RECOVERY PLAN FOR

HIBISCADELPHUS DISTANS

JUNE, 1996

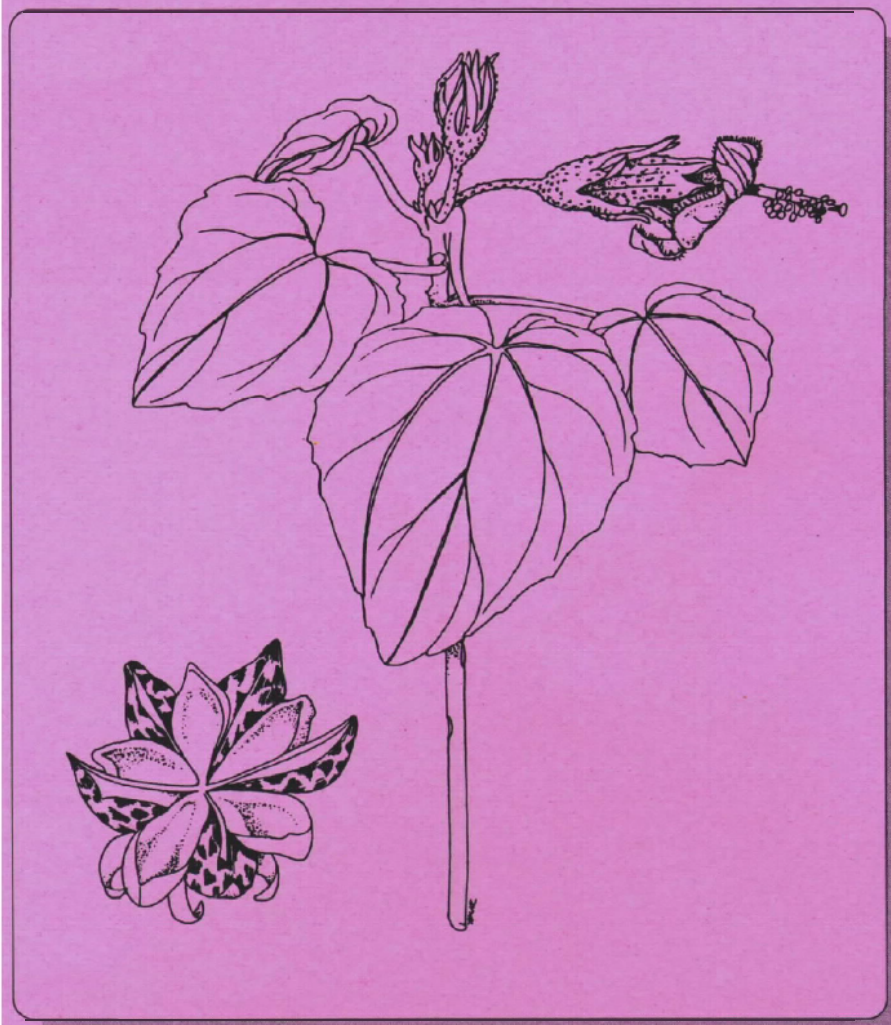

Illustration of H. distans *from Bates (1990)*

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RECOVERY PLAN FOR

Hibiscadelphus distans

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ACKNOWLEDGEMENTS

The recovery plan for *Hibiscadelphus distans* was prepared by Dr. Diane Ragone, Program Coordinator, Hawaii Plant Conservation Center, National Tropical Botanical Garden, P.O. Box 340, Lawai, Kauai, Hawaii 96765. Modifications have been made by the U.S. Fish and Wildlife Service.

EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR *HIBISCADELPHUS DISTANS*

Current Species Status: *Hibiscadelphus distans* is restricted to the island of Kauai and is federally listed as endangered. There are only two known naturally-occurring populations, one with 6 individuals, which has been supplemented with 19 transplants, and the other with approximately 100 individuals, 50 of which are mature plants. There are also two planted populations, each with fewer than 10 individuals.

Habitat Requirements and Limiting Factors: *Hibiscadelphus distans* is found within low to mid-elevations, between 300 to 550 meters (1000 to 1800 feet), in highly degraded native dryland forests. The substrate is basaltic bedrock overlain by dry, crumbly red-brown soil (inceptisol). All populations are threatened by alien plant competitors, introduced herbivores (goats and insects), human disturbance, rockslides, catastrophic events, and a limited gene pool. The originally discovered population was destroyed by a landslide in 1989.

Recovery Objective: To delist *Hibiscadelphus distans*.

Recovery Criteria: The species may be downlisted when it is represented by at least six naturally reproducing, fenced populations on the island of Kauai, each with at least 50 reproductive individuals for a minimum of 9 years. Delisting would further require sufficient reduction of threats to allow unassisted reproduction and stable or increasing populations, with a 10-year average of 250 reproductive plants in each of the six populations.

Actions Needed:

1. Protect and stabilize existing populations.
2. Increase and diversify populations, re-establish in former range, and manage threats, as needed.
3. Conduct research on limiting factors and monitor populations.
4. Validate recovery objectives.

Total Estimated Cost of Recovery ($1,000):

Year	Need 1	Need 2	Need 3	Need 4	Total
1996	41.5	42.5	5	0	89
1997	135	42.5	49	0	226.5
1998	221	49	49	0	319
1999	172	26	49	0	247
2000	157	39.5	49	0	245.5
2001	122	31	49	0	202
2002	102	28	49	0	179
2003	102	8	49	0	159
2004	102	8	49	0	159
2005	95	8	49	40	152
2006	95	7	49	40	151
2007	55	7	5	40	67
2008	42	7	5	0	54
2009	42	7	5	0	54
2010	42	7	5	0	54
2011	42	0	5	0	47
2012	42	0	5	0	47
2013	42	0	5	0	47
2014	42	0	5	0	47
2015	42	0	5	0	47
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Total	1735.5	317.5	540	120	2713

Date of Recovery: Downlisting to Threatened should initiate in 2015, if recovery criteria are met.

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I. INTRODUCTION

Brief Overview

Hibiscadelphus (Malvaceae, the Mallow family), is an endemic Hawaiian genus that is considered one of the world's rarest groups of trees. This genus once inhabited the diverse mesic forests of Hawaii at middle elevations, where rainfall was moderate. Introduced animals and land clearing for agriculture over the past two hundred years have so altered and destroyed these forests that little intact primary habitat remains.

The subject of this recovery plan, *Hibiscadelphus distans*, occurs only on the island of Kauai (Figure 1). Only six plants were known to exist in the wild until April 1991, when a new population of approximately 100 plants was discovered above the known population. This is the largest population of any *Hibiscadelphus* species ever found. *Hibiscadelphus distans* is threatened by feral goat browsing, rock slides, competition from alien vegetation, insect herbivory, human disturbance, catastrophic events, such as fire and hurricanes, and a limited gene pool.

