Bidens conjuncta
(koʻokoʻolau)

5-Year Review
Summary and Evaluation

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

5-YEAR REVIEW

Species reviewed: *Bidens conjuncta* (koʻokoʻolau)

TABLE OF CONTENTS

5-YEAR REVIEW
Bidens conjuncta (ko‘oko‘olau)

1.0 GENERAL INFORMATION

1.1 Reviewers:

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Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
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Lead Field Office:
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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 (Service), beginning in October 2019. The review was based on the final rule listing this species; the final critical habitat designation; peer reviewed scientific publications; unpublished field observations by the Service, State of Hawai‘i, and other experienced biologists; unpublished survey reports; notes and communications from other qualified biologists; as well as a review of current, available information. The evaluation of Cheryl Phillipson, Biologist, was reviewed by Lauren Weisenberger, Plant Recovery Coordinator, and Megan Laut, Conservation and Restoration Team Manager.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

[USFWS] U.S. Fish and Wildlife Service. 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews for 156 species in Oregon, Washington, Hawaii, Palau, Guam, and the Northern Mariana Islands. Federal Register 88(83): 20088–20092, May 7, 2018.

1.3.2 Listing history:

Original Listing
FR notice: [USFWS] U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; determination of endangered status for 38 species

on Molokai, Lanai, and Maui; final rule. Department of the Interior, Federal Register 78 (102): 32014–32065, May 28, 2013.

Date listed: May 28, 2013
Entity listed: *Bidens conjuncta*
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:

FR notice: [USFWS] U.S. Fish and Wildlife Service. 2016. Endangered and threatened wildlife and plants; designation and nondesignation of critical habitat on Molokai, Lanai, Maui, and Kahoolawe; final rule. Department of the Interior, Federal Register 81 (61): 17790–18110, March 30, 2016.

Critical habitat was designated on Maui for *Bidens conjuncta*, totaling 12 units in the lowland wet, montane wet, and wet cliff ecosystems (3,219 ha; 14,509 ac) (81 FR 17790).

1.3.4 Review History:

This is the first 5-year review for *Bidens conjuncta*.

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

2

1.3.6 Current Recovery Plan or Outline:

Name of plan or outline: Recovery Outline for the Islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui)
Date issued: October 2019
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
____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
__X_No

2.2.2 Adequacy of recovery criteria.

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

____Yes
____No

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

____Yes
____No

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:
A synthesis of the threats (Listing Factors A, C, D, and E) affecting this species is presented in section 2.3.2 and Table 2. Listing Factor B (overutilization for

commercial, recreational, scientific, or educational purposes) is not known to be a threat to this species.

The recovery plan is currently being drafted. However, the Hawai‘i and Pacific Plants Recovery Coordinating Committee (HPPRCC) has outlined the actions and goals for stages leading towards recovery (2011). These stages are described below.

Current information is lacking for many Hawaiian plant species on the status of the species and their habitats, breeding systems, genetics, and propagule storage options. The following downlisting and delisting criteria for plants have therefore been adopted from the revised recovery objective guidelines developed by the HPPRCC (2011). Many of the Hawaiian plant species are at very low numbers, so the Service also developed criteria for avoiding imminent extinction and an interim stage before downlisting, based on the recommendations of the HPPRCC, to assist in tracking progress toward the ultimate goal of recovery. These criteria are assessed on a species-by-species basis, especially as additional information becomes available.

In general, long-lived perennials are those taxa either known or believed to have life spans greater than 10 years; short-lived perennials are those known or believed to have life spans greater than one year but less than 10 years; and annuals are those known or believed to have life spans less than or equal to one year. When it is unknown whether a species is long- or short-lived, the Service has erred on the side of caution and considered the species short-lived. This will be revised as more is learned about the life histories of these species. Narrow extant range and broad contiguous range are recognized as not needing different numbers of individuals or populations, but that the populations will be distributed more narrowly or more broadly, respectively, across the landscape. Obligate outcrossers are those species that either have male and female flowers on separate plants or otherwise require cross-pollination to fertilize seeds, and therefore require equal numbers of individuals contributing to reproduction as males and females, doubling the number of mature individuals. Species that reproduce vegetatively may reproduce sexually only on occasion, resulting in the majority of the genetic variation being between populations, therefore requiring additional populations. Species that have a tendency to fluctuate in number from year to year require a larger number of mature individuals on average to allow for decline in years of extreme habitat conditions and recuperation in numbers in years of more normal conditions.

