

HAKALAU FOREST NATIONAL WILDLIFE REFUGE

Hilo, Hawaii

ANNUAL NARRATIVE REPORT

Calendar Year 1987

U.S. Department of the Interior  
Fish and Wildlife Service  
NATIONAL WILDLIFE REFUGE SYSTEM

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REVIEW AND APPROVALS

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7/31/89

Date

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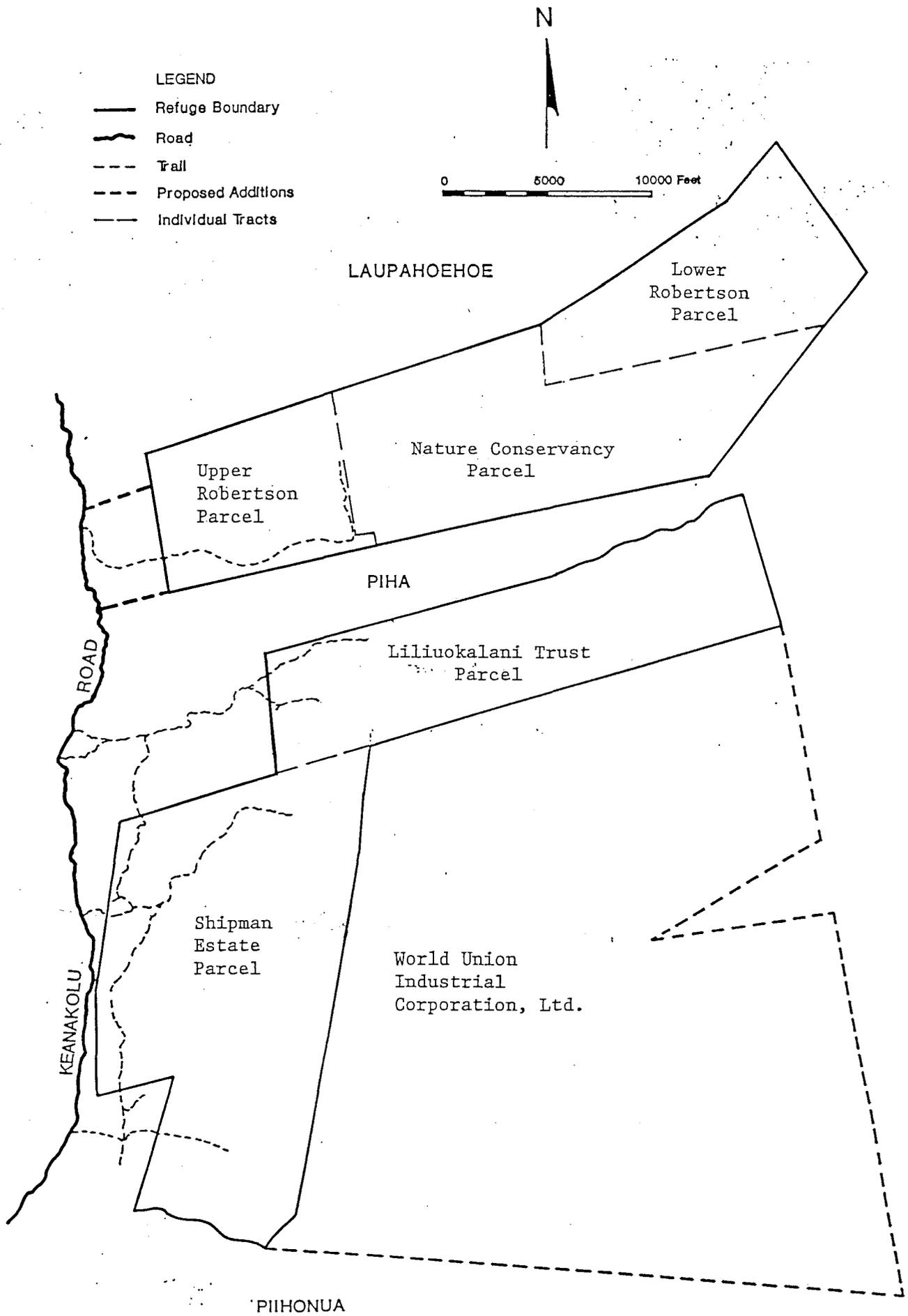
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## INTRODUCTION

Hakalau Forest National Wildlife Refuge was established October 29, 1985 with the purchase of two properties totaling 8,313 acres. Three additional parcels were acquired by the close of 1987 bringing the total area to 15,084 acres. Negotiations toward the purchase of two additional properties are ongoing. The refuge is located about 14 mi. northwest of Hilo, Hawaii on the windward slope of Mauna Kea. It lies between the elevations of 2,500 and 6,600 ft. and contains some of the finest stands of koa and ohia forest remaining in Hawaii (and the world). The lower slopes receive very high rainfall and are vegetated with dense forests dominated by ohia and treeferns and bisected with numerous streams and gullies. Upslope, at elevations above 4,500 ft., koa becomes codominant with ohia. The typical structure of this forest is characterized by tall koa and ohia trees forming a closed canopy. Younger ohia trees dominate the mid-story and tree ferns and native shrubs form the understory. Higher elevations (above about 5,400 ft.) experience less rainfall and have been subject to considerable grazing pressure for over 100 years which has eliminated or severely reduced the native understory. A fairly dense canopy of mature koa and ohia trees over a ground cover of exotic grasses characterizes this area. Intensive grazing on the uppermost portion of the refuge (above about 6,000 ft.) has eliminated even the trees except for remnant individuals scattered through the gulches. This area is carpeted with introduced grasses including the noxious weed, gorse.

