PACIFIC COOPERATIVE STUDIES UNIT
UNIVERSITY OF HAWAI`I AT MĀNOA
Dr. David C. Duffy, Unit Leader
Department of Botany
3190 Maile Way, St. John #408
Honolulu, Hawai'i 96822

Technical Report 172

Moving I`iwi (*Vestiaria coccinea*) as a Surrogate for Future Translocations of Endangered `Akohekohe (*Palmeria dolei*)

April 2010

Dusti Becker[1], Greg Massey, James Groombridge, and Ruby Hammond

[1] E-mail dusti@mauiforestbirds.org. Maui Forest Bird Recovery Project, 2465 Olinda Rd., Makawao, HI 96768. www.mauiforestbirds.org

PCSU is a cooperative program between the University of Hawai`i and U.S. National Park Service, Cooperative Ecological Studies Unit.

Organization Contact Information:
Maui Forest Bird Recovery Project, 2465 Olinda Rd., Makawao, HI 96768. www.mauiforestbirds.org
Office: (808) 573-0280, Mobile: (808) 269-2627, Fax: (808) 573-05192.

Recommended Citation:
Becker, D., G. Massey, J. Groombridge and R. Hammond. 2010. Moving I`iwi (*Vestiaria coccinea*) as a Surrogate for Future Translocations of Endangered `Akohekohe (*Palmeria dolei*). Pacific Cooperative Studies Unit Technical Report 172. University of Hawai'i at Mānoa, Department of Botany. Honolulu, HI. 13 pg.

Key words:
Avian translocation, recovery plan, bird conservation*, Vestiaria coccinea, Palmeria dolei*

Place key words:
Pacific islands, Hawaii, Maui

Editor: Clifford W. Morden, PCSU Deputy Director (e-mail: cmorden@hawaii.edu)

Moving I`iwi (*Vestiaria coccinea*) as a Surrogate for Future Translocations of Endangered `Akohekohe (*Palmeria dolei*)

C. Dustin Becker, Greg Massey, James Groombridge, and Ruby L. Hammond

ABSTRACT
Translocations often play an important role in the recovery of endangered species. To assess feasibility for translocation of endangered `Akohekohe (*Palmeria dolei*), we conducted an experimental translocation of I`iwi (*Vestiaria coccinea*) from east to west Maui. Mist-netting, veterinary screening of candidate birds, and helicopter transport of healthy I`iwi were successful, resulting in no injuries or mortalities. Translocated birds were assigned to two types of release. Hard release birds were radio tagged and released on the day of translocation. In contrast, soft release birds were held in large cages for 7 days and fed artificial nectar. During holding soft release I`iwi feeding rates, fecal production, and mass were monitored. Soft release birds suffered 33% mortality during the holding period. At the end of the holding period, soft release survivors were outfitted with a radio transmitter and released. All translocated I`iwi were followed by radio telemetry for an average of 21 days. Once released, soft release birds showed higher rates of movement, possibly reflecting conflict with established hard released I`iwi. Our results suggest that translocation efforts for wild `Akohekohe will be successful if hard release protocols are followed.

INTRODUCTION

Translocation and reintroduction, or more generally, moving individuals to previously occupied habitat has become increasingly commonplace as a tool for recovering critically endangered species (Sarrazin & Barbault 1996). Assuring the survival of individuals before, during, and after translocation can make the difference between recovery and failure (Scott & Carpenter 1987). Developing translocation methods with a more abundant surrogate species that is taxonomically related to the target endangered species can increase the likelihood of success (Sarrazin and Barbault 1996).

Habitat loss, alien predators, and the introduction of mosquito borne diseases limit endangered native forest birds to moist forest habitats on the windward slopes of

Haleakala Volcano on east Maui, above 1450 m. (USFWS 2006; Benning et al. 2002). The recovery plan for the endangered `Akohekohe (*Palmeria dolei*) includes reestablishing populations on leeward Haleakala and on west Maui (USFWS 2006), but the species has never been translocated. In 2001, we were permitted to conduct experimental translocation of I`iwi (*Vestiaria coccinea*) from the Hanawi Natural Area Reserve on east Maui to forest habitat on west Maui. The translocation was a prelude to moving the `Akohekohe. Like its closest genetic relative the `Akohekohe (Tarr and Fleischer 1995), the I`iwi is a nectar feeding honeycreeper that forages in conspecific groups and is known to be sensitive to habitat quality (Fancy and Ralph 1998). Breeding behavior, territoriality, and resource defense in I`iwi are also similar to those of the `Akohekohe (Fancy and Ralph 1998).

