Orangeblack Hawaiian Damselfly
(*Megalagrion xanthomelas*)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawai‘i

5-YEAR REVIEW

Species reviewed: Orangeblack Hawaiian Damselfly (*Megalagrion xanthomelas*)

TABLE OF CONTENTS

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1.0 GENERAL INFORMATION

1.1 Reviewers

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John Vetter, Animal Recovery Coordinator, PIFWO
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Lead Field Office: Region 12, Pacific Islands Fish and Wildlife Office, Honolulu, HI

Cooperating Field Office(s):
N/A

Cooperating Regional Office(s):
N/A

1.2 Methodology used to complete the review:

This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS), beginning on January 7, 2021. The review is based on the final rule to list the orangeblack Hawaiian damselfly, the draft Kaua‘i islandwide recovery plan completed in September of 2019, the recovery outline for Hawaiian multi-island species signed on July 30, 2020, the orangeblack Hawaiian damselfly species report completed in August of 2020, current published and unpublished materials, and expert opinions and knowledge on the *Megalagrion xanthomelas* species. The draft 5-year review was then reviewed by John Vetter, the Animal Recovery Coordinator, and Megan Laut, the Conservation and Restoration Team Manager..

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2019a. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon, Washington, Hawai‘i, and American Samoa. Federal Register 84 (112): 27151–27154.

1.3.2 Listing history

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; endangered status for 49 species from the Hawaiian Islands. Federal Register 81 (190): 67786-67860.
Date listed: September 30, 2016
Entity listed: Species
Classification: Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.3.3 Associated rulemakings: N/A

1.3.4 Review History: N/A

1.3.5 Species' Recovery Priority Number at start of this 5-year review: 5

1.3.6 Current Recovery Plan or Outline

[USFWS] U.S. Fish and Wildlife Service. 2019b. Draft Kauaʻi Islandwide Recovery Plan. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaiʻi. 43 pp. https://ecos.fws.gov/docs/recovery_plan/Draft_KIRP_Hyperlinks_20200424.pdf.
Name of plan or outline: Draft Kauaʻi Islandwide Recovery Plan
Date issued: September 2019
Dates of previous revisions, if applicable: N/A

[USFWS] U.S. Fish and Wildlife Service. 2020. Recovery Outline for Hawaiian Multi-Island Species. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaiʻi. 36 pp. https://ecos.fws.gov/docs/recovery_plan/SIGNED_Multi-Island_recovery_outline_07-30-2020_1.pdf.
Name of plan or outline: Recovery Outline for Hawaiian Multi-Island Species
Date issued: July 30, 2020
Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

_____ *Yes*
__X_ *No*

2.1.2 Is the species under review listed as a DPS?

____ *Yes*
_X__ *No*

2.1.3 Was the DPS listed prior to 1996?

____ *Yes*
____ *No*

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

____ *Yes*
____ *No*

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

____ *Yes*
____ *No*

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____ *Yes*
__X_ *No*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

____ *Yes*
_X__ *No*

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

____ *Yes*
____ *No*

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery?

____*Yes*
____*No*

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:
No final recovery plan including recovery criteria for *Megalagrion xanthomelas* has been developed by the time of the completion of this 5-year review.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:
The orangeblack Hawaiian damselfly is a lowland species that occupies a wide range of habitats (e.g. anchialine pools, coastal, and wetland ecosystems) and has broad ecological tolerances (Polhemus and Asquith 1996, p. 91). However, *Megalagrion xanthomelas* is most commonly found sheltering in the vegetation along the borders of low elevation streams and coastal wetlands, particularly those fed by basal springs (Polhemus and Asquith 1996, p. 91). They can also be found breeding along terminal and lower mid-reaches of perennial streams. If fish and other aquatic predators are not present, *M. xanthomelas* can also breed in reservoirs and ornamental ponds, as documented at the old Lodge at Kōʻele (now Four Seasons Hotel Lānaʻi at Kōʻele) on Lānaʻi (Polhemus and Asquith 1996, p. 91). This species can also exploit temporary habitats, such as ephemeral side pools bordering flashy streams on the island of Hawaiʻi and pipeline seepages on Lānaʻi (Polhemus and Asquith 1996, p. 91).

Megalagrion xanthomelas is typically observed at lower elevations (between 0–200 feet (ft) [61 meters (m)]) but has been spotted up to 2,000 ft (610 m) (Polhemus and Asquith 1996, p. 92). Results from salinity readings at Palaʻau, Molokaʻi demonstrate that individuals at this location could tolerate concentrations of at least 2 parts per thousand (ppt), and may be able to tolerate salinity as high as 8 ppt (Polhemus and Asquith 1996, p. 92).

Anchialine pools provide breeding habitat for *Megalagrion xanthomelas*, but only if sufficient freshwater inflow is present (Tango 2010, p. 11). In brackish waters, naiads are likely osmoregulators that either maintain or regulate their internal fluids within a narrow range even when salinity fluctuates (Tango 2010, p. 11). However, if the salinity exceeds the osmoregulating ability of *M. xanthomelas* (>15 ppt), the naiad may experience lethal or sub-lethal stress such as changes in growth, development, or feeding (Tango 2010, pp. 11-12, 32). *Megalagrion xanthomelas* has also been found to tolerate water temperatures ranging from 63°F to 88°F (17.5°C to 31°C) but prefers temperatures ranging from 68°F to 82°F (20°C to 28°C), and with pH's ranging from 6.5 to 9.5 (Polhemus and Asquith 1996, p. 92; Johnson 2001, p. 45; Haines 2020a, in litt). While *M. xanthomelas* appears to tolerate the presence of carp and apple snails, it does not do well in habitats containing guppies or top minnows (Polhemus and Asquith 1996, p. 92).

In the period after emergence but before reaching reproductive maturity (~20 days), it is generally unknown where adult damselflies (particularly females) go when they are not near their breeding habitats (stream, riparian vegetation) (Haines 2020b, in litt.). The relative rarity of females compared to males during surveys suggests that females spend most of their time away from aquatic habitats (perhaps as much as several hundred meters) in surrounding riparian forest habitat (Haines 2020b, in litt.). Corbet (1999, pp. 271–272) noted that other tropical damselfly species utilize multiple forest habitats, such as canopy and crowns of forest trees, strata close to the forest floor, and forest margins, but the distance from water varies by species (Haines 2020b, in litt.). While a related species, *Megalagrion blackburni*, has been documented as much as 0.25 miles (mi; 0.4 kilometer [km]) away from their breeding habitat, surveys and monitoring of *M. xanthomelas* populations suggest that they do not move great distances away from their breeding habitat. While we still do not know the extent to which *M. xanthomelas* uses the surrounding riparian vegetation, the surrounding habitat likely provides a necessary post-emergence, pre-breeding refugium for this species (Polhemus 2020, in litt.).

The orangeblack Hawaiian damselfly appear to be generalists at all stages (Haines 2020c, in litt). As in most species of Hawaiian damselflies, the immature larval stages (naiads) are aquatic, breathing through three flattened abdominal gills, and are predacious (Williams 1936, p. 303). *Megalagrion xanthomelas* naiads are passive predators with exceptional vision, stalking live prey that swim or crawl within reach (Evenhuis et al. 1995, p. 18). Early stage naiads consume small zooplankton such as cladocerans, copepods, and ostracods while late stage naiads consume larger zooplankton and a variety of aquatic invertebrates (Haines 2020c, in litt). Typical adult damselflies form a basket with their spiny legs to capture prey while flying or will perch and pounce on prey (Polhemus and Asquith 1996, p. 7). *Megalagrion xanthomelas* has been observed eating fruit flies, mosquitos, crane flies, small moths, leafhoppers, plant bugs, and sometimes other species of damselflies (Haines 2020c, in litt). The orangeblack Hawaiian damselfly has also been observed feeding on conspecifics, however, this does not appear to be a common occurrence (Haines 2020c, in litt).

Over their lifetime, male and female *Megalagrion xanthomelas* mate with multiple partners. When male *M. xanthomelas* are sexually mature, they fly to a stream and establish a territory, usually with light gaps along the stream corridor containing resting sites (Johnson 2001, p. 7). Males are territorial and guard areas of habitat where the female lays eggs (Moore 1983, p. 89). During copulation, and often while the female lays eggs, the male grasps the female behind the head with terminal abdominal appendages to guard the female against rival males; thus males and females are frequently seen flying in tandem. After mating, the male continues to grasp the female with his abdomen and will remain with her until the eggs are laid to prevent other males from mating with the female (Haines 2020c, in litt). The eggs (typically several hundred) are deposited in the tissues of aquatic plants such as honohono grass (*Commelina diffusa*), white shrimp plant (*Justica betonica*), ivy gourd (*Coccinia grandis*), ‘ae‘ae (*Bacopa monnieri*), and lily pads through an incision cut in the vegetation (Polhemus and Asquith 1996, p. 91; Johnson 2001, p. 41; Haines 2019, in litt). After the eggs are laid, the male and female separate and the female will usually fly away from the stream (Haines 2020c, in litt). It takes a few more days for additional eggs to mature, at which point, the female is ready to mate again with a new male (or may use stored sperm from the previous encounter to fertilize a new batch of eggs) (Haines 2020c, in litt). Eggs hatch after a 21-day incubation period and the developing naiad undergoes 11–17 instar stages, lasting 103–111 days, before emerging as tenerals (Johnson 2001, p. 8). Naiads of *M. xanthomelas* also behave similarly to *Megalagrion pacificum*, as these larvae tend to swim to the surface when disturbed (Englund 1999, p. 232). At the time of adult emergence, tenerals (newly emerged adults) are approximately 0.7–0.8 inch (in; 18-20 millimeters (mm)) in size. After they emerge, both male and female *M. xanthomelas* fly away from the stream and move to adjoining terrestrial habitats where they prey on small flying insects (Johnson 2001, p. 7). Adults have been documented to fly around for about 20 days before they are reproductively mature (Haines 2020a, in litt).

