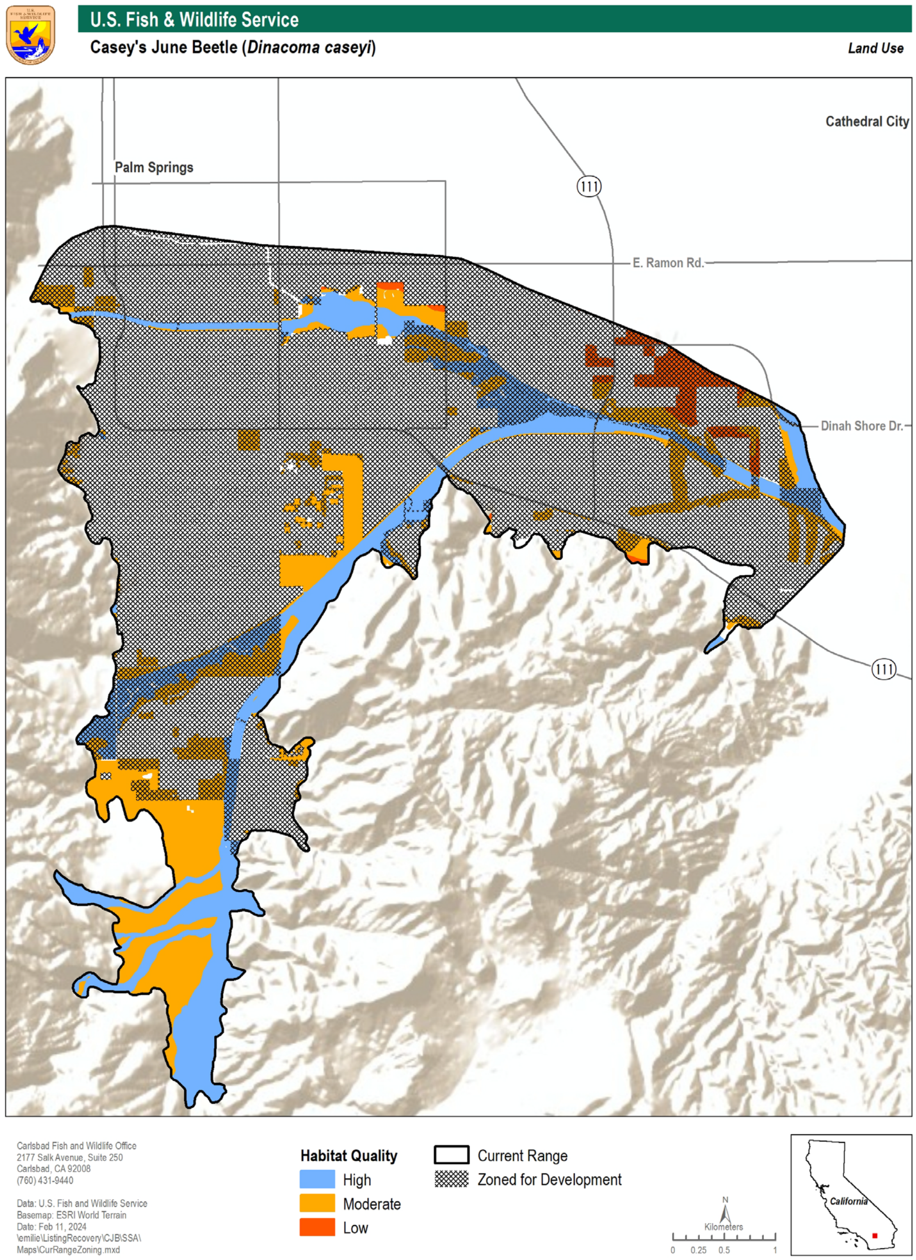


Figure 6-2. Suitable habitat within Casey's June beetle's current range that is zoned for development.[9]

---

[9] Figure 6-2 excludes Rural Residential designation on Tribal lands from the area zoned for development. Future development in the Rural Residential designation will be at very low density and the area is anticipated to provide long-term habitat value for the beetle. The habitat suitability model used to define the beetle's current range is presented in section 7.3.2-Habitat Quality and Quantity.

the land outside of checker-board tribal ownership. Overall, areas outside of the watercourses and open space are designated for development and are limited to in-fill projects within areas of existing development (Figure 6-2).

Habitat loss and fragmentation continues to be a pervasive, ongoing, high magnitude threat to Casey's June beetle. The intensity of the threat to Casey's June beetle is considered strong because 819 ac (331 ha; approximately 41 percent) of the species' remaining suitable habitat is zoned for development.

6.2 Altered Hydrology

The listing rule identified natural flooding events as a threat that may result in local extirpations (USFWS 2011, p. 58965). Casey's June beetle habitat in desert washes and creeks can undergo intense flooding and scouring events. Past and ongoing development adjacent to waterways prompted channelization and development of levees and other flood-control structures beginning in the 1950s. As a result, the two main drainages in occupied habitat, Palm Canyon Wash and Tahquitz Creek, have reduced channel widths which concentrates flows in a smaller area resulting in higher magnitude flood events and increased flow velocities. The beetle has persisted under these conditions over the last 70 years that flood control structures have been in place, though over a reduced area than it occupied historically.

The hydrological pattern includes cycles of drought to average rainfall followed by significant flooding, extreme precipitation, and scouring events, defined as rainfall in excess of 6 to 7 in (15.2 to 17.8 cm) per season or greater than 2.5 in (6.4 cm) in single day (Figure 3-4; WRCC 2024, unpaginated). Average seasonal rainfall of 5.5 in (13.9 cm) is typically contained within the existing levee system. However extreme rainfall events have occurred infrequently, approximately once a decade between 1906-2009, though no events were recorded between 1980 and 2010. Under future climate predictions, annual precipitation is not expected to vary significantly from historical records (4.7 in; 12 cm; Hopkins et al. 2018, p. 67; Cal-Adapt 2021, entire). However, precipitation is expected to be more variable including an increased probability of extreme daily precipitation events (up to 30 percent, Hopkins et al. 2018, p. 18). For example, the August 2023 (2.6 in; 6.7 cm) and February 2019 (3 in; 7.6 cm) extreme rainfall events surpassed the levee system west of the South Gene Autry Trail bridge and included 2 of the last 4 high magnitude flood events in the last 10 years (every 2.5 years on average), highlighting the potential for increased frequency of flood events with climate change.

These flood control structures have been in place for 40 to 70 years and additional constriction of hydrological flows are not anticipated; however, Casey's June beetle did not evolve with high frequency, intense flood events concentrated within flood control structures. Therefore, we expect that the changes to the disturbance regime associated with an increase in extreme precipitation events may impact the beetle's habitat and likely increase individual mortality in those areas. Concentrated flood events result in greater inputs of water, sediment, debris in a smaller area and larger water quantities contribute to more scouring and increased transport of sediment and vegetation that the beetle relies on. Under these concentrated flow conditions, sediment deposition tends to occur further downstream with less layering of organic debris and sediment upstream, reducing the future availability of detritus (the larval food source) in those areas. Substantial vegetation, such as large *Chilopsis* trees, tends to capture organic debris (such as driftwood) which later becomes buried by sedimentation. This organic debris appears to be the resource on which immature stages of the beetle depend.

The increase in the frequency and magnitude of flood events can remove vegetation and sediment in larger areas potentially reducing food resources, including rootlets and organic inputs, and habitat structure. The force of the concentrated flow often removes established vegetation on the soil surface and can remove entire plants and their associated root structure. While the beetle requires the deposition of sediment and organic material during these periodic events, they are also suspected to utilize plant rootlets that may be displaced. However, the proportion of their diet attributed to detritus versus rootlets is unclear. Also, if there is insufficient time between disturbance events, the vegetation community may not recover during which time the area may be of lower quality for the beetle. Based on a review of available Google Earth aerial imagery from 1998 to 2021, it takes approximately four to six years for the vegetation to begin to recover (defined as approximately 20 percent cover) following a significant flood event and/or subsequent sediment removal event and is dependent on annual rainfall (Google Earth Pro 2021, unpaginated). Although larvae can feed on detritus, sufficient vegetation (rootlets) for larvae nutrition is not expected to be present for several years after a major flood and scouring event and these events are likely to deposit detritus farther downstream than unconcentrated, slower flows.

Beetles are presumed to be dispersed downstream during flood events; however, the degree of dispersal and any associated mortality are unknown. Preliminary evidence suggests that larvae may be at depths greater than 8 ft (2.4 m) during the summer and winter months such that winter storms may have minimal impacts, depending on the depth of scouring and the sediment present within any given area. However, immature stages move closer to the surface as the adult flight season approaches; therefore, significant rain events in March and April could result in higher mortality and the potential to transport beetles to unsuitable habitat. Because flood events may transport beetles downstream, we previously hypothesized that scoured areas would result in local extirpations that may not be readily recolonized because female beetles are flightless (USFWS 2011, p. 58958). Based on the February 2019 event, monitored locations that were occupied prior to the event remained occupied afterwards and localized extirpations were not realized, although some areas experienced reduced abundance (Table 4-3). We currently lack information to support the potential for local extirpations. However, we acknowledge that there could be significant impacts to the beetle depending on the size, frequency, and timing of hydrological events, and the potential for local expirations increase under projected climate change.

As a result of sediment and debris deposition following large rainfall events, the District removes sediment to maintain flood capacity within the levee (Table 6-1; Appendix E). Sediment removal occurs every 5 to 10 years since construction of the flood control structures in the mid-1950s (USFWS 2023, p. 4). Maintenance events have occurred eight times over the last 41 years of available maintenance records (1978, 1980, 1985, 1993, 1998, 2005, 2010 and 2019; USFWS 2023, p. 14). Maintenance generally occurred after 2 to 4 above average rainfall events ranging in total rainfall from 10 to 35 in (25.4 to 89 cm). For example, the District recently removed sediment from Palm Canyon Wash and repaired levee damaged from the February 2019 storm event. Between 0.5 and 8 ft (0.15 to 2.4 m; approximately 270,000 cubic yards; 206,430 cubic meters) of sediment and debris was removed in the channel from approximately South Araby Drive to the South Gene Autry Trail bridge following three above average rainfall events over the previous three years. Sediment removal resulted in impacts to approximately 42 ac (17.0 ha) of Casey's June beetle critical habitat and 12.8 ac (5.2 ha) associated with levee repairs in Palm Canyon Wash (USFWS 2023, p. 51). This event is typically in scope though the maximum work area for sediment removal could be as much as 134 ac (54.2 ha; USFWS 2023, p. 151). This emergency action and future maintenance actions (e.g., geotechnical investigations, sediment removal, levee repair, structure repair, and vegetation management) are addressed in a programmatic consultation addressing the District's operations and maintenances activities in Palm Canyon Wash, Tahquitz Creek, Whitewater River and at the Eagle Canyon Dam. Maintenance work is typically task and area specific and does not include the entire area at any one time. The programmatic biological opinion includes conservation measures to offset impacts to the beetle due to future sediment removal, and maintenance activities (e.g., water quality measures, worker education, working outside of the flight season, limiting permanent lighting, avoiding mature vegetation, burying woody vegetation to provide a food resource for beetle larvae, funding monitoring research, habitat mitigation, conservation acquisition and other recovery actions), thereby minimizing and mitigating future impacts (USFWS 2023, pp. 4–12). Nonetheless, the removal of substantial sediment in areas of deposition that include immature stages of the beetle is considered an imminent, high magnitude threat that is anticipated to increase in the future under projected climate change; but is required to maintain the safety of individuals and properties adjacent to the wash.

Table 6-1. Frequency of Flood Control Maintenance and Sediment Removal Activities.[10]

Year of maintenance	Years since last maintenance	No of above average events	Total rainfall of above average events in (cm)	Rainfall Data year-in (cm)
1978*	-	-	10.44 (26.5)	
1980	2	2	20.59 (52.2)	1979-9.38 (23.8), 1980- 11.21 (28.4)
1985	5	2	26.82 (68)	1982-6.62 (16.8), 1983-13.72 (34.8)
1996	11	4	34.62 (87.9)	1991-7.7 (19.56), 1995-8.47 (21.36), 1993-11.2 (28.45), 1995-7.25 (18.4)
1998	2	2	9.54 (24.2)	1997-4.5 (11.43), 1998-5.04 (12.8)
2005	7	2	17.15 (43.6)	2004-7.82 (19.86), 2005-9.33 (23.7)
2010	5	2	19.69 (50)	2008-6.31 (16.0), 2010-13.38 (34)
2019	9	3	24.3 (61.7)	2017-7.99 (20.3), 2018-5.49 (13.94), 2019-10.52 (26.7)
Average	***5.9***	***2.4***	***20.4 (51.8)***	

Natural hydrology is critical to sustaining suitable habitat, maintaining soil moisture, and the periodic deposition of detritus (Osborne 2024, pers. comm.). The first flood control structures were installed in the 1950's and the levee system has been in place since at least the 1980's. The persistence of the beetle under altered hydrological conditions for the last 40 or more years suggests some level of tolerance and resiliency. However, recent and projected future increases in the frequency of flood events are expected to increase disturbance and along with projections of prolonged, vegetation in the wash and surrounding watershed are not expected to have sufficient time to recover. Additionally, a lower water table and increased depth to soil moisture in channelized waterways is expected to reduce habitat suitability; and is expected to be exacerbated under drought conditions (**see section 6.5**) with impacts on soil moisture for the beetle and vegetation recovery. The hydrogeological patterns of periodic (flood-based) erosion, scouring, and deposition are also expected to change the quality, quantity, and spatial distribution of suitable habitat and corresponding beetle abundance. Increases in the magnitude and frequency of flooding events are currently a moderate magnitude, infrequent threat to Casey's June beetle occupied habitat within Palm Canyon Wash and Tahquitz Creek, approximately 21 percent of modeled suitable habitat. Although the hydrological effects are moderate in their

[10] Frequency of flood control maintenance and sediment removal activities relative to the number of above average rainfall events and the total inches of above average rainfall events (District 2020, p. 2; WERC 2021). 1978 is the first date of recorded maintenance; therefore, we are not able to determine pre-maintenance conditions.

magnitude and spatial distribution, the sediment removal activities impact wash and creek habitat where there is the highest relative abundance of male Casey's June beetles, resulting in a high magnitude threat overall. (see **section 7.3.3 - Abundance**). There is however some uncertainty around the intensity of these impact on the beetle. Following the 2019 flood event, all survey trap locations were occupied the following year. Though abundance was often lower, local expirations were not observed. Preliminary research suggests that the beetle may be able to burrow deeper into the wash sediment than originally anticipated and avoid impacts and the potential for local extirpations (Ronan et al. 2024, p. 105); or have other adaptations we are not aware of. Further research is necessary to determine the degree of mortality during flood events and the potential need for recolonization or augmentation following sediment removal activities to maintain a viable population in the future.

6.3 Soil Disturbance

At listing, temporary soil disturbance due to equestrians, vehicles, and other human activities was identified as a threat to the beetle because of its subterranean life history (USFWS 2011, p. 58965). These sources of disturbance are known to degrade habitat quality by increasing erosion, reducing both plant and vertebrate diversity, and changing soil density through compaction, which may also influence soil water retention capacity. Soil disturbance destroys emergence holes and is suspected to injure or kill individuals immediately below the surface. Casey's June beetle is particularly susceptible immediately before and during the adult flight season when larvae, pupae and adults are close to the surface. Soil disturbing activities that cause direct mortality, compact, or disturb soils, or affect soil conditions at a depth where immature stages or resting adults are affected could reduce survival and species' persistence in the immediate area. However, outside of the breeding season the beetle is in the larval growth stage; and preliminary field investigations suggest that larvae are deeper in the soil and may be less susceptible to soil disturbance during approximately June to March (Ronan et al. 2024, p. 105). To better understand the extent and impact of the threat of soils disturbance, the District installed cameras to monitor off-road access at their 40 ac (16.2 ha) conservation easement in Palm Canyon wash (USFWS 2023, p. 44).

Additionally, homeless encampments in Palm Canyon Wash contribute to physical soil disturbance and may be degrading habitat quality through the dumping of waste and chemicals (e.g., gasoline and batteries). Homeless encampments are generally associated with the densest vegetation cover, which is subject to change depending on the timing and magnitude of flood events. It is expected that adult beetles cannot successfully emerge or mate through ground cloths, blankets, tarps, and tents which cover areas of ground surface during the flight season. The greatest number of camps has occurred immediately east and west of South Gene Autry Trail bridge. The magnitude of the potential impacts to the species are expected to be to moderate, localized, and periodic. Due to periodic flooding and subsequent sediment removal, sufficient cover to support homeless encampments may only occur for several years at a time. However, instances have occurred that may require that the encampments are cleared from suitable habitat to reduce take of the beetle and reduce the risk of human injury during the rainy season.

Soil disturbance continues to be a localized, periodic, low magnitude threat, though largely unstudied, with the greatest impacts in Palm Canyon Wash due to the presence of loose soils and a high proportion of the Casey's June beetle population. Equestrian activity occurs throughout Palm Canyon Wash but is most concentrated at access points near Smoke Tree Stables. Similarly, vehicle traffic can be observed in the broader areas of the wash and is concentrated near access points at South Araby Drive and Rim Road. There is also recent evidence that the magnitude and frequency of vehicles in Palm Canyon Wash has increased at these access points (Ronan 2024, pers. comm.).

6.4 Artificial Light Sources

Male Casey's June beetles are attracted to light, artificial sources of light (e.g., streetlights and residential lighting), and swimming pools, which pose a risk to the beetle through direct mortality or reduced reproductive output (USFWS 2011, p. 58977). Swimming pools appear to attract beetles regardless of whether there is an internal source of light; the reflection of the moon or surrounding lights may be sufficient (Osborne 2024, pers. comm.). Male beetles are reported to disperse 328 ft (100 m) to artificial sources of light potentially removing them from suitable habitat, disrupting breeding behavior, and potentially resulting in mortality (USFWS 2011, p. 58961). The magnitude of the threat of artificial light and swimming pools is not well understood. Spatially both threats are pervasive in developed areas of the species' range, particularly in the northern third. Near the peak of the adult flight season, approximately 15 beetles were attracted to a single swimming pool for one evening (USFWS 2021, p. 7). This observation was near occupied habitat in the low-density Smoke Tree Ranch development. We expect that pools near occupied habitat, particularly near the active channels will have similar levels of impact; and that the beetle is unlikely to be attracted to pools surrounded by development. However, all portions of the species' range that are adjacent to urbanized areas are subject to impacts from artificial light. Concentrations of artificial lights in commercial and residential developments may become a population sink by attract beetles that die or otherwise do not return to suitable habitat. The number of beetles impacted is unknown. It is expected that numerous individuals are impacted through the disruption of breeding during the flight season each year and an unquantified number of beetles die, drown, or are unable to return to suitable habitat. Artificial light continues to be an ongoing threat that is projected to increase with increasing development and the ubiquitous construction of pools in the desert. We estimate that 1,426 ac (577 ha; 72 percent) of suitable habitat, primarily in the northern extent of the species' range, is affected which represents a moderate magnitude threat to the species (Appendix F).

6.5 Drought and Increased Temperatures

Desert climates in California are predicted to be more extreme in the future with increasing daily and maximum temperatures, and greater variability in annual precipitation resulting in extreme precipitation events and prolonged droughts (Hopkins et al. 2018, p. 21; Cal-Adapt 2021, unpaginated). Climate data is presented for the Palm Canyon Wash hydrological unit which includes the valley floor and surrounding montane watershed. Daily average maximum temperatures are expected to increase by 4.1ºF to 4.9ºF (2.3ºC to 2.7ºC) by mid-century (2035-2064) based on Representative Concentration Pathway (RCP) 4.5 and RCP 8.5, respectively, contributing to an increase in the number of extreme heat days (18 Days, RCP 4.5; Hopkins et al. 2018, p. 15; Cal-Adapt 2021, unpaginated). Historically during the adult flight season maximum air temperatures averaged 92ºF (33.3ºC) with a high of 104ºF (40ºC in May; WRCC 2021, unpaginated). The projected future temperatures would range between 108.5ºF and 112.5ºF (42.5ºC and 44.7ºC); and is comparable to current summer temperatures extreme, when the beetle is below ground. Similar increases in summer are expected to exceed the highest temperatures recorded in the region (123ºF (50.6ºC) in June 2021). Air temperature and soil temperature are correlated; and higher temperatures increase evapotranspiration which is expected to decrease soil moisture conditions for all life stages and may reduce vegetative cover and the availability of detritus, particularly during periods of extended drought. Air temperatures are tied to beetle emergence and below ground temperature affects the probability of capturing an individual beetle in a trap, potentially resulting in changes in emergence and abundance patterns (Harju 2021, pp. 9–10). Higher temperatures are also likely to increase the rate of larvae development, and may result in smaller individuals, particularly if food resources are also limited. We expect these conditions to affect all individuals similarly, with limited potential for substantial incongruity in the timing of adult mass emergence. Projected temperatures are within the range of historical temperatures in the region. However, it is less clear how prolonged periods of high temperature earlier in the season will impact the beetle. We expect the potential for increased mortality particularly during periods of prolonged drought.

Higher temperatures are also expected to increase wind speeds in the desert by 5 to 10 percent (Hopkins et al. 2018, p. 12). These projections are likely to result in slightly stronger winds during the Casey's June beetle adult emergence period; because the strongest winds tend to occur in the evenings beginning in April each year (Hopkins et al. 2018, p. 21). Increased temperatures and wind speeds also accelerate the dispersal of female pheromones and may disrupt breeding and reproduction (USFWS 2011, p. 58961). Another species within the subfamily, *Hypothyce mixta*, was observed to be unable to make contact with a female just a few inches away, highlighting the importance of wind speed and direction in reproduction, though successful encounters within 3 ft (0.9 m) were recorded under laboratory conditions (Barfield and Gibson 1975, p. 253). Maximum wind speed has been shown to be negatively correlated with the probability of trapping adult males, along with below ground temperature (Harju 2021, p. 11). Casey's June beetle will be most susceptible to increased wind speeds in exposed areas with less vegetation (e.g., after flood or sediment removal events) and in the north and central portions of the floodplain that are less protected by the surrounding mountain ranges.

In addition, extended droughts are expected to be more common, exacerbating water availability and conflicts with development and other land uses. The Coachella Valley currently experiences ground level subsidence due to groundwater pumping and a compressed aquafer which can alter surface drainage, flood control structures, and create fissures (USGS 2014, p. 2). Drought exacerbates the effects of increased temperature described above including soil moisture with potential effects on beetle development, availability of nutrients, reproduction, and vegetation growth and habitat recovery. The impact of drought is evident in the male capture data. Per trap capture data from 2018, after two years of above average rainfall, captures increased by 35 to 633 percent compared to 2016 surveys which followed five years of drought (with the exception of the trap furthest upstream where only one male was captured; Table 4-3). The region is also expected to see a reduction in summer monsoonal rainfall which typically contributes up to 40 percent of the yearly rainfall and is a potentially significant contributor to soil moisture conditions (Hopkins et al. 2018, p. 18). We have no field data to inform on the capacity of the species to overwinter during periods of inclement weather, though they have been observed to do so under laboratory conditions (Osborne 2022, pers. comm.). Therefore, we project that severe environmental conditions may have potential direct effects on individual survival and reproduction in a given drought season, with reduced abundance in the subsequent year or years.

Climate change is a threat to Casey’s June beetle identified at listing because the species is: 1) dependent on soil moisture and the natural hydrological regime that supports desert alluvial fan ecosystems; 2) has restricted mobility and limited ability to adapt behaviorally or through a range shift; 3) a narrow endemic; 4) vulnerable to variations in disturbance regime; and 5) its historical range is significantly contracted due to habitat loss and fragmentation (USFWS 2011, p. 58961). However, we expect some degree of behavioral adaptation, particularly in larvae that have the ability to move within the soil column to find food and optimal soil moisture conditions, though there may still be impacts on development and emergence if the upper soil column in not suitable. There is also documented variability in the timing, peak and duration of adult emergence that may be a response or adaptation to climatic conditions on the order of weeks, assuming suitable conditions return. Similarly, adult male activity is reduced under high wind conditions (Harju 2021, pp. 9–11), which may be an adaptation to reduce desiccation and conserve energy. Because the beetle’s reproductive and adult survival strategy is based on a mass emergence strategy, we do not expect decoupling between nutrient availability and reproductive opportunities. Casey’s June beetle has evolved under the hot, arid conditions of the Sonoran desert and is believed to be adapted to some degree to future climatic conditions. The threat of drought and increased temperatures is on-going and increased aridity is imminent with similar affects throughout the species’ distribution. There is a high likelihood that the beetle will be impacted but we lack information to quantify the intensity of the impact. Based on the best available information including post-drought capture data, we consider drought and increased temperatures to be a moderate magnitude threat to the species. Alternating periods of high precipitation may help alleviate these impacts potentially allowing the population to rebound, based on the available data for droughts extending 4 to 6 years. There is less certainty that the beetle will persist should droughts extend for a substantially longer period of time. These threats are expected to exacerbate threats already facing the species as a result of its restricted range, habitat specialization, and small population size.

