# Hawaiian Endangered Bird Conservation Program

## Report To:

U.S. Fish and Wildlife Service
and
State of Hawai`i

Cooperative Agreement No. 122001J001
Exempt Purchase Approval No. 01-9-R
October 1, 2000 - September 30, 2001

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## 1. ABSTRACT

At the request of the US Fish and Wildlife Service (Service) and State of Hawai`i Division of Forestry and Wildlife (DOFAW), in cooperation with Kamehameha Schools (KS), the `Alala, Kaua`i and Maui Partnerships, and the Biological Resources Division of U.S. Geological Survey (BRD); the Peregrine Fund (TPF)/Zoological Society of San Diego (ZSSD) - Hawaiian Endangered Bird Conservation Program had the following goals for the period between October 1, 2000 - September 30, 2001:

1) Continue the restoration program for the endangered Puaiohi (*Myadestes palmeri*) by breeding this species in captivity and reintroducing birds in order to enhance the existing population and to establish a second population in the Alaka`i Swamp, Kaua`i.
2) Continue captive-breeding `Alala (*Corvus hawaiiensis*) at the Maui Bird Conservation Center (MBCC) and Keauhou Bird Conservation Center (KBCC) for reintroduction to the wild. Utilize the newly divided `Alala aviaries to improve the socialization of juvenile `Alala and to enhance the process of mate-choice among reproductively mature `Alala.
3) Continue captive-breeding Nene (*Nesochen sandvicensis*) at the MBCC and KBCC to produce at least 20 goslings for DOFAW's Nene release program. When possible collect wild eggs to improve the genetic diversity of the captive flock (funds permitting).
4) If found, collect wild eggs from Maui Parrotbill (*Pseudonestor xanthophrys*), `Akiapola`au (*Hemignathus munroi*), and "on the brink" species to develop captive propagation techniques and restoration programs.
5) Establish long-term captive husbandry and breeding protocols for endemic Hawaiian passerines.
6) Continue the environmental education program, funded by grants and private donations.
7) Continue to rehabilitate and renovate facilities at MBCC.
8) Maintain the KBCC is excellent working order.
9) In collaboration with DOFAW and the Service, develop a draft programmatic Five-Year Workplan for the Hawaiian Endangered Bird Conservation Program.

All ZSSD/TPF programmatic goals were met except for the collection of wild eggs from "on the brink species". Biologists from the U.S. Geological Survey - Biological Resources Division (BRD), (Service), DOFAW and TPF/ZSSD were unable to locate accessible nests for these species.

## 2. INTRODUCTION

The Hawaiian Endangered Bird Conservation Program is a unique partnership composed of government agencies (the U.S. Fish and Wildlife Service, State of Hawai`i Department of Land and Natural Resources, and the U.S Geological Survey, Biological Resources Division), non-profit conservation organizations (The Peregrine Fund and The Zoological Society of San Diego) and private land-owners (Kamehameha Schools and the `Alala, Maui and Kaua`i Partnerships). The overall mission of this partnership is to collaborate to aid the recovery of native Hawaiian ecosystems and endangered bird species and communities at the landscape-level. The mission of the ZSSD/TPF within this partnership is to establish self-sustaining populations of birds in the wild using management programs including captive propagation and reintroduction. Our Cooperative Agreement states: "*This agreement is made for the purpose and objective of carrying out management efforts for recovery of Hawaiian birds through the design, construction and operation of captive propagation facilities in the State of Hawai`i and reintroduction of captive-reared birds...* ".

The Hawaiian Islands are home to species of birds that are found nowhere else on the planet, exhibiting a staggering array of adaptations to life in their unique habitats. Prior to human disturbance, Hawaiian birdlife was abundant from the montane cloud forests to the rain forests by the sea in what are thought to have been the highest densities of any birds on earth. These natural treasures are integral elements of the biological and cultural heritage of the Hawaiian Islands and their people. Unfortunately, many Hawaiian bird species are highly endangered or already extinct. Of the more than 140 native breeding species and subspecies present prior to the colonization of the islands by humans, more than half have been lost to extinction. Among the remaining 71 endemic forms, 30 are federally listed as endangered, and fifteen of these are literally on the brink of extinction, numbering fewer than 500 individuals. The causes of these declines are numerous and extensive, including loss and degradation of habitat, and introduced diseases, predators and competitors. The task of preventing further declines and recovering imperiled species will require wide-ranging efforts to address and mitigate the diversity of threats faced by species in natural populations.

For many bird species in Hawai`i, habitat enhancement and protection is not occurring quickly enough to guarantee a safe haven for populations on the verge of extinction. In these critical cases, manipulation of wild birds and hands-on intervention techniques are being used as recovery management tools. Collection of wild eggs to establish captive breeding programs to produce birds for reintroduction has proven to be a valuable conservation strategy for Peregrine Falcons (*Falco peregrinus*), California Condors (*Gymnogyps californianus*), and San Clemente Island Loggerhead Shrikes (*Lanius ludovicianus mearnsi*). Populations of endangered bird species can be established in captivity without removing adult birds from the wild. Also, captive propagation of hand-reared birds is often more successful than attempting to collect and breed wild-caught birds. However, propagation of birds in captivity is labor-intensive, costly and not necessarily an effective recovery tool for all species. For some endangered bird populations translocation, and/or intensive habitat management is a preferable recovery

strategy.

The Partnership was formalized in 1994, soon after The Peregrine Fund joined conservation efforts in Hawaii, establishing a program to breed native and endangered Hawaiian birds in captivity. At that time an effective partnership was needed that would integrate existing strategies and programs with captive propagation efforts to aid in the recovery of endangered species. In 2000, the administration of the Hawaiian Endangered Bird Conservation Program was transferred from The Peregrine Fund to the Center for the Reproduction of Endangered Species, a division of the Zoological Society of San Diego. This transition was completed in April, 2001.

The accomplishments of the Hawaiian Endangered Bird Conservation Program during the past seven years to preserve Hawai`i's endangered birds are significant. Over 250 endemic forest birds of 12 species have hatched in captivity (seven endangered species) and a new captive propagation facility, the Keauhou Bird Conservation Center (KBCC), was constructed. During 1999-2001, 34 captive-bred Puaiohi have been released in the Alaka`i Swamp. These releases have led to the successful reintroduction in the wild of this critically endangered species. This is the first release program for an endangered passerine that has successfully incorporated a wide spectrum of conservation techniques to include the collection of wild eggs, artificial incubation and hand rearing, captive breeding, release, and subsequent breeding of the released birds in native habitat. This complete reintroduction program for the Puaiohi, from the wild to captivity and back to the wild, where breeding by reintroduced birds has been confirmed (Kuehler et al., 2000) has occurred over only three years time— a remarkably successful recovery action. Equally important, the environmental education program at the KBCC reaches over 1,500 Hawaiian school children annually.

Additional background information regarding the Hawaiian Endangered Bird Conservation Program is available on Partner web sites:

**State of Hawaii - Division of Forestry and Wildlife:**
http://www.state.hi.us/dlnr/dofaw/captiveprop/consprog.htm

**U.S. Fish and Wildlife Service:**
http://pacificislands.fws.gov/

**The Zoological Society of San Diego:**
http://www.sandiegozoo.org/index.html
http://www.sandiegozoo.org/conservation/fieldproject_hawaiian_birds.html

**The Peregrine Fund:**
http://www.peregrinefund.org/
http://www.peregrinefund.org/conserv_hawaii.html

## 2.1 ZSSD/TPF - Hawaiian Endangered Bird Conservation Program

**Program Goals:** at the request of the US Fish and Wildlife Service (Service) and State of Hawai`i Division of Forestry and Wildlife (DOFAW), in cooperation with Kamehameha Schools (KS), the `Alala, Kaua`i and Maui Partnerships, and the Biological Resources Division of U.S. Geological Survey (BRD); the Peregrine Fund (TPF)/Zoological Society of San Diego (ZSSD) – Hawai`i Endangered Bird Conservation Program had the following goals for the period between October 1, 2000 – September 30, 2001:

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All ZSSD/TPF programmatic goals were met except for the collection of wild eggs from "on the brink species". Biologists from the U.S. Geological Survey - Biological Resources Division (BRD), (Service), DOFAW and TPF/ZSSD were unable to locate accessible nests for these species.

