5-YEAR REVIEW

Short Form Summary

Species Reviewed: Hawaiian picture-wing fly (*Drosophila differens*)

Current Classification: Endangered

Federal Register Notice announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2021. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 77 species in Oregon, Washington, Idaho, and Hawaii. Federal Register 86(120): 33726–33728, June 25, 2021.

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
Lauren Weisenberger, Recovery Team Manager, PIFWO

Methodology used to complete this 5-year review:

This review was conducted by staff of the PIFWO of the U.S. Fish and Wildlife Service (USFWS) beginning in March 2023. The review was based on a review of current, available information since the last 5-year review for the Hawaiian picture-wing fly, *Drosophila differens* (USFWS 2018). The evaluation by Diane Sether, Invertebrate and Wildlife Biologist, was reviewed by John Vetter, Animal Recovery Coordinator, and Lauren Weisenberger, acting Recovery Team Manager.

Background:

For information regarding the species' listing history and other facts, please refer to the USFWS Environmental Conservation Online System (ECOS) database for threatened and endangered species at *https://ecos.fws.gov/ecp/species/217*.

Review Analysis:

Please refer to the Recovery Plan for 50 Hawaiian Archipelago Species (USFWS 2022, entire), and the previous 5-year reviews for *Drosophila differens* signed on August 28, 2012 (available at https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2005.pdf and signed on May 15, 2018 (available at https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2546.pdf for a complete review of the species' status, threats, and management efforts, and references cited. No new information regarding the species' biological status have come to light since listing to warrant a change in the Federal listing status of *D. differens* as endangered.

Drosophila differens is a picture-wing fly historically known from three sites in the wet montane habitats of the island of Moloka‘i. By 1999, the species was only found at one of the three areas. This population occurs in wet montane habitat of Pu‘ukolekole. The number of individuals at this population is unknown. Adult picture-wing flies are

generalist microbivores (microbe eating) and feed upon decomposing plant material. Females lay their eggs only in decaying stems and bark of *Clermontia* spp. Current status and trends for *Drosophila differens* are provided in the tables below.

New Status Information:

- The number of populations is estimated to be ≥ 1, although the current population size or distribution of *Drosophila differens* throughout its historic range is unknown. The species was last observed in the Kaunuohua area in 1969, the Hanalilolilo area in 1983, and the Puʻukolekole area in 1999 (Kaneshiro 2005, entire). The picture-wing fly species is believed to be extant within the critical habitat area on the Kamakou Preserve managed by The Nature Conservancy of Hawaiʻi (TNCH), though no recent surveys have been conducted to confirm the species' presence. Generally, the critical habitat area extends from Puʻukolekole to Hanalilolilo and Kaunuohua (USFWS 2008). Other locations within the wet montane habitat where *Clermontia* spp. are present may support undocumented *D. differens* populations provided threats are not limiting. The species is not in captive rearing.

New Threats:

- The picture-wing fly's host plants (*Clermontia* spp.) are highly susceptible to competition from nonnative plants. The most significant appears to be *Psidium cattleyanum* (strawberry guava), which displaces *Clermontia* spp. and changes the microclimate and hydrology of the area it occupies (Povak et al., 2017, entire). This conversion has negative impacts on the host plants that the picture-wing fly depends for essential life-history needs and creates opportunities for subsequent establishment of nonnative vertebrates and invertebrates.

- Wet montane habitats of *Drosophila differens* on Molokaʻi have experienced periods of abnormally dry to moderate drought conditions for the past 10 to 20 years (NIDIS 2020, entire). Severe episodes of drought not only kill individuals or populations of the *Drosophila* species (Carson 1986, pp. 4, 7), but frequently lead to an increase in the number and intensity of forest and brush fires. This results in a reduction of native plant cover and habitat, an increase in nonnative plant and animal species, and a reduction in availability of host plants for the picture-wing fly (Giambelluca et al. 1991, p. v; D'Antonio and Vitousek 1992, pp. 77–79). On Molokai, ʻōhiʻa (*Metrosideros polymorpha*) is an important overstory tree in the wet montane habitats of *D. differens* and is vulnerable to drought. This can result in overall habitat degradation and appears to alter decay processes of the picture-wing fly host plants. Drought also alters the *Clermontia* spp. community on which the fly depends.