6.6 Increased Wildfire

There is evidence of an increased frequency of wildfire currently and the risk and frequency are expected to increase in the future with projected climate change (Figure 6-3). A total of eight

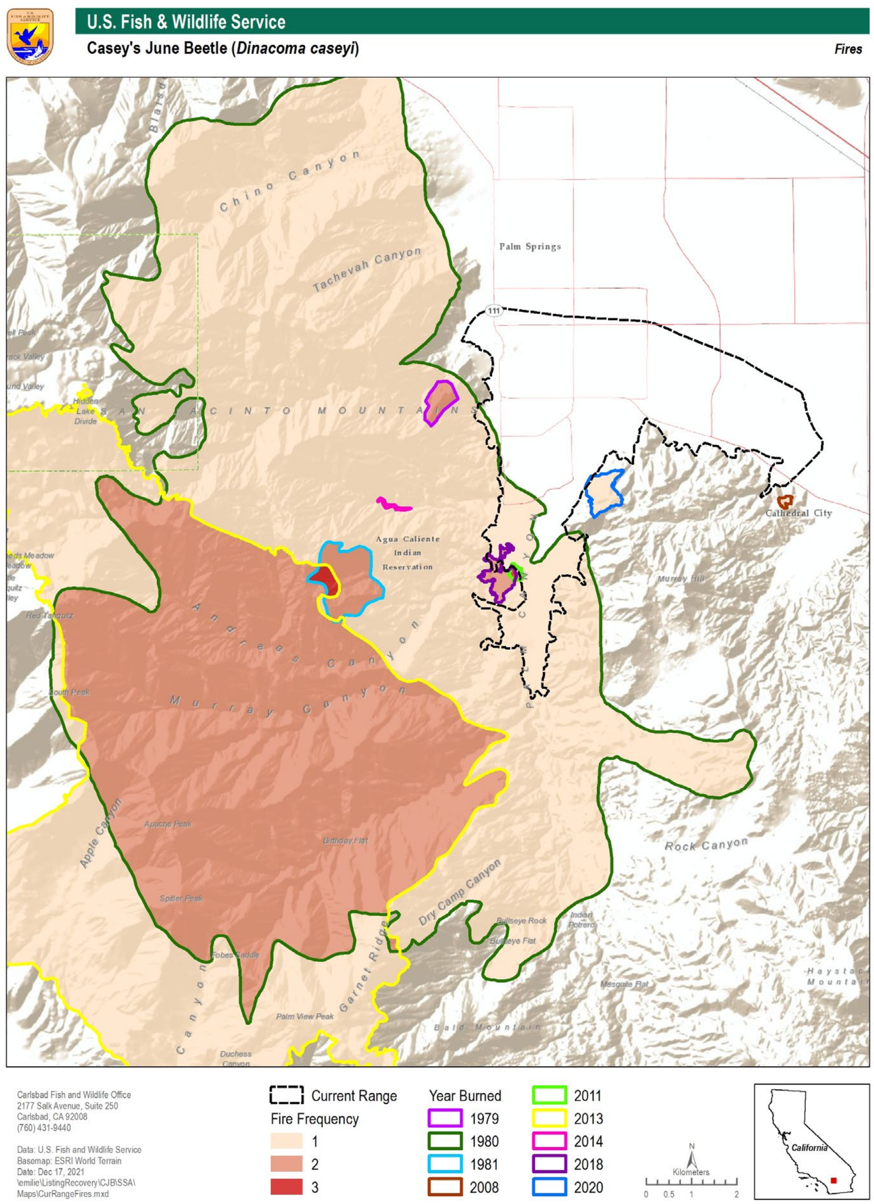


Figure 6-3. Fire history and frequency (number of fires in the last 40 years) within the current range of Casey's June beetle and the surrounding watershed.

large fires [greater than 10,000 ac (4,047 ha)] occurred over the last 100 years in the vicinity of the beetle's range or approximately every 13 years on average, though the desert ecosystem did not evolve with wildfire (CalFire 2021, unpaginated). Over the last 50 years, there have been 9 fires in the watersheds above Palm Canyon Wash, with 5 (56 percent) occurring in the last 10 years (CalFire 2021, entire; Figure 6-4). The majority of fires are less than 500 ac (202 ha) and have not substantially impacted suitable habitat. But two of the largest fires were greater than 20,000 ac (8,096 ha) each and occurred in the recent past in 1980 [41,756 ac (16,898 ha)] and 2013 [27,523 ac (11,138 ha)]. The 1980 Dry Falls fire burned the slopes to the west and the south including suitable habitat on the valley floor in the southern portion of the species' current range. It was the largest fire on record in the last 100 years and the only fire in the last 50 years to burn a substantial portion of suitable habitat. With respect to the fire return interval, a small portion of the current range (28 ac; 11 ha) burned more than once in the last 50 years, primarily on upland terraces to the southwest. Approximately 14,916 ac (6,036 ha) of the surrounding watershed has burned more than once, and the majority burned twice with a 33-year fire return interval (1980 and 2013).

The risk of wildfires is expected to increase in the future due to the effects of climate change, increased probability of ignitions correlated with population growth, and homeless encampments in the wash. But there is uncertainty in where fires will occur, the burn severity, and fire-return interval, which depends on future climate conditions (e.g. temperature, wind, and precipitation), as well as pest, nonnative plants, and development patterns (Cal-Adapt 2021, unpaginated). Wildfires and the average annual acreage burned are expected to increase by approximately 8 percent under RCP4.5 to 13 percent under RCP8.5 by mid-century (2035-2064) on the valley floor [from 9.4 ac (3.8 ha) to 10 ac (4.1 ha)]. The rate of increase is expected to be higher in the surrounding watershed due to higher dry fuel loads associated with cycles of high precipitation and vegetation growth followed by periods of drought. Future projections estimated a 20 percent increase under RCP4.5 and up to 26 percent increase under RCP8.5 over the same time period [from 72.4 ac (29.3 ha) to 84 ac (33.9 ha)] (Cal-Adapt 2021, unpaginated). Individual fires are also expected to be larger due to increased winds associated with warming temperatures. The range of acres burned per year on the valley floor is similar to current conditions, with a high of up to 30 ac (12 ha) per year though desert habitats are generally not adapted to wildfire. The forecasted maximum acres burned increases from 146 ac (59 ha) to 180 ac (73 ha) in the surrounding watershed. Increased wildfires are expected to alter the vegetation cover of the surrounding watershed with more limited effects within the floodplain due to the characteristically low vegetative cover of desert plant communities. Wildfires, particularly if they increase in frequency, may limit the ability of the vegetation to recover in the wash and limit the organic inputs from the surrounding watershed that form the detritus that immature beetle stages feed upon. The potential effects of the chemical and mineral inputs from fires on immature stages of the beetle are not known but we expect discharge of organic materials (e.g. charred or dead wood) after fires may enhance beetle resource availability in sediments.

In addition, extreme precipitation and flooding events forecasted under future climate change will result in increased run-off and erosion following wildfires contributing additional organic and sediment inputs into the system that support the beetle but may limit vegetation recovery. Although changed dynamics may simply shift the optimal depositional environments further downstream. The increase in the quantity of sediment inputs and frequency of events under a projected increase in the size and frequency of wildfire are anticipated to increase the need for flood control maintenance, particularly sediment removal to maintain flood capacity. The combination of these factors is expected to significantly reduce the time between disturbances and the ability of the habitat and population abundance to recover. Increased wildfire is an imminent threat of moderate scope, with the largest impacts within the wash and creek that are fed from the surrounding watershed. Although there is some uncertainty regarding future fire frequency, the increased risk of wildfire is a highly likely future threat that we consider to be an overall moderate magnitude threat to Casey's June beetle.

6.7 Threats Not Carried Forward

Predation and pesticides are potential threats to Casey's June beetle that are not carried forward in this analysis. The species has evolved some adaptations to predation by native bird species such as kingbirds and nighthawks through the strategy of mass emergence, allowing some individuals to survive and reproduce at the expense of others. It is not clear to what extent development and concentrating habitat within existing flood control structures increases local densities and the risk of predation compared to what would have been observed historically on the larger floodplain. The increased prevalence of species such as crows and mockingbirds that have adapted to urbanized environments may also increase the predation risk; but we have no information to evaluate whether the impact on the species is substantially greater than historical conditions. Ants are also an emerging threat first observed in 2021. The native ant species, *Dorymyrmex bicolor*, was observed swarming a female and possibly responsible beetle mortalities in the vicinity of Tahquitz Creek along North Riverside Drive (Ronan et al. 2024, p. 111). As such ants are often saprophytic, it is likely that these events involved beetles that were already damaged or moribund. This behavior has not been observed previously nor within Palm Canyon Wash. It is hypothesized that the ants are preferentially utilizing habitat supplemented by irrigation and that the threat may be restricted to ornamental landscape and limited in scope. Mites have also been observed on male beetles; but we do not have information to indicate that these predators or pest are a substantial threat, especially in light of the other threats to the species; and they are not analyzed further in this SSA.

Pesticides including herbicides, insecticides and rodenticides are a potential threat to Casey's June beetle. These chemicals are used in residential, commercial and golf course settings adjacent to the beetle habitat to control pests and have the potential to impact beetle habitat through drift or contaminated run-off. There is also the potential for direct spraying of herbicides within occupied habitat in association with the maintenance of invasive plant species, flood control structures, and golf course management. Insecticides are expected to have a negative effect on the beetle. We lack information on the quantity and concentrations of insecticides in occupied habitat; but expect it to be generally of low concentration when diluted in run-off. Although there are toxicology studies available for the various pesticides, including invertebrates, the beetle is unlikely to be sprayed directly because of its crepuscular habit and many chemicals will at least partially be bound to the soil when sprayed, further reducing the potential for contact. Therefore, we recognize pesticides as a negligible, potential impact to the beetle and do not discuss it further in this SSA.

6.8 Conservation

6.8.1 Conservation within Current Distribution

A total of 350 ac (142 ha; 18 percent) within the species' current distribution is preserved in perpetuity or are planned to be conserved through a conservation easements or deed restriction in the immediate future (e.g. Prescott Preserve). This total represents modeled suitable habitat not occupied habitat, and some lands will require habitat restoration to improve their suitability for the beetle. Conserved lands by definition are not at risk of habitat loss and fragmentation and contribute toward ameliorating the threat of artificial light and soil disturbance, depending on their location. Most of these lands were conserved through permitted development actions described above (see **section 6.1-Habitat Loss and Fragmentation**). In addition, there are several recent conservation efforts that are approved or in process that may benefit the beetle and are included in the total above. In October 2019, the Agua Caliente Band of the Cahuilla Indians established a 38.6-ac (15.6 ha) conservation easement on a tribal allotment (80E) within Indian Canyons. The parcel is located on the upland terrace, adjacent to Palm Canyon Wash near the southern limit of suitable habitat and contains important biological and physical habitat features (USFWS 2011, p. 58970). In addition, the Oswit Land Trust has been instrumental in securing the 124.6-ac (50.4 ha; Prescott preserve). The Prescott Preserve is located at the former Mesquite Golf course and restoration of the wash habitat at the confluence of Tahquitz Creek and Palm Canyon Wash is planned in the near future. Additionally, approximately 10 ac (4 ha) of the Tahquitz Creek Golf Resort is being removed from golf activities and the habitat will be restored for Casey's June beetle, in association with the Coachella Valley Link Project. The project is in the planning phases, but the area has been included in the acreage conserved.

In addition to in perpetuity conservation easements, Agua Caliente Tribe, and City of Palm Springs zoning designations over an additional 821 ac (332 ha) reduce the potential for habitat destruction, including 41 percent of the species' current distribution. The THCP preserve system includes the Tribal Reserve, designated as open space, and Rural Residential (1 unit/20 ac) zoning with a goal of 85 percent or greater conservation across 614 ac (Helix 2010, Figure 6 and 29; 248 ha; Malcolm 2023, pers. comm.). These designations, particularly in the southern portion of the species' current distribution, will reduce the potential for habitat loss and degradation; and in combination with open space zoning designations in Palm Canyon Wash and Tahquitz Creek will contribute toward ensuring that hydrological processes remain intact. Similar designations in the surrounding watershed, including Federal and local land ownership, help to support the ecological and hydrological processes, though they do not carry the same long-term conservation and management status as in perpetuity conservation easements.

In total, the threat of development is prohibited or reduced over approximately 60 percent of the species' current distribution (1,993 ac; 807 ha)[11] through the conserved and protected lands described above.

6.8.2 Conservation within Historical Range

There are several conservation areas or open space designations within the historical distribution of the Casey's June beetle managed by Federal, State, and non-profit partners (Figure 6-5). The Bureau of Land Management manages lands in a checkerboard pattern throughout the current distribution and surrounding watersheds to the west and south including the Santa Rosa Wilderness. The California Department of Parks and Recreation manages the Mount San Jacinto State Park in the watershed that supports Tahquitz Creek. The State also owns or manages the Santa Rosa Mountains Wildlife Management Area (including Carrizo Canyon Ecological Reserve), the Santa Rosa Mountains State Game Refuge and Magnesia Canyon Ecological Preserve. To the north and south of the State Park, the U.S. Forest Service manages the San Jacinto Wilderness and San Bernardino National Forest. Non-profit groups also support conservation in the watersheds in the eastern portion of the species' historical range including the Bighorn Institute, University of California Natural Reserve System and the Living Desert Nature Preserve (Helix 2010, Table 2-1and Figure 6-6).

6.9 Summary of Factors Influencing Viability

Because Casey's June beetle has a naturally restricted range, is adapted to specialized habitat and soil types, and has limited dispersal potential, it is particularly vulnerable to threats to its habitat. The highest magnitude threats are habitat loss and degradation. Drought and increased temperatures, altered hydrology, increased risk of wildfires, and artificial light are all moderate magnitude threats (Table 6-2). Approximately 41 percent of the suitable habitat remaining in Palm Springs is threatened by development and 21 percent is subject to altered hydrology and increased frequency of disturbance. Drought conditions affect all habitats throughout the species' range and extended droughts are expected to substantially reduce abundance.

---

[11] There is an approximate 4-acre discrepancy in the acreage of modeled suitable habitat (1,989 ac; 805 ha) and the acreage conserved (1,993 ac; 807 ha) due to numerous, small overlapping polygons in the GIS database that could not be resolved.

Table 6-2. Summary of Current Factors Influencing Viability.[12]

Threat	Scope	Likelihood	Immediacy	Intensity	Overall Magnitude
Habitat Loss and Fragmentation	High	Very likely	On-going	Severe	High
Altered Hydrology	Moderate	Very likely	On-going	Moderate*	Moderate
Soil disturbance	Localized	Very likely	On-going	Weak*	Low[13]
Artificial Light	Moderate	Very likely	On-going	Moderate*	Moderate
Drought and Increased Temperatures	Pervasive	Very likely	On-going	Moderate*	Moderate
Increased Wildfire	Moderate	High	Imminent	Moderate-Strong	Moderate
Predation	Pervasive	Low	On-going	Weak*	Low
Pesticides	Localized	Low	On-going	Negligible*	Low

[12] Scope - spatial extent of threat within the context of the species' range (localized, moderate, high, or pervasive). Likelihood-probability that the stressor will impact the species in the foreseeable future [not likely (0 percent), low (1-25 percent), medium (26-50 percent), high (51-75 percent) or very likely (76-100 percent)]. Immediacy-time frame of the threat (ongoing, past, imminent, or future). Intensity-magnitude of the impact on the species (negligible, weak, moderate, strong, or severe). * Highlights threats with a high degree of uncertainty.

[13] Although soils disturbance is a low magnitude threat overall, localized impacts at homeless encampments is high, particularly when they occur in the wash during the flight season.

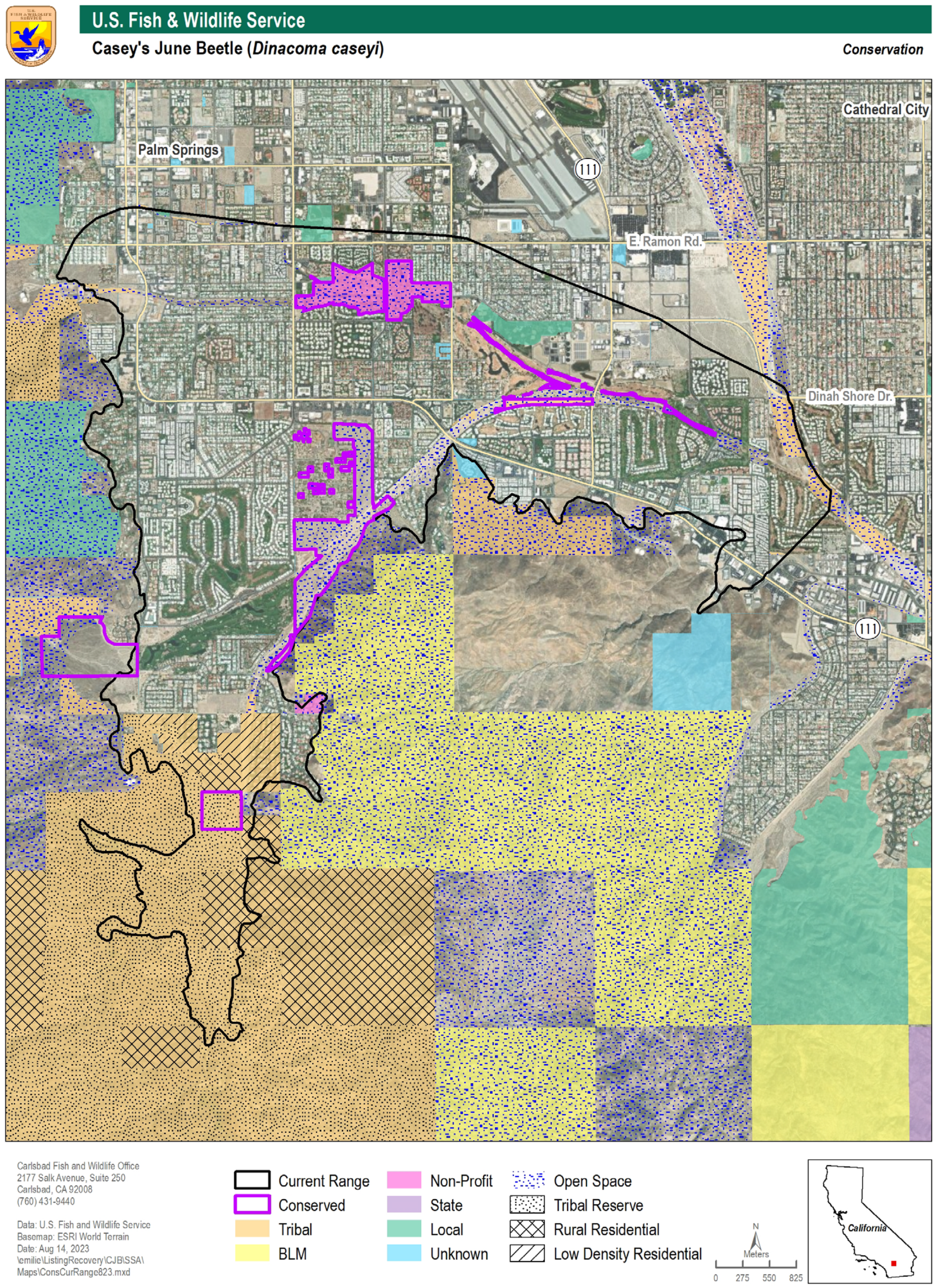


Figure 6-4. Conserved habitat within the species' current range.[14]

---

[14] Open space designation includes areas that support beetle habitat needs and are unlikely to be developed. However, they typically do not have the same level of restrictions, management, and monitoring as conserved lands.

CHAPTER 7 – CURRENT CONDITIONS

7.1 Current Distribution

At listing, our understanding was that the species' distribution was confined to an area of approximately 605 ac (245 ha) in southern Palm Springs, California (USFWS 2011, p. 58956). Since 2011, there have been additional detections within and outside of the previously documented range. Most known occurrences of Casey's June beetles were found in locations within or near the historical Palm Canyon Wash floodplain. Recent survey data within and along Tahquitz Creek, upstream of the confluence with Palm Canyon Wash, extended the distribution to the northwest (Wood 2020, entire; Wood 2021, entire) Tahquitz Creek was a known locality in the 1990s but positive detections were not recorded until recently (Duff 1990, p. 2). No additional observations outside of the species' current range and the Palm Canyon Wash floodplain have been recorded since listing.

The current distribution of Casey's June beetle is defined as suitable habitat within approximately 2,539 ft (774 m) of positive trap detections, the maximum male flight distance recorded (Table 7-4), and generally followed the elevation of the valley floor to the south and a maximum elevation of approximately 750 ft (229 m). The southern limit was extended to include potentially suitable habitat upstream that supports hydrological process throughout the range on Tribal land that was not identified at listing. Suitable habitat was modeled to define the species' current distribution based on important habitat associations in occupied habitat including alluvial soils, vegetation, and hydrology and is estimated at 1,989 ac (805 ha; Figure 7-1; Appendix A), see **section 7.3.2 Habitat Quality and Quantity** below. Low quality habitat is generally considered to be marginal and is not considered further in our future analysis of viability, though these areas may be important for future restoration. We assume moderate and high-quality suitable habitat areas adjacent to and between occupied Casey's June beetle detections are potentially occupied due to male dispersal capacity. However, there is limited data for modeled suitable habitat in the southern portion of the range on Tribal land; and this area is not known to be occupied at this time.

All known occupied habitats are within the jurisdiction of the City of Palm Springs and the Agua Caliente Band of the Cahuilla Indians. The majority of the suitable habitat is under tribal ownership (1,115 ac; 451 ha; 56 percent), and private lands (731 ac; 296 ha; 37 percent), though the flood control structures are maintained by the District through ownership in fee or a right-of-way easement (Table 7-1). Land ownership is presented as a percentage of modeled suitable habitat (see section Appendix A).

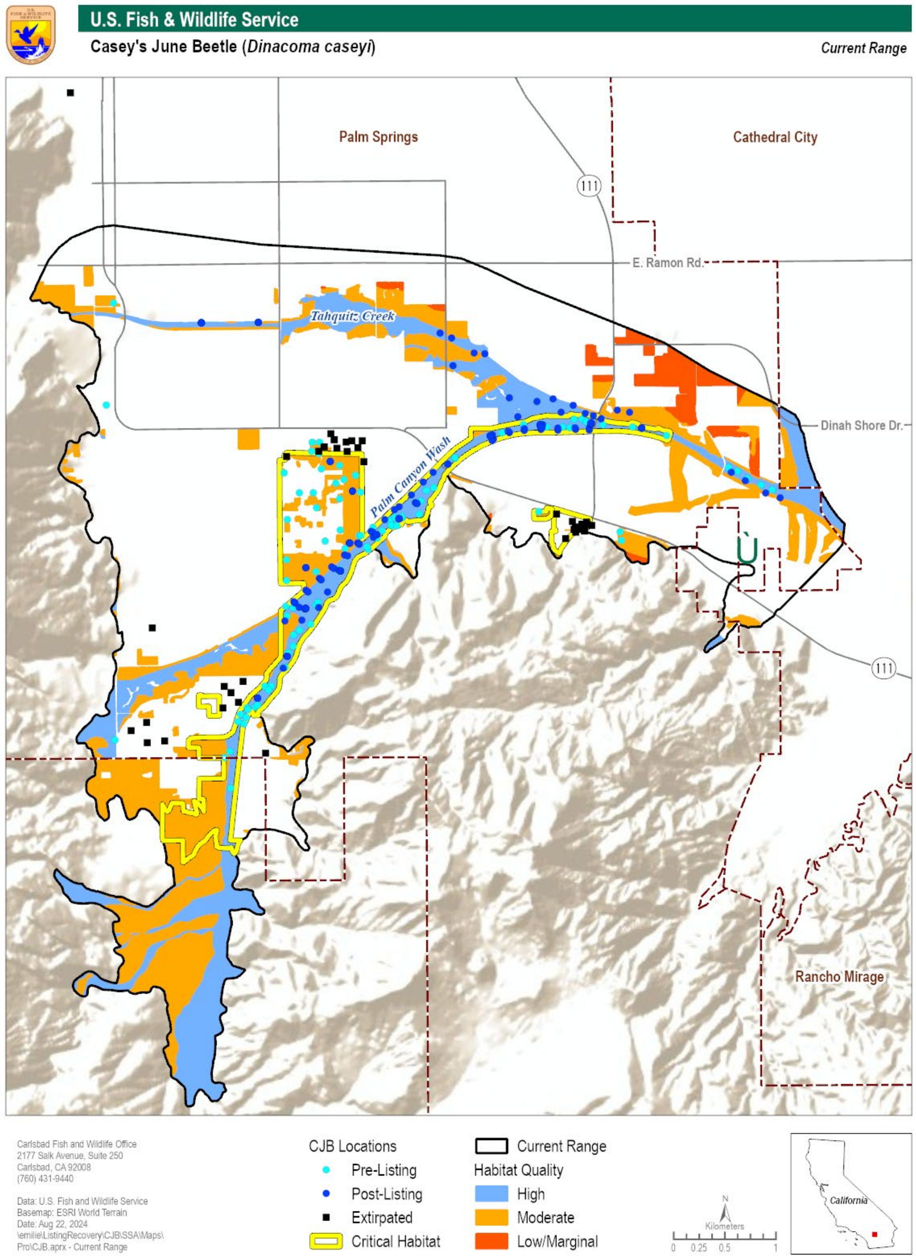


Figure 7-1. Map of Casey's June beetle's current range and distribution (1,989 ac; 805 ha). [15]

---

[15] Casey's June beetle's current range and distribution including critical habitat, pre- and post-listing records, and those records considered extirpated due to historical or permitted habitat impacts. Suitable habitat (1,989 ac; 805 ha) is also illustrated including modeled low, moderate and high-quality habitat within the species current range (6,444 ac; 2,608 ha; Appendix B) and is used to define the species current distribution. Only high and moderate quality habitat are addressed in our future viability analysis.

Table 7-1. Summary of land ownership within the current distribution of the Casey's June beetle.

Ownership Type	Size ac (ha)	Percentage of Remaining Suitable Habitat
Tribal	1114.7 (451)	56
Private	731 (296)	37
Local Jurisdictions	19 (7.7)	1
Federal	0.5 (0.2)	0.02
Non-Profit	123.3 (50)	6
Unknown	1 (0.4)	0.1
Total	***1,989 (805.3)***	***100***

The current distribution excludes those projects permitted since the species was listed, whether or not the project has been constructed. A total of 28.4 ac (11.5 ha) of potentially suitable Casey's June beetle habitat has been impacted by permitted projects since listing in 2011 (Table 7-2). This rate of development per decade was used to inform the rate of development for future scenario projections in **section 8.0 Future Conditions**.

Table 7-2. Acreage of permanent Casey's June beetle habitat impacts permitted since listing[16].

Project Type	Permitted Impacts ac (ha)
Flood Control	10.2 (4.1)
Residential	14.3 (5.8)
Transportation	3.7 (1.5)
Total	***28.4 (11.5)***

As a result of recent efforts, a total of 350 ac (142 ha) of the species' current distribution is now conserved including 174 ac (70.4 ha) of private land, 53.3 ac (21.6 ha) of tribal land, and 116.7 ac (47 ha) owned and managed by non-profit groups. Habitat was conserved through permits issued by the Service and through collaboration with our partners. Refer to **section 6.8.1 Conservation within Current Range** for additional details on recent conservation efforts for the Casey's June beetle.

Approximately 587 ac (237 ha) of critical habitat for Casey's June beetle was designated concurrent with the species' listing in 2011, in one unit in the south Palm Springs area of the

[16] Summary table does not include the programmatic biological opinion issued to the District for future maintenance activities.

Coachella Valley (Figure 4-2; USFWS 2011, p. 58969). We designated critical habitat lands that were considered occupied at the time of listing and that contain sufficient physical or biological features to support life history processes essential to the conservation of Casey's June beetle. At that time, we determined that over 97 percent of the historical range had since been impacted directly or indirectly by development. In our 2021 5-year review, we reported authorized modification of 218.4 ac (88.4 ha) of designated critical habitat since listing (USFWS 2021, p. 5).

7.2 Populations Defined for Further Analysis

The Palm Canyon Wash Floodplain population was defined to support our analysis of population resiliency. We consider all known occurrences of Casey's June beetle to constitute a single population in the Palm Canyon Wash floodplain (Gillett et al. 2020, entire). Three areas are often referenced within the Palm Canyon Wash floodplain that represent different habitat types, beetle abundance, and threat profiles that constitute the species' current range (6,444 ac; 2,608 ha): Palm Canyon Wash, Smoke Tree Ranch and Tahquitz Creek. The species' current distribution is a smaller area within the current range and is centered on the Palm Canyon Wash Floodplain, including 1,989 ac (805 ha) of potentially suitable habitat of which 1,884 ac (358 ha) are moderate to high quality.

