VICIA MENZIESII

Recovery Plan

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RECOVERY PLAN

U.S. Fish and Wildlife Service

Portland, Oregon

Approved: Robert E. Lohmann

Director, U.S. Fish and Wildlife Service

MAY 18 1984

Date

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ACKNOWLEDGMENTS SHOULD READ AS FOLLOWS:

THE VICIA MENZIESII RECOVERY PLAN, DATED May 18, 1984, PREPARED BY THE U.S. FISH AND WILDLIFE SERVICE UNDER CONTRACT WITH WAYNE TAKEUCHI, HONOLULU, HAWAII.

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I. Introduction

In 1794, Vancouver expedition botanist Archibald Menzies collected a previously unknown leguminous vine from the forested slopes of Mauna Loa, Hawai'i. The name Vicia grandiflora was conferred upon the plant in the initial description of the new species. But due to a subsequent nomenclatural invalidation, the original binomial designation was later amended to V. menziesii Sprengel (1826). Since the time of its discovery, the species has been referred to by a variety of vernacular names; frequently cited are "Hawaiian vetch" and "Hawaiian wild broad-bean" (Lassetter and Gunn 1979). This species was listed as endangered in 1978 (Federal Register, April 26, 1978; 43 FR 17916).

A vigorous perennial liana, V. menziesii extends upward into the subcanopy of the native forest, often exhibiting extensive lateral branching. Stems of 20 m length have been alleged. An individual plant has been known to bear as many as 235 flowers in as many as 39 discrete inflorescences (Ralph et al. 1980). The flowers are frequently visited by native birds, especially the 'I'iwi (Vestiaria coccinea) and 'Amakihi (Loxops virens) (Ralph 1978, Ralph et al. 1980). The possibility of an avian pollinator for this species is consistent with the relatively large size of the floral corolla and of its conspicuous pink-rose pigmentation.

Species distribution

In spite of the distinctive inflorescence and foliage of V. menziesii, the number of extant herbarium specimens and published references to the species' original habitat and distribution is very limited. This paucity of specimens and citations is indicative of the rarity of the species since European settlement of Hawai'i, though there exists a contrary account by MacCaughey (1916) contending that the plant was a characteristic component of the high mountain flora at least until the beginning of this century. The available evidence indicates that V. menziesii has always been of rather limited range. Even before extensive modification of upland forests it was only definitely known from the montane forests of Mauna Loa and Mauna Kea on the island of Hawai'i. It appears to be extirpated from Mauna Kea.

The original type specimen of Menzies was collected along the present day 'Ainapo Trail (Fig. 1), from an area on southeast Mauna Loa referred to as 'Anipe'ahi on contemporary topographic maps. Menzies' journal specifies that the collection locality was situated near the forest edge at an altitude of 6,500 feet (1980 m) (Menzies 1920). The next record of the species was a collection from the forests of the adjacent Mauna Kea by James Macrae (1922) in 1825. Substantiation for the presence of V. menziesii on this second mountain was further provided by the collection of sterile material by members of the U.S. Exploring Expedition in 1841 (Gray 1854). This collection came from an area possibly in the general vicinty of the Macrae sighting. The Jules Remy collection of 1851-1855 represents the last record of the species

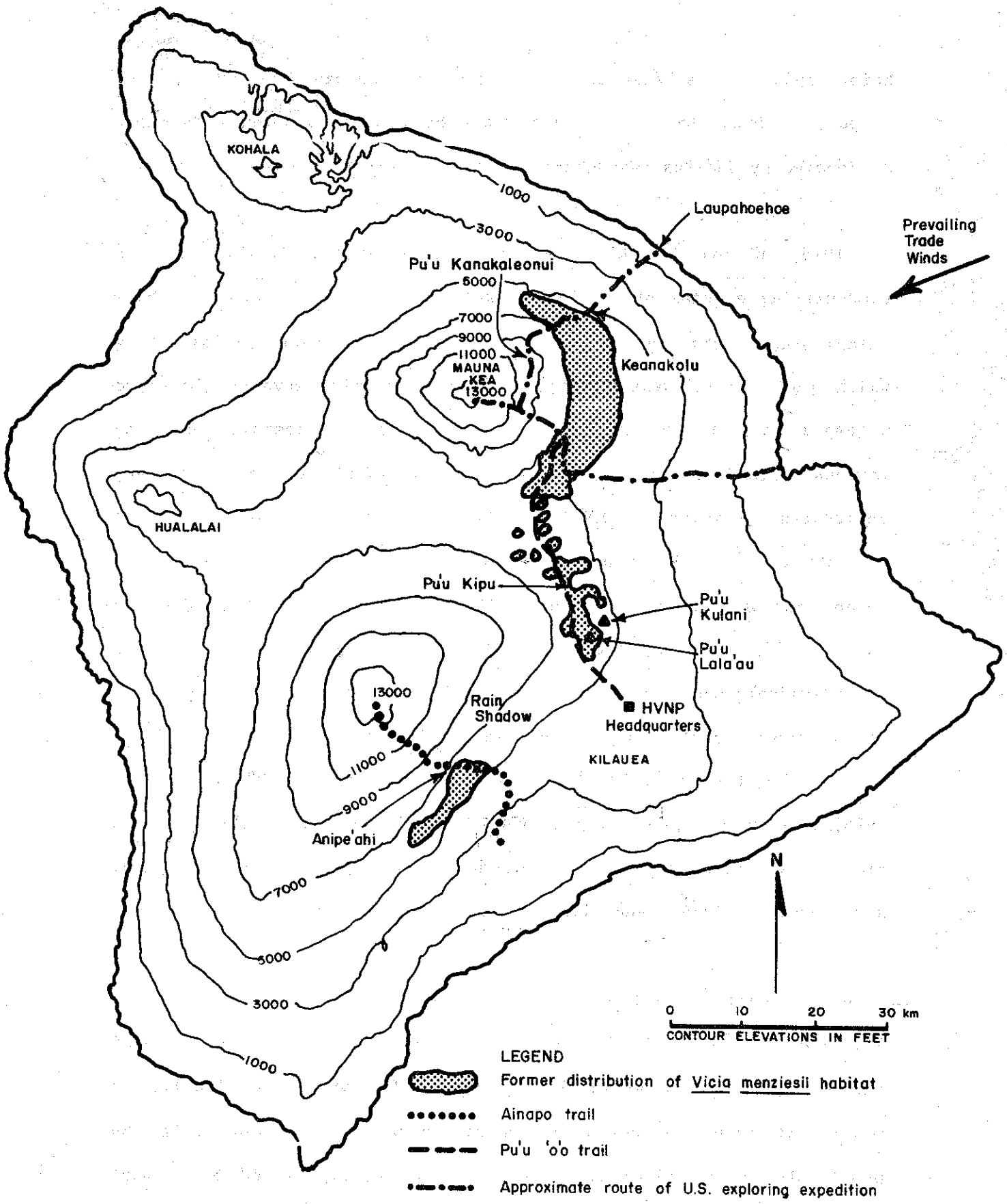

Figure 1 The presumed former range for V. menziesii, based upon current assumptions regarding the species' habitat requirements (from Warshauer and Jacobi 1982)

before 1900. It is believed that Remy's specimen was obtained from the slopes of Mauna Loa -- perhaps from the same population originally discovered by Menzies (Warshauer and Jacobi 1982).

