

Picture-wing fly
(*Drosophila heteronera*)

5-Year Review
Summary and Evaluation

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii

5-YEAR REVIEW

Species reviewed: Picture-wing fly (*Drosophila heteroneura*)

TABLE OF CONTENTS

1.0	GENERAL INFORMATION	3
1.1	Reviewers	3
1.2	Methodology used to complete the review:	3
1.3	Background:	3
2.0	REVIEW ANALYSIS.....	4
2.1	Application of the 1996 Distinct Population Segment (DPS) policy	4
2.2	Recovery Criteria.....	5
2.3	Updated Information and Current Species Status	6
2.4	Synthesis.....	12
3.0	RESULTS	13
3.1	Recommended Classification:.....	13
3.2	New Recovery Priority Number:	13
3.3	Listing and Reclassification Priority Number: N/A	13
4.0	RECOMMENDATIONS FOR FUTURE ACTIONS	13
5.0	REFERENCES.....	14
	Signature Page.....	17

5-YEAR REVIEW

Picture-wing fly/*Drosophila heteroneura*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:

Region 1, Endangered Species Program, Division of Recovery Jesse D'Elia,
(503) 231-2349

Lead Field Office:

Pacific Islands Fish and Wildlife Office, Loyal Mehrhoff, Field Supervisor,
(808) 792-9400

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 April 8, 2010. The review was based on the final rule to list 12 Hawaiian picture-wing flies, designation of Critical Habitat for 12 species of picture-wing flies from the Hawaiian Islands Final Rule, the Recovery Outline for 12 Hawaiian picture-wing flies, current published and unpublished materials and expert opinions and knowledge on the *Drosophila heteroneura* species. The draft five-year review was then reviewed by the Endangered Species Recovery Program Leader and the Assistant Field Supervisor for Endangered Species, before signature by the PIFWO Field Supervisor and transmittal to the Regional Office.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[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, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 75(67):17947-17950.

1.3.2 Listing history

Original Listing

FR notice: [USFWS] U.S. Fish and Wildlife Service. 2006. Endangered and threatened wildlife and plants; Determination of status for 12 species of picture-wing flies from the Hawaiian Islands. Federal Register 71(89):26835-26852.

Date listed: May 9, 2006

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:

[USFWS] U.S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; Designation of critical habitat for 12 species of picture-wing flies from the Hawaiian Islands. Final Rule. 73(234):73794-73888.

Five Critical Habitat management units totaling 855 hectares (4,582 acres) have been designated for *Drosophila heteroneura* on the island of Hawaii.

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

Name of plan or outline: Recovery Outline for 12 Hawaiian Picture-wing Flies

Date issued: August 2006

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*

☒ *No*

2.2 Recovery Criteria

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

☐ *Yes*

☒ *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:

A draft recovery plan for *Drosophila heteroneura* is being developed but was not published at the time of completing 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 general life cycle of Hawaiian *Drosophila* is typical of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow they molt (shed their skin) through three successive stages (instars); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults. *Drosophila heteroneura* is restricted to the island of Hawaii where the flies have been recorded in five different mesic to wet montane environments.

Drosophila heteroneura larvae primarily feed within the decomposing bark and stems of *Clermontia* sp. (family Campanulaceae), including *Clermontia clermontioides*, and *Delissea parviflora* (family Campanulaceae), but are also known to feed within decomposing portions of *Cheirodendron trigynum* (family Araliaceae) in open mesic and wet forest habitat.

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:

Bait can be used to survey for Hawaiian *Drosophila* but only to indicate the presence or absence of taxa. There is no technique currently available to uniquely mark individual flies and thereby quantify the number of *D. heteroneura* visiting the bait (K. Magnacca, *in litt.* 2010). In addition, Hawaiian *Drosophila* life cycles, are influenced by rainfall patterns and other environmental variables, making survey results difficult to compare over time and across sites. Even the very common species of picture-wing flies fluctuate widely seasonally as well as daily, confounding negative survey records for a taxa (K. Magnacca, *in litt.* 2012b).

