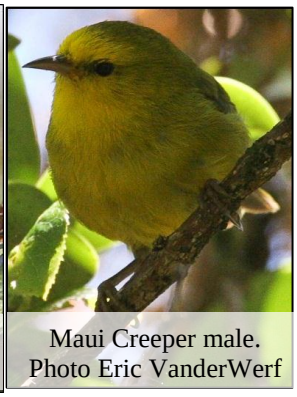
Focal Species: Maui rain forest honeycreepers
Maui Parrotbill or Kiwikiu (*Pseudonestor xanthophrys*)
Crested Honeycreeper or ʻĀkohekohe (*Palmeria dolei*)
Maui Creeper or Maui ʻAlauahio (*Paroreomyza montana*)

Synopsis: These three species of Hawaiian honeycreepers are endemic to Maui and are restricted to high elevation areas of native forest. They share the same habitat and also the same threats. The Maui Creeper is least specialized and occurs in some areas on non-native forest and is more widespread and more numerous. The Maui Parrotbill is more specialized and occurs at lower population density and is thus least numerous. Keys to the conservation of these species are continued management of existing native forest habitat, restoration of additional habitat, and translocations to create additional populations in restored habitat.


Maui Parrotbill. Photo E. VanderWerf


Crested Honeycreeper. Photo E. VanderWerf


Maui Creeper male. Photo Eric VanderWerf


Hanawī Reserve. Photo Eric VanderWerf.

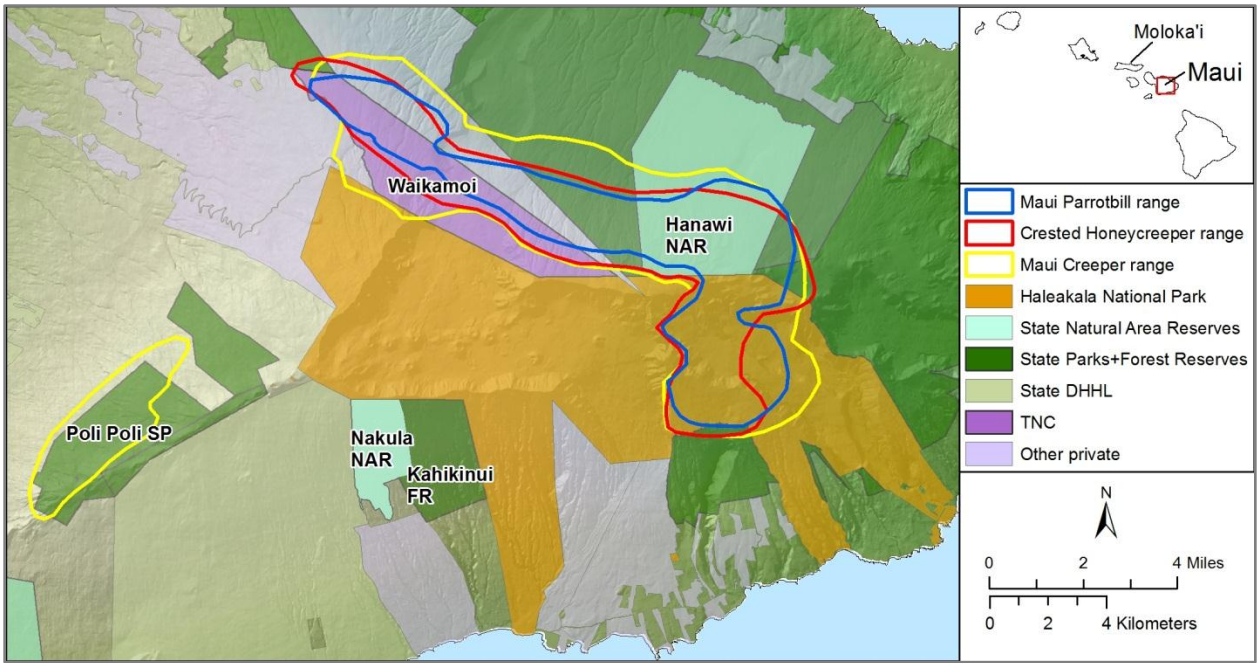
Geographic region: Hawaiian Islands
Group: Forest birds
Federal Status: Maui Parrotbill, ʻĀkohekohe Endangered, Maui Creeper Cons. Concern
State status: Maui Parrotbill, ʻĀkohekohe Endangered
IUCN status: Parrotbill, ʻĀkohekohe Critically Endangered, Maui Creeper Endangered
Conservation score, rank: 18/20, At-risk
Watch List 2007 Score: RED
Climate Change Vulnerability: HIGH