## 2.2 Major Concerns and Program Needs:

The Hawaiian Endangered Bird Conservation Program is a conservation coalition involving government agencies, non-governmental agencies (NGOs) and private land-owners,

responsible for the environment in the Pacific Islands. In order for restoration strategies to aid the recovery of endangered species, programs designed to understand, restore and preserve native habitat require funding and implementation. Many of the limiting factors causing the decline of wild populations of bird species in the Hawaiian Islands remain unchecked. Until those limiting factors can be substantially reduced or somehow mitigated, it will not be possible to establish viable wild populations using captive propagation/reintroduction as a recovery strategy. Captive-breeding is not the sole answer to an extinction problem; it must be part of an overall, integrated conservation strategy including research, habitat management and public education. Recovery programs which utilize captive propagation/reintroduction without habitat management programs to mitigate the limiting factors in the wild cannot realistically succeed. Successful avian restoration programs require landscape level programs focused on ecosystem health and protection, as a prerequisite to reintroduction.

The Hawaiian Endangered Bird Conservation Program was established to provide birds for reintroduction to the wild for recovery of endangered species. Currently, captive-bred endangered birds (Nene, ʻAlala, and Palila), surplus to the breeding stock, are being held in captivity because acceptable habitat is unavailable for reintroduction. Until managed habitat becomes available for reintroduction, the program will not have enough enclosure space to house all the birds produced in the captive-breeding program. Restoration programs cannot proceed. Our primary programmatic concerns are:

(1) Inability to reintroduce birds propagated in captivity back to the wild due to lack of acceptable habitat/release sites.

(2) ʻAlala - insufficient/inadequate enclosures for captive flock. Lack of: (a) final ʻAlala Recovery Plan (b) final Environmental Assessment for reintroduction of ʻAlala and (c) genetic/demographic guidelines for captive propagation/reintroduction.

(3) Palila - inadequate coordination of responsible parties to complete the program of reintroduction of Palila in managed habitat; i.e. identify release site, pre-release predator control, long-term monitoring of release flock, long-term predator control.

The program is currently holding birds that cannot be released. There is insufficient enclosure space to hold the additional birds we expect will hatch next year (2001/2002). Given these limitations, the focus of the captive-breeding program was changed in 2001 to parent-rearing instead of artificially incubating and hand-rearing the majority of eggs. This has decreased the reproductive output of the program, because we did not induce multiple clutches by removing eggs. The expected decrease in hatchability and survivability under parent-rearing conditions in captivity was realized. As expected, production was lower than artificial incubation and hand-rearing as has been done in the past. Space constraints leave no other alternative until managed habitat becomes available and birds produced in captivity can be released in a timely fashion.

**Six Key Elements required for Restoration Programs involving Captive Propagation to Succeed:**

(1) **Information about the birds in the wild** – natural history research and monitoring
(2) **Information about limiting factors and ongoing programs to reverse the trend** – habitat research and management
(3) **Captive propagation technology** - the ability to successfully collect, maintain, artificially incubate eggs, hand-rear chicks and breed the species in captivity (if *necessary)*
(4) **Release technology** - the ability to successfully release birds that survive and reproduce in the wild
(5) **Practical considerations** - captive facilities, labor, the ability to locate eggs in the wild, long-term financial support, public/private landowner partnerships
(6) **Acceptable release sites** - protected, accessible, suitable habitat

In our monthly reports, Action Items and Concerns addressed to the contracting agencies are reported, as per the Service - Cooperative Agreement: "*A statement explaining any problems, delays, or adverse conditions that materially impair the ability of the Recipient to meet the objectives of the agreement Include efforts undertaken for problem resolution, any proposed changes in the statement of work (with justification) or proposed changes in the schedule (with justification)*". Following are the outstanding programmatic action items reported in our monthly reports for the period October 1, 2000 – September 30, 2001.

- **Programmatic Concern/Action Item:** (First reported in February, 2001). KBCC and MBCC are now being used as holding facilities for birds propagated in captivity that cannot be reintroduced because acceptable, accessible release sites are not available in managed habitat. Restoration programs for Palila, and `Alala are being impacted. The KBCC and MBCC are not large zoos with extensive holding facilities. The mission of the facilities is to provide birds for reintroduction. If birds cannot be released, propagation activities will need to be re-directed towards parent-rearing (less productive) during the 2002 breeding season instead of higher production (multiple-clutching via artificial incubation and hand-rearing). This may result in higher egg/chick mortality and fewer chicks produced. Addended comment (8/1/01): There were two Puaiohi chicks that failed to survive under the parents. There were two Palila chicks that did not survive under the parents. Parent-rearing has inherent risks in captivity.

- **Programmatic Concerns/Action Items – Alala**

1) Finalize EA for additional 'Alala release sites. Gain access to current `Alala range for monitoring of the last birds. Finalize the `Alala Recovery Plan and establish genetic/demographic goals for captive propagation/reintroduction. We recommend that the

USFWS and DOFAW support the following management policy for the captive flock of Alala in support of recovery of this species.

a) Maintain the current level of genetic diversity and establish a demographically stable flock, in accordance with established IUCN and AZA guidelines for recovery of endangered species.

b) Release candidates should be expendable birds that are redundant to the genetic/demographic stability of the captive flock.

c) Whenever possible, include parent-reared juveniles in the release cohort to possibly improve the long-term survivability of the released birds (e.g. increase predator wariness).

These recommendations should remain in effect until the wild population (reintroduced population) demonstrates the ability to contribute to the genetic diversity and demographic stability of the species (e.g. is growing at a satisfactory rate).

2) (First requested in monthly report, December, 2000) Provide funding to renovate `Alala aviaries at MBCC and/or build additional enclosures at KBCC.

3) (First requested December 2000) Provide funding to immediately replace mosquito netting to include significant lumber replacement on all the `Alala aviaries and replacement of all vertical members of one aviary. Estimated cost of immediate repairs at MBCC required in fy01 is $25,000. Repairs will be covered from operating funds. This will cover the cost of repairing the "remote" `Alala aviary and replace two of the roof structures of the `Alala breeding complex (there are 16 roof structures, estimated TOTAL cost = $160,000).

4) Provide funding commitment in fy01 for construction of at least two additional breeding aviaries to set up additional pairs, or holding cages to accommodate `Alala production of 2002. The `Alala production for 2001 can be maintained in the existing facilities, but given the time required to acquire funds, bid the construction, mobilization of construction, begin and complete construction, furnish and install video cable, perching, nesting platforms, etc., the process must begin immediately (i.e. at least one year ahead) in order to have aviaries available for the 2002 breeding season. At least one and perhaps two additional pairs of `Alala will "come on line" in 2002. In addition, expansion of basic facilities will require the augmentation of operating costs. Estimated cost of construction: $100,000 for two breeding aviaries, video capability and aviary "furniture". Please note, this estimate is based on building two aviaries simultaneously. The cost of building but one aviary will be higher since there are cost savings by building more than one aviary at a time. Holding aviaries to hold 8-10 young birds will cost approx. $50,000 plus operating. Estimated increase of operational costs (labor, forage, insurance, utilities,

etc): $30,000-50,000/annum. There are no funds currently available in the operating budget for these expenses.

- **Programmatic Concerns/Action Items - Palila**

*(*First requested in monthly report, June 2000*).* Service-DOFAW to designate responsible parties to complete the program of reintroduction of Palila in managed habitat (e.g. identify release site, pre-release predator control, long-term monitoring of release flock, long-term predator control).

- **Programmatic Concerns/Action Items - Puaiohi**

Irrespective of the qualified success of the releases in 1999, 2000, and 2001, it remains imperative that a long-term predator control program be incorporated in the release/recovery program for Puaiohi. Service and DOFAW to establish long-term predator control and habitat management program.

- **Programmatic Concerns/Action Items - Nene**

Resolve issue of non-releasability of Nene to other sites (inter-island) due to malaria concerns. Because of the restrictions imposed by the embargo on Nene movement, the increase in Nene production will be reduced in coming seasons. The proposal is to parent-rear Nene in each facility (MBCC and KBCC) and release goslings only on the island of their origin. Eight pairs of Nene (four pairs plus fosters at each facility) should be able to produce twelve to sixteen birds for release on each of the producing islands. However, the management and maintenance of the genetic diversity of the Nene in the program will decrease due to the restriction of free exchange of genetic material between the facilities. As well, the concerns of biosecurity of free-ranging Nene at KBCC will eliminate the option to release birds directly from KBCC grounds. All birds will be managed in controlled pens decreasing the number of birds under management (also decreasing the ability to maintain the flock's genetic variability).