Hakalau Forest NWR was established to assure the protection, perpetuation and maintenance of five endangered forest bird species and their rain forest habitat. It supports a superb avifauna, rich in species and high in density. Thirty-six species are found on the refuge including 16 natives (seven of which are endangered) and 20 aliens. Substantial populations of four of the seven endangered forest birds inhabiting the Big Island occur on the refuge. They are the 'Akiapola'au, the Hawaii Creeper, the Hawaii 'Akepa and the 'Io (Hawaiian Hawk). The other three endangered birds found at Hakalau include the very rare 'O'u which is reported from the lower elevation ohia forests, the Nene (Hawaiian Goose) which nests in adjoining areas, and the Koloa (Hawaiian Duck) which inhabits streams and stockponds on the refuge. The endangered Hawaiian Hoary Bat and a number of candidate endangered plants are also found at Hakalau.



HAKALAU FOREST NATIONAL WILDLIFE REFUGE

## A. HIGHLIGHTS

1. A fifth parcel of land was added to Hakalau Forest NWR bringing the total size of the refuge to 15,084 acres. The 1,977.82 acre addition was purchased for \$550,000 through the Nature Conservancy from George Robertson, Richard Sutton, et. al. (Section C.1).
2. Dr. Leonard A. Freed, University of Hawaii, began a forest bird research project on the refuge. Initial effort will be concentrated on banding as many native birds as possible and a study of the evolution of sexual dichromatism and cavity-nesting in the Hawaii Akepa, an endangered species. (Section D.5).
3. Two experimental reforestation plots were established under an Interagency Agreement with the U.S. Forest Service. The grassland plot was planted with koa, ohia and mamane tree seedlings. The woodland plot was scarified with a disk to stimulate germination of seeds naturally present. (Section F.4).
4. A Cooperative Agreement with the Alfred Nobriga Ranch was signed to permit cattle grazing on the Upper Robertson Parcel. A total of 218 AUY's of cattle grazing occurred on the refuge during 1987 under this agreement. A Cooperative Agreement with the Pua Akala Ranch, which was signed in 1986, permitted an additional 447 AUY's of grazing on the refuge during the year. (Section F.7).
5. The use of the herbicide Tordon 22k and prescribed burns for the control of the noxious weed gorse was recommended under an Interagency Agreement with the Soil Conservation Service. (Section F.10).
6. A reoccurring biannual forest bird census program was established under a Research Work Order with the University of Idaho. (Section G.2).
7. A feral pig control effort was recommended under an Interagency Agreement with the National Park Service. Key management recommendations include an extensive fencing effort and the removal of all feral ungulates through a program of systematic hunting by paid hunters. (Section G.15).

## B. CLIMATIC CONDITIONS

The climate at Hakalau Forest NWR is characterized by moderate temperatures and wet conditions with relatively little seasonal variation. There is considerable variation within the refuge, however, depending primarily on elevation. Mean annual temperatures vary between about 67 degrees F at the lower elevations and 57 degrees F at the higher elevations. Daily temperatures in the vicinity of the refuge cabin range between highs of 55 degrees F to 80 degrees F and lows of 30 degrees F to 50 degrees F.

Rainfall also shows significant variation with elevation. A chart for the island of Hawaii indicates an annual rainfall of approximately 300 inches for the lowermost elevations of the refuge decreasing to about 80 inches for the upper elevations bordering Keanakolu Road. For a 25-year period between 1906 and 1931, rainfall data were recorded at the Pua Akala rain gauge located at an elevation of 6,200 ft. on property now belonging to the refuge. Annual rainfall ranged between 38.3 and 144.4 inches with a median of 88.2 inches. At the higher elevations of the refuge, considerable moisture (perhaps as much as an additional 35%) is also received in the form of fog drip from cloud formations that usually gather in the early afternoon on the upper slopes of Mauna Kea. These afternoon low clouds are responsible for the cool and damp climate that generally prevails at Hakalau.

A thermometer and rain gauge were installed on the refuge at Hakalau cabin early in 1987. Data from these instruments are summarized in Table I.

Table I. Meteorological observations at Hakalau cabin during 1987. Data were recorded from a maximum/minimum thermometer and a rain gauge at intervals of 1 day to 4 weeks with an average interval of about 2 weeks. The thermometer was mounted on the exterior wall of the cabin under the porch roof so temperature extremes were constrained by the heat mass of the cabin. Therefore, the actual lows were probably lower and the actual highs, higher. The instruments were not installed until January 25 so the January figures in the table are those recorded for January 1988.