In 1915, Bishop Museum botanist Charles Forbes (1915) reported encountering a total of 24 Vicia plants in the Pu'u Kipu-Palakea-Pu'u Kulani area. Subsequent to the Forbes account, 50 years passed during which the species went totally unrecorded despite several concerted attempts to relocate it. The situation led to speculation among various botanical authorities that this unique endemic had been extirpated. However, in 1974, a small Vicia population was located in a section of the Kilauea Forest 300-400 m northeast of the Palakea fence line at an elevation of 1,590 m (5,200 feet) (Warshauer and Jacobi 1982). Shortly after this discovery, a concentration of about 85 individuals was discovered on nearby Keauhou Ranch during the course of a forest bird study which was being conducted some 1.5 km west-northwest of Pu'u Lala'au (Fig. 2) (Ralph et al. 1980). In July 1978, a botanical survey established the existence of an additional 25 plants within the area of a silviculture project between the bird study site and the Palakea fence line (Corn, et al. 1978).

Recent intensive field work by the State Division of Forestry and Wildlife (DOFAW) in the Keauhou Ranch-Kilauea Forest area has expanded the known distribution of V. menziesii (Clarke et al. 1983). An additional group of colonies was discovered just upslope from the previously known colonies, in an area between 5,700 and 6,080 feet elevation. A total of 706 plants in 114 colonies were found in 1980;

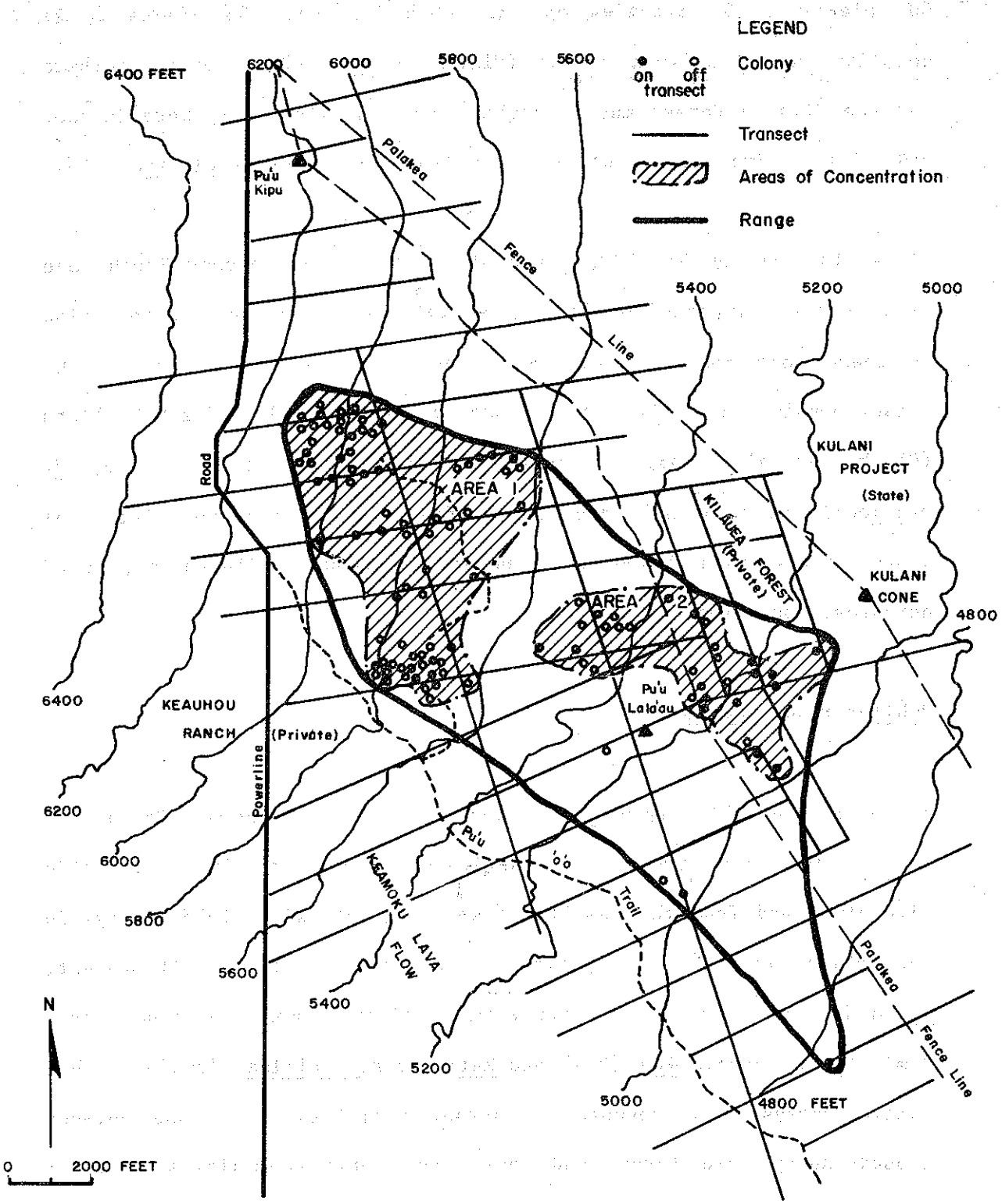

Figure 2 Range and distribution of V. menziesii colonies. (Clarke et al, 1983)

602 plants in 93 colonies on the Keauhou Ranch, 104 plants in 21 colonies in the Kilauea Forest (Clarke et al. 1983). Actual numbers for the Kilauea Forest may be higher than 104; visibility here is poor and little time was spent off the transects (Clarke et al. 1983).

Since this survey in 1980, areas within the upper Keauhou Ranch have been severely impacted by logging activities. Based on extrapolation of these most recent data, current estimates place the size of the extant population of the species roughly between 1,500 and 2,000 plants (Clarke et al. 1983). Despite extensive searches elsewhere, V. menziesii has apparently disappeared from all of its former historical range except this 1,600 ha area in the Keauhou-Kilauea region of northeast Mauna Loa.

Habitat requirements

The ecology and biology of V. menziesii are not well known. Certain of the species' requirements can be inferred, however, from scientific literature and from the results of several, intensive field surveys in the habitat in which the species has been recently found. At present, Vicia is found almost exclusively in a primarily mesic montane forest dominated by Acacia koa (koa) and Metrosideros collina ('ohi'a). This native ecosystem represents a narrow, transitional ecotone between closed-canopy rain forest and more open, xeric communities of lower stature (Warshauer and Jacobi 1982). Clarke et al. (1983) characterize the habitat occupied by V. menziesii as closed-canopy koa-'ohi'a-hapu'u forest or open-canopy koa-'ohi'a forest. Based on 1954 aerial photos,

apparently most of this area, including the presently open-canopy forest, was formerly a closed-canopy koa-'ohi'a forest.