Drosophila heteroneura has been recorded from 24 localities on four of the island's five volcanoes (Hualalai, Mauna Kea, Mauna Loa, and Kilauea) in five different mesic to wet montane environments (K. Kaneshiro *in litt.* 2005). Based on the relatively extensive survey data, the population decline of *D. heteroneura* has been demonstrated clearly. For example, *D. heteroneura* was recorded 760 times during surveys between 1975 and 1979. In the early 1980s, the first disappearance of a *D. heteroneura* population was recorded from the Olaa Forest site in Hawaii Volcanoes National Park (Carson 1986; Foote and Carson 1995). Subsequently, the absence of the species was noted in several other locations in southern and western parts of the island where *D. heteroneura* had previously been relatively common. By the late 1980s, *D. heteroneura* was believed to be extinct until an extremely small population

was discovered on private land at Hualalai Volcano in 1993. The species was not observed again until 1998 when Foote (2000) recorded six specimens of *D. heteroneura* inhabiting a site at approximately 1,352 meters (4,436 feet) above sea level near a host plant species, *Clermontia clermontoides*. A *D. heteroneura* population was recorded at the Hakalau Forest National Wildlife Refuge in 1999. At this Kona site, over 134 individuals have been observed from 1999-2001 (D. Foote, U.S. Geological Survey, *in litt.* 2005). Over a three year period from 2009-2011, 23 individuals have been observed at Kukuiope (4600 ft elevation) in the South Kona Forest Reserve (K. Magnacca *in litt.* 2012a). Additional surveys in historical and under-surveyed areas are needed to better estimate the demographics of *D. heteroneura*.

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

No new information is available.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Perkins (1910) initially described this species as *Idiomyia heteroneura*, based on specimens from Olaa on the island of Hawaii. This taxon was later transferred to the genus *Drosophila* (Hardy 1969), forming its presently accepted name. *Drosophila heteroneura* has very large spots on the bases of the wings and the males have a broad head with the eyes situated laterally, giving them a hammerhead appearance. The hammer-shaped head and entirely yellow face differentiate it from *D. silvestris*, a closely related species. The thorax is predominantly yellow with several black streaks and markings on top. The legs are yellow except for slight tinges of brown on the ends of the middle and hind femora and tibiae. The wings are hyaline (transparent) and are very similar in markings and venation (vein markings) to those of *D. silvestris*, except that the marking in the front margin of the wing of *D. heteroneura* extends nearly to the marking at the end of the wing. The abdomen is shiny black with a large yellow spot on the top of each segment. This species is about 5.7 millimeters (0.22 inches) in length with wings approximately 7.0 millimeters (0.30 inches) long. The picture wing group is divided into four major subgroups based on maps of chromosomal inversions. *Drosophila heteroneura* is in the plantitibia subgroup (Edwards et al., 2007).

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.):

Seasonal and day-to-day variability of *Drosophila* presence and detection with baits significantly complicates assessing the range of this species. *Drosophila heteroneura* has been the most intensely studied of the