The goals of the I`iwi translocation included: (1) Development of techniques for maintaining wild-caught native forest birds in temporary captivity for translocation; (2) Development and evaluation of criteria for assessing the health of prospective translocation candidates and monitoring their health status during temporary captivity; (3) Comparison of survival and site fidelity associated with two release strategies - immediate "hard" release versus delayed "soft" release; and (4) Development of radio-tracking strategies for released individuals. We report results related to all goals, evaluate lessons learned, and comment on implications for successful translocation of the `Akohekohe.

We predicted that the soft release birds would have higher site fidelity and better survival than hard release individuals because they would have reliable access to food and a roosting site and could slowly adjust to the new location.

METHODS

In June 2001 I`iwi were captured by Maui Forest Bird Recovery Project biologists using mist nets at the Hanawi Natural Area Reserve (Fig. 1). Nets were operated from sunrise to 1300 and were closed during rain to prevent hypothermia in captured birds. I`iwi were weighed, measured, and banded follow standard protocols (Ralph *et al.* 1993). An aluminum US Federal band and a unique combination of three plastic color bands were placed on each bird. In the field, a blood sample (<1% of body weight) was

collected from the jugular vein and examined for evidence of avian malaria (*Plasmodium relictum*) using microscopy of smears (Kirkpatrick and Smith, 1988). Birds were then transferred to an opaque, cloth-sided acclimation cage (30 x 30 x 60 cm) after being offered artificial nectar (Roudybush Nectar 15 Trademark) from artificial nectar tubes. To evaluate their suitability for translocation, birds were monitored for two hours.

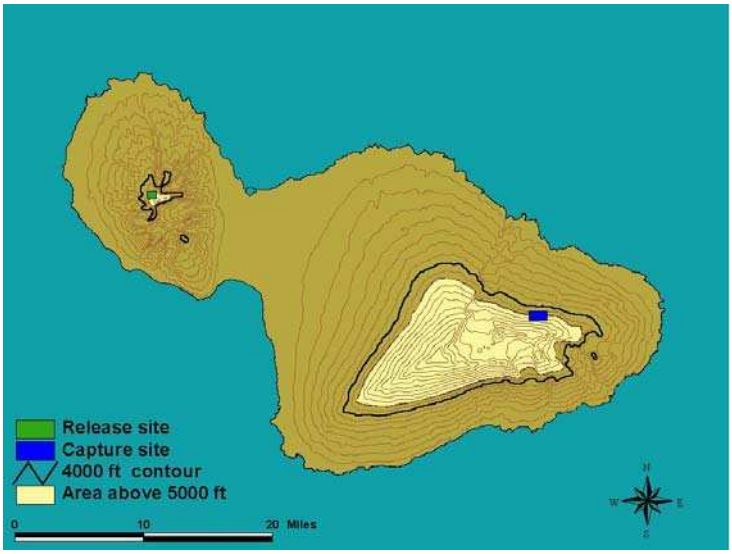

Figure 1. Location of capture site at Hanawi Natural Area Reserve on east Maui and release site on west Maui.

We used birds' ability to acclimate to captivity as an indication that they would successfully cope with translocation and subsequent release. Birds that readily consumed nectar and were able to maintain a steady body weight were considered viable translocation candidates. In addition, to determine health, fecal material collected on cage paper was evaluated using a scoring system relating total number of droppings with a visual estimate of the percentage urate content (Work et al. 1999), and a blood sample was taken for disease screening. If a bird's body weight remained within 15% of the capture weight, at least 50% of the droppings contained ≤ 50% urates, and a thin blood smear had no evidence of avian malaria, the bird was considered viable for translocation. If all criteria were not met, the bird was immediately released. This rapid assessment was repeated until 20 birds suitable for translocation were obtained.

Translocation

Translocation was done by helicopter to the native ohia forest release site, Nakalalua, on West Maui (Figure 1) at around 1350 m. I`iwi were maintained in their individual acclimation cages until 10 minutes prior to their scheduled flight, at which point they were transferred to a wooden translocation box with multiple side-by-side compartments measuring 15 x 15 x 25 cm. The ceiling and inner walls of each compartment were cushioned with air-filled plastic "bubble wrap" and each cage contained two wooden perches. Ventilation was provided by mosquito-screen covered holes. To decrease disturbance from engine noise during the helicopter flight, the translocation box was placed inside a sound-proofed chamber. The entire translocation package was secured to the rear seat of the helicopter using elastic bungee cords. When birds arrived at the release site, they were randomly assigned to a release group (soft, hard) and placed in individual acclimation cages.