Population Size and Trend:
Maui Parrotbill – In 1980, the total population was estimated to be 502 ± 116 birds based on surveys of the species' entire range (Scott et al. 1986). Population density (birds/km^2) was estimated to be 17.2 ± 4.2, 17.0 ± 4.2, and 11.8 ± 2.6 based on surveys in 1980, 1992-1996, and 1997-2001, respectively, suggesting a possible decline in abundance, but the large errors associated with the estimates caused the trend assessment to be statistically inconclusive (Camp et al. 2009, Gorresen et al. 2009). Brinck et al. (2102) estimated that abundance of Maui Parrotbills in the core of their range was 421 birds (95% CI 209-674) based on repeated surveys in 2006 and 2011, but this did not include Kipahulu Valley and Waikamoi Preserve. Population density is higher in the core of the species range; from 1995–1997, research in Hanawī Natural

Area Reserve (NAR) indicated that Maui Parrotbill density was approximately the same (40/km^2) as in 1980 (Simon et al. 2002). In 2010, intensive demographic monitoring of banded parrotbills found densities in the core of the range (190 ha surveyed) to be 33-36/km^2 (Maui Forest Bird Recovery Project [MFBRP], unpubl. data).

Crested Honeycreeper – In 1980, the total population was estimated to be 3,753 ± 373 (Scott et al. 1986). Subsequent surveys from 1997-2001 over the species' entire range yielded higher densities, which resulted in a population estimate of 6,745 ± 1,546 individuals (Camp et al. 2009). Surveys in the core of the species' range in Hanawī NAR during 1980 and 1995-1997 also recorded increasing densities (183 and 289/km^2, respectively; Scott et al. 1986, Simon et al. 2002), supporting the conclusion that abundance of ʻĀkohekohe has increased.

Maui Creeper – In 1980, the total population was estimated to be 34,839 ± 2,723 (Scott et al. 1986). Population density (birds/km^2) was estimated to be 731 ± 64, 1482 ± 77, and 1167 ± 74 based on surveys in 1980, 1992-1996, and 1997-2001, respectively, suggesting a possible increase in abundance, but surveys in 1980 were conducted after the peak in breeding, and the species' range may be contracting up slope (Camp et al. 2009). Brinck et al. (2102) estimated that abundance of Maui ʻAlauahio within the range the Maui Parrotbill (i.e., not their entire range) was 55,262 birds (95% CI 52,729-57,921) based on repeated surveys in 2006 and 2011.



Range:

Maui Parrotbill – The Maui Parrotbill currently is restricted to a single population occupying 50 km^2 between 1,200 and 2,350 m elevation on the northeastern slope of Haleakalā Volcano (Scott et al. 1986, Simon et al. 1997). It is most common from 1,700 to 2,100 m (Scott et al. 1986) and absent from most areas below 1,350 m (USFWS 2006). Surveys in 2001 indicated that parrotbills have persisted over roughly the same area identified in 1980 by Scott et al. (1986), although an upslope contraction of about 100 m appears to have occurred at the bottom of the

species range (from 1,100 to 1,200 m elevation; Camp et al. 2009). Maui Parrotbill historically occurred in drier, low elevation forests on Maui and Molokaʻi (James and Olson 1991).

Crested Honeycreeper – The ʻĀkohekohe currently is restricted to a single population that has a range of 58 km^2 on the northeastern slope of Haleakalā Volcano, similar to that of the Maui Parrotbill but slightly larger (Scott et al. 1986). It occurs between 1,100 and 2,300 m elevation but is most abundant between 1,500 and 2,100 m (Conant 1981, Scott et al. 1986). The ʻĀkohekohe occurs at higher and lower elevations than the Maui Parrotbill. The ʻĀkohekohe was extirpated from Moloka'i in the early 1900s (Bryan 1908).

Maui Creeper – Most of the species' population occurs on the northeastern slope of Haleakalā Volcano, where it is sympatric with the Maui Parrotbill and Crested Honeycreeper; a smaller population occurs on the drier, leeward slopes of Haleakalā in and around Poli Poli State Park (Baker and Baker 2000). Maui Creepers were found historically in Kahikinui on the southern slope of Haleakalā and on west Maui and Lāna'i. The Lānaʻi subspecies was last seen in 1937 and is considered extinct (Munro 1944, Hirai 1978). The range in east Maui appears to be contracting up-slope (Camp et al. 2009).