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

The orangeblack Hawaiian damselfly was once Hawai‘i’s most abundant damselfly species, found on all of the main Hawaiian islands, except Kaho‘olawe. (USFWS 2016, p. 67817). Although there are no quantitative population estimates for this species, *Megalagrion xanthomelas* is now only found on the islands of Hawai‘i, Maui, Moloka‘i and O‘ahu. *Megalagrion xanthomelas* is now considered extirpated from Kaua‘i (Polhemus and Asquith 1996, p. 91) and Lāna‘i (Polhemus and Haines

2020, entire). The status of the population on Niʻihau is unknown. Populations on Molokaʻi and Hawaiʻi are considered locally abundant. The three populations on Maui are still extant but not abundant. Until recently, the last report of the orangeblack Hawaiian damselfly on Oʻahu was in 1935 (Williams 1936, p. 310), and it was believed extirpated on this island (Polhemus 1993, pp. 344, 346). In 1994, a very small population was discovered existing in pools of an intermittent stream at the Tripler Army Medical Center (TAMC) (Englund 2001, p. 256). Aside from translocated populations set out by the State of Hawaiʻi Division of Forestry and Wildlife (DOFAW), *M. xanthomelas* at TAMC is still the only known naturally occurring population remaining on Oʻahu.

The U.S. Fish and Wildlife in partnership DOFAW, the University of Hawaiʻi, the Bishop Museum, and U.S. Army's Natural Resources Program have been working on re-establishing populations of *Megalagrion xanthomelas* on Oʻahu through translocations and a captive propagation program. Within the last 25 years, conservation efforts have included site suitability testing and more recently, translocation releases in the Dillingham Military Reservation, Waiʻanae Kai Forest Reserve, Lyon Arboretum, and at a site adjacent to the remaining wild population at TAMC. Some challenges to establishing a successful translocated population have included predators such as non-native fish in adjacent streams or ponds creating population sinks, storms, and environmental conditions that are not conducive for early life history stages (HDLNR 2014, in litt).

Two recent surveys of Molokaʻi (Polhemus and Haines 2020, entire) and Lānaʻi (Polhemus et al. 2020, entire) offer extensive insights into the populations on both islands. In a 2020 re-survey of four sites on Molokaʻi known to host *Megalagrion xanthomelas*, this species was still found in most historical sites (Polhemus and Haines 2020, p. 18). No *M. xanthomelas* were found at the original site at Kainalu Stream, which is now channelized and fenced, but adjacent wetlands on private property may still present suitable habitat (Polhemus and Haines 2020, p. 8). The other Molokaʻi site from which *M. xanthomelas* was reported in the 1990s, but not seen during the current surveys was the Pahiomu Fishpond, on the leeward coast (Polhemus and Haines 2020, p. 18). Since the last survey in 1995, the Pahiomu Fishpond has become overgrown and shaded by mangroves, which is not preferred by *M. xanthomelas* (Polhemus and Haines 2020, p. 9). One of the historical sites on Molokaʻi that still supported *M. xanthomelas* was at Kapuāiwa coconut grove (Polhemus and Haines 2020, p. 5) where a robust population was observed. The basal springs within this area have been protected from significant biological disturbance, such that the spring heads and outflows are still free from introduced fishes (Polhemus and Haines 2020, p. 6). Another site where *M. xanthomelas* was still found was in the Palaʻau wetland complex.

Although there are introduced topminnows (*Gambusia* sp.) that occupy the least saline pools in this complex, *M. xanthomelas* still persists in the area, perhaps taking advantage of escape space from topminnows due to its greater salt-tolerance (Polhemus and Haines 2020, p. 7). Polhemus and Haines (2020, p. 20) also noted that the population at Palaʻau appears to offer a potential source of breeding individuals that may be used to reintroduce to Lānaʻi, where it has been recently extirpated (Polhemus et al. 2020, entire), because they are haplotypically similar (Jordan et al. 2005, p. 3460). The open marshy areas on the flat valley floors of Pelekunu Valley appear to support moderately abundant populations of *M. xanthomelas*; here, they were found flying together with *Megalagrion pacificum* and perching on emergent vegetation amid pig wallows (Polhemus and Haines 2020, p. 15). In observing populations of *M. pacificum* and *M. xanthomelas* in Pelekunu valley, Polhemus and Haines (2020, p. 17) noted that the habitats exploited by *M. xanthomelas* may be seasonal in more dynamic aquatic systems. In dry summer months, when the old taro fields dry out and large scouring floods are infrequent, *M. xanthomelas* may breed in the terminal pond and seepage-fed side channels along the lower course of the main stream channel (Polhemus and Haines 2020, p. 17). However, during the winter, when the old taro fields become partially flooded and marsh-like, *M. xanthomelas* appears to move back into this area, possibly to avoid impacts from high impact stream flooding (Polhemus and Haines 2020, p. 17). It is also possible that individuals seen along the stream channel during the summer months are spillover from the larger core breeding populations in the old taro fields that persist throughout the year (Polhemus and Haines 2020, p. 17). Overall, Polhemus and Haines (2020, p. 18) noted that Molokaʻi has always had a much more limited human population in comparison to nearby islands such as Oʻahu and Maui and they conclude that this relatively limited development on Molokaʻi has as a consequence preserved populations of lowland *Megalagrion* damselflies that are now very rare or extirpated on other islands (Polhemus and Haines 2020, p. 18).

Recent survey work on Lānaʻi demonstrated that all populations of *Megalagrion xanthomelas* present on that island in the 1990s are now apparently extirpated (Polhemus et al. 2020, entire). Up until 1995, Lānaʻi harbored what was probably the second-largest set of populations for this endangered species outside of the island of Hawaiʻi. In the 1995 survey, *M. xanthomelas* was found occupying a small wetland area on the floor of the Maunalei Gulch Canyon (Polhemus et al. 2020, p. 6). But examination of this same area in 2020 showed that all aquatic habitat has disappeared because the pipeline that used to feed the wetland is now broken, discontinuous, and inoperative (Polhemus et al. 2020, p. 6). Another area in the upper reaches of Maunalei Gulch was observed to contain suitable habitat for *M. xanthomelas* if the poeciliid fishes were eliminated

(Polhemus et al. 2020, p. 7). *Megalagrion xanthomelas* was also found in Keōmuku town in 1994, but 2020 surveys found no sign of the species and no suitable habitat as former freshwater inflows have now been taken over by mangroves (Polhemus et al. 2020, p. 12). *Megalagrion xanthomelas* also used to be present in multiple ornamental features on the Experience at Kōʻele golf course, which was detailed by Polhemus (1996, pp. 37–38). Since the mid-1990s, the main pond at the old Lodge at Kōʻele, pond at the former 18th hole, former 8th hole, and former 4th hole, where *M. xanthomelas* was previously observed has been drained, reconfigured, and stocked with topminnows; consequently, there are no damselflies present (Polhemus et al. 2020, p. 16). Other areas such as ponds at the former 16th and 17th hole have not been extensively modified but topminnows have been introduced which prevent the persistence of *M. xanthomelas* (Polhemus et al. 2020, p. 17).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Apparent limits of the current orangeblack Hawaiian damselfly population will likely reduce genetic diversity and cause inbreeding depression. Jordan et al. (2005) found that this species is separated into three clades genetically: Oʻahu, Maui, and Hawaiʻi.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No changes in taxonomic classification have occurred.

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

The orangeblack Hawaiian damselfly was once Hawaii's most abundant damselfly species likely because of its ability to use a variety of aquatic habitats for breeding sites. Historically, the orangeblack Hawaiian damselfly probably occurred on all of the main Hawaiian Islands (except Kahoʻolawe) in suitable aquatic habitat within the anchialine pool, coastal, lowland dry, and lowland mesic ecosystems (Perkins 1913, p. clxxviii; Zimmerman 1948, p. 379; Polhemus 1996, p. 30). Its historical range on Kauaʻi is unknown. On Oʻahu, it was recorded from Honolulu, Kaimukī, Koko Head, Pearl City, Waialua, the Waiʻanae Mountains, and Wai'anae (Polhemus 1996, pp. 31, 33). On Moloka'i, it was known from Kainalu, Meyer's Lake (Kalaupapa Peninsula), Kaunakakai, Mapulehu, and Pālāʻau (Polhemus 1996, pp. 33–41). On Lānaʻi, small populations occurred on Maunalei Gulch, and in ephemeral coastal ponds at the mouth of Maunalei Gulch drainage, at Keōmuku, and in a mixohaline (brackish water) habitat at Lōpā (Polhemus 1996, pp. 37–41; HBMP 2010). On Maui, this species was recorded from an unspecified locality in the west Maui Mountains (Polhemus 1996, pp. 41–42; Polhemus et al. 1999, pp. 27–29). On Hawai'i Island, it was known from Hilo, Kona, and Nā'ālehu (Polhemus 1996, pp.