endangered *Drosophila*. This species is restricted to the island of Hawaii where, historically, it was known to be relatively widely distributed between 915 to 1,830 meters (3,000 and 6,000 feet) above sea level. *Drosophila heteroneura* has been recorded from 24 localities on four of the island's five volcanoes (Hualalai, Mauna Kea, Mauna Loa, and Kilauea) in five different mesic to wet montane environments (K. Kaneshiro, *in litt.* 2005). Based on the relatively extensive survey data, the population has clearly declined. *Drosophila heteroneura* was recorded 760 times during surveys between 1975 and 1979. In the early 1980s, the first disappearance of a *D. heteroneura* population was recorded from the Olaa Forest site in Hawaii Volcanoes National Park (Carson 1986; Foote and Carson 1995). Subsequently, the absence of the species was noted in several other locations in southern and western parts of the island where *D. heteroneura* had previously been relatively common. By the late 1980s, *D. heteroneura* was believed to be extinct until an extremely small population was discovered at Hualalai Volcano in 1993. The species was not observed again until 1998 when Foote (2000) recorded six specimens of *D. heteroneura* inhabiting a site at approximately 1,352 meters (4,436 feet) above sea level near a host plant species, *Clermontia clermontioides*. In 2001, *D. heteroneura* was observed at the Kona Unit of the Hakalau Forest National Wildlife Refuge (D. Foote, U.S. Geological Survey, *in litt.* 2005). In December 2009 and September 2010, ten individuals were observed at Kukuiopae in the South Kona Forest Reserve (K. Magnacca *in litt.* 2012a). In September 2011, three *D. heteroneura* were observed at Kukuiopae (K. Magnacca *in litt.* 2012a). The South Kona Forest Reserve is located near the Kona Unit of the Hakalau Forest National Wildlife Refuge.

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

In accordance with section 3(5)(A)(i) of the Endangered Species Act and the regulations at 50 CFR 424.12, in determining which areas occupied at the time of listing to propose as Critical Habitat, we consider the Primary Constituent Elements (PCE) to be those physical and biological features that are essential to the conservation of the species and that may require special management consideration or protection. The PCE for *D. heteroneura* are: (1) Mesic to wet, montane, ohia and koa forest between the elevations of 908–1,754 meters (2,980–5,755 feet); and (2) the larval stage host plants *Cheirodendron trigynum* subspecies *trigynum*, *Clermontia clermontioides*, *Clermontia clermontioides* subspecies *rockiana*, *Clermontia hawaiiensis*, *Clermontia kohalae*, *Clermontia montis-loa*, *Clermontia parviflora*, *Delissea parviflora*, and three federally endangered species, *Clermontia lindseyana*, *Clermontia peleana*, *Clermontia pyrularia*, which exhibit one or more life stages (from seedlings to senescent individuals) (USFWS, 2008).

A Final Rule establishing Critical Habitat for *D. heteroneura*, went into effect January 5, 2009 (USFWS, 2008). *Drosophila heteroneura*-Unit 1-Kau Forest consists of 51 hectares (125 acres) of montane, wet, ohia forest, and is located on the southern flank of Mauna Loa on the island of Hawaii. Ranging in elevation between 1,590–1,680 meters (5,215–5,510 feet), this unit is owned by the State of Hawaii, and is largely managed as part of a State forest reserve.

Drosophila heteroneura-Unit 2-Kona Refuge consists of 1,459 hectares (3,604 acres) of montane, mesic, closed koa and ohia forest, and is located on the western flank of Mauna Loa on the island of Hawaii. Ranging in elevation between 910–1,755 meters (2,980–5,755 feet), this unit is owned by the U.S. Fish and Wildlife Service, and is managed as part of the Kona Unit of the Hakalau Forest National Wildlife Refuge.

Drosophila heteroneura-Unit 3-Lower Kahuku consists of 278 hectares (687 acres) of montane, mesic to wet, ohia forest, and is located on the southern flank of Mauna Loa on the island of Hawaii. Ranging in elevation between 3,705–4,685 feet (1,130–1,430 meters), this unit is owned and managed by the National Park Service, Hawaii Volcanoes National Park.

Drosophila heteroneura-Unit 4-Pit Crater consists of 18 hectares (46 acres) of montane, mesic, open ohia forest with mixed grass species, and is located on the western flank of Hualalai and south of the Kaupulehu lava flow on the island of Hawaii. Ranging in elevation between 1,170–1,380 meters (3,835–4,525 feet), this unit is privately owned and managed.

Drosophila heteroneura-Unit 5-Waihaka Gulch consists of 49 hectares (120 acres) of montane, wet, koa and ohia forest, and is located on the southern flank of Mauna Loa on the island of Hawaii. Ranging in elevation between 1,240–1,340 meters (4,065–4,390 feet), this unit is owned by the State of Hawaii, and is largely managed as part of a State forest reserve.