## 3. HAWAIIAN ENDANGERED BIRD CONSERVATION PROGRAM HISTORY - ACTIVITIES AND MILESTONES:

### 1993

- In collaboration with the Service, DOFAW, McCandless Ranch, KSBE, BRD, the ZSSD and Greenfalk Consultants, seven `Alala are hatched, hand-reared and five released to the wild.

### 1994

- Veterinary/Pathology consortium established including *Drs. Pat Morris, Don Janssen, and*

*Bruce Rideout (ZSSD).*

- `Alala studbook initiated.
- Five `Alala reared and seven released (additional birds from DOFAW).
- Service modifies an existing agreement with TPF to design, build and operate a captive propagation facility for endangered Hawaiian forest birds.
- Congressional Appropriation, $1.5 million, for capital construction is received.
- Site is chosen for the development of the KBCC on 155 acres of KSBE land in Volcano, Hawai`i. Subsequently a 35 year license agreement is signed and the Regional Director of the Service approved the Environmental Assessment.
- Five Common `Amakihi hatched and reared; the first successful artificial incubation and hand-rearing from hatch of a Hawaiian honeycreeper species.

1995

- Common `Amakihi, `Oma`o, I`iwi, and Hawai`i `Elepaio hatched and reared.
- Hack tower built in Pu`u Wa`aWa`a (PWW) and `Oma`o and `I`iwi released to test release techniques. `Amakihi released at KBCC to test release techniques.
- Pest control program begins at KBCC for rats, cats, mongoose, mosquitoes and introduced plants.
- Native plant propagation program for native plants is initiated. These plants are now being used to enrich aviary environments and re-forest KBCC.
- Began food production program for maintaining Hawaiian bird species in captivity.
- Finished the A+E for the KBCC by completing the plans, the site survey, soils exploration and civil engineering.
- Facility plans were reviewed and bids submitted by six general contractors. *Kawika General Contracting was selected. Construction of Phase I initiated.*
- In collaboration with KSBE, several weeks spent working in the Alaka`i Swamp doing reconnaissance for rare Kaua`i endemic bird species. Observations were made on six Puaiohi and one observation of a Nukupu`u.
- KBCC building site blessed according to Hawaiian tradition.

1996

- Phase I construction of KBCC is completed including: brooder/office building, forest bird barn, staff residence, `Alala aviary, storage building, civil work, water, power, A+E, and permits. Began operation of the facility on March 15, 1996.
- Assumed management of the Olinda Endangered Species Propagation Facility at the request of DOFAW, and the Service, March 1, 1996 -- renamed the Maui Bird Conservation Center (MBCC).
- Cleaned, renovated and remodeled areas in MBCC critical to the captive propagation of `Alala (incubation and brooder rooms, bird kitchens).
- *Reared six `Alala, 23 `Oma`o, 11 Palila, and five Puaiohi.*

- Developed a behavioral program to monitor incubation attentiveness in captive `Alala, in collaboration with the ZSSD.
- Began intern/volunteer program at KBCC.
- Added two new local members to veterinary consortium: Sterrett Grune (Big Island) and Greg Massey (Maui).
- Dr. Bruce Rideout, Director of Pathology - ZSSD is named Research Associate of TPF.
- Built a second hack tower for the release of `Oma`o at PWW.
- Released 23 additional `Oma`o (25 total) at PWW.
- Released four `Alala in Kona.
- Hosted the semi-annual TPF Board Meeting, in Hawai`i.

1997

- Received congressional appropriation ($987,500) for capital construction (Phase II).
- Completed Phase II construction of the KBCC: four laboratories, eight fledgling aviaries, five `Alala aviaries, four Nene pens, staff residence and road improvements.
- Initiated major renovation of MBCC by repairing `Alala aviaries, painting and cleaning incubator and chick rearing rooms for forest birds, and constructing new outdoor Nene enclosures.
- Hatched and reared ten Puaiohi, four Hawai`i Creeper, two `Apapane, five `Akohekohe, one Maui Parrotbill and nine `Alala.
- Transferred two pairs of `Alala and two pairs of Nene from MBCC to KBCC for breeding. Transferred one juvenile `Alala from KBCC to MBCC.
- Released eight `Alala in Kona.
- Initiated captive population studbooks for all species housed in captivity.

1998

- Hatched and reared 23 Puaiohi , five Hawai`i Creeper, four `Alala, one `Elepaio and one Hawai`i `Akepa. The `Akepa is the smallest passerine to ever be successfully artificially incubated and hand-reared in captivity.
- Hatched and reared 31 Nene (15 for DOFAW release program).
- First captive-breeding of Puaiohi (parents collected as wild-eggs in 1996 and 1997).
- First reported observation of hand-reared reintroduced birds breeding in the wild (`Oma`o).
- Zoological Society of San Diego sponsored a two week Avian Medical Training Workshop at KBCC for TPF staff, February 1998.
- Added a new member to the veterinary consortium: Stephen Diana (veterinarian, TPF).
- Initiation of Environmental Education Program at KBCC.
- Congressional Appropriation, $985,000, for capitol construction (Phase III) is received.

1999

- Hatched and reared five Puaiohi, two `Alala, five `Akepa, two Maui Parrotbill, and eight `Elepaio.
- Hatched and reared 13 Nene for DOFAW 's release program.
- Fourteen captive-reared Puaiohi were released in the Alakai Swamp, Kauai. This is the first successful endangered passerine conservation program using recovery techniques that include: collection of wild eggs, hand-rearing, captive-breeding and release; where reintroduced birds subsequently survived and bred in the wild.
- Completion of Phase III construction of a second Forest Bird Barn at KBCC.
- Completion of additional Nene enclosures at KBCC (total = eight).
- Continuation of Environmental Education Program: 1600 students participated in TPF programs in 1999. Publication of Treasures of the Rainforest - an introduction to the endangered forest birds of Hawai`i.
- Continuation of renovation of facilities at MBCC: `Alala aviaries and Nene pens. The "great room" was painted/carpeted in preparation for an environmental education program on Maui.
- Began intern/volunteer program at MBCC.

2000

- First captive-breeding of the Palila. Two pairs produced eleven chicks; ten hand-reared and one parent-reared.
- First captive-breeding of the Hawai`i Creeper; one chick.
- First captive breeding of the Maui Parrotbill; two chicks.
- First captive-breeding for the Hawaiian Endangered Bird Conservation Program of the Common `Amakihi; one parent-reared chick.
- Hatched and reared 49 Nene; 34 birds for the DOFAW release program, additional birds retained to maintain the genetic/demographic integrity of the captive flock
- Hatched and reared fifteen Puaiohi for release on Kauai (in 2001) and to maintain the genetic/demographic integrity of the captive flock.
- Collected, hatched and reared six wild Hawai`i `Akepa.
- Collected, hatched and reared two wild Hawai`i Creeper.
- Collected, hatched and reared four wild `I`iwi.
- Collected, hatched and reared three wild Palila.
- Released five Puaiohi on Kauai with 100% survivorship for 30 days (release independence).
- Completed Phase III construction at KBCC and occupied second Forest Bird Barn.
- Established Dr. Patrick Morris (ZSSD) as Veterinary Coordinator for the Hawaiian Endangered Bird Conservation Program.
- Hosted over 1,8000 students, conservationists, professionals and interested community members at KBCC and MBCC.
- Seven Nene established as a free-ranging (clipped) semi-captive flock on fenced, predator-controlled KBCC grounds.

- Completed an education display mural at KBCC funded by private donations.
- Contractual transition from The Peregrine Fund to the Center for Reproduction of Endangered Species, Zoological Society of San Diego.