Hibiscadelphus distans was federally listed as endangered on April 29, 1986 (Herbst 1986); the effective date of the listing was May 30, 1986. Critical habitat was not designated for this species. It has been assigned a recovery priority number of 2. Priority numbers range from 1C-18 based on magnitude and immediacy of threat as well as recovery potential, with priority number 1C being given the highest priority number and 18 the lowest A priority of 2 indicates that it is a species subjected to a high degree of threat, but with high recovery potential (48 FR 43104).

Taxonomy

The genus *Hibiscadelphus* was established by Joseph Rock in 1911 (Radlkofer and Rock 1911) to describe three species found on the islands of Maui and Hawaii. *Hibiscadelphus* is most closely allied to the genus *Hibiscus*, hence its epithet meaning "brother of *Hibiscus*." The Hawaiian name, hau kuahiwi, means upland or mountain hau because of its resemblance to the common lowland *Hibiscus tiliaceus* (Rock 1913; Bates 1990).

Hibiscadelphus distans was discovered on Kauai in June 1972 by L. Earl Bishop and Derral Herbst (1973) in the lower reaches of Waimea Canyon. They named it *Hibiscadelphus distans* because of its geographic isolation and morphological differences from other known species. Its morphological characters suggest that it represents the earliest evolutionarily divergent lineage for this genus (Hobdy 1984). Herbarium specimens are housed at the Bishop Museum, University of Hawaii Botany Department, U.S. National Herbarium, and The National Tropical Botanical Garden (NTBG).

Species Description

Hibiscadelphus distans is a shrub or small tree up to 18 feet (5.5 meters) tall with smooth bark and a rounded crown. The green, heart-shaped leaves are 1.5 to 4 inches (4 to 10 centimeters) long with numerous whitish hairs on the underside (Figure 2). The narrow, tubular, curved flowers are approximately 1 inch (2.5 centimeters) long with persistent leaf-like structures below the flowers. The flowers are greenish yellow, turning maroon with age. The seed pods are woody capsules with five sections, each containing two seeds. This species is readily grown from seeds and can be vegetatively propagated from cuttings.