Month	Lowest Low (degrees F)	Highest High (degrees F)	Rainfall (inches)
January	39	69	2.10
February	36	74	1.33
March	40	69	6.43
April	46	64	5.16
May	41	66	6.29
June	42	70	6.50
July	44	77	4.71
August	46	73	0.72
September	42	78	3.73
October	43	74	5.33
November	41	69	16.40
December	40	69	11.80
		TOTAL	70.67

### C. LAND ACQUISITION

#### 1. Fee Title

A fifth parcel of land (the "lower Robertson parcel") was added to Hakalau Forest NWR (which also includes the Shipman Estate parcel, the Liliuokalani Trust parcel, the Nature Conservancy parcel and the upper Robertson parcel) during 1987. On December 11, 1987 the Fish and Wildlife Service purchased 1,977.82 acres through The Nature Conservancy from George Robertson, Richard Sutton, et. al. at a total cost of \$550,000. The parcel extends from 4,400 ft down to 2,500 ft. Previously, the lowermost point of the refuge was in the Liliuokalani Trust parcel at about 3,500 ft. The new property is forested with ohia and koa and an understory of native ferns and shrubs. Except for the ridges, the ground is very wet and swampy due to the high rainfall (about 300 inches annually). Feral pigs and cattle have stressed the native plant community by grazing, uprooting and trampling vegetation though the area has been zoned "Conservation" since the inception of the state zoning system. The area is accessed by helicopter or an arduous day of hiking each way so detailed resource surveys have not been done.

The acquisition of the lower Robertson parcel brings the total acreage of Hakalau Forest NWR to 15,084 acres and the total purchase price to \$6,504,325. Two additional tracts have been authorized for purchase in the near future. They include 400 acres owned by Richard Sutton, George Robertson, et. al. and 16,275 acres owned by World Union Industrial Corporation, Ltd. Acquisition of these properties will bring

the refuge total to approximately 31,800 acres.

#### D. PLANNING

##### 5. Research and Investigations

Forest bird research was initiated at Hakalau by Dr. Leonard A. Freed, Professor of Zoology, University of Hawaii. He was issued a Special Use Permit (HAK-2-87) to "conduct ornithological research within Hakalau forest National Wildlife refuge and to study evolution of sexual dichromatism and cavity-nesting in the Hawaii 'Akepa."

During March, April and May, Dr. Freed and four of his colleagues and graduate students constructed aerial mist net stations and initiated an intensive banding study of native birds in the area of the refuge immediately below the Pua Akala Ranch cabin and barn. They also set up a simple field station (tent) in which two of the students lived continuously during June and July, operating mist nets, banding birds and observing bird behavior.



Birds captured by entanglement in a mist net are weighed, measured, sexed and banded with a numbered band and a unique combination of colored bands to enable their subsequent identification through a pair of binoculars.

The following species were captured and banded during the year by Dr. Freed:

<u>Endangered Species</u>	<u>No. Individuals</u>
Hawaii 'Akepa	42
Hawaii Creeper	15
Total	<u>57</u>

<u>Other Native Species</u>	<u>No. Individuals</u>
'Oma'o	23
'Elepaio	9
Common 'Amakihi	89
'Apapane	83
'I'iwi	86
Total	<u>290</u>

<u>Introduced Species</u>	<u>No. Individuals</u>
Red-Billed Leiothrix	14
Northern Cardinal	1
Japanese White-Eye	10
House Finch	8
Common Myna	1
Total	<u>34</u>

GRAND TOTAL 381

Dr. Freed and crew also discovered three 'Akepa nests in tree cavities, and one 'Io (Hawaiian Hawk) nest on branches.

#### E. ADMINISTRATION

##### 1. Personnel

Prior to 1987, the administrative, management and planning duties for Hakalau Forest NWR were shared by the Hawaiian and Pacific Islands NWR Complex Manager and the Endangered Species Coordinator in Honolulu. Early in 1987, the position of Refuge Manager (GS-485-11 PFT) was established for Hakalau. Richard C. Wass was assigned the position and based within the Hawaii and Pacific Islands NWR Complex office in Honolulu on the island of Oahu. On August 21, he moved to Hilo on the island of Hawaii to establish the permanent administrative headquarters. No further staff were added during 1987.



Richard C. Wass, Refuge Manager, is seen participating in one of the two forest bird censuses conducted during 1987.

#### 4. Volunteer Program

Cynthia Krakowski spent 16 hours during May assisting with the set-up of an outdoor toilet at Hakalau cabin.

Betsy Gagne and Torrie Haurez each spent 40 hours on the refuge during the month of May participating in the semi-annual forest bird census.

#### 5. Funding

Almost \$130,000 was expended for special projects at Hakalau in FY86 which included Interagency Agreements to survey pigs and vegetation, to conduct reforestation studies and to recommend gorse control measures; a Research Work Order to design and conduct a forest bird census; the construction of a cabin; the purchase of materials for six miles of fence; and a contract to erect the fence.

The refuge began receiving its funds through the Hawaii and Pacific Islands NWR Complex in FY87. Expenditures for this year totaled about \$98,000. Major items were the manager's salary, travel between Hilo and Honolulu, equipment for the new office in Hilo, fence materials, and an ATV motorcycle.

## 7. Technical Assistance

As a member of the Sea Turtle Recovery Team, Refuge Manager Richard Wass attended meetings January 20-23 and September 17 at the National Marine Fisheries Service Office in Honolulu during which the Sea Turtle Recovery Plan was drafted and discussed.

