5-YEAR REVIEW

Species Reviewed: Hawaiian picture-wing fly (*Drosophila heteroneura*)
Current Classification: Endangered

Federal Register Notice announcing initiation of this review:
[USFWS] U.S. Fish and Wildlife Service. 2023. Endangered and threatened wildlife and plants; Initiation of 5-year status reviews for 133 species in Oregon, Washington, Idaho, Montana, California, Nevada, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 88(56):17611–17614.

Lead Region/Field Office:
Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i

Name of Reviewer:
Diane Sether, Ph.D., Invertebrate and Wildlife Biologist
John Vetter, Animal Recovery Coordinator, PIFWO
Megan Laut, Conservation & Restoration Team Manager, PIFWO

Methodology used to complete this 5-year 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 in February 2025. The review was based on a review of current, available information since the last 5-year review for *Drosophila heteroneura* (USFWS 2020). The evaluation by Diane Sether, Invertebrate and Wildlife Biologist, was reviewed by John Vetter, Animal Recovery Coordinator, and Megan Laut, Recovery Program Manager.

Background:
For information regarding the species' listing history and other facts, please refer to the Fish and Wildlife Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species at https://ecos.fws.gov/ecp/species/7895.

Review Analysis:
Please refer to the Recovery Plan for 50 Hawaiian Archipelago Species (USFWS 2022), the Species report for *Drosophila heteroneura* (Picture-wing fly) (USFWS 2021), and the previous 5-year review for *Drosophila heteroneura* signed September 28, 2020 (available at https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3137.pdf for a complete review of the species' status, threats, management efforts, and references cited. We are not aware of any significant new information regarding the species' biological status since listing to warrant a change in the Federal listing status of *D. heteroneura* as endangered.

Drosophila heteroneura, in the family Drosophilidae, is a picture-wing fly endemic to mesic to wet montane habitats on the island of Hawai‘i. Historically, the species was known from 24 sites on four of the island‘s five volcanoes (Hualālai, Kīlauea, Mauna Kea, Mauna Loa). The species was observed in 2011 in the mesic montane habitat in the Kukuiopa‘e and Ka‘ohe area of the South Kona Forest Reserve. *Drosophila heteroneura*

was not observed in surveys conducted Kukuiopa‘e in 2022. *Clermontia* spp. are considered the primary hosts of *D. heteroneura*, though larvae have been known to feed within decomposing portions of *Cheirodendron trigynum* spp. *trigynum* (‘ōlapa) in open mesic and wet forest habitat (Montgomery 1975, pp. 83, 96–97; Kaneshiro and Kaneshiro 1995, p. 20; Science Panel 2005 in litt., p. 20; Magnacca et al. 2008, pp. 14, 20; USFWS 2012 p. 6). The main host plant of *D. heteroneura*, *Clermontia clermontiodes*, has disappeared from the higher elevations preferred by *D. heteroneura* since the surveys conducted in 2011.

New Status Information:

- *Drosophila heteroneura* was not observed during surveys conducted from May 9–10 and June 27–July 1, 2022, in the middle and lower portions of the Honomalino Forest Reserve (FR). Insects were collected by bait sponges and targeted searches of habitat such as dead tree trunks in lower ‘olopua (*Notelaea sandwicensis*) and āulu (*Rockia sandwicensis*) forest near the seaward boundary and near the center of the Forest Reserve, and along the Honomalino FR and The Nature Conservancy’s Kona Hema Preserve boundary at 3,445-3,600 feet (ft; 1,050–1,100 m) in elevation (Magnacca 2022a, p. 2). *Clermontia* species are not regenerating at the Kona Hema Preserve with *C. hawaiiensis* appearing to have died out (Magnacca and Matsunaga 2025 pers. comm.).