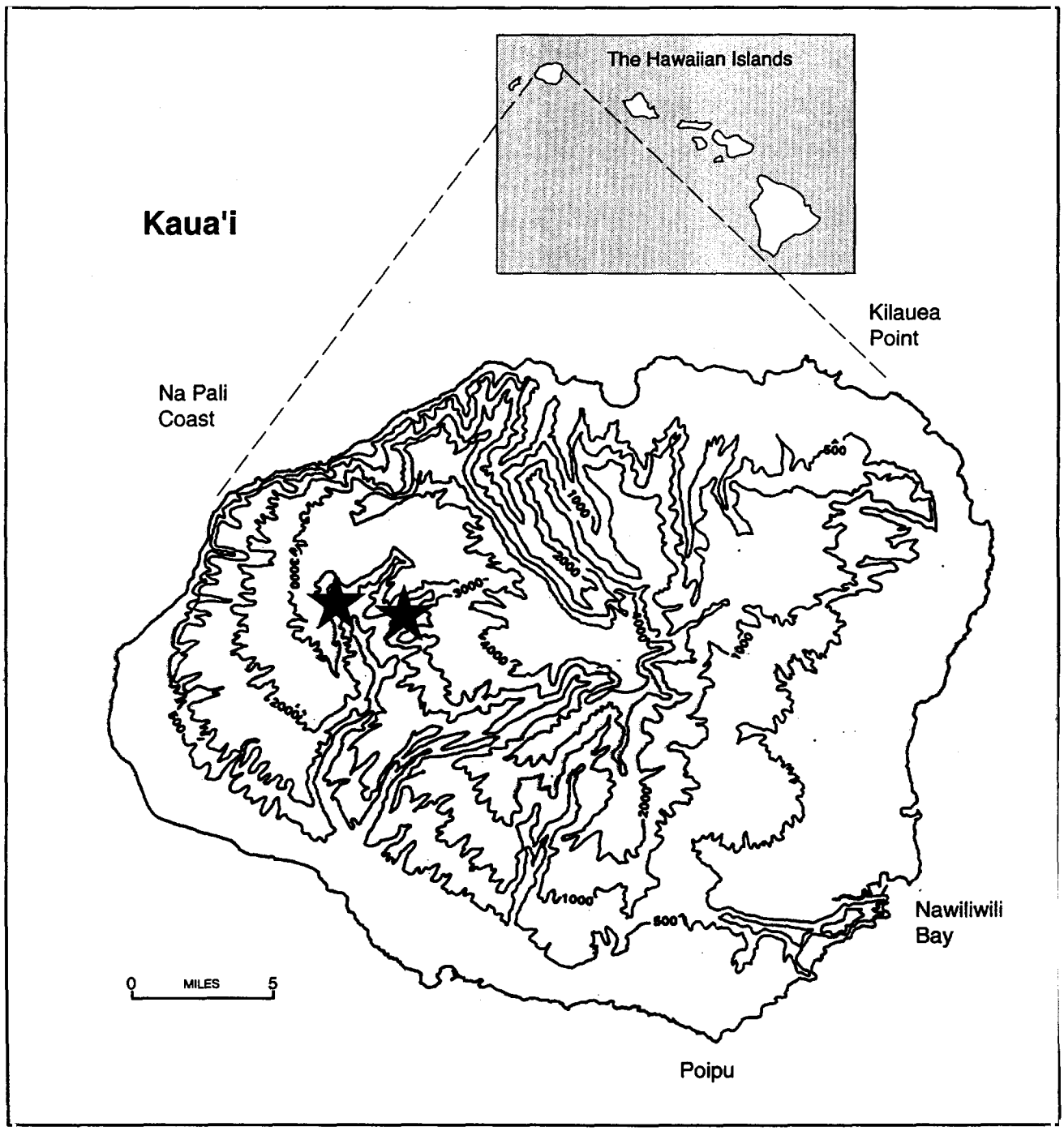

Figure 1. Locations of *Hibiscadelphus distans*

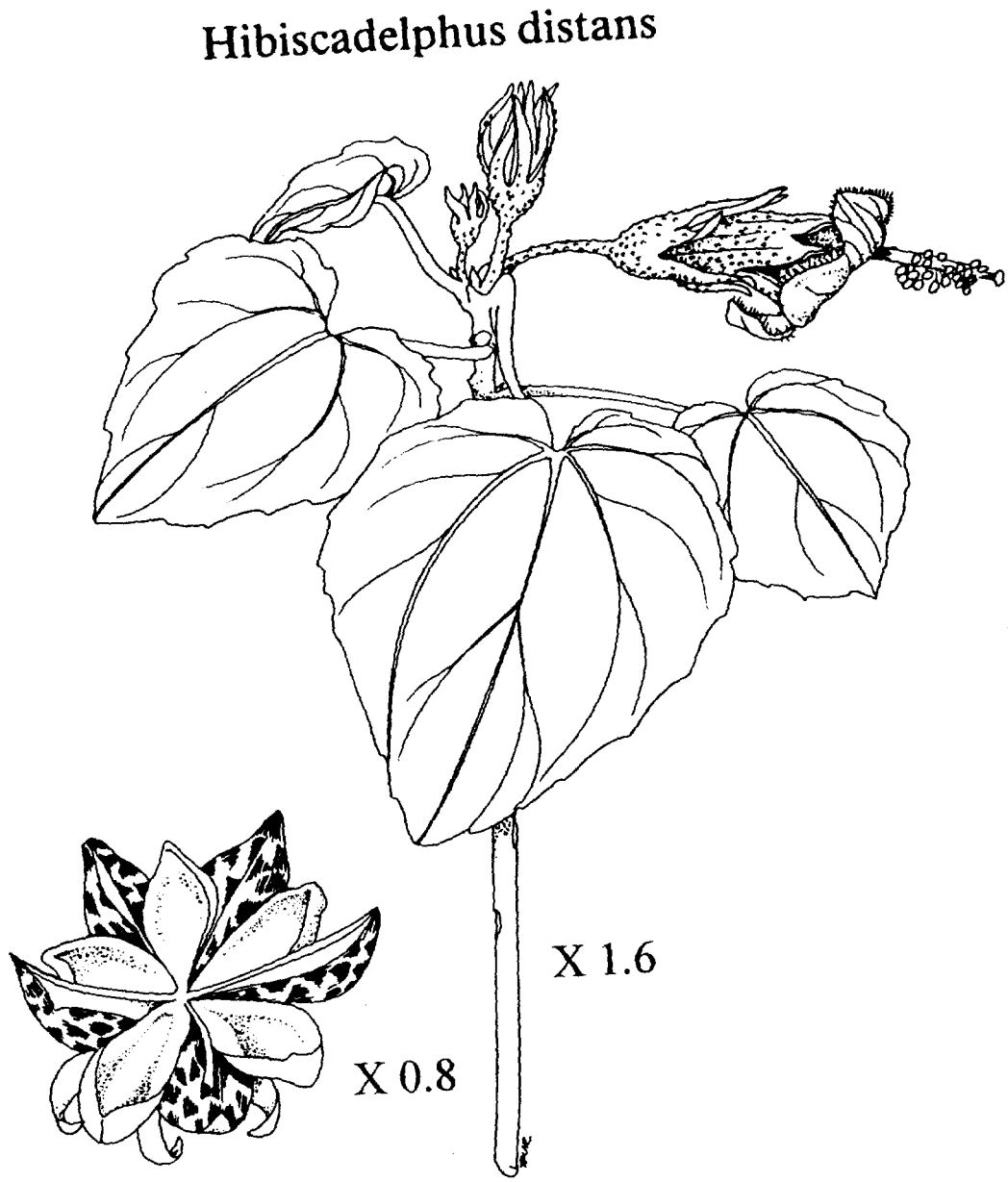

Figure 2. Illustration of *H. distans* from Bates (1990).

Life History

Very little is known about the life history of this species. Trees in cultivation have begun flowering in 3 years, but the age at which trees in the wild begin flowering is unknown. Neither the number of years this species remains reproductive nor its longevity is known. No demographic or other ecological studies have been reported, with the exception of nectar production and pollinator relationships. The narrow, curved flowers produce abundant nectar, indicating that they may have had an important pollination-feeding relationship with one native bird family, Meliphagidae (honey-eaters), and one subfamily, Drepanidinae (honeycreepers) (Hobdy 1984). Hobdy speculated that the decline and extinction of certain native birds, especially the Meliphagids in the genera *Moho* and *Chaetoptila*, may be closely linked to the decline of *Hibiscadelphus*.

Distribution and Population Status

The original population found by Bishop and Herbst in 1972 was located within the State-owned Na Pali Kona Forest Reserve, Koaie Canyon. The colony of ten trees was located at approximately 1,000 feet (300 meters) elevation on a bluff above Koaie Stream. A total of seven mature trees were subsequently found, beginning with the discovery of four additional plants in 1980 upstream of the original colony.

In 1989, the original colony of 10 trees was destroyed by a landslide. In January 1990, Tim Flynn, Chip Wichman, and Steve Perlman from NTBG and Tom Telfer and Galen Kawakami of the Kauai District of the Hawaii Division of Forestry and Wildlife (DOFAW) visited the Koaie Canyon *Hibiscadelphus*. They were able to locate all seven plants. Plant No. 5, which was seriously undermined by erosion and was leaning against a *Melia azedarach* tree, and plant No. 4 each had single, small seedlings beneath them. These were the only seedlings found in the area. The other plants had very little soil beneath them and were in such

seriously eroded sites that seedling survival was considered to be nearly nil. Seed was collected from the plants during this trip (Telfer 1990).

In March 1990, DOFAW personnel erected four exclosures (5-foot high (1.5 meters) hogwire fences) encompassing approximately 1/10 acre (0.04 hectares). Plant Nos. 1 and 2 were contained in one exclosure, plant No. 4 and its seedling were contained in an additional exclosure, and plants No. 5 and 6 were individually fenced. (The seedling that had been seen under plant No. 5 during the January 1990 site visit was no longer extant.) Plant No. 7 was not fenced, because it was situated on a rock prominence and could not be reached by goats, and Plant No. 3 was not fenced due to the unlikelihood that it would survive, given the extensive goat damage it had already suffered and the high level of erosion at the site. By April 1991, when Steve Perlman revisited the site, plant No. 3 had died. In August 1991, 19 saplings, propagated in the District Nursery from seed collected during the January 1990 site visit, were planted into the exclosure containing plant No. 5. In September 1992, when Hurricane Iniki struck the island of Kauai, a rockslide destroyed plant No. 6 and its exclosure.

In April 1991, Steve Perlman and Ken Wood, NTBG, discovered a new population of *Hibiscadelphus distans*, the largest recorded for any *Hibiscadelphus* species. On a cliff above the known colony, 56 mature plants up to 16 feet (5 meters) tall, 20 to 40 saplings ranging from 1 to 4 feet (0.3 to 1.2 meters) in height, and numerous seedlings were counted. The plants occur midslope on the north-facing cliff at an elevation of approximately 1,800 feet (550 meters). The steepness of the cliff face prevents goats from reaching the plants, but increases the likelihood of destruction as a result of land or rock slides.