2001

- Hatched nine and hand-reared eight `Alala from four pairs of birds. A total of six pairs produced fertile eggs.
- Hatched five and reared three Palila. Additionally, one injured Palila chick was collected from the wild.
- Hatched 16 and reared twelve Puaiohi.
- Released fifteen Puaiohi (year 2000 hatch) in the Alaka`i Wilderness Area on Kaua`i. Twelve birds survived the 30 day monitoring period until release independence.
- Hatched 47 and reared 46 Nene (DOFAW released four birds - W. Maui; 11 - Molokai; 36 - Hawai`i Volcanoes National Park and 17 - Hakalau National Wildlife Refuge).
- With agreement from DOFAW, eliminated the free-ranging nene flock at KBCC and reduced the captive-breeding population to 20 birds; four potential breeding pairs at KBCC and MBCC, respectively.
- Collected the program's first `Akiapola`au egg from Hakalau National Wildlife Refuge (infertile).
- Hatched and reared three captive-bred Maui Parrotbill. Collected, hatched and hand-reared one wild egg. Quarantined one wild injured Maui Parrotbill which was then integrated into the captive flock (at the request of DOFAW and the Service)
- Increased capacity of water collection and storage at KBCC from 43,000 gallons to 48,000 gallons.
- Established a new release site for the release of Puaiohi in 2002 in the Halepaakai drainage of the Alakai Wilderness Area.

## 4. FACILITIES AND LAND MANAGEMENT

**Goals:** Our goal is to construct and maintain the best facilities possible to propagate Hawaiian forest birds in captivity, using the best husbandry techniques available - within our current budgetary environment. A summary of recovery strategies and faculties-use (by species) are presented in Appendix 1.

**Justification:** Hawaiian Endangered Bird Conservation Programs are designed to contribute to recovery efforts by providing reservoirs of genetic and demographic material that can be used periodically to reinforce, revitalize or re-establish populations in the wild. Reinforcement of wild populations using captive propagation requires management programs that are designed to maintain genetic and demographic security.

## 4.1 Keauhou Bird Conservation Center (KBCC)

Projects include:

- **Occupation and Operation of Forest Bird Building #2 (FBB#2):** This building, following the successful design of Forest Bird Building #1 (FBB#1), contains 18 aviaries for forest birds, each measuring 10' x 20' x 12-14' high. Each aviary has a cement basin and drain for discarded food, natural cinder substrate, native plantings, nesting areas, misting system (automatic), ventilation system, and a mosquito netting cover. The 18 aviaries are divided into six batteries of three aviaries each, connected by common hatches and divided from other batteries by a solid wall. Coaxial cable to each aviary allows video monitoring of nesting pairs. This building also contains a full food preparation kitchen that has the capacity to service all of the breeding stock in KBCC. This kitchen allows for the separation of food preparation activities between adult breeding birds and the neonatal chicks, whose food is prepared in the kitchen in the Brooder-Office Building. FBB#2 also has an office/video monitoring room, and a full bathroom with independent entrance. In the event of a quarantine situation, this bathroom with shower can serve as a "cleanup" area. Total forest bird aviaries with FBBI and FBBII = 37.

- **Ten `Alala Aviaries:** These ten `Alala aviaries are the result of Phases I-III, and with interim modifications are all now uniform in their construction and management. Each aviary measures 20'x40'x18' high, with a service vestibule that measures 10'x20'x18' high. Each aviary now has a dividing wall down the center of each aviary (lengthwise) that allows for the physical separation of birds. The ability to isolate birds in this fashion has proven to be extremely valuable when introducing prospective reproductive pairs, and socializing young birds. `Alala aviaries = ten.

## 4.2 Maui Bird Conservation Center (MBCC)

**ZSSD/TPF Results:** No new construction at the MBCC. Rehabilitation and renovation of the existing structures is the focus at this facility.

- **Old Nene Building:** The twelve Nene enclosures in the Nene Building have been vacant for the past three years. They were converted to Forest Bird aviaries to accommodate birds produced by the program, either as eggs collected from the wild or from chicks hatched and reared at the KBCC. Each aviary received a new coat of paint where necessary, new mosquito netting, new plantings, and a "pass through" hatch to shift birds from one aviary to the other. Two pairs of Puaiohi were successfully housed in this newly renovated building, built nests and successfully laid eggs.

- **Forest Bird Aviaries:** Interior Forest Bird Aviaries are being cleaned out, replanted and reperched in anticipation of working with a more extensive inventory of forest birds. One

pair of Puaiohi were successfully maintained in this building.

- **`Alala Enclosures:** The ongoing program to replace rotting wood continues. Rotten structures are removed and replaced with plastic lumber. Replaced were trusses, structural beams and load-bearing vertical supports. Rotting plywood was replaced. Rotting perches were replaced.

- **Main Buildings:** Maintenance as necessary to include roof patching, painting, plumbing repair and replacement, back-up generator rehabilitation, landscaping, etc.

## 5. 2000/2001 RESTORATION/CAPTIVE BREEDING PROGRAMS

### 5.1 NENE

**ZSSD/TPF Goals:** Continue captive-breeding Nene at MBCC and KBCC to produce a minimum of 20 goslings for DOFAW's Nene release program. Collect wild eggs to improve the genetic diversity/demographic stability of the captive flock (if possible). The original 2000/2001 workplan goal was to establish a captive (clipped) free-ranging flock on fenced, predator-controlled KBCC grounds, to increase parent-rearing production and decrease operational costs for rearing Nene. However, recent studies have revealed the presence of avian malaria in some Nene. Although malaria has not been implicated as a limiting factor for Nene, the Service and DOFAW have requested that efforts to minimize the potential for transmitting unique regional strains of avian malaria between islands be considered in developing release criteria for captive bred birds. Currently, at the request of DOFAW/Service, birds transferred between islands will either need to be screened for malaria prior to transfer or be raised in mosquito-proof facilities. Therefore, in concurrence with the Service and DOFAW, due to operational funding constraints, the captive Nene population at KBCC was decreased. The total captive population at KBCC and MBCC numbers 20 birds.

**Justification:** The wild Nene population occupies only a portion of its former distribution and is self-sustaining or increasing only in a portion of those occupied areas. Populations are increasing only in selected areas under intensive management or where predators do not occur. Recovery will require habitat management to control predators and improve foraging opportunities. Releases will be used to establish new populations or to increase Nene numbers in areas with good habitat and reduced Nene numbers.

**ZSSD/TPF Results:** In 2000/2001, 92 eggs (53 viable) were laid in captivity by 15 fertile pairs. Forty-seven eggs hatched (KBCC-32; MBCC-14), 46 chicks survived 30 days (Table 1). All goslings were parent-reared .

Sixty-eight birds were provided to DOFAW for release (26 – Hawaii Volcanoes National Park, 17 – Hakalau National Wildlife Refuge, 11 – Molokai and 4 – Maui). One bird is still pending release (Appendix 2).

Some of the historical pedigree records from DOFAW have been compiled by K. Reininger (Nene studbook keeper) into SPARKS format to provide a historical studbook for future analysis after DOFAW provides the remaining records (Reininger, pers. comm.). This analysis will be available in our annual report when this information becomes available to us. The current genetic analysis of the captive flock provided in Appendix 2 is incomplete due to incomplete pedigree records.

Veterinary/Pathology information is summarized in Tables 4 and 5, and Appendix 2. The current inventory of Nene at KBCC and MBCC is. 9.11 Genetic analysis is provided in Appendix 2.

**Concerns and Needs:** Over 2,000 captive-reared Nene have been reintroduced throughout Hawai`i, but many released populations were not self-sustaining because habitat management programs had not been implemented to decrease the limiting factors (Black et., 1997). The wild population on Kaua`i is growing due to the abundance of grasses and absence of mongoose. Captive propagation of Nene is costly and labor-intensive and will become even more so with the enhanced disease concerns relating to transportation of birds between islands. Increased recovery efforts should be directed towards protection of wild populations in managed habitat and establishment of new populations where needed. This will require continued captive-breeding and releases over the near term. But, this component of recovery management should be reduced at the earliest opportunity once stable populations have been established in managed habitat on all islands. Holding surplus Nene at MBCC that cannot be released because of unresolved safe harbor issues is not practical. The facilities at MBCC are not designed for long-term holding and the physical well-being of large numbers of Nene held in small enclosures jeopardizes the health and safety of the birds.