Essential Biology:

Maui Parrotbill – The Maui Parrotbill had no historically recorded Hawaiian name until 2010, when Kiwikiu was created for it with the help of Hawaiian linguists (MFBRP 2010). It is a medium-sized (20–25 g) Hawaiian honeycreeper with a short tail and a large, parrot-like bill (Simon et al. 1997). Adults are olive-green above with a yellow breast, belly, and cheeks, and a yellow supercilium. Males are larger and brighter than females and have larger bills. The song is a series of "*chewy, chewy, chewy*," notes descending in pitch and volume (Simon et al. 1997).

Maui Parrotbills occur in mesic and wet native montane forests dominated by ʻōhiʻa (*Metrosideros polymorpha*), ʻōlapa (*Cheirodendron trigynum*), kōlea (*Myrsine lessertiana*), and kawaʻu (*Ilex anomala*), with a diverse understory of native plants including ʻākala (*Rubus hawaiensis*), ʻōhelo (*Vaccinium calycinum*), ʻalani (*Melicope* spp.), pūkiawe (*Styphelia tameiameiae*), and kanawao (*Broussaisia arguta*) (Simon et al. 1997, Stein 2007). They forage mainly on the woody portions of native shrubs and trees, using their powerful bill to dig, crush, and chisel bark and wood for insects and other arthropods, especially larvae and pupae of beetles and moths (Perkins 1903, Mountainspring 1987, Simon et al. 1997, Stein 2007). Perkins (1903) noted a preference for koa (*Acacia koa*), which is scarce is the current range.

Maui Parrotbill pairs defend year-round territories that average 2.3-5.1 ha (5.7-12.6 ac) in size (Pratt et al. 2001, Iknayan et al. 2010). The nesting season extends primarily from December to July, though nests have been found in all months except September. Most nests are built high (10.6 ± 3.0 m) in ʻōhiʻa trees, typically close to branch tips. Clutch size is one egg and pairs raise only one fledgling per year. Fledglings remain with parents and are fed for several months. The female incubates the egg and broods the chick, the male feeds the female on the nest and provides most food for the dependent young (Simon et al. 1997). Nest success averages 19%, with inclement weather resulting in most nest losses (Mounce et al. 2011). Renesting is common after failure, and pair success (proportion of pairs observed with a fledgling) averages 46% per year (Mounce et al. 2011). Based on mark-recapture data, annual adult and juvenile survival are 0.84±0.04 and 0.76±0.09, respectively (Vetter et al. 2012), but more recent analyses indicate juvenile survival is lower (MFBRP unpubl. data).

Crested Honeycreeper – The ʻĀkohekohe is a large (24-29 g) nectarivorous honeycreeper (Berlin and Vangelder 1999). Adults have black plumage highlighted with red and silver feathers and a bushy white crest that curves forward over the bill. Calls include a variety of loud whistles and low, guttural sounds. They may forage alone, with a mate, or with 1–2 offspring, but are usually solitary outside the breeding season. ʻĀkohekohe are aggressive toward smaller honeycreepers, such as the ʻIʼiwi (*Vestiaria coccinea*), and may defend flowering trees. They do not join mixed-species foraging flocks.

ʻĀkohekohe occur in wet and mesic montane rain forest dominated by ʻōhiʻa (see Maui Parrotbill for other plant species found in this habitat). They feed mostly on ʻōhiʻa nectar, but also take nectar seasonally from other trees and shrubs and glean insects from leaves, flower buds, and twigs (Vangelder 1996). They forage mainly in the upper and middle forest canopy.

ʻĀkohekohe maintain year-round territories around the nest or nectar sources. The breeding season extends from November – June, with a peak in March, and coincides with ʻōhiʻa bloom. Multiple broods are common, with up to 3 clutches laid per year (Vangelder 1996). The nest is built primarily by the female. Clutch size is 1–2 eggs (Vangelder 1996). The male defends the nesting territory and regurgitates food to female during courtship, incubation, and brooding. Both parents feed chicks by regurgitation. Young are independent 10–14 d after fledging and often associate with siblings or other juveniles. The percentage of nests that produced fledglings in Waikamoi Preserve was 80% and 36% in 1992–1993, with an average of 1.6 young per nest reared from successful nests (Vangelder 1996). In Hanawī NAR from 1994–1997, 78%, 87%, and 62% nests fledged young, with an average of 1.4 young fledged from successful nests.