In the late 1980's, the Kauai District of DOFAW constructed two 1/4 acre (0.1 hectare) exclosures on the west side of Waimea Canyon, within the Puu Ka Pele Forest Reserve. In 1990, they planted 10 *Hibiscadelphus distans* saplings into one of the exclosures (Kahoaloha Exclosure), located at 3,150 feet (960 meters) between Papalai and Lapa Ridges, and 8 saplings into the other exclosure (Kaulaula Exclosure), located in Kaulaula Valley at approximately 1,970 feet

(600 meters) (G. Kawakami, Protection Forester, DOFAW Kauai District, personal communication 1991). During a follow-up survey of the exclosures after Hurricane Iniki struck Kauai in September 1992, DOFAW personnel found that the populations in each of the exclosures were reduced by roughly one-half (G. Kawakami, personal communication 1993) (Table 1).

Habitat Description

The naturally occurring *Hibiscadelphus distans* in Lower Koaie Canyon are found within a highly degraded native mesic forest that receives full sun in summer with no direct sun in winter. Exposure is 320 to 340 degrees NNW. The area receives approximately 60 inches (15.2 centimeters) of rain annually, with yearly mean temperature ranging from 64° to 82°F (18° to 28°C). The substrate is basaltic bedrock overlain by dry, crumbly red-brown soil. Goats have denuded large areas causing severe erosion, and the entire area is prone to frequent rock slides.

Several of the downslope plants grow in a small drainage that is dry except during heavy run-off periods. Associated species include *Aleurites moluccana*, *Artemisia kauaiensis*, *Psydrax odoratum*, *Diospyros sandwicensis*, *Lipochaeta connata*, *Myrsine* sp., *Nototrichium sandwicense*, *Pouteria sandwicensis*, *Triumfetta senitriloba* and *Sapindus oahuensis*. *Melia azedarach*, an alien species, is now the dominant tree in the area. The ground cover is sparse and consists mainly of exotic grasses and broad-leaved herbaceous plants, including *Lantana camara*, which presents a major threat to this small population of *Hibiscadelphus distans*. Associated with the newly discovered cliffside population (upslope) are *Artemisia kauaiensis*, *Bidens sandwicensis*, *Psydrax odoratum*, *Carex meyenii*, *Dodonaea viscosa*, *Lipochaeta connata*, *Lobelia niihauensis*, and *Schiedea spergulina*. *Melinus minutifolia*, *Kalanchoe pinnata*, and *Opuntia* sp. are problem species at this location (Table 2).

TABLE 1. The current status of Hibiscadelphus distans on the island of Kauai, Hawaii. Data from Bishop and Herbst (1973), Telfer (1990), Steve Perlman (Hawaii Plant Conservation Center, field notes 1990), and G. Kawakami, personal communication 1991, 1993, 1994.

Population	Number of Plants	Number of Exclosures
Lower Koaie Canyon Na Pali Kona Forest Reserve		
1. Downslope	25[1]	3
2. Upslope	100	0[2]
Waimea Canyon Puu Ka Pele Forest Reserve		
1. Kahoaloha Exclosure	5[3]	1
2. Kaulaula Exclosure	4[3]	1
Total	134	

[1] 6 naturally-occurring individuals
19 individuals from captive stock

[2] cliff face too steep for feral ungulate browsing

[3] individuals planted from captive stock.

Table 2. List of plant species associated with the two populations of *Hibiscadelphus distans*.

Scientific name	Native or introduced	Protective status
Aleurites moluccana	introduced, Polynesian	
Artemisia kauaiensis	endemic	
Bidens sandvicensis	endemic	
Carex meyenii	indigenous	
Diospyros sandwicensis	endemic	
Dodonaea viscosa	indigenous	
Kalanchoe pinnata	introduced	
Lantana camara	introduced	
Lipochaeta connata	endemic	
Lobelia niihauensis	endemic	endangered[1]
Melia azedarach	introduced	
Melinus minutifolia	introduced	
Myrsine sp.	endemic	
Nototrichium sandwicense	endemic	
Opuntia sp.	introduced	
Pouteria sandvicensis	endemic	
Psydrax odoratum	indigenous	
Sapindus oahuensis	endemic	
Schiedea spergulina	endemic	endangered[2]
Triumfetta senitriloba	introduced	

Key to terms used in Table 2.

endemic = native only to Hawaii
indigenous = native to Hawaii, but found elsewhere
endangered = listed as an endangered species
introduced = not native to Hawaii
introduced, Polynesian =not native to Hawaii, but introduced before European contact

[1] Recovery of this taxon addressed in the Waianae Plant Cluster Recovery Plan

[2] Recovery of this taxon addressed in the Kauai Plant Cluster Recovery Plan

Reasons for Decline and Current Threats

The threats to *Hibiscadelphus distans* may be summarized as follows:

1. Feral Goats. The major threat to this species and its habitat is browsing and associated damage by feral goats. Goats chew on the foliage and bark of *Hibiscadelphus distans* and eat any seedlings they can reach. They also cause landslides by dislodging rocks from ledges above the plants, damaging the trees and destroying seedlings. The surrounding vegetation has also been over-browsed, causing increased erosion and danger from rock and land slides. Consequently, even those plants that do not suffer direct damage from goats can be indirectly harmed by goat activities. The large feral goat herds still extant on Kauai result from the game management practices of the State of Hawaii Department of Land and Natural Resources (DLNR), which maintain population levels for hunting (Herbst 1986). The large goat population on Kauai was probably responsible for the species' decline and now seriously threatens the continued existence of the few remaining plants.

2. Alien Plants. Habitat disturbances have favored the introduction and spread of exotic (non-native) plants, which compete with and smother native vegetation, especially seedlings. These exotic plants include *Melia azedarach*, *Lantana camara*, *Melinus minutifolia*, *Kalanchoe pinnata*, *Opuntia* sp. and *Myrica faya*, an extremely aggressive non-native tree species that has overgrown hundreds of acres in exclosure areas (Diane Ragone, Program Coordinator, NTBG, personal observation). The threat posed by these and other exotic plants becomes even more serious as browsing goats are removed from exclosures. In addition to negatively affecting many native species, the goats also act to keep the exotic plants in check. The invasion of alien plants may be the greatest single threat to the survival of *Hibiscadelphus distans* once the threat of goat browsing is eliminated.

3. Human Disturbance. A hiking trail passes below the area where the plants are located, and hikers and hunters can readily reach the plants. The area has experienced incidents of unauthorized taking and vandalism (Herbst 1986).

4. Catastrophic Events. A single landslide, fire, or other catastrophic event could easily extirpate remaining wild *Hibiscadelphus distans*.

(a) Rock and Landslides. The limited range of this endangered species makes it especially vulnerable to natural disasters. Overgrazing by goats has increased erosion in this area, and heavy rains in 1989 caused an extensive landslide that destroyed the original known colony.

(b) Fire and Other Stochastic Disasters (e.g. wind, hurricanes). The remaining populations of *Hibiscadelphus distans* occur in xeric areas, which are prone to fires. High winds may knock down trees and create bridges between microhabitats, allowing fires to spread farther than would be possible in fragmented terrain. The fire danger may increase if alien plant cover increases with reduced ungulate populations. Severe hurricanes occasionally pass through the Hawaiian Islands and produce winds of a magnitude that can be extremely damaging to the vegetation. During Hurricane Iniki in 1992, winds clocked in excess of 200 mph a few miles to the north of Waimea Canyon reduced the number of outplanted individuals to approximately one-half (G. Kawakami, personal communication 1993). *Hibiscadelphus distans*, reduced to remnant populations, remains under threat from stochastic events.

