

during State forest bird surveys in 1994 on private lands along the Halekua and Waiau streams at the southern edge of the species' range, but neither population was detected during surveys in March 2000 (T. Telfer pers. comm.). Surveys in March 2000 confirmed the existence of a small population along the upper reaches of a tributary to the Koai'e Stream, although its size and extent remain to be documented (J. Foster/U.S. Geological Survey unpubl. data).

A captive propagation and release program has been implemented for the Puaiohi, and a total of 42 birds have been released in 2 sites since 1999 (Kuehler et al. 2000; The Peregrine Fund 1999; ZSSD 2000, 2001, 2002). Captive-bred released Puaiohi readily paired with both captive and wild birds, and bred in the wild in the first season following their release. Thirty-six of forty-two (85.7%) released birds survived to 30 days post-release, and survival during the subsequent 40-50 day post-independence period ranged from 67% in 1999 to 71% in 2001 and 83% in 2002. However, only 20-43% of released birds established breeding territories in the target drainage each year, and the majority of released birds dispersed several km away, frequently in the direction of high-density populations (Tweed et al. 1999, Monahan et al. 2001, Pratt et al. 2002, Tweed et al. 2003), so although released birds have survived well and reproduced, the efficacy of captive releases at establishing new, disjunct populations has yet to be demonstrated. .

Primary Threats. Predation by alien rats (*Rattus* spp.) may be a serious limiting factor on Puaiohi populations. Although their habit of nesting on steep cliff faces may provide some protection from nest predation, data from 1998 and 1999 showed that 14 percent and 22 percent of nests, respectively, failed due to rat predation. Eggs, nestlings, and incubating females all have been depredated by rats. Snetsinger *et al.* (in prep.) demonstrated that nests protected by rat bait stations fledged significantly more birds than untreated nests. In addition, the tendency of young Puaiohi to remain close to the ground for several days after fledging probably makes them particularly vulnerable to predation by feral cats.

Only five wild Puaiohi have been tested for disease, of which one had antibodies to malaria but none had active infections, suggesting that at least some Puaiohi may survive malaria infection (Atkinson *et al.* 2001). However, disease likely limits Puaiohi from inhabiting the lower reaches of stream drainages with suitable nesting cliffs.

The disruption of seedling regeneration of beneficial plants, the invasion of non-native weeds, and soil erosion are some of the many forest management problems within the remaining Puaiohi range. Feral pigs and goats have had long-term damaging effects upon native forests by opening space for weeds and transporting weed seeds into the forest. Hurricanes in 1982 and 1992 also severely disturbed areas of native forest and made space for the germination and expansion of alien plants. Habitat degradation resulting from the invasion of many non-native weeds has drastically changed the forest structure and integrity.

The population size of 200 to 300 birds in several subpopulations falls well below the effective population size of 500 individuals recommended for long-term maintenance of genetic diversity (Soulé 1988).

Recovery Strategy. Several tools exist that can be used to manage Puaiohi populations, including captive propagation and release, predator control, use of rat-resistant artificial nest boxes, and fencing and ungulate control. All of these tools are likely to be important components of the long-term recovery strategy for Puaiohi, but knowing which tool is most effective will allow more efficient short-term use of limited conservation resources. In addition, the most appropriate conservation strategy and the most urgent management needs of the Puaiohi depend on the size, distribution, and trend of the population, and these parameters are only partly known. If the population is relatively large and stable, then management of wild birds may be most effective and releases of small numbers of captive-bred birds are not needed. On the other hand, if unoccupied areas of suitable habitat can be identified that are isolated from the existing population, then it may be preferable to decrease the threat from local catastrophes by creating additional disjunct populations through release of captive birds. If the population is stable, then there is time to investigate the efficacy of different tools; if it is declining, then it may be necessary to simultaneously augment the population through release of captive birds. Until this information is known, it is prudent to continue existing management programs that have shown some degree of success, such as captive propagation and release (Kuehler et al 2001), and ground-based predator control around nest sites (Snetsinger et al. 1999).

Interim Recovery Objectives. In order to meet the long-term recovery goals for the Puaiohi, the following short-term goals should be accomplished first:

- Investigate management tools for stabilizing/increasing the Puaiohi population and determine which is most effective.
- Determine the total current population size and distribution.
- Determine the Puaiohi population trend.

If these objectives are met within five years, then new interim recovery objectives will be identified to continue to guide progress toward full recovery. If these objectives are not met within five years, then the causes for failure should be identified and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is deemed ineffective, then a new strategy will be developed.

Five-year Recovery Actions (2003-2007). In order to realize the interim recovery objectives described above, the following actions are necessary:

- Compile and summarize existing survey data (USGS-BRD/Bethany).
- Complete surveys in additional areas (State DLNR field crew). Areas requiring surveys are:
 - **Riley, Jeff, and Erik please fill in this list**
- Identify a new release site that fulfills the criteria of providing high quality habitat, zero or low density of wild Puaiohi, sites for the erection of release towers, and helicopter access.
- If a release site is identified, relocate the release infrastructure (towers, cages, weatherport, etc) to new release site.
- Use landsat images and geographic and biological data to model Puaiohi habitat with GIS and identify additional potential habitat (USGS-BRD/Marcos).
- Conduct large-scale rodent control by aerial broadcast of diphacinone. Possible treatment sites include upper Mohihi, and Halepa`akai. Treatment of both a high-density site and a medium-density site might provide valuable comparison. In order to implement and fully evaluate the efficacy of an aerial broadcast, the following actions also are needed:
 - Collect baseline data on survival and reproduction of Puaiohi for comparison, from a spatial control, a temporal control, or both.
 - Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone.
 - Collect before and after data on water quality and possible contamination of game species if these are deemed necessary to obtain public support.
- Evaluate efficacy of rat-resistant artificial nest boxes at reducing predation.
 - Test different designs of nest boxes, with wild birds, captive birds, or both (grad student and ZSSD).
 - Compare nest success and female survival in natural nests vs. artificial nest boxes (grad student).
 - Fledge captive birds from artificial nest boxes so they recognize and use artificial nest boxes after release (ZSSD).
- Measure survival and dispersal of adult and juvenile Puaiohi, through mist-netting, banding, resighting, and radiotracking, for use in demographic modeling and determination of population trend (grad student).
- Model Puaiohi population to determine whether it is stable and the effect of management tools (grad student).

Annual Workplan - 2003. The following tasks are planned for 2003:

- Release 18 captive-bred HY birds at the Halepa`akai hack site.
- Document dispersal and survival of all released birds for the life of the transmitters using ground based or helicopter access as needed.
- Conduct systematic surveys in the Kawaikoi, Halepa`akai, Mohihi, Upper Kawaie, Waikoale, and Unnamed Other Branch Kawaie drainages. Methodology described in Pratt et al. 2002.
- Install an additional 20 artificial nest boxes in the Halepa`akai area.

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