- Bark-breeding picture-wing fly species like *Drosophila differens* are sensitive to declines in host plant populations due to their dependence on older, senescent, or dying plants (Magnacca et al. 2008, p. 32). Altered decay cycles in host plants caused by decreasing availability of host plants due to browsing and trampling by nonnative ungulates, competition with nonnative plants, drought, or other

phenomena can subsequently alter the life cycle of the picture-wing fly by disrupting the early stages of development.

- Few ant species have been able to colonize undisturbed montane wet ecosystems (Reimer 1993, pp. 13-17). The Papuan thief ant (*Solenopsis papuana*) is the only abundant, aggressive ant that has invaded intact mesic to wet forest, as well as coastal and lowland dry habitats. This species occurs on all main Hawaiian Islands, and is still expanding its range (Reimer 1993, p. 14). This ant is known to prey on picture-wing flies (Krushelnycky et al. 2017, entire). Because of the ant's expanding range and its widespread occurrence that overlaps with the habitat of *Drosophila differens*, the ant species is a threat to the picture-wing fly throughout its range.

- The Hawaiian picture-wing fly is particularly sensitive to disturbances due to low number of individuals, one known population, and the isolation of suitable hosts. *Drosophila differens* was last observed in 1999 at only one of its three historically known locations (Kaneshiro 2005, entire; Science Panel 2005, entire; Magnacca 2019 in litt., entire). It is possible undocumented, isolated populations occur at the other historical sites or on unsurveyed steep slopes or ridges where suitable host plants and habitat occur in east Moloka‘i, but the species is highly vulnerable to extinction due to threats associated with low number of individuals and only one observed population.

- Picture-wing flies are adversely impacted by competition with several species of nonnative limoniid crane flies (large crane flies) in the family Limoniidae, for larval host substrates. The larvae of nonnative limoniid crane flies feed within the decomposing bark of the host plants utilized by *Drosophila differens* (Science Panel 2005, pp. 1–23; Magnacca 2005 in litt., entire). Competition between *Drosophila* spp. larvae and other fly larvae can exhaust food resources, which affects both the probability of larval survival and the body size of adults, resulting in reduced adult fitness, fecundity, and lifespan. It has been suggested that several species of soldier flies and neriid flies also impose a similar threat to Hawaiian picture-wing flies (Science Panel 2005, pp. 1–23).

- Because of limited numbers of individuals, and only one population last observed in 1999, a single catastrophic event (e.g., hurricane, drought) may result in extirpation of the extant populations and extinction of this species. Species with few known populations, such as *Drosophila differens,* are less resilient to threats that might otherwise have a relatively minor impact on widely distributed species. Reduced availability of host plant substrate or an increase in predation of the picture-wing fly adults that might be absorbed in a widely distributed species could result in a significant decrease in survivorship or reproduction of a species with limited distribution. Limited distribution of populations magnifies the severity of the impact of the other threats.

- Currently, four agencies are responsible for inspection of goods arriving in Hawai‘i (USFWS 2006, pp. 26846–26848; USFWS 2013, p. 64679). The Hawai‘i Department of Agriculture inspects domestic cargo and vessels and focuses on pests of concern to Hawai‘i, especially insects or plant diseases not yet known to be present in the State. The U.S. Department of Homeland Security‘s Customs and Border Protection is responsible for inspecting commercial, private, and military vessels and aircraft and related cargo and passengers arriving from foreign locations (USFWS 2006, pp. 26846–26848; USFWS 2013, p. 64679). The U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Plant Protection and Quarantine inspects propagative plant material, provides identification services for arriving plants and pests, and conducts pest risk assessments among other activities (USFWS 2006, pp. 26846–26848; USFWS 2013, p. 64679–64680). The USFWS 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 (USFWS 2006, pp. 26846–26848; USFWS 2013, p. 64680). The State of Hawai‘i allows the importation of most plant taxa, with limited exceptions (USFWS 2006, pp. 26846–26848; USFWS 2013, p. 64680). 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 in Hawai‘i 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 2006a, pp. 26846–26848; USFWS 2013, p. 64680–64681).