## 8. Other Items

As mentioned under Section E.1, an administrative headquarters for the refuge was established on the island of Hawaii during late August. The office occupies two rooms on the second floor of the Federal Building in downtown Hilo which also houses the Post Office and several other federal agencies. The building is on the National Register of Historic Places so it is very well maintained. The only drawback is that the refuge is a two-hour drive from the office. No suitable office sites are any closer, however, and it is not feasible to have the office on the refuge because of its isolation.

A Programmatic Evaluation of all the refuges within the Hawaiian and Pacific Islands Refuge Complex was conducted by Regional Office Personnel (ARD Larry DeBates, Sandy Wilbur, Fred Caslick and Dick Kuehner) during February 23-27. The team visited Hakalau February 24 for a first-hand view of the refuge and management concerns. Their general perception was "that there is no need to move quickly on fencing, pig control, vegetation control, or other major forest bird management efforts. The key short term emphasis should be continued acquisition and establishment of staff presence on the Big Island." The team also concluded that a general leaflet explaining the resource values and allowed activities of the refuge should be developed and that the entrance sign should be installed on a base to be designed by EPIC.

## F. HABITAT MANAGEMENT

### 3. Forests

One of the primary management objectives for Hakalau Forest NWR is restoration of the native forest. The entire refuge has experienced considerable degradation from feral pigs and the introduction of alien plants, and large areas at the upper elevations have been nearly denuded of native plants by grazing cattle.

On September 11, 1986 an Interagency Agreement between the FWS and the U.S. Forest Service's Pacific Southwest Forest and Range Experiment Station was signed. The agreement transferred \$15,000 to the Forest Service "for the purpose of developing guides for re-establishing the native forest on pasture areas of the Hakalau Forest NWR...." The objectives

were to conduct the necessary field trials to determine what methods for regeneration of the native forest are most efficient and cost effective and to provide management prescriptions for future large-scale reforestation effort.

In May 1987 an experimental reforestation plot (termed the Magnetic Hill Exclosure) of about 6 acres was established in open grassland below Magnetic Hill at the 6,500 ft elevation. The area was fenced to exclude cattle and pigs. Koa seedlings, mamane seedlings and rooted ohia cuttings were planted in pure stands and in combination with each other at 2-meter and 2.5-meter spacings in seven- by seven-tree matrices. Site preparation prior to planting was minimal and consisted of scalping the vegetation (mostly kikuyugrass) from a circular area about 1/3 m across at each planting spot. No subsequent weed control was conducted.

Observations made in January 1988 indicated that growth of both koa and ohia after 8 months was slow compared to a second plot established at a lower elevation. Vigor was rated average for koa and below average for ohia. The ohia that looked best were those under some cover of surrounding plants. Frost damage may be the cause of the relatively poor vigor. The plot is located at the upper limit of the elevational range of ohia. Survival of the planted stock was surprisingly high. Koa seedling survival was 97% and ohia survival was 88%.

A second experimental reforestation plot (termed the Woodland Exclosure) was established in July 1987. It is located at about 5,500 ft in the SW corner of the Liliuokalani Trust parcel. The understory has been heavily impacted by cattle and pigs and consists mostly of introduced grasses. There is a scattered overstory of koa, ohia, and other species, however, to produce seeds and root-sprouts. This plot was established to determine the efficacy of soil scarification for producing koa forest regeneration from the residual soil seed bank. A disk plow was used to turn over the sod to a depth of about 5 inches, thereby exposing the soil surface and allowing sunlight to penetrate and warm the soil to stimulate seed sprouting.

Areas beneath five live koa trees, four clusters of live koa trees, five dead and down koa trees and five open areas were selected at random for scarifying by disking. The open spots were at least 100 ft from a live or dead koa and were marked to be about 30 ft across after disking. The seedlings established as of January 1988 were counted and flagged as a baseline study. Each of the scarified areas associated with live trees contained at least 29 seedlings and some contained hundreds. Seedling counts associated with dead trees ranged between 1 and 660. The range of 0 to 17 seedlings in the five open areas suggests that at least some seeds are spread away from the existing mature trees. Overall seedling condition

was good. Their foliage was darker green and thicker than that of the seedlings at Magnetic Hill. Some trees were more than 16 inches tall.



A disk dragged behind a bulldozer was used to scarify an area to stimulate germination of koa and other naturally occurring seeds.



In response to abrasion from the disking process and the light and warmth from the sun, koa seedlings appeared about two weeks after the Woodland Exclosure was scarified.

Conclusions that can be drawn from the two experimental plots are limited at this early stage. Seedlings and rooted cuttings of koa, ohia and mamane survive at both sites but the lower site is better for koa and probably for ohia because of the warmer temperature. Scarifying the soil in woodland areas results in significant numbers of koa seedlings. Competition from grasses such as kikuyu is severe but, once established, koa seedling growth is vigorous. Most koa seed is not far from the seed source. Beyond about 80 ft, the number of seedlings drops dramatically. Prevailing wind does not appear to have much impact on seedling distribution. Existing data do not allow a determination of how long koa seeds remain viable in the soil but it appears that dead tree skeletons remain after most of the seeds have lost viability.

The reforestation study is described and discussed in considerable detail in a manuscript that is currently being prepared for publication. It is titled "Reforestation Research in Hakalau Forest National Wildlife Refuge" and is authored by C. Eugene Conrad, Paul G. Scowcroft, Richard C. Wass and Donovan S. Goo.