Palm Canyon Wash extends from Andreas and Murray Canyons to the south that drain the east slope of Mount San Jacinto into Palm Canyon, downstream to the Whitewater River to the north (which ultimately flows into the Salton Sea). The wash consists of an earthen bottom ephemeral wash with sections of concrete lined levees, rock lined slope protection, and drop structures. Plant communities found in and adjacent to Palm Canyon Wash include riparian and desert wash habitat including desert willow, smoketree, cheesebush scrub, and salt cedar. Desert scrub generally occurs on the upland terraces outside of the wash due to flood control structures that constrain flow and may also occur in undisturbed areas of the wash. Adjacent land uses include commercial, residential, rural and open space, with rural and open space being more prevalent in the upstream portion of the canyon. Riverwash, Carsitas Gravelly sand, Myoma fine sand, Coachella fine sand, Carsitas fine sand, and Carsitas cobbly sand soil types are the dominant soil types within the floodplain (USFWS GIS 2021, unpaginated).

Smoke Tree Ranch is a gated, low-density, residential community on the upland terrace adjacent to Palm Canyon Wash that incorporates native desert landscape and has minimized the disturbance to beetle habitat. Beetles continue to be recorded in this area though it is not clear if they may be supported by current irrigation practices that provide suitable soil moisture and habitat conditions for immature stages of the beetle or if the males observed originated from the adjacent wash. The area was also historically occupied by females, though females have not been documented during recent survey efforts.

Tahquitz Creek (52.7 ac; 21.3 ha) drains the east slope of Mount San Jacinto at Tahquitz Canyon, and flows from the debris basin at the upstream end of the channel west of South

Belardo Road, downstream to the confluence with Palm Canyon Wash, just upstream of Gene Autry Trail. Tahquitz Creek includes earthen bottom, naturally vegetated ephemeral wash, a rock lined trapezoidal channel, a concrete lined side drain channel, and a debris basin at the upstream end of the channel. The flood control facility area also includes existing sidewalks on top of the levee and portions of the previous Mesquite Golf and Country Club now known as the Prescott Preserve. Although Tahquitz Creek is not within designated Casey's June beetle critical habitat, the area has since been determined to be occupied and includes important habitat features for the beetle (Ronan et al. 2024, pp. 46, 61). Known occupied habitat occurs along the top of the Tahquitz Creek levee adjacent to the paved walking path on North Riverside Drive from approximately South Camino Real east to South Sunrise Way and also occurs throughout the Tahquitz Creek Golf Resort located within the Tahquitz Creek channel at and upstream of the confluence with Palm Canyon Wash. We consider the habitat downstream of South Sunrise Way and west of East Cielo Road (i.e., between upper Tahquitz Creek and the Tahquitz Creek Golf Resort) as potentially suitable habitat. The remainder of the habitat upstream of South Palm Canyon Drive appears to be unsuitable habitat for Casey's June beetle.

7.3 Genetics

The population structure for Casey's June beetle has been described as multiple mini colonies clustered around established females (Hovore 2003, p. 3). Therefore, potential population differentiation was hypothesized due to poor female dispersal capability and habitat fragmentation. Genetic studies that sampled throughout the species' current distribution, including Palm Canyon Wash, Smoke Tree Ranch, and Tahquitz Creek, revealed no population substructure, though the sites were isolated by roads, highways and development (Gillett et al. 2020, entire; Rubinoff and San Jose 2021, p. 1). There is some evidence of inbreeding based on individuals that are more closely related than would be expected based on random mating. The degree of inbreeding was not characterized in terms of its potential effect on the viability of the species and may simply reflect the species' geographical isolation and small population size. The authors caution that the current factors contributing to habitat fragmentation and isolation are recent and it could take numerous generations before detectable levels of inbreeding or isolation are observed (Rubinoff and San Jose 2021, p. 1). The current level of habitat fragmentation within the population still allows for some mixing of genes by male dispersal (where patches are effectively close enough to each other), but it would preclude recolonization of isolated sites should all flightless female individuals be eliminated (Driscoll and Weir 2005, entire). Therefore, the data should not be interpreted as having high levels of gene flow between all occurrences. We also lack data on historical genetic variability and presume that it may be lower than more widespread species because Casey's June beetle is a narrow-endemic.

7.4 Summary of Methods

To develop condition categories, the best available scientific information was used, including research papers, survey reports, GIS models and feedback from species' experts (Table 7-1). Based on the habitat and demographic needs identified earlier in the SSA, our assessment of population resiliency is based on three condition categories: habitat quality and quantity, abundance, and habitat connectivity as described below. Condition categories were defined describing low, moderate, and high condition (Table 7-5). Each parameter was scored as high (5), medium (3) or low (1) based on the category descriptions below. The sum of the demographic values was divided by 2, so that habitat and demographic needs contributed equally to population resiliency and the total score was determined by taking the average between the two. A high overall resiliency condition score (3.6 to 5.0) means all population needs are clearly met in the analysis unit (Table 7-6). A medium overall resiliency condition score (2.1-3.5) means some population needs may be minimally present in the analysis unit. An overall low population resiliency condition (0-2) means that one or more population needs were not met.

7.5 Habitat Quality and Quantity

To better understand the species' current distribution and population resiliency a habitat suitability model was developed to characterize the amount, quality, and distribution of potentially suitable habitat. An occupancy-based GIS analysis was conducted that evaluated important habitat parameters at recorded observations including soil type, hydrology, and vegetation community (Appendix A). Habitat parameters were ranked based on their frequency at known records within occupied habitat. This was a GIS exercise to characterize current conditions, and individual parcels were not ground truthed; therefore, we acknowledged that additional field investigations may be required to verify habitat suitability.

Casey's June beetle is known to occur on several soil associations within each soil series, which are defined by slope and the proportion of gravel to sand; therefore, all associations were grouped and analyzed at the level of the soil series. Occupied Casey's June beetle habitat is characterized by a preference for alluvial and riverine soils particularly of the Carsitas, Riverwash and Fluvents soil series. Myoma soils series is considered moderate habitat based on decreased use of that soil type and because it is derived from sand blown from alluvium and does not have the same characteristics as the alluvial soils described above. Coachella fine sands are considered lower quality because they are associated with the lacustrine conditions of historic Lake Cahuilla that characterizes much of the Coachella Valley and are not specific to alluvial fans.

The hydrological regime was characterized using Federal Emergency Management Agency floodplain mapping that takes into account present flood control structures and the corresponding diversion of water. Areas within the 100-year floodplain, which encompasses existing streams and channels, were considered high quality hydrology. Areas within the 500-year floodplain, including areas with reduced risk due to levees, were considered moderate quality habitat, though they are unlikely to be exposed to hydrological inputs in an average year. Lower quality hydrology included higher elevation areas above the 500-year floodplain. We acknowledge that this is a GIS mapping exercise and floodplain mapping may not always reflect current conditions.

With respect to vegetation, desert riparian including the desert wash plant community, is considered the preferred vegetation community based on the number of sites occupied and is consistent with areas of higher population density. Desert scrub is generally considered moderate habitat because it typically occurs on upland terraces outside of areas of hydrological influence in an average year. Disturbed and barren vegetation communities are considered lower quality habitat because they often lack native vegetative cover and the detritus it provides. Golf courses were classified as disturbed vegetation unless they were surrounded by development or otherwise lacked habitat connectivity, in which case they were considered developed and excluded from further analysis. Similarly, permanent ponds found in golf courses were not considered suitable. Disturbed areas that experience a natural hydrologic regime have the potential to be recolonized or restored; and therefore, received a higher habitat ranking under those conditions.

We limited the analysis to suitable habitat on the valley floor and excluded slopes, rocky outcrops, developed areas, and other areas not considered suitable.

The combination of habitat parameters on the landscape were classified as marginal, moderate or high-quality habitat (Appendix A). High quality habitat required the presence of high-quality soils (e.g., Carsitas, Riverwash, and Fluvents) and/or either the preferred vegetation (e.g., Riparian) and hydrological associations (e.g., 100-year floodplain). Moderate habitat included two or more moderate (e.g., Myoma soils, area between the 100- and 500-year floodplain and desert scrub) to high quality habitat features. Marginal quality habitat was dominated by the non-preferred habitat features (e.g., Coachella soils, 500-year floodplain, barren or disturbed vegetation) and was most often driven by lower quality hydrology.

The modeling effort identified a much larger area of potential Casey's June beetle habitat in the species' current range compared to the estimate at listing (605 ac; 245 ha), though there has not been an actual increase in the amount of habitat (USFWS 2011, p. 58956). A total of 1,989 ac (805 ha) of potentially suitable was modeled to define the species' current distribution of which 889 ac (360 ha) is considered high quality and 995ac (403 ha) is of moderate quality. (Figure 7-1). The distribution of high-quality habitat generally mirrored the location of hydrological features. It is important to note that a substantial portion of newly defined suitable habitat occurs in the upper floodplain on Tribal land, that was not identified at listing. These results inform our understanding of potentially suitable habitat but does not indicate that the species occupies all modeled habitat. For example, surveys conducted for a small project in Indian Canyons documented that the species was not observed in modeled moderate quality habitat during two surveys conducted in 2015 and 2017 (Osborne 2015, entire; Osborne 2017, entire). However, the upstream portion of the floodplain is critical for the functionality of the alluvial fan ecosystem and beetle habitat throughout its range.

All the individual habitat needs including desert vegetation with an open canopy, alluvial soils, and natural hydrology were incorporated into the model to quantify habitat suitability (Appendix A). Based on this analysis, the availability of suitable habitat was assessed based on the availability of high to moderate quality habitat. It should be noted that the habitat suitability model that the condition category and this SSA rely on is different than the model used at listing; and the habitat available at listing is slightly greater than the habitat available at the preparation of this SSA [1,989 ac (805 ha); Table 7-1] due to projects permitted since listing. We considered that the acreage of suitable habitat at listing [605 ac (245 ha)], along with threats acting on the species, to constitute low to moderate condition and contributed to the endangered listing determination (USFWS 2011, p. 58956). Therefore, low quantity of suitable habitat was defined as 500 ac (202 ha) or less, with limited conservation and management. Moderate availability of suitable habitat was defined between 500 and 2,000 ac (202 to 806 ha) with the majority of the range under no conservation or management mechanisms (20 to 70 percent); and high condition is greater than 2,000 ac (806 ha) and greater than 70 percent of the moderate and high-quality habitat under conservation or management.

7.6 Abundance

Casey's June beetle is currently represented by a small population that has exhibited a significant decline in available habitat and a substantially reduced distribution compared to it modeled historical range. Population size has likely been declining, concomitant with the loss of habitat, though we lack information on historical abundance. From 2016 to 2020, the Service conducted annual rangewide black light surveys for adult, male Casey's June beetle to characterize male population abundance and determine important environmental covariates across a total of 18 trap locations in Palm Canyon Wash, Smoke Tree Ranch, and upper Tahquitz Creek, though not all traps were surveyed every year. In years where only a subsample of traps was surveyed, trap locations generally represented the range of habitat conditions and relative abundance counts, based on the results of previous surveys. In addition, one trap (defined as a sentinel trap) was surveyed daily, or every third day during the breeding season, depending on the year. In 2021 and 2022, 9 additional traps were surveyed in Tahquitz Creek within the golf course.

Traps consisted of an 18 in (46 cm) long, 15-watt ultraviolet light (black light) used to attract male beetles positioned above 5-gallon buckets fitted with a smooth surface funnel to trap individuals (Figure 4-2). Insect surveys using black light traps have recorded male Casey's June beetles being attracted to the trap from a median distance range of 131 ft (40 m) to 328 ft (100 m) across all trap locations and dates surveyed (Table 7-4; Ronan 2024, p. 67). We used the effective capture radius around trap locations of 253.6 ft (77.3 m) to define a 4.6 ac (1.9 ha) trap survey area (Harju 2022, p. 6).

The raw capture results presented below provide a relative index of male abundance and density within the limited percent of suitable habitat sampled and should not be interpreted as a population estimate (Table 7-3). Male capture rates are correlated with survey effort and other environmental covariates and the probability of detection is low (0.02-0.14; Harju 2021, p. 11). The male capture data shown has not been corrected for detection probability and thus is not reflective of true abundance by trap. Therefore, it is not appropriate to extrapolate potential trends, or a population abundance based on raw count data over a limited time period.

Figure 7-2. Black light trap for Casey's June beetle sampling. [17]

[17] Surveys were run from 1 hour before sunset to 2 hours after sunset([USFWS] U.S. Fish and Wildlife Service 2016, p. 5). Survey area is approximated at 253.6 ft (77.3 m) radius and 4.6 ac (1.7 ha) based on distances of release-to-recapture across all trap locations and dates surveyed.

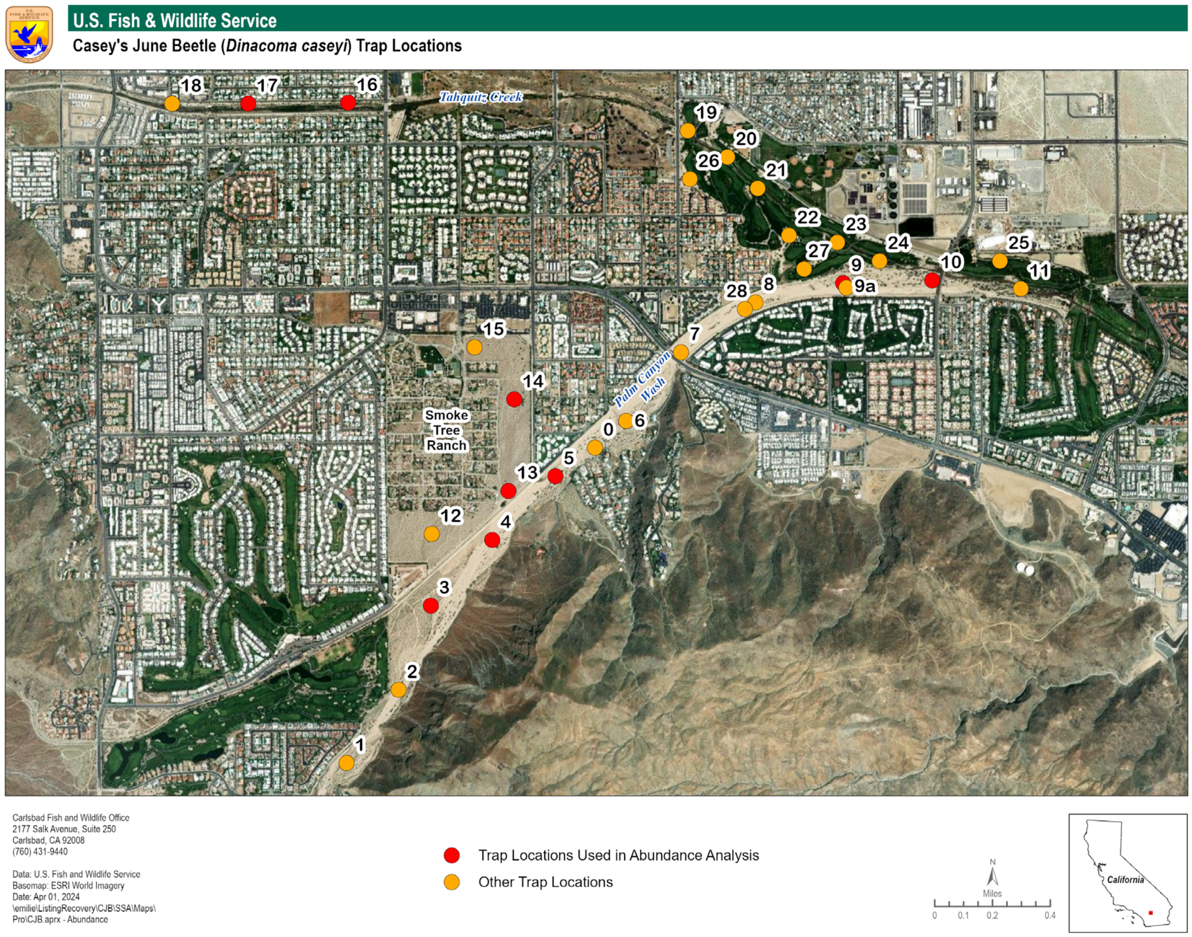


Figure 7-3. Map of rangewide survey trap locations within Palm Canyon Wash, Tahquitz Creek and Smoke Tree Ranch.

Table 7-3. Summary of male Casey's June beetle annual capture data by trap.[18]

Trap No.	Location	2016	2017	2018	2019	2020	2021	2022
0	PCW				73 (16)	171(37)	215(46)	
1	PCW	4 (1)	4 (1)	9 (2)				
2	PCW	6 (1)	11 (2)	18 (4)				
3	PCW	8 (2)	6 (1)	1 (.2)	3 (1)	15 (3)		
4	PCW	17 (4)	20 (4)	48 (10)	61 (13)	85 (18)		
5	PCW	14 (3)	76 (16)	53 (11)	80 (17)	182 (39)		
6	PCW	69 (15)	64 (14)	70 (15)				
7	PCW	1 (.2)	1 (.2)	0				
8	PCW	6 (1)	27 (6)	10 (2)				
9	PCW	95 (20)	173 (37)	128 (28)	148 (32)	133 (29)	73 (16)	58 (13)
10	PCW	112 (24)	165 (36)	241 (52)	142 (31)	280 (60)	76 (16)	128 (28)
11	PCW	51 (11)	54 (12)	114 (25)				
12	ST	5 (1)	3 (1)	5 (1)				
13	ST	12 (3)	9 (2)	17 (4)	9 (2)			
14	ST	3 (1)	4 (1)	22 (5)	14 (3)			
15	ST	13 (3)	7 (2)	10 (2)				
16	TC				41 (9)	15 (3)	27 (6)	25 (5)
17	TC				60 (13)	70 (15)		
18	TC				0			
19	TC						6 (1)	6 (1)
20	TC						2 (.4)	3 (1)
21	TC						0	0
22	TC						1 (.2)	0
23	TC						2 (.4)	2 (.4)
24	TC						16 (3)	13 (3)
25	TC						1 (.2)	
26	TC						1 (.2)	1 (.2)
27	TC						5 (1)	0
28	TC							38 (8)
Yearly Total	-	***416***	***624***	***746***	***631***	***951***	***425***	***236***
Number of Traps	-	15	15	15	11	8	13	14
Trap Average	-	***27.7***	***41.6***	***49.7***	***57.4***	***118.9***	***32.7***	***16.9***

[18] Data presented includes the total from the highest 3-survey dates per year and an index of male population density per acre surveyed, in parentheses. In 2020, summary data for Traps 16 and 17 utilized the second through fourth survey, instead of the third through fifth surveys, because the emergence peak was one week earlier than the rest of the trap locations.

Results from rangewide surveys are presented for the trap locations that were surveyed 2016 and 2020 (Figure 7-4). This subsample includes Palm Canyon Wash (Traps 3 through 10) beginning upstream to the South Gene Autry Trail bridge downstream, the upland terrace at Smoke Tree Ranch (Traps 13 and 14) and Tahquitz Creek (Traps 16 and 17). Because capture numbers are correlated with survey effort, the data presented is standardized to include the sum of males captured during the 3 peak emergence survey dates per year (Table 7-3; Figure 7-4). In 2019 all subsampled traps were surveyed, resulting in a total of 558 males captured in 9 traps, with the number captured per trap ranging from 3 to 148. Population density, number captured per survey area [4.6 ac (1.9 ha)], ranged from less than one to 37 males/ac (92 males/ha).

The surveys were conducted within a period of both climatic variability and corresponding floodplain maintenance. The study began in 2016 following 5 years of extended drought (2011 to 2015; Figure 3-4). We believe the 2016 data to represent a lower bound of relative male abundance and the increases observed provide some indication of the species' ability to rebound from depressed population numbers. In addition, on February 2019, Palm Springs received 3.7 in (9.4 cm) of rain in a single day resulting in a significant flood event in Palm Canyon Wash; average annual rainfall in the area is approximately 5.5 in (14 cm; WRCC 2024, unpaginated). The event resulted in significant flows that surpassed the cement lined levee system in certain locations, resulting in scoured areas and substantial movement of sediment and vegetation downstream. Downstream trap locations (Trap 9 and 10) received approximately 8 ft (2.4 m) of deposited sediment and debris that was transported from upstream. The last year of above average rainfall was in 2010 (13.4 in; 34 cm). In response to these high precipitation events, the District conducted sediment removal activities in Palm Canyon Wash (**see section 6.2 – Altered Hydrology**). Traps 4, 5, 9 and 10 occur within the limits of the District's right-of-way easement and are subject to sediment removal activities.

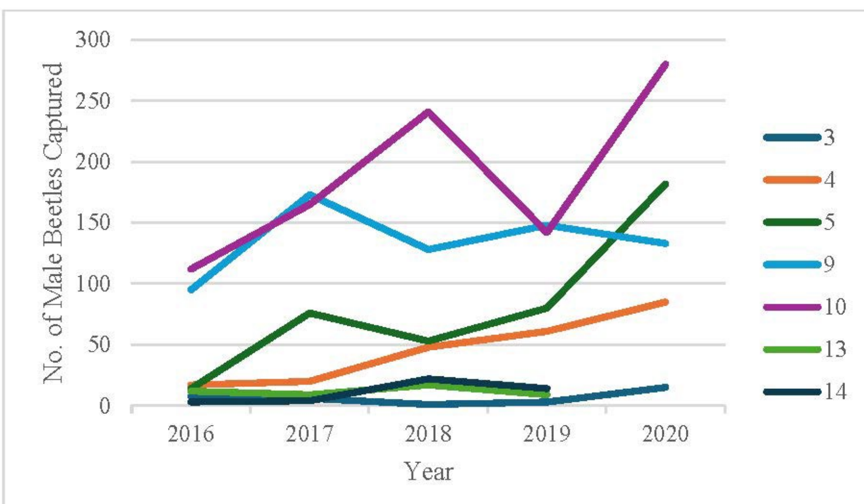


Figure 7-4. Summary of yearly raw male capture data by trap from a subsample of the 2016–2020 rangewide survey effort.

Overall, there is spatiotemporal variability across the surveyed range, with some sites showing constant capture numbers while other sites are more variable. In general, higher capture numbers were recorded in the downstream portion of Palm Canyon Wash relative to upstream (Harju 2021, p. 13) and in the wash overall relative to the upland terrace at Smoke Tree Ranch. The highest capture rates were observed at the most downstream areas surveyed (Traps 9 and 10) with between 95 and 280 males captured per year, and densities ranging from 20 to 60 males/ac (52 to 149 males/ha). This area corresponds to a curve in the Palm Canyon Wash channel associated with a large area of sediment deposition and mature desert riparian habitat. There is substantial year-to-year variation in the numbers captured downstream of the channel curve, with twice the number captured in 2018 compared to 2016 at Trap 10. The decline in 2019 is attributed to the flood event, with subsequent sediment removal in late 2019 through spring 2020; and there is no evidence of local extirpation due to sediment removal activities at this location. Densities ranged from 16 to 39 males/ac (41 to 97 males/ha) in the middle reach of the wash (Traps 4 and 5) and there is evidence for an increasing number of captures over the timeframe of the study. This reach is relatively narrow in width and both traps are located in the active channel. Trap 4 is within the maintenance right-of-way but was not subject to sediment removal activities in 2019-2020. Tahquitz Creek is substantially narrower than Palm Canyon Wash and densities are moderate ranging from 3 to 15 males/ac (8 to 36 males/ha). Lower abundance, less than 20 males captured per year, was observed at the traps furthest upstream (Traps 3), and on the upland terrace (13 and 14) with 4 or less males per acre (11 males/ha). These areas are typically not subject to maintenance activities and are dominated by desert scrub.

Analyses were conducted to calculate the probability of detection using N-mixture abundance modeling of unmarked individuals (R package ‘unmarked’ [R v3.6.3]), whereby repeated surveys are conducted within a period of assumed population closure (Harju 2021, p. 5); male detection probability was evaluated by trap and year. Results indicated that the probability of male capture was negatively correlated to maximum wind speed, below ground temperature, or a combination of parameters depending on the year (Harju 2021, p. 15). We also expect there is a relationship between beetle abundance and rainfall. An analysis of stream flow (cubic feet per second) found that abundance of Casey’s June beetles declined with a site’s increasing location upstream (Harju 2022, p. 18). Nightly mean corrected abundance across all traps per year from 2016 - 2019, within the effective capture area (4.6 ac [1.9 ha]) ranged from 39 (95 percent confidence interval = 28 – 48) to 102 (95 percent confidence interval = 83 – 120) males (Appendix G). Further analyzes are needed to develop a robust estimate of male abundance rangewide, incorporating hierarchical distance sampling and additional habitat covariates. Similarly, to evaluate population abundance inclusive of females, eggs, and larvae, additional research is required to understand female prevalence, determine the sex ratio, and characterize survival and abundance at all life stages.

The population demographic needs of abundance and reproduction incorporate quantitative condition definitions based on the results of male capture data. The abundance and reproduction demographic categories are combined, as abundance in any given year is a function of the reproduction and abundance in the previous year. The beetle’s live span is one year, and we are uncertain if any life stages that can diapause for more than one year. Although we only have data for a short period of time, we believe the dataset characterizes the range of likely abundance and male capture data (1 to 280 captured males; Table 7-3; Figure 7-4), because surveys were conducted over a range of abiotic conditions, as described above. Over this time period, annual trap averages across 7 traps per year ranged from 37 to 111 males. The highest annual total occurred in 2020 (Trap 1; 280 males; Figure 4-6), as well as the highest annual average (111 captured males across 7 trap locations). Based on this information, we consider the annual average trap totals greater than 100 males to represent high condition, between 20 and 100 as moderate, and less than 20 is considered low condition. This scale is based on the average male captures per year, which is the best available data at this time, and does not represent the abundance across the range.

7.7 Connectivity

Males are primarily responsible for genetic mixing and dispersal within the one known extant population (and historically among interconnected populations) because they fly and can travel considerable distance. Our understanding of male dispersal potential is based on both anecdotal observations and Service funded research. Initially anecdotal observations indicated that male Casey's June beetle were believed to travel at least 750 ft (230 m) based on an observation at a streetlight in a suburban neighborhood away from suitable habitat (Hovore 2003, p. 6; USFWS 2011, p. 58955). More recently, the Service conducted a mark-recapture study in 2016 to 2021. Individual traps were positioned 1,640 ft (500 m) apart and marked beetles were released at 131ft (40 m), 328 ft (100 m), and 820 ft (250 m) intervals from the trap location. Their subsequent movements were recorded if they were observed at black light traps that same or subsequent evening. Recaptured males were documented to travel a median distance of 131 ft (40 m) to black light traps and up to a maximum documented distance of 2,539 ft (774 m) within a single evening, including all trap locations (Table 7-4; Ronan et al. 2024, p. 67). Unconstrained by the attraction to black light traps and habitat connectivity, males have the potential to move these distances each night of their approximate 3-day lifespan searching for females. Based on the results of the same study, between 3.5 and 6.8 percent of the individuals captured and marked were recaptured in the same evening; these results suggest that the majority of the individuals either move outside of the sampling area or burrow back into the ground if released later in the evening. Consistent with this, the probability of capturing an individual male beetle varied across years (2016 – 2020) but was always low (2 - 14 percent (Harju 2021, p. 11). It is not clear how or if the presence of multiple black light traps affects beetle behavior or contribute to the low recapture rates.