5. Insect pests. Insect pests on the genus *Hibiscadelphus* were first reported by Rock (1913), who noted the occurrence of worm-eaten seed capsules and caterpillars feeding on the leaves and mature capsules of *H. hualalaiensis*. This insect was identified as the introduced pink bollworm, *Pectinophora gossypiella*,

which attacks *Hibiscadelphus* and other native Malvaceae (Zimmerman 1978). The moth lays as many as 100 eggs in the calyx or flower, and the larvae feed on the seeds, destroying them. This insect is a quarantine pest under U.S. Department of Agriculture regulations (7 CFR 318.47) due to the damage it causes to commercial cotton production.

Larvae found in seed capsules of *Hibiscadelphus distans* were identified as the pink bollworm in 1990 by the State of Hawaii Department of Agriculture (L. Ishii, Plant Quarantine Inspector, State of Hawaii Department of Agriculture, personal communication 1991). The majority of capsules of *Hibiscadelphus distans* examined were infested by the pink bollworm, greatly reducing the amount of viable seed available for reproduction. Introduced grasshoppers and rose beetles have also been observed eating the leaves, in some cases causing extensive damage (S. Perlman, NTBG, personal communication 1991).

6. Genetic Problems. Although *Hibiscadelphus distans* was not known prior to 1972, the mesic habitat that the genus characteristically inhabited was extensive, which suggests that this species may once have been more widely distributed. If the species has gone through a bottleneck, the genetic diversity of *Hibiscadelphus distans* may already be severely reduced, possibly leaving the species prone to deleterious effects of inbreeding.

Conservation Efforts

1. Federal actions. The U.S. Fish and Wildlife Service listed *Hibiscadelphus distans* as an endangered species in 1986 (Herbst 1986). The decision was based principally on a status report by Derral Herbst (1978). Critical habitat was not designated.

2. State of Hawaii actions. The State of Hawaii listed *Hibiscadelphus distans* as an endangered species in 1986 following the federal listing, pursuant to Chapter

195D of the Hawaii Revised Statutes. The plants are included in and managed as Conservation District Forest Land, under the jurisdiction of the State Division of Forestry and Wildlife (DOFAW). As summarized above in the section entitled Distribution and Population Status, DOFAW has constructed exclosures around those naturally occurring plants that require protection from feral goat browsing and has undertaken a program of outplanting of propagated seedlings into exclosure sites. Exclusion of the goats, weeding, watering, and fertilizing have in a short time resulted in the regeneration of *Hibiscadelphus distans* in the Lower Koaie Canyon area.

3. Nongovernmental actions.

(a) **Cultivation**. *Hibiscadelphus distans* is easily propagated if undamaged seeds are available. In fact, germination rates averaging from 80 to 100 percent have been achieved with undamaged seeds (K. Lilleeng-Rosenberger, Propagator, NTBG, personal communication 1991). Several botanical gardens in Hawaii have been involved in *ex situ* conservation of this species. NTBG in Lawai, Kauai, has two mature, flowering trees in its living collection. Seeds are being collected from these plants, and storage and germination trials are being conducted to determine the storage requirements for this species. Another 20 saplings were planted at NTBG in 1991. Sixty seedlings are currently growing in the nursery. All of the *Hibiscadelphus distans* at NTBG were grown from wild-collected seeds.

The Waimea Arboretum in Haleiwa, Oahu, has six mature plants that produce flowers and seeds. The plants were grown from wild-collected seeds. The Honolulu Botanical Gardens on Oahu had three mature plants at its Wahiawa site, and seeds from these plants were sometimes collected and propagated at Foster Botanic Garden. Two of the three trees have died, and the third is unhealthy. The Lyon Arboretum on Oahu has a single mature plant that is faring poorly due to the high rainfall at this site. It does set seed, however, and seedlings are grown in the nursery.

(b) **Research activities.**

1) **Pollination Studies**. Little research has been conducted on this species, beyond propagation trials. Dr. Loyal Mehrhoff, a botanist with the U.S. Fish and Wildlife Service (formerly with the Bishop Museum), is investigating bird pollination and the impact of bird extinctions on related native flora of Hawaii. In an initial study of *Hibiscadelphus distans* conducted in September and October of 1991, he put pollinator exclosure bags around seven flowers on a single tree at the Waimea Arboretum. One of these bagged flowers set seed, compared to seven unbagged, control flowers that did not. Several flowers on this tree (unbagged) did produce fruits. Seedlings growing under the tree demonstrate that it produces viable seeds in the absence of native bird pollinators. This limited study indicates that *Hibiscadelphus distans* may be capable of self-pollination. However, cross-pollination, hence pollinators, may still be very important for maintaining the species' long-term genetic variability (and overall fitness).

2) **Genetic Studies**. A preliminary study of genetic variation of wild and cultivated individuals of *Hibiscadelphus* utilizing gel electrophoresis was conducted in 1990 by Zella E. Ellshoff, a former Ph.D candidate in the Department of Botany at the University of Hawaii. Results of this study have not been reported.

Recovery Strategy

To achieve recovery of *Hibiscadelphus distans*, steps to control and minimize the threats acting upon the existing four populations must be undertaken. At the same time, surveys within likely habitat areas in Waimea Canyon must be carried out to determine whether any other populations currently exist, and all newly discovered populations must be adequately protected. If additional populations are not found, steps must be taken to reestablish at least two new populations on the island of Kauai. Research on the basic ecological

requirements of the species must be carried out, and better methods of controlling the threats that impact the species will need to be developed. Finally, the recovery objectives will need to be validated and the recovery plan revised as necessary.

II. RECOVERY

A. Objective

The ultimate objective of this plan is to delist *Hibiscadelphus distans*.

B. Criteria

Downlisting *Hibiscadelphus distans* to threatened status can be considered when the following conditions are met:

1) the currently occupied habitat on Kauai remains protected (under the jurisdiction of the Hawaii Division of Forestry and Wildlife) and managed to perpetuate the species (including maintenance of fencing to prevent feral ungulate damage);

2) at least two additional protected populations are located or established;

3) each population contains at least 50 reproductive individuals;

4) newly established populations are geographically isolated from the extant populations to ensure that all populations are not eliminated by a single small-scale catastrophic event; and

5) the 6 populations are maintained at the level of at least 50 reproductive individuals each for a minimum of 9 years.