- Changes in environmental conditions that may result from global climate change include increasing temperatures, decreasing precipitation, and increasing storm intensities. The habitats of *Drosophila differens* are likely to be affected by changes in temperature, humidity, precipitation and the frequency and severity of storms (Clark et al. 2020, entire). These stressors may change the habitats on Moloka‘i and exacerbate other threats making the habitats unsuitable for the *D. differens*, 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, p. 69) an assessment of *Clermontia arborescens, Clermontia grandiflora, Clermontia kakeana, Clermontia oblongifolia,* and *Clermontia pallida* at the species level concluded that these *Drosophila differens* larval host species are vulnerable to the impacts of climate change, with vulnerability scores of 0.367, 0.365, 0.315, 0.329, and 0.733, respectively (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Additionally, changes in temperature and humidity may alter the decay cycle of the host plant substrates the picture-wing flies require to breed.

New Management Actions:

- Lands that support *Drosophila differens* at the Kamakou Preserve, including the *Drosophila differens* critical habitat unit within the Kamakou Preserve, are continuously monitored for feral ungulates, such as pigs, goats and axis deer. Portions of the Kamakou Preserve and the Puʻu Aliʻi Natural Area Reserve have been fenced to restrict ungulates since 2011. These fenced areas include Puʻukolekole, where *D. differens* was last documented in March 1999 (Kaneshiro in litt., 2005, entire), as well as additional unsurveyed areas for the picture-wing fly. Monitoring in support of zero tolerance for ungulate presence is being conducted and maintained in the fenced Kamakou forest unit (TNCH 2018, entire). In addition, fencing encloses the Pākuʻi area and provides protection of the occurrences of *Drosophila differens* larval host, *Clermontia* spp. at Kaholoapele and Uapa as well as nonlisted *Clermontia* species (TNCH 2016, entire). It is not known if undocumented extant populations of *Drosophila differens* occur at this wet montane location.

- The lands that support *Drosophila differens* at the Kamakou Preserve are also monitored by TNCH for understory vegetation quality and presence of invasive plant species that can alter the ecosystem (TNCH 2015, entire; TNCH 2018a, entire). Priority habitat-modifying weeds are targeted and removed, such as *Phormium tenax* (New Zealand flax), *Pinus* spp. (pines), *Melaleuca quinquenervia* (paperbark), strawberry guava, *Chaetogastra herbacea* (glory bush), *Miconia crenata* (Koster's curse), *Rubus argutus* (blackberry) and *Bischofia javanica* (toog) (TNCH 2018a, entire). Strawberry guava is particularly harmful to *Clermontia* spp., often displacing it in the wet habitat utilized by *D. differens*.

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

Date	Populations/ Individuals[1]	Downlisting Criteria Identified in Recovery Plan	Downlisting Criteria Completed
2006 listing	≥1/Unknown	No recovery plan developed	N/A[2]
2006 recovery outline	≥1	No recovery plan developed	N/A[2]
2008 critical habitat	≥1	No recovery plan developed	N/A[2]
2012 5-year review	≥1	No recovery plan developed	N/A[2]
2018 5-year review	≥1	No recovery plan developed	N/A[2]
2020 recovery outline	≥1	No recovery plan developed	N/A[2]
2021 species	≥1	No recovery plan	N/A[2]

report Version 1		developed	
2022 recovery plan, USFWS 2022)	≥1	Criterion 1: 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
		Criterion 2: A captive rearing program is established to support reestablishment in historical and suitable range.	No
		Criterion 3: Each picture-wing fly population site in *Downlisting Criterion 1* has viable populations of appropriate host plant species.	Partially
		Criterion 4: Threats to suitable habitats supporting *Downlisting Criterion 1* are managed and afforded land protections to ensure long-term persistence of each species.	Partially
		Criterion 5: All major threats to individuals and populations in *Downlisting Criterion* 1 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
2023 5-year review	≥1	Criterion 1: At least five populations with stable population indices are distributed throughout each species' range; all units of designated critical habitat	No

		occupied by at least one population.	
		Criterion 2: A captive rearing program is established to support reestablishment in historical and suitable range.	No
		Criterion 3: Each picture-wing fly population site in *Downlisting Criterion 1* has viable populations of appropriate host plant species.	Partially
		Criterion 4: Threats to suitable habitats supporting *Downlisting Criterion 1* are managed and afforded land protections to ensure long-term persistence of each species.	Partially
		Criterion 5: All major threats to individuals and populations in *Downlisting Criterion* 1 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

[1]Based on surveys from 1967 to 1999
[2]N/A=not applicable

Table 2. Threats to *Drosophila differens* and ongoing conservation efforts.