Table 7-4. Summary of recapture data from 2016 through 2021 at rangewide survey locations in Palm Canyon Wash and Tahquitz Creek.[19]

Year	Number of Trap Locations	Total Number of Recaptures (percent of captures)	Median Recapture Distance ft (m)	Maximum Recapture Distance ft (m)
2016	15	19 (4.4)	328 (100)	820 (250)
2017	15	22 (3.5)	131(40)	328 (100)
2018	15	41 (5.5)	131 (40)	820 (250)
2019	11	36 (5.7)	131(40)	820 (250)
2020	8	65 (6.8)	131 (40)	2,539 (774)
2021	11	19 (6.7)	131 (40)	1,585 (483)
Total	**-**	***202* (*5.5*)**	***131* (*40*)**	***2,539* (*774*)**

We do not know if the flightless females disperse or how far they might disperse; reported observations of females are limited to emergence to mate followed by re-entering the soil minutes thereafter. Flightless females may disperse slowly by terrestrial crawling or by limited vertical or horizontal movements as immature stages. Hydrological events are expected to contribute to both male and female dispersal potential; but the proportion of individuals dispersed in this manner and the survival rates under variable flow velocities and magnitudes is unknown. Based on soil investigations in occupied habitat, Casey's June beetle was not observed within a depth of 8 ft (2.4 m) from the surface during the winter months (November and December); suggesting that individuals may not be susceptible to dispersal by average rainfall events during this period. However, they are more likely to be closer to the surface prior to emergence (April and May), indicating that later winter and early spring precipitation events could result in dispersal events; but this has not been specifically evaluated. Flightless adult beetles are not likely to be dispersed by other means such as by wind or larger animals; but we do not know whether they may disperse by other means such as incidental movement by birds.

Dispersal ability is limited by the flightlessness of females, which significantly hinders the species' ability to colonize new areas. Gene flow is believed to be maintained through long distance movements by males, which may help mitigate the negative effects of habitat fragmentation. We do not have information on whether male beetles can traverse extended stretches of unsuitable habitat, such as developed areas, beyond anecdotal observations of males in suburban developments and shopping centers, as described above. Therefore, conservation of existing female occupied habitat and maintaining habitat connectivity can help ensure long-term genetic exchange within the *D. caseyi* population (Gillett et al. 2020, entire).

---

[19] The summary includes the numbers of recaptured Casey's June beetle individuals, proportion of the total number recaptured, and median and maximum recapture distances across all trap locations and survey years.

The habitat connectivity condition category was based on the median male recapture distance of 131 ft (40 m), which we interpret as the maximum distance between habitat patches to ensure connectivity assuming there are no obstacles to dispersal. Habitat patches greater than 131 ft (40 m) away from core habitat areas have a reduced likelihood of maintaining connectivity. The threshold between moderate and high condition categories were based on the maximum annual recapture distance [2,539 ft (774 m); Table 7-4]. Further recapture distances were considered rare and unlikely to support connectivity.

Table 7-5. Condition Category Table.[20]

Condition	Availability of Suitable Habitat	Abundance and Reproduction	Connectivity
High	>2,000 ac (809 ha) of moderate to high quality habitat; and majority of habitat conserved or at reduced risk of habitat modification.	Annual male trap average >100	High to moderate quality habitat patches within the median male recapture distance [131 ft (40 m)], without major barriers to dispersal.
Moderate	Between 500 (202 ha) and 2,000 ac (809 ha) of moderate to high quality habitat; and majority of habitat conserved or at reduced risk of habitat modification.	Annual male trap average between 20 and 100	Habitat within 302 ft (92 m) to 2,539 ft (774 m) of high to moderate quality habitat, with limited barriers to dispersal.
Low	Less than 500 ac (202 ha) of moderate to high quality habitat; large portion of the distribution is subject to habitat loss	Annual male trap average <20	Habitat within the median male recapture distance [>2,539 ft (774 m)] of high to moderate quality habitat or substantial barriers to dispersal present.

7.8 Current Population Resiliency

Resiliency is the ability of the population to withstand stochastic events and was assessed within the Palm Canyon Wash floodplain analysis unit (6,444 ac 2,608 ha) which encompasses the species' current distribution based on the habitat suitability model (1,989 ac; 805 ha). The Palm Canyon Wash floodplain is considered to have moderate to high resiliency with a score of 3.7 (Table 7-2). The population represents the current and historical core of the species' distribution. The alluvial processes are still intact, though modified due to the existing flood levee system within the wash channel and Tahquitz Creek. Approximately 350 ac (142 ha; 18 percent) are or will be conserved under a conservation easement, and 821 ac (332 ha; 41 percent) is designated Tribal Reserve or open space, resulting in approximately 60 percent of the current distribution

[20] The habitat needs (vegetation with an open canopy, alluvial soils, and natural hydrology) are combined in a habitat suitability model to characterize the availability of suitable habitat and the species distribution. The demographic needs of abundance and reproduction are combined into one category.

that is conserved or where the threat of habitat loss is reduced. The abundance condition category, which is informed by data with a low capture probability, is ranked moderate based on an annual average of 69 males captured across 7 trap locations. Connectivity is ranked moderate to high because of the continuity of habitat and beetle records throughout both Palm Canyon Wash and Tahquitz Creek; and the majority of suitable habitat is within the median male recapture distance. However, there is development and other obstacles to dispersal outside of these hydrological features.

Table 7-6. Population resiliency within the Palm Canyon Wash Floodplain.

Analysis Unit	Availability of Suitable Habitat	Abundance	Connectivity	Overall Resiliency
Palm Canyon Wash Floodplain	MODERATE/HIGH 1,884 ac (358 ha) of moderate to high quality habitat; >50 percent conserved or at reduced risk of habitat loss	MODERATE Annual male capture average (69)	MODERATE/HIGH Habitat within the media male recapture distance [131 ft (40 m)] of high to moderate quality habitat.	MODERATE/HIGH (3.7)

7.9 Current Species Redundancy

Redundancy is by definition limited for a narrow endemic with a naturally restricted range. The Palm Canyon Wash floodplain represents the current population of the Casey's June beetle and is substantially contracted compared to the range of modeled potential habitat historically. However, the area includes what we believe to be the core population over at least the last 30 years. Beetles have been recorded throughout Palm Canyon Wash, Tahquitz Creek and the adjacent terraces. Occupancy in both streams improves redundancy for catastrophic events such as wildfire and flood events. Should a catastrophic event impact one waterway, it is highly likely that the other feature will continue to contribute water, sediment, and detritus to at least 20 to 30 percent of the current range. However, catastrophic events such as extended droughts are expected to affect the entire range and region similarly. Although we cannot characterize population trends, male capture data suggests variable but generally stable abundance between 2016 and 2020 over a range of abiotic conditions.

7.10 Current Species Representation

Representation is the ability of a species to adapt to both near-term and long-term changes in its physical and biological environment including adaptations for the species to persist in place or shift in space to maintain appropriate habitat conditions (Thurman et al. 2020, entire; Appendix B). We evaluated representation in Casey's June beetle based on the ecological diversity of the habitats it occupies, as a surrogate for genetic diversity, and the species' life history characteristics that support or hinder adaptive capacity.

The species has life history and ecological characteristics that confer both high and lower adaptive capacity. Casey's June beetle evolved under arid desert conditions and demonstrates a tolerance to the range of environmental extremes and temperature increases in the recent past. It is a narrow endemic associated with desert alluvial fans limited to a suitable habitat within approximately 1,989 ac (805 ha) which confers lower representation. The species' current distribution includes habitat niches that are important to maintain ecological diversity including a range of suitable alluvial soils, vegetation type, vegetation cover, elevation, slope, and aspects that could help mitigate short term changes in environmental conditions. It is an insect with short (~1 year) generation time improving its ability to adapt to progressive changes in its environment. The species has a relatively broad diet niche including detritus and rootlets from a varied number of plant species and is not believed to be tied to an obligate host plant. Behaviorally, immature stages of the beetle are expected to move to some degree within the sediment column to forage on detritus and rootlets and to find appropriate soil moisture conditions, potentially offsetting the impacts of increasing temperatures. The variability in the timing and peak of male emergence suggests some limited ability to shift phenology, though emergence typically occurs within a the same 2-to-3-week time period and constrained by the moon phase. Although most of these behavioral and ecological characteristics contribute toward higher representation, there is also some evidence of the effects of small population size and lower heterozygosity which limits the species evolutionary potential to adapt. Because it is a narrow endemic there is not likely to be suitable habitat outside of its current or historical range; and even if suitable habitat were present the beetle is not likely to be able to disperse outside of its current distribution. Therefore, we consider Casey's June beetle to have sufficient representation to adapt to the range of environmental conditions experienced over the recent past. But the species has no to limited adaptive capacity to shift in space beyond average dispersal rates to overcome more rapid or extreme variability.

CHAPTER 8 - FUTURE CONDITIONS

8.1 Future Scenario Considerations

Scenario planning is a comprehensive exercise that involves the development of scenarios that capture a range of plausible future conditions, which is then followed by an assessment of the potential effects of those scenarios on a given species. Scenarios are not predictions or forecasts of what will happen in the future for a species but are projections or explorations into the range of conditions that may exist based on current information (Figure 8-1). The scenarios are intended to provide the "upper" and "lower" bounds of plausible conditions (Figure 8-2), outline uncertainties, and provide decision makers with a means for managing risk and maintaining flexibility in current and future decisions.

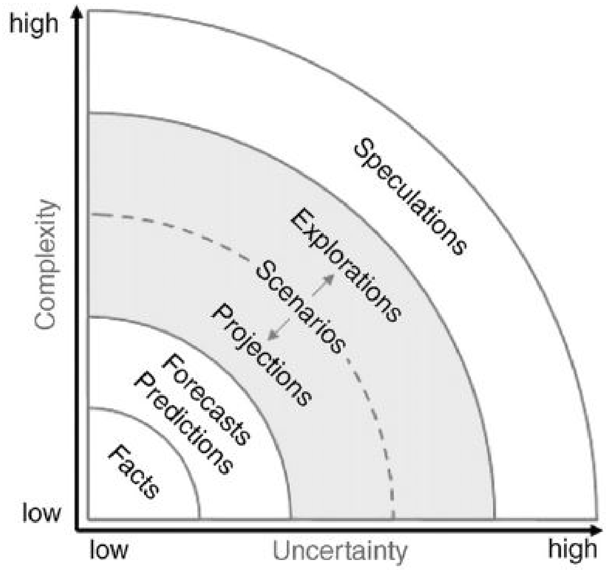


Figure 8-1. The levels of uncertainty and complexity in situations for which scenarios can be useful in considering future possibilities [adapted from (Rowland et al. 2014, p. 7)].

A range of time frames with a multitude of possible scenarios allows us to create a "risk profile" for the Casey's June beetle and its viability into the future. While we do not expect every condition for each scenario to be fully realized, we are using these scenarios as examples for the range of possibilities. For each scenario, we describe the threats that would occur in each population and how they may change in the future. We used the best available science to predict trends in future threats facing the beetle. Data availability varies across the range of the species. Where data on future threats or trends are not available, we look to past threats and their trends. We evaluate if it is reasonable to assume these trends will continue into the future and to what degree.

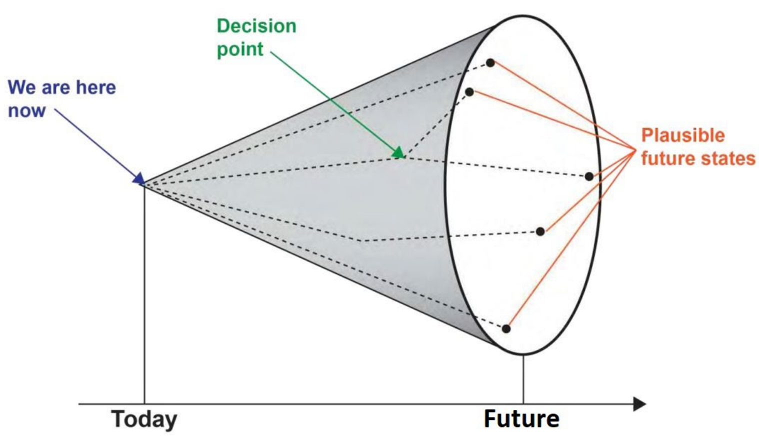


Figure 8-2. Conceptual diagram of the broadening range of plausible alternative futures as one moves farther away from the present and different events and decision points shift trajectories (Rowland et al. 2014, p. 6).

In order to analyze future conditions, we developed three plausible scenarios to assess how the species' needs, threats, and habitat conditions may change over the next 20 to 80 years. Plausible changes in threats impacting the Casey's June beetle analysis unit are summarized in Table 8-1 and discussed in each of the three scenarios below. Soil disturbance, predation and pesticides were not carried forward as the magnitude of the threats is considered low or negligible in comparison to the threats included in the analysis.

8.2 Scenario 1

Scenario 1 has similar magnitude threats as current conditions and was forecasted for 2040-2069. Under this scenario approximately 120 ac (49 ha) of suitable Casey's June beetle habitat will be developed approximating the rate of development since listing [30 ac/decade (12 ha/decade); Table 4-2]. Development is expected to be a combination of in-fill within existing urban centers and on the upland terraces adjacent to the waterways potentially reducing dispersal. Development will comply with standard mitigation ratios for occupied Casey's June beetle habitat or a mitigation fee to support the acquisition of lands for conservation (THCP Valley Floor planning area[21]) resulting in an increase in the proportion conserved. But mitigation opportunities are projected to be limited by the availability of suitable habitat for conservation. Current flood control structures remain in place and concentrate peak flows. The potential for increased peak flows due to increases in impervious surfaces are anticipated to be mitigated such that no additional flood control structures are anticipated. Extreme flood events and corresponding sediment removal occur every 5 to 6 years (approximately 7 events over 40 years), with some vegetation recovery between events (defined as approximately 20 percent vegetation cover). We expect that the range of environmental stochasticity is more variable compared to what the species has experienced in the recent past and that the hottest days of the year may increase by 5ºF (2.8ºC) to as much as 128ºF (53.3ºC). Drought conditions are common between years of high rainfall, with droughts lasting between 2 to 5 years which is anticipated to limit vegetation recovery. Warming trends continue including an increase in windy days, maximum temperature, and extreme heat days. Low quality habitat and a small portion of the upland terraces are expected to be too dry to provide suitable habitat. High rainfall followed by drought and high temperatures increases the risk, frequency, and size of wildfires. Within suitable habitat, the risk of fire increases with more acres burned (8 percent) and the potential for larger fires fueled by high winds and low monsoonal precipitation. In the surrounding watershed, annual acres burned is anticipated to increase by 20 percent. As a result of these forecasted conditions, we expect a small reduction in the acreage of suitable habitat and abundance in 2040-2069.

[21] Future acquisition of conservation lands associated with the THCP Valley Floor planning area may not be located within suitable Casey's June beetle habitat.

Table 8-1. Plausible changes in higher magnitude threats identified in each of the three future scenarios.

Factors Influencing Viability	Scenario 1: Current Threats 2040-2069	Scenario 2: Slight Increase in Threats 2070-2100	Scenario 3: Current Threats (Scenario 1) with Increased Conservation 2070-2100
Habitat Loss and Fragmentation (including artificial light)	Incremental development [30 ac/decade, total of 120 ac (49 ha)]; species' distribution 1,600 ac (648 ha) including the effects of all threats	Increased rate of development [45 ac/decade, total of 315 ac (127 ha)]; species' distribution 1,000 ac (405 ha) including the effects of all threats	Lower rate of development. [20 ac/decade, total of 140 ac (57 ha)]; species' distribution 1,900 ac (767 ha) including the effects of all threats
Altered Hydrology	Current flood control structures and concentrated peak flows; extreme flood events and corresponding sediment removal every 5-6 years (approximately 7 events in total) with some vegetation recovery between events.	Extreme flood events and corresponding sediment removal every 4-5 years (19 events); limited vegetation recovery between events; ground water pumping and arid conditions lowers water table.	Scenario 1 with reduced water use, golf courses restored, groundwater pumping stabilizes, management of tamarisk; and corresponding increases in water availability and native vegetative cover.
Increased Temperatures and Drought	Warming trend continues with corresponding increase in windy days under RCP4.5 [Max. Temp: +4.2°F (2.4°C) to 85.8°F (29.9°C); Extreme Heat Days: +17 d (21 d)]	Increased warming trend continues with corresponding moderate increase in windy days and extended droughts under RCP8.5 [Max. Temp: +8.6°F (4.8°C) to 90.2°F (29.9°C); Extreme Heat Days: +50 d (54 d)]	Warming trend continues with corresponding increase in windy days under RCP4.5 [Max. Temp: +5.2 °F (2.9°C) to 86.8°F (30.4°C); Extreme Heat Days: +23 d (27 d)]
Wildfire	Increased risk of wildfire in floodplain and surrounding watershed [RCP4.5- Annual Acres Burned: +16.7 %]	Increased risk of wildfire in floodplain and surrounding watershed [RCP8.5-Annual Acres Burned: +16.7%]	Increased risk of wildfire in floodplain and surrounding watershed [RCP4.5-Annual Acres Burned: +11.2%]

8.2.1 Resiliency

Under Scenario 1, the Palm Canyon Wash floodplain is considered to have moderate resiliency (3.0; Table 8-2), similar but slightly reduced relative to current conditions. The core of the current distribution of Casey's June beetle remains intact with approximately 1,600 ac (648 ha) of suitable habitat available including greater than 50 percent under conservation or at a reduced risk of habitat loss. Most of the development occurs in the northern portion of the species' distribution and is not anticipated to result in substantial habitat fragmentation or new centers of artificial light that may disrupt beetle reproduction and dispersal. Climatic conditions are expected to result in less suitable habitat through decreased soil moisture and vegetative cover due to the combined effects of higher temperatures, increased winds, and more frequent disturbance events. In the surrounding watershed, the combined effects of drought, fire, and erosion are expected to result in intermittent, large inputs of sediment and debris with reductions in vegetation and detritus inputs over time. Projected environmental stochasticity is expected to result in lower and more variable abundance. Lower abundance is expected following periods of drought with the potential for populations to increase during periods of higher rainfall; overall abundance is expected to be moderate and slightly reduced relative to current conditions. Connectivity is considered moderate to high because the habitat along Tahquitz Creek and Palm Canyon wash will be largely intact with no new, large barriers to dispersal.

Table 8-2. Changes in population resiliency within the Palm Canyon Wash Floodplain, future Scenario 1.

Analysis Unit	Availability of Suitable Habitat	Abundance	Connectivity	Overall Resiliency
Palm Canyon Wash Floodplain	MODERATE 1,400 ac (567 ha) of moderate to high quality habitat; >50 percent of modeled habitat preserved	MODERATE Similar to current conditions and with a slight decreasing trend	MODERATE Suitable habitat within the average male dispersal distance of high to moderate quality habitat. Limited increase in habitat fragmentation	MODERATE (3.0)

8.2.2 Redundancy

Redundancy continues to be limited in Scenario 1 and slighted reduced compared to current conditions. We expect that the core population of Casey's June beetle will occupy a similar distribution as current conditions over the next 50 years (1,600 ac; 648 ha); however, low quality and portions of modeled moderate quality habitat are expected to no longer be suitable due to climatic conditions, particularly habitat areas removed from seasonal hydrological events. Occupancy is expected to be maintained in both Palm Canyon Wash and Tahquitz Creek but there will be years where large portions of habitat have not recovered from flood events and sediment removal and are considered unsuitable or of low quality. Occupancy of Smoke Tree Ranch is also expected to be maintained because the area appears to be supported by irrigation and that is expected to continue, though beetle densities may be reduced. Redundancy is forecasted to decrease due to reductions in abundance associated with the combined effects of drought, flood and wildfires described above. Reductions in the acreage of upland terrace due to development is expected to reduce but is not expected to substantially alter the species' redundancy.

8.2.3 Representation

The habitat and ecological characteristics of Casey's June beetle that confer lower representation (e.g., habitat specialization, limited range, and small population size) and ecological diversity under Scenario 1 are similar and slight reduced relative to current conditions (Appendix B). Within the range of historical environmental stochasticity, we expect potential behavioral adaptations such as the ability of larvae to move deeper in the soil column to help mitigate warmer and more arid conditions to help maintain survival rates during short periods of drought. However, we have no information on whether the hottest days of the year may approach the species' physiological limits; but some limited mortality is expected for extreme heat days that occur in spring and early summer when individuals are closer to the surface. As a result, we expect lower representation due to reductions in abundance and distribution tied to extended droughts, severe flood events, and wildfire including the combined effects that increase the disturbance regime and reduce the availability of food resources. Reductions in projected abundance have the potential to intensify the effects of small population size; but we do not expect substantial reductions in genetic variation under Scenario 1 because connectivity is largely maintained. However, there is projected to be restricted topographic and vegetative heterogeneity across the species' narrow distribution, lower potential for climate refugia, and reduced ability to persist in place in response to changing climatic and habitat conditions.

8.3 Scenario 2

Scenario 2 reflects increases in habitat loss and degradation due to development, flood control maintenance, and more arid and variable climatic conditions under RCP8.5 for 2070-2099. The majority of the areas zoned for development are anticipated to be developed; but the corresponding mitigation and projected conservation is constrained by the availability of suitable habitat for mitigation. We assumed that current zoning designations would remain the same, particularly areas assigned as open space in the regional HCPs. As a result, 60 percent of modeled suitable habitat is anticipated to be preserved. Development is expected to be primarily in-fill within existing urban centers on the upland terraces with limited park facilities and low-density development in the southern portion of the species' distribution. Current flood control structures remain in place and concentrate peak flows, and no additional structures are anticipated. Extreme flood events and corresponding sediment removal occur every 4 years on average (at least 9 events over 40 years), with limited vegetation recovery between events. Vegetation recovery is further limited by drought conditions that are common between years of high rainfall, typically lasting between 3 to 6 years. Warming trends continue including increases in windy days, maximum temperature, and extreme heat days. The hottest days of the year are expected to increase by 8 to 10°F (4.5 to 5.6°C) and likely outside of the range of temperatures that the species experienced historically. We expect that the majority of extreme heat days will occur in summer, but it is likely that warmer days and nights will also occur during the flight season and when individuals are close to the soil surface. As a result, the acreage of suitable habitat is expected to decrease such that low quality and moderate quality habitat outside of the wash may no longer be suitable due to increased aridity, though these areas likely corresponded with areas of projected development. High rainfall followed by drought and high temperatures increases the risk, frequency, and size of wildfires. The risk of fire increases with more acres burned and the potential for larger fires fueled by high winds and low monsoonal precipitation in suitable habitat and in the surrounding watershed. We expect suitable habitat under this scenario to be further reduced to approximately 1,000 ac (405 ha).

8.3.1 Resiliency

When increasing threats are forecasted under Scenario 2, population resiliency decreases too low to moderate. There will be periods of time when large portions of the species' distribution have no to minimal suitability due to extreme flood events followed by sediment removal where the vegetation and detritus resources have not recovered. These conditions are expected to be exacerbated under more arid conditions with moderate habitat availability. The increase in the magnitude and frequency of the disturbance regime is expected to result in substantial declines in abundance and local extirpations; overall abundance is expected to be low. Projected reductions in abundance are likely to be exacerbated by reduced food resources (vegetation inputs) due to an increase in the frequency and size of fires in the surrounding watershed, in addition to lower vegetation cover in the wash itself. We lack information on the minimum population size that would allow the species to recover from an extreme climatic event; but the possibility exists that abundance may remain low such that the species long-term viability may be at risk. Overall suitable habitat is expected to be limited to hydrologically active areas of the floodplain and upland terraces are projected to be too dry to support immature stages of the beetle without supplemental water. Available habitat within the creek and wash is likely to be patchy due to scouring and maintenance activities that is projected to further reduce the condition of connectivity to low to moderate.

Table 8-3. Changes in population resiliency within the Palm Canyon Wash Floodplain, future Scenario 2.

Analysis Unit	Availability of Suitable Habitat	Abundance	Connectivity	Overall Resiliency
Palm Canyon Wash Floodplain	MODERATE 1,000 ac (405 ha) of moderate to high quality habitat; portions of modeled habitat conserved or protected are no longer suitable	LOW Decreasing trend toward mid-century	LOW/MODERATE Small scale development results in obstacles to dispersal and artificial light disrupts reproduction	LOW/MODERATE (2.2)

8.3.2 Redundancy

Casey's June beetle's naturally limited redundancy is further reduced under the increased threats projected under Scenario 2. Portions of the species' historical suitable habitat within the Palm Canyon Wash floodplain, particularly on the upland terrace, are expected to no longer be suitable resulting in decreased abundance and local extirpations. We project the species will continue to occupy both Palm Canyon Wash and Tahquitz Creek but with reduced abundance and distribution; and habitat patches by females are anticipated to be more widely dispersed. Occupancy of Smoke Tree Ranch is expected to be maintained as long as supplemental watering continues, though beetle densities are projected to be reduced. Total abundance is expected to be low due to extended droughts and an increase in the frequency of disturbance events thereby reducing redundancy. There is a possibility that abundance declines will surpass the threshold for population recovery following a catastrophic event (e.g., prolonged drought, or wildfire followed by an extreme rain event) inhibiting the species' ability to rebound in more hospitable climatic conditions (e.g., periods of average rainfall and lower temperatures). The combination of future threats decreases connectivity across the species' range and lowers the probability that the species may recolonize previously occupied areas after a catastrophic event further limiting the species distribution and redundancy. Overall redundancy is very limited given the potential contraction of the species' limited distribution and the multiple factors that contribute to low abundance.

8.3.3 Representation

The habitat and ecological characteristics of Casey's June beetle that confer low representation (e.g., habitat specialization, limited range, and small population size) are exacerbated by projected reductions in suitable habitat and abundance. The projected range contractions and habitat fragmentation further limit environmental diversity, connectivity, and gene flow. There is a low likelihood of stable climate refugia at the end of century because of the contrasting climatic patterns acting on beetles and their habitat. Drought and warmer temperatures may be offset by individuals persisting in the wash and riparian areas because of the shade and higher soil moisture content under these conditions; however, the increase in the disturbance and hydrological regime puts individuals in wash habitat at higher risk. Abundance is expected to decrease across all habitat types resulting in loss of genetic variation and increased effects associated with small population (e.g., inbreeding depression, reduced reproductive fitness, and increased risk of extinction). As a result, Casey's June beetle is projected to have a substantially reduced capacity to persist in place and is already ecological constrained in its ability to shift in place in response to projected future climatic and habitat conditions.