- The last sighting of *Drosophila heteroneura* was in 2011 in wet forest within the Kukuiopa‘e unit of the South Kona Forest Reserve (Magnacca 2012a in litt., entire; Magnacca 2012b in litt, entire; Magnacca 2019 in litt., entire). Surveys were conducted in this area from August 8-11, 2022, and October 24-27, 2022, at the 3,970 ft (1,210 m), 4,200 ft (1,280 m), 4,593 ft (1,400 m), and 4,921 ft (1,500 m) elevations, and along the road between the cabin and the mauka boundary from 4,921-5,577 ft (1,500–1,700 m) within the unit (Magnacca 2022b, p. 1). Brief surveys were also made at 2,362 ft (720 m) and 3,117 ft (950 m). *Drosophila heteroneura* was not observed during the 2022 surveys (Magnacca 2022b, p. 2). According to Magnacca (2022, p. 2), *Clermontia* hosts were severely reduced compared to the previous site visit in 2011, though *Drosophila setosimentum*, a species that also uses *Clermontia* for breeding, was found at the former *D. heteroneura* site, indicating sufficient hosts exist somewhere in the area. *Clermontia clermontioides* was formerly abundant at elevations above 3,940 ft (1,200 m), but has drastically declined in the past decade due largely to damage from mouflon sheep (*Ovis gmelini musimon*). At Kukuiopa‘e, this host plant is now found mainly below 3,940ft (1,200 m), where more ‘ōhi‘a trees suitable for epiphytic growth occur and mouflon are less likely to enter the forest (Magnacca 2022b, entire). Grasses dominate the mid to low elevations of the unit (Magnacca and Matsunaga 2025 pers. comm.).

- The current population size or distribution of *Drosophila heteroneura* throughout its historical or suitable range is unknown.

- The complete genome of *Drosophila heteroneura* from a captive population originating from Kukuiopa‘e has been sequenced (Kang et al. 2016, entire), but the species is not currently in captive breeding (Magnacca and Matsunaga 2025 pers. comm.).

New Threats:

- Drought continues to be a threat to *Drosophila heteroneura*. ‘Ōhi‘a (*Metrosideros polymorpha*) is an important overstory tree in the mesic montane and wet montane habitats of this picture-wing fly. The tall ‘ōhi‘a trees intercept fog, contributing largely to the water supply of the plant community. Most of the historical mesic and wet montane habitats of *D. heteroneura* have experienced prolonged periods of abnormally dry to extreme drought conditions for the past 20 to 35 years (NIDIS 2025). Almost the entire ‘ōhi‘a canopy has died in the mesic montane habitats in the southern part of the Ka‘u District, South Kona, and on Hualālai over the past 20 years, due in part, to drought. This has resulted in overall habitat degradation and appears to alter decay processes of the picture-wing fly host plants (Magnacca and Matsunaga 2025 pers. comm.). Drought also alters the entire plant community on which the fly depends.

- Rapid ‘ōhi‘a death (ROD) caused by *Ceratocystis* fungi has also devastated ‘ōhi‘a, in the mesic and wet montane habitats of *Drosophila heteroneura* (Barnes et al., 2018, entire; Friday et al. 2020, entire; Heller et al. 2019, entire). This lethal fungal-caused disease of ‘ōhi‘a currently exists in or near the historical and known areas supporting *D. heteroneura* understory habitats (CTAHR 2025, Hawai‘i Island Figure). Like drought, the loss of canopy allows more sunlight to reach the forest floor increasing the temperature and lowering the humidity, subsequently causing adverse effects on the picture-wing fly and its habitat (Magnacca and Matsunaga 2025 pers. comm.)

- Nonnative feral ungulates continue to pose a threat pose a threat to *Drosophila heteronura* through destruction and degradation of the species’ habitat and herbivory of its host plants (Magnacca 2022a pp. 2-3; Magnacca 2022b, p. 4; Magnacca 2025 in litt., entire; Magnacca and Matsunaga 2025 pers. comm.). The increased ungulate damage in Kukuiopa‘e has significantly affected the main host of *D. heteroneura, Clermontia* spp,. and its possible occasional host, *Cheirodendron trigynum* (Magnacca 2022b, p. 4). *Cheirodendron*, though likely only an occasional host of *D. heteroneura*, grows slowly, and thus the rate at which *Cheirodendron* trees are being damaged and killed by ungulates is not sustainable without fencing and removal of ungulates (Magnacca 2022b, p. 4).

- Endemic Hymenopteran parasitoids (family Figitidae) known to parasitize flies, including *Drosophila* spp., were observed during surveys at Kukuiopa‘e in the South Kona FR (Magnacca, 2022b, p. 3). Of the 12 species observed all but one are apparently undescribed. The specific habits of the Figitid parasitoids are unknown (Magnacca 2022b, p. 3; Magnacca and Matsunaga 2025 in litt., entire).

Currently, the risk to *Drosophila heteroneura* is unknown, but these may be a limiting factor given the small population sizes of the picture-wing fly.

