5-YEAR REVIEW

Short Form Summary

Species Reviewed: Hawaiian picture-wing fly (*Drosophila neoclavisetae*)
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 neoclavisetae* (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/5761*.

Review Analysis:
Please refer to the Recovery Plan for 50 Hawaiian Archipelago Species (USFWS 2022, entire), and the previous 5-year reviews for *Drosophila neoclavisetae* signed on August 28, 2012 (available at https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/1999.pdf) and signed on May 15, 2018 (available at https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2549.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. neoclavisetae* as endangered.

Drosophila neoclavisetae is endemic to the island of Maui where, historically, it was rare and known only from the Pu‘u Kukui area of West Maui between 3,400 to 4,500 feet (ft) (1,040 to 1,372 meters [m]) in wet forest habitat. The species has only been observed

twice: once in 1969 at 4,500 ft (1,372 m) and once in 1975 at 3,400 ft (1,040 m). Despite surveys of approxiately 95 percent of its likely range, the species has not been observed since 1975. Picture-wing flies may breed throughout the year, but egg laying generally increases following the rainy season as their larval food supply increases. The specific host of *D. neoclavisetae* is not known, though closely related species such as *Drosophila clavisetae*, use the decaying bark of *Cyanea* spp. as an oviposition and larval host. Female picture-wing flies lay their eggs in decomposing bark, of their host plants, which the larvae use as their feeding substrate. Adult flies are generalist microbivores (microbe eating) and feed upon a variety of decomposing plant material.

New Status Information:
No new status information for *Drosophila neoclavisetae.*

New Threats:

- Though less impact has occurred in the wet montane habitats of *Drosophila neoclavisetae*, Maui has experienced prolonged periods of abnormally dry to extreme drought conditions for the past 10 to 25 years (NIDIS 2020). This has resulted in overall habitat degradation and appears to alter decay processes of the picture-wing fly host plants. Drought also alters the entire plant community on which the fly depends. ʻŌhiʻa (*Metrosideros polymorpha*) is an important tree is the wet montane habitat of *D. neoclavisetae* and is susceptible to prolonged drought (Magnacca 2012 in litt., entire). *Drosophila neoclaviseae* prefers the dense shade in the fern understory, which is negatively impacted by the lack of dense and continuous overstory.

- 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 fly (Krushelnycky et al. 2017, entire). Because of the ant's expanding range and its widespread occurrence that overlaps with the habitat of *Drosophila neoclavisetae*, the ant species is a threat to the picture-wing fly throughout its range.

- Picture-wing flies are adversely impacted by competition with several species of nonnative limoniid crane flies in the family Limoniidae, for larval host substrates. The larvae of nonnative limoniid crane flies, such as *Libnotes* sp., feed within the decomposing bark of the host plants likely utilized by *Drosophila neoclavisetae* (Science Panel 2005, pp. 1–23; Magnacca 2005 in litt., entire). The effect of limonid crane fly competition is a reduction of available host plant material for the larvae of the picture-wing fly. In laboratory studies, Grimaldi and Jaenike (1984, pp. 1113–1120) demonstrated that 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).

- The plant disease, rapid ʻōhiʻa death (ROD) is an ongoing threat to ʻōhiʻa, an important canopy tree in the wet montane habitats. This lethal disease of ʻōhiʻa is caused by two fungal pathogens, *Ceratocystis lukuohia* and *C. huliohia* (Barnes et al., 2018, entire). *C. huliohia* is less aggressive and has been found on the islands of Kauaʻi, Oʻahu, Maui, and Hawaiʻi; *C. lukuohia* is highly aggressive and has been identified on the islands of Hawaiʻi and Kauaʻi (Friday et al. 2020, entire; Heller et al. 2019, entire). In July 2019, a single ʻōhiʻa tree was confirmed to be infected with *C. huliohia* on Maui and that tree was destroyed. Hundreds of thousands of ʻōhiʻa have died from this fungus infection on the island of Hawaiʻi, but the severe pathogen has not yet established on Maui (Friday et al. 2020, entire). Should *C. lukuohia* become established in the wet habitat of *Drosophila neoclavisetae* it would have similar impacts as drought. Like drought, the loss of canopy allows more sunlight to reach the forest floor increasing the temperature and lowering the humidity, and subsequently, adversely affecting the picture-wing fly and its habitat.

- Because of limited numbers of individuals and only one population observed in the last 50 years (1975), a single catastrophic event (e.g., hurricane, drought, fire) may result in extirpation of the extant population and extinction of this species. Species with few known locations, such as *Drosophila neoclavisetae,* are less resilient to threats that might otherwise have a relatively minor impact on widely distributed species. For example, the 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. The limited numbers and only one population observed in the last half century magnifies the severity of the impact of the other threats.