Historical accounts suggest that V. menziesii is normally restricted to such an ecotone distribution. Reports by early authors place the species within the upper margins of the forests on Mauna Loa and Mauna Kea, where there is a gradation in community structure from forest to scrub vegetation. Known past and present distribution also suggests that the species is restricted in elevational range. Its occurrence has been reliably established only in the elevations between 1,470 and 1,990 m (4,780 and 6,500 feet). The existence of an altitude constraint is further supported by the complete absence of a record for V. menziesii on Hualalai and leeward Mauna Loa, where the mesic montane communities are located at considerably lower elevations than that from which Vicia is presently known. Although the ecological amplitude of the plant is not precisely known, Hillebrand's (1888) contention that this species could formerly be found up to the 2,440 m (8,000 feet) level, and Skottsberg's (1931) claim of an extension to 2,500 m (8,200 feet) are questionable. Such accounts have not been substantiated by actual collections, and are questionable in implying a species' penetration into the arid region above the atmospheric thermal inversion at 2,100 m (7,000 feet) (Warshauer and Jacobi 1982).

The possibility that V. menziesii is capable of a wider distribution than presently believed cannot be completely discounted; however, several thorough surveys have been conducted within suspected habitat with negative results. Although a small number of individuals may have

gone unnoticed it appears that the only significant extant population is in the Keauhou-Kilauea area. The reconstructed former range of the species is illustrated in Figure 1.

Present status and threats

The apparent drastic reduction in the distribution of V. menziesii since the early 1800's has been accompanied by a pervasive deterioration and elimination of its habitat. In nearly all cases, the environmental permutations associated with the species' decline are directly attributable to the activities of exotic ungulates. Since herbivory by vertebrates was never a selective force in the evolution of the Hawaiian flora, native species tend to be extremely susceptible to browsing, grazing or trampling by mammalian herbivores. Consequently, when such animals were introduced into the Islands, the flora of the native ecosystems was severely disrupted. Tomich reports that European exploration was accompanied by the ingress of cattle, sheep, goats, pigs, into the uplands of the island of Hawai'i. The lack of any natural predators or diseases to control these animals allowed the development of large feral populations (Tomich 1969). Within the montane habitats, the influence of exotic mammalian herbivores rapidly induced a variety of radical environmental changes.

As a typical effect, the rooting and browsing activities of ungulates resulted in extensive disturbance of the understory component in native forests. This has resulted in an array of microclimatic modifications. This situation fostered the invasion and proliferation of exotic plants

in the forest communities and was responsible for a denial of habitat to certain specialized native forms. Direct consumption of plants by herbivores further contributed to the decline and extirpation of a number of endemic flora. Because of protracted intermittent cropping of the seedlings and suckers of tree species, entire areas of forest were denuded. Recruitment of new individuals into the population was insufficient to replace normal attritional losses within mature stands. This resulted in severe disruption of the native ecosystems with the loss of numerous endemics and the establishment of many exotics (Rock 1913).

On some parts of Mauna Kea, the impact of animal introductions was particularly damaging. The continuity of the montane forest on the windward slopes allowed the progressive expansion of herbivore-degraded areas as ungulates dispersed outward from initial population concentrations. Cattle, goats and pigs had the largest impact. In 1825, Macrae (1922) noted that replacement of indigenous forest cover by open savanna was already evident at higher elevations on the mountain. Forest fires and logging operations contributed to further decline of the Vicia habitat. Some time following the last Mauna Kea collection in 1841, the plant apparently was extirpated from this portion of its former range.

On Mauna Loa, the structure and composition of the native forest were also altered by the introduction of ungulates. However disturbance was less severe than that on Mauna Kea, presumably because the montane forest communities of Mauna Loa were dissected by recent lava flows

extending onto the lower slopes. The interposition of relatively barren flows between areas of forest has served as a partial impediment to free movement of herbivore populations (Warshauer and Jacobi 1982). This dissection of potential Vicia habitat contrasts sharply with the situation with Mauna Kea, where the cessation of volcanic activity beyond historic time had permitted development of several vegetation types in a relatively continuous belt about the summit. The heterogeneity of the mesic zone on Mauna Loa's northeast flank is believed to account for the persistence of the Vicia in this region.

The effects of exotic mammals continue to threaten the species. Most of the existing Vicia concentrations in the Kilauea-Keauhou parcels remain subject to foraging by wild pigs and grazing cattle. Due to their proximity to ranching operations, the Kilauea subpopulations are further threatened by the periodic entry of cattle into the forest habitat. Animal predation continues to have an adverse effect on the Keauhou colonies as demonstrated by the restriction of most of the extant individuals to sites protected from herbivore access. In the survey of the silviculture tract, for example, V. menziesii was found to be rooted invariably where fallen logs formed an effective barrier against cattle and to some extent, pigs. Fifty-three percent of the known colonies (70% of the individual plants) on the Keauhou Ranch and 67% of the known colonies (84% of the individual plants) in the Kilauea Forest are found within these log jams. By contrast only 1 percent of the known colonies on the Keauhou Ranch and 5 percent of the known colonies in the Kilauea Forest are rooted in areas without barriers to ungulates and none of these were flowering (Clarke et al. 1983).

Qualitative observations also indicate that presumed herbivore losses are accompanied by an animal-caused inhibition of forest regeneration.

Beginning in 1957, the selective logging of koa on Keauhou ranchland has also contributed to the deterioration of the Vicia habitat. Disturbances to community structure resulting from logging activities currently extend through virtually all of the species' present range in the Pu'u Lala'au area. Recently, the development of a silviculture project in this vicinity has further impacted occupied habitat of V. menziesii. As part of this project, 200 acres of koa-'ohi'a forest have been bulldozed in what is now realized to have been the central portion of the known Vicia range. Although most of the known colonies in this 200 acre area were allowed a small buffer of standing vegetation, these colonies have now apparently died (USFWS pers. comm.). In spite of the prolonged history of habitat changes in the Kilauea-Keauhou region, the possibility that a general floristic recovery is still possible is shown by the spontaneous rehabilitation of adjoining areas upon suspension of all logging and herbivore influences (Warshauer and Jacobi 1982). However, the likelihood of a species restoration continues to decline. The persistent effects of herbivores, potential new introductions of aggressive weed plants, and other negative habitat influences are expected to produce a progressive depletion in the size and reproductive capacity of the existing population.

Rodents also have a role in the mortality of some established Vicia plants. Herbst (pers. comm.) has observed plants whose main stem was

chewed off at ground level by rodents. Rodent damage was noticed at 13% of the ranch colonies by Clarke et al. (1983). Insects may also cause problems. The overall effect of rodents on Vicia is not clear, but some believe it could be significant.