Release Groups

Birds in the hard release group remained in an acclimation cage for one hour, after which they were weighed and given a subcutaneous injection of lactated Ringer's solution (50 ml/kg). Radio transmitters were glued to the back of each bird with a silk patch interface. Each bird was offered artificial nectar and released.

Birds in the soft release group remained in acclimation cages overnight. Mass was remotely monitored using a digital scale. The next morning, birds were placed inside larger cages (1.2 x 0.6 x 0.9 m). Each I`iwi was allowed to fly freely in the cages for seven days and their food consumption was monitored. On the morning of the eighth day, birds were captured, weighed, had a blood sample (~1% of body weight) collected from the right jugular vein, and were given a subcutaneous injection of lactated Ringer's solution. Radio transmitters were attached to each bird as described above. I`iwi were returned to their cages for an hour and then the cages were opened, allowing the birds to leave. Nectar tubes were left inside and outside of the welded wire cages, and in nearby trees. Beginning on day six, the concentration of artificial nectar powder was reduced and tubes were removed on day 10.

Post Release Telemetry

I'iwi were tracked using multiple hand-held receivers and a stationary receiver. The hand-held receivers (Telonics model TR-4) were mobile units attached to metal or rubberized directional H and Yagi antennas. The stationary receiver was attached to an omni directional antennae array coupled with an automatic data logger (Francis 5000; Kona, Hawaii). Hand-held receivers and antennae were transported to pre-determined locations to triangulate signals simultaneously throughout the day. Three to four biologists tracked I`iwi from 0900 to 1600 daily, cycling through one frequency every five minutes. Individual I`iwi frequency reception was attempted multiple times per day immediately after birds were released from June 12 through July 24, 2001, at which point most batteries had died.

Every five minutes, reception of one I'iwi transmitter signal was attempted simultaneously by receivers from three to five locations. Signal reception efforts included detections from both hand-held receivers and the automatic data logger. When the signal of a transmitter was detected by two or more receivers at a scheduled time, the location of each receiver and bearing of the signal were recorded using the program Location of a Signal 4.0 (LOAS) (Ecological Software Solutions). Signals received at scheduled times, along with their corresponding strengths and interferences, also were used to determine presence or absence of translocated birds and overall detection capacity for monitoring the release.

Data Analyses

Locations calculated using LOAS were entered into a GIS database and analyzed spatially using ArcMap 9.2 software. GIS data were used to estimate rates of movement, distances traveled between detections, and to compare the distances from the release site to which I`iwi from the two different groups dispersed.

The presence of deep gulches and steep terrain in the montane forest of west Maui caused anomalous detection of radio frequencies. Locations estimated by LOAS 4.0 were excluded from the spatial analysis of bird detections when four signals created two different biangulations.

JMP software (SAS 2008) was used to calculate T-tests, ANOVAs, and regressions.

RESULTS

Eighteen I`iwi were selected for the translocation and 15 survived to be color-banded and released (Table 1). None of the color banded I`iwi were re-sighted during the month-long assessment period and despite casual searches by biologists familiar with the birds during monthly visits to the release site there have been no re-sights since.

Table 1. Fate of I`iwi in translocation experiment with selected telemetry results.

Bird Radio Freq.	**Sex**	**Age**	**Group**	**Release date**	**Days detected**	**Attempts to detect /days**	**Max. distance (m) from release site**	
134	M	SY	Hard	6/13/01	18	101/25	808	
403	M	ASY	Hard	6/12/01	31	111/25	1330	
64	F	HY	Hard	6/12/01	21	110/25	2410	
342	M	ASY	Hard	6/12/01	24	109/24	2108	
453	M	ASY	Hard	6/13/01	18	104/23	1464	
313	F	HY	Hard	6/14/01	16	94/23	1684	
249	F	HY	Hard	6/13/01	20	100/24	1435	
192	F	HY	Hard	6/13/01	41	44/8	2875	
167	M	ASY	Hard	6/12/01	24	107/24	1500	
516	M	SY	Soft	6/19/01	36	69/18	4500	
574	M	ASY	Soft	6/21/01	15	61/15	8000	
226	M	ASY	Soft	6/19/01	13	69/17	1722	
476	F	HY	Soft	6/19/01	16	65/16	2285	
427	M	ASY	Soft	6/19/01	6	7/2	1867	
DIED	M	HY	Soft					
DIED	M	ASY	Soft					
DIED	M	SY	Soft					
Escape	F	HY	Soft					