Threat	**Listing Factor**	**Current Status**	**Conservation/Management Efforts**
Ungulates	A	Ongoing	Partial—some strategic fencing is in place in Kamakou Preserve and the Puʻu Aliʻi Natural Area Reserve. These fenced areas include Puʻukolekole. Monitoring in support of zero tolerance for ungulate presence is being conducted

Threat	Listing Factor	Current Status	Conservation/Management Efforts
			and maintained in the fenced Kamakou forest unit (TNCH 2018a, entire). In addition, fencing encloses the Pāku‘i area and protects occurrences of *Clermontia* spp. at Kaholoapele and Uapa, which can be *Drosophila differens* larval hosts (TNCH 2016, entire).
Nonnative plants	A	Ongoing	Partial—Lands that support *Drosophila differens* at the Kamakou Preserve are also monitored by TNCH for understory vegetation quality and presence of invasive plant species that can alter the ecosystem (TNCH 2015, entire; TNCH 2018a, entire). Priority habitat-modifying weeds were targeted and removed (TNCH 2018b, entire).
Fire	A	Ongoing	Partial—general fire management plans are in place for the Kamakou Preserve and the Pu‘u Ali‘i Natural Area Reserve
Stochastic events (drought, hurricane)	A	Ongoing	None
Altered decay cycle of host plants	A	Ongoing	None
Predation by nonnative invertebrates	C	Ongoing	None
Inadequate existing regulatory mechanisms	D	Ongoing	Partial—restrictions on transport of invasive species to Moloka‘i are insufficient to prevent introduction of invasive species and diseases; regulatory mechanisms are inadequate to address the threat of ungulate destruction of habitat.
Habitat altering plant disease	E	Ongoing	None
Loss of plant hosts	E	Ongoing	Outplanting of the *Clermontia* species is ongoing at several locations in Pu‘u Ali‘i Natural Area Reserve and along the rim of Pelekunu Valley.
Rats	E	Ongoing	None
Limited population/individual numbers	E	Ongoing	None

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Competition for breeding substrates	E	Ongoing	None
Not in captive rearing	E	Ongoing	None
Climate change	E	Ongoing	None

Synthesis:
Drosophila differens (picture-wing fly) belongs to the family Drosophilidae. The species is endemic to Molokaʻi where it is known from only three locations in the wet montane ʻōhiʻa habitat, ranging in elevation from approximately 3,800 to 4,500 feet (ft) (1,158 to 1,372 meters [m]). The species was last observed at Kaunuohua in 1969, at Hanalilolilo in 1983, and most recently at Puʻukolekole in 1999. Adults are generalist microbivores (microbe eating) and feed upon a variety of decomposing plant material. In general, picture-wing fly species may breed throughout the year, but egg laying generally increases following the rainy season. *Drosophila differens* females are known to lay eggs in decomposing bark and stems of several species of *Clermontia*, which the larvae use as their feeding substrate.

Threats to the picture-wing fly include parasitization from wasps and predation from non-native invertebrates such as western yellowjacket. Because *D. differens* larvae feed on decaying stems and bark and pupate in the soil, the larvae and pupae are also vulnerable to predation by ants. Competition for limited larval substrate with crane flies can exhaust food resources, which affects both the probability of *D. differens* larval survival and the body size of adults. This can result in reduced adult fitness, fecundity, and lifespan of *D. differens*. The plant hosts of *D. differens* are particularly vulnerable to ungulate damage from grazing and trampling. Rats are known to feed on seeds, stems, and flowers of *Clemontia* spp. and may also predate picture-wing fly larvae in the stems.

In summary, the primary factors that pose serious and ongoing threats to the species, its plant hosts, and its habitat range include the following: habitat degradation and destruction, nonnative ungulates and 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. Threats from ungulates, fire, host plant availability, and rat threats to host plant through seed consuption are partially managed. A recovery plan for *D. differens* was completed in 2022. Due to the limited area of occurrence, few populations and uncertain number of individuals, *Drosophila differens* meets the definition of endangered.