Preventing Extinction

Stabilizing (interim), downlisting, and delisting objectives have been updated according to the draft revised recovery objective guidelines developed by the HPPRCC (2011). The HPPRCC identifies an additional initial objective, the Preventing Extinction Stage, in addition to the Interim Stabilization, Delisting, and Downlisting objectives. Furthermore, life history traits such as breeding

system, population size fluctuation or decline, and reproduction type (sexual or vegetative), have been included in the calculation of goals for the number of populations and reproducing individuals for each stage. The goals for each stage remain grouped by life span defined as annual, short-lived perennial (fewer than 10 years), or long-lived perennial.

Bidens conjuncta is a short-lived perennial herb. To prevent extinction, which is the first milestone in recovering the species, the taxon must be managed to control threats (*e.g*., fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in *ex situ* (secured off-site, such as a nursery or seed bank) collections. In addition, a minimum of three populations should be documented on Maui where they now occur or occurred historically. Each of these populations must be naturally reproducing (*i.e*., viable seeds, seedlings, saplings) and increasing in number, with a minimum of 50 mature individuals per population.

There are three populations that are estimated to total 2,000 individuals; however, strategic fencing provides only partial protection, and other threats such as nonnative plant control, slug control, and possible hybridization are not being addressed at all populations. In addition, it is uncertain how many founders are represented in collections as reported collection sources are pooled and some may be hybrids. Therefore, this recovery objective has not been met (see Table 1).

Interim Stage

To meet the interim stage of recovery of *Bidens conjuncta*, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an *ex situ* collection as defined in the Center for Plant Conservation's guidelines (Guerrant *et al.* 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management.

This recovery objective has not been met (see Table 1).

Downlisting Criteria

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the

factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes major limiting factors, breeding system, population structure and density, and proven management methods for major threats.

This recovery objective has not been met (see Table 1).

Delisting Criteria
In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis.

This recovery objective has not been met (see Table 1).

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:

Bidens conjuncta is an erect, perennial herb, 0.7 to 2 meters (m) (2.3 to 6.6 feet (ft)) tall, with horizontal or ascending lateral branches. The leaves are simple or pinnately (in two rows) compound, 6 to 15 centimeters (cm) (2.4 to 6 inches (in)) long, comprised of one to five leaflets (ultimate unit of a compound leaf) which are ovate-lanceolate (oval-lanced shaped), 5.5 to 10.5 cm (2.2 to 4 in) long, 3 to 6 cm (1.2 to 2.4 in) wide, densely pubescent (hairs) along veins, and have toothed margins. Flower heads are 15 to 45 and bear 8 to 15 disk florets (small flower that is part of a cluster) in compound cymes, and corollas (petals) are yellow. Achenes (dry, one-celled indehiscent (remaining closed at maturity) fruit) are brownish black, straight, or slightly curved, 12 to 20 millimeters (mm) (0.5 to 0.8 in) long, and 1 to 1.2 mm (0.04 to 0.05 in) wide (Ganders and Nagata 1999, pp. 273–274).

Bidens is a taxonomically difficult genus, encompassing more than 230 species according to Sherff (Ganders *et al*. 1999, p. 268). The name is

derived from the Latin *bi*, two, and *dens*, teeth, in reference to the awns. The 19 species that are endemic to the Hawaiian Islands represent adaptive radiation from a single-known ancestor, and all can interbreed (Ganders and Nagata 1984; Knope *et al.* 2012, p. 2). Some *Bidens* species were used medicinally by Hawaiians and are still harvested for herbal tea (Ganders and Nagata 1999, p. 268). *Bidens conjuncta* has been observed to hybridize with *B. campylotheca* and *B. micrantha* subsp. *micrantha* (Oppenheimer 2019, pers. comm.). These hybrids are scattered and show similar characteristics; however, there is a difference in the central stem structure (Oppenheimer 2019, pers. comm.).

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:
In 2013, when *Bidens conjuncta* was listed Endangered, there were nine occurrences totaling an estimated 7,000 individuals (78 FR 32014, September 18, 2013). By 2016, the numbers were estimated to range from 3,000 to as many as 7,000; however, it was uncertain if these occurrences were self-sustaining (82 FR 27790, March 30, 2016). Currently, there are three populations of *B. conjuncta* in the west Maui Mountains totaling an estimated 2,000 individuals (Oppenheimer 2019, pers. comm.). Two populations are within the west Maui Natural Area Reserve (NAR)-Kahakuloa section. The third population is located within Puʻukukui and on adjacent county land. A fourth population was located in Waiheʻe valley, but has been displaced by the nonnative plant *Clidemia hirta* (Koster's curse) (Oppenheimer 2019, pers. comm.).