[1] **loss of strong radio signal**

Survival by Release Group

All nine hard release birds were outfitted with transmitters and released. They survived for an extended period of time after the release. Eight had functional transmitters with moving signals for 16 to 31 days. One transmitter emitted a signal from the same location for 37 days suggesting it had fallen off the bird. Some attempt was made to locate the transmitter/bird, but due to the extreme terrain of West Maui neither was physically retrievable, leaving the fate of one hard release bird unclear.

Three of the nine soft release birds (33%) died in captivity on West Maui. Two died on the second night and one on the third night of the 7-day acclimatization period. Necropsies indicated no infectious pathology. A fourth soft release I`iwi (female)

escaped on the release day just before being outfitted with a transmitter. Of the five soft release birds outfitted with transmitters, the longest signal lasted 36 days, while the other four were detectable for 6 to 16 days.

Nectar consumption, fecal output, and mortality in soft release birds

Survivors of the 7-day soft release period had nectar consumption rates averaging 6.1 ± 2.5 (SE) ml/hr (N = 6 birds). Consumption rates were more variable at the beginning of captivity than at the end with standard error dropping from 2.2 to 0.5 on day 1 to day 7, respectively. Nectar consumption by the three I`iwi that died was higher on average, 9.6 ± 2.2 (SE) ml/hr, but not significantly so at a 95% confidence level (T-test, $p < 0.13$). Percentage weight change during day one of captivity shifted from a positive average (1.2% ± 5.4 (SD), N= 16) after a three-hour acclimatization period to a negative average (-0.14% ± 2.1 (SD), N=16) after six hours, a decline, but not a statistically significant one. Weight changes in the three I`iwi that died were well within these values.

Fecal output was the only health-related indicator that differed substantially between I'iwi that survived the acclimatization period and those that did not. Two of the birds that died had both the highest nectar consumption rates (13.4 and 9.6 ml/h) and the highest fecal outputs, 108 and 49 droppings/3 h, respectively. In comparison, surviving I`iwi produced only 8 to 30 fecal droppings over the same assessment period. Urate scores for the two I`iwi that died were not different from survivors.

Telemetry of Released I`iwi

All 14 birds survived for more than one day. Tracking was limited by short battery lives and ability to detect signals. Telemetry from helicopter was required to relocate some birds towards the end of average battery functionality (~21 days). Telemetry yielded 51 location records for which distances moved by I`iwi could be calculated. On average, locations were determined for each bird every two h (122 mins ± 73, N=51), but time lapses ranged from one to six h. Distances moved by I`iwi between detections varied from 123 to 3,814 m but were not a function of the time elapsed ($r^2 = 0.0$, $p = 0.71$). We standardized movement rates to m/hr to compare the release groups. Soft release I`iwi moved twice the distance per hour compared with hard release birds ($t = 2.0$, $p = 0.047$). Soft release birds averaged 1 ± 0.9 km/hr (N = 28 records), whereas hard release birds averaged only 0.56 ± 0.5 km/hr (N =23). Individual variation did not

affect release group variation (ANOVA $_{11, 39}$ F=1.3, P = 0.26) and there were no significant differences in movement rates of individuals as a function of the time of day (ANOVA $_{2, 45}$ F=0.5, p = 0.6).

Distances that I`iwi travelled from the release site were highly variable and were related to release group and to individual birds. Mean of maximum distances from the release site for the five soft release birds, 3.7 ± 2.6 km, was greater than the mean for the nine hard releases, 1.7 km ± 0.6 km (Student's T-test, $p < 0.05$). Maximum individual flight distances were strongly correlated with final dispersal distance from the release site ($r^2 = 0.8$, $p = 0.003$). The mean distance from the release site on the last day of monitoring was 1.6 ± 0.8 km.

The locations of hard release I`iwi were clustered mainly to the west of the release site (Fig. 2). In contrast, soft release I`iwi ranged mainly to the east of the release site and were more dispersed (Fig. 2). Most birds ranged above 1130 m, but several ventured to 800 m.