- Currently, four agencies are responsible for inspection of goods arriving in Hawaiʻi (USFWS 2006, pp. 26846–26848; USFWS 2013, p. 64679). The Hawaiʻi Department of Agriculture inspects domestic cargo and vessels and focuses on pests of concern to Hawaiʻi, especially insects or plant diseases not yet known to be present in the State. The U.S. Department of Homeland Securityʻs 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 habitat of *Drosophila neoclavisetae* 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 Hawai‘i and exacerbate other threats making the habitats unsuitable for the *D. neoclavisetae*, its host plants, or both. Changes in temperature and humidity may alter the decay cycle of the host plant substrates the picture-wing flies require in order to breed.

New Management Actions:

No new management actions have occurred for *Drosophila neoclavisetae.*

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

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

2022 recovery plan, USFWS 2022)	≤1	Criterion 1: At least five populations with stable population indices are distributed throughout the 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.	No
		Criterion 4: Threats to suitable habitats supporting *Downlisting Criterion 1* are managed and afforded land protections to ensure long-term persistence of the species.	No
		Criterion 5: All major threats to individuals and populations in *Downlisting Criterion* 1 are managed; monitoring and management plans are completed and implemented for *Drosophila neoclavisetae*; 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 the species' range; all units of designated critical habitat occupied by at least one	No

		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.	No
		Criterion 4: Threats to suitable habitats supporting *Downlisting Criterion 1* are managed and afforded land protections to ensure long-term persistence of the species.	No
		Criterion 5: All major threats to individuals and populations in *Downlisting Criterion* 1 are managed; monitoring and management plans are completed and implemented for *Drosophila neoclavisetae*; measures are in place to prevent introduction of new threats to host plants.	No

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

Threat	**Listing Factor**	**Current Status**	**Conservation/Management Efforts**
Ungulates	A	Ongoing	• Partial; Fencing, ongoing pig control and invasive plant management in the Pu‘u Kukui Watershed lands has decreased the negative impacts to *Cyanea* spp. and other native fauna (Science Panel 2005 pp. 19–20; Bartlett 2006 in litt., entire).

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Nonnative plants	A	Ongoing	None
Fire	A	Ongoing	None
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	None
Habitat altering plant disease	E	Ongoing	None
Loss of plant hosts	E	Ongoing	None
Rats	E	Ongoing	None
Limited population/individual numbers	E	Ongoing	None
Competition for breeding substrates	E	Ongoing	None
Not in captive rearing	E	Ongoing	None
Climate change	E	Ongoing	None

Synthesis:
Drosophila neoclavisetae is a picture-wing fly in the family Drosophilidae. Downlisting and delisting criteria for *Drosophila neoclavisetae* are listed in the recovery plan finalized in 2022 (USFWS 2022). The only populations of *Drosophila neoclavisetae* observed in the last 55 years (1969 and 1975) are from the Puʻu Kukui area of West Maui (Kaneshiro 2005, entire; Kaneshiro 2006 in litt., entire). A population may still occur at Puʻu Kukui, but the current status of that population is unknown. No observations of the species have been made at this location in 50 years, despite years of thorough surveys of 95% of the potential habitat for the species. If an extant population exists it is certainly isolated. If not already extirpated, the population on West Maui is at high risk of extirpation, which would lead to extinction of the species. The host of *D. neoclavisetae* is not known, though closely related picture-wing fly species use *Cyanea* spp. The primary factors that pose serious and ongoing threats to *Drosophila neoclavisetae* and its habitat include limited numbers of individuals and known populations, predation by nonnative wasps and ants, parasitization by nonnative wasps, competition with nonnative invertebrates for host resources, habitat degradation and destruction from nonnative ungulates and nonnative invasive plants, limited availablity of host plants, drought and declining humidity, and changes in canopy cover. The extremely limited number of known populations makes the species especially vulnerable to catastrophic events, such as hurricanes or fire. Fencing

and pig control in the Puʻu Kukui Watershed lands has decreased the negative impacts to *Cyanea* spp. and other native flora which may provide benefits to the species if the species is extant. Due the limited range of the species and the unknown population status, *Drosophila neoclavisetae* meets the criteria of endangered.

Recommendations for Future Actions:

- Determine the current distribution and status of the species and its habitat**.**
  - Develop a survey methodology for *Drosophila neoclavisetae* species' population based on the species' historical, known, and potentially new range
  - Conduct range-wide surveys for *Drosophila neoclavisetae* to determine or confirm its current distribution and status
    - Identify and document current ranges.
    - Determine demographic structure of populations.
    - Assess genetic diversity.

- Protect *Drosophila neoclavisetae* 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 neoclavisetae* distribution 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 neoclavisetae*).
  - 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 neoclavisetae* 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 neoclavisetae* 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 neoclavisetae* 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 neoclavisetae*.
  - Conduct research on threats to the viability of all life stages of *Drosophila neoclavisetae*.
  - 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 neoclavisetae*.
  - Monitor the range-wide populations, status, population trends, and distribution at time intervals appropriate for *Drosophila neoclavisetae*.
- 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 Maui.
  - 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 neoclavisetae*)

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 **Field Supervisor, Pacific Islands Fish and Wildlife Office**

LAUREN WEISENBERGER Digitally signed by LAUREN WEISENBERGER Date: 2023.08.17 15:50:11 -10'00'

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