In addition to the factors previously discussed, volcanic eruptions and subsequent wildfires must be considered as part of the spectrum of threats. The surviving Vicia population is located in close proximity to Mauna Loa's northeast rift zone, which is a major locus of volcanic activity on the island of Hawai'i. Lava flows emanating from this rift source could overrun habitat essential to V. menziesii, resulting in a serious population decline or extinction, the recent (March 1984) lava flow from Mauna Loa came within 8 km of the only extant population of Vicia. Due to the species' localized distribution, fires have the potential of exerting similar effects.

Exotic vegetation often invades disturbed habitats such as those described above. Some species are intentionally introduced (e.g. to create pasture) but most exotics become established through their own dispersal and colonization abilities. The vigorous exotic plants, once well established, may preclude any regeneration of Vicia under wild conditions.

The precarious nature of the present situation has been acknowledged through official recognition of endangered status for V. menziesii (USDI 1978). This species remains endangered in light of the range of threats arrayed against the plant, the declining population numbers,

and its restricted distribution. The number of individuals currently estimated, although more encouraging than previously thought, tends to draw attention from the more crucial factors which affect the status of the species. The restricted range and array of threats which continue to operate are the primary basis of concern. All remaining individuals are presently or potentially subject to these threats. The limited number of reproducing individuals is additional evidence of a stressed population. Only 13 to 14 percent of the colonies had plants in flower or fruit during the State DOFAW surveys and all were found within the protection of log barriers (Clarke et al. 1983). In light of the present status of this species and the threats facing it, it is apparent that immediate action is necessary to prevent eventual extinction.

II. Recovery

A. Objective

The recovery plan for V. menziesii delineates those actions which are regarded as necessary to effect restoration of the species as a viable and self-sustaining member of its ecosystem. The objective of this plan is to accomplish certain goals which will move this species towards recovery. The data are insufficient to quantify recovery objectives at this time. The interim objective will be to identify, secure, and maintain all existing populations and not allow the populations to decline further. With additional research and investigation detailed in this plan, recovery goals can be further defined at a later date.

B. Step-down Outline

1. Protect existing Vicia habitat from further degradation.

   11. Identify essential habitat.

   12. *Secure property comprising essential habitat.

* Securing habitat refers to any number of means for assuring that management of the habitats in question will, as a primary concern, provide the maintenance of those qualities necessary to sustain Vicia menziesii. This does not necessarily preclude other uses of the area, but it does require that all manipulation of that habitat be compatible with its utility to Vicia menziesii. Methods to achieve this may range from a simple cooperative agreement to perhaps acquisition of the land, in fee, by a conservation agency or organization. Any number of other methods may be applicable and appropriate depending on the circumstances.

121. Secure that portion of the Kilauea Forest considered as essential habitat.

122. Secure that portion of the Keauhou Ranch parcel considered as essential habitat.

123. Secure that portion of the Kulani Prison Farm parcel considered as essential habitat.

13. Prevent entry of ungulates into the essential habitat.

131. Construct an ungulate-proof fence around the area of essential habitat or along boundaries, as necessary and practical.

132. Inspect and maintain the fence line.

1321. Establish a schedule of fence-line inspection.

1322. Effect repairs when necessary.

14. Upon completion of the perimeter barrier, eliminate the ungulate population within the enclosed parcel.

141. Promote a hunting program within the essential habitat area(s).

1411. Secure approval from affected landowners for access to hunting area.

1412. Explore and develop use of general public hunting effort to reduce ungulate populations.

1413. Determine needs and direct actions to use contracted hunters or agency personnel to eliminate the last animals within the exclosure.

142. Explore use of other control measures to eliminate feral animal populations in exclosure.

15. Devise and implement measures for removal of exotic plants from present Vicia habitat as necessary (see 2441 below).

2. Conduct investigative and research studies for determination of recovery alternatives.

21. Conduct preliminary survey of population's known and suspected habitat.

211. Obtain demographic data on existing populations.

212. Attempt to locate new Vicia colonies in areas where the presence of the species is not currently established -- but is suspected.

2121. Survey area between Pu'u Lala'au and Pu'u Kipu for possible presence of V. menziesii.

2122. Survey those areas in and adjacent to the Ka'u Forest Reserve where koa-'ohi'a forest remains relatively undisturbed.

22. Identify sites outside the present species range (but within suspected historical range) for possible reintroduction of propagules.

221. Determine the ecological requirements of V. menziesii.

222. Determine sites which would be most conducive to a successful reintroduction. (Priority areas for reintroduction include Mauna Kea and former habitat on Mauna Loa.)

23. Determine the horticultural procedures which should be employed in the species reintroduction plan.

231. Determine feasibility of artificial propagation.

232. Determine the manner and form of propagule outplanting.

233. Determine the optimal conditions for outplanting.

24. Conduct a quantitative evaluation of population mortality factors; develop and implement a program to alleviate such factors.

241. Provide additional data on the effects of ungulates as a mortality factor in selected study areas where ungulates persist.

242. Determine the relative significance of insect predation.

243. Determine the relative significance of rodent predation.

244. Evaluate other habitat factors contributing to decline of Vicia.

2441. Determine the impact of exotic plants on the regeneration, growth, and survival of the native flora (including Vicia) within the management area.

2442. Determine extent of habitat degradation due to other land-use activities.

245. Identify any as-yet unrecognized mortality factors.

3. Instigate management to maintain and improve population status of V. menziesii.

31. Implement a program for population reintroduction on the basis of studies outlined in #22 and #23 above.

32. Implement a program for the amelioration of existing mortality factors.

33. Develop and implement integrated management approach for the restoration of all endangered species within the present Vicia range.

4. Monitor the effects of management actions.

41. Determine the condition and trend of vegetation and the Vicia population within the Kilauea-Keauhou parcel so as to evaluate the success of the habitat restoration measures.

411. Establish permanent plots for a repetitive sampling study.

412. Assess the vegetative changes occurring within the sample plots at 3-year intervals.

413. Conduct aerial surveys to obtain an area evaluation of the koa-'ohi'a community at 10-year intervals.

42. Conduct a similar monitoring program for those areas into which Vicia is introduced as part of action #31, as necessary.

5. Develop and implement a public relations strategy to increase awareness and support of the recovery effort.

51. Prepare posters, leaflets, and summary information for general dissemination and media use.

52. Establish interpretive displays at Hawaii Volcanoes National Park headquarters and major public libraries.

C. Narrative

The prime objective of the V. menziesii recovery plan is to restore the species to delisted status. This will require enhancement of the

species to a self-sustaining population with adequate distribution and abundance. Currently there are insufficient data on the ecological relationships of the species to quantify these recovery goals. The critically endangered status of this species requires that some immediate action be taken. As interim objectives it is intended to: (1) secure and maintain essential habitat (1,600 ha); (2) conduct necessary ecological investigations; (3) consider the need and feasibility of reestablishing the species in historical habitat which is secure; (4) continue inventory of potential habitats to determine presence or absence of species within historical range.