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

2.3.1.4 Taxonomic classification or changes in nomenclature:
Bidens conjuncta was described by Sherff (1923, p. 162) from a collection at Honokōhau drainage basin on west Maui. It differed from *B. sandvicensis* by its larger leaves, sessile lateral leaflets, larger bracts, longer ray flowers, and larger achenes. This species is recognized as a distinct taxon in Ganders and Nagata (1999) and Wagner and Herbst (2003), the most recently accepted Hawaiian plant taxonomy.

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.):
See section 2.3.1.2 above for spatial distribution of the species.

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

Currently, this species is found scattered throughout the upper elevation drainages of west Maui in the lowland wet, montane wet, wet cliff, and bog ecosystems (The Nature Conservancy of Hawai‘i (TNCH) 2007; Oppenheimer 2019, pers. comm.). The populations range from 670 to 1,300 m (2,200 to 4,250 ft) including montane rainforest dominated by *Metrosideros* (‘ōhi‘a) bog communities of *Rhynchospora* (kuolohia) and *Oreobolus furcatus* (an endemic sedge) (Gagne and Cuddihy 1990, p. 103). Other associated native species include *Dicranopteris linearis* (uluhe), *Cheirodendron trigynum* (‘ōlapa), *Dubautia* spp. (na‘ena‘e), and *Hydrangea arguta* (kanawao) (Hawaii Biodiversity and Mapping Program (HBMP) 2010).

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 (Factor A):

Ungulate degradation of habitat—The effects of nonnative animals (primarily pigs) to the habitat and populations of *Bidens conjuncta* includes the trampling of plants and seedlings; direct consumption of *B. conjuncta* and associated native bog vegetation; soil disturbance; dispersal of nonnative plant seeds on hooves and coats, and through the spread of seeds in feces; and the creation of open, disturbed areas conducive to further invasion by nonnative plant species (HBMP 2010; Loope 1998, entire; van Riper and van Riper 1982, pp. 34–35).

Established ecosystem-altering invasive plant modification and degradation of habitat—Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990, entire). Habitat modification and destruction by invasive nonnative plants negatively affects all occurrences of *Bidens conjuncta* (HBMP 2010). Nonnative plants with the greatest impacts on *B. conjuncta* include *Tibouchina herbacea* (cane tibouchina), *Ageratina adenophora* (Maui pāmakani), *Psidium cattleianum* (strawberry guava), *Clidemia hirta* (Koster’s curse), *Rubus rosifolius* (thimbleberry), and several *Juncus* (bog rush) species (HBMP 2010; Oppenheimer 2019, pers. comm.).

Climate change loss or degradation of habitat—Fortini *et al.* (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative

inability of a species to display the possible responses necessary for persistence under climate change. The assessment concluded that *Bidens conjuncta* is highly vulnerable to the impacts of climate change with a vulnerability score of 0.705 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts.

Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel *et al.* 2008; Yu *et al.* 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami *et al.* 2013). Hurricanes pose an ongoing and ever-present threat because they can happen at any time. A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes (Factor B):
Not a threat.

2.3.2.3 Disease or predation (Factor C):
Herbivory and predation by slugs and rats—Research and field observations indicate that herbivory by slugs and rats is a threat to *Bidens conjuncta* in the wild (HBMP 2010; Joe 2006, entire; Oppenheimer 2019, pers. comm.).

2.3.2.4 Inadequacy of existing regulatory mechanisms:
Not a threat.

2.3.2.5 Other natural or manmade factors affecting its continued existence (Factor E):
Hybridization—*Bidens conjuncta* can hybridize with *B. campylotheca* and *B. micrantha* subsp. *micrantha* when they occur sympatrically (Oppenheimer 2019, pers. comm.). Hybridization is a phenomenon in which can lead to the formation of a new species (Orians 2000, p. 1949) or sometimes a decline of species genetics or "introgression" (Ellstrand 1992, pp. 77, 81; Levin *et al*. 1996, pp. 10–16; Rhymer and Simberloff 1996, p. 85). Hybridization is problematic for any rare species that come in contact with a species that are more abundant and common (Rhymer and Simberloff 1996, p. 83).