Although rearing Nene on the island where they will be released has been proposed as the safest approach to minimizing risk of disease transfer, this management practice will affect maintenance of genetic diversity and production in the captive flock. Maintenance of genetic variation among the limited number of captive pairs on each island, collecting and transporting eggs between islands, and transporting goslings that have been hatched in mosquito-proof enclosures are practices that could help to maintain/increase genetic diversity. However, implementation of these strategies are currently not within the realm of available operational funding. Additionally, importation of wild eggs does not guarantee an "increase in genetic diversity" for Nene, if the pedigree of the wild birds is unknown. In some cases, collection of wild eggs from sites where releases occurred may only increase the inbreeding coefficient in the captive flock. Lastly, the inability to transfer Nene between facilities in a timely fashion during the breeding season to increase/enhance behavioral compatibility in breeding pairs will negatively impact production. It will not be practical to "re-pair" birds during the breeding season due to the logistical/time constraints involved with malaria testing

(breeding incompatibility cannot always be identified until the onset of reproduction). Long-term, the practical/logistical disease constraints involved with transportation of Nene between islands, and the subsequent down-sizing of the captive flock, will slow down production of captive-bred birds and increase genetic isolation of different populations between islands. (Appendix 2).

**Service/DOFAW Responsibilities:** Define recovery and management goals and draft a Nene Recovery Plan including plans for future Nene release and relocation sites. Develop Safe Harbor Agreements for reintroduction of Nene onto private lands and continue habitat management programs in Nene habitat to enable birds to successfully reproduce in the wild and become reestablished into unoccupied areas. Develop management and release plans within the Nene Recovery Action Group and coordinate with the captive-breeding program to provide adequate time to produce desired number of goslings for release. Conduct an independent review of disease risks associated with transportation of Nene between islands.

## 5.2 PUAIOHI

**ZSSD/TPF Goals:** Continue the restoration program for the endangered Puaiohi by breeding this species in captivity and reintroducing birds to establish a second population in the Alaka`i Swamp, Kaua`i.

**Justification:** The Puaiohi, is a critically endangered Hawaiian solitaire endemic to the island of Kaua`i. An estimated 200-300 individuals persist in the remote Alaka`i Wilderness Preserve, of which 75% are resident to a 5-km$^2$ area in the Waiakoali/Mohihi stream drainages. Historically, Puaiohi existed in greater numbers over a wider geographical region. Drastic declines are thought to be the caused by introduced mammalian predators and avian competitors, exotic diseases and disease vectors, and habitat degradation resulting from impacts of alien species. The current small population size and limited range place this species at risk due to environmental and demographic factors. Establishment or enhancement of additional populations has been recommended for recovery.

The Puaiohi restoration program is a continuing Kaua`i Partnership recovery effort. The program has been successful in breeding and reintroducing 34 birds between 1999-2001 (Kuehler et al., 2000). Captive propagation/release will continue until more cost-effective habitat management strategies have been demonstrated to sufficiently protect (and recover) the species in the wild. Because Puaiohi breed successfully in captivity; "captive-breeding and release" is more cost-effective than a "rear and release" program for this species (~50% less cost).

**ZSSD/TPF Results:** In 2000/2001 breeding season , 85 eggs (19 viable) were laid in captivity. Sixteen eggs hatched, 12 chicks survived (30 days) (Table 1). The low viability of captive-laid eggs was due to infertility and egg breakage, caused by the high density of birds at KBCC and

subsequent intra-specific aggression in the captive flock. Breeding birds were moved to MBCC to provide additional housing to decrease the population size at KBCC. In the 2002 breeding season continuing attempts will be made to improve pair compatibility by re-pairing and moving birds, but we expect infertility and egg breakage to be a continuing problem for this captive flock due to density problems.

Fifteen birds were released in the Alaka`i Swamp, on Kauai, 12 birds survived 30 days after released (Appendix 2 and Tables 2 & 5). Long-term population monitoring and habitat management is the responsibility of the Service, DOFAW and BRD.

Veterinary/Pathology information is summarized in Tables 4 and 5, and Appendix 3. The current inventory of Puaiohi at KBCC and MBCC is 12.14. Genetic analysis is provided in Appendix 3.

**Major Concerns and Needs:** The recovery goals for this small isolated population need to be defined. Additionally, rats have been documented to cause mortality in Puaiohi (E. Tweed and T. Snetsinger, pers. comm.). An ongoing predator control program will be necessary to recover this species.

**Service/DOFAW Responsibilities:** Define recovery goals. Continue habitat management efforts to control predators for both the wild and reintroduced population.

## 5.3 `AKOHEKOHE

**ZSSD/TPF Goals:** Continue to develop captive propagation techniques. Develop a "rear and release" program in the future, to establish a second wild population – if translocation of wild birds fails.

**Justification:** Historically, `Akohekohe were found in the wet forests of Molokai and West Maui. Currently, one population remains on the windward side of Haleakala between 4500'-7200' elevation. `Akohekohe nests are accessible and a "rear and release" program may be feasible. However, `Akohekohe are difficult to breed and maintain in captivity. Survival of wild, translocated birds may be greater than reintroducing captive-reared birds. For this reason, a recovery strategy involving translocation of wild birds is expected to be more effective and less costly and is the first recovery strategy that will be implemented.

**Major Concerns and Needs:** It is unclear if habitat for a second population of `Akohekohe is currently suitable. `Akohekohe may be very susceptible to introduced diseases. Prior to the initiation of a translocation or restoration program, potential habitat for a second population needs to be evaluated, including an assessment of disease prevalence and vegetation structure. In addition, previous work translocating birds has found post-release site fidelity to be low. Work is therefore needed to explore methods to increase the probability that translocated birds will remain at the site of translocation. If suitable habitat is identified and

the surrogate work is successful, a restoration program involving translocation of ʻAkohekohe will be implemented.

If translocation is unsuccessful, then a "rear and release" strategy may be considered. However, ʻAkohekohe are very aggressive birds. Due to the pugnacious nature of this species, it will be advisable to test the reliability of release techniques prior to the implementation of a full-scale "rear and release" program (should translocation fail). ʻAkohekohe must be released at the appropriate age using the correct methods to insure survivability after independence.

**ZSSD/TPF Results:** In 1997, the first wild ʻAkohekohe eggs were hatched and hand-reared. These birds are extremely territorial nectivores requiring single-cage housing in captivity. There was no sustained reproductive activity observed in captive ʻAkohekohe during the 2001 breeding season. Due to the limited number of individuals currently housed in captivity and the behavioral problems involved with breeding these birds (mate incompatibility), a successful captive-breeding program is unlikely. The current inventory is 2.1 (Appendix 4).

**Service/DOFAW responsibilities:** Define recovery and management goals and draft Recovery Plan section for ʻAkohekohe. Conduct an experimental translocation surrogate and evaluate long-term results. Continue habitat restoration and management programs to mitigate limiting factors and assess the impact of management programs on limiting factors.

## 5.4 MAUI PARROTBILL

**ZSSD/TPF Goals:** If found, collect wild eggs from Maui Parrotbill to develop captive propagation techniques and establish long-term captive husbandry and breeding requirements. Establish a second self-sustaining wild population through captive propagation and release in secure/restored habitat.

**Justification:** This endangered honeycreeper has a low reproductive rate (one egg clutch) and is restricted to one small patch of forest in East Maui. Immediate management of this species is a recovery priority.

**ZSSD/TPF Results:** One nest was located in 1997, the egg was collected and the chick hatched in captivity. This chick was sexed as a male. DOFAW biologists were unable to locate wild nests in 1998. In 1999, two eggs were collected from two different wild nests. Both eggs hatched and chicks were subsequently hand-reared and sexed as females. In 2000, we reported the first successful captive-breeding of Maui Parrotbill at KBCC. And in 2001 we report a total of three eggs laid in captivity and one egg collected from the wild; four chicks hatched and survived (Table 1). Parental incubation and rearing was attempted for the first time on the third clutch of the breeding pair. The nest was monitored on video. However, the chick was removed from the parents on day five due to inadequate/inappropriate parental behavior. The chick has been treated extensively for health problems. One bird, injured in

the wild, was quarantined and integrated into the captive flock (at the request of the Service and DOFAW).

Veterinary information is summarized in Tables 4. The current inventory of Maui Parrotbill at KBCC and MBCC is. 3.7 (Appendix 5). Genetic analysis is provided in Appendix 5.

**Major Concerns and Needs:** Limiting factors for the Maui Parrotbill may be disease, habitat degradation and food availability, predation, and competition from exotic species. Most of the original range has been converted to exotic vegetation that the species does not inhabit. Maui Parrotbill may currently occupy all suitable habitat available, and protected habitat for a second population may not be currently available. Before an additional population can be established, potential habitat needs to be identified, evaluated, restored, and managed.