Additional information is required to quantify size of populations and habitat necessary to reclassify to threatened status and ultimately to delisted status.

When the above goals have been met, the prime objective will be further defined in measurable terms.

In order to achieve the above objective, certain steps will be taken:

1. Protect existing Vicia habitat from further degradation.

   The majority of historical Vicia habitat has been significantly modified through the effects of logging, grazing and trampling by domestic cattle and feral ungulates, and the invasion of exotic plant species which out-compete Vicia. A major step to arrest the decline of this species will be to eliminate or control the influences which result from the above actions. Any success to this end will require a thorough

knowledge of the present range of this species and a cooperative effort of all affected parties.

11. Identify essential habitat.

To protect the existing Vicia populations, the areas of remaining habitat must be identified. With this information, the essential habitat areas will be determined and delineated (see Appendix).

12. Secure lands comprising essential habitat.

The primary need in protecting the remaining Vicia is to maintain the viability of its habitat. This will require maintaining the overall habitat conditions, to the best of our understanding, which allow the species to sustain itself. The means to secure habitat for Vicia could take a variety of forms and will depend on the particular situation. A Land Protection Plan, evaluating the many options for securing habitat, will be developed by the USFWS. Cooperation with and assistance of landowners (public and private) is imperative to achieve this particular goal.

121. Secure that portion of the Kilauea Forest considered as essential habitat.

Essential habitat for Vicia includes some portions of land in the Kilauea Forest area. This area is known to be one of the last tracts of land to support the species. Securing the necessary habitat in this forest is extremely important for the species. Discussion with landowners is

necessary to seek mutually agreeable means to protect habitat.

122. Secure that portion of the Keauhou Ranch parcel considered as essential habitat.

This parcel of land is also known to support some of the most important habitat for Vicia. Steps need to be taken to secure that portion within Keauhou Ranch. This in combination with habitat in the Kilauea Forest is the last known remaining viable area for Vicia. Again, discussion with landowners is imperative to seek mutually agreeable means to protect habitat.

123. Secure that portion of the Kulani Prison Farm parcel considered as essential habitat.

Essential habitat includes some land within the Kulani Prison Farm area. Any Vicia habitat within this area should be maintained also. Discussion with officials should seek mutually agreeable means to protect habitat.

13. Prevent entry of ungulates into the essential habitat.

Once essential habitat is secured, the feral ungulates of the area must be controlled. The first step would be to prevent ungulates from entering tracts of habitat supporting the species. Continual access by various ungulates to Vicia habitat has resulted in deterioration of the quality of the habitat. This should be coordi-

nated with objectives of the Hawaii Forest Birds Recovery Plan which considers this habitat essential as well.

131. Construct an ungulate-proof fence around the area of essential habitat, or along boundaries, as necessary and practical.

To effectively prevent ungulates from entering Vicia habitat, it will be necessary to construct an ungulate-proof fence around the essential habitat or along pertinent boundaries. The Kilauea and the Keauhou parcels may be included into one or two units totalling about 1,600 ha. Exact dimensions of a fence will depend on terrain, land protection arrangements with landowner, and other factors. The number of units and location of fence line will be selected based on effective management strategy.

132. Maintain the fence line.

To prevent entry of ungulates into the essential habitat on a permanent basis, the fence will have to remain totally intact. Wear and tear on a fence by the weather and other elements can quickly result in holes which allow passage to ungulates. This would nullify other efforts to protect habitat inside the essential habitat.

1321. Establish a schedule of fence-line inspection.

To insure the long-term effectiveness of the fence, regular inspection will be needed.

Someone will have to travel the length of the fence to check for breaks which might allow access to ungulates.

1322. Effect repairs when necessary.

When breaks in the fence line are discovered, repairs must be completed promptly. Even minor failures in the fence line can lead to reinvasion of the exclosed area by feral ungulates.

14. Upon completion of the perimeter barrier, eliminate the ungulate population within the exclosed parcel.

Once an ungulate-proof fence is in place, the next step is to eliminate all feral animals within the exclosure. At present, many individual plants germinate and grow but are destroyed by ungulates before they mature and reproduce. Elimination of these animals will allow the reproductive population (which is presently very small) to increase, enhancing chances of recovery.

141. Promote a hunting program within the essential habitat area(s).

Eliminating all feral ungulates within the exclosed areas will not be easy and may not be possible. A program will have to be developed that will assure that most if not all animals will be taken. A continual effort will be necessary to assure that any remaining population will not negate prior efforts.

1411. Secure approval from affected landowners for access to hunting areas.

The hunting program must be preceded by obtaining full approval from any affected landowner or agency. The hunting program must insure minimal impacts to the activities of these landowners and agencies.

1412. Explore and develop use of general public hunting effort to reduce population.

The opportunities for public hunting within the exclosures may be limited simply because of the anticipated small size of these areas. Some public hunt may, however, be possible and useful to initially bring the population down to low levels. The potential for a public hunt can be explored when other specifics are known (e.g. size and location of exclosure).

1413. Determine needs and direct actions to use contracted hunters or agency personnel to eliminate the last animals within the exclosure or prevent remaining population from increasing.

The effectiveness or practicality of a public hunt will be limited at best. To effectively eliminate or control the last animals within the exclosure, it will be

necessary to use experienced people and effective techniques. This approach will have to be developed as the situation unfolds.

142. Explore use of other control measures to eliminate feral animal population in exclosure.

It may be infeasible or impractical to use hunting solely as a means of eliminating feral ungulates within the exclosures. Other means may be necessary at some time and should be considered.

15. Devise and implement measures for removal of exotic plants from present Vicia habitat as necessary (see 2441 below).

Exotic plants may also play a role in threatening the population of Vicia. Aggressive invader species such as meadow ricegrass (Microlaena stipoides) may be a serious problem. The ecological influence of exotic plants is not as well understood as is the influence of exotic animals. Item 2441 below discusses the need to determine the impact of exotic plants on Vicia. If the results indicate the need, control actions should be taken.

2. Conduct investigative and research studies for determination of recovery alternatives.

Various investigative and research studies will be needed to obtain information for recovery efforts. Some will be necessary to prevent Vicia from further decline and other studies

will provide information to help move the species towards recovery.

21. Conduct preliminary survey of populations known and suspected habitat.

Although the genus Vicia is well known, there remain some gaps in the knowledge of this particular species. Some questions remain regarding the known populations and there are some areas which could possibly support some undocumented colonies of Vicia. Some studies in these areas will be useful in the maintenance and eventual recovery of the species.

211. Obtain demographic data on existing population.

Demographic data from natural populations will aid in direction of specific recovery actions. Individual colonies should be monitored. Enumerate size and age classes, and determine reproductive capabilities and relative vigor of individuals.