Current Management Actions:

- Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) monitors occurrences of *Bidens conjuncta* (Oppenheimer 2019, pers. comm.).
- Captive propagation for genetic storage and reintroduction—
    - The Lyon Arboretum Seed Conservation Laboratory reports 1,774 seeds collected and pooled from several plants at Kahakuloa stream (Lyon Arboretum 2018, 2019).
    - The Olinda Rare Plant Nursery (ORPF) reports propagation of 31 individuals (ORPF 2019).
- Reintroduction and translocation—ORPF reports preparing nine individuals for reintroduction at Waiheʻe (ORPF 2018).

Table 1. Status and trends of *Bidens conjuncta* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Preventing Extinction Criteria identified by HPPRCC	Preventing Extinction Criteria Completed?
2013 (listing)	ca 7,000	0	All threats managed in all 3 populations	Partially, strategic fencing
			Complete genetic storage	Partially, many collections pooled
			3 populations with 50 mature individuals each	Partially, two populations >1,000
2016 (critical habitat)	3,000–7,000	0	All threats managed in all 3 populations	Partially, strategic fencing
			Complete genetic storage	Partially, many collections pooled
			3 populations with 50 mature individuals each	Partially, two populations >1,000
2020 (5-year review)	3,000	0	All threats managed in all 3 populations	Partially, strategic fencing
			Complete genetic storage	Partially, many collections pooled
			3 populations with 50 mature individuals each	Partially, two populations >1,000

Table 2. Threats to *Bidens conjuncta* and ongoing conservation efforts.

Threat	Listing Factor	Current Status	Conservation/Management Efforts
Ungulate degradation of habitat	A	Ongoing	Partial, strategic fencing
Established ecosystem-altering invasive plant	A	Ongoing	Partial, some landscape-scale nonnative plant management

modification and degradation of habitat			
Climate change degradation or loss of habitat, including hurricanes	A	Ongoing	Partial, some landscape-scale nonnative plant management
Predation and herbivory by rats	C	Ongoing	None
Hybridization	E	Ongoing	None

2.4 Synthesis

There are approximately 2,000 wild individuals of *Bidens conjuncta* on west Maui, a decline from the 7,000 reported at the time of listing in 2013. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini *et al.* (2013) and their analysis showed that *B. conjuncta* is highly vulnerable to the effects of climate change. There are seeds and propagules in collections and some reintroduction is ongoing. Strategic fencing provides protection from habitat degradation and browsing by feral ungulates in most areas.

Preventing extinction, interim stabilization, downlisting, and delisting objectives are provided in HPPRCC's Revised Recovery Objective Guidelines (2011). To prevent extinction, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g.*, fenced) and have 50 individuals (or the total number of individuals if fewer than 50 exist) from each of three populations represented in an *ex situ* (at other than the plant's natural location, such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on Maui where they now occur or occurred historically and each of these populations must be naturally reproducing (*i.e.*, viable seeds, seedlings, or saplings) with a minimum of 50 mature, reproducing individuals per population.

The preventing extinction goals for this species have not been met as, although there are an estimated 2,000 individuals in three populations, numbers continue to decline. There is only partial genetic representation (Table 1) and all threats are not being sufficiently managed throughout the range of the species (Table 2). Therefore, *Bidens conjuncta* meets the definition of endangered as it remains in danger of extinction throughout its range.

3.0 RESULTS

3.1 Recommended Classification:

____Downlist to Threatened
____Uplist to Endangered

____**Delist**

___*Extinction*

____*Recovery*

____*Original data for classification in error*

__X__**No change is needed**

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

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

- Surveys and inventories—Continue to assess the status of known occurrences of *Bidens conjuncta* in historical locations and potentially suitable habitat.
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates.
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with *B. conjuncta*.
- Predation and herbivory by rodents—Implement effective control methods for rats at all populations.
- Predation and herbivory by slugs—Implement effective control methods for slugs at all populations.
- Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts for maintenance of genetic stock, and keep track of individual founders.
- Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change
- Reintroduction and translocation—Increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of habitat degradation by feral ungulates, nonnative plants, and events associated with climate change; and predation/herbivory by feral ungulates, rats, and slugs.
- Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Bidens conjuncta*
(koʻokoʻolau)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____Downlist to Threatened
____Uplist to Endangered
____Delist
_X__No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: _____

Review Conducted By:
Cheryl Phillipson, Fish and Wildlife Biologist, PIFWO
Lauren Weisenberger, Plant Recovery Coordinator, PIFWO
Megan Laut, Conservation and Restoration Team Manager, PIFWO

FIELD OFFICE APPROVAL:

MEGAN LAUT Digitally signed by MEGAN LAUT
Date: 2020.03.02 11:20:28 -10'00'

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