Recommendations for Future Actions:

- Determine the current distribution and status of the species and their habitats**.**
  - Develop a survey methodology for *Drosophila differens* species' population based on the species' historical, known, and potentially new range

- Conduct range-wide surveys for *Drosophila differens* to determine or confirm the species' current distribution and status
  - Identify and document current ranges.
  - Determine demographic structure of populations.
  - Assess genetic diversity.

- Protect *Drosophila differens* populations and manage threats to habitat.
  - Identify sites to support each population.
  - Develop microclimate models to identify suitable habitat based on historical and current *Drosophila differens* distributions and habitat that would be suitable under potential future climate conditions.
  - Ensure long-term protection of sites from threats. Protect sites via land acquisition, conservation easements, landowner agreements, and/or other regulatory mechanisms.
    - Identify threats to sites occupied by populations used to meet recovery criteria.
    - Construct and maintain ungulate-proof fences around all occupied recovery sites.
    - Keep fenced recovery sites ungulate-free. Control or eradicate habitat-modifying invasive plants at all occupied recovery sites. Develop and implement rat control or eradication programs within all occupied recovery sites. Provide wildfire protection as necessary.
      - Assess the effects of climate change on wildfire risk and need for fire management plans.
      - Develop and implement fire management plans to assure occupied recovery sites are protected and likelihood of fire is reduced, especially in the dry and mesic habitats.
    - Prevent other habitat modifying threats, including incipient invasive species, from invading occupied recovery sites.
    - Control other existing threats to occupied recovery sites.
  - Monitor management and use results to adjust management actions.

- Control or manage species-specific threats.
  - Develop and implement control programs for nonnative rats (Polynesian, Norway, and roof rat).
  - Develop and implement control programs for nonnative ants (e.g., Papuan thief ant or others that threaten *Drosophila differens*).
  - Develop and implement control programs for nonnative western yellowjacket.
  - Develop and implement control programs for nonnative crane flies and other invertebrates that compete for host resources.
  - Develop and implement control programs for parasitoid wasps.
  - Control other direct threats to the *Drosophila differens* species as appropriate.
  - Monitor management and use results to adapt management actions.
- Expand the distribution of existing wild populations and establish new populations.
  - Establish and maintain *ex situ* captive propagation or rearing programs with genetically representative founders.
  - Identify areas appropriate for translocating individuals to increase the number of occupied recovery sites.
  - Select individuals for translocation.
  - Translocate genetically appropriate individuals into managed sites

- Consider the feasibility and conservation benefit of translocating *Drosophila differens* outside of the species' known historical range as appropriate (e.g., assisted colonization).
- Monitor management and use results to adapt management actions.

- Conduct additional research essential to recovering *Drosophila differens* and restoring the species habitat.
  - Develop tools to enhance habitat and species survival and reproduction.
  - Develop tools to inform actions that will improve species viability *in situ* and *ex situ.*
  - Maintain long-term studies on the range, demographics, and dispersal of *Drosophila differens*.
  - Conduct research on threats to the viability of all life stages of *Drosophila differens*.
  - Develop tools for monitoring population growth and status.
  - Conduct population viability analyses for the species.
  - Conduct studies on optimizing conservation translocation survival and success.
  - Conduct long-term genetic studies on captive and wild populations of *Drosophila differens*.
  - Monitor the range-wide populations, status, population trends, and distribution at time intervals appropriate for *Drosophila differens*.
- Implement regulations and policy to support species recovery.
  - Provide support to implement the Hawai'i interagency biosecurity plan to prevent the arrival and spread of new invasive species into the Hawaiian Archipelago and inter-island movement of invasive species already established to Moloka'i.
  - Implement public outreach and education and enforce policies that prohibit species collection and harassment.
  - Resolve state restrictions for using invasive species removal techniques.

References:

See previous 5-year reviews for a full list of references (USFWS 2018 and USFWS 2012)

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

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

For **Programmatic Deputy Field Supervisor, Pacific Islands Fish and Wildlife Office**

LAUREN WEISENBERGER

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