According to the most recent survey data (K. Kaneshiro, *in litt.* 2005), these units were occupied by *Drosophila heteroneura* at the time of listing. These units include the known elevation range, moisture regime, and native forest components used by foraging adults that have been identified as the PCEs for this species. These units also include populations of *Cheirodendron trigynum*, *Clermontia* spp., and *Delissea parviflora*, the larval stage host plants associated with this species.

2.3.1.7 Other:

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:

Drosophila heteroneura were historically known from 24 locations, widely distributed between 915 to 1,830 meters (3,000 to 6,000 feet) above sea level on the island of Hawaii. However, the species has not been recently observed at many of these sites (K. Kaneshiro, *in litt.* 2005; Science Panel 2005; Magnacca, *in litt.* 2012a). Loss of populations at different localities can result in reductions in the gene pool (K. Kaneshiro *in litt.* 2008). The major threats to *D. heteroneura* include current and future degradation and modification to their remaining habitat from feral ungulates, nonnative plants, rats, wildfire, resource competition and predation by nonnative insects, and inadequate regulatory mechanisms that protect the species (Smith 1985; Cuddihy and Stone 1990; Howarth et al. 2001; Kishinami 2001, Science Panel 2005).

Feral ungulates destroy host plant seedlings and habitat by the trampling action of their hooves and through the spread of seeds of nonnative plants (Kishinami 2001). Goats, pigs, cattle, and rats directly feed upon the larval stage hosts of *D. heteroneura* that include *Cheirodendron trigynum* subspecies *trigynum*, *Clermontia clermontioides*, *Clermontia clermontioides* subspecies *rockiana*, *Clermontia hawaiiensis*, *Clermontia kohalae*, *Clermontia montis-loa*, *Clermontia parviflora*, *Delissea parviflora*, and three federally endangered species; *Clermontia lindseyana*, *Clermontia peleana*, *Clermontia pyralaria*. Cattle and goats contribute to erosion on some steeper slopes where host plants occur.

The invasion of several nonnative plants, particularly *Psidium cattleianum*, *Rubus ellipticus* (yellow Himalayan raspberry), *Passiflora mollissima*, and *Pennisetum setaceum*, contributes to the degradation of picture-wing host plant habitat on the island of Hawaii (Wagner *et al.* 1999; Science Panel 2005). Jacobi and Warshauer (1992) reported that nonnative plants, including *Passiflora mollissima*, *Pennisetum setaceum*, and *Psidium cattleianum*, were found in 72 percent of 64 vegetation types sampled in a 5,000 square kilometer (1,930 square mile) study area on the island of Hawaii. *Psidium cattleianum* and *Rubus ellipticus* form dense stands that exclude other plant species (Cuddihy and Stone 1990; Wagner *et al.* 1999), and the vine *Passiflora mollissima* overloads the branches of native trees and shades out native plants below (Wagner *et al.* 1999).

The invasion of wildfire-adapted alien plants, facilitated by ungulate disturbance, has contributed to wildfire frequency. This change in wildfire regime has reduced the amount of forest cover for native species (Hughes *et al.* 1991; Blackmore and Vitousek 2000) and resulted in an

intensification of fire threat and feral ungulate disturbance in the remaining native forest areas. Habitat damaged or destroyed by wildfire is more likely to be revegetated by nonnative plants that cannot be used as host plants by these picture-wing flies. The grass *Pennisetum setaceum* has greatly increased fire risk in some regions, especially on the dry slopes of Hualalai, Kilauea, and Mauna Loa Volcanoes on the island of Hawaii (Wagner *et al.* 1999). This species quickly reestablishes itself after fires, unlike its native Hawaiian plant counterparts (Wagner *et al.* 1999).

The Hawaiian Islands now support several established species of nonnative insects which compete with the picture-wing flies within their larval stage host plants. The most important group of nonnative insect competitors includes tipulid flies (crane flies, family Tipulidae). The larvae of some species within this group feed within the decomposing bark of *Cheirodendron* and *Clermontia* spp., the host plants for *D. heteroneura* (Science Panel 2005).