212. Attempt to locate new Vicia colonies in areas where the presence of the species is not currently established -- but is suspected.

Although the present distribution of this species is assumed to be well known, it is possible that it still occurs in additional areas. All remaining habitat which possibly could have undocumented Vicia plants in them, should be adequately surveyed as opportunities arise. Refined habitat data and detailed vegetation maps from the Hawai'i

Forest Bird Project will help pinpoint other possible suitable habitat if they exist.

2121. Survey area between Pu'u Lala'au and Pu'u Kipu for possible presence of V. menziesii.

One area which may require more thorough searching is the region between Pu'u Lala'au and Pu'u Kipu. The known populations are at the downhill end of this area near Pu'u Lala'au. Perhaps there are still some extant individuals or groups uphill towards Pu'u Kipu. Units of vegetation between Puu Kipu and the Saddle Road should be surveyed for V. menziesii also, once the above areas have been adequately surveyed.

2122. Survey those areas in and adjacent to the Ka'u Forest Reserve where koa-'ohi'a forest remains relatively undisturbed.

Areas in and around the Ka'u Forest Reserve still contain some relatively undisturbed koa-'ohi'a forest. This vegetation type represents the kind of area that may possibly contain unrecorded Vicia plants. These areas should be surveyed.

22. Identify site outside the present species range (but within suspected historical range) for possible reintroduction of propagules.

To achieve full recovery for this species may require reintroduction of the plant into historical habitat it presently does not occupy. This action will depend largely on the availability of suitable or rehabilitated habitat. The scope and detail of this effort remain to be formulated; however, it may eventually become an important task.

221. Determine the ecological requirements of V. menziesii.

If reintroduction efforts are initiated, the ecological requirements of the species must be understood. The proper microhabitat conditions must be known before a site can be selected. Certain ecological investigations should be conducted to get answers to these questions. A quantitative assessment of the relationship between plant performance and site parameters will aid in selecting reintroduction sites.

222. Determine sites which would be most conducive to a successful introduction.

With the information generated from the above investigations, sound recommendations can be made for reintroduction sites. Priority areas will be a pro-

tected, historic habitat of Vicia on Mauna Kea or especially in the Ka'u-Kapapala area of Mauna Loa.

23. Determine the horticultural procedures which should be employed in the species reintroduction plan.

If a reintroduction plan is expected to be successful, the proper horticultural techniques must be used. Some work has been done with artificial propagation of this species. Additional experimentation must be done to determine successful methods.

231. Determine feasibility of artificial propagation.

There are not enough data presently to know if artificial propagation would be successful or not. Initial efforts will focus on determining the success which can be expected from this kind of effort. This will then determine whether or not such a program should continue.

232. Determine the manner and form of propagule outplanting.

Once it is determined that Vicia can be propagated artificially, the techniques for establishing it in the field must be learned; e.g., at what age should the seedlings be planted, how should they be planted, etc. Experimentation in these areas will be necessary.

233. Determine the optimal conditions for outplanting.

After the techniques for outplanting are established, the optimal field sites for the propagules

must be selected. The optimal spacing of propagules, soil depth, canopy cover, etc. should be known to enhance likelihood of survival.

24. Conduct a quantitative evaluation of population mortality factors; develop and implement a program to alleviate such factors.

Other research and investigations are necessary to clearly understand the threats to Vicia. Various mortality factors affecting Vicia have been identified yet quantitative evaluations are lacking. Such data is needed to further demonstrate what problems still face Vicia. With this information, a program should be developed to focus on alleviating these factors.

241. Provide additional data on the effects of ungulates as a mortality factor.

There is ample evidence that ungulates have caused a deterioration in the habitat of Vicia. A recent survey by the State DOFAW provided additional data on this. Additional information should be gathered which may assist in developing management strategies.

242. Determine the relative significance of insect predation.

Little is known of the effects of insects on Vicia. Stem borers have been found in dead branches, but it is not known if the insects attack living, weakened or dead tissues. Does insect predation

present a mortality factor? Can it have an effect on the long-term survival of the population? These questions need to be answered.

243. Determine the relative significance of rodent predation.

The effects of rodents on Vicia is not well known. However, there is some evidence suggesting that rodents can cause mortality of Vicia plants. Observations have been made of Vicia stems which have been gnawed through near the ground, presumably by rats. This could become a significant problem and should be investigated. It is unknown whether the seeds of Vicia are eaten by rodents.

244. Evaluate other habitat factors contributing to decline of Vicia.

Changes in the vegetation of Vicia habitat have taken place. Many exotic species of plants have become established and human land uses have resulted in significant changes. The effects of these changes on Vicia need to be evaluated.

2441. Determine the impact of exotic plants on the regeneration, growth, and survival of the native flora (including Vicia) within the management area.

Exotic plants undoubtedly compete with Vicia for resources. This should be investigated to determine if this competition is result-

ing in the exclusion of Vicia. Are any particular exotic species especially harmful to Vicia? Such information is needed.

2442. Determine extent of habitat degradation due to other land-use activities.

Human land use in the range of Vicia has changed the habitat considerably. As early as the mid 1800's, cattle grazing had had a major impact on habitat on Mauna Kea. Cattle grazing has continued to expand. More recently, logging operations have had marked impacts as well. The current assessment of such land uses suggests they can significantly affect Vicia. The degree of various land uses which can be tolerated by Vicia especially needs to be evaluated.

245. Identify any as-yet unrecognized mortality factors.

Other factors may or may not play some role in the survival of Vicia plants. Any other suspected mortality factors should be investigated.

3. Instigate management to maintain and improve population status of V. menziesii.

The information on hand and that gained from the above research and investigations must be turned into management actions. This will be directed towards maintaining and ultimately improving the population status of this species.

31. Implement a program for population reintroduction on the basis of studies outlined in #22 to #23 above.

Needed research and survey work will further define the current status of the species. If additional populations are needed to achieve recovered status, the information gathered from tasks #22 and #23 will be used. Management alternatives will be developed using this information.

32. Implement a program for the amelioration of existing mortality factors.

A wealth of information on threats and other detrimental factors exists or will be generated from the above studies. An integrated approach should be developed to deal with all these factors. Management action will be implemented to eliminate these factors.

33. Develop and implement an integrated management approach for the restoration of all endangered species within the present Vicia range.

Vicia menziesii shares its habitat with the endangered Hawaiian hoary bat (Lasiurus cinereus semotus) and four endangered birds: the Hawaii akepa (Loxops coccineus coccineus), the Akiapolaau [Hemignathus munroi (= wilsoni)], the Hawaii creeper [Oreomystis (= Loxops) mana] and the Hawaiian hawk (Buteo solitarius). As the opportunities arise, management of Vicia habitat for Vicia should also take into consideration anything positive that could be done for these other species. Eventually this habitat can be managed with an integrated ap-

proach as one system, to benefit all native species, in addition to the listed species.