Reforestation studies at Hakalau are far from complete. The establishment and growth of native species within the two experimental plots described above must be monitored for several more years, techniques for propagating seedlings and cuttings of additional species need to be worked out, the efficacy of using fertilizer and grassicides needs study, and the extent of the koa seed bank along a gradient of decreasing koa tree cover needs further testing. A new agreement with the U.S. Forest Service to continue and expand their initial study will be signed in 1988.

## 7. Grazing

Native Hawaiian plants are ill-adapted to withstand grazing pressure. Consequently, the 100-year period of grazing has had a devastating impact on the upper-elevation forests of the refuge. Another primary management objective, therefore, is the elimination of grazing.

Three of the five parcels currently comprising the refuge were leased for grazing at the time of their acquisition by the FWS. As conditions of sale, the Service consented to continued grazing by the lessees on two of the parcels for three years to allow time for the ranches to phase out their operations and to allow the Service time to determine if the benefits of a limited grazing program might outweigh the adverse impacts. To this end, a Cooperative Agreement was signed with the Pua Akala Ranch which permits grazing on the upper portions of the Shipman Estate parcel (approximately 3,000 of the 4,994 acres) from January 1, 1986 to December 31, 1988. Grazing privileges were provided in exchange for equivalent value services from Pua Akala Ranch relating to

grazing and grassland management such as fence and trail construction, boundary posting, exotic vegetation control and removal of feral cattle from adjoining refuge property. The agreement specified a maximum stocking rate of one animal unit per five acres and set the value of one animal unit year (AUY) of grazing at \$22.00 based on a rate survey conducted by the Service. Beginning in 1988, that figure will be adjusted annually to account for increases or decreases in the price of beef.

Grazing by Pua Akala Ranch cattle amounted to 447 AUY's for 1986 valued at \$9,819 in services and 355 AUY's during 1987 valued at \$7,789. Most of this amount is on account to be utilized during the remaining year of the agreement. During 1987, \$3,225 worth of bulldozer time was used to scarify the Woodland Exclosure and \$200 of services were performed by ranch employees posting boundaries.

On April 11, 1987, a Cooperative Agreement was signed with the Alfred Nobriga Ranch which permits grazing on the entire 1,542 acres of the upper Robertson parcel through the end of 1989. The terms are generally similar to the Pua Akala Ranch agreement described above in that grazing privileges are provided in exchange for equivalent value services at the base rate of \$22.00 per AUY subject to annual adjustment. The maximum stocking rate again is one animal unit per five acres (308 AUY's).

A total of 218 AUY's of grazing valued at \$4,787 in services occurred on the upper Robertson parcel during 1987. The entire amount was placed on account and will be used during the remaining years of the agreement.

The Alfred Nobriga Ranch was also issued a Special Use Permit (HAK-3-87) for the construction of a 4 million gallon water catchment pond on the upper Robertson parcel. Water from the pond will be pumped 1-1/2 miles upslope to a holding pond off the refuge and then to a series of troughs to provide water to the permittee's cattle. Prior to acquisition of the property, the FWS informally agreed to allow Mr. Nobriga to take water from the refuge during periods of drought. The pipeline has yet to be constructed so no water was pumped from the pond during 1987.

#### 9. Fire Management

Regional Fire Management Coordinator Herb Troester visited the refuge December 7-11 to assist with the preparation of a Fire Management Plan. Accompanied by the Refuge Manager, he discussed fire management with specialists from Hawaii Volcanoes National Park, the Hawaii State Division of Forestry and Wildlife, the Gorse Steering Committee and the U.S. Forest Service and with the Cooperators currently grazing cattle on the refuge. The use of prescribed burns to control gorse was

also discussed and observed. Prior to Troester's departure, an outline of a Fire Management Plan for Hakalau was drafted. The Plan was completed in 1988 and will be described in the narrative for that year.

#### 10. Pest Control

A major management concern is the establishment and spread of alien plants which crowd out and compete with native species and provide little or no habitat for the endangered birds the refuge is mandated to protect. In addition to the introduced grasses that have already been mentioned, banana poka and gorse are invading species that require control. At present, the banana poka vine is kept in check by cattle. As grazing is phased out, however, it will likely become a problem.

Gorse is a noxious weed that was introduced to Hawaii over 100 years ago either to create hedgerows for penning sheep or accidentally from seeds tangled in sheep wool. Sheep are no longer ranched on a large scale and the plant, which was grazed by sheep (but not cattle), is now rapidly invading grassland areas on the slopes of Mauna Kea.

Gorse presently occurs in large patches on the upper-elevation grasslands in the southwestern corner of the refuge. It provides no habitat for native wildlife, grows in impenetrable thickets in which no native plants can establish, and poses a fire hazard. The use of herbicide, fire, and bulldozers offers only short-term control because the millions of seeds in the ground are often stimulated to sprout by these procedures. Biocontrol through the introduction of insects and pathogens which naturally prey on gorse appears to be the only viable long-term solution.