42–47). At the time of listing, the orangeblack Hawaiian damselfly occurred on O‘ahu, Moloka‘i, Lāna‘i, Maui, and Hawai‘i Island. In 1994, on O’ahu, a very small population was discovered in pools of an intermittent stream (Englund 2001, p. 256). On Moloka‘i, populations occurred at the mouths of two streams, and in wetlands on the south coast (Polhemus 1996, p. 47). On Lāna‘i, a large population occurred in an artificial pond (Polhemus 1996, p. 47). The species was present on west Maui at a stream and near anchialine pools on east Maui (Polhemus et al. 1999, p. 29). Several large populations existed in coastal wetlands on Hawai’i Island at 14 locations (Polhemus 1996, pp. 42–47; Orlando 2015, in litt). The species is believed to be extirpated from Kaua‘i (Polhemus and Asquith 1996, p. 91).

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

The orangeblack Hawaiian damselfly was once Hawai‘i’s most abundant damselfly species, historically found on all the Hawaiian islands except for Kaho‘olawe. Now, *Megalagrion xanthomelas* is found only on O‘ahu, Maui, Moloka‘i, and Hawai‘i. This suggests a moderate but severely reduced level of resiliency compared to its historic distribution. *M. xanthomelas* inhabits wetlands, streams, and anchialine pools (USFWS 2016, p. 67817). The orangeblack damselfly has even been found exploiting and thriving in a number of artificial habitats (e.g. TAMC, Kō‘ele). This ability to exploit different types of habitats gives *M. xanthomelas* a high level of resiliency. However, most if not all of these habitats have also experienced a high rate of disturbance and loss since prehuman contact. Although there has not been a formal assessment of either the wetland or stream habitat in Hawai‘i, it is estimated that at approximately 31 percent of coastal wetland has been lost since prehuman contact (Kosaka 1990, in litt; van Rees and Reed 2014, pp. 345-348; Hiromasa-Browning 2020, p. 221) and one-fifth of Hawai‘i’s streams have been channelized or straightened for anthropogenic purposes (Valeros et al. 2020, p. 386). Similarly, over 90 percent of anchialine pools across the state have been destroyed (Brock 2004, p. i). No critical habitat has been designated for the orangeblack Hawaiian damselfly.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Degradation, modification, and destruction of native damselfly habitat threaten the existence of the orangeblack Hawaiian damselfly. The factors that contribute to these detriments are stream modifications, wetland and anchialine pool habitat destruction, introduced feral ungulates, invasive plants, stochastic events such as hurricanes, flooding, and drought, and inadequate existing regulatory mechanisms to protect habitat and the introduction of nonnative plants and invertebrates. The ongoing and likely increasing effects of global climate change (such as increasing temperature and changing rainfall patterns) are also likely to directly or indirectly impact the habitat of native Hawaiian damselflies in general (USFWS 2016, p. 67818).

Habitat destruction: Although there has never been a comprehensive, site-by-site assessment of wetland loss in Hawaiʻi, Erikson and Puttock (2006, p. 40) estimated that at least 12 percent of all lowland to upper-elevation wetlands in Hawaiʻi had been converted to non-wetland habitat by the 1980s. Habitat loss resulted from and continues to be caused by: agricultural and urban development; stream diversion, channelization, and improper well placement; anchialine pool destruction through development; introduced feral pigs (*Sus scrofa*); introduced plants; and hurricanes, landslides, and drought. The ongoing and likely increasing effects of global climate change, while currently unquantifiable, are also likely to directly or indirectly impact the habitat of the orangeblack Hawaiian damselfly.

Stream habitat destruction: Stream modifications began with the early Hawaiians who diverted water to irrigate taro. However, early diversions often took no more than half the stream flow, and typically were periodic, to occasionally flood taro ponds year round, rather than continuously flood them (Handy and Handy 1972, pp. 58–59). The advent of plantation sugarcane cultivation led to far more extensive diversions (Wilcox 1996, p. 54). These systems were designed to tap water at upper elevations (above 984 ft; 300 m) by means of a concrete weir in the stream (Wilcox 1996, p. 54). All of most of the low or average flow of the stream was, and often still is, diverted into fields or reservoirs, leaving many stream channels completely dry (Takasaki et al. 1969, pp. 27–28; Wilcox 1996, p. 56). By 1978, the stream flow in over half of the 366 perennial streams in Hawaiʻi had been altered in some manner (Brasher 2003, p. 1055). This type of dewatering threatens the orangeblack Hawaiian damselfly species since reproduction and early life history stages occur within these lentic habitats. In addition to the destruction or diversion of most stream habitats in Hawaiʻi, the channelization of streams creates artificial, wide-bottomed streambeds and often results in the removal of riparian vegetation, which serves as habitat and potential breeding areas for *Megalagrion xanthomelas* (Brasher 2003, p. 1052). These ongoing and extensive stream diversions continue to degrade the quality of orangeblack Hawaiian damselfly habitat and its capability to support viable populations of this species.

Wetland habitat destruction: Agriculture and urban development have caused the loss of at least 30 percent of Hawaiʻi's coastal plain wetlands and 80 to 90 percent of lowland freshwater habitat in Hawaiʻi (Kosaka 1990, in litt).

Anchialine pool habitat destruction: It is estimated that >90 percent of anchialine habitats across the state of Hawaiʻi have been historically and contemporarily lost or degraded by anthropogenic activities like coastal development and the spread of exotic species (Brock 2004, p. i). On the island of Hawaiʻi, much development occurred in the major areas for anchialine pools between Kawaiahae and Kailua-Kona which resulted in the infilling of many anchialine pools (Mitchell et al. 2005, pp. 3–19, 4–1). For example, during the construction of the Waikoloa Resort in 1985, at least 130 pools were destroyed (Brock et al. 1987, p. 201). While similar destruction is extremely unlikely to be allowed by present day regulatory agencies, given the scarcity of the anchialine pools, habitat destruction remains a potential threat (Brock and Kam 1997, p. 11). Besides the direct destruction of anchialine pools during development, more indirect but persistent effects can occur including nutrient loading and reduction in water quality. The addition of fertilizers, pesticides, and other runoff from resort, urban, and commercial development may leach into the groundwater and into anchialine pools. For example, anchialine pools at both Waikoloa and Hokuliʻa had nutrient concentrations that were >70 percent higher than concentrations reported for anchialine pools in undeveloped locations (Wiegner et al. 2006, p. 4). Moreover, it is estimated that nutrient concentrations have more than doubled since the resort's development (Cox et al. 1969, p. 2). The runoff that may leach into the groundwater may directly introduce effluents that can directly harm naiads of *Megalagrion xanthomelas* or it can also alter the chemical properties of the anchialine pool, thereby affecting productivity and all the flora and fauna that depend on that environment.

Habitat destruction by feral ungulates and invasive plants: Another major threat to *Megalagrion xanthomelas* is the ongoing destruction and degradation of wetland and lowland stream habitat by nonnative animals, particularly feral pigs (Polhemus and Asquith 1996, p. 22; Erickson and Puttock 2006, p. 42). Animals such as pigs, goats (*Capra hircus*), axis deer (*Axis axis*), black-tailed deer (*Odocoileus hemionus*), and cattle (*Bos taurus*) were introduced either by the early Hawaiians around 400 A.D. or more recently by European settlers for food and/or commercial ranching activities (Tomich 1986, pp. 120–121). In particular, pigs threaten the existence of *M. xanthomelas* by trampling the forest floor, thereby encouraging the establishment of nonnative plants, and by removing vegetation by wallowing in moist depressions (Stone 1985, p. 263; Cuddihy and Stone 1990, p. 65). In nitrogen-pool soils, feral pig excrement increases nutrient availability, enhancing establishment of nonnative weeds that are more adapted to richer soils than are native plants (Cuddihy and Stone 1990, p. 65). Rooting by feral pigs was observed to be related to the search for earthworms, with rooting depths averaging 8 in (20 centimeters; cm), and rooting was found to greatly disrupt the leaf litter and topsoil layers, and contribute to erosion and changes in ground topography (Diong 1982, pp. 150, 160–167). In addition, Mountainspring (1986, p. 98) surmised that rooting by pigs depresses insect populations that rely on ground litter for reproduction; this could impact prey availability for the damselflies (Foote 2008, in litt; Polhemus 2008, in litt., p. 48). Feral pigs are often managed as game animals for public hunting (The Nature Conservancy 2014, p. 12). In contrast to a total eradication program, this action makes it more likely that feral pigs will continue to exist in Hawaiʻi, and thus likely that pigs will continue to destroy and degrade habitat of *M. xanthomelas*.

The invasion of nonnative plants primarily contributes to habitat destruction and modification by: 1) adversely impacting microhabitats by modifying the availability of light; 2) altering soil-water regimes, 3) modifying nutrient cycling processes; and 4) outcompeting native plant species (Cuddihy and Stone 1990, p. 74). For example, the invasive nonnative California grass (*Urochloa/Brachiaria mutica*), forms dense stands that can completely eliminate open water and thus continues to alter the habitat of *Megalagrion xanthomelas* through conversion of marshlands to meadowlands (Mazzacano 2007, p. 2). Other invasive plants that threaten habitat suitable to *M. xanthomelas* include pickleweed (*Salicornia* sp.) and mangrove (*Rhizophora mangle*); mangroves create dark, dense-canopied swamp habitats that are not favored by *M. xanthomelas* (Polhemus and Haines 2020, p. 7).

Anthropogenic habitat destruction: Until 1995, the island of Lānaʻi hosted the second largest set of *Megalagrion xanthomelas* populations (Polhemus et al. 2020, p. 20). A number of these populations were within or near the former golf course at Kōʻele. However, massive reconfigurations of the water features have caused extensive disturbance to the habitat of *M. xanthomelas* and therefore no longer support any populations. Additionally, the stocking of invasive fish have made these habitats additionally unsuitable for the persistence of this species.