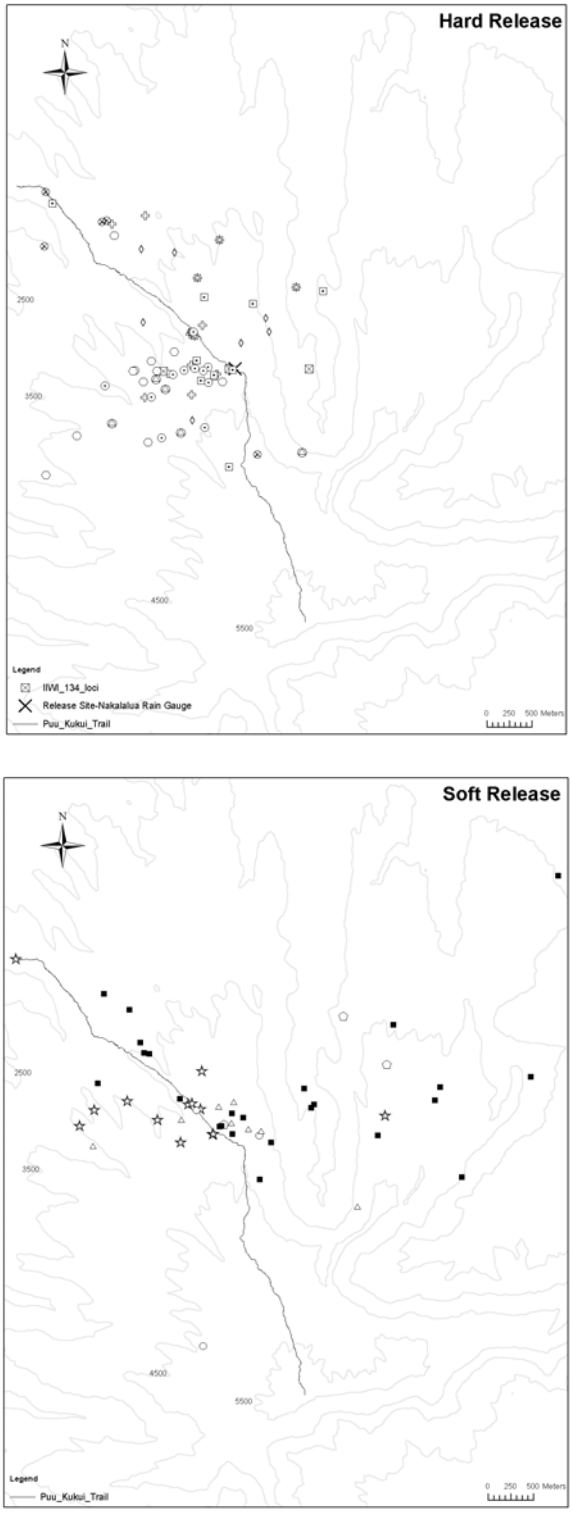

Figure 2. Locations of translocated I`iwi from soft and hard release groups relative to release site (X) on West Maui during June-July, 2001. Birds released immediately, hard-release show a more clumped distribution than soft release birds.

DISCUSSION

Translocation of I`iwi was successful with no mortality occurring during helicopter transport and all birds appeared in good physical condition upon arrival on west Maui. Hard release birds established themselves at the release site, and moved and survived well during the monitoring period. In contrast 33% of the soft release birds perished during the first 48 hours of captivity. Artificial nectar may have been a factor in these mortalities as two fatalities were associated with higher than average nectar consumption rates and high fecal production. Artificial nectar ferments quickly and provides a good medium for bacteria and mold that can harm birds. Exposure to rain and wind may also have exacerbated mortality as cages were somewhat open to ambient weather. These results suggest that translocation of `Akohekohe should follow soft release protocol.

At the end of the monitoring period, positions of all released birds described an area of about 800 ha, large enough to accommodate many I`iwi (Fancy & Ralph 1998, Eddington 1970). After being released, the soft release birds were more mobile than the hard released birds, moving faster and farther. The hard release I`iwi had approximately one week to establish territories prior to the release of the soft release birds. Given their territorial nature (Carothers 1986) it is possible that hard release birds displaced the soft release birds from roosting and feeding locations. Resource defense by the hard release I`iwi could have forced soft release birds to move farther in search of food and other needs. The fact that soft release birds moved east of the Pu`u Kikui trail in the opposite direction of the hard release birds supports the idea that they were avoiding established birds, but other resource variables may have been factors.