Present goals for this species are to develop captive breeding technology and establish a captive population, and to continue and increase restoration and protection of Parrotbill habitat. If captive production is successful and habitat is identified and managed, a test release of Parrotbill mail take place in late 2002. Habitat restoration and management is ongoing within some of the present range of the Parrotbill, but funding is limited for restoration elsewhere. Currently Haleakala National Park protects and manages habitat in the Kipahulu area, and the Service and DOFAW Partnership protects and manages habitat in the Hanawi area. Completion of the lower Hanawi-East Maui Watershed fence is needed to protect a large portion of existing habitat. Evaluation and restoration of additional habitat areas are needed both along Parrotbill range edges as well as in areas where restoration may provide habitat for a disjunct population.

**Service/DOFAW Responsibilities:** Define recovery and management goals and draft a Recovery Plan section for Maui Parrotbill. Continue the habitat management efforts in Hanawi NAR and East Maui watershed areas and assess the impact of management programs on limiting factors, if needed. Conduct nest searches to locate and collect eggs for addition to the captive propagation program.

## 5.5 HAWAI`I CREEPER , HAWAI`I `AKEPA and `AKIAPOLA`AU,

**ZSSD/TPF Goals:** If found, collect wild eggs from `Akiapola`au to develop captive propagation techniques for restoration programs, when habitat becomes available. Develop captive propagation techniques for Hawai`i Creeper and Hawaii `Akepa currently in captivity.

**Justification:** `Aki would benefit from a captive propagation/release program given the current distribution and low reproductive rate (S. Fancy, J. Jeffrey, T. Pratt; pers. comm.). The `Akiapola`au population is fragmented and declining. The Hawai`i forest bird surveys found four disjunct populations of `Akiapola`au totaling 1500±400. Fancy et al. analyzed

more recent surveys and estimated a total population of 1163 in three disjunct populations, with most birds being found in the Hamakua forest. The species' distribution has been greatly reduced in the Kapapala/Ka`u forest, where the estimated population has declined from 533 to 44 birds. The upper elevation, relict population in mamane forest at Kanakaleionui has only 2-10 birds and is functionally extinct (Fancy, unpubl. data -pers. comm.).

Populations of Hawai`i Creeper and `Akepa are also fragmented and reduced in range. Dispersal between populations (ability to recolonize former habitat) may be limited by high philopatry. `Akepa population dynamics are likely closely tied to habitat structure. Each of these factors appears to be limiting populations in some areas. Additional suitable habitat is needed to reduce the risk of extinction. These species will benefit from habitat restoration work in connection with recovery efforts for `Akiapola`au, for example in areas such as the Saddle Road kipukas, Power Line Road, Mauna Loa Strip Road, upper Keauhou Ranch, and Kapapala and Ka`u forests.

**ZSSD/TPF Results: Hawai`i Creeper** - In 2000, we reported the first successful captive-breeding of endangered Hawai`i Creepers at KBCC. In 2001, three infertile eggs were laid by one breeding pair in captivity (Table 1). The captive inventory is 4.4 and the genetic analysis of the population is supplied in Appendix 6.

**Hawai`i `Akepa** - In 1998 the first wild Hawai`i `Akepa egg was hatched, hand-reared and fledged; probably the smallest passerine (1.13 grams) ever artificially incubated and hand-reared from hatch. In 2000, 11 wild `Akepa eggs were collected; eight eggs were viable, seven chicks hatched and six birds fledged. In 2001, no wild eggs were collected and nesting behavior was not observed in captive birds. The inventory is 4.5 and the genetic analysis is presented in Appendix 7.

**`Akiapola`au** - Beginning on February 9, 2000 and ending on June 28, 2000 TPF/ZSSD biologists spent 50 days searching for nests of `I`iwi, Hawai`i `Elepaio, Hawai`i Creeper, Hawai`i `Akepa and `Akiapola`au. Although a total of 34 nests of all these species were found; no `Akiapola`au nests or eggs were located during the 2000 breeding season. In 2001, TPF/ZSSD biologists did not search for `Akiapola`au nests due to labor constraints. However, three `Akiapola`au nests were located by BRD biologists in April and May, 2001, but only one nest was accessible. This eggs was collected (infertile) and given to the Bishop Museum (Table 1).

**Major Concerns and Needs:** `Akiapola`au eggs are very difficult to locate (Banko and Williams, 1993; P. Harrity and J. Jeffrey, pers. comm.). Although TPF spent ~500 hours nest-searching in 1999 and over 400 hours nest-searching in 2000 - no nests were located . Of ~400 bird nests located in the Hakalau National Refuge by BRD, only three were `Aki nests (Woodworth, pers. comm.). "Rear and release" is not a recommended program strategy for this species; "captive-breeding (immediate release)" is preferable. However, accessible, acceptable habitat for reintroduction must be available before a full-scale restoration program

can be initiated. We support a landscape-level conservation program focused on ecosystem health in selected areas on the Big Island for these three species (`Akiapola`au, Hawai`i Creeper and Hawai`i `Akepa) in collaboration with community partners.

**Service/DOFAW Responsibilities:** Define recovery and management goals and draft Recovery Plan sections for these three species. Provide labor for nest searching for `Akiapola`au. Continue to expand habitat management and work with land-owners to prioritize sites for population re-establishment.

## 5.6 PALILA

**ZSSD/TPF Goals:** Continue development of captive propagation and release program. Evaluate the pilot study to determine the role of disease as a limiting factor in Palila recovery. Assess the status of *Mycoplasma* disease in wild population and captive flock and determine its impact on releases or translocations of Palila. Release captive-reared birds into managed habitat on the North Slope of Mauna Kea or other area suitable for Palila when the habitat is evaluated to be "safe" from limiting factors.

**Justification:** The isolated Palila population on Mauna Kea is threatened by fire, habitat degradation by grazing ungulates, predators and limited food resources. Management efforts to recover the species by establishing new populations through translocation have met with equivocal success. The majority of birds return to their site of origin after translocation (Fancy et al., 1997, Banko, pers. comm.). It is not clear whether this is due to poor quality habitat or site tenacity in this species.

Recent work comparing the fate of wild translocated `Oma`o to captive-reared released `Oma`o demonstrate that captive-reared birds had greater site fidelity to the release site (Fancy et al., 2001). A "captive-breeding (immediate release)" program may provide an effective alternative recovery strategy to establish a second population in a new site.

The Pu`u Lehua lease (KS land) is an isolated site (Mauna Loa vs. Mauna Kea) within the historical distribution of this species (collection site of specimen "type") and may be a suitable alternative to Mauna Kea release sites. The Service is currently funding KS for habitat restoration as part of a land-owner partnership agreement (T. Casey; P. Simmons and C. Rowland, pers. comm.).

**ZSSD/TPF Results:** In 2000/2001 five eggs were laid by a captive breeding pair of Palila. All five chicks hatched and attempts were made to allow the parents to rear the chicks. It was necessary to remove the chicks from the nests due to inadequate/inappropriate parental care and aggression. Three chicks were subsequently hand-reared. One chick was removed from the wild due to injuries and also reared in captivity (Table 1 and Appendix 8).

In 1996, initial attempts to hand-rear Palila in captivity were less successful than for other species of related honeycreepers under similar conditions (50% vs. 89% survivability of chicks). A possible cause of mortality included egg-transmitted disease (*Mycoplasma*) from the wild population or infection during the hand-rearing process. A *Mycoplasma*-like organism was isolated from several captive and wild birds (Rideout, pers. comm.).

In order for recovery efforts using captive propagation techniques to proceed for this species, it was necessary to determine whether disease is a limiting factor to the successful hand-rearing of chicks in captivity. A pilot study to clarify the role of M*ycoplasma* and/or other pathogenic agents (s), was conducted by collecting three viable wild eggs for artificial incubation and hand-rearing in an isolated facility. The results of this preliminary study are presented in the Nov. 16, 2000 – meeting notes with DOFAW, the Service, BRD and TPF/ZSSD biologists (Appendix 8).

Veterinary/Pathology information for Palila is summarized in Tables 4 and 5. The total captive collection inventory is 8.16 and the genetic analysis is provided in Appendix 8.