- Changes in environmental conditions that may result from global climate change include increasing temperatures, decreasing precipitation, and increasing storm intensities. The habitats of *Drosophila heteroneura* are likely to be affected by changes in temperature, humidity, precipitation and the frequency and severity of storms (Clark et al. 2020, entire; Magnacca and Matsunaga 2025 pers. comm.). These stressors may change the habitats on the island of Hawai‘i and exacerbate other threats making the habitats unsuitable for the *D. heteroneura*, its host plants, or both. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change (changes in rainfall and temperatures). Based on Fortini et al. (2013, pp. 69, 73), an assessment of the host plants at the species level concluded that the *D. heteroneura* larval host species vary in vulnerability to the impacts of climate change. On a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change, *Cheirodendron trigynum* ssp. *trigynum*, thought to be a minor host of *D. heteroneura*, has a vulnerability score of 0.126, *Clermontia* spp. had vulnerability scores between 0.0727 to 0.617, and *Delissea argutidentata* (listed as *Delissea undulata*) has a vulnerability of 0.593. Additionally, changes in temperature and humidity may alter the decay cycle of the host plant substrates the picture-wing flies require to breed.

- *Drosophila heteroneura* is vulnerable to extinction due to threats associated with low number of individuals and only one observed population last observed in 2011 (Service Panel 2005 in litt., entire; Magnacca 2019 in litt., entire). Because of limited numbers of individuals and only one known population, a single catastrophic event (e.g., hurricane, drought) may result in extirpation of the extant population and extinction of this species. Species with few known locations, such as *Drosophila heteroneura,* are less resilient to threats that might otherwise have a relatively minor impact on widely distributed species. The inability to document the species at its last known location during 2022 surveys (Magnacca 2022b, entire) highlights this threat.

New Management Actions:

- Fencing – The upper part of the Kukuiopa‘e unit (South Kona FR) above 3,200 ft. (975 m) is being fenced, but it will be a long-term effort. In addition, it will take several years to remove ungulates, namely mouflon, cattle, and pigs once the fence is completed.

Table 1. Known populations of *Drosophila heteroneura* from listing to this 5-year review.

Date	No. Populations	No. Individuals	Downlisting Recovery Criteria	Downlisting Criteria Completed?
2006 listing	≤24 (based	unknown	N/A	N/A

	on surveys from 1965 to 1999)			
2006 recovery outline	≤5	unknown	N/A	N/A
2008 critical habitat	≤5	unknown	N/A	N/A
2012 5-year review	≤5	unknown	N/A	N/A
2020 recovery outline	≥1	unknown	N/A	N/A
2020 species report	≥1	unknown	N/A	N/A
2020 5-year review	≥1	unknown	N/A	N/A
2022 recovery plan	≥1	unknown	At least five populations with stable population indices are distributed throughout each species' range; all units of designated critical habitat occupied by at least one population.	No
			A captive rearing program is established to support reestablishment in historical and suitable range.	No
			Each picture-wing fly population site in the Downlisting Criterion has viable populations of appropriate host plant species.	No
			Threats to suitable habitats supporting Downlisting Criterion are managed and afforded land protections to ensure long-term persistence of each species.	No
			All major threats to individuals and populations supporting Downlisting Criterion are	No

			managed; monitoring and management plans are completed and implemented for each species; measures are in place to prevent introduction of new threats to host plants.	
2025 5-year review	≥1	unknown	At least five populations with stable population indices are distributed throughout each species' range; all units of designated critical habitat occupied by at least one population.	No
			A captive rearing program is established to support reestablishment in historical and suitable range.	No
			Each picture-wing fly population site in the Downlisting Criterion has viable populations of appropriate host plant species.	No
			Threats to suitable habitats supporting Downlisting Criterion are managed and afforded land protections to ensure long-term persistence of each species.	No
			All major threats to individuals and populations supporting Downlisting Criterion are managed; monitoring and management plans are completed and implemented for each species; measures are in place to prevent introduction of new threats to host plants.	No