Stochastic (random, naturally occurring) events such as hurricanes, landslides, and drought, can alter or degrade the habitat of *Megalagrion xanthomelas* directly by modifying and destroying native riparian, wetland, and stream habitats (e.g. rocks and debris falling in a stream; mechanical damage to riparian and wetland vegetation), and indirectly by creating disturbed areas conducive to invasion by nonnative plants that outcompete the native plants used by damselflies for perching. Data on precipitation in Hawaiʻi shows a steady and significant decline of about 15 percent over the last 15–20 years (Diaz et al. 2005, p. 2; Chu and Chen 2005, pp. 4803–4805; Hiromasa-Browning 2020, p. 227). These stochastic events like droughts and storms may also cause temporary habitat loss (e.g. desiccation of streams, die-off of surrounding vegetation). For example, the last natural population of *M. xanthomelas* on Oʻahu was nearly eliminated during a flood and was recolonized from a remnant population occurring in mitigation ponds that were built upslope of the flooded area (Mazzacano 2007, p. 2). Similarly, on Molokaʻi, a re-survey in 1995 of an area known to host widespread *M. xanthomelas* revealed that *M. xanthomelas* was now only found in a small area along the seaward margin of the stream (Polhemus and Haines 2020, p. 16). The cause of this decline was attributed to a major flood that scoured the area, allowing large stands of non-native plants such as Job's tears (*Coix lachrymal-jobi*) and Guinea grass (*Panicum maximum*) to overtake the wetland area making it unsuitable for *M. xanthomelas* (Polhemus and Haines 2020, p. 16). A further resurvey of this area resulted in no sightings of *M. xanthomelas* (Polhemus and Haines 2020, p. 17). Floods have also been implicated in dramatically reducing numbers of *M. xanthomelas* in Olowalu Valley on Maui (Bustamente 2020, in litt).

Catastrophic events such as hurricanes, landslides, tsunamis, and volcanic eruptions represent a significant threat to native riparian, wetland, and stream habitats. These types of events are known to cause significant habitat damage and could result in local extirpation events. For example, *Megalagrion vagabundum*, a related damselfly species, was extirpated from the entire Hanakāpīʻai Stream system on Kauaʻi as a result of the impacts from Hurricane Iniki in 1992 (USFWS 2012, p. 57673). Tsunamis also pose a threat since *Megalagrion xanthomelas* typically inhabits low-lying wetland areas. Finally, although no formal survey has been conducted, the population of *M. xanthomelas* that used to occupy Green Lake (Wai-a-Pele) near Kapoho is presumed extirpated as during the eruption of Kīlauea in 2018, lava flows entered the lake thereby evaporating the water and completely filling the basin (Peterkin 2018, entire).

While the exact nature of the impacts of climate change on native Hawaiian ecosystems are unknown, they will likely include the loss of aquatic habitat through reduced stream flow, the evaporation of standing water, flooding of nearshore wetlands, and the loss of native riparian plants that comprise the habitat in which *Megalagrion xanthomelas* occurs (USFWS 2010, p. 36000). Future changes in precipitation and the forecast of those changes are highly uncertain because they depend in part, on how the El Niño-La Niña weather cycle might change (HDBEDT 1998, pp. 2–10). Although sea level rise is expected to increase the total amount of Hawaiʻi's wetlands through groundwater inundation as well as marine flooding and inundation (Hiromasa-Browning 2020, p. 226), significant changes in water chemistry due to increased flooding and inundation during storms and high tides are also expected (Hiromasa-Browning 2020,

p. 226). These changes in water chemistry are likely to limit the types of flora and fauna that are able to live in this new system. In addition, sea level rise is likely to impact the availability of anchialine pool habitat availability. While current geospatial models show new pools are likely to form inland due to sea level rise and that the high subsurface hydrologic connectivity can allow for these new habitats to be used for breeding by *M. xanthomelas* (Oki 1999, pp. 1–70; Kano and Kase 2003, pp. 423–424; Craft et al. 2008, pp. 676–677), higher water levels and more frequent storm surges may allow introduced fishes to disperse into new areas which predate upon naiads (Marrack et al. 2015, entire).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:
As was stated in the Final Listing Rule we are not aware of any threats to the orangeblack Hawaiian damselfly that are attributable to overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2016, p. 67824).

2.3.2.3 Disease or predation:
Nonnative fish: The absence of Hawaiian damselflies, including *Megalagrion xanthomelas*, in many streams and other aquatic habitats around the Hawaiian islands is strongly correlated with the presence of predatory nonnative fish as documented in numerous observations and reports (Englund 1999, p. 237; Englund 2004, p. 27; Englund et al. 2007, p. 215). In fact, the introduction of non-native fish has been implicated in the extirpation of a related damselfly, the Pacific Hawaiian damselfly (*M. pacificum*), from Oʻahu, Kauaʻi, and Lānaʻi (USFWS 2014, p. 5). Naiads of *M. xanthomelas* are particularly vulnerable to predation from nonnative fish, especially species within the Poeciliidae family, as they feed and rest near the surface of the water (USFWS 2010, p. 35992). Hawaiian damselflies evolved with very few, if any, predatory fish and the exposed behavior of most of the fully aquatic species, such as *M. xanthomelas*, makes them particularly vulnerable to predation by nonnative fish which can be very aggressive (USFWS 2014, p. 5). For example, when disturbed, naiads of *M. xanthomelas* tend to swim to the surface; however, this appears to be a completely ineffective response against the surface-oriented poeciliid predators (Englund 1999, p. 232). Thus, the orangeblack Hawaiian damselfly is no longer found in most lentic habitats in Hawaiʻi, such as ponds and taro (*Colocasia esculenta*) fields, due to predation on larvae by nonnative fish that now occur in these systems (Moore and Gagne 1982, p. 4; Englund et al. 2007, p. 215). Over 51 species of nonnative fishes are established in freshwater habitats on the Hawaiian Islands from sea level to over 3,800 ft (1,152 m) elevation (Staples and Cowie 2001, p. 32; Brasher 2003, p. 1054; Englund 1999, p. 226, Englund and Polhemus 2001, entire; Englund 2004, p. 27, Englund et al. 2007, p. 232). The spread of these nonnative fishes has also been facilitated by

intentional human introduction in the recent past. For example, in 2001 during a dengue fever outbreak, people intentionally introduced fish to streams on Maui in an effort to control mosquito populations (Polhemus 2008, p. 48). Since the time of human contact, over 70 species of fish have been introduced into Hawaiian freshwater habitats (USFWS 2014, p. 5).

Invasive fish are particularly a problem in anchialine pools. It is estimated that more than 95 percent of anchialine pools in West Hawaiʻi have been contaminated by invasive fish and that this spread has only occurred over the past 20–30 years (Yamamoto and Tagawa 2000, entire; Havird et al. 2013, pp. 189–190). The effects of invasive fish on the damselfly naiads are unknown but may include direct competition and predation to indirect, e.g. the introduction and transmission of parasites and disease (Maciolek and Brock 1974, entire). Some alien species include members of the Poeciliidae (e.g. mosquito fish (*Gamubusia affinis*), shortfin or Atlantic molly (*Poecilia mexicana*), and guppy (*Poecilia reticulata*)) and the tilapia (*Tilapia mossambica*). Tilapia (family Cichlidae) were brought to Hawaiʻi for aquaculture. *Gambusia affinis* was introduced to the island as a biological control agent in 1905 and has since spread throughout Hawaiʻi (Dudley et al. 2017, p. 2). While invasive fishes remain the main threat, other native fishes commonly found offshore such as āholehole (*Kuhilia* spp.) or ulua/pāpio (*Caranx* sp.) may also pose a threat if introduced into the anchialine pool system.

Backswimmers: Backswimmers are aquatic insects in the family Notonectidae, which are nonnative to Hawaiʻi. Several species (*Anisops kuroiwae*, *Buenoa pallipes*, and *Notonecta indica*) are established on the islands of Maui, Hawaiʻi, Lānaʻi, and Oʻahu (USFWS 2016, p. 67818). These insects prey on damselfly naiads in streams and other aquatic habitat, and are considered a threat to the orangeblack Hawaiian damselfly since this species has an aquatic naiad life stage. In addition, the presence of backswimmers inhibits the foraging behavior of damselfly naiads, with negative consequences for growth, development, and survival (USFWS 2010, p. 36002).

Other insects: *Megalagrion xanthomelas* frequently co-occurs with a number of non-native insects that may pose a threat to their continued existence. For example, it was initially thought that there was no evidence of adverse interactions between *M. xanthomelas* and the non-native damselflies *Ischnura ramburi*, *Ischnura posita*, and *Enallagma civile* (Polhemus and Asquith 1996, p. 92). However, Daigle (2000, p. 4) reported seeing these two introduced species preying on teneral adult *M. xanthomelas* at thet Nīnole Springs, Hawaiʻi population site. Another insect group that may pose a threat to *M. xanthomelas* are the nonnative insect group, Trichoptera (or caddisflies) (USFWS 2014, p. 7). While it cannot be confirmed due to a lack of research on the subject, it is suspected that the introduced caddisflies may adversely affect *M. xanthomelas* through competition for space and resources (USFWS 2014, p. 7).