Maui Creeper – The Maui Creeper is a small (12-14 g) insectivorous honeycreeper with a short, thin bill (Baker and Baker 2000). Adult males are olive-green above and bright yellow below. Adult females are less brightly colored. The song, given by males only, is an ascending "*k-weedy, k-weedy, k-weeet*" (Baker and Baker 2000). A sharp "chip" note is frequently given and used as contact call between group members. Maui Creepers are often found in small family groups of 2–6 birds consisting of 2 adults, 1 or 2 young from the current breeding season, and sometimes 1 or 2 young from the previous year.

Maui Creepers are found primarily in native montane mesic and wet forest dominated by ʻōhiʻa (see Maui Parrotbill for other species found in this habitat), but they also use sub-alpine māmane (*Sophora chrysophylla*) scrub, and mesic alien forest composed of various conifers, especially *Pinus* spp. (Baker and Baker 2000). Maui Creepers glean a variety of invertebrates from leaves, branches, small twigs, and trunks, especially the orders Homoptera and Lepidoptera in native forest and Coleoptera and Hemiptera in non-native forests (Foster 2005). They forage most often on ʻōhiʻa and koa, but also use a variety of other plant species and also take some nectar. They join mixed-species foraging flocks and sometimes examine sites excavated by Maui Parrotbills (Baker and Baker 2000).

Pairs defend home ranges year round, averaging 0.5-0.9 ha in size (1.2-2.2 ac; Iknayan et al. 2010). ʻAlauahio are socially monogamous and pair for life, although extra-pair copulations have been confirmed through genetic analysis (Baker and Baker 2000). Females choose the nest site and build an open-cup nest. Clutch size is two, and birds will renest after failure, but double brooding has not been documented. Only females incubate eggs and brood nestlings. Fledglings are fed for two to three months, and young remain with their parents in family groups for 18-20

months. Maui ʻAlauahio do not breed until their third year, and young birds may stay with their parents and help raise subsequent offspring.

Primary Threats:

- Habitat loss and degradation. Cutting of native forest for logging, cattle ranching, and silviculture of non-native trees has reduced the amount of native forest habitat and fragmented it in many areas. Most areas of native forest important to these species are now protected, but habitat degradation from invasive plants and non-native ungulates remains a problem even in protected areas. Habitat fragmentation may hinder natural re-colonization by these species into unoccupied but suitable habitat.
- Invasive alien plants. Invasive plants such as strawberry guava (*Psidium cattleianum*) and blackberry (*Rubus argutus*) have invaded native forests and reduced habitat quality in all but the most remote parts of the island. Other serious invasives are found at lower elevations but have not yet reached the range of these species, such as *Miconia calvescens*. The Maui Creeper is known to forage and nest in non-native plants in the Waikamoi and Poli Poli areas, but the more specialized Maui Parrotbill and Crested Honeycreeper are restricted to native forest.
- Non-native ungulates. Browsing by feral cattle (*Bos taurus*), feral sheep (*Ovis aries*), feral goats (*Capra hircus*), and axis deer (*Cervus axis*) has degraded habitat quality in many areas and hindered recruitment of native trees. Rooting and wallowing by feral pigs (*Sus scrofa*) has destroyed understory vegetation in many areas, hindered recruitment of native trees, and provided breeding sites for mosquitoes that carry diseases.
- Disease. Avian malaria (*Plasmodium relictum*) and avian pox virus (*Poxvirus avium*) carried by the alien southern house mosquito (*Culex quinquefasciatus*) limit the distribution of many native Hawaiian forest birds (van Riper et al. 1986, Atkinson et al. 1995, Atkinson and LaPointe 2009). These three birds are absent or rare in most areas of suitable forest below 1,350 m (Maui Parrotbill), 1,100 m (Akohekohe), and 1,600 m (Maui Creeper), likely because of disease (Simon et al. 1997, Berlin and Vangelder 1999, Baker and Baker 2000, USFWS 2006).
- Non-native Predators. Introduced predators are a serious threat to some Hawaiian forest birds, particularly during nesting (Atkinson 1977, VanderWerf 2009), but direct evidence of predation by non-native species is lacking in these three species. Feral cats (*Felis catus*) and Barn Owls (*Tyto alba*) are known to prey on birds at Hanawī NAR (Kowalsky et al. 2002). Black (*Rattus rattus*) and Pacific rats (*R. exulans*) are serious predators on adults and nests of other Hawaiian forest birds and are abundant in the habitats occupied by these species (Malcolm et al. 2008).
- Wildfires. The Poli Poli area on the leeward side of Haleakala, which supports an isolated population of the Maui Creeper, is drier and more susceptible to fire than the wetter forest on the windward side of the volcano. A wildfire burned 2,300 acres of largely alien forest at Poli Poli in January 2007, including part of the Maui Creeper range. The fire probably resulted in some loss of habitat, but the long-term impact of the fire on the Maui Creeper population is unknown (Mounce et al. 2007).
- Small Population Size and Range. Species with small populations and ranges are inherently more vulnerable to extinction than widespread species because of the higher risks posed by random demographic fluctuations and localized catastrophes such as hurricanes, fires, disease