Delisting can occur once the downlisting targets are realized and:

1) threats, especially feral goats, have been sufficiently reduced or eliminated to allow the six populations to reproduce unassisted;

2) the populations are stable or increasing and contain an adequate number of reproductive, self-regenerating adults to produce a mixture of reproductive stages (e.g. seedlings, juveniles, and adults) sufficient to ensure self-perpetuation; and

3) there is a 10-year average of at least 250 reproductive plants in each of the six populations.

Based on our current understanding of *Hibiscadelphus distans*, we believe the numbers of individuals and populations given in the above objectives should provide for the maintenance of the majority of the genetic diversity and some assurance that a single small-scale catastrophic event will not destroy all members of the species. However, much basic research on the life history and reproductive biology of *Hibiscadelphus distans* needs to be conducted in order to ascertain whether these objectives are indeed valid. This recovery plan should, therefore, be modified to incorporate any new information as it becomes available.

Step-down Outline

1. Protect and stabilize populations of *Hibiscadelphus distans*.

    11. Control threats to all current populations.

        111. Ensure maximum protection from feral ungulates.

            1111. Maintain exclosures.

            1112. Improve control methods and control feral goats.

        112. Control erosion and landslides.

        113. Improve control methods and control alien plants.

        114. Improve control methods and control insect predators.

        115. Develop disease monitoring and response protocol and control disease.

        116. Control and minimize human disturbance.

    12. Conduct surveys, particularly in Waimea Canyon, to locate undiscovered populations.

    13. Protect and manage newly discovered populations of *Hibiscadelphus distans*.

2. Develop and implement plans to augment the extant populations, and create new populations, if necessary.

    21. Evaluate genetic diversity and select genetic stock to use in augmenting existing populations and establishing new populations.

    22. Determine appropriate introduction techniques.

    23. Propagate seedlings for outplanting.

    24. Augment existing populations with transplanted individuals.

    25. Locate potential habitat areas for two additional populations.

    26. Protect and manage new sites.

27. Establish new populations through outplanting.

28. Control threats to the newly established populations.

3. Determine factors limiting growth and reproduction.

31. Investigate the ecology of *Hibiscadelphus distans*.

32. Determine the effects of introduced birds on reproduction.

4. Develop and maintain a detailed monitoring program.

41. Map, tag, and monitor all wild plants and their propagules.

42. Map, tag, and monitor all transplanted plants and propagules.

5. Verify or determine the scientific validity of the recovery objectives.

51. Determine the number of populations needed to ensure survival over the next 200 years and the number of individuals needed to ensure long-term survival of each population.

52. Revise recovery objectives.

Narrative

1. Protect and stabilize populations of *Hibiscadelphus distans*.

The last few remaining wild plants exist on State-owned lands in the Na Pali Kona Forest Reserve. Small populations have also been initiated on the Puu Ka Pele Forest Reserve. The Kauai DOFAW has already begun to take steps to stabilize these populations and manage the habitat for the survival of these plants. These actions (i.e. maintaining fences, controlling feral goats, weeding, watering, etc.) need to be continued and expanded. Additional surveys should be conducted to identify new populations, and all introduced predators and competitors of *Hibiscadelphus distans* must be evaluated and brought under control.

11. Control threats to all current populations.

All known threats to the existence of the downslope and upslope Lower Koaie Canyon populations and the Waimea Canyon populations (Kahoaloha and Kaulaula exclosures) must be controlled or removed.

111. Ensure maximum protection from feral ungulates.

Feral ungulates, in particular goats, are the major threat to the survival of *Hibiscadelphus distans* in the wild. Goats feed on the foliage, bark, and seedlings of *Hibiscadelphus distans*. Also, because goats are voracious browsers, they cause increased erosion in habitat areas. Goats also dislodge rocks from ledges above plants, damaging trees and killing seedlings. Successful recovery depends on control, and eventual elimination, of feral goats on Kauai.

1111. Maintain exclosures

The exclosure sites will need to be visited on a regular basis and the fences examined and repaired several times per year to ensure maximum protection from goats and other feral ungulates. Thought should be given to expanding the exclosures to include plants currently without fencing and allowing for expansion of the populations within the exclosures.

1112. Improve control methods and control feral goats.

Methods for goat control should be improved. Methods might include, for example, the use of helicopters and radio-telemetry to find herds, which can then be removed. Unlimited hunting may be a feasible technique to keep goat populations down, minimizing the damage to the wild plants. However, hunters may also cause erosion, so access to the most sensitive areas must be carefully regulated.

112. Control erosion and landslides.

The first population of *Hibiscadelphus distans* to be discovered was lost as a result of a landslide in 1989, and both of the naturally occurring populations in the Lower Koaie Canyon are in immediate danger of extinction due to this natural phenomenon, which has increased as a result of goat browsing. Methods of controlling or minimizing erosion must be developed and implemented. Techniques might include selective weeding (i.e. allowing some less invasive weed species to remain, to hold the soil), but the advantages of such techniques must be weighed against the potential impacts of the techniques themselves (see Task #113).

113. Improve control methods and control alien plants.

Alien plants pose a serious threat to the recovery of *Hibiscadelphus distans*, and methods must be developed and implemented for their control. Current weeding activities should be continued and improved upon. Weed species should be evaluated as to invasiveness and potential threat to H. distans and consideration given to leaving some of the less harmful weeds in place for erosion control. Alien plant control methods should be developed carefully, especially in areas of erosion, where removal of the existing vegetation may increase the threat of harm to *H. distans* individuals. Any control method to be potentially used should be carefully designed to have no adverse effect on *Hibiscadelphus distans* or any other native component of the ecosystem.

114. Improve control methods and control insect predators.

Predation by insects, such as the pink bollworm (*Pectinophora gossypiella*), introduced grasshoppers, and Chinese rose beetle (*Adoretus sinicus*), must be controlled. Control and monitoring programs designed to detect these problems at the earliest possible time should be designed and initiated. In particular, pink bollworm infestations should be monitored on a seasonal and annual basis to determine whether control is necessary. A spray program to control pink bollworm may not be advisable, since the insecticides may negatively affect insect pollinators. Instead, lure methods may be the preferred alternative where applicable.

115. Develop disease monitoring and response protocol and control disease.

Little is known of the diseases that may affect *Hibiscadelphus distans*; however, the introduction and spread of disease in a small population such as the downslope Koaie Canyon population could be devastating. A monitoring system to track diseases and specific recommendations for swift reaction to disease introduction should be developed.

116. Control and minimize human disturbance.

The threats from intentional vandalism and unintentional damage by humans should be addressed via an active public education campaign, signs, and law enforcement activities by State and Federal officers, when necessary.

12. Conduct surveys, particularly in Waimea Canyon, to locate undiscovered populations.

An important step in the *Hibiscadelphus distans* recovery effort is the identification of new populations. New populations may increase the available genetic variability of this species and provide additional propagules for establishing new, genetically diverse populations. Additional wild populations will also help alleviate the risk of stochastic extinction due to the currently limited range of *Hibiscadelphus distans*. Finding new populations, which may have greater selective vigor than captive stock, may obviate the need for establishing new populations from propagules. If additional populations are found, it may be necessary to amend the recovery plan to include measures for protecting these new populations.