Coqui frogs: Coqui frogs, *Eleutherodactylus coqui*, were introduced to the State of Hawaiʻi in the late 1980s (Woolbright et al. 2006, p. 122) and are widespread on the island of Hawaiʻi (HDLNR 2020, entire). They are also known to be in a few locations on Maui, Kauaʻi, and Oʻahu (HDLNR 2020, entire). On Maui, populations of frogs are known in and around nurseries and hotels, residential areas, and there are several large populations in natural areas (Maui Invasive Species Committee 2021, entire). Although there have been significant efforts to control the coqui frogs on Maui (O'Neill 2018, in litt) the frogs have limited predators (mongoose, rats, and feral cats) enabling them to become successful invaders across wet forest habitats and allowing their populations to grow extraordinarily dense in Hawaiʻi compared to in their native habitat of Puerto Rico (Woolbright et al. 2006, pp. 124–126). The spread in natural areas poses a threat to *Megalagrion xanthomelas*. While naiads are not likely affected by the coqui frog as these frogs do not breed in streams or other places where *M. xanthomelas* immatures occur (O'Neill 2018, in litt), adults may be threatened. An analysis of coqui frog diets at lowland sites on the islands of Hawaiʻi and Maui found many invertebrates consumed by the frogs were leaf litter insects. However, a large number of flying insects were also present, indicating these frogs are actively foraging while climbing trees or understory plants (Beard 2007, pp. 281, 283). Dietary analysis of the coqui frog on the island of Hawaiʻi showed that aerial insects make up 33.8 percent of the diet (Bernard and Mautz 2016, p. 3413). The frogs have the ability to consume 4,500–56,000 prey/hectare/night, with 1,500–19,000 of these being aerial insects (Bernard and Mautz 2016, p. 3414). Based on the spatial patterns of the coqui frog foraging behavior, the orangeblack Hawaiian damselfly adult stages are potentially vulnerable to coqui frog predation. Further, coqui could compete with the orangeblack Hawaiian damselfly for food resources.

Bullfrogs: Nonnative bullfrogs, *Lithobates catesbeianus*, are strongly correlated with the absence of Hawaiian damselflies (Englund et al. 2007, pp. 215, 219). Bullfrogs are reported to occur on all of the main Hawaiian islands (IUCN 2015, entire). The bullfrog was first introduced into Hawaiʻi in 1899 (USFWS 2011, p. 14) to help control insects, specifically the nonnative Japanese beetle (*Popillia japonica*), a significant pest of ornamental plants (USFWS 2011, p. 14). Bullfrogs have demonstrated great success in establishing new populations wherever they have been introduced (Moyle 1973, p. 19) and are flexible in both habitat and food requirements (Bury 1984, p. 11). Bullfrogs also prefer habitats with dense vegetation and relatively calm water (Bury and Whelan 1985, entire).

Because of this behavior, it is likely of particular threat to *Megalagrion pacifium* because this species also prefers calm water habitat. In addition, bullfrog tadpoles feed mainly on aquatic plants and invertebrates and thus may also be a threat to *M. xanthomelas*.

Ants: Nonnative, predatory ant species pose a threat to both naiads and adults of *Megalagrion xanthomelas*. Naiads are vulnerable to predation in their terrestrial or semi-terrestrial habitats, or when emerging from the water for metamorphosis. In a 1998 survey of an Oʻahu stream, researchers observed predation by ants upon *M. xanthomelas* (USFWS 2010, p. 36001). The range of the orangeblack Hawaiian damselfly overlaps with that of several particularly aggressive, nonnative, predatory ant species. Notable predatory species that pose a direct threat include the big headed ant (*Pheidole megalocephala*), yellow crazy ant (*Anoplolepis gracilipes*), Argentine ant (*Linepithema humile*), and the thief ant (*Solenopsis papuana)* that currently occur on all of the main Hawaiian islands (Reimer 1993, pp. 11–22; Bertelsmeier et al. 2015, pp. 2491–2503; Krushelnycky et al. 2017, pp. 254–259). The threat is amplified by the fact that many of these species have winged reproductive adults (Borror et al. 1989, p. 738) and can quickly establish new colonies in suitable habitats (Staples and Cowie 2001, p. 55). While ants generally prefer drier habitat sites, some species of ants (e.g. the yellow crazy ant and thief ant) have increased their range into riparian areas. Based on observations by Dr. David Foote of the U.S. Geological Survey (Foote 2008, in litt), yellow crazy ants may threaten populations of *M. xanthomelas* in mesic areas up to 2,000 ft (600 m) in elevation. In addition, an unknown number of new species of ants are established every few years (Staples and Cowie 2001, pp. 55–57). These attributes allow some ants to destroy otherwise geographically isolated populations of native arthropods like *M. xanthomelas* (Nafus 1993, pp. 19, 22–23).

Birds: At TAMC, red-vented bulbuls (*Pycnonotus cafer*) and red-whiskered bulbuls (*Pycnonotus jocosus*) were observed foraging along the stream and catching insects (Preston and Arakaki 2012, p. 4). On a single occasion, a red-whiskered bulbul was observed catching and eating a newly emerged *Megalagrion xanthomelas* adult (Preston and Arakaki 2012, p. 4). In another observance, staff at Lyon Arborteum on Oʻahu observed a bulbul catch a teneral damselfly as it flew away from the pond shortly after emergence (Haines 2019, in litt). At this time it is unknown exactly what impact bulbuls may have on *M. xanthomelas*, but from these two observances it appears that bulbuls exert pressure on teneral damselflies and once they mature and harden, the damselflies may be able to evade bird predation relatively well.

Other predators: In laboratory tests, Johnson (2001, p. 66) found that the crayfish *Procambarus clarkii* ate *Megalagrion xanthomelas* naiads in 71 percent of the feeding tests conducted. Actual predation of naiads in the wild have not been documented as of yet. Another potential predator of *M. xanthomelas* adults is the Jackson's chameleon, *Trioceros jacksonii* (USFWS 2016, p. 67818).

2.3.2.4 Inadequacy of existing regulatory mechanisms:
Inadequate Habitat Protection: Nonnative feral ungulates pose a threat to *Megalagrion xanthomelas* through destruction and degradation of the species' habitat, but regulatory mechanisms are inadequate to address this threat (USFWS 2016, pp. 67824, 67844–67847). The State of Hawaiʻi provides game mammal (feral pigs and goats, axis deer, and mouflon sheep) hunting opportunities on 10 State-designated public hunting units on the island of Hawaiʻi (HDLNR 2003, pp. 10–11 and 62–65); 7 units for Maui (HDLNR 2003, p. 57); 5 units for Molokaʻi (HDLNR 2003, p. 52); 7 units for Oʻahu (HDLNR 2003, p. 47); 11 units for Kauaʻi (HDLNR 2003, p. 8). However, the State's management objectives for game animals range from maximizing public hunting opportunities (e.g., "sustained yield") in some areas to removal by State staff, or their designees, in other areas (State of Hawaiʻi, H.A.R. 13-123). In addition, the State Water Code has the regulatory mechanism in place to protect *M. xanthomelas* or their habitat, but water regulations have not been followed or enforced in a consistent manner by the State's Water Commission to prevent degradation of habitat. The State of Hawaiʻi considers all natural flowing surface water (streams springs, and seeps) as State property (Hawaiʻi Revised Statues 174c 1987) and the Hawaiʻi Department of Land and Natural Resources (HDLNR) has management responsibility for the aquatic organisms in these waters (Hawaiʻi Revised Statutes Annotated, 1988, Title 12:1992 Cumulative Supplement). However, administration of the Clean Water Act permitting program by the U.S. Army Corps of Engineers has not provided substantive protection of damselfly habitat, including any requirements for retention of adequate instream flows. This dewatering may threaten the orangeblack Hawaiian damselfly species as they are dependent on streams and seeps. State and Federal regulatory mechanisms are not adequately controlling the spread of nonnative animal species between islands and watersheds. Predation by nonnative animal species poses a major ongoing threat to *M. xanthomelas*. Because existing regulatory mechanisms are inadequate to maintain aquatic habitat for the damselflies and to regulate the spread of nonnative species, the inadequacy of existing regulatory mechanisms is considered to be a significant and immediate threat.

Introduction of Nonnative Plants and Insects: Currently, four agencies are responsible for inspection of goods arriving in Hawaiʻi (USFWS 2016, pp. 67824, 67844–67847).
The Hawaiʻi Department of Agriculture (HDOA) inspects domestic cargo and vessels and focuses on pests of concern to Hawaiʻi, especially insects

or plant diseases. The U.S. Department of Homeland Security-Customs and Border Protection (CBP) is responsible for inspecting commercial, private, and military vessels and aircraft and related cargo and passengers arriving from foreign locations (USFWS 2016, pp. 67824, 67844–67847). The U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine (USDA-APHIS-PPQ) inspects propagative plant material, provides identification services for arriving plants and pests, and conducts pest risk assessments among other activities (HDOA 2009, p. 1). The Service inspects arriving wildlife products, enforces the injurious wildlife provisions of the Lacey Act (18 U.S.C. 42; 16 U.S.C. 3371 *et seq*.), and prosecutes CITES (Convention on International Trade in Wild Fauna and Flora) violations. The State of Hawaiʻi allows the importation of most plant taxa, with limited exceptions (USFWS 2016, pp. 67824, 67844–67847). It is likely that the introduction of most nonnative invertebrate pests to the State has been and continues to be accidental and incidental to other intentional and permitted activities. Many invasive weeds established on Hawaiʻi have currently limited but expanding ranges. Resources available to reduce the spread of these species and counter their negative ecological effects are limited. Control of established pests is largely focused on a few invasive species that cause significant economic or environmental damage to public and private lands, and comprehensive control of an array of invasive pests remains limited in scope (USFWS 2016, pp. 67824, 67844–67847).