The Critical Habitat units designated for *D. heteroneura* occur on Federal, State, and privately managed lands. Management strategies for the State-owned forest reserves, USFWS-owned national wildlife refuge, and National Park Service-owned national park units include reducing the risk of wildfire, ungulate control through fencing and hunting, and protection of *D. heteroneura* larval host plants.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Overutilization is not known to be a threat to this species.

2.3.2.3 Disease or predation:

Disease is not known to be a threat to any of the Hawaiian picture-wing flies. However, predation by nonnative insects and other arthropods poses a grave threat to Hawaii's native *Drosophilae* (Howarth and Medeiros 1989; Howarth and Ramsay 1991). Western yellowjackets and ants are other nonnative arthropods that pose a serious threat to *D. heteroneura* through predation (Howarth and Medeiros 1989; Howarth and Ramsay 1991; Howarth *et al.* 2001).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Regulatory mechanisms remain inadequate for thorough protection of the species, particularly quarantine regulations pertaining to the prevention of accidentally introduced arthropods, and augmentation and introduction of biological control agents in Hawaii.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Several species of nonnative rats, including the Polynesian rat (*Rattus exulans*), the roof rat (*Rattus rattus*), and the Norway rat (*Rattus norvegicus*), are present on the Hawaiian Islands and cause considerable environmental degradation (Kishinami 2001). The seeds, bark, and flowers of several of the picture-wing flies' host plants, including *Cheirodendron* sp. and *Clermontia* spp., are susceptible to herbivory by all the rat species (Science Panel 2005; K. Magnacca, *in litt.* 2005). The herbivory by rats causes host plant mortality, diminished vigor, and seed predation, resulting in reduced host plant fecundity and viability (Science Panel 2005; K. Magnacca, *in litt.* 2005).

The effects of climate change on picture-wing flies and host-plant range will likely be significant. Life cycle characteristics such as length of larval period and adult longevity are highly dependent on temperature and other environmental factors affected by climate change. In general, stage length and longevity decrease with temperature increase. Fecundity and sex ratio can also be influenced by temperature. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013.

2.4 Synthesis

Hawaii picture-wing fly, *Drosophila heteroneura*, is an endangered endemic species found only on the island of Hawaii. Historically, *D. heteroneura* has been recorded from 24 localities on four of the island's five volcanoes (Hualalai, Mauna Kea, Mauna Loa, and Kilauea) in five different mesic to wet montane environments. Based on the relatively extensive survey data, the population *D. heteroneura* has clearly declined, now occupying only a few localities.

The Primary Constituent Elements for *D. heteroneura* are: (1) Mesic to wet, montane, ohia and koa forest between the elevations of 908–1,754 meters (2,980–5,755 feet); and (2) the larval stage host plants *Cheirodendron trigynum* subspecies *trigynum*, *Clermontia clermontioides*, *Clermontia clermontioides* subspecies *rockiana*, *Clermontia hawaiiensis*, *Clermontia kohalae*, *Clermontia montis-loa*, *C. parviflora*, *Delissea parviflora*, and three federally endangered species, *Clermontia lindseyana*, *Clermontia peleana*, *Clermontia pyralaria*, which exhibit one or more life stages (from seedling to senescent individuals). On January 5, 2009, the Final Rule establishing Critical Habitat for *D. heteroneura*, went into effect. Five Critical Habitat management units totaling 4,582 acres (855 ha) have been designated for *D. heteroneura* on the island of Hawaii. The Critical Habitat units designated for *D. heteroneura* occur on Federal, State, and privately managed lands. Conservation and management strategies for these State-owned forest reserves, USFWS-owned national wildlife

refuge, and National Park Service-owned national park units include reducing the risk of wildfire, ungulate control through fencing and hunting, and protection of *D. heteroneura* larval host plants

The major threats to *D. heteroneura* include current and future degradation and modification to their limited remaining habitat from feral ungulates, nonnative plants, rats, and fire, resource competition and predation by nonnative insects, and inadequate regulatory mechanisms that protect the species from the introduction of nonnative insects and the loss of picture-wing fly host plants. Climate change will significantly impact the life cycle characteristics of *D. heteroneura* and the range of its host plants. A draft recovery plan for this species is being developed.