outbreaks. As populations and ranges of island birds decline due to other threats, the extinction risk from catastrophic events also increases and conservation options narrow.

- Global Climate Change. Rising temperatures associated with climate chance may exacerbate the threat of disease by increasing the elevation at which regular transmission of avian malaria and avian pox virus occurs (Reiter 1998, Benning et al. 2002, Harvell et al. 2002, Hay et al. 2002, Loiseau et al. 2012). GIS modeling indicates that malaria transmission currently occurs at least periodically across 20% of the Maui Parrotbill range. An increase in temperature of 2°C, which is a conservative figure based on recent data (IPCC 2007), would decrease the area of disease-free forest within the species current range from 40 km^2 to 9 km^2 (Benning et al. 2002, Giambelluca et al. 2008, Hammond et al. 2009). Loss of such a large proportion of suitable habitat would likely result in extinction of the Maui Parrotbill (Pounds et al. 1999, Still et al. 1999).

Conservation Actions to Date:

The Maui Parrotbill and Crested Honeycreeper were listed as endangered in 1967. Life history and demographic studies of these species were conducted by USGS from 1994-1996 and have been ongoing since then by the MFBRP under the direction of the Hawai'i Division of Forestry and Wildlife (DOFAW). As of August 2010, about 75% of the range of the Maui Parrotbill and Crested Honeycreeper was fenced and ungulate free or ungulate eradication was underway. The entire range of these two species is within the East Maui Watershed Partnership (EMWP), and the entire range of the Maui Creeper falls within EMWP and the Leeward Haleakala Watershed Restoration Partnership (LHWRP). Invasive plant control is conducted by Haleakalā National Park, The Nature Conservancy (TNC), Maui Natural Area Reserves, EMWP, LHWRP. In 2009, the U.S. Fish and Wildlife Service (USFWS) provided funds to collect data necessary to initiate the establishment of a second Maui Parrotbill population on leeward east Maui. Funds from the USFWS, U.S. Forest Service (USFS), and the American Bird Conservancy (ABC)/National Fish and Wildlife Foundation (NFWF) are supporting fencing and restoration of the Kahikinui Forest Reserve (FR) and the Nakula NAR, the area selected to establish the second population. The Kahikinui area is drier and experiences fewer storms; once restored, it will provide additional high elevation, disease-free habitat, which is critical as climate change increases temperatures. A captive propagation program has successfully reared Maui Parrotbill, both from wild collected eggs and from captive pairs. Although recent production is insufficient to establish a second population, the San Diego Zoological Society is working to increase the productivity of the captive flock (Kuehler et al. 2001, ZSSD 2009). Conservation actions have not yet been taken specifically for Maui ʻAlauahio but it has been used to evaluate translocation methods for Hawaiian honeycreepers and stress response (Groombridge et al. 2004). Survey data has been re-analyzed by USGS to improve information about population size and trend, but these results are not yet available.

Planning/Research Needs:

All species would benefit from determining if genetic markers or genotypes are associated with disease resistance. If disease-resistant individuals can be identified, they could be used in translocations to establish new populations or to augment existing populations currently lacking disease resistance.

- Determine if genetic markers or specific phenotypes are associated with disease resistance or tolerance. If disease-tolerant individuals can be identified, they could be used in

translocations to establish new populations or to augment existing populations that lack disease tolerance.
- Analyze and publish existing data on nesting success, fecundity, and survival of all three species collected by the MFBRP.
- Survey the range and abundance of Maui Creepers in the Poli Poli area, which has not been surveyed since 1980, and examine the species use of non-native forest.
- Develop cost effective methods to restore mesic forest habitat on leeward east Maui.
- Determine feasibility of restoring habitat in windward east Maui, especially high elevation forests dominated by alien trees (e.g., Hosmer's Grove in Haleakalā National Park and Waikamoi Preserve).