A systematic survey for new populations should be planned and executed. Highest priority should be given to surveying similar mesic sites in Waimea Canyon. If found, new populations should be mapped and counted, and threats to them evaluated.

13. Protect newly discovered populations of *Hibiscadelphus distans*.

It is important to protect any wild populations that are discovered through negotiations with the landowners and development of conservation easements, cooperative agreements, leases, fee purchases, etc.

14. Manage newly discovered populations.

Once new populations are protected, the most important action is to immediately ensure that all known threats to the populations are identified and controlled. At the very least, steps should be taken to control those threats that are known to negatively impact the currently extant populations. See Tasks #111 through #116.

2. Develop and implement plans to augment the extant populations, and create new populations, if necessary.

The two known, naturally-occurring, extant populations of *Hibiscadelphus distans* are located in degraded, landslide-prone habitat in Koaie Canyon. In addition, these populations are located in close proximity to one another. The likelihood of the stochastic extinction of the only two, naturally occurring populations of this species due to a single environmentally catastrophic event is, therefore, quite high. New populations must be established in more protected, stable habitats. In addition, the sizes of the existing populations must be increased, in order to optimize genetic diversity and achieve recovery goals.

21. Evaluate genetic diversity and select genetic stock to use in augmenting existing populations and establishing new populations.

Genetic diversity of the species (i.e. total array of genotypes available) must be evaluated, through gel electrophoresis or other molecular means, in order to make wise decisions about which plants to propagate and transplant. Populations should be augmented only with transplants that originated from that population, unless future research dictates otherwise. However, new populations should be established from genetically diverse stock, as determined from genetic analyses. This strategy will optimize reproductive vigor of new populations and serve as a buffer against possible inbreeding depression in the original populations, while still maintaining the genetic "purity" of the original two populations.

22. Determine appropriate introduction techniques.

Trial plantings of *Hibiscadelphus distans* have already been established in exclosures as detailed in the section on conservation activities. These plantings need to be carefully monitored and assessed to determine how to establish new populations. Transplantation methods, care after establishment, and other factors must be determined.

23. Propagate seedlings for outplanting.

The propagation of healthy, viable propagules is essential to the recovery of this species. A qualified grower must be selected, and a protocol for producing quality propagules should be established. Proper cleaning, handling, and storage techniques must be developed to ensure the maximum viability of propagules. Storage of *Hibiscadelphus distans* propagules must be done in a manner that will maintain the genetic integrity of this species. Meticulous records of propagule lineages (seeds and cuttings) are essential. Possible impacts of seed collection or removal of cuttings from natural populations must be closely monitored to detect any effect the harvest may have on the source populations.

24. Augment existing populations with transplanted individuals.

Once introduction techniques that will provide maximal chances for survival are developed and proper genetic stock is propagated, a protocol for augmenting current populations should be established and implemented. Propagules should be transplanted into selected areas within the exclosures that house the wild populations in order to amplify these populations as quickly and as efficiently as possible. Specific areas within the exclosures must be identified as the precise anticipated location of all transplants (with a resolution of a few feet). Locations should be chosen that will cause minimum disturbance to the wild individuals, while optimizing conditions required for growth of transplanted individuals. Steps should be taken to ensure that transplanting does not introduce diseases or pests into the wild populations.

25. Locate sites for two additional populations.

If naturally-occurring populations are not discovered, sites within the historical range of the species should be identified for establishment of new populations. Site selection is extremely important. Selected sites must possess, as nearly as possible, the same habitat characteristics as Koaie Canyon and should be geographically isolated from the extant populations to help ensure that all populations are not eliminated by a single small-scale

catastrophic event. Ideally, the sites should permit ready access for demographic studies, seed collection, and other recovery activities. Sites should be large enough to support a fully recovered population according to the criteria in this plan (i.e. 250 reproductive plants) plus a buffer area. Preference should be given to sites that can be legally protected.

26. Protect and manage new sites.

Once sites have been selected efforts should be made to enter into long-term agreements with land owners. Fencing of the new sites, initial control of alien plants and other necessary preliminary management activities should be accomplished prior to outplanting.

27. Establish new populations through outplanting.

Once the proper sites have been identified, the proper genetic stock propagated, and the appropriate introduction techniques determined, establishing new populations through outplanting can commence. Some site-specific management may be necessary (e.g. watering and fertilizing) and should be determined prior to establishing the new populations.

28. Control threats to the newly established populations.

Protective measures initiated in Task #26 should be continued and expanded, as described in Tasks #111 through #116.

3. Determine factors limiting growth and reproduction.

In order to develop an adequate management and control program, it is necessary to determine all of the factors that are limiting the growth and reproduction of the species.

31. Investigate the ecology of *Hibiscadelphus distans*.

Since very little is known of the basic biology of this species, life history, genetic variability, reproductive biology, and habitat requirements should be studied to isolate additional factors that may limit growth and reproduction. An understanding, in particular, of soil composition, moisture preferences, other habitat requirements, pollination biology and other factors affecting seed set and germination is necessary both to proper management of existing populations and establishment of new ones.

32. Determine the effects of introduced birds on reproduction.

The effects of introduced birds on reproduction of *Hibiscadelphus distans* need to be addressed. The specific mechanisms by which they impact the species, through competition with, or elimination of the natural pollinators, need to be determined.

4. Develop and maintain a detailed monitoring program.

Propagules gleaned from wild and cultivated individuals will form the basis of any reintroduction, restoration, or augmentation plan. Careful records must be maintained on the fate and location of each cutting or seedling in botanical gardens and each plant in the wild.

41. Map, tag, and monitor plants in all four populations and their propagules.

Each of the plants that make up the upper and lower Koaie Canyon and Waimea Canyon populations must be mapped, tagged and monitored on a regular basis. Each cutting that is taken from these populations should be identified as to its origin by tag number and date. Accurate records must then be maintained on the fate and location of each cutting in botanical gardens, and on each wild plant and cultivar in the exclosure sites.

42. Map, tag, and monitor all transplanted plants and their propagules.

All transplanted individuals must be mapped, tagged, and monitored in order to determine the success of the program. It is important to know the lineages of all transplants, so that in the event that some seedlings die, they can be replaced with genetically similar plants to insure that the populations do not become dominated by a single lineage or genotype. Knowledge of the lineages of individual plants also allows for the selective culling of specific genetic stocks should research dictate a change in management philosophy.

5. Verify or determine the scientific validity of the recovery objectives.

In constructing a management strategy for the recovery of an endangered species, it is essential to consider the long range implications of the stated objectives in the recovery plan, and to assess the scientific validity of these objectives.

51. Determine the number of populations needed to ensure survival over the next 200 years and the number of individuals needed to ensure the long-term survival of each population.