4. Monitor the effects of management actions.

The results of management actions need to be monitored. Progress towards recovery, resulting from management, must be followed to indicate potential need for changes in the recovery program. It can not be assumed that all management direction selected now will be totally adequate for the life of the recovery program.

41. Determine the condition and trend of vegetation within the Kilauea-Keauhou parcel so as to evaluate the success of the habitat restoration measures.

Baseline information on habitat condition will be invaluable. Some measure is needed to gauge success or failure trends in the status of Vicia and its recovery. Monitoring the Kilauea-Keauhou area will follow the population and habitat trend of the largest Vicia population presently known.

411. Establish permanent plots for a repetitive sampling study.

To adequately monitor habitat trends, quantitative sampling techniques should be employed. Permanent plots are needed to establish a sampling area. Plots should be established for a long-term quantitative study.

412. Assess the vegetative changes occurring within the sample plots at 3-year intervals.

Quantitative sampling will be able to monitor habitat changes over time. The sample plots established should be checked every three years to assess vegetative changes. Thus, interim conclusions can be drawn regarding trends in the Vicia population and its habitat. Certain individuals may be selected for more frequent monitoring to obtain information on phenology, insect damage, etc.

413. Conduct aerial surveys to obtain an area evaluation of the koa-'ohi'a community at 10-year intervals.

Widespread, subtle changes in the habitat can possibly occur. Quantitative sampling described in tasks #411 and #412 may detect some changes. Aerial surveys over wide areas can complement this on-the-ground sampling by evaluating the entire koa-'ohi'a community. This effort need only be every 10 years.

42. Conduct a similar monitoring program for those areas into which Vicia is introduced as part of action #31, as necessary.

It may be necessary to reintroduce Vicia into historical habitat as part of the overall recovery program. If these actions are taken, the status of the reintroduced Vicia plants and their habitat should be monitored.

Monitoring will provide information indicating the relative success of this work.

5. Develop and implement a public relations strategy to increase awareness and support of the recovery effort.

Any recovery program is dependent, in part, on the support of the public. Vicia is not as well known as some other species in Hawai'i, thus public education will vastly improve the appreciation of this species and its current condition. A whole public relations strategy should be developed to increase awareness and support of the recovery effort.

51. Prepare posters, leaflets, and summary information for general dissemination and media use.

Basic written and illustrated material can be useful in informing wide varieties of people. Various types of posters, leaflets and summary information could be used to reach schools, conservation groups, museums, media etc. to explain the circumstances surrounding Vicia. Initially a poster, an informational leaflet and a press release should be developed to explain the present status of Vicia and the recovery program.

52. Establish interpretive displays at Hawaii Volcanoes National Park headquarters and major public libraries.

The similarity of habitat, the potential of reintroduction habitat, and the proximity of Hawaii Volcanoes National Park provide a good educational opportunity regarding Vicia. An interpretative display could be erected at the Visitor Center of the park. This would

reach many people. Major libraries in Hawai'i would also be good locations for interpretative facilities. These would reach a variety of Hawaiian citizens.

D. Literature Cited

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PART III

IMPLEMENTATION SCHEDULE

Table I, which follows, is a summary of scheduled actions and costs for the Vicia menziesii recovery program. It is a guide to meet the objectives of the Vicia menziesii Recovery Plan, as elaborated upon in Part II, Action Narrative Section. This table indicates the priority in scheduling tasks to meet the objectives, which agencies are responsible for performing these tasks, a timetable for accomplishing these tasks, and lastly, the estimated costs to perform them. Implementing Part III is the action of the recovery plan, that when accomplished, will satisfy the prime objective. Initiation of these actions is subject to the availability of funds.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULES

Information Gathering - I or R (Research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Task Priority

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.

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	Responsible Agencies Other Program	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
I2	Delineate essential habitat	11	2	Completed	1	SE	-	-	-	Completed 1984 (See Appendix)
A7	Secure Keauhou portion of essential habitat, develop	121	1	1	1	SE	?	-	-	
A7	Secure Kilauea portion of essential habitat, develop	122	1	1	1	SE	?	-	-	
A7	Secure Kulani Prison Farm (state lands) portion of essential habitat	123	1	1	1	SE	?	-	-	

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	FWS Program	Other	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
M5	Fence habitat, as needed	131	1	2	1	SE	DOFAW	?	?	?	Approximately 8.8 linear miles of fence; however objectives could be combined with those Hawaii Forest Birds and adjacent land managers (Hawaii Volcanoes NP and State DOFAW)
M5	Maintain perimeter fence line	132	1	Continual	1	SE	DOFAW	Funds to be allocated as required			
M5	Promote a hunting program within the essential habitat area to eliminate ungulates	141	1	Continual	1	SE	DOFAW	- 1	- 1	- 1	Program likely to be contingent upon securing land

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	Responsible Agencies FWS Program	Responsible Agencies Other	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
M5	Explore use of other control measures to eliminate feral animal populations in this area	142	2	5	1	SE	DOFAW				Extent of this action dependent on whether previous measure is carried out and level of public response of same
M3	Devise and implement measures for removal of exotic plants from present Vicia habitat	15	2	5	1	SE		To be determined			Necessity of action contingent upon #2441 of Plan
I1	Obtain demographic information of existing population	211	2	Already Completed							State DOFAW conducted extensive surveys in 1980. Follow-ups would be worthwhile.

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	Responsible Agencies Other Program	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
I1	Survey area between Pu'u Lala'au and Pu'u Kipu for possible presence of V. menziesii	2121	2	Completed						State DOFAW completed extensive surveys in 1980
I1	Survey areas in and adjacent to the Ka'u Forest Reserve for possible presence of V. menziesii	2122	2	Completed						State DOFAW completed extensive surveys in 1980
I3	Determine ecological requirements of V. menziesii	221	2	2	1	SE	5	5	-	
I13	Determine reintroduction sites as needed	222	3	2	1	SE	-	-	2	
I7	Determine the horticultural procedures to be employed in species dispersal plan	23	3	2	1	SE	-	-	2	

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	Other Program	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
I9	Provide additional data on the effects of ungulates	241	3	1	1	SE		-	-	Partially completed by work done by DOFAW
R9	Determine significance of insect predation	242	2	2	1	RES SE	3	3	-	
R9	Determine significance of rodent predation	243	3	2	1	RES SE			-	Partially completed by work done by DOFAW
R10	Determine the impact of exotic plants on the regeneration, growth and survival of the native flora within the management area	2441	1	6	8	RES	5	5	5	
2	Further determine extent of habitat degradation due to conflicting land-use activities	2442	1	1	8	RES	3	-	-	Partially completed by work done by DOFAW