5-Year Conservation Goals:
- Continue habitat management, including fence maintenance, in Hanawī NAR, Haleakalā National Park, Waikamoi Preserve, and adjacent areas.
- Complete fencing of about 1,200 ha in the Kahikinui FR and Nakula NAR, remove ungulates, and begin habitat restoration (fencing and ungulate removal are fully funded). Support fencing and restoration on adjacent property owned by the Department of Hawaiian Home Lands.
- Create a second population of Maui Parrotbills by translocating birds into the Kahikinui FR and Nakula NAR.
- Create a third population of Maui Creepers by translocating birds into the Kahikinui FR and Nakula NAR.

Conservation Actions:
- Habitat Management.
  - Maintain existing areas that are fenced and ungulate free, including weed control, fence maintenance, and outplanting of native species as needed.
  - Begin habitat restoration in Kahikinui FR and Nakula NAR. Develop infrastructure to support habitat management and eventually bird translocations.
- Small Population Size and Range.
  - Translocate Maui Parrotbills. Develop protocols and translocate birds into restored habitat in the Kahikinio FR and Naukla NAR. An adaptive approach should be used to collect information and determine how parrotbills use mesic habitats on leeward east Maui.
  - Translocate Maui Creepers. Develop a reintroduction plan and translocation protocols and conduct an experimental translocation to refine protocols and to determine how creepers will use mesic habitats on leeward east Maui. Could be done in advance of Maui Parrotbill translocation to help develop protocols and serve as an experiment, or simultaneously to save money.
- Disease. Translocation of Maui Parrotbill to Kahikinui should result in less exposure to disease. Continued fencing and feral pig control in windward habitat will reduce mosquito breeding habitat.

Summary of 5-year Actions, 2013-2017:

Conservation Action	Year(s)	Annual cost	Total Cost
Manage existing ungulate-free habitat	1 - 5	$400,000	$2,000,000

Habitat restoration in Kahikinui FR+Nakula NAR	1 - 5	$350,000	$1,750,000
Develop (years 1-2) and implement (years 3-5) Maui Parrotbill translocation	1 - 5	$50,000, $200,000	$700,000
Develop (years 1-2) and implement (years 3-5) Maui Creeper translocation	1 - 5	$50,000, $200,000	$700,000
Survey and study Maui Creeper in Poli Poli SP	1-2	$30,000	$60,000

Potential Partners: U.S. Fish and Wildlife Service, National Park Service, Hawai'i Division of Forestry and Wildlife, Department of Hawaiian Homelands, East Maui Watershed Partnership, Leeward Haleakala Watershed Restoration Partnership, The Nature Conservancy, and the American Bird Conservancy.

Ancillary Species: Management that would benefit these species also would benefit all native birds that use forest habitat on Maui, including the 'I'iwi (*Vestiaria coccinea*), 'Apapane (*Himatione sanguinea*), and Hawaii 'Amakihi (*Hemignathus virens*). The Po'o-uli (*Melamprosops phaeosoma*) is probably extinct (USFWS 2006, VanderWerf et al. 2006), but its former range overlapped with these species and any remaining individuals would benefit from management.

References:

Atkinson, C. T., and D. A. Lapointe. 2009. Ecology and pathogenicity of avian malaria pox. In Conservation biology of Hawaiian forest birds: implications for island avifauna (T. K. Pratt, C. T. Atkinson, P. C. Banko, J. D. Jacobi, and B. L. Woodworth, eds.). Yale University Press, London.

Atkinson, C. T., K. L. Woods, R. J. Dusek, L. Sileo, and W. M. Iko. 1995. Wildlife disease and conservation in Hawaii: Pathogenicity of avian malaria (*Plasmodium relictum*) in experimentally infected Iiwi (*Vestiaria coccinea*). *Parasitology* 111:S59-S69.

Atkinson, I. A. E. 1977. A reassessment of factors, particularly *Rattus rattus* L., that influenced the decline of endemic forest birds in the Hawaiian Islands. Pacific Science 31:109-133.

Baker, H. and P.E. Baker. 2000. Maui Alauahio (*Paroreomyza montana*). Number 504 *in* The Birds of North America (A. Pool and F. Gill, Eds.). Philadelphia, Pennsylvania, USA

Becker, C.D., H.L.Mounce, T.A Rassmussen, A. Rauch-Sasseen, K.J Swinnerton, and D.L. Leonard. 2010. Nest success and parental investment in the critically endangered Maui Parrotbill *Pseudonestor xanthophrys* with implications for recovery. Endangered Species Research 10:189-194.