The U.S. Soil Conservation Service, the U.S. Forest Service, and the Hawaii State Department of Agriculture are currently studying and testing various gorse control measures. The FWS funded a portion of this work through an Interagency Agreement with the U.S. Soil Conservation Service (SCS) signed September 15, 1986. This agreement transferred \$10,000 to the SCS "to coordinate the development of techniques to control/eradicate the plant pest, gorse (Ulex europaeus) on the Island of Hawaii". Objectives of this Interagency Agreement were for SCS "to establish a committee on gorse control, to investigate a number of control techniques and to develop methods for controlling gorse under various conditions. This will prevent the spread of gorse into the more open portions of Hawaiian forest bird habitat, including the Hakalau Forest NWR."

The agreement was completed at the end of 1987 and the results submitted in a report dated April 4, 1988. The bulk of the FWS funds were used to support the quarantine work necessary to ensure that potential biocontrol insects are host specific

to gorse and pose no threat to native Hawaiian plants or those with economic value. Specific accomplishments included: 1) Established monthly rain gauges and meteorological stations in the Mauna Kea gorse area. 2) Collected gorse samples and gorse pod samples at monthly intervals and surveyed them for insects. 3) Received, propagated and tested shipments of foreign insects. 4) Conducted various research and studies pertaining to gorse. 5) Arranged for Dr. Richard Hill of New Zealand to visit Hawaii to consult with George Markin on the development of a comprehensive insect biocontrol program and to establish a cooperative working agreement with the Ministry of Forestry and Fisheries, New Zealand. 6) Sponsored an information field trip for the news media and legislators.

The report also contained specific recommendations for short term control of gorse on the refuge. They included application of the restricted use herbicide, Tordon 22k, at a rate of two pounds acid equivalent per acre followed by burning and repeated applications of herbicide to kill new sprouts and plants that were only weakened initially.

## G. WILDLIFE

### 2. Endangered and Threatened Species

As was mentioned in the introduction, Hakalau Forest NWR was established primarily to protect and restore endangered forest bird populations and their habitat. Four endangered forest birds are relatively common on the refuge. They are the Hawaii 'Akepa, the Hawaii Creeper, the 'Akiapola'au and the 'Io (Hawaiian Hawk). Three other endangered birds, the 'O'u, the Nene (Hawaiian Goose) and the Koloa (Hawaiian Duck), and the endangered Hawaiian Hoary Bat also occur on the refuge.

An annual census is required to monitor the status and population trends for the 36 bird species occurring on the refuge. Such a survey will enable the Refuge Manager to determine if the populations are responding to management efforts and what strategies are most productive. To this end, a Research Work Order was signed September 22, 1986 with the Cooperative Fish and Wildlife Research Unit, University of Idaho. This unit was selected because it is led by Dr. J. Michael Scott who directed the Service's Hawaii forest bird research effort at the Mauna Loa field station for several years. The Work Order provided \$20,000 to accomplish the following objectives: 1) Develop a permanent monitoring program for the forest bird populations of Hakalau Forest NWR. 2) Select and permanently mark the locations of transects and plots for the forest bird monitoring program. 3) Determine what frequency of monitoring is necessary to measure seasonal, annual and long-term population trends. 4) Conduct two initial surveys during the period of this research work order and train refuge personnel to continue the monitoring program

upon completion of this work. The period of performance was one year.

Dr. Scott and his crew of census takers and trainees made their first trip to the refuge during the last two weeks of November, 1986. They set up fourteen downslope transects at 500-1,000 m. intervals to cover the entire refuge as well as the Piha area managed by the State Division of Forestry and Wildlife. Count stations (239 total) were established on each transect at 200 m intervals. All birds seen and heard at each station during eight-minute observation periods were identified and counted. Distances to each bird were also estimated. Additional censuses were conducted along the 14 transects by Dr. Scott and crew during late May-early June and again in October 1987. Data from all three censuses were computerized and densities were calculated for each species at each station using the variable circular plot method.

The results will be summarized in the 1988 Narrative because the completion date for the research work order with the University of Idaho was extended to March 15, 1988 to permit the inclusion of data collected during the third survey.



The 'Akiapola'au uses its lower mandible in woodpecker-like fashion and its upper mandible as a probe in the search for insect larvae on which it feeds. Photo by Jaan Lepson.

#### 14. Scientific Collections

A Special Use Permit (HAK-4-87) was issued to Dr. Hampton Carson, a geneticist with the University of Hawaii, to survey

and collect native Drosophila flies for genetic studies. On September 23 the fruit flies were baited to plastic sponges saturated with fermented mushrooms and bananas below Pua Akala at elevations near 5,500 ft. Few specimens were collected, probably due to the sparseness of the understory which is attributed to cattle grazing. Very few native host plants (Cheirodendron and Clermontia) were observed. The following species were collected:

Picture-winged Drosophila:

D. silvestris, 1 male and 1 female

D. sproati, 1 male

Cheirodendron leaf-breeding species:

D. tanythrix, about 25

Fungus-feeding species:

D. canipolita, about 25

D. fungiperda, about 25

D. longipedis, about 25

D. ochopleura, about 25

The last two names represent undescribed species. The two specimens of silvestris yielded laboratory progeny.