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Representation, resilience, and redundancy appears to be severely limited in the *Megalagrion xanthomelas* species. The threat to the orangeblack Hawaiian damselfly from limited numbers of populations and individuals is ongoing and is expected to continue into the future due to several factors. While exact population numbers are unknown, most populations of *M. xanthomelas* are thought to be relatively small in size. As a result of low known numbers, *M. xanthomelas* may experience the following: reduced reproductive success due to inbreeding depression, reduced levels of genetic variability leading to diminished capacity to respond and adapt to environmental changes, and increased vulnerability to localized catastrophes such as hurricanes, tsunami, and drought. Together these may result in population extirpation and extinction of this species (USFWS, 2016, p. 67818).

Although there are a number of populations of *Megalagrion xanthomelas* the persistence of *M. xanthomelas* is threatened by having several small geographically isolated populations across four islands. This leaves the species vulnerable to local extirpation events and extinction from natural and anthropogenic caused factors. The demographic structure needed to support *M. xanthomelas* is unknown. Small isolated populations may be particularly vulnerable to reduced mating encounters and decreased reproductive success caused by inbreeding depression. These populations may suffer a loss of genetic diversity over time due to random genetic drift, resulting in a decreased evolutionary potential and lessened ability to cope with environmental change (Lande 1988, p. 1455).

Table. Threats to *Megalagrion xanthomelas* and the status of ongoing conservation or management actions.

Threats	Listing Factor	Current Status	Conservation or Management Actions
Agriculture/urban development	A	Ongoing	Agriculture and urban development continue to pose a threat to the native Hawaiian damselfly habitat through encroachment and modification of water resources.
Stream alteration	A	Ongoing	Ongoing and extensive stream diversion and channelization continues to degrade the quantity and quality of native Hawaiian damselfly habitat and needed seeps.
Habitat modification by feral ungulates	A	Ongoing	Ongoing habitat destruction and degradation of wetland and lowland stream habitat caused by feral ungulates promote the establishment and spread of nonnative plants.
Habitat modification by nonnative plants	A	Ongoing	Nonnative plants that displace native species, increase runoff, and modify the wetland and lowland stream community lower or destroy the capability of the habitat to support viable populations of the orangeblack Hawaiian damselfly.
Stochastic events	A	Ongoing	The apparent restriction of the orangeblack Hawaiian damselfly to 34 small populations puts the species at risk of extinction from catastrophic events (drought, flooding, hurricanes).
Climate change	A	Ongoing	Climate change is expected to affect water levels in stream corridors. Reduced genetic diversity of the remaining populations may limit the ability of the orangeblack Hawaiian damselfly to adapt.
Predation	C	Ongoing	Nonnative fish, backswimmers, nonnative damselflies, coqui frogs, bullfrogs, ants, birds, crayfish, and Jackson's chameleon pose threats to orangeblack Hawaiian damselfly adults and naiads.
Inadequate habitat protection	D	Ongoing	The State of Hawaiʻi considers all natural flowing surface water (streams, springs, and seeps) as State property (Hawaiʻi Revised Statues 174c, 1987). However, the State's Water Commission has not consistently enforced State Water Code regulations to protect native Hawaiian damselfly stream and seep habitat. This dewatering may threaten the orangeblack Hawaiian damselfly if it proves to be dependent on seeps, streams, and the stream corridor where it has been observed.
Limited populations	E	Ongoing	Exact population numbers of *Megalagrion xanthomelas* are unknown and most populations are thought to be relatively small in size. The species appears to have low representation, resiliency, and redundancy.

2.4 Synthesis

The orangeblack Hawaiian damselfly, *Megalagrion xanthomelas*, is an endangered endemic species historically found on all of the main Hawaiian islands except Kahoʻolawe. It is a lowland species that occupies a wide range of habitats (e.g. anchialine pools, coastal, and wetland ecosystems) and has broad ecological tolerances (Polhemus and Asquith 1996, p. 91). However, *M. xanthomelas* is most commonly found sheltering in the vegetation along the borders of low elevation streams and coastal wetlands, particularly those fed by basal springs (Polhemus and Asquith 1996, p. 91). They can also be found breeding along terminal and lower midreaches of perennial streams.

Little is known about the historical abundance, population trends, and demographic features of the orangeblack Hawaiian damselfly. This species used to be Hawaiʻi's most abundant species of damselfly and it utilized a variety of aquatic habitats for breeding sites (USFWS 2014, p. 3). This species was historically common and abundant in a variety of lowland habitats through the 1970s, after which populations declined (Mazzacano 2007, p. 2).

Megalagrion xanthomelas is now only found on the islands of Hawaiʻi, Maui, Molokaʻi and Oʻahu where thirty-four known naturally occurring population units are found (USFWS unpublished data). *Megalagrion xanthomelas* is now considered extirpated from Kauaʻi (Polhemus and Asquith 1996, p. 91) and Lānaʻi (Polhemus and Haines 2020, entire). The status of the population on Niʻihau is unknown. Populations on Molokaʻi and Hawaiʻi are considered locally abundant. The three populations on Maui are still extant but not abundant. Until recently, the last report of the orangeblack Hawaiian damselfly on Oʻahu was in 1935 (Williams 1936, p. 310), and it was believed extirpated on this island (Polhemus 1993, pp. 344, 346). In 1994, a very small population was discovered existing in pools of an intermittent stream at the TAMC (Englund 2001, p. 256). Aside from translocated populations set out by DOFAW, *M. xanthomelas* at TAMC is still the only known naturally occurring population remaining on Oʻahu.

Feral ungulates and invasive plants continue to threaten the existence of *Megalagrion xanthomelas* by destroying vegetative habitat that is essential for hunting, breeding, and rearing. Howevever, the lack of *M. xanthomelas* in many aquatic habitats around the Hawaiian islands is strongly correlated with the presence of predatory nonnative fish, which are the biggest current threat. Based on severe restriction of its range due to habitat modification/destruction, water management practices, drought and other stochastic events, feral ungulates, nonnative plants, predators, and the limited number of populations, the resiliency of *M. xanthomelas* is very low.

Currently, existing regulations are inadequate to protect this species from introduction of nonnative species and to maintain their aquatic, wetland and lowland habitat. The draft Kauaʻi islandwide recovery plan which included this species was completed in September of 2019, the recovery outline for Hawaiian multi-island species was signed on July 30, 2020, and the *Megalagrion xanthomelas* species report was completed in August of 2020. Recovery criteria will be established in a multi-island recovery plan that is scheduled for completion in 2022. Threats identified in the Final Listing Rule, the draft Recovery Plan, the Recovery Outline, the Species Report, and this 5-Year Review are not sufficiently managed throughout the range of the species. Therefore, the orangeblack Hawaiian damselfly meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ **No change is needed**

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number: N/A

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (regardless of current classification) Priority Number: ____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Conduct targeted surveys for *Megalagrion xanthomelas* to determine the distribution of the species.

- Based on survey results, stabilize and protect extant populations of *Megalagrion xanthomelas* and develop and implement a recovery plan.

- Identify the primary habitat features and characteristics necessary for *Megalagrion xanthomelas* recovery.

- Identify and evaluate the primary biological characteristics necessary for *Megalagrion xanthomelas* recovery.

- Maintain and protect the habitat of *Megalagrion xanthomelas*.

- Refine and calibrate the indices for invertebrate communities that are used for monitoring programs to improve stream habitat.

- Eliminate or manage nonnative predators of *Megalagrion xanthomelas.*

- Survey, document, and manage threats to *Megalagrion xanthomelas*.

5.0 REFERENCES

Beard, K.H. 2007. Diet of the invasive frog, *Eleutherodactylus coqui,* in Hawai‘i. Copeia 2007:281–291.

Bernard, R.F. and W.J. Mautz. 2016. Dietary overlap between the invasive coqui frog (*Eleutherodactylus coqui*) and the Hawaiian hoary bat (*Lasiurus cinereus semotus*) on the island of Hawai‘i. Biological Invasions 18:3409–3418.

Bertelsmeier, C., A. Avril, O. Blight, A. Confais, L. Diez, H. Jourdan, J. Orivel, N. St. Germes, and F. Courchamp. 2015. Different behavioural strategies among seven highly invasive ant species. Biological Invasions 17:2491–2503. doi:10.1007/s10530-015-0892-5

Borror, D.J., C.A. Triplehorn, and N.F. Johnson. 1989. Chapter 35–Order Hymenoptera, Family Formicidae–Ants. *In* Introduction to the Study of Insects. Saunders College Publishing, Philadelphia. Pp. 737–741.

Brasher, A.M.D. 2003. Impacts of human disturbances on biotic communities in Hawaiian streams. BioScience 53:1052–1060.

Brock, R.E. 2004. Anchialine Resources in Two Hawai‘i State Natural Area Reserves: Ahihi Kinau, Maui Island and Manukā, Hawai‘i Island with Recommendations for Their Management. Prepared for the U.S. Fish and Wildlife Service by Environmental Assessment, LLC. Pacific Science. 63:27–37.

Brock, R.E. and A.K.H. Kam. 1997. Biological and water quality characteristics of anchialine resources in Kaloko-Honokōhau National Historical Park. NPS Cooperative Agreement CA8008-2-9004.

Brock, R.E., J.E. Norris, D.A. Ziemann, and M.T. Lee. 1987. Characteristics of water quality in anchialine ponds of the Kona, Hawaiʻi, coast. Pacific Science 41:200–208.

Bury, R.B. 1984. Ecology and Management of the Bullfrog. Resource Publication 155, Washington, D.C. U.S. Fish and Wildlife Service. 30 pp

Bury, R.B. and J.A. Whelan. 1985. Ecology and management of the bullfrog. Resource Publication 155, Washington, D.C. U.S. Fish and Wildlife Service. 23 pp.

Chu, P. and H. Chen. 2005. Interannual and interdecadal rainfall variations in the Hawaiian islands. Journal of Climate 18: 4796–4813.