Since *Drosophila heteroneura* was listed as endangered under the Endangered Species Act, observations of only 23 individuals at a single population site have been reported. Most threats are not being managed. Therefore, *D. heteroneura* 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

☒ 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

1. Develop and implement a Recovery Plan.

2. Protect *Drosophila heteroneura* and *Cheirodendron*, *Clermontia* and *Delissa* spp., the larvae hosts of *Drosophila heteroneura*, from habitat destruction and control fire, rat, nonnative insect, and ungulate threats.
3. Eliminate or manage nonnative *Psidium cattleianum*, *Rubus ellipticus*, *Passiflora mollissima*, and *Pennisetum setaceum* plants and other invasive plants that compete with larvae host plants and increase wildfire risk.
4. Survey and document predatory threats.
5. Develop and implement a systematic *Drosophila heteroneura* survey and monitoring plan that includes historic habitats and other suitable habitats.
6. Evaluate the need to re-establish or supplement larvae host plants and wild picture-wing fly populations within their historical range.

5.0 REFERENCES

- Blackmore, M., and P.M. Vitousek. 2000. Cattle grazing, forest loss, and fuel loading in a dry forest ecosystem at Puu Waawaa Ranch. *Biotropica* 32:625-632.
- Carson, H.L. 1986. *Drosophila* populations in the Olaa Tract, Hawaii Volcanoes National Park, 1971-1986. Pages 3-9 in C.W. Smith (Editor), Proceedings of the Sixth Conference in Natural Sciences, Hawaii Volcanoes National Park. Cooperative National Park Resources Studies Unit. University of Hawaii. Honolulu, Hawaii.
- Cuddihy, L.W., and C.P. Stone. 1990. Alteration of the Native Hawaiian Vegetation; Effects of Humans, Their Activities and Introductions. Cooperative National Park Resources Studies Unit. University of Hawaii. Honolulu, Hawaii.
- Edwards K.A., L.T. Doescher, K.Y. Kaneshiro, D. Yamamoto. 2007. A Database of Wing Diversity in the Hawaiian *Drosophila*. *PLoS ONE* 2(5): e487.
- Foote, D., and H.L. Carson. 1995. *Drosophila* as monitors of change in Hawaiian ecosystems. In: E. T. La Roe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac (Eds.) *Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems*. U. S. Department of Interior, National Biological Service. Washington, D. C.
- Foote, D. 2000. Rediscovery of *Drosophila heteroneura* on the island of Hawaii. *Bishop Museum Occasional Papers* 64:27-28.
- Hardy, D. E. 1969. Chapter 6, Notes on Hawaiian "idiomyia" (*Drosophila*). Pp.71-77. In: M. R. Wheeler (Ed.). *Studies in Genetics V*. University of Texas Publication No. 6918. Austin, Texas.