8.4 Scenario 3

In the following scenario, the current level of threats (Scenario 1) are projected into the future (2070-2100) under RCP4.5. Warmer temperatures are forecasted that are generally within the range of climatic variation that the species experienced in the recent past, with periodic extreme rain events that help to recharge the system but also contribute to increased disturbance. Approximately 110 ac (45 ha) of suitable habitat will be developed within existing urban areas with a corresponding reduction in the acreage of suitable habitat. Like the previous scenarios, opportunities to mitigate development with on the ground conservation are limited by the availability of suitable habitat. However, this scenario includes conservation and restoration of the Tahquitz Creek golf course which is currently in the planning stages and the former Mesquite golf course (e.g., Prescott Preserve) for approximately 300 ac (121 ha) of new beetle habitat. These efforts will significantly augment the population in Tahquitz Creek at the confluence with Palm Canyon wash, improve connectivity, and increase the proportion of suitable habitat conserved. In addition to the increase in acreage of suitable habitat, the majority of the Tahquitz Creek golf course parcel is just outside the flow of Palm Canyon Wash and is expected to provide refugia from catastrophic flood events. Based on the areas currently zoned for development, approximately 300 ac (121 ha) of suitable habitat will not be conserved and therefore subject to future development. No additional flood control structures are anticipated. Extreme flood events and corresponding sediment removal occur every 5 to 6 years with vegetation recovery between events supported by average or above average rainfall. We expect that the range of environmental stochasticity is generally similar to what the species has experienced in the recent past, with the exception of a 5ºF (2.8ºC) increase in the hottest days of the year. It is not clear if this temperature increase will approach the physiological limit of the beetle; but we expect some reduced mortality if extreme heat days occur during, immediately before or after the flight season when individuals have emerged or are close to the surface. Drought conditions are common between years of high rainfall and are projected to be mitigated to a limited degree by years of average or above average rainfall. Vegetation and habitat recovery is anticipated but will be slower than Scenario 1 creating periods of reduced habitat quantity and suitability. Increased risk of fire is projected over current conditions with more acres burned within the species' current range (11.2 percent) and within the surrounding watershed. The pulse of debris from wildfires and subsequent flood events will help contribute detritus for the intervening dry periods; and the frequency of fire is not expected to reduce long term availability of food resources. We expect suitable habitat under this scenario to be further reduced to approximately 1,476 ac (597 ha).

8.4.1 Resiliency

The Palm Canyon Wash floodplain has moderate overall resiliency under a scenario of on-going threats and anticipated conservation (2.8; Table 8-4). The restoration of the Tahquitz Creek and Mesquite golf courses are expected to help offset habitat loss due to development, warming temperatures, and increased disturbance (e.g. flood events, flood maintenance, and wildfires). The restoration is anticipated to result in high quality habitat due to its location within the active channel and is expected to improve population wide abundance and connectivity, though temporal declines in abundance and habitat availability are still forecasted under this scenario. Less than half of the available habitat is projected to be preserved. The anticipated conservation efforts will incrementally improve the availability of habitat, abundance, and connectivity relative to Scenario 2; but are not anticipated to substantially improve the overall resiliency of the population relative to Scenario 1 in the context of the remaining threats.

Table 8-4. Changes in population resiliency within the Palm Canyon Wash Floodplain, future Scenario 3.

Analysis Unit	Availability of Suitable Habitat	Abundance	Connectivity	Overall Resiliency
Palm Canyon Wash Floodplain	MODERATE 1,476 ac (597 ha) of moderate to high quality habitat; <50 percent of modeled habitat preserved	LOW/MODERATE Decreasing trend offset in part by restoration efforts	MODERATE Suitable habitat within the average male dispersal distance. Improved by restoration at confluence of Palm Canyon Wash	MODERATE (2.7)

8.4.2 Redundancy

In Scenario 3, we expect redundancy to be similar but slightly reduced relative to current conditions and Scenario 1, but with greater spatial and temporal variability in abundance and the quantity of suitable habitat. The majority of the species' current distribution is expected to be intact and the proposed restoration efforts are expected to largely offset reduction in habitat and abundance related to development, more arid conditions, and increased disturbance (e.g. wildfire, flood events, and flood control maintenance). We project that portions of the habitat on the upland terraces may no longer be suitable; but that Smoke tree is expected to be occupied by the beetle due to supplemental watering, though beetle densities may be reduced. Palm Canyon Wash and Tahquitz Creek will also continue to be occupied, though rangewide abundance is expected to be reduced slightly due to more extreme environmental conditions and increases in the disturbance regime. Minor increases in abundance are projected due to restoration at and upstream of the confluence in an area of periodic sediment deposition which is expected to provide high quality habitat. The restoration efforts are also anticipated to improve connectivity and opportunities for the beetle to colonize the wash after a catastrophic event. Overall, the species' distribution and redundancy continue to be limited under Scenario 3; but higher than Scenario 2.

8.4.3 Representation

The habitat and ecological characteristics of Casey's June beetle that confer low representation (e.g., habitat specialization, limited range, and small population size) are similar but slightly reduced relative current conditions and Scenario 1. Environmental diversity is more restricted because of the threat of warming temperatures, prolonged drought, and increased disturbance that are anticipated to make portions of the species' distribution unsuitable, at least temporally. Uncertainty regarding the species' physiological limits and the effects of extreme heat days during and immediately prior to the flight season remain; however, we project reductions in abundance and occupancy in the driest areas with corresponding reductions in representation. We expect behavioral adaptations to partially mitigate warming temperatures and decreased soil moisture. But reductions in abundance and representation are still anticipated in response to threats because of the species limited ability to adapt and persist in place or shift in space in response to the more extreme climatic and habitat conditions forecasted at the end of century. Overall, the species' distribution is similar though representation is expected to be reduced, though substantial reductions in abundance and genetic variation are not anticipated.

CHAPTER 9 - OVERALL SYNTHESIS AND SPECIES VIABILITY ANALYSIS

This SSA for Casey's June beetle summarizes the current conditions and a range of plausible future scenarios incorporating threats that we considered likely over two future time periods (2040-2069, 2070-2100). The results describe a range of possible conditions for the beetle within the Palm Canyon Wash population under three scenarios and projected future resiliency under these conditions (Table 9-1). In consideration of forecasted conditions, we evaluated resiliency, redundancy, and representation to characterize the species' future viability using the best available information, including sources of uncertainty and how they were treated in this analysis.

We had several challenges to evaluating the species' viability and likelihood to persist over the next 80 years. We do not have a clear understanding of the amount and variability of abundance and the quantity of suitable habitat historically, or current population trends to better quantify the magnitude of effects projected under these scenarios. Information is not available on the minimum population abundance required for the population to rebound and persist following a significant climatic or disturbance event. There are also several threats for which the magnitude of the threat to the species includes a high degree of uncertainty. We are not clear how deep into the soil column immature stages travel and the degree that they can potentially avoid mortality due soil disturbance; therefore, we forecasted a limited amount of mortality that increases with the frequency and magnitude of the events. Similarly, we are not clear to what extent movement deeper in the soil column provide climate refugia or if there are specific physiological thresholds for the different life stages. Therefore, we considered the possibility that behavioral adaptation could ameliorate some but not all the effects of increasing temperatures and prolonged drought, with increasing magnitude of effects with increasing temperatures.

Our literature review indicates that habitat loss and fragmentation due to urbanization, altered hydrology, and the effects of climate change (e.g., warming temperatures, increased aridity, prolonged droughts, and increased risk of wildfire) are the dominant threats acting on the species. Except for conservation driven by the mitigation of development and flood control maintenance projects, we are not aware of mechanisms to help ameliorate the remaining threats. In addition, we expect threats to act cumulatively with the potential for higher magnitude net impacts to individuals, the population, and the species, as outlined in the individual scenarios. For example, aridity and increased evaporation is exacerbated by warming temperatures and prolonged droughts, which increases the flammability of vegetation and increases the risk of wildfire.

9.1 Resiliency

The main factors driving resiliency are the quantity, connectivity, and conservation status of suitable habitat. Currently, the Palm Canyon Wash floodplain population has moderate to high population resiliency. Population resiliency in the future is expected to be reduced, though the single core population in the Palm Canyon Wash floodplain is anticipated to continue to have moderate resiliency under both Scenario 1 (extension of current threats until 2040-2069) and Scenario 3 (current threats and increased conservation through 2070-2100; Table 9-1). Increased warming and extended droughts under RCP4.5 are expected to reduce the availability of suitable habitat, along with the threat of development, with corresponding reductions in the quantity of suitable habitat and abundance. Small to moderate increases in the frequency and magnitude of the disturbance regime are also projected including extreme precipitations events, wildfire, and corresponding flood maintenance activities that are also expected to exacerbate declines in habitat quantity and abundance. The additional water, sediment and vegetation inputs associated with flood events also have the potential to improve habitat conditions if the wash habitats are provided sufficient time to recover; and we expect abundance to respond similarly as long as a population numbers have not reached a critical minimum threshold. We project that forecasted losses in occupied habitat, abundance, and connectivity will reduce resiliency relative to current conditions; but that Palm Canyon Wash floodplain will have sufficient resiliency to persist into the future on Scenario 1 and 3.

Table 9-1. Summary of population resiliency within the Palm Canyon Wash Floodplain analysis unit under current condition and across three future scenarios.

Scenario	Availability of Suitable Habitat	Abundance	Connectivity	Overall Resiliency
Current Conditions	MODERATE/ HIGH	MODERATE	MODERATE/ HIGH	MODERATE/ HIGH

				(3.7)
1	MODERATE	MODERATE	MODERATE	MODERATE (3.0)
2	MODERATE	LOW	LOW/ MODERATE	LOW/ MODERATE (2.2)
3	MODERATE	LOW/ MODERATE	MODERATE	MODERATE (2.7)

An increase in the magnitude of threats associated with habitat loss and fragmentation due to urbanization, altered hydrology, and climate change effects were projected under RCP8.5 for Scenario 2 to the end of the century (2070-2100). Approximately 20 percent of the current distribution is forecasted to be lost due to development, much of which will not be mitigated through conservation due to a lack of available habitat. The effects of climate change (e.g., warming temperatures, more extreme heat days, prolonged drought, extreme precipitation events, and increased risk of wildfire) are forecast to be more extreme including conditions that the species has not experienced in the past. Although populations numbers may rebound in some areas of the species' distribution following average or extreme precipitation events, we project that portions of the current distribution will no longer be occupied (e.g., upland terraces), or the numbers of individuals will be so low that reproduction is limited. We project that forecasted losses in occupied habitat, abundance, and connectivity will result in low population resiliency and that Casey's June beetle is unlikely to have sufficient resiliency to persist into the future on Scenario 3.

9.2 Redundancy

Redundancy describes the ability of a species to withstand catastrophic events based on the number of individuals or resilient populations, and the spatial extent of occupied and suitable habitat. Impacts from climate change including warmer temperatures, extended droughts, extreme precipitation events, and increased risk of wildfires, are the highest magnitude threat to the species' future redundancy and are also the main sources of potential catastrophic events (e.g., drought, flood events, and wildfires). Redundancy is, by definition, limited for a narrow endemic with a naturally restricted range. The Palm Canyon Wash floodplain represents the current population of the Casey's June beetle and the core population over at least the last 30 years. Beetles have been recorded throughout Palm Canyon Wash, Tahquitz Creek and the adjacent upland terraces including Smoke Tree Ranch. Occupancy in both streams improves redundancy for catastrophic events such as wildfire and flood events; however, events such as extended droughts are expected to affect the entire range and region similarly.

Redundancy continues to be limited in the future and slighted reduced compared to current conditions under Scenario 1 and Scenario 3. We expect that the core population of Casey's June beetle will occupy a similar distribution as current conditions over the next 40 years; however, some areas are expected to no longer be suitable due to climatic conditions, particularly habitat areas removed from seasonal hydrological events. In Scenario 3 (2070-2100), we expect redundancy to be further reduced with greater spatial and temporal variability in abundance and the quantity of suitable habitat. The proposed restoration efforts are expected to help offset reductions in habitat and abundance related to development, more arid conditions, and increased disturbance (e.g. wildfire, flood events, and flood control maintenance). Nonetheless, portions of the habitat on the upland terraces may no longer be suitable, though beetle densities may be reduced. Under Scenario 1 and 3, we expect redundancy to be sufficient to support the species' long-term viability.

In contrast, the species' redundancy is projected to be substantially reduced under the increased threats projected for Scenario 2 (2070-2100). Portions of the species' historical suitable habitat within the Palm Canyon Wash floodplain are expected to no longer be suitable, resulting in decreased abundance and local extirpations. We project the species will continue to occupy both Palm Canyon Wash and Tahquitz Creek but with reduced habitat quantity, abundance, and connectivity; moreover, habitat patches suitable for females are anticipated to be more widely dispersed. Overall redundancy is projected to be very limited given the potential contraction of the species' distribution and the multiple factors that contribute to low abundance. It is possible that a more frequent disturbance regime, in the context of extended droughts such as modeled under Scenario 3, could reduce population numbers to a point where the species could not recover from a catastrophic event.

9.3 Representation

Representation is the ability of a species to adapt to both near-term and long-term changes in its physical and biological environment including adaptations for the species to persist in place or shift in space to maintain appropriate habitat conditions. Currently, Casey's June beetle has the adaptive capacity to persist in place under the range of environmental conditions it has experienced in the recent past and limited ability to shift in space to avoid unsuitable habitat and climate conditions. Across all future scenarios, representation is projected to be lower. Scenarios 1 and 3 are reduced from current conditions but the species is projected to have sufficient representation to ensure long-term viability. Representation is most limited in Scenario 2 due to reductions in the amount and variability of suitable habitat and decreased population abundance that are anticipated to reduce ecological and genetic diversity. Should low abundance be realized, we would expect to see evidence of the effects of small population size such as lower heterozygosity and inbreeding depression which further limits the species' potential to adapt to changing environmental conditions. It is unlikely that the species' adaptive capacity will be sufficient to ensure persistence and species' viability in the long-term under more extreme climatic conditions and more frequent disturbance.

Table 9-2. Summary of Casey's June beetle viability analysis.

Condition	Current	Scenario 1	Scenario 2	Scenario 3
Resiliency	MODERATE TO HIGH (3.7)	MODERATE (3.0)	LOW/MODERATE (2.2)	MODERATE (2.7)
Redundancy	High. Analysis unit includes most of the core population over the last 30 years and the species occupies Palm Canyon Wash, Tahquitz Creek, and Smoke Tree Ranch.	Decrease in the ability to withstand catastrophic events due to small decreases in distribution and populations size. All portions of the analysis unit remain occupied.	Greater reduction in the ability to withstand catastrophic events due to loss of occupied habitat along upland terraces due to more arid conditions and loss of habitat in the wash due to decreased disturbance compared to Scenario 3. A catastrophic event has a high probability of extirpating the entire analysis unit.	Decrease in the ability to withstand catastrophic events compared to Scenario 1 due to decreases in distribution and populations size. All portions of the analysis unit remain occupied, but Smoke Tree Ranch and the upland terraces are expected to have low abundance.
Representation	High. Analysis unit includes the same ecological diversity as the species has experienced over the last 30 years and the species occupies all portions of its distribution.	Slight decrease in the ability to adapt to change environmental conditions relative to current conditions due to minor loses in ecological diversity.	Greater reduction in adaptive capacity due to the likely loss of occupied habitat and ecological diversity with corresponding low abundance and high potential for inbreeding depression. Species' life history characteristics limit dispersal and ability to adapt to rapid changes in climate conditions.	Decrease in the ability to adapt to change environmental conditions relative to Scenario 1 due to the potential loss of occupied habitat along upland terraces and associated decrease in ecological diversity.

9.4 Viability

Overall, Casey's June beetle is likely to persist to mid-century based on the scenarios modeled, with viability varying with the environmental conditions realized. The species has persisted in a landscape with modified hydrology for approximately 70 years. During that time and including the recent past, the population has experienced temperatures, drought periods and extreme precipitation events that represent the mid-range of future environmental conditions. However, viability is projected to decrease with an increase in the frequency and magnitude of threats and disturbance events forecasted at the end of the century for Scenario 2 and 3. Although abundance likely cycles with environmental conditions, long-term population declines are anticipated under all scenarios at the end of the century due to warming and drying weather conditions and increases in the disturbance regime. Periods of low abundance are expected to have genetic implications, particularly under Scenario 2, that are likely to hamper subsequent upturns in periods of more amenable environmental conditions, likely leading to reduced species' viability.

REFERENCES CITED

Anderson, Alison. 2012. Casey's June beetle trapping notes, April 24, 2012.

Barfield, Carl S. and William W. Gibson. 1975. Observations on the Life History of Hypothyce mixta Howden (Coleoptera: Scarabaeidae). 29: p. 251–256.

Bates, Robert L. and Jackson, Julia A. 1987. Glossary of Geology.: American Geological Institute, Alexandria, Virginia. 754 pp.

Beever, E.A., J. O'Leary, C. Mengelt, J.M. West, S. Julius, N. Green, D. Magness, L. Petes, B. Stein, A.B. Nicotra, J.J. Hellmann, A.L. Robertson, M.D. Staudinger, A.A. Rosenberg, et al. 2016. Improving Conservation Outcomes with a New Paradigm for Understanding Species' Fundamental and Realized Adaptive Capacity: A new paradigm for defining adaptive capacity. Conservation Letters 9: p. 131–137.

Blaisdell, F. E. 1930. Revision of the genus and species of Dinacoma with description of a new species (Coleoptera: Scarabaeidae). Pan-Pacific Entomologist 6: p. 171–177.

Bruyea, G.P. 2006. Casey's June Beetle (Dinacoma caseyi) Focused Survey and Technical Report Palm Springs MDP Line 41 Riverside County, California. Prepared for Helix Environmental Planning, Inc. 22 pp.

Cal-Adapt. 2021. Local climate change snapshot for Palm Springs California, Website accessed December 9, 2021, https://cal-adapt.org/tools/local-climate-change-snapshot.

[CalFire] California Department of Forestry & Fire Protection. 2021. Historic Fire Perimeters.

City of Palm Springs. 2007. Chapter 2 Land Use Element. 56 pp.

Coca-Abia, M.M. 2000. *POLYLAMINA* Hardy, a Junior Synonym of *POLYPHYLLA* Harris (Coleoptera: Scarabaeidae, Melolonthinae, Melolonthini). The Coleopterists Bulletin 54: p. 11–22.

Cornett, Jim. 2004. Prepared for Saxony Group. Distribution and Abundance of the endangered Casey's June Beetle (Dinacoma caseyi) on the 13.28-acre Saxony Site located in Palm Springs, California. 24 pp.

Crandall, K.A., O.R.P. Bininda-Emonds, G.M. Mace, and R.K. Wayne. 2000. Considering evolutionary processes in conservation biology. Trends in Ecology and Evolution 15: p. 290–295.

[District] Riverside County Flood Control and Water Conservation District. 2020. Palm Canyon Wash and Tahquitz Creek Flood Control Facility Maintenance Biological Assessment. 22 pp.

Driscoll, D.A., and T. Weir. 2005. Beetle Responses to Habitat Fragmentation Depend on Ecological Traits, Habitat Condition, and Remnant Size. Conservation Biology 19: p. 182–194.

Dudek. 2019. Casey's June Beetle Vegetation Mapping Methodology and Results. Prepared for the U.S. Fish and Wildlife Service, Palm Springs, California by Dudek, La Quinta, California. Dated November 15, 2019. 14 pp.

Duff, Robert. 1990. Unspecified submission recipient. Dinacoma caseyi: Current Status of Endangered Species. 7 pp.

Evans, A. V. and Hougue, J.N. 2006. Field Guide to Beetles of California. California Natural History Guides.: University Of California Press. 334 pp.

Gillett, C.P.D.T., K.H. Osborne, J.B. Reil, and D. Rubinoff. 2020. A new species of melolonthine chafer in the endemic Californian genus Dinacoma Casey (Coleoptera: Scarabaeidae). Journal of Insect Biodiversity 17: p. 28–35.

Google Earth Pro. 2021. Aerial imagery of Palm Canyon Wash Floodplain 1985-2021, Website viewed October 28, 2021, https://cal-adapt.org/tools/local-climate-change-snapshot.

Harju, Seth. 2021. Prepared for U.S. Fish and Wildlife Service, Palm Springs, California and Dudek, Encinitas, California. Casey's June Beetle Population Analyses, Factors affecting emergence and relative abundance. 20 pp.

Harju, Seth. 2022. Casey's June Beetle Population Analyses. Revised analyses dated April 20, 2022. Prepared for U.S. Fish and Wildlife Service, Palm Springs, California and Dudek, Encinitas, California. Supplementary Report. 19 pp.

Hawks, David. 2010. Email between Alison Anderson, Carlsbad Fish and Wildlife, and David Hawks, Entomologist. Dated June 15, 2010. Subject: Casey's June beetle preliminary results.

Helix. 2010. Tribal Habitat Conservation Plan. Prepared for Agua Caliente Band of Cahuilla Indians. Dated August 2010. 606 pp.

Hill, K.E., and R. O'Malley. 2010. A picky palate? The host plant selection of an endangered June beetle. Journal of Insect Conservation 14: p. 277–287.

Hopkins, F., V. Carranza, H. Ajami, J.E. Allison, R.G. Anderson, C.W. Barrows, M. Barth, D.R. Jenerette, W.C. Porter, T. Rolinski, K. Schwabe, C. Yáñez, and N. Yu. 2018. Inland Deserts Region Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-008. 67 pp.

Hovore, F. 1995. Report of field surveys: Coachella Valley Multi-species HCP, Invertebrates - Palm Springs June beetle (Dinacoma caseyi). Unspecified submission recipient. 7 pp.

Hovore, F. 2003. Report of focused surveys for Casey's June beetle: Smoketree Ranch and vicinity. Prepared for Krieger & Stewart, Inc. 10 pp.

Knecht, A. A., Simonsen, C. R., and Spencer, E. 1980. Soil Survey of Riverside County, California Coachella Valley Area. United States Department of Agriculture in cooperation with University of California Agricultural Experiment Station. 99 pp.

La Rue, Delbert. 2004. Email from Delbert La Rue to David Wright.

La Rue, Delbert. 2006. Email correspondence between Alison Anderson, Carlsbad Fish and Wildlife Office and Delbert La Rue, Entomologist. Dated June 13, 2006. Subject: Casey's June beetle taxonomy.

La Rue, Delbert. 2008. Email communication between Tonny McKinney, Carlsbad Fish and Wildlife Office and Delbert La Rue, Casey's June Beetle species expert. Subject: Casey's June Beetle.

La Rue, Delbert. 2016. Natural history, ecology, and conservation of the genus Polyphylla Harris, 1841. New species from the southwestern United States and Baja California, Mexico with notes on distribution and synonymy (Coleoptera: Scarabaeidae: Melolonthinae) from the southwestern United States and Baja California. Insecta Mundi: 0491: p. 1–41.

Malcolm, D. 2023. Director of Planning, Agua Caliente Band of Cahuilla Indians. Email communication with Julie Simonsen, Fish and Wildlife Biologist, USFWS, Carlsbad Fish and Wildlife Office. Subject: Preliminary tribal review of sections of the Casey's June beetle Species Status Assessment. Clarification on Tribal zoning designations.

Mangel, M., and C. Tier. 1993. A simple direct method for finding persistence times of populations and application to conservation problems. Proceedings of the National Academy of Sciences of the United States of America 90: p. 1083–1086.

Nicotra, A.B., E.A. Beever, A.L. Robertson, G.E. Hofmann, and J. O'Leary. 2015. Assessing the components of adaptive capacity to improve conservation and management efforts under global change. Conservation Biology 29: p. 1268–1278.

O'Brien, Mark. 2007. Collection Manager. University of Michigan Museum of Zoology Insect Division. Email correspondence to Alison Anderson, Entomologist, USFWS, Carlsbad Fish and Wildlife Office, California. Dated January 8, 2007. Subject: Dinacoma caseyi specimen info.

Osborne, K.H. 2022. Entomologist, Osborne Biological Consulting. Email correspondence to Noelle Ronan, Fish and Wildlife Biologist, USFWS, Palm Springs Fish and Wildlife Office, Palm Springs, California. Dated June 7, 2022. Subject: CJB analysis reports. Communication included update on Casey's June beetle larvae maintained in controlled captive conditions that did not molt during the breeding season.

Osborne, Kendall, H. 2015. Survey for Casey's June beetle (Dinacoma caseyii) on a Water Line Project Site, Agua Caliente Indian Reservation, Palm Springs, Riverside County, California. Agua Caliente Band of Cahuilla Indians. 22 pp.

Osborne, Kendall, H. 2017. Second Year Survey for Casey's June beetle (Diacoma caseyi) on a Water Line Project Site, Agua Caliente Indian Reservation, Riverside County, California. 23 pp.

Osborne, Kendall, H. 2024. Email Communication between Julie Simonsen, Carlsbad Fish and Wildlife Office, and Kendall H. Osborne, Osborne Biological Consulting. Dated May 20, 2024. Subject: Casey's June beetle Species Status Assessment.

Ratcliffe, Brett. 2007. Curator and Professor. University of Nebraska. Email correspondence to Alison Anderson, Entomologist, USFWS, Carlsbad Fish and Wildlife Office, California. Dated February 20, 2007. Subject: Dinacoma.

Redford, K.H., G. Amato, J. Baillie, P. Beldomenico, E.L. Bennett, N. Clum, R. Cook, G. Fonesca, S. Hedges, F. Launay, S. Lieberman, G.M. Mace, A. Murayama, A. Putnam. 2011. What does it mean to successfully conserve a (vertebrate) species? BioScience 61: p. 39–48.

Ronan, Noelle A. 2024. Email correspondence between Julie Simonsen, Carlsbad Fish and Wildlife Office, and Noelle Ronan, Palm Springs Fish and Wildlife Office. Subject: Documentation of personal communication in the Casey's June beetle Species Status Assessment.

Ronan, Noelle A., Osborne, Kendall, H., and Gregory, C.J. 2024. Determining and Measuring Environmental Influences on the Distribution and Abundance of Casey's June beetle (Dinacoma caseyi) 2015-2022. U.S. Fish and Wildlife Service. 152 pp.

Rowland, E.L., M.S. Cross, and H. Hartmann. 2014. Considering multiple futures: scenario planning to address uncertainty in natural resource conservation: U.S. Fish and Wildlife Service. 162 pp.

Rubinoff, D and San Jose, M. 2021. Unpublished report submitted to Noelle Ronan, Palm Springs Fish and Wildlife Office, Palm Springs, California. Date submitted March 5, 2021. Report for supplemental Sequencing of Casey's June beetle (Dinacoma caseyi) samples from the Tahquitz creek drainage. 3 pp.

[SCAG] Southern California Association of Governments. 2020. Current Context Demographics and Growth Forecast Technical Report. Adopted September 2, 2020. 56 pp.

Sgró, C.M., A.J. Lowe, and A.A. Hoffmann. 2010. Building evolutionary resilience for conserving biodiversity under climate change. Evolutionary Applications 4: p. 326–337.

Shaffer, M., and B.A. Stein. 2000. Safeguarding our precious heritage *in* Precious heritage. The status of biodiversity in the United States, The Nature Conservancy and Biodiversity Information. Oxford University Press.