Benning, T. L., D. LaPointe, C. T. Atkinson, and P. M. Vitousek. 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 Science 99:14246-14249.

Berlin, K.E. and E.M. Vangelder. 1999. Akohekohe (*Palmeria dolei*). Number 400 *in* The Birds of North America (A. Pool and F. Gill, Eds.). Philadelphia, Pennsylvania, USA.

Brinck, K.W., R.J. Camp, P.M. Gorresen, D.L. Leonard, H.L. Mounce, K.J. Iknayan, and E.H. Paxton. 2012. 2011 Kiwikiu (Maui Parrotbill) and Maui 'Alauahio abundance estimates and the effect of sampling effort on power to detect a trend. Hawai'i Cooperative Studies Unit, Technical Report HCSU-035. 16 pp.

Bryan, W.A. 1908. Some birds of Molokai. Occasional Papers of the Bernice P. Bishop Museum 4:133-176.

Camp, R.J., P.M Gorresen, T.K. Pratt, and B.L. Woodworth. 2009. Population trends of native Hawaiian forest birds, 1976-2008: the data and statistical analyses. Hawai'i Cooperative Studies Unit Technical Report HCSU-012.

Conant, S. 1981. Recent observations of endangered birds in Hawaii's national parks. 'Elepaio 41:55-61.

Giambelluca, T. W., H. F. Diaz, and M. S. A. Luke. 2008. Secular temperature changes in Hawaii, Geophysical Research Letters 35, L12702, doi:10.1029/2008GL034377.

Gorresen, P.M., R.J. Camp, M.H. Reynolds, B.L. Woodworth, and T.K. Pratt. 2009. Status and trends of native Hawaiian songbirds. In Conservation biology of Hawaiian forest birds: implications for island avifauna (T.K. Pratt, C.T. Atkinson, P.C. Banko, J.D. Jacobi, and B.L. Woodworth, eds.). Yale University Press, London.

Groombridge, J. J., J. G. Massey, J. C. Bruch, T. R. Malcolm, C. N. Brosius, M. M. Okada and B. Sparklin. 2004. Evaluating stress in a Hawaiian Honeycreeper, *Paroreomyza montana*, following translocation. Journal of Field Ornithology, 75:183-187.

Hammond, R. L., C. D. Becker, W. W. Li, and D. L. Leonard. 2009. Use of spatial analysis to evaluate the effect of climate change on numbers of Maui Parrotbill (*Pseudonestor xanthophyrys*). Poster Presentation, Hawaii Conservation Conference.

Harvell, C. D., C. E. Mitchell, J. R. Ward, S. Altizer, A. P. Dobson, R. S. Ostfield, and M. D. Samuel. 2002. Climate warming and disease risks for terrestrial and marine biota. Science 296: 2158–2162.

Hirai, L.T. 1978. Native birds of Lāna'i, Hawai'i. Western Birds 9:71-77.

Iknayan, K.J., H.L. Mounce, C.D. Becker. August 2010. Home Range Patterns of Maui Alauahio and Maui Parrotbill. Poster Presentation. Hawaii Conservation Conference.

Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: The Physical Science Basis. Cambridge University Press.

James, H.F., and S.L. Olson. 1991. Descriptions of thirty-two new species of birds from the Hawaiian Islands. Part II. Passeriformers. Ornithological Monographs 46:1-88.

Kowalsky, J. R., T. K Pratt, and J. C. Simon. 2002. Prey taken by cats (*Felis catus*) and Barn Owls (*Tyto alba*) in Hanawi Natural Area Reserve, Maui Hawai'i. 'Elepaio 62:127-131.

Kuehler, C., A. Leiberman, P. Harrity, M. Kuhn, J. Kuhn, B. McIlraith, and J. Turner. 2001. Restoration techniques for Hawaiian forest birds: collection of eggs, artificial incubation and had rearing of chicks, and release to the wild. Studies in Avian Biology 22:354-358.

Loiseau C, Harrigan RJ, Cornel AJ, Guers SL, Dodge M, et al. 2012. First Evidence and Predictions of Plasmodium Transmission in Alaskan Bird Populations. PLoS ONE 7(9): e44729. doi:10.1371/journal.pone.0044729

Maui Forest Bird Recovery Project. 2010. Semi-annual report – October 2010. http://www.mauiforestbirds.org/Newsletters/October_2010.pdf

Malcolm, T. R., K. J. Swinnerton, J. J. Groombridge, B. D. Sparklin, C. N. Brosius, J. P. Vetter, and J. T. Foster. 2008. Ground-based rodent control in a remote Hawaiian rainforest on Maui. Pacific Conservation Biology 14:206-214.