## 15. Animal Control

Feral pig control is a major management concern. Pigs find several species of native plants particularly delectable and have the destructive habit of rooting up vegetation and the top layer of soil in search of earthworms and edible roots. An Interagency Agreement with the Cooperative National Park Resources Studies Unit, National Park Service, University of Hawaii was signed September 26, 1986 to document the extent of the problem and recommend measures for reducing the damage. The agreement provided \$18,000 over a nine-month period to: 1) Develop indices of feral ungulate (both pigs and cattle) abundance and distribution by vegetation type and elevation. 2) Provide indices to introduced plant abundance and distribution by vegetation type and elevation. 3) Provide indices to rare plant abundance and distribution by vegetation type and elevation as another indicator of pig activity. 4) Establish semi-permanent transects for determining pig control progress and evaluating vegetation response. 5) Recommend locations for additional transects for the above purpose on properties targeted for future acquisition. and 6) Summarize the findings in the form of recommendations for a comprehensive feral pig and alien plant control strategy on the Hakalau Forest NWR.

The draft report is dated December 1987 and is titled Technical Report 63: Preliminary Survey of Feral Ungulate and Alien and Rare Plant Occurrence on Hakalau Forest National Wildlife Refuge by C.P. Stone, P.K. Higashino, L.W. Cuddihy,

and S.J. Anderson.

The ungulate and plant surveys were conducted on the same 14 transects as the bird censuses described above under Section G.2. The presence of dung, tracks, digging, feeding on plants, trails, other sign and sightings of ungulates within a 5-meter corridor centered on each transect was recorded and rated as fresh, intermediate or old for each 20-meter length. The presence of alien plants within each 5- x 20-meter plot was recorded by species and an estimate of cover abundance was made for each. Rare plants encountered along or near transects were recorded and special effort was made to locate them in gulches and other areas of difficult access to cattle and pigs. Additionally, six 20- x 20-meter plots were established in lightly grazed and heavily grazed areas on transects 5, 10 and 13 for the collection of detailed vegetation data.

Some of the more significant results of the survey include the following: Six major vegetation types were identified with closed canopy koa-ohia being the most prominent. Thirty detailed vegetation types were identified within the six major types. The most prominent of these was closed canopy koa-ohia forest with native tree understory, native shrubs and alien grasses. A list of the 68 alien plants encountered is presented. The six most common aliens (sweet vernal grass, meadow ricegrass, kikuyugrass, banana poka, blackberry and gorse) are analyzed for frequency of occurrence and cover abundance by elevation, vegetation type and geographical area. A checklist of all vascular plants occurring on the refuge was also prepared along with lists of 14 rare plants sighted and 26 other rare species that may occur.

Fresh to intermediate-aged feral pig sign was observed on 26% of the 2,293 transect intervals surveyed. Fresh to intermediate cattle sign was observed on 31% of the intervals. Feral pig and cattle abundance are analyzed and correlated with vegetation type, elevation and geographical area. Pig sign was most abundant in closed canopy koa-ohia with alien tree subcanopy, banana poka and native shrub. Pig sign was particularly abundant in Piha, the upper Robertson parcel and the Liliuokalani parcel and more common in the lower portions of each transect than the upper. Cattle sign was most abundant in open ohia with koa, native tree understory and alien grasses. As expected, cattle sign was common in pasture areas grazed by the two cooperators. However, some cattle sign occurred in the lower portions of all transects indicating the ubiquitous presence of feral cattle throughout the forest areas as well.

The report's management recommendations include: Cattle should be removed as soon as possible with priority given to the lower elevations and northern portions of the refuge which are not as dominated by alien plants in the understory. Feral

pigs should be controlled through establishment of 11 fenced units ranging in size from about 700 to 2,100 acres. Priority should be given to the lower units where forest integrity and reclamation potential are highest. Pigs should be eradicated from each unit by systematic hunting with dogs where hunters are required to return to hard-to-hunt areas. Public hunting reduces pig populations in accessible areas and is a good public relations tool but is no substitute for a systematic program where hunters are paid and a variety of innovative methods such as snaring, trapping, baiting, use of exit gates and ramps, and wing fences are utilized to reduce pig populations to near zero. Kalij pheasants and wild turkeys should be viewed as distributors of banana poka and other alien plants rather than as game species. A study of their food habits should be conducted on the refuge, reducing their populations in the process. Transects should be systematically surveyed to monitor abundance and distribution of feral ungulates and alien plants. Additional effort should be expended to document the presence and distribution of rare plants. Control of alien plants should emphasize outlying or new populations rather than central infestations. Banana poka, blackberry and gorse should be aggressively attacked with existing manual and chemical methods. Existing roads should be improved for more dependable access during wet weather but no new roads should be constructed unless absolutely necessary. Hakalau cabin should be expanded and improved to provide better accommodations for more personnel. Nauhi cabin should be rehabilitated to serve as a base camp for management and research.

#### 16. Marking and Banding

As mentioned under Section D.5, Dr. Leonard Freed and colleagues banded 381 birds during the year including 57 endangered Hawaii 'Akepa and Hawaii Creeper.

### H. PUBLIC USE

#### 1. General

Public entry was not permitted on the refuge during 1987. There are no facilities for self-guided tours and no staff to act as guides. Also, the more accessible portions of the refuge are grazed by cattle which require locked gates and lots of barbwire fences. Visitors gained access only through Special Use Permit, in the company of the Refuge Manager or FWS staff, through the volunteer process or during guided tours conducted by the Refuge Manager. One such tour was held during the year. It was organized by the State Agriculture Extension Service for local ranchers agriculturists and conservationists. About 25 participants viewed the upland portions of the refuge and listened to the Refuge Manager summarize the history and outline management objectives for

Hakalau.