Smith, D.R., N.L. Allan, C.P. McGowan, J.A. Szymanski, S.R. Oetker, and H.M. Bell. 2018. Development of a Species Status Assessment Process for Decisions under the U.S. Endangered Species Act. Journal of Fish and Wildlife Management 9: p. 302–320.

Smith, A.T.B and Evans, A.V. 2005. A supplement to the checklist of New World chafers (Coleoptera: Scarabaiedae: Melolonthinae) with notes on their tribal classification. Zootaxa: p. 29–60.

Thurman, L.L., B.A. Stein, E.A. Beever, W. Foden, S.R. Geange, N. Green, J.E. Gross, D.J. Lawrence, O. LeDee, J.D. Olden, L.M. Thompson, and B.E. Young. 2020. Persist in place or shift in space? Evaluating the adaptive capacity of species to climate change. Frontiers in Ecology and the Environment 18: p. 520–528.

USFWS. 2016. USFWS species status assessment framework: an integrated analytical framework for conservation. 21 pp.

USFWS. 2021. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 76 species in California and Nevada. Federal Register 86: p. 27462–27464.

USFWS. 2023. Formal Section 7 Consultation for Emergency Authorization for Sediment Removal and Levee Repair in Palm Canyon Wash and Programmatic Consultation for Future Flood Control Facility Maintenance Activities in Palm Canyon Wash, Tahquitz Creek, Whitewater River, and Eagle Canyon Dam, City of Palm Springs and Cathedral City, Riverside County, California (SPL-2020-00101-JEM).

USFWS GIS. 2021. Casey's June beetle habitat suitability model developed for the Species Status Assessment. Unpaginated.

[USFWS] U.S. Fish and Wildlife Service. 2006. Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition to List the Casey's June beetle (Dinacoma caseyi) as Endangered. Federal Register 71: p. 44960–44966.

[USFWS] U.S. Fish and Wildlife Service. 2011. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for Casey's June Beetle and Designation of Critical Habitat; final rule. Federal Register 76: p. 58954–58998.

[USFWS] U.S. Fish and Wildlife Service. 2013. Recovery Outline for the Casey's June Beetle (Dinacoma caseyi).

[USFWS] U.S. Fish and Wildlife Service. 2016. Casey's June Beetle (Dinacoma caseyi) Survey Guidelines.

[USFWS] U.S. Fish and Wildlife Service. 2021. 5-Year Review for Casey's June Beetle (Dinacoma caseyi).

USGS. 2014. Scientific Investigations Report 2014-5075. Prepared in cooperation with the Coachella Valley Water District. Land Subsidence, Groundwater Levels, and Geology in the Coachella Valley, California, 1993–2010. 75 pp.

Wall, Michael. 2007. Collection Manager. University of Michigan Museum of Zoology Insect Division. Email correspondence to Alison Anderson, Entomologist, USFWS, Carlsbad Fish and Wildlife Office, California. Dated January 10, 2007. Subject: *Dinacoma caseyi* locality data.

Windfinder. 2021. Wind & Weather statistics for the Palm Springs Airport. Website viewed May 4, 2021, https://www.windfinder.com/windstatistics/palm_springs_airport.

Wilkinson, C.F. and H.M. Anderson. 2002. Land and Resource Planning in the National Forests. Modern National Forest Management Pages 720–737 in Federal Public Land and Resources Law (5th ed.), Foundation Press, New York, New York.

Wolf, S., B. Hartl, C. Carroll, M.C. Neel, and D.N. Greenwald. 2015. Beyond PVA: Why recovery under the Endangered Species Act is more than population viability. BioScience 65: p. 200–207.

Wood. 2020. Memo report submitted to Jason Swenson, Riverside County Flood Control & Water Conservation District by Michael D. Wilcox, Wood Environment & Infrastructure Solutions, Inc., Dated June 5, 2020. Casey's June Beetle (Dinacoma caseyi) rangewide Survey 2020. 27 pp.

Wood. 2021. Memo report submitted to Randy Sheppeard, Riverside County Flood Control & Water Conservation District by Nathan T. Moorhatch, Wood Environment & Infrastructure Solutions, Inc., Dated July 20, 2021. Casey's June Beetle (Dinacoma caseyi) rangewide Survey 2021 (Tahquitz Area). 66 pp.

[WRCC] Western Regional Climate Center. 2021. Climate Summary for Palm Springs, California, Website viewed May 4, 2021, https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6635.

[WRCC] Western Regional Climate Center. 2024. 100 Year Summary of Extreme Daily Precipitation Events, Website viewed October 31, 2021, https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6635.

Zackay, A. 2007. Random genetic drift and gene fixation. Unpaginated.

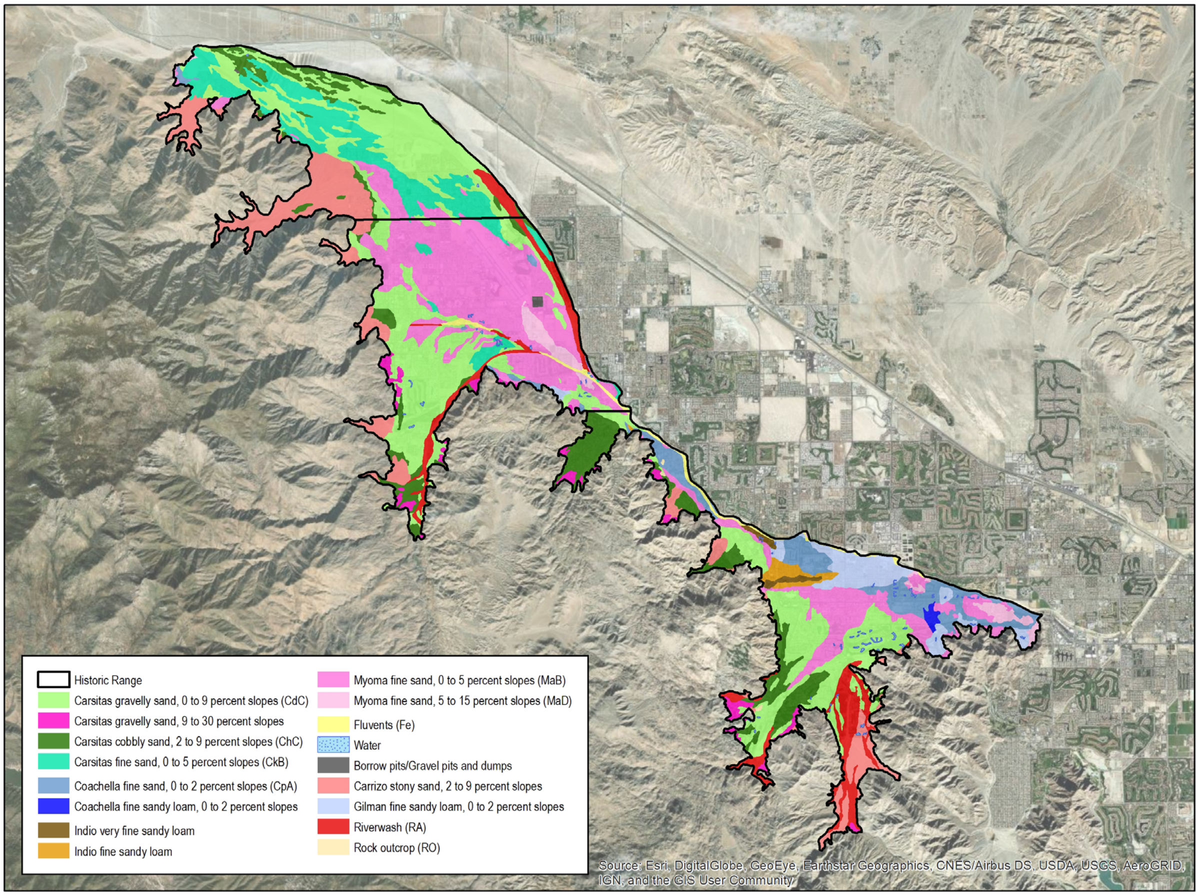
APPENDIX A - HABITAT SUITABILITY MODEL

A habitat suitable model was developed to characterize the amount, quality, and distribution of potentially suitable habitat and to delineate the species current and historical range (USFWS GIS 2021, unpaginated). The current range includes potential habitat within approximately 2,539 ft (774 m) of known records (trap locations; Figure 7-1), which corresponds to the maximum male recapture distance recorded (Table 7-4). The species historical range was estimated based on preferred soil types, historical records, and was defined geographically along the foothills to the south (Figure 4-1). The northern and western limit is believed to be constrained by wind conditions that increase soil evaporation and inhibit male activity during the breeding season. The San Jacinto Mountains serves as a windbreak for winds coming from the west and northwest. Whitewater River is considered the north and eastern limit as it defines a significant hydrological input and aeolian sands tend to dominate the central part of the valley to the north and east of the river. The historical range was limited to the valley floor or a maximum elevation of approximately 750 ft (229 m).

An occupancy-based GIS analysis was conducted that evaluated important habitat parameters at recorded observations including soil type, hydrology and vegetation community. Important habitat parameters were ranked based on their frequency in occupied habitat and known preferences documented in the literature. A framework was developed to weight and combine the individual parameter rankings with separate models within the current range and historical range, based on available data. The final habitat quality rankings and associated data were used to refine the current and historical range as described below.

Soil Type

Soil preference was determined within occupied Casey's June beetle habitat. Individual records were buffered by 328 ft (100 m; USFWS 2016, p. 4) and the Natural Resources Conservation Service Soil Survey data was used to determine the acreage of each soil type within the buffer of occupied habitat (Figure B-1). Casey's June beetle habitat is characterized by a preference for alluvial soils, particularly soils of the Carsitas series (50 percent) and Riverwash (25 percent). Fluvents (3 percent) were also considered high quality habitat because they occur on the channel levees adjacent to the wash. Myoma soils series (16 percent) is considered moderate habitat, based on the lower relative frequency of use; and because it is derived from sand blown from alluvium and does not have the same characteristics as the alluvial soils described above. Coachella fine sands (3 percent) are considered low quality habitat due to low occupancy and because they are associated with the lacustrine conditions of historic Lake Cahuilla that characterizes much of the Coachella Valley and are not specific to alluvial fans, although these deep sands have high water retention at depths. If soil type was indicated as water due to the presence of permanent ponds, habitat quality deferred to the surround habitat quality ranking.



Document Path: S:\stem\emilie\ListingRecovery\CJB\SSA\Analysis\CJB_Working.mxd

Figure A-1. Distribution of all soil associations within the historical range of Casey's June beetle.

Hydrology

The historical alluvial fans surrounding Palm Canyon Wash now sit on terraces that are often isolated from infrequent natural flows or are subject to periodic flood disturbance on a substantially less frequent timescale due to flood control structures (Figure B-2). The natural hydrological regime was characterized using Federal Emergency Management Agency (FEMA) floodplain mapping that takes into account present flood control structures and the corresponding diversion of water. The FEMA data describes three flood control that characterize hydrological conditions (REF). Areas within the 100-year floodplain, which encompasses existing streams and channels, generally delineates high quality habitat that typically receive hydrological inputs during years of average rainfall and may flood during large precipitation events. The 500-year floodplain is typically higher elevation or otherwise removed from the 100-year floodplain, such as the upland terrace, and may not receive surface inputs during an average rainfall year and is therefore considered moderate quality. Low quality hydrology included those areas outside of a special flood hazard area designation and is typically higher elevation than the 500-year floodplain. As a result of the reduced hydrological inputs, low quality habitat may not sustain the species in the long term without artificial management.

This data structure was used to help delineate Casey's June beetle's current and historical range. We acknowledge that flood control was not part of the long-term historical context for Casey's June beetle; however, the Palm Canyon levee system was constructed in the 1950's and many of the water diversion structures have been in place for 50 to 70 years (District 2020, p. 2). These flood control were also used to inform habitat quality throughout the historical range where other hydrological or vegetation data was lacking.

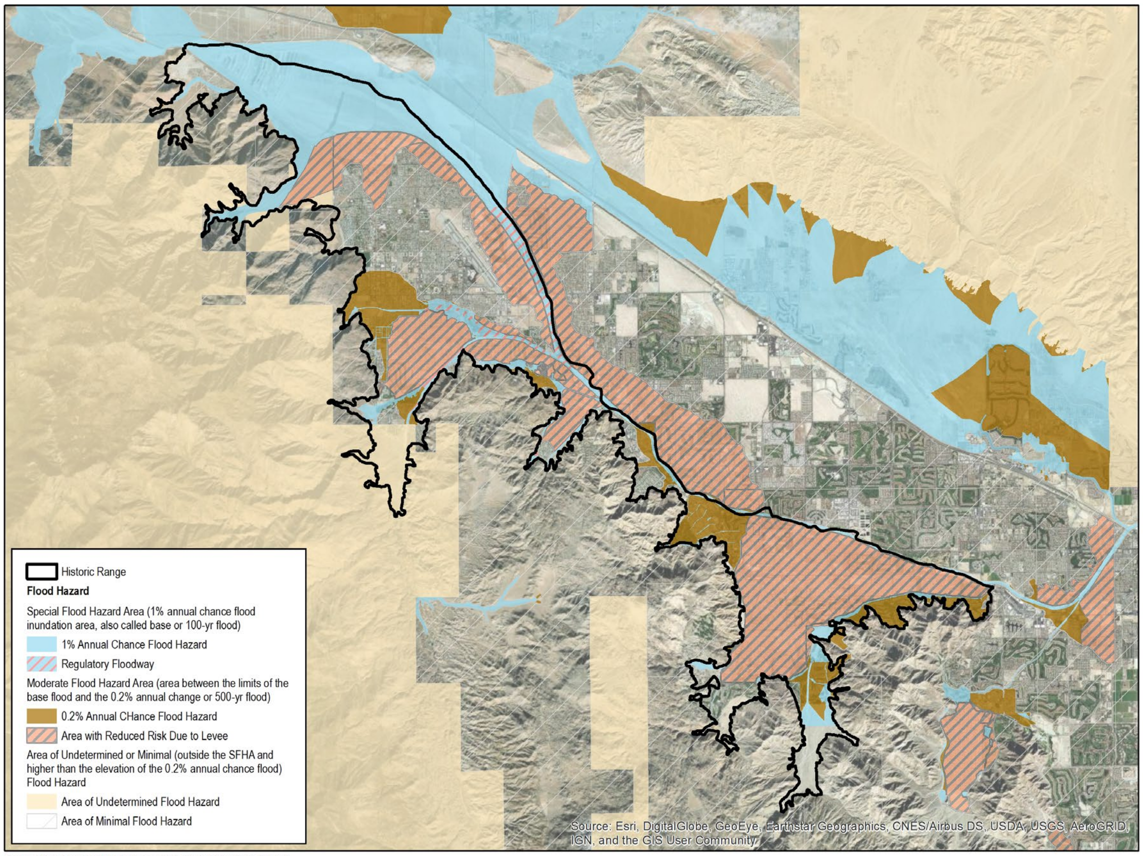


Figure A-2. Map of Federal Emergency Management Agency (FEMA) flood zones as a metric for characterizing current hydrological processes within the historical species range.

Vegetation Community

Vegetation associations were also determined within a 328 ft (100 m; USFWS 2016, p. 4) buffer of occupied trap locations. Vegetation community mapping was conducted concurrent with rangewide survey efforts within the wash and upland terrace habitats where trapping occurred (Dudek 2019, entire). Vegetation associations from this field effort were grouped into broader habitat categories to allow for consistency across the species current range (Table B-1). To address gaps in this dataset within the species current range, aerial imagery was used to digitize habitat polygons into the following broad categories: riparian, desert scrub, disturbed and developed (Figure B-3). Desert riparian including the desert wash plant community, is considered the preferred vegetation community due to its association with water and the proportion of sites occupied (37 percent). There is also higher population density in desert riparian habitat, in association with desert willow (Trap 10; Table 4-3), although this has not been evaluated statistically. Desert scrub is generally considered moderate habitat because it typically occurs on upland terraces outside of areas of hydrological influence and accounts for 39 percent of the occupied habitat within the species current range. Disturbed habitat including golf courses and barren areas are generally considered low quality or marginal habitat because they lack vegetation and the cover and detritus it provides. However, disturbed areas that experience a natural hydrologic regime have the potential to be recolonized or restored; and therefore, receive a higher habitat ranking under those conditions.

Table A- 1. Summary of vegetation communities and associations within the current range of the Casey's June beetle (Dudek 2019, USFWS GIS 2021).[22]

Vegetation Community	Vegetation Association	Acres	Percent	Habitat Quality Ranking
Desert Scrub	Disturbed fourwing saltbush	0.2	0.0	Moderate
Desert Scrub	Creosote bush	1.9	0.5	Moderate
Desert Scrub	Creosote bush-brittle bush	3.0	0.9	Moderate
Desert Scrub	Disturbed Creosote bush	3.3	0.9	Moderate
Desert Scrub	Cheesebush-Thurber's sandpaper plant	3.4	1.0	Moderate
Desert Scrub	Creosote bush-white bursage	4.5	1.3	Moderate
Desert Scrub	Creosote bush-allscale	12.3	3.5	Moderate
Desert Scrub	Cheesebush	110.5	31.2	Moderate
Disturbed	Disturbed Habitat/Golf courses	7.9	2.2	Low
Developed	Urban/Developed/Permanent Ponds	76.7	21.7	No
Riparian	Disturbed Desert Willow	1.3	0.4	High
Riparian	Smoke tree	19.6	5.5	High
Riparian	Desert willow-Tamarisk	1.7	0.5	High
Riparian	Tamarisk thickets	5.1	1.4	High
Riparian	Disturbed Smoke tree	5.4	1.5	High
Riparian	Unvegetated Channel	7.2	2.0	High
Riparian	Smoke tree	19.6	5.5	High
Riparian	Desert willow-smoke tree	20.5	5.8	High
Riparian	Desert willow	31.1	8.8	High
Riparian	Desert willow/cheesebush	38.6	10.9	High

[22] Calculations based on vegetation type found within a 328 ft (100 m) buffer of trap locations in occupied habitat.

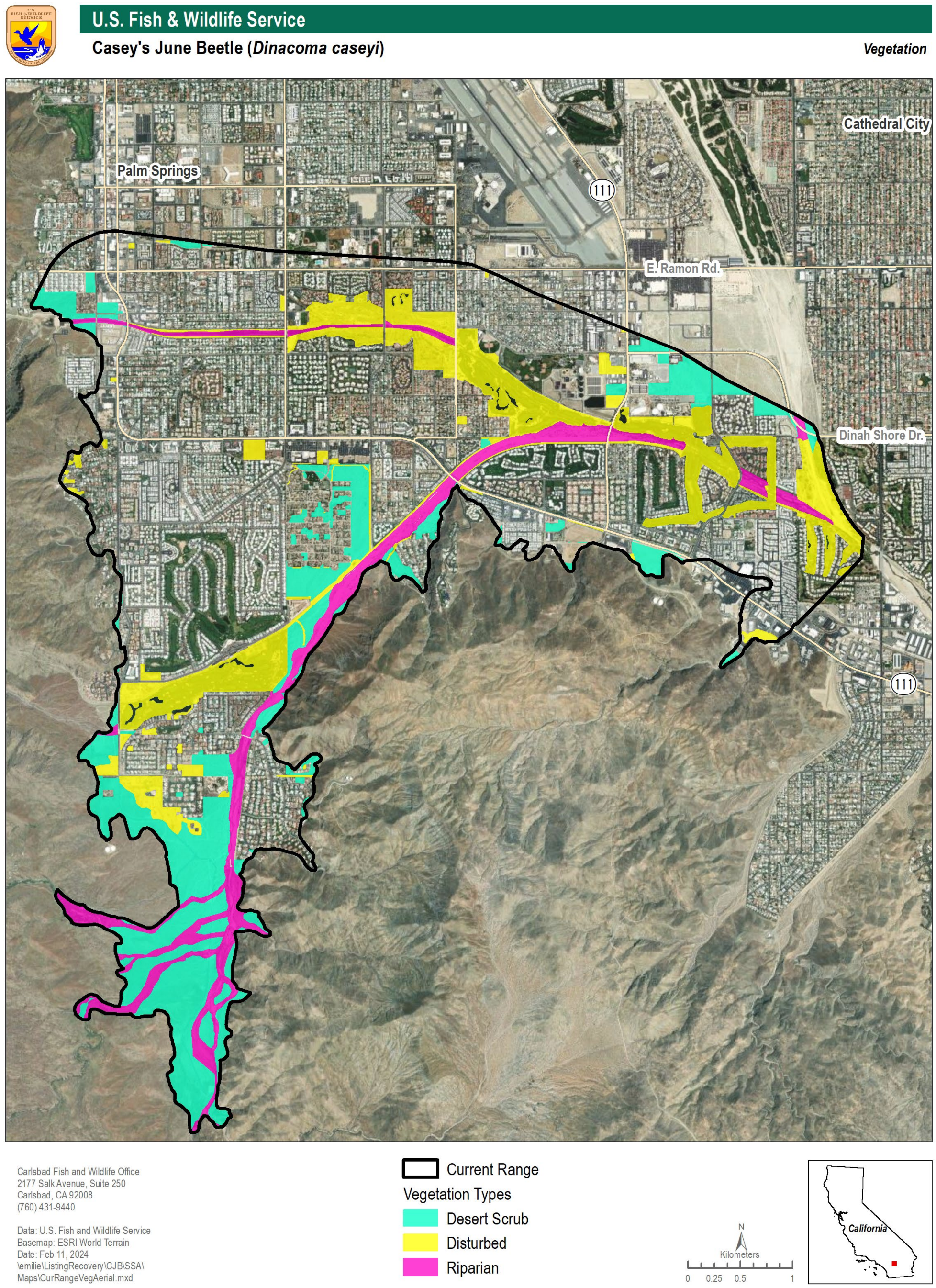


Figure A-3. Vegetation communities and habitat ranking within the current range of Casey's June beetle.

Combined Habitat Suitability Model

A framework was developed based on the literature and expert opinion to rank the combination of habitat parameters on the landscape as low, moderate or high-quality habitat for Casey's June beetles current range (Table B-2) and historical range (Table B-3). High quality habitat within the species current range required the presence of high-quality soils (Carsitas, Riverwash, and Fluvents) and/or either the preferred vegetation (Riparian) and hydrological associations (100-year floodplain). Moderate habitat included two or more moderate (Myoma soils, 500-year floodplain, and/or desert scrub) to high quality habitat features. Low quality habitats were dominated by the non-preferred habitat features (Coachella soils, outside of a special flood hazard area designation, and barren or disturbed vegetation) and were most often driven by low quality hydrology. The approach was similar for the historical range considering only soil type and flood hazard.

Table A- 2. Habitat Ranking within Casey's June beetle's Current Range (high quality features are in blue, moderate features are in yellow and low-quality features are in red).

Vegetation	Soils	Hydrology (Flood Hazard)	Habitat Ranking
Riparian	Carsitas, Riverwash, Fluvents	100-year flood	High
		500-year flood	High
		Higher than 500-year flood; no special flood hazard area designation	High
	Myoma	100-year flood	High
		500-year flood	Moderate
		Higher than 500-year flood; no special flood hazard area designation	Moderate
Desert Scrub	Carsitas, Riverwash, Fluvents	100-year flood	High
		500-year flood	Moderate
		Higher than 500-year flood; no special flood hazard area designation	Moderate
	Myoma	100-year flood	Moderate
		500-year flood	Moderate
		Higher than 500-year flood; no special flood hazard area designation	Marginal
	Coachella fine sands	100-year flood	Moderate
		500-year flood	Moderate
		Higher than 500-year flood; no special flood hazard area designation	Marginal
		100-year flood	High
		500-year flood	Moderate

Disturbed	Carsitas, Riverwash, Fluvents	Higher than 500-year flood; no special flood hazard area designation	Moderate
	Myoma	100-year flood	Moderate
		500-year flood	Moderate
		Higher than 500-year flood; no special flood hazard area designation	Marginal
	Coachella fine sands	100-year flood	Moderate
		500-year flood	Moderate
		Higher than 500-year flood; no special flood hazard area designation	Marginal

Table A-3. Habitat Ranking within Casey's June beetle's Historical Range (high quality features are in blue, moderate features are in yellow and marginal quality features are in red).

Soils	Flood Hazards	Habitat Ranking
Carsitas, Riverwash, Fluvents	100-year flood	High
	500-year flood	Moderate
	Higher than 500-year flood; no special flood hazard area designation	Moderate
Myoma	100-year flood	Moderate
	500-year flood	Moderate
	Higher than 500-year flood; no special flood hazard area designation	Marginal
Coachella fine sands	100-year flood	Moderate
	500-year flood	Marginal
	Higher than 500-year flood; no special flood hazard area designation	Marginal

As a result of this analysis, we identified substantially more potential habitat within the species current range than was previously recorded. A total of 1,989 ac (805 ha) of suitable habitat was identified including 889 ac (360 ha) of high-quality habitat, 995 ac (403 ha) of moderate quality habitat and 105 ac (43 ha) of marginal quality habitat. High quality habitat generally followed the distribution of waterways. The results using the different current and historical range models were similar. In some cases, moderate quality habitat in the historical range was considered high quality in the current range based on mapped riparian vegetation, a high-quality habitat feature; however, that data was not available at the scale of the historical range. Within the historical range, 8,816 ac (3,568 ha) of suitable habitat was identified including 4,858 ac (1,966 ha) of high-quality habitat, 3,344 ac (1,353 ha) of moderate quality habitat and 614 ac (248 ha) of marginal quality habitat. This analysis will be used to inform areas of restoration and translocation outside of the current range.