Corbet, P.S. 1999. Dragonflies: behavior and ecology of Odonata. Aquatic Insects 23:83.

Cox, D.C., F.F. Peterson, W.M. Adams, C. Lau, J.F. Campbell, and R.D. Huber. 1969. Coastal evidence of groundwater conditions in the vicinity of Anaehoomalu and Lalamilo. South Kohala, Hawaiʻi. Water Resources Research Center Technical Report. 24. University of Hawaiʻi, Honolulu, 53 p.

Craft, J.D., A.D. Russ, M.N. Yamamoto, T.Y. Iwai Jr., S. Hau, J. Kahiapo, C.T. Chong, S. Ziegler-Chong, C. Muir, Y. Fujita, D.A. Polhemus, R.A. Kinzie III, and S.R. Santos. 2008. Islands under islands: the phylogeography and evolution of *Halocaridina rubra* Holthuis, 1963 (Crustacean: Decapoda: Atyidae) in the Hawaiian archipelago. Limnology and Oceanography 53:675–689.

Cuddihy, L.W. and C.P. Stone. 1990. Alteration of native Hawaiian vegetation: effects of humans, their activities and introductions. University of Hawaiʻi Press. Honolulu, Hawaiʻi. 138 pp.

Daigle, J. 2000. The distribution of the Odonata of Hawaiʻi. Bulletin of American Odonatology 6:1–5.

Diaz, H.F., P.S. Chu, and J.K. Eischeid. 2005. Rainfall changes in Hawaiʻi during the last century. Presented at the 16th Conference on climate variability and change. Boston, Massachusetts: American Meteorological Society. 3 pp.

Diong, C.H. 1982. Population biology and management of the feral pig (*Sus scrofa*) in Kipahulu Valley, Maui. PhD Dissertation. University of Hawaiʻi, Honolulu, Hawaiʻi. 408 p.

Dudley, B.D., R.A. MacKenzie, T.S. Sakihara, M.H. Riney, and R. Ostertag. 2017. Effects of invasion at two trophic levels on diet, body condition, and population size structure of Hawaiian red shrimp. Ecosphere 8:e01682

Englund, R.A. 1999. The impacts of introduced poeciliid fish and Odonata on the endemic *Megalagrion* (Odonata) damselflies of Oahu Island, Hawaii. Journal of Insect Conservation 3:225–243.

Englund, RA. 2001. Long-term monitoring of one of the most restricted insect populations in the United States, *Megalagrion xanthomelas* (Selys-Longchamps), at Tripler Army Medical Center, Oahu, Hawaiʻi (Zygoptera: Coenagrionidae). Odonatologica 30:255–263.

Englund, R.A. 2004. Assessing the spectrum of threats - impacts of invasive freshwater fish species on native Hawaiian aquatic insects. Abstract for the Hawaiʻi Conservation Conference, June 29–30, 2004, Honolulu, Hawaiʻi.

Englund, R. A. and D.A. Polhemus. 2001. Evaluating the effects of introduced rainbow trout (*Oncorhynchus mykiss*) on native stream insects on Kauai Island, Hawaii. Journal of Insect Conservation 5:265–281.

Englund, R.A., M.G. Wright, and D.A. Polhemus. 2007. Aquatic insect taxa as indicators of aquatic species richness, habitat disturbance, and invasive species impacts in Hawaiian streams. Bishop Museum Bulletin in Cultural and Environmental Studies 3: 207–232.

Erickson, T.A. and C.F. Puttock. 2006. Hawaiʻi wetland field guide: an ecological and identification guide to wetlands and wetland plants of the Hawaiian islands. Bess Press, Inc., Honolulu, Hawaiʻi. 294 p.

Evenhuis, N., D. Polhemus, S. Swift, K. Arakaki, and D. Preston. 1995. A study of the biology of the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*), with special reference to conservation of the population at Tripler Army Medical Center, Oahu. Bishop Museum Technical Report 8.

Handy, E.S.C. and E.G. Handy. 1972. Native planters in old Hawaiʻi: their life, lore, and environment. Bishop Museum Press, Honolulu, Hawaiʻi.

[HBMP] Hawaiʻi Biodiversity and Mapping Program. 2010. Hawaiian species database, unpublished.

[HDBEDT] State of Hawaii Department of Business, Economic Development & Tourism. Hawaiʻi Climate Change Action Plan. 1998. https://planning.hawaii.gov/wp-content/uploads/2016/06/HawaiiActionPlan1998.pdf

[HDOA] State of Hawaiʻi Department of Agriculture. 2009. Plant guidelines for importation to Hawaiʻi. 2 pp.

[HDLNR] State of Hawaiʻi Department of Land and Natural Resources, Division of

Forestry and Wildlife. 2003. Title 13 Chapter 123 Rules Regulating Game Mammal Hunting. 56 pp.

[HDLNR] State of Hawai‘i Department of Land and Natural Resources. 2020. Aquatic invasive species. https://dlnr.hawaii.gov/ais/. Last accessed July 10, 2020.

Hawai‘i Revised Statues 174c. 1987. http://www.hawaii.edu/ohelo/statutes/HRS174C/HRS174C.html

Hawai‘i Revised Statutes Annotated. 1988. Title 12:1992 Cumulative Supplement

Havird, J.C., J.R. Weeks, S. Hau, and S.R. Santos. 2013. Invasive fishes in the Hawaiian anchialine ecosystem: investigating potential predator avoidance by endemic organisms. Hydrobiologia 716:189–201.

Hiromasa-Browning, J., M. Reeves, F. Amidon, and S. Miller. 2020. Hawai‘i: the wetland system of Hawai‘i. Encyclopedia of the World’s Biomes. Elsevier 4: 211–234.

[IUCN] International Union for the Conservation of Nature Species Survival Commission Amphibian Specialist Group. 2015. *Lithobates catesbeianus*. The IUCN Red List of Threatened Species 2015: e.T58565A53969770. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T58565A53969770.en.

Johnson, C.G. 2001. Conservation biology of the orangeblack Hawaiian Damselfly, *Megalagrion xanthomelas*, (Odonata:Coenagrionidae) on O‘ahu. University of Hawai‘i at Mānoa. Master’s thesis.

Jordan, S., C. Simon, D. Foote, and R.A. Englund. 2005. Phylogeographic patterns of Hawaiian *Megalagrion* damselflies (Odonata: Coenagrionidae) correlated with Pleistocene island boundaries. Molecular Ecology 14: 3457–3470.

Kano, Y. and T. Kase. 2003. Genetic exchange between anchialine cave populations by means of larval dispersal: the case of a new gastropod species, *Neritilia cavernicola*. Zoologica Scripta 33:423–437.

Krushelnycky, P.D., C.S. Ogura-Yamada, K.M. Kanegawa, K.Y. Kaneshiro, and K.N. Magnacca. 2017. Quantifying the effects of an invasive thief ant on the reproductive success of rare Hawaiian picture-winged flies. Biological Conservation 215:254–259. doi:10.1016/j.biocon.2017.09.023

Lande, R. 1988. Demographic models of the northern spotted owl (*Strix occidentalis caurina*). Oecologia 75:601–607.

Maciolek, J.A. and R.E. Brock. 1974. Aquatic survey of the Kona coast ponds, Hawai‘i Island. Sea Grant Advisory Report UNIHI-SEAGRANT-AR-74-04. University of

Hawaiʻi at Mānoa, Honolulu.

Marrack, L., S. Beavers, and P. O'Grady. 2015. The relative importance of introduced fishes, habitat characteristics, and land use for endemic shrimp occurrence in brackish anchialine pool ecosystems. Hydrobiologia 758:107-122.

Maui Invasive Species Committee. 2021. Coqui Frog Website. http://mauiinvasive.org/coqui-frog/ Last accessed August 4, 2021.

.

Mazzacano, C. 2007. Species profile: *Megalagrion xanthomelas*. The Xerces Society for Invertebrate Conservation. https://xerces.org/endangered-species/species-profiles/at-risk-aquatic-invertebrates/orangeblack-hawaiian-damselfly. Accessed August 4, 2021.

Mitchell, C., C. Ogura, D.W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. Hawaiʻi's Comprehensive Wildlife Conservation Strategy. Department of Land and Natural Resources. Honolulu, Hawaiʻi. 722 pp.

Moore, 1983. Territorial behavior in the genus *Megalagrion* (McLachlan) (Zygoptera: Coenagrionidae). Odonatologica 12:87–92.

Moore, N.W. and W.C. Gagnè. 1982. *Megalagrion pacificum* (McLachlan) a preliminary study of the conservation requirements of an endangered species. Reports of the Odonata Specialist Group, Species Survival Commission, International Union for the Conservation of Nature and Natural Resources 3:1–5.

Mountainspring, S. 1986. An ecological model of the effects of exotic factors on limiting Hawaiian honeycreeper populations. Ohio Journal of Science 86:95–100.

Moyle, P.B. 1973. Effects of introduced bullfrogs, *Rana catesbeiana*, on the native frogs of the San Joaquin Valley, California. Copeia 1:18–22.

Nafus, D.M. 1993. Movement of introduced biological control agents onto nontarget butterflies, *Hypolimnas* spp. (Lepidoptera: Nymphalidae). Environmental Entomology 22:265–272.

Oki, D. 1999. Geohydrology and numerical simulation of the ground-water flow system of Kona, Island of Hawaiʻi. U.S. Geological Survey, Water-Resources Investigation Report 99-4073, Reston, Virginia.