Given the lack of re-sights during the experimental release and in subsequent years, radio tracking appears necessary to assess the efficacy of translocation in honeycreepers. The 21-day average battery life limited monitoring of translocated individuals, but 12 of 14 I`iwi were detectable long enough to confirm that translocation did not result in rapid mortality. Rainy conditions may explain the high variability in battery function. The superglue and silk patch mounting had a success rate of 85%, and would appear suitable for tracking `Akohekohe and other honeycreepers post release.

Results of this I`iwi translocation suggest that in future translocations of honeycreepers, veterinary assessments and manipulations should be minimized, perhaps being limited to making sure healthy birds are selected for the translocation. Future releases should focus on rapid transport to the release site, immediate release, and radio telemetry to monitor success. The soft release techniques we used were detrimental to birds during the holding period (high mortality) and delayed release may have resulted in competition with hard release birds. However, soft releases may be appropriate for translocations using birds from captive breeding facilities.

In conclusion, our translocations of I`iwi as surrogates for `Akohekohe highlight the importance of doing feasibility studies using surrogate species and doing post-release monitoring (Kleiman et al. 1994). Since behavioral and physical responses to captivity and translocation are species-specific, results can never be completely predicted by using a surrogate, but pitfalls of techniques can be assessed with no harm to the endangered species. Our work suggests that `Akohekohe can be successfully translocated.

Acknowledgements. Maui Land and Pine provided cabins, access, and logistical support. We thank Hawaii Division of Forestry and Wildlife for financial support, the Maui Veterinary Services Office for I`iwi health monitoring, and the Pacific Cooperative Studies Unit of the University of Hawaii for administrative support. Dr. Schmidt's necropsy analyses were valuable to the study. We greatly appreciate the difficult fieldwork conducted by staff at the Maui Forest Bird Recovery project. We thank T. Malcolm and C. Brosius for their contributions in field biology and radio telemetry, and their careful recollections of the project. Special thanks to D. Leonard, P. Hart, and D. Duffy for review of the manuscript.

Literature Cited

Benning, T. L., D. LaPointe, C. T. Atkinson, and P. M. Vioutsek. 2002. Interactions of climate change with biological invasions and land use in the Hawaiian Islands: Modeling the fate of endemic birds using a geographic information system. Proceedings of the National Academy of Sciences 99:14246-49.

Carothers, J. H. 1986. Behavioral and ecological correlates of interference competition among Hawaiian honeycreepers. Condor 88: 421-426.

Eddinger, C. R. 1970. A study of the breeding behavior of four species of Hawaiian honeycreeper (Drepanididae). Ph.D. diss., Univ. of Hawai'i, Honolulu.

Fancy, S. G. and C. J. Ralph. 1998. Iiwi (*Vestiaria coccinea*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/327

Kirkpatrick, C. E. and T. B. Smith. 1988. Blood parasites of birds in Cameroon. Journal of Parasitology 74: 1009-1013.

Kleiman, D. G. , M. R. Stanley Price, and B. B. Beck. 1994. Criteria for reintroductions, in Creative Conservation: Interactive Management of Wild and Captive Animals (Olney, P. J. S., Mace, G. M. and Feistner, A. T. C., eds.), pp. 288-303. Chapman & Hall. London.

Ralph, C. J. , G. R. Geupel, P. Pyle, T. Martin, D. f. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Albany, CA. Pacific Southwest Reasearch Station, Forest Service, U. S. Department of Agriculture, 41 p.

Sarrazin, F. and R. Barbault. 1996. Reintroduction: challenges and lessons for basic ecology. TREE 11: 474-478.

Scott, J. M. and J. W. Carpenter. 1987. Release of captive-reared or translocated endangered birds: What do we need to know? Auk 104: 544-545.

Tarr, C. L. and R. C. Fleischer. 1995. Evolutionary relationships of the Hawaiian honeycreepers (Aves, Drepanidinae): Hawaiian Biogeography: Evolution on a Hot Spot (Wagner, W. L. and Funk, V. A., eds.). pp. 147-159. Smithsonian Institute Press, Washington, D. C.

U.S. Fish and Wildlife Service. 2006. Revised Recovery Plan for Hawaiian Forest Birds. Region 1, Portland. OR. 622 pp.

Work, T. M., J. G. Massey, L. Johnson, S. Dougill, and P. C. Banko. 1999. Survival and physiologic responses of common amakihi and Japanese white-eye during simulated translocation. Condor 101: 21-27.