It will be necessary to know whether the 6 populations recommended for delisting are adequate to safeguard against catastrophic events over the next 200 years. It is also important to determine the number of individuals needed to ensure the long-term survival of each population. Mathematical modeling may be useful in determining these numbers.

52. Revise recovery objectives.

Recovery objectives should be revised as often as warranted by new information.

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated cost for the *Hibiscadelphus distans* recovery program, as set forth in this recovery plan. It is a guide for meeting the objectives discussed in Part II of this Plan. This schedule indicates task priority, task numbers, task descriptions, duration of tasks, the agencies responsible for committing funds, and lastly, the estimated costs. The agencies responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. When more than one agency is listed as the responsible party, an asterisk is used to identify the lead entity.

The actions identified in the Implementation Schedule, when accomplished, should protect habitat for the species, stabilize the existing populations, and increase the population sizes and numbers on Kauai. Monetary needs for all parties involved are identified to reach this point.

Priorities in Column 1 of the following implementation schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Key to Acronyms Used in Implementation Schedule

FWES - U.S. Fish and Wildlife Service, Division of Ecological Services, Honolulu, Hawaii

DOFAW - Division of Forestry and Wildlife, Hawaii Department of Land and Natural Resources

NTBG - National Tropical Botanical Garden, Hawaii Plant Conservation Center

NBS - National Biological Survey

Key to Other Codes Used in Implementation Schedule

C - Continuous task

O - Ongoing (already begun as of writing of plan)

TBD - To be determined

Recovery Plan Implementation Schedule for *Hibiscadelphus distans*

April, 1996

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY2003	FY 2004	FY2005	FY2006	FY2007
1	1111	Maintain exclosures.	O	DOFAW*	110	5	5	5	10	5	5	5	5	5	5	5	10
				FWES	56	2	2	2	10	2	2	2	2	2	2	2	10
1	1112	Improve methods and control feral goats.	O	DOFAW*	165	6	15	15	15	15	15	6	6	6	6	6	6
				FWES	135	4	15	15	15	15	15	4	4	4	4	4	4
1	112	Control erosion and landslides.	O	DOFAW*	46	5	5	2	2	2	2	2	2	2	2	2	2
				FWES	40	2	2	2	2	2	2	2	2	2	2	2	2
1	113	Improve methods and control alien plants.	O	DOFAW*	152	5	12	11	11	11	11	11	11	11	11	11	4
				FWES	134	5	12	10	10	10	10	10	10	10	10	10	3
				NBS	100	0	10	10	10	10	10	10	10	10	10	10	0
1	114	Improve methods and control insect predators.	C	DOFAW*	81	1.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	0.5
				FWES	80.5	1	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	0.5
				NBS	100	0	10	10	10	10	10	10	10	10	10	10	0
1	115	Develop and implement disease monitoring protocol.	C	DOFAW*	10	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
				FWES	10	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
				NBS	50	0	5	5	5	5	5	5	5	5	5	5	0
1	116	Control and minimize human disturbance.	C	DOFAW*	40	2	2	2	2	2	2	2	2	2	2	2	2
				FWES	40	2	2	2	2	2	2	2	2	2	2	2	2
1	12	Conduct surveys.	2	DOFAW*	20		10	10									
				FWES	20		10	10									
				NTBG	4		2	2									
1	13	Protect and manage new populations.	C	DOFAW*	208			51.5	31.5	30	10	10	10	10	5	5	5
				FWES	134			40.5	20.5	20	5	5	5	5	3	3	3
NEED 1 (Protect and stabilize)					1735.5	41.5	135	221	172	157	122	102	102	102	95	95	55

Recovery Plan Implementation Schedule for *Hibiscadelphus distans*

April, 1996

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY2003	FY 2004	FY2005	FY2006	FY2007
1	21	Evaluate genetic diversity and select stock for augmenting/establishing.	5	DOFAW*	43	13	13	13	2	2							
				FWES	23	7	7	7	1	1							
				NTBG	23	7	7	7	1	1							
1	22	Determine appropriate introduction techniques.	5	DOFAW*	14	3	3	3	3	2							
				FWES	9	2	2	2	2	1							
				NTBG	9	2	2	2	2	1							
1	23	Propagate seedlings for outplanting.	15	DOFAW*	45	3	3	3	3	3	3	3	3	3	3	3	3
				FWES	30	2	2	2	2	2	2	2	2	2	2	2	2
				NTBG	30	2	2	2	2	2	2	2	2	2	2	2	2
1	24	Augment existing populations.	10	DOFAW*	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		
				FWES	5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		
				NTBG	2.5	0.5	0.5	0.5	0.5	0.5							
1	25	Locate habitat for two additional populations.	2	DOFAW*	6			3	3								
				FWES	6			3	3								
				NTBG	1			0.5	0.5								
1	26	Protect and manage new sites.	3	DOFAW*	33					11.5	11.5	10					
				FWES	33					11.5	11.5	10					
1	27	Establish new populations through outplanting.	10	DOFAW*	0					TBD							
				FWES	0					TBD							
				NTBG	0					TBD							
1	28	Control threats to the new populations.	C	DOFAW*	0						TBD						
				FWES	0						TBD						
		NEED 2 (Increase and diversify populations)			317.5	42.5	42.5	49	26	39.5	31	28	8	8	8	7	7

Recovery Plan Implementation Schedule for *Hibiscadelphus distans*

April, 1996

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY2003	FY 2004	FY2005	FY2006	FY2007
2	31	Investigate the ecology of *Hibiscadelphus distans.*	10	NBS*	100		10	10	10	10	10	10	10	10	10	10	
				FWES	70		7	7	7	7	7	7	7	7	7	7	
				DOFAW	70		7	7	7	7	7	7	7	7	7	7	
2	32	Determine the effects of introduced birds.	10	NBS*	100		10	10	10	10	10	10	10	10	10	10	
				FWES	50		5	5	5	5	5	5	5	5	5	5	
				DOFAW	50		5	5	5	5	5	5	5	5	5	5	
2	41	Map, tag, and monitor all wild plants.	C	DOFAW*	40	2	2	2	2	2	2	2	2	2	2	2	2
				FWES	10	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2	42	Map, tag, and monitor all transplants.	C	DOFAW*	40	2	2	2	2	2	2	2	2	2	2	2	2
				FWES	10	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
		NEED 3 (Conduct research and monitor)			540	5	49	49	49	49	49	49	49	49	49	49	5
3	51	Determine number of populations and individuals needed for survival.	3	FWES*	60										20	20	20
				NBS	30										10	10	10
				DOFAW	30										10	10	10
3	52	Revise recovery objectives, if necessary.	1	FWES*	0												
				DOFAW	0												
		Need 4 (Validate recovery objectives)			120												
		TOTAL COST			2713	89	226.5	319	247	245.5	202	179	159	159	152	151	67

APPENDIX A

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