Perkins, R.C.L. 1913. Fauna Hawaiiensis. Vol. 1. Part VI. Cambridge University Press, London. Pp. xi–ccxxviii.

Peterkin, O. 2018. Into thin air: Lava flows claim Hawaiʻi's largest lake in a matter of hours. Hawaii News Now. https://www.hawaiinewsnow.com/story/38346982/where-pele-first-visited-residents-react-to-the-loss-of-a-400-year-old-lake-due-to-lava/. Last accessed August 10, 2020.

Polhemus, D.A. 1993. Damsels in distress: a review of the conservation status of Hawaiian *Megalagrion* damselflies (Odonata: Coenagrionidae). Aquatic Conservation: marine and Freshwater Ecosystems 3:343–349.

Polhemus, D.A. 1996. The Orangeblack Hawaiian Damselfly, *Megalagrion xanthomelas* (Odonata: Coenagrionidae): Clarifying the Current Range of a Threatened Species. Bishop Museum Occasional Papers. Bishop Museum Press, Honolulu No. 45. 25 pp.

Polhemus, D.A. and A. Asquith. 1996. Hawaiian damselflies: a field identification guide. Bishop Museum Press, Honolulu. Pp. 1–41, 64–67, 69, 72–73, 76–77, 83, and 106.

Polhemus, D.A. and W. Haines. 2020. Field survey report: Moloka‘i inland waters assessment, native damselfly baseline survey- Endangered Species Act. 34 pp.

Polhemus, D.A., H. Oppenheimer, F. Starr, and K. Martz. 1999. Notable rediscoveries of *Megalagrion* species on Maui (Odonata: Coenagrionidae). Records of the Hawaii biological survey for 1998–Part 2: Notes. Bishop Museum Press, Honolulu. 3 pp.

Polhemus, D.A., W. Haines, and K. Bustamente. 2020. Lanai Inland Waters Assessment, Native Damselfly Baseline Survey. U.S. Fish and Wildlife Service. Honolulu. 36 pp.

Preston, D.J. and K. Arakaki. 2012. The 2011-2012 monitoring and translocation efforts of the Orange-Black damselfly *Megalagrion xanthomelas* (Selys Longchamps) (Zygoptera:Coenagrionidae). Contribution No. 2012-015 to the Hawaii Biological Survey. Contribution No. 2013-016 to the Hawaii Biological Survey.

Reimer, N.J. 1993. Distribution and impact of alien ants in vulnerable Hawaiian ecosystems. *In* Exotic Ants: Biology, Impact, and Control of Introduced Species, D.F. Williams (ed), Westview Press, Boulder. Pp. 11–22.

Staples, G.W. and R.H. Cowie. 2001. Insects and other terrestrial arthropods. *In* Hawaii’s Invasive Species: A Guide to Invasive Plants and Animals in the Hawaiian Islands, Mutual Publishing and Bishop Museum Press, Honolulu. Pp. 41, 52–57.

Stone, C.P. 1985. Alien animals in Hawai‘i’s native ecosystems: toward controlling the adverse effects of introduced vertebrates. Pages 251–297 in Stone, C.P. and J.M. Scott, editors. Hawai‘i's terrestrial ecosystems: preservation and management. Cooperative National Park Resources Study Unit, University of Hawai‘i, Honolulu.

Takasaki, K.J., G.T Hirashima, and E.R. Lubke. 1969. Water resources of windward O‘ahu, Hawai‘i: U.S. Geological Survey Water-Supply paper. 2217. 77 p.

Tango, L.K.K. 2010. The effect of salinity and temperature on survival of the orange black Hawaiian damselfly, *Megalagrion xanthomelas*. University of Hawai‘i at Hilo. Master's thesis. 46 pp.

The Nature Conservancy. 2014. Waikamoi Preserve East Maui Irrigation (EMI) Addition. East Maui, Hawai‘i. Long-Range Management Plan Fiscal Years 2015-2020. pp. 1–29.

Tomich, P.Q. 1986. Mammals in Hawai‘i, 2nd Edition. Bishop Museum Press, Honolulu, Hawai‘i. 375 p.

[USFWS] U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 69 species in Idaho, Washington, Hawai‘i, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 75: 35990-36012.

[USFWS] U.S. Fish and Wildlife Service. 2011. Recovery outline for two Hawaiian damselflies. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i. 20 pp. https://www.fws.gov/pacific/ecoservices/endangered/recovery/documents/HI%20Damselflies%20Outline%20signed%20031511.pdf

[USFWS] U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; listing the Pacific Hawaiian damselfly and Hawaiian damselfly as endangered throughout their ranges. Federal Register 77: 57481-57979.

[USFWS] U.S. Fish and Wildlife Service. 2014. Species Assessment and Listing Priority Assignment Form for *Megalagrion xanthomelas*. Honolulu. 14 pp.

[USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; Endangered status for 49 species from the Hawaiian Island. Federal Register 81 (190): 67786-67860.

[USFWS] U.S. Fish and Wildlife Service. 2019a. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 91 species in Oregon,Washington, Hawai‘i, and American Samoa. Federal Register 84 (112): 27152–27154.

[USFWS] U.S. Fish and Wildlife Service. 2019b. Draft Kaua‘i Islandwide Recovery

Plan. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i. 43 pp.

[USFWS] U.S. Fish and Wildlife Service. 2020. Recovery Outline for Hawaiian Multi-Island Species. U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, Honolulu, Hawai‘i. 36 pp.

Valeros, N.M.L., F. Amidon, M.K. Reeves, and W.M. O’Neill. 2020. Hawaiian Islands Streams. Encyclopedia of the World’s Biomes. Elsevier 4:379-399.

Van Rees, C.B. and J.M. Reed. 2014. Wetland loss in Hawaii since human settlement. Wetlands 34:335-350.

Wiegner, T., J. Beets, W. Dudley, L. Muehlstein, and M. Parsons. 2006. A review of coastal monitoring data for developments in West Hawai‘i. Prepared for County of Hawai‘i.

Wilcox, C. 1996. Sugar Water: Hawai‘i’s plantation ditches. University of Hawai‘i Press, Honolulu, Hawai‘i.

Williams, F.X. 1936. Biological studies in Hawaiian water-loving insects. Part I. Coleoptera or beetles. Part II. Odonata or Dragonflies. Proceedings of the Hawaiian Entomological Society 9: 235–349.

Woolbright, L.L., A.H. Hara, C.M. Jacobsen, W.J. Mautz, and F.L. Benevides Jr. 2006. Population Densities of the Coquí, *Eleutherodactylus coqui* (Anura: Leptodactylidae) in Newly Invaded Hawaii and in Native Puerto Rico. Journal of Herpetology 40 (1): 122–126.

Yamamoto, M.N. and A.W. Tagawa. 2000. Hawai‘i’s native and exotic freshwater animals. Mutual Publishing. Honolulu, HI. 200 pp.

Zimmerman, E.C. 1948. Volume 2: Apterygota-Thysanoptera. *In* Insects of Hawaii, University of Hawaii Press, Honolulu. Pp. 341–351, 368–380.

IN LITT. **REFERENCES**

Bustamente, K. Electronic mail message regarding *Megalagrion xanthomelas* on Maui. (August 5, 2020). 2 pp.

Foote, D. 2008. Personal communication regarding the damselfly *Megalagrion xanthomelas*, and threats to Hawaiian damselflies from the long-legged ant *Anoplolepis gracilipes*. (September 5, 2008). 1 pp.

Haines, W. 2019. Electronic mail message regarding *Megalagrion xanthomelas* at Waianae Kai site. (October 18, 2019). 5 pp.

Haines, W. 2020a. Electronic mail message regarding a summary of *M. xanthomelas* conservation efforts by DOFAW. (August 7, 2020). 3 pp.

Haines, W. 2020b. Electronic mail message regarding the range of *Megalagrion xanthomelas*. (August 31, 2020). 2 pp.

Haines, W. 2020c. Electronic mail message regarding a weekly summary of releases and monitoring efforts to the *Megalagrion xanthomelas* working group. (August 7, 2020). 4 pp.

[HDLNR] State of Hawaiʻi Department of Land and Natural Resources. 2014. *Megalagrion xanthomelas* meeting notes (October 22, 2014). 4 pp.

Kosaka, E. 1990. Technical review of draft report, Wetland Losses in the United States, 1780's to 1980's, compiled by National Wetlands Inventory, USFWS, Saint Petersburg, Florida.

O'Neill, W. 2018. Electronic mail message regarding whether coqui frogs are a threat to *M. xanthomelas*. (September 4, 2018). 1 pp.

Orlando, C. 2015. Letter to Mary Abrams, Field Supervisor of PIFWO, from Cynthia L. Orlando, Superintendent of the National Park Service, on current information from Hawaiʻi Volcanoes National Park on 11 of the species proposed for endangered species listing. 4 pp.

Polhemus, D.A. 2008. Review of draft proposed rule to list as endangered 4 Hawaiian damselflies. Communication to the U.S. Fish and Wildlife Service. Honolulu, Hawaiʻi. (September 29, 2008). 80 pp.

Polhemus, D. 2020. Electronic mail message regarding the range of *Megalagrion xanthomelas*. (August 31, 2020). 2 pp.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Orangeblack Hawaiian Damselfly
(*Megalagrion xanthomelas*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable: _______

Review Conducted By:
Charmian Dang, Fish and Wildlife Biologist, PIFWO
John Vetter, Animal Recovery Coordinator, PIFWO
Megan Laut, Conservation & Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

for MEGAN LAUT Digitally signed by MEGAN LAUT
Date: 2021.08.18 08:53:00 -10'00'
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Field Supervisor, Pacific Islands Fish and Wildlife Office