**Major Concerns and Needs:** Managed habitat on the North Slope of Mauna Kea or any other area suitable for Palila is not available for release. Palila are currently being held in captivity until "safe" habitat is available. There is insufficient enclosure space at KBCC for Palila when the birds breed again next year.

**Service/DOFAW Responsibilities:** Define recovery and management goals and draft a Recovery Plan section for Palila. Continue habitat management efforts on Mauna Kea and Army managed lands at Pohakaloa. Assess the impact of management programs on limiting factors and collaborate with BRD to recover Palila on north slope of Mauna Kea. Investigate potential for future safe harbor agreements with interested landowners (e.g. Pu`u Lehua lease - KS land).

## 5.7 `I`IWI, HAWAI`I `ELEPAIO AND COMMON `AMAKIHI

**ZSSD/TPF Goals:** Whenever possible (funding and space permitting), captive propagation and release techniques are developed and tested with closely related surrogate species prior to working with endangered species. Additionally, non-endangered Hawaiian endemic forest bird species are used in educational exhibits.

**Justification:** These species are presently not thought to be at risk of extinction. However, each is likely to be an important component of Hawaiian forest ecosystems. `I`iwi are likely important pollinators for many native plant species, and, as generalist insectivores, `Elepaio may have significant effects on forest arthropod community structure, both at ecological and evolutionary time scales.

Additionally, `I`iwi, and Hawai`i `Elepaio are surrogate species for endangered Hawaiian forest birds. For example the techniques developed for the Hawai`i `Elepaio may be useful for restoration of the `Oahu `Elepaio (*Chasiempis sandwichensis gayi).* Once very common, the `Oahu `Elepaio has disappeared from 90% of its historic range and only 200 – 500 O`ahu `Elepaio remain. Additionally the `I`iwi is a surrogate species for the `Akohekohe.

**ZSSD/TPF Results: `I`iwi** - Due to their nectivorous, pugnacious nature `I`iwi and `Akohekohe are difficult species to work with in captivity. Their dietary requirements are stringent and housing birds to minimize their aggressive tendencies is challenging. We have developed the necessary techniques for a "rear and release" program for these species (if necessary). We do not recommend a captive propagation program. One infertile `I`iwi egg was laid and broken in captivity in 2001 (Table 1). The current captive inventory of `I`iwi is 1.0 (Appendix 9). Veterinary/Pathology information is summarized in Tables 4 and 5.

**`Amakihi** – In 2000, we reported the first successful parent-rearing of `Amakihi in our facilities. We have successfully developed artificial incubation, hand-rearing and breeding techniques for this species in captivity. Due to space constraints these non-endangered birds were relocated to the Brookfield Zoo (Appendix 10).

**Hawai`i `Elepaio** – In 2001, two infertile `Elepaio eggs were laid. in captivity (Table 1). These birds will are being used as a surrogate species to develop propagation and release techniques for the `Oahu `Elepaio. Veterinary/Pathology information is summarized in Tables 4 and 5. The current inventory is 3.1 and the genetic analysis is presented in Appendix 11.

## 5.8 ON THE BRINK SPECIES

**ZSSD/TPF Goals:** Collaborate with partners and rescue species from extinction if no other viable recovery strategies are available.

**Justification:** The "search and rescue" or last ditch strategy should be considered if extinction is imminent and the strategy of captive propagation/release has a greater probability of recovering the species than other recovery strategies (e.g. translocation or habitat management). Although we may be saving the last few eggs/birds by removing them from their natural habitat, we are losing an opportunity to study and protect the species in the wild. This strategy is high risk, but may be the only option remaining for a few species.

**ZSSD/TPF Results:** The Nukupu`u, Kama`o and Po`ouli are considered to be so rare that it is presently difficult to build a program around the remote possibility that nests may still be found.

Based on our work over the last eight years developing artificial incubation and hand-rearing techniques for twelve species of Hawaiian forest birds, we believe the collection of wild eggs

from "on the brink species" may be a viable "search and rescue" strategy. Based on our restoration work and captive husbandry experience with `Oma`o and Puaiohi, we also believe collection of wild adult Kama`o may be a viable "search and rescue" strategy. However, there is insufficient data available to determine whether or not this recovery strategy would be successful. If and when nests are located, we are prepared to collect first clutch eggs and initiate a propagation program. No nests were located during the 2001 breeding season for any of these species

**Concerns and Needs:** It is unknown whether "rescuing" eggs/birds would actually provide enough founders for genetic and demographic stability of the species; or, if enough birds could be captive-bred for recovery. Captive-breeding programs need to be established before species are reduced to critically low numbers if they are to have a reasonable chance of saving a species from extinction.

Example Po`ouli: Recommendations for proposed conservation activities for Po`ouli are available in the public document (Final Environmental Assessment - Possible Management Actions to Save the Po`ouli). The Service and DOFAW determined that the best management strategy to conserve the Po`ouli is intensive habitat management rather than an intensive captive management strategy. This decision was based on experience with the known challenges of aviculture and also recognizing the difficulties of working with highly specialized insectivorous songbirds. It was also based on numerous discussions with experts in the field of zoology, aviculture, predator control, reforestation and animal husbandry, and included discussions with public officials and legislators to gain a perspective on the efficacy of choosing a preferred alternative of habitat management over captive management. The stated DOFAW/Service position on "species rescue" by bringing into captivity the "last of the last" can only be defended for those species which have a better chance of surviving the rigors of captivity vs. the anticipated survivability in their native habitat calculating the benefits derived from habitat management and protection from predation. In the case of the Po`ouli, with habitat management and translocation still available as options, bringing adult Po`ouli into captivity is not considered to be a "last resort" scenario.

**Service/DOFAW Responsibilities:** Define recovery and management goals and draft Recovery Plan section for "on the brink species". Continue the statewide forest bird surveys.

## 5.9 `ALALA

**ZSSD/TPF Goals:** Manage the captive population to increase the production of chicks in captivity to provide birds for release.

**Justification:** This species is at the brink of extinction in the wild. The current wild population is 2 non-reproductive birds. The captive population is 35 birds (29 potentially reproductive).

**ZSSD/TPF Results:** In 2001, nine pairs were set up for breeding and seven pairs built nests and copulated (Figure 1). Six breeding pairs of `Alala produced 21 eggs; nine chicks hatched and eight were successfully hand-reared (Table 3). Modifications to `Alala aviaries are described in Section 4.1 and 4.2. New pairings have been identified and mate selection is currently ongoing. All breeding pairs are selected based on behavioral compatibility, sex, age and pedigree analysis in accordance with IUCN/AZA guidelines.

Veterinary/Pathology information for `Alala is summarized in Tables 4 and 5. The total captive collection inventory is 17.18 and the genetic analysis is provided in Appendix 12.

**Major Concerns and Needs:** The major concern/need for this program is the reduction of the limiting factors in `Alala habitat to enable captive-reared birds to successfully survive and breed in the wild. We cannot produce enough birds in captivity to overwhelm the limiting factors and offset losses without adequate habitat management prior to release. Pre-release "site preparation criteria" need to be established, and habitat management implemented prior to reintroduction of birds.

When the NRC report for the Hawaiian Crow was written, both a captive and wild breeding population existed. Reintroduction strategies assumed that there would be genetic exchange between these populations. Today all the reproductive `Alala exist in captivity. In order to safeguard the species' genetic/demographic stability we recommend that genetic diversity be maintained in captivity, and that release candidates be selected whose removal from the captive population will not jeopardize the species' long-term survival. Additionally, we recommend parent-rearing of potential release candidates to improve long-term survival. We do not endorse behavioral modification programs for Alala (and/or `Io) until reintroduction of parent-reared birds in managed habitat has been determined to be unsuccessful.

**Service/DOFAW Responsibilities:** Define recovery and management goals (including genetic/demographic guidelines) and complete the draft Recovery Plan for this species. Obtain access to the Kona Unit of the Hakalau Refuge and continue ongoing habitat management efforts in current `Alala release sites in Kona, Kona NWR and Pu`u Wa`awa`a Forest Bird Sanctuaries. Evaluate and select potential additional release sites (finalize the EA). Increase the involvement of stakeholders in the negotiations necessary for designing successful land management programs (safe harbor, partnership agreements etc.). Inform the general public regarding proposed conservation activities through policy documents, conservation education programs, public relation activities, etc. Evaluate selected release site and establish pre-release "site preparation criteria" to prepare for future reintroductions. Obtain the funding to increase the number of breeding enclosures at KBCC and renovate enclosures at MBCC. Increase the operating budget to accommodate the increase in facilities.