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	Responsible Agencies Other Program	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
I9	Identify any unknown mortality factors	245	2	2	1	SE	2	2	-	
M2	Implement reintroduction program (as needed)	31	3	Unknown	1	SE	-	-	5	
M3	Implement a program for the amelioration of existing mortality factors	32	1	Unknown	1	SE	To be determined			
M3	Develop proposals to achieve an integrated management approach to the restoration of other endangered species within present Vicia habitat	33	2	1	1	SE	2	-	-	
R6	Establish permanent plots for repetitive sampling study (within the Kilauea-Keauhou parcel)	411	2	1	8	RES	2	-	-	

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	Responsible Agencies Other Program	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
I2	Assess the vegetative changes occurring within the sample plots at 3-year intervals	412	2	Continual	1	SE	-	-	7	
I2	Conduct aerial surveys at 10-year intervals	413	2	Continual	1	SE	To be determined			
I2	Conduct a similar monitoring program consisting of studies 411,412,413 above, for those areas into which the Vicia is introduced as part of the dispersal plan - if appropriate	42	3	Continual	1 8	SE RES	To be determined			

PART III: IMPLEMENTATION SCHEDULE
Hawaiian Vetch Recovery Program

General Category	Plan Task	Task No.	Task Priority	Task Duration (yrs.)	Responsible Agencies FWS Region	Responsible Agencies FWS Program	Responsible Agencies Other	Fiscal Year Costs (est. in $1,000) FY84	FY85	FY86	Comments and Notes
01	Prepare posters, leaflets, and summary information for general dissemination and media use	51	2	1	1	SE		3			
01	Establish interpretive displays at Hawaii Volcanoes National Park HQ and major public libraries	52	2	1	1	SE		1			
							NPS	3			

Continual -- The action will be required for an indefinite period of time once implemented.
? -- Costs unknown
- -- No costs

Agency Abbreviations:
FWS - Fish and Wildlife Service
SE - Endangered Species Program (FWS)
RE - Research (FWS)
NPS - National Park Service
DOFAW - Division of Forestry and Wildlife (State of Hawaii)

IV. APPENDIX

Essential Habitat Description

Vicia menziesii

The essential habitat is illustrated in Figure 3. The area encompasses all known colonies, including adjacent areas or areas in between which could provide habitat for a stable or expanding population. Recent field studies have failed to find any other colonies in other locations. This effort has included several intensive surveys in other suspected habitat by qualified field biologists. The essential habitat thus describes the remaining habitat occupied by this species.

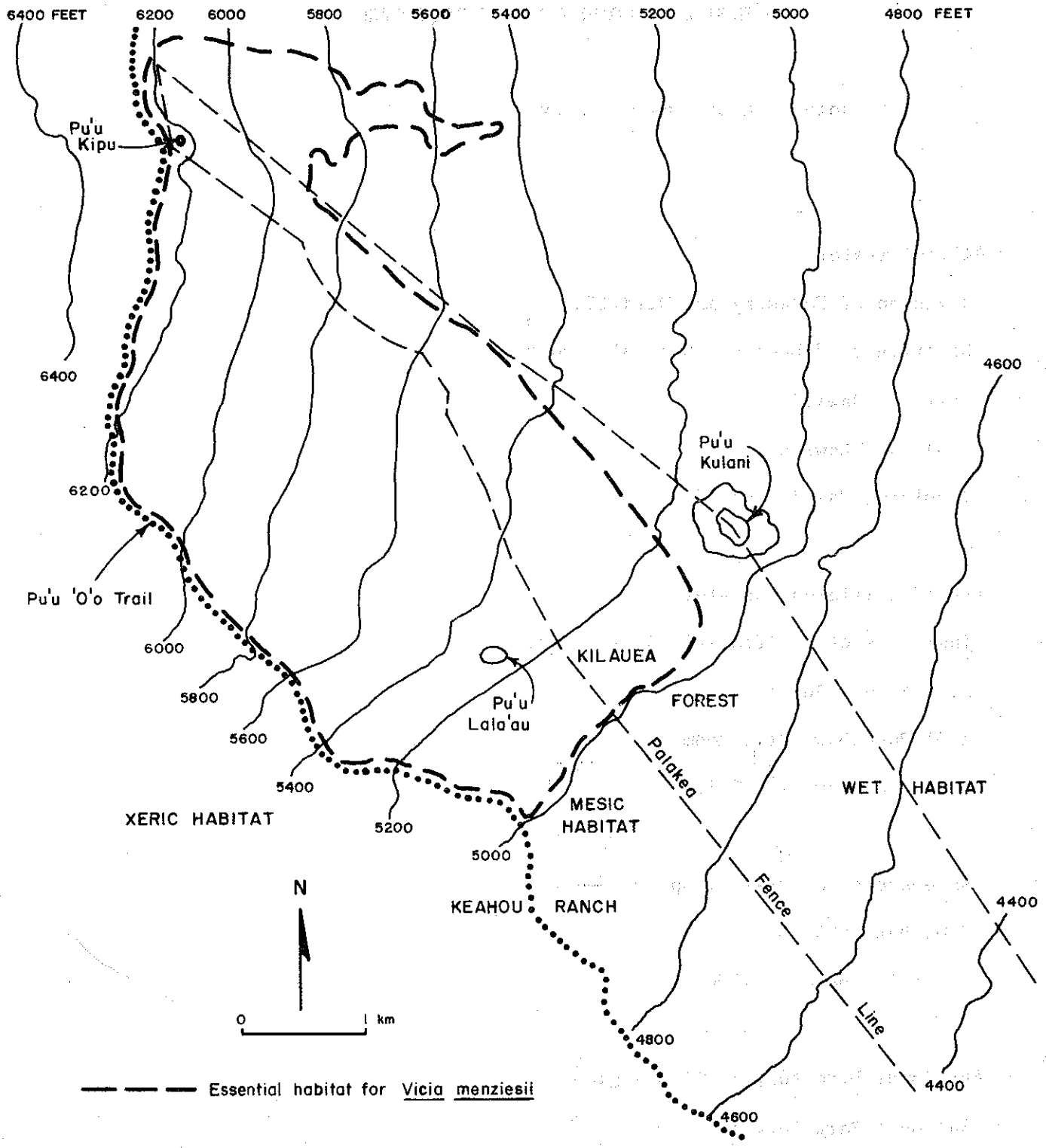

Figure 3 (Base map adapted from Warshauer and Jacobi 1982)

APPENDIX B: AGENCIES OR ORGANIZATIONS FROM WHOM COMMENTS WERE REQUESTED

(*denotes those agencies or organizations that responded)

*Administrator
Division of Forestry and Wildlife
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl St.
Honolulu, Hawaii 96813

*Pacific Islands Forester
Institute of Pacific Islands Forestry
U.S. Forest Service
1151 Punchbowl St., Room 323
Honolulu, Hawaii 96813

Kamehameha Schools/Bishop Estate
P.O. Box 3466
Honolulu, Hawaii 96801

*Regional Director, Western Region
National Park Service
450 Golden Gate Avenue - Box 36062
San Francisco, CA 94102

Kulani Correctional Facility

Stainback Highway

Hilo, Hawaii 96720