Table 2. Status of threats to *Drosophila heteroneura* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulates	A	Ongoing	Partial—some strategic fencing in the upper Kukuiopa‘e unit above 3,200 ft (975 m) is being installed, but this is a long-term project and will take years for ungulate removal. Removal of mouflon, cattle, and pigs should be a priority.
Invasive nonnative plants	A	Ongoing	None
Fire	A	Ongoing	Partial—general fire management plans are in place for State Forest Reserves and Natural Area Reserves, but fire load is an ongoing issue
Stochastic events (drought, hurricane)	A	Ongoing	None
Altered decay cycle of host plants	A	Ongoing	None
Predation by wasps	C	Ongoing	None
Predation by ants	C	Ongoing	None
Parasitization by nonnative wasps	C	Ongoing	None
Inadequate existing regulatory mechanisms	D	Ongoing	Partial – restrictions on transport of invasive species to the island are insufficient to prevent introduction of invasive species and diseases; regulatory mechanisms are inadequate to address threats of ungulate destruction of *Drosophila heteroneura* habitat
Habitat altering plant disease	E	Ongoing	None
Loss of plant hosts	E	Ongoing	Partial—large populations of *Clermontia* spp. have been outplanted and have shown remarkable ability to recover in areas such as Pu‘u Maka‘ala and Kūlani due to fencing and ungulate removal, but, once ungulates are removed, outplantings are needed in the higher elevations of Kukuiopa‘e and South Kona Hema units preferred by *Drosophila heteroneura*; regeneration in the Kona Hema Preserve has been

Threat	Listing Factor	Current Status	Conservation/Management Efforts
			minimimal due to lack of *Clermontia* natural recruitment.
Rats	E	Ongoing	None
Limited numbers	E	Ongoing	None
Competition from flies	E	Ongoing	None
Climate change	E	Ongoing	None

Synthesis:
Drosophila heteroneura, a species of picture-wing fly, is a member of the family Drosophilidae (Order Diptera). The species is historically endemic to the mesic and wet montane habitat on the island of Hawai‘i, from four of the island‘s five volcanoes (Kīlauea, Mauna Kea, Mauna Loa, Hualālai). The species is known from the mesic and wet montane forests between the elevations of 2,980 to 5,755 ft (908 to 1,754 m). Historically, the species was known from 24 sites in the mesic to wet, montane habitats of the island of Hawai‘i. Based on surveys conducted in 2009, 2010, and 2011, the species was present in the mesic montane habitat in the Kukuiopa‘e area of the South Kona Forest Reserve. The species was not found during surveys in 2022 of the last known location of *D. heteroneura* in the Kukuiopa‘e unit and in the Honomalino Forest Reserve.

Host plants of *Drosophila heteroneura* are decreasing throughout their range due to damage from ungulates in unfenced areas and habitat degradation caused by drought and ROD changing the overstory, which results in reduced humidity (Magnacca 2008, entire). *Drosophila heteroneura* was last recorded in the wet forest of Kukuiopa‘e. However, it is substantially degraded compared to the previous survey in 2011. Ungulates have extirpated the formerly extensive upper elevation stands of *Clermontia clermontioides* and have severely damaged nearly all *Cheirodendron trigynum*, an important native tree in this unit. Ungulate removal and outplanting are urgently needed at the last known occupied areas of *D. heteroneura*. Rats are known to feed on seeds, stems, and flowers of its *Clermontia* spp. hosts and may also depredate picture-wing fly larva in the stems. Loss or decrease in host plant resources and degradation or loss of canopy trees from drought and ROD degrade the habitat capable of meeting the humidity needs of the fly and decay cycle of the plant host threaten the existence of *D. heteroneura*. The limited known population of *D. heteroneura* make it particularly vulnerable to catastrophic events such as fire, drought, and hurricanes. This picture-wing fly is also threatened by predation from wasps and ants, parasitization by nonnative wasps, and competition for resources from crane flies. These threats can reduce adult fitness, fecundity, and lifespan of the species. *Drosophila heteroneura* is not currently in captive rearing at the time of this review, but the species has previously been reared successfully in captivity. The complete genome of the species has been sequenced.

In summary, the primary factors that pose serious and ongoing threats to the species, its plant hosts and its habitat range continue to include the following: habitat degradation

and destruction; nonnative ungulates, primarily mouflon, cattle, and pigs; rats; invasive plants; drought; fire; predation; parasitization; competition for breeding resources; inadequate regulatory mechanisms to address nonnative species; natural disasters; limited numbers of populations and individuals; potential environmental changes, and the interaction of these threats. Most of these threats are ongoing and uncontrolled and the recovery criteria as identified in the Recovery Plan for 50 Hawaiian Archipelago Species (USFWS 2022, pp. 98-100) have not been achieved (Table 2). For these reasons, *Drosophila heteroneura* continues to meet the definition of endangered.