## 6. CAPTIVE COLLECTION INVENTORY (9/20/00)

| Species | Status |
|---|---|
| Nene (*Branta sandvicensis*) | 9.11 |
| Palila (*Loxioides bailleui*) | 8.16 |
| Puaiohi (*Myadestes palmeri*) | 12.14 |
| Hawai`i Creeper (*Oreomystis mana*) | 4.4 |
| Maui Parrotbill (*Pseudonestor xanthophrys*) | 3.7 |
| `Akohekohe (*Palmeria dolei*) | 2.1 |
| `Alala (*Corvus hawaiiensis*) | 18.17 |
| `Akepa (*Loxops coccineus*) | 4.5 |
| Hawai`i `Elepaio (*Chasiempis s. sandwichensis*) | 3.1 |
| `I`iwi (Vestiaria coccinea) | 1.0 |
| Common `Amakihi (Hemignathus virens wilsoni) | 0.0 |

**Key: male.female.unknown**

## 7. ENVIRONMENTAL EDUCATION PROGRAM

During the 2000 - 2001 school years, over 1,500 students, teachers and visitors were hosted at the KBCC as well as given presentations in venues outside of the facilities. The primary focus was providing this environmental education opportunity to the sixth grade classes of the State of Hawai`i's Department of Education and the conservation education program held at Keakealani Outdoor Education Center. Additional tours were given to students from several other elementary schools including the University of the Pacific, UH Manoa, Punahou School and KS-Honolulu. Students spend two-three hours at KBCC where they are given video presentations, lectures, slides, and "hands-on" opportunities to experience some of the conservation work undertaken by TPF/ZSSD. Activities include cage building, planting native vegetation, insect collecting, bird watching, bird behavioral observations, and in general - how to "do" biology.

In 1999, TPF published an environmental education book for Junior High School age students entitled Treasures of the Rainforest, funded by private donations. This introduction to the avifauna of the Hawaiian Islands has been available to teachers/classes that visit KBCC (at no cost) during the academic year. Public sales of this book have been good and will be used to support future reprinting of this publications.

## 8. VETERINARY PATHOLOGY REPORT

A summary of clinical veterinary consultations for the Keauhou Bird Conservation Center

and the Maui Bird Conservation Center are presented in Table 4. A summary of pathology results are presented in Table 5. All captive Hawaiian forest birds are necropsied by Dr. Bruce Rideout (Director of Pathology, Zoological Society of San Diego) or Dr. Thierry Work (BRD) and final necropsy findings are circulated to the appropriate agencies. Clinical care and pre-release screening is conducted by our Veterinary Consortium coordinated by Dr. Pat Morris (Director of Veterinary Service, San Diego Zoo). Additional members include: Dr. Sterret Grune (Big Island Veterinary Care), Dr. Pat Morris Dr. Don Janssen (Director of Veterinary Services, Zoological Society of San Diego) or Dr. Greg Massey (DOFAW). All clinical care provided by Drs. Janssen, Morris and Grune and pathology support by Dr. Bruce Rideout are donations to the program. Additional information regarding veterinary/pathology activities for the Hawaiian Endangered Bird Conservation Program is available by contacting Dr. Pat Morris (Veterinary Consortium Coordinator).

## 9. SUMMARY

During the past eight years, The Peregrine Fund/Zoological Society of San Diego's – Hawaiian Endangered Bird Conservation Program has developed many of the artificial incubation and hand-rearing techniques required to propagate and release endangered Hawaiian forest birds. Twelve endemic Hawaiian passerine species have been hatched and reared in captivity and five of these species (all endangered) have now bred in captivity; `Alala, Hawai`i Creeper, Palila, Maui Parrotbill, and Puaiohi. The Keauhou Bird Conservation Center was built in Volcano, Hawai`i. Captive-bred Puaiohi reintroduced to the wild have successfully reproduced in the wild. Additionally, an environmental education program is being funding through public support.

As the captive flocks of the endangered species grow, and the techniques for rearing and release are refined, it is hoped that many of the endangered Hawaiian birds will benefit from restoration efforts. However, captive propagation and reintroduction is only one aspect of the ecosystem management tools required in Hawai`i. Commensurate action will continue to be required on the part of land-owners (state, private and federal) to protect and enhance the native habitat.

Additional information regarding the Hawaiian Endangered Bird Conservation Program is available in our publications/presentation summary (1991-2001).

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## 12. GLOSSARY OF TERMS

**Population Analysis (Glossary of terms and assumptions used in this report)**

- Population Management 2000. (J. Ballou, R. Lacy and J.P. Pollak). The Population Management 2000 (PM2000) software package incorporates modeling tools for genetic and demographic analysis of pedigreed animal population (a studbook). PM2000 combines the tools available in GENES (written by Robert Lacy), DEMOG (written by Laurie Bingaman-Lackey and Jon Ballou) and CAPACITY (written by Jon Ballou).

  There are many scenarios/strategies available for modeling in PM2000. Usually the wild-caught founders are not included in tallies of the genetic status (GD, GV and FGE) of the population. Instead, the measures show the genetic status of the descendant animals produced within the captive population. This is the assumption we followed in this report based on standard export files from each individual studbook. All breeding pairs are selected based on: 1) behavioral compatibility 2) past reproductive performance 3) age 4) sex and 5) genetic considerations (AZA - Small Population Management Group Guidelines).

- **Theoretical Founder Requirements for Captive Populations**

| Gene Diversity | Number of Wild Founders |
|---|---|
| .50 | 1 |
| .75 | 2 |
| .90 | 5 |
| .95 | 10 |
| .98 | 25 |
| .99 | 50 |

A standard goal often proposed by population biologists it the retention of 90% of the wild gene diversity in the captive population (representing the equivalent of about five wild-caught birds). The higher the level of gene diversity to be retained in captivity over a longer period, the more founders (wild-caught animals) and breeding enclosures required. Note: Small increases in gene diversity between .98 and .99 represent an increase of 25 wild-caught founders in captivity.

Founder is an individual at the top of a pedigree, assumed to be unrelated to all other founders. An individual is not yet a founder of the captive-hatched population until it has living descendants in the population.

Founder Genome Equivalents (fge) is the number of equally represented founders with no loss of alleles that would produce the same gene diversity as that observed in the living descendant population. Equivalently, the number of animals from the source population that contains the same gene diversity as does the descendant population.

Founder Genomes Surviving is the sum of allelic retentions of the individual founders.

Gene diversity (GD) is the heterozygosity expected in a population if the population were in Hardy-Weinberg equilibrium. Gene diversity is calculated from allele frequencies, and is the heterozygosity expected in a progeny produced by random mating. It is important for the population as it defines in part the rate of genetic drift as well as the rate of genetic adaptation to a given selection pressure. Gene diversity can be viewed as the variation in the founder's representatives in the living descendant population. Gene diversity is lost when founder lines become over-represented relative to or at the expense of other founder lines.

Gene Value (GV) is the expected heterozygosity or gene diversity that would be expected in the next generation if all animals bred at random and produced a number of progeny for the next generation equal to their reproductive values.

Heterozygosity is a measure of the percent of loci that are polymorphic within an individual and is calculated as one minus an individual's inbreeding coefficient (F). Heterozygosity is important for the health and vitality of birds, by masking the effect of deleterious recessive alleles and maintaining hybrid vigor. Loss of heterozygosity occurs as a result of inbreeding,

and reduces fertility, survivability, disease resistance, and reproduction in domestic and exotic captive populations.

Mean F is the probability that two alleles at a genetic locus are identical by descent from a common ancestor to both parents. The mean inbreeding coefficient of a population will be the proportional decrease in the observed heterozygosity relative to the expected heterozygosity of the founder population.

Mean kinship (MK) is the average relatedness of an animal to all animals in the living descendant population. Individuals with low mean kinships have genes that are on the average under-represented in the population and are therefore animals with high breeding priority. A drawback to using mean kinship is that full sibships have identical mean kinship values until they produce offspring. This means that full siblings would often be paired if only mean kinship was used to make pairings resulting in substantial loss of heterozygosity. Therefore, the inbreeding coefficient of potential offspring is evaluated secondarily when pairings are made.