- Howarth, F.G., and A. Medeiros. 1989. Non-native invertebrates. Pages 82-87 in C.P. Stone and D.B. Stone (Editors), *Conservation Biology in Hawaii*. Cooperative National Park Resources Studies Unit. University of Hawaii. Honolulu, Hawaii.
- Howarth, F.G., and G.W. Ramsay. 1991. The conservation of island insects and their habitats. Pages 71-107 in N.M. Collins and J.A. Thomas (Editors), *The Conservation of Insects and Their Habitats*. Academic Press. London. UK.
- Howarth, F.G., G.M. Nishida, and N.L. Evenhuis, N.L. 2001. Insects and other terrestrial arthropods. Pages 41-62 in *Hawaii's invasive species. A Hawaii Biological Survey Handbook*. Mutual Publishing and Bishop Museum Press. Honolulu, Hawaii.
- Hughes, R.F., P.M. Vitousek, and T. Tunison. 1991. Alien grass invasion and fire in the seasonal submontane zone of Hawaii. *Ecology* 72:743-46.
- Jacobi, J.D., and F.R. Warshauer. 1992. Distribution of six alien plant species in upland habitats on the island of Hawaii. Pages 155-188 in C.P. Stone, C.W. Smith, and J.T. Tunison (Editors), *Alien Plant Invasions in Native Ecosystems of Hawaii*. University of Hawaii Cooperative National Park Resources Studies Unit, University of Hawaii Press, Honolulu, Hawaii.
- Kishinami, C. H. 2001. Mammals. Pages 17-20 in G.W. Staples and R.H. Cowie (Editors), *Hawaii's Invasive Species*. Mutual Publishing and Bishop Museum Press. Honolulu, Hawaii.
- Perkins, R.C.L. 1910. Supplement to Hemiptera, Hymenoptera, Orthoptera, Neuroptera, and Diptera. *Fauna Hawaiiensis* 2:531-700.
- Science Panel for 12 Species of Hawaiian Picture-wing Flies. 2005. Notes for science panel hosted by the Pacific Islands Fish and Wildlife Office, November 15 to 16, 2005. 23 pp.
- Smith, C.W. 1985. Impact of alien plants on Hawaii's native biota. Pages 180-250 in C.P. Stone and J.M. Scott (Editors), *Hawaii's Terrestrial Ecosystems: Preservation and Management*. Cooperative National Park Resources Studies Unit. University of Hawaii. Honolulu, Hawaii.
- [USFWS] U.S. Fish and Wildlife Service. 2006. Endangered and threatened wildlife and plants; Determination of status for 12 species of picture-wing flies from the Hawaiian Islands. *Federal Register* 71:26835-26852.
- [USFWS] U.S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; Designation of critical habitat for 12 species of picture-wing flies from the Hawaiian Islands. *Final Rule*. 73:73794-73888.

[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, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 75:17947-17950.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. Manual of the Flowering Plants of Hawaii. University of Hawaii Press and Bishop Museum Press. Honolulu, Hawaii. 919 pp.

IN LITT. REFERENCES

Foote, D. 2005. Information regarding yellow-jacket studies in and around Hawaii Volcanoes National Park. Email message from David Foote, U.S. Geological Survey, Biological Resources Discipline, to Mike Richardson, U.S. Fish and Wildlife Service.

Kaneshiro, K. *in litt.* 2005. Complete collection data for the 12 species of Hawaiian picture-wing flies. Compiled from the Hawaiian *Drosophila* Database Project. Excel program file format. 16 pp.

Magnacca, K. *in litt.* 2010. Army environmental sites collecting report. Puu Hapapa, February 23-25, 2010. Submitted by Karl Magnacca, Department of Biology, University of Hawaii, Hilo. 1 pp.

Magnacca, K. *in litt.* 2012a. Collection and survey data set for listed Hawaiian *Drosophila* from 2009 to 2011 compiled by Karl Magnacca, Research Entomologist, Division of Forestry and Wildlife and sent to Diane Sether, U.S. Fish and Wildlife Service, Honolulu, HI.

Magnacca, K. *in litt.* 2012b. Email communication between K. Magnacca, Research Entomologist, Division of Forestry and Wildlife and D. Sether, U.S. Fish and Wildlife Service, Honolulu, HI on May 1, 2012.

Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Picture-wing Fly
(*Drosophila heteroneura*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

- ☐ Downlist to Threatened
- ☐ Uplist to Endangered
- ☐ Delist
- ☒ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:

Diane Sether, Invertebrate Biologist
Jess Newton, Endangered Species Recovery Program Leader
Assistant Field Supervisor for Endangered Species

Approved Jess Newton Date 8/28/2012
for Field Supervisor, Pacific Islands Fish and Wildlife Office