Recommendations for Future Actions:

- Construct and maintain fenced exclosures to protect host plants of *Drosophila heteroneura* from the negative impacts of feral ungulates.
- Control feral ungulates that threaten *Drosophila heteroneura* and its hosts throughout the picture-wing flies' habitat.
- Conduct surveys for extant populations throughout the historically known range and new areas that may be suitable for *Drosophila heteroneura.*
- Establish a captive rearing program for *Drosophila heteroneura*.
- Monitor and assess abundance of individuals and growth trend of populations.
- Identify and prepare suitable habitats for translocation of picture-wing flies.
- Outplant populations of *Drosophila heteroneura* host plants in suitable habitats that can support the plant host and the picture-wing fly.
- Protect existing host plants of *Drosophila heteroneura* from rats.
- Increase numbers of populations and individuals in suitable habitat through translocation to build resilient populations with redundancy and representation.
- Develop and implement fire management plans for all populations of *Drosophila ocrobasis* and its habitat.
- Control invasive, nonnative plant species that compete with the host plants in *Drosophila heteroneura* habitats.
- Evaluate the distribution and impact of nonnative parasitic wasps on *Drosophila heteroneura*.
- Develop and implement effective control methods for rats in the *Drosophila heteroneura* and host plant habitats.
- Develop and implement effective control methods for nonnative wasps at all *Drosophila heteroneura* and host plant populations.
- Develop and implement effective control methods for ants at all *Drosophila heteroneura* and host plant populations.
- Evaluate the threats to *Drosophila heteroneura* from newly introduced pests such as *Libnotes* sp., which compete with the picture-wing fly for resources.
- Develop and implement effective control methods for crane flies at all *Drosophila heteroneura* and host plant populations.
- Control any new threats to *Drosophila heteroneura* before they become widespread.
- Develop fine-scale climate models to identify future suitable habitat based on existing and historical distributions and determine potential future climate conditions.

- Identify, develop, and support alliances and partnerships to plan and implement *Drosophila heteroneura* habitat restoration and management to benefit and recover the species.

References:
See previous 5-year reviews for a full list of references.

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Kaneshiro, K.Y., and K. Kaneshiro. 1995. Draft listing proposal for 18 species of Hawaiian picture-wing *Drosophila*. Submitted to the U. S. Fish and Wildlife Service, Pacific Fish and Wildlife Office, Honolulu, HI. 47 pp.

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[USFWS] U.S. Fish and Wildlife Service. 2021. Species report for the Hawaiian picture-wing fly, *Drosophila heteroneura*. Version 1. Pacific Islands Fish and Wildlife Office, Pacific Islands Interior Region 12, Portland OR. 48 pp.

[USFWS] U.S. Fish and Wildlife Service. 2022. Recovery plan for 50 Hawaiian Archipelago Species. Portland, Oregon. xvii + 166 pp. + Appendices

In Litteris

Magnacca, K. 2025. 5-Year Review Status call for updates on Drosophila. Email received by Diane Sether, Ph.D., USFWS, Pacific Islands Fish and Wildlife Office from Dr. Karl Magnacca, Research Entomologist, State of Hawaiʻi, Department of Land and Natural Resources, Department of Forestry and Wildlife. Received February 27, 2025.

Personal Communication

Magnacca, K. and J. Matsunaga. 2025 pers. comm. Meeting notes from a call regarding federally listed *Drosophila* species with Drs. Karl Magnacca, Research Entomologist, State of Hawaiʻi, Department of Land and Natural Resources, Department of Forestry and Wildlife (DLNR-DOFAW), Janis Matsunaga, State Entomologist, DLNR-DOFAW, and Diane Sether, Invertebrate and Wildlife Biologist, USFWS, Pacific Islands Fish and Wildlife Office. March 10, 2025.

U.S. FISH AND WILDLIFE SERVICE
SIGNATURE PAGE for 5-YEAR REVIEW of
Drosophila heteroneura **(Hawaiian picture-wing fly)**

Pre-1996 DPS listing still considered a listable entity? N/A

Recommendation resulting from the 5-year review:

_____ Delisting
_____ Reclassify from Endangered to Threatened status
_____ Reclassify from Threatened to Endangered status
__X__ No Change in listing status

Name of Reviewer:
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John Vetter, Animal Recovery Coordinator, PIFWO
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For **Field Supervisor, Pacific Islands Fish and Wildlife Office**

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