#### 11. Wildlife Observation

A Special Use Permit (HAK-1-87) was issued to Mark S. Collins, Hawaiian Sunrise Excursions, permitting him to conduct guided bird observation tours on the Shipman parcel of Hakalau Forest NWR. Most of the public's requests to visit the refuge were directed to Mr. Collins. He is familiar with the area having participated in the Service's forest bird surveys throughout the island in years past. A Special Condition of his permit requires that he report all visits to the refuge as well as a list of the endangered birds the group observes. During 1987 Mr. Collins conducted 7 tours (averaging about 3-1/2 hours of observation time) with a total of 44 participants. He reported a total of 10 Hawaii 'Akepa, 8 Hawaii Creeper, 2 'Akiapola'au and 4 'Io (Hawaiian Hawk). Only one trip resulted in no endangered bird observations.

A Special Use Permit (HAK-5-87) was also issued to Paul Higashino, Hawaii Volcanoes National Park to allow him to lead a training session on native bird identification for eight people staffing the Interpretive Division at the National Park.

#### 17. Law Enforcement

The general area of law enforcement receives little emphasis at Hakalau due to the lack of public entry and hunting. Two incidents occurred during the year, however, which are worthy of note.

The first occurred during the month of March on the property purchased from Robertson, Sutton, et. al. the previous December. Mr. Robertson had arranged for a logger to enter the 550 acres of property he and Sutton retained to harvest koa trees that had blown down during a high wind. The boundary between Robertson's property and that recently purchased by the Fish and Wildlife Service was pointed out to the logger on a map, but the actual boundary was unmarked and unfenced due to the recency of purchase. During the ensuing weeks, more than 19 koa logs varying in length from 9-1/2 to 26 ft. and with proximal end diameters as great as 55 in. were taken from refuge property. The points of origin of these logs were between 20 m. and 530 m. inside the refuge boundary. The case was documented and passed to the Fish and Wildlife Service's Law Enforcement Office in Honolulu. After consultation with the United States Attorney's Office, "prosecution was declined based upon the unlikelihood of a conviction due to the lack of posted refuge boundaries."



A log was illegally cut from this koa tree blown down by the wind.

The second incident involved a suspicion that marijuana was being grown on the refuge. Discussions were held with law enforcement personnel from the Fish and Wildlife Service, the National Park Service, the Drug Enforcement Agency and the Vice Division, Hawaii County Police Department. All of these agencies recommended that a helicopter search be conducted in the area below Pua Akala Ranch which was deemed the most likely site for marijuana cultivation. On September 19 a search was conducted from a helicopter chartered by Hawaii Volcanoes National Park. It was crewed by the pilot, two National Park Service Rangers with extensive experience on marijuana searches and the Refuge Manager. Lots of marijuana plots were sighted in the sugarcane fields and at the lower boundary of the forest but no plots were sighted within or near the refuge boundary. Subsequently, numerous forest bird, feral ungulate and vegetation surveys have failed to find any evidence of marijuana cultivation on the refuge.

## I. EQUIPMENT AND FACILITIES

### 1. New Construction

In September of 1986, a contract in the amount of \$24,535.50 was let to Kama'aina Fence Builders, the low bidder, for the construction of approximately six and one-half miles of boundary and internal fence. Two and one-half miles of the

fence will form the boundary between the refuge and the 500 acres of property retained by the W.H. Shipman Estate. The remaining four miles will be erected on the Liliuokalani Trust parcel. About half of it will bound the property retained by the Liliuokalani Trust to the west and the Piha state game management area to the north. The remainder will extend from the ends of these two fence lines to enclose approximately 550 acres as a pig management unit.

All fence materials will be supplied by the refuge. The fence is designed to exclude both feral pigs and cattle. It is constructed of triple-galvanized 47 inch square mesh wire with a strand of barbwire running along both the top and the bottom. The bottom of the fence is to be no more than two inches above the ground to prevent pigs from squeezing underneath. Gaps greater than two inches will be closed by pulling the fence down with anchors, filling in the holes with large rocks or splicing in additional fence material.

The onset of the project was delayed until January 1987 due to problems encountered in procuring and shipping the materials. Bad weather, further shipping delays, equipment breakdowns and the snail-like pace of the contractor all contributed toward additional delays and the contract was still unfinished by the end of 1987.



Construction began on 6-1/2 miles of fence designed to exclude cattle and feral pigs from portions of the refuge.

#### 6. Computer Systems

With considerable assistance from the Regional Office, an IBM compatible computer system was purchased for installation at the administrative headquarters in Hilo. The system consists of a Mitac computer with a 30 MB hard disk and 640 bytes of RAM, a high density and a double density disk drive, a Fujitsu DL2400 dual mode dot matrix printer, a Thomson color monitor and an Anchor external modem. Software includes Word Perfect V, RBase V, and Lotus 123. The system has performed very well thus far.

#### J. OTHER ITEMS

#### 4. Credits

This narrative was written and the photographs were taken by Richard C. Wass.