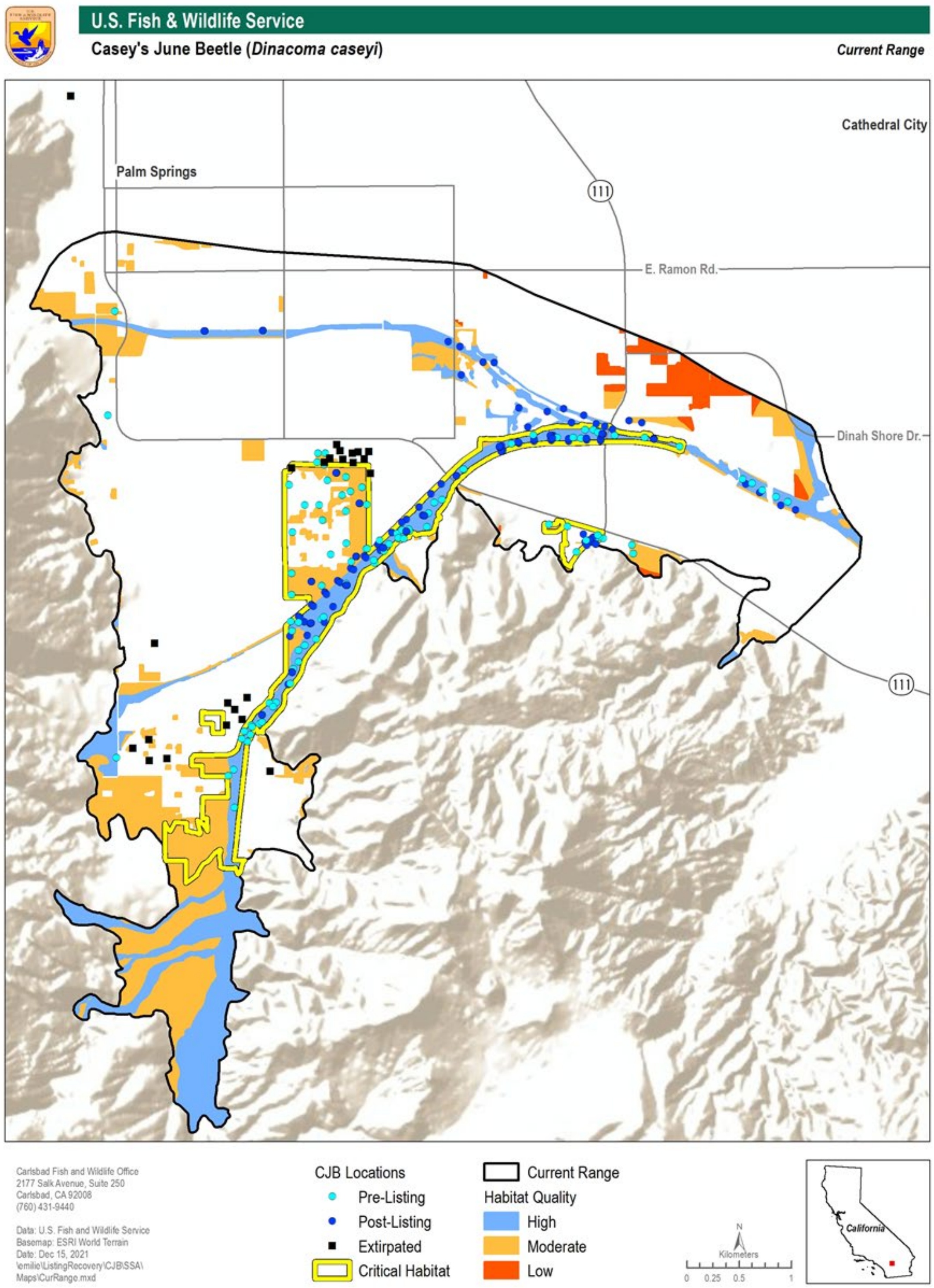


Figure A-4. Habitat ranking and distribution within the current range of Casey's June beetle.

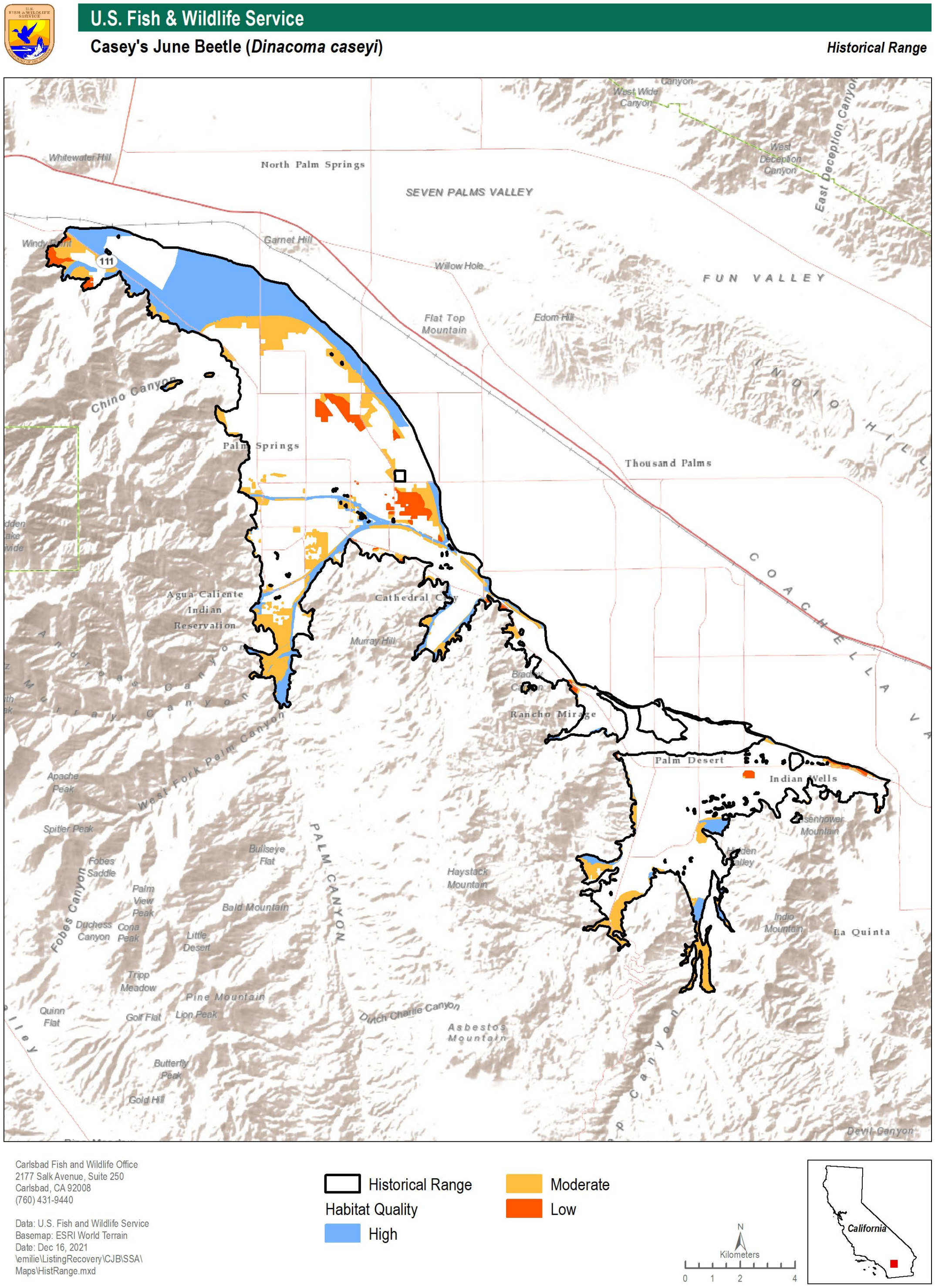


Figure A-5. Habitat ranking and distribution within the historical range of Casey's June beetle.

APPENDIX B – ADAPTIVE CAPACITY

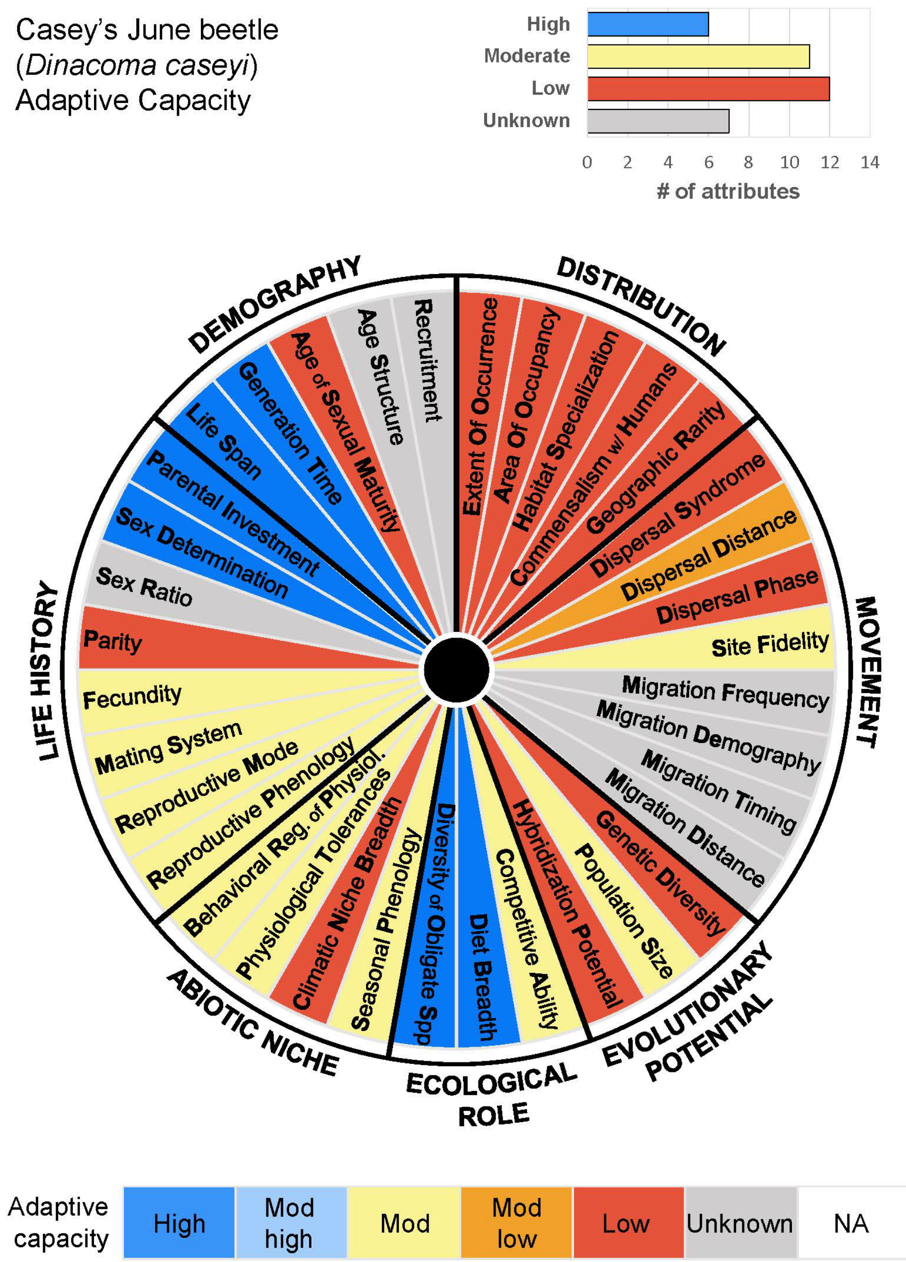


Figure B- 1. Summary assessment of Casey's June beetle adaptive capacity.[23]

[23] The ability of Casey's June beetle to "persist in place" (PiP) or "shift in space" (SiS) was assessed following Thurman et al. (2020) including demographic, life history, distribution, movement, evolutionary potential, ecological role, and abiotic niche attributes.

Table B-1. Assessment of Casey's June beetle adaptive capacity by attribute.

Adaptive Capacity Attributes (core attributes in blue) {suggested search terms}			AC Assessment	Justification / Information used in assessment	Evidence
DISTRIBUTION	PiP, SiS	**Extent of Occurrence (EOO)** {extent of occurrence, EOO, range, distribution, occurrence, occupancy}	Low	6,444 ac (2,608 ha) Palm Canyon wash floodplain analysis unit (USFWS GIS 2021)	Moderate
DISTRIBUTION	PiP, SiS	**Area of Occupancy (AOO)** {area of occupancy, AOO range, distribution, occurrence, occupancy}	Low	1,617 ac (654 ha) of available suitable habitat based on habitat model (USFWS GIS 2021)	Moderate
DISTRIBUTION	PiP, SiS	**Habitat Specialization (HS)** {habitat specialization, habitat utilization, habitat association, habitat}	Low	Alluvial fans within a restricted geography (USFWS 2011, USFWS 2013).	Moderate
DISTRIBUTION	PiP, SiS	**Commensalism with Humans (CH)** {human tolerance, human avoidance, disturbance}	Low	Low tolerance to habitat impacts and artificial light may result in a sink, although some tolerance to flood control improvements.	Low

DISTRIBUTION	PiP, SiS	**Geographic Rarity (GR)** {geographic rarity, rarity, occurrence, distribution, range, population size, connectivity}	Low	Geographically isolated with one single, isolated population (USFWS GIS 2021, USFWS 2011, USFWS 2013).	Moderate
MOVEMENT	SiS	**Dispersal Syndrome (DS)** {dispersal capacity, dispersal behavior, dispersal, movement}	Low to moderate	Fixed timing associated with adult emergence that is triggered by moon phase in April and soil temperatures (Harju 2021). Females immobile with the potential for dispersal doing flow events.	Moderate
MOVEMENT	SiS	**Dispersal Distance (DD)** {dispersal distance, dispersal capacity, dispersal behavior, dispersal, movement}	Moderately Low	Recaptured males were documented to travel an average distance of 302 ft (92 m) to ultraviolet black light traps and up to a maximum documented distance of 2,539 ft (774 m) within a single evening (USFWS unpublished).	Moderate
MOVEMENT	SiS	**Dispersal Phase (DP)** {dispersal capacity, dispersal behavior, dispersal, movement}	Low	Dispersal primarily through male flight, limited unquantified dispersal during flow events in channels.	Low

MOVEMENT	SiS	**Site Fidelity (SF)** {site fidelity, philopatry, natal site fidelity, dispersal}	Moderate	Low for males based on low recapture rate, but high for females with limited mobility.	Low
MOVEMENT	PiP, SiS	**Migration Frequency (MF)** {migration, migration cue, migratory behavior}	NA		
MOVEMENT	PiP, SiS	**Migration Demography (MDe)** {migration, migration cue, migratory behavior}	NA		
MOVEMENT	PiP, SiS	**Migration Timing (MT)** {migration, migration cue, migratory behavior}	NA		
MOVEMENT	PiP, SiS	**Migration Distance (MDi)** {migration, migration cue, migratory behavior, migration distance}	NA		

EVOLUTIONARY POTENTIAL	PiP, SiS	**Genetic Diversity (GD)** {genetic diversity, genetic variability, genetic variation, genetics, heterozygosity, genetic adaptation, adaptation, phenotypic plasticity}	Low	Some evidence of inbreeding based on individuals that are more closely related than would be expected based on random mating; however, the degree of inbreeding was not characterized (Gillett et al. 2020, entire).	Moderate
EVOLUTIONARY POTENTIAL	PiP	**Population Size (PS)** {population size, population, abundance}	Moderate	An index of abundance was estimated based on male capture data for 2020 indicating a yearly average of 111 males across 7 trap locations. This is a subset of the population and not a population estimate.	Moderate
EVOLUTIONARY POTENTIAL	PiP, SiS	**Hybridization Potential (HP)** {hybridization, hybrid vigor, fitness, interbreeding}	Low	No hybridization occurs. Species within the genus are isolated by mountain ranges (Gillett et al. 2020, entire).	Moderate
ECOLOGICAL ROLE	PiP, SiS	**Competitive Ability (CA)** {competition, interspecific competition, biotic interactions, species interactions, community dynamics}	Moderate	High degree of uncertainty. Expect diffuse interactions but lack information on specific competitors and whether resources such as detritus are limiting.	Very Low

ECOLOGICAL ROLE	PiP, SiS	**Diet Breadth (DB)** {diet, food, food resources, prey}	High	Not strongly dependent on one species. Experts indicate that there is not a host plant preference. The species feeds on detritus formed from a diverse array of vegetation and rootlets of potential several to numerous species	Low
ECOLOGICAL ROLE	PiP, SiS	**Diversity of Obligate Species (DOS)** {obligate species, mutualisms, symbionts, interspecific dependencies}	High	Diffuse interactions; no obligations noted.	Low
ABIOTIC NICHE	PiP, SiS	**Seasonal Phenology (SP)** {phenology, seasonal behavior, life cycle, timing}	Moderate	Year to year variability in adult emergence indicates some limited ability to adjust to environmental cues (i.e. air and soil temperature) but also linked to moon phase. Environmental cues for immature stages of the beetle are unknown.	Low

ABIOTIC NICHE	PiP, SiS	**Climatic Niche Breadth (CNB)** {climatic niche, niche, climatic tolerances, climate change}	Low	Habitat tied to alluvial fans and hydrological flows which may be more extreme and delayed due to periods of extended drought or potentially more frequent altering the disturbance regime that the beetle is adapted to (Hopkins 2018, entire).	Moderate
ABIOTIC NICHE	PiP, SiS	**Physiological Tolerances (PT)** {physiological tolerances, physiology, thermal tolerance, thermal optima, stress response, phenotypic plasticity}	Moderate	Lack of information regarding tolerance limits but recent extremes in precipitation and temperature suggest sublethal effects, particularly for immature stages that have the potential to burrow deeper in the soil to offset temperature increases. Similarly, population persisted following extreme flood events. However, we do not have data for extended periods of drought.	Low

ABIOTIC NICHE	PiP	**Behavioral Regulation of Physiology (BRP)** {behavior, flexibility, activity, exposure}	Moderate	Reduced male activity on windy days indicates that individuals assess and respond to environmental cues. We suspect that subterranean stages may be able to move within the soil column to ameliorate temperature extremes, but we lack information to confirm this hypothesis.	Low
LIFE HISTORY	PiP	**Reproductive Phenology (RP)** {phenology, seasonal behavior, life cycle, timing, reproduction, breeding, mating, life history}	Moderate	Similar to Seasonal Phenology above as reproduction is tied to adult emergence. Evidence of a shift in peak emergence and varying end dates indicate some flexibility to changes in abiotic conditions (Harju 2021, entire).	Moderate
LIFE HISTORY	PiP	**Reproductive Mode (RM)** {reproductive mode, reproduction, breeding, mating, sexual, asexual, parity, life history}	Moderate	Oviparity (female lays eggs) is typical in beetles although a few have been discovered to be ovoviviparous (live births)	High. No specific evidence for CJB but generally accepted for beetles.
LIFE HISTORY	PiP	**Mating System (MS)** {mating system, reproduction, breeding, mating, life history}	Moderate	Polygamy but we do not know if females have multiple mates.	Low

LIFE HISTORY	PiP	**Fecundity (F)** {fecundity, offspring, eggs, propagules, life history}	Moderate	We do not know how many eggs a female lays, assumed to be <10.	Very Low
LIFE HISTORY	PiP	**Parity (P)** {parity, reproduction, life cycle, life history}	Low	Semelparous (single reproductive event)	Low
LIFE HISTORY	PiP	**Sex Ratio (SR)** {sex ratio, males, females, males to females, sex-biased survival, male-biased, female-biased}	Low	Unknown. Anecdotal information suggesting a potential male sex bias based on the low number of females observed; however, that may be due to the short time period that they are above ground.	Very Low
LIFE HISTORY	PiP	**Sex Determination (SD)** {sex determination, chromosomes}	High	Chromosomal	High
LIFE HISTORY	PiP	**Parental Investment (PI)** {parental care, rearing, altricial, precocial, altruism, offspring, energetics}	High	Precocial. Offspring are capable of feeding themselves.	High

DEMOGRAPHY	PiP, SiS	**Life Span (LS)** {life span, longevity, life expectancy, mortality, survival, survivorship, demography, demographics}	High	1 year.	Low
DEMOGRAPHY	PiP, SiS	**Generation Time (GT)** {generation, maturity, reproduction, population growth, demography, demographics}	High	1 year.	Low
DEMOGRAPHY	PiP, SiS	**Age of Sexual Maturity (ASM)** {age of sexual maturity, age at recruitment, maturation, maturity, reproduction, population growth, demography, demographics, life history}	Low	Reproduction in last month of lifecycle.	Low
DEMOGRAPHY	PiP, SiS	**Age Structure (AS)** {age structure, age class, population growth, demography, demographics}	NA. Essentially an annual species.		

DEMOGRAPHY	PiP, SiS	**Recruitment (R)** {recruitment, survival, survivorship, demography, demographics, juvenile, population growth}	Unknown	We have no age/stage-based survivorship information.	Very Low

APPENDIX C - HABITAT IMPACTS SINCE LISTING

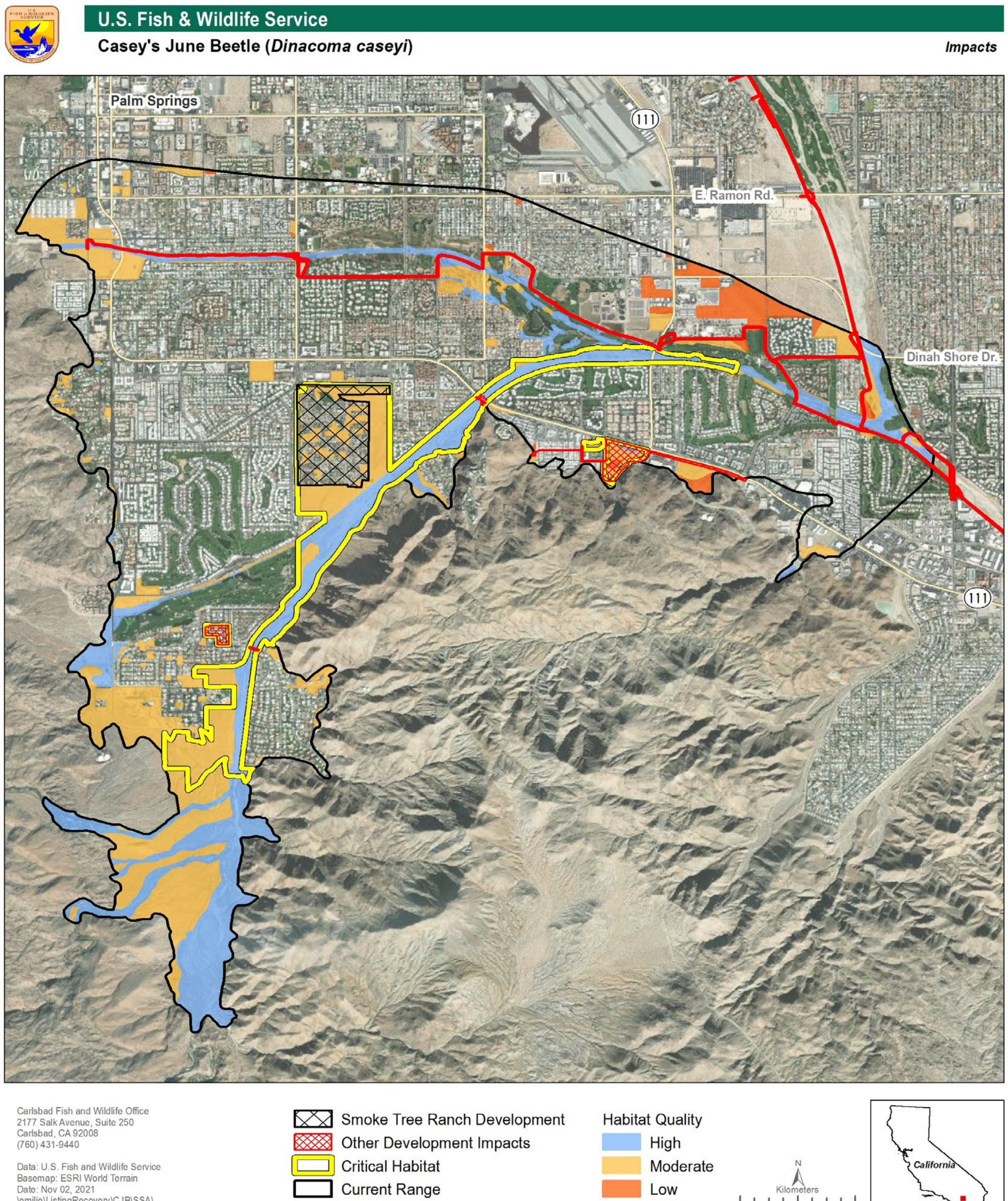


Figure C-1. Distribution of habitat impacts since Casey's June beetle was listed in 2011.[24]

---

[24] Smoke Tree Ranch was preexisting but a HCP was signed to cover their activities after the species was listed.

APPENDIX D - REGULATORY MECHANISMS

D.1 Federal

Less than 1 percent of the land within the distribution of Casey's June beetle is federally owned (Table 7-1). However, a substantial portion of the watershed that supports Palm Canyon Wash and Tahquitz Creek is owned and managed by the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). Management of these areas depends on the agency, based on each agency's respective regulatory framework, though some existing regulatory mechanisms are not agency-specific, as described below. Additionally, the Army Corps of Engineers regulates the creeks and alluvial fans where the species occurs that meets the definitions of waters of the United States under the Clean Water Act.

D.1.1 National Environmental Policy Act

All Federal agencies are required to comply with the National Environmental Policy Act (NEPA) of 1970 (as amended; 42 USC §§ 4321 *et seq*.), which is a procedural statute. Prior to implementation of projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. If an Environmental Impact Statement is prepared for an agency action, the agency must provide a full and fair discussion of significant environmental impacts and inform decision makers and the public of reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the human environment (40 CFR § 1502.1). The public notice provisions of NEPA provide an opportunity for interested parties to review proposed actions and provide recommendations to the implementing agency. The NEPA process provides the opportunity for lead agencies and the public to recommend avoidance and minimization for impacts to Casey's June beetle.

D.1.2 Federal Land Policy and Management Act of 1976

The Federal Land Policy and Management Act (FLPMA) (as amended; 43 USC §§ 1701-1785) authorizes the BLM to manage public lands under the principles of multiple use and sustained yield. Section 202 of FLMPA directs the BLM to prepare resource management plans (RMPs) that establish the basis for actions and approved uses on public lands for specific planning areas. Through these plans, habitat for all federally listed or State listed species will be managed to maintain or increase current species populations. BLM has also issued policy guidance to implement its obligations under FLPMA. These include BLM's Integrated Vegetation Management Handbook H-1740-2, which guides BLM's various programs to use an interdisciplinary and collaborative process to plan and implement a set of actions that improve biological diversity and ecosystem function that promote and maintain native plant communities that are resilient to disturbance and invasive species, and BLM's Travel and Transportation Handbook H-8342, which clarifies policies and establishes procedures for implementing travel and transportation planning and management in land use and implementation plans. Additionally, BLM Manual Section MS-6840, Release 6-125 provides guidance with respect to sensitive species managed as a BLM sensitive species which are defined as "species that require special management or considerations to avoid potential future listing". Under this policy, BLM initiates proactive conservation measures including programs, plans, and management practices to reduce or eliminate threats affecting the status of the species or improve the condition of the species' habitat on BLM-administered lands.

D.1.3 Clean Air Act

The Clean Air Act (CAA) amended in 1990 regulates air emissions from both stationary (e.g., factories and chemical plants) and mobile sources (e.g., cars, trucks, and off-road vehicles) to protect public health and regulate hazardous air pollutants. The CAA sets standards for greenhouse gas emissions associated with global warming, and fuel economy standards to reduce the use of fossil fuels. Although these regulations may contribute toward reduced greenhouse gas emissions in the United States, they are unlikely to alter the trajectory of projected climate change and potential climate change impacts to Casey's June beetle that are ultimately tied to global emission rates.

D.1.4 National Forest Management Act

The National Forest Management Act (NFMA) (16 U.S.C. § 1600 *et seq.*) requires the USFS to develop a planning rule under the principles of the MUSY of 1960 (16 U.S.C. 528–531). The NFMA outlines the process for the development and revision of the land management plans and their guidelines and standards [16 U.S.C. 1604(g)].