Mounce, H. L., F. Duvall, and K. J. Swinnerton. 2007. Poli Poli fire demonstrates vulnerability of Maui 'Alauahio. 'Elepaio 67(9):67-69.

Mounce, H. L., Iknayan, K. J., Berthold, L. K., and D. L. Leonard. 2011. Kiwikiu productivity: Nest survival and annual reproductive success in the Hanawi Natural Area Reserve, Maui, Hawaii. Poster Presentation. Hawaii Conservation Conference.

Mountainspring, S. 1987. Ecology, behavior, and conservation of the Maui Parrotbill. Condor 89:24-39.

Munro, G.C. 1944. Birds of Hawai'i. Tongg Publ. Co. Honolulu, HI.

Perkins, R. C. L. 1903. Vertebrata (Aves). Pages 368-465 *in* Fauna Hawaiiensis. Vol. 1, part 4 (Sharp, D., Ed.) University Press, Cambridge, England.

Pounds, A. J., M. P. Fogden, and J. H. Campbell. 1999. Biological response to climate change on a tropical mountain. Nature 398:611-614.

Pratt, T. K., J. C. Simon, B. K. Farm, K. E. Berlin, and J. R. Kowalsky. 2001. Home range size and territoriality of two Hawaiian honeycreepers, the 'Akohekohe and Maui Parrotbill. Condor 103:746-755.

Reiter, P. 1998. Global warming and vector-borne disease in temperate regions and at high altitudes. Lancet 352:839–840.

Scott, J.M., S. Mountainspring, F.L. Ramsey, and C.B. Kepler. 1986. Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Studies in Avian Biology 9:1-431.

Simon, J. C., P.E. Baker, and H. Baker. 1997. Maui Parrotbill (*Pseudonestor xanthophrys*). Number 311 *in* The Birds of North America, No.311 (A. Poole and F. Gill, eds.). Philadelphia, Pennsylvania, USA.

Simon, J. C., T. K. Pratt, K. E. Berlin, and J. R. Kowalsky. 2001. Reproductive ecology and demography of the ʻĀkohekohe. Condor 103:736-745.

Simon, J. C., T. K. Pratt, K. E. Berlin, J. R. Kowalsky, S. G. Fancy, and J. S. Hatfield. 2002. Termporal variation in bird counts within a Hawaiian rainforest. Condor 104:469-481.

Stein, V. 2007. Critical assessment of habitat for release of Maui Parrotbill. Pacific Cooperative Studies Unit. Technical Report 146.

Still, C. J., P. N. Foster, and S. Schneider. 1999. Simulating the effects of climate change on tropical montane cloud forests. Nature 398:608-610.

U.S. Fish and Wildlife Service. 2006. Revised recovery plan for Hawaiian forest birds. U.S. Fish and Wildlife Service, Portland.

van Riper, C., III, S. G. van Riper, M. L. Goff, and M. Laird. 1986. The epizootiology and ecological significance of malaria in Hawaiian land birds. Ecological Monographs 56:327-344.

VanderWerf E. A. 2009. Importance of nest predation by alien rodents and avian poxvirus in conservation of Oʻahu ʻelepaio. Journal of Wildlife Management 73:737-746.

VanderWerf, E. A, J. J. Groombridge, J. S. Fretz, and K. J. Swinnerton. 2006. Decision analysis to guide recovery of the Po'ouli, a critically endangered Hawaiian honeycreeper. Biological Conservation 129:383-392.

Vangelder, E.M. 1996. The breeding biology of the ʻĀkohekohe (*Palmeria dolei*), an endangered Hawaiian honeycreeper. Master's Thesis. San Francisco State Univ., San Francisco, CA.

Vetter, J. P, Swinnerton, K. J., VanderWerf, E. A., Garvin, J. C., Mounce, H. L., Breniser, H. E., Leonard, D. L., and Fretz, J. S. 2012. Survival estimates for two Hawaiian honeycreepers. Pacific Science 66:299-309.

Wiley, J. W., and J. M. Wunderle. 1994. The effects of hurricanes on birds, with special reference to Caribbean islands. Bird Conservation International 3: 319-349.

Zoological Society of San Diego. 2011. Hawaiʻi Endangered Bird Conservation Program. Report to U.S. Fish and Wildlife Service and State of Hawaii. October 1, 2010-September 30, 2011.