A new National Forest System (NFS) land management planning rule (Planning Rule) was adopted by the USFS in 2012 (77 FR 21162; April 9, 2012). The new Planning Rule guides the development, amendment, and revision of land management plans for all units of the NFS to maintain and restore NFS land and water ecosystems while providing for ecosystem services and multiple uses. Land management plans (also called Forest Plans) are designed to: (1) provide for the sustainability of ecosystems and resources; (2) meet the need for forest restoration and conservation, watershed protection, and species diversity and conservation; and (3) assist the USFS in providing a sustainable flow of benefits, services, and uses of NFS lands that provide jobs and contribute to the economic and social sustainability of communities (77 FR 21261; April 9, 2012). A land management plan does not authorize projects or activities, but projects and activities must be consistent with the plan (77 FR 21261; April 9, 2012). The plan must provide for the diversity of plant and animal communities, including species-specific plan components in which a determination is made as to whether the plan provides the "ecological conditions necessary to . . . contribute to the recovery of federally listed threatened and endangered species . . ." (77 FR 21265; April 9, 2012).

The Record of Decision for the final Planning Rule was based on the analyses presented in the Final Programmatic Environmental Impact Statement, National Forest System Land Management Planning (77 FR 21162–21276; April 9, 2012), which was prepared in accordance with the requirements of the NEPA. In addition, the NFMA requires land management plans to be developed in accordance with the procedural requirements of the NEPA, with a similar effect as zoning requirements or regulations as these plans control activities on the national forests and are judicially enforceable until properly revised (Wilkinson and Anderson 2002, entire).

A Species of Special Concern (SSC) is defined in the 2012 Planning Rule and in regulation [36 CFR 219.9(c)], as "a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area." The 2012 Planning Rule requires Regional Foresters to identify SCC for plan revision, and, when identified for a National Forest, monitoring plans are changed as needed (77 FR 21250, 21267; April 9, 2012).

D.1.5 Organic Administration Act of 1897 and the Multiple-Use, Sustained-Yield Act of 1960

The USFS Organic Act of 1897 (16 U.S.C. 475–482) established general guidelines for administration of timber on USFS lands, which was followed by the Multiple-Use, Sustained-Yield Act (MUSY) of 1960 (16 U.S.C. 528–531), which broadened the management of USFS lands to include outdoor recreation, range, watershed, and wildlife and fish purposes.

D.1.6 Endangered Species Act of 1973, as Amended (Act)

The Endangered Species Act of 1973, as amended (Act) (16 USC §1531 et seq.), is the Federal law that provides the most significant protection for Casey's June beetle. The purpose of the Act is to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved. The Service and the National Marine Fisheries Service (NMFS) of the Department of Commerce's National Oceanic and Atmospheric Administration share responsibility for implementing the Act. Generally, Service manages land and freshwater species, while NMFS manages marine and anadromous species. We address the Service's role herein. Upon its listing as an endangered species in 1986, the least Bell's vireo benefited from the protections of the Act, which include the following provisions.

Section 9 of the Act and Federal regulations prohibit the take of endangered and threatened species without special exemption. The Act defines take as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. 1532(19)). Our regulations define harm as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 CFR 17.3). Our regulations further define harass as "intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR 17.3).

Section 7(a)(1) of the Act requires all Federal agencies to utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered species and threatened species. Section 7(a)(2) of the Act requires Federal agencies, in consultation with the Service, to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species or destroy or adversely modify their critical habitat. Depending on the circumstances of the action, the consultation process may result in the Service issuing a biological opinion that addresses (1) whether the action will jeopardize the species or adversely modifies critical habitat, if any, and (2) statement addressing any incidental take of the species from the action. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and 7(o)(2) of the Act, taking that is incidental to and not intended as part of the proposed Federal action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an incidental take statement provided to the action agency by the Service.

Impacts and potential impacts to Casey's June beetle and/or its critical habitat have been addressed by section 7(a)(2) consultations since the species was listed. Several of the consultations involved Federal actions associated with implementation of section 404 of the Clean Water Act (see below) because the creeks and alluvial fans where the beetle and its habitat occur are associated with waters of the U.S., as interpreted under the Clean Water Act.

Under section 10(a)(1)(B) of the Act, the Service may permit, with terms and conditions, any taking otherwise prohibited by section 9 if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity by non-Federal applicants. To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved Habitat Conservation Plan (HCP) that details measures to avoid, minimize, and mitigate the project's adverse impacts to the listed species. Two HCPs in the region were developed in accordance with the State of California's NCCP Act (see below) that have measures that benefit the beetle, but Casey's June beetle is not a covered species.

Section 6 of the Act is implemented through the Cooperative Endangered Species Conservation Fund. This fund provides grants to States and Territories for species and habitat conservation actions on non-Federal lands. States and Territories must contribute a minimum non-Federal match of 25 percent of the estimated program costs of approved projects, or 10 percent when two or more States or Territories implement a joint project. A State or Territory must currently have a cooperative agreement with the Secretary of the Interior to receive grants, which the State of California has. The types of Cooperative Endangered Species Conservation Fund grants include the following: (1) Traditional Conservation Grants, which provides financial assistance to conservation projects for listed, candidate, and at-risk species; (2) Conservation Planning Assistance Grants, which supports the development, renewal or amendment of habitat conservation plans, safe harbor agreements, and candidate conservation agreements with assurances; (3) Habitat Conservation Plan (HCP) Land Acquisition Grants, which support acquisition of land associated with approved HCPs; and (4) Recovery Land Acquisition Grants, which supports acquisition of habitat for endangered and threatened species in support of draft and approved recovery plans. Implementation of section 6 in cooperation with State of California has contributed to the conservation benefit of the Casey's June beetle through the acquisition of land in potentially suitable beetle habitat.

D.1.7 Clean Water Act (CWA)

The Clean Water Act (CWA) (33 U.S.C. §§ 1251–1387) regulates discharges of pollutants into the waters of the United States and regulates quality standards for surface waters. Under section 404 of the CWA, the U.S. Army Corps of Engineers (Corps) regulates the discharge of dredged or fill material into the waters of the United States, including certain wetlands (33 U.S.C. 1344). Any action with the potential to impact the waters of the United States must be reviewed under the CWA and National Environmental Policy Act, which as a Federal action, is subject to review under section 7 of the Act should it also adversely affect a listed species or its critical habitat. In general, the term wetland refers to areas meeting the Corps' criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands) with specific definitions in the arid west supplement applied to desert regions. The interpretation of what constitutes "waters of the United States," and thus what falls under Federal jurisdiction, has ranged in scope over time. When taken broadly, Federal agencies interpret the waters of the United States to include not only traditional navigable waters and wetlands, but also smaller, more isolated streams and wetlands adjacent to or hydrologically connected with traditional navigable waters. Over the years, in Southern California especially, section 404 permits under the CWA have also included section 7 consultations under the Act that addressed potential impacts to the beetle or its critical habitat.

D.2 State

The following State regulations minimize impacts to Casey's June beetle.

D.2.1 California Environmental Quality Act

Casey's June beetle is not provided protections under the California Endangered Species Act; but the alluvial fan habitat where it occurs is regulated by the California Department of Fish and Wildlife (CDFW) under the Lake and Streambed Alteration Program (see below) and should be considered during the environmental review process under the California Environmental Quality Act (CEQA; California Public Resources Code §§ 21000-21177). Similar to the Federal NEPA, the CEQA requires State agencies, local governments, and special districts to evaluate and disclose impacts from "projects" in the State. Section 15380 of the CEQA Guidelines indicates that California SCCs should be included in an analysis of project impacts if they can be shown to meet the criteria of sensitivity outlined therein.

D.2.2 Lake and Streambed Alteration Program

California Fish and Game Code Sections 1600-1616 requires that a streambed alteration agreement is needed for actions that may (1) substantially divert or obstruct the natural flow of any river, stream, or lake; (2) substantially change or use any material from the bed, channel, or bank of any river, stream, or lake; or (3) deposit debris, waste, or other materials that could pass into any river, stream, or lake. A streambed alteration agreement is a discretionary permit issued by CDFW. CDFW must be notified before starting any project or activity that will. Streambed alteration agreements contains avoidance, minimization and/or mitigation measures to protect fish and wildlife and their habitat. Casey's June beetle and its habitat has benefited from ongoing implementation of the State's Lake and Streambed Alteration Program.

D.2.3 California Climate Policies

The State of California has a number of policies and regulations to help reduce greenhouse gas emissions through the State's climate adaptation and resiliency plan, reduced emissions, promotion of electrical vehicles, and penalties for polluters. Senate Bill (SB) 32 and Assembly Bill (AB) 32 require California to reduce emission and develop policies to meet stated goals and California's climate registry catalogs and verifies greenhouse gas emission reductions (SB 1771). Legislation has been adopted to require energy procurement from renewable resources, improve energy efficiency of existing buildings, and promote investment in electric vehicle charging infrastructure (SB 100; SB 350; AB 1236). Transportation legislation includes improvements in efficiency, emission reduction (SB 1), and to mitigate the vehicle miles traveled associated with new development (SB 375). AB 617 increases air monitoring and penalties for polluters who exceed limitations in vulnerable communities and projects are funded in disadvantaged communities by directing funding from cap-and-trade revenues (SB 535; AB 1550). The State's climate adaptation and resiliency strategy is called for in several bills (AB 1482; SB 246; SB 379; AB 2800; SB 1035; and SB 30) which require state agencies to account for climate change in planning new construction, including oversight and reporting (AB 197). State law set emission standards for passenger vehicles (AB 1493). Legislation requires a strategy for reducing short-lived climate pollutant such as methane (SB 605; SB 1383).

D.3 Jurisdiction Specific Policies and Ordinances

The following policies and ordinances outline measures to that benefit Casey's June beetle or its habitat.

Agua Caliente Tribal Habitat Conservation Plan

The Agua Caliente Band of Cahuilla Indians Tribal Habitat Conservation Plan (THCP) continues the Tribe's traditional use and stewardship of reservation lands while streamlining permitting requirements for protected species. The THCP preserve system includes the Tribal Reserve, designated as open space, and Rural Residential (1 unit/20 ac) zoning with a goal of 85 percent or greater conservation across 614 ac (Helix 2010, Figure 6 and 29; 248 ha; Malcolm 2023, pers. comm.). These designations, particularly in the southern portion of the species current distribution, will reduce the potential for habitat loss and degradation and support hydro geomorphological processes in the watershed that maintain Casey's June beetle habitat.

City of Palm Springs General Plan

In coordination with the goals of the MSHCP, the City of Palm Springs General Plan designates open space and along natural landforms and hillsides to protect the desert character the City is known for (City of Palm Springs 2007, 2-1 to 2-11). The Open Space-Water designation reduces the potential for habitat destruction within suitable habitat for the beetle, such as Palm Canyon Wash and Tahquitz Creek, that fall within the 100-year flood zone. No structures are allowed within these areas. Low density development is allowable within Open Space-Conservation at a maximum of 1 unit per 20 acres; and the beetle is known to occupy other low-density developments such as Smoke tree Ranch. However, no specific management is afforded to these habitat areas.

APPENDIX E - DISTRICT MAINTENANCE ACTIVITIES

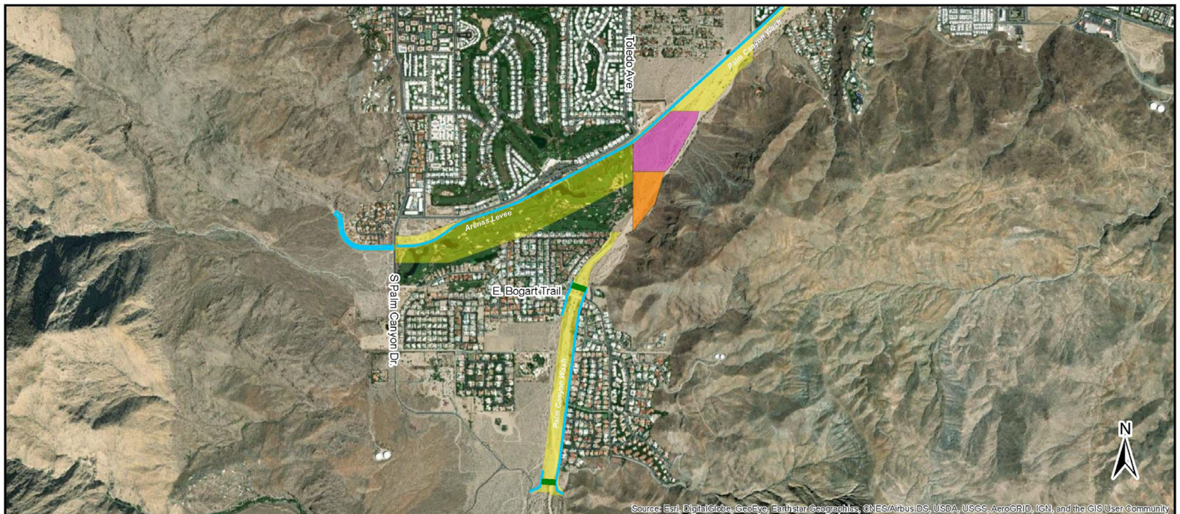


Figure 5a:
Palm Canyon Wash (West)
Flood Control Facility
Maintenance Activities

Casey's June Beetle
Programmatic Biological Opinion
Flood Control
Facility Maintenance

RIVERSIDE COUNTY FLOOD CONTROL
AND WATER CONSERVATION DISTRICT

Palm Canyon Wash Maintenance Activities

Maintenance Activity	Color	Potential Maximum Work Area	Typical Work Area
Access Road Repairs		3.3 Hectares (8.2 Acres)	0.4 Hectares (1.0 Acres)
Vegetation Trimming		3.3 Hectares (8.2 Acres)	1.41 Hectares (3.5 Acres)
Channel Mowing		56.3 Hectares (139 Acres)	0.8 Hectares (2.0 Acres)
Fence Repair		0.5 Hectares (1.3 Acres)	0.008 Hectares (0.02 Acres)
Trash and Debris Removal/ Homeless Cleanup	All	2.8 Hectares (7.0 Acres)	1.62 Hectares (4.0 Acres)
Rock Slope Repair		0.2 Hectares (0.4 Acres)	0.16 Hectares (0.4 Acres)
Concrete Levee Repair		11.3 Hectares (28.0 Acres)	2.4 Hectares (6.0 Acres)
Washout Repair		3.2 Hectares (7.8 Acres)	2.0 Hectares (5.0 Acres)
Drop Structure Rehabilitation and/or Replacement		1.2 Hectares (3.0 Acres)	0.4 Hectares (1.0 Acres)
Herbicide Treatment	All	56.3 Hectares (139 Acres)	2.8 Hectares (7.0 Acres)
Sediment Removal		56.3 Hectares (139 Acres)	18.0 Hectares (44.0 Acres)
Conservation Easement		5.3 Hectares (13.2 Acres)	5.3 Hectares (13.2 Acres)
Deed Restriction		10.8 Hectares (26.6 Acres)	10.8 Hectares (26.6 Acres)

*Acreages include both east and west Palm Canyon Wash.

Figure E-1. Map of proposed District flood maintenance activities in the upstream portion of the Palm Canyon Wash floodplain included in the programmatic biological opinion (USFWS 2023, entire).

Figure 5b:
Palm Canyon Wash East
Flood Control Facility
Maintenance Activities

Casey's June Beetle
Programmatic Biological Opinion
Flood Control
Facility Maintenance

RIVERSIDE COUNTY FLOOD CONTROL
AND WATER CONSERVATION DISTRICT

Palm Canyon Wash Maintenance Activities

Maintenance Activity	Color	Potential Maximum Work Area	Typical Work Area
Access Road Repairs		3.3 Hectares (8.2 Acres)	0.4 Hectares (1.0 Acres)
Vegetation Trimming		3.3 Hectares (8.2 Acres)	1.41 Hectares (3.5 Acres)
Channel Mowing		56.3 Hectares (139 Acres)	0.8 Hectares (2.0 Acres)
Fence Repair		0.5 Hectares (1.3 Acres)	0.008 Hectares (0.02 Acres)
Trash and Debris Removal/ Homeless Cleanup	All	2.8 Hectares (7.0 Acres)	1.62 Hectares (4.0 Acres)
Rock Slope Repair		0.2 Hectares (0.4 Acres)	0.16 Hectares (0.4 Acres)
Concrete Levee Repair		11.3 Hectares (28.0 Acres)	2.4 Hectares (6.0 Acres)
Washout Repair		3.2 Hectares (7.8 Acres)	2.0 Hectares (5.0 Acres)
Drop Structure Rehabilitation and/or Replacement		1.2 Hectares (3.0 Acres)	0.4 Hectares (1.0 Acres)
Herbicide Treatment	All	56.3 Hectares (139 Acres)	2.8 Hectares (7.0 Acres)
Sediment Removal		56.3 Hectares (139 Acres)	18.0 Hectares (44.0 Acres)
Conservation Easement		5.3 Hectares (13.2 Acres)	5.3 Hectares (13.2 Acres)
Deed Restriction		10.8 Hectares (26.6 Acres)	10.8 Hectares (26.6 Acres)

*Acreages include both east and west Palm Canyon Wash.

Figure E-2. Map of proposed District flood maintenance activities in the downstream portion of Palm Canyon Wash floodplain included in the programmatic biological opinion (USFWS 2023, entire).

APPENDIX F - ESTIMATED AVAILABLE HABITAT IMPACTED BY ARTIFICAL LIGHT

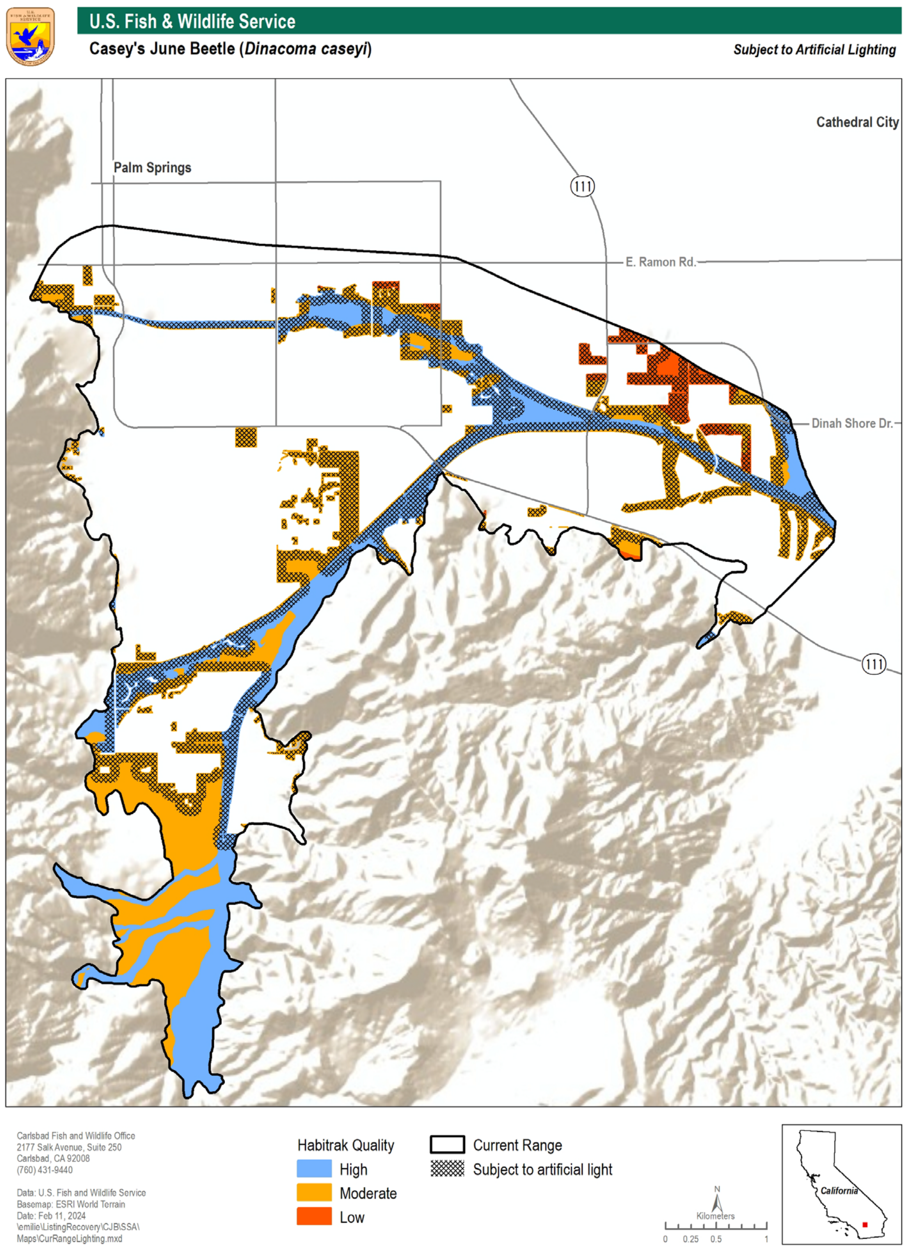


Figure F-1. Estimate of area of the current range subject to the impacts of artificial light. [25]

---

[25] Figure does not account for the effects of swimming pools.

APPENDIX G - ABUNDANCE ANALYSIS

Analyses to assess the probability of capturing an individual male assuming it has emerged and is present within the trap area based on rangewide survey data, using dynamic N-mixture abundance modeling of unmarked populations (Harju 2021, entire).

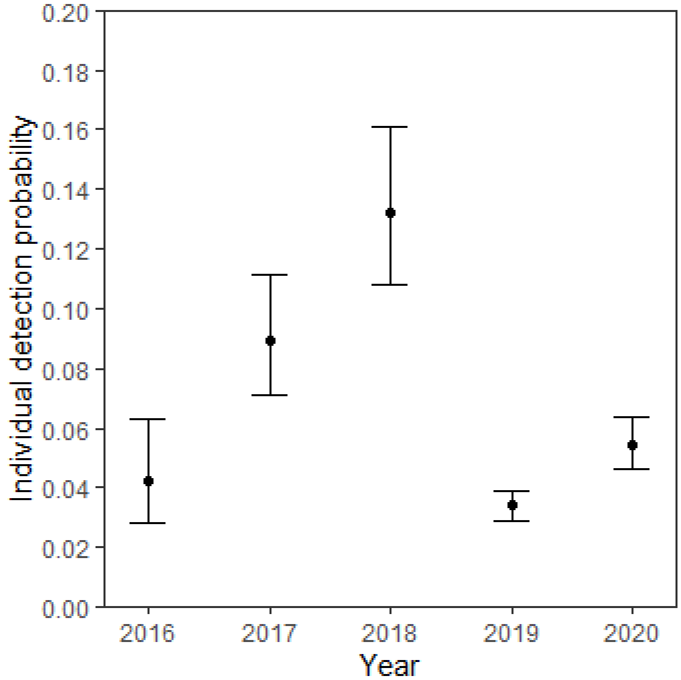


Figure G-1. Yearly probability of detecting (i.e., capturing) an individual male Casey's June beetle, given that it has emerged and is present in the trapping area.[26]

[26] Error bars are 95 percent confidence intervals (Harju 2021, p. 12).

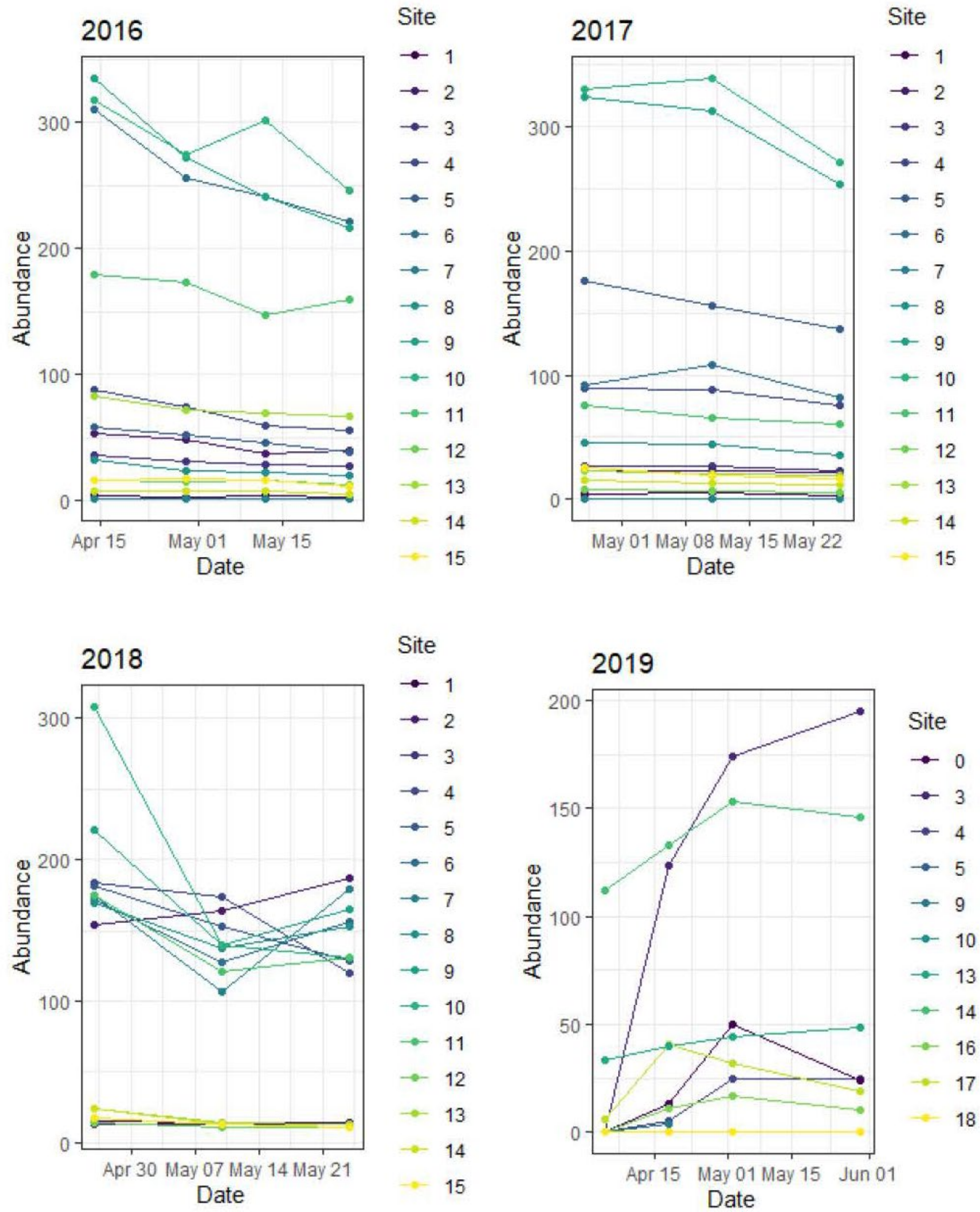


Figure G-2. Within-year estimated corrected abundance at each trap site, after accounting for imperfect detection of individual male Casey's June beetles within a given evening.[27]

---

[27] Abundance is the estimated number of male beetles with activity areas overlapping each trap site on a given night. Estimated abundance in 2020 is not provided because of convergence errors for the estimates. Note variable y-axes (Harju 2021, p. 14).