

CONCLUSIONS AND RECOMMENDATIONS

This work details habitat use in Manawainui, provides information on the suitability of the area as a release site, and gives insight into the habitat requirements of Maui Parrotbill. The data from this study suggest that Maui Parrotbill already occupy the most suitable habitat in Manawainui. The unoccupied habitat in this area may lack the necessary vegetation attributes for parrotbill survival, such as dense subcanopy and canopy layers, and specific plants, as noted above. This paucity may reflect inadequate food resources and could be one reason why breeding activities were not observed during this study. The results of this research support the ideal-free distribution model of Fretwell and Lucas (1972), which assumes birds will freely select the most suitable habitat for survival and reproduction. It follows then that the “available” (i.e. unoccupied) habitat in Manawainui lacks the appropriate vegetation conditions necessary for parrotbill survival.

Based on this research, releases of Maui Parrotbill into Manawainui at this time are not recommended. Immediate recovery efforts should instead focus on alternate areas and research on habitat use. Future recovery efforts for this species should include replication of vegetation measurements and habitat use as detailed in this study. Additional research might also investigate use and availability of nesting habitat, invertebrate food resources and associated plant species, and wood quality of branches. While I did not find significant interactions of parrotbill with dead trees in this study, anecdotal observations of birds foraging on dead limbs of living trees suggest these trees may be an important foraging substrate and could be a crucial component of parrotbill habitat. Mountainspring (1987) found similar associations. It is possible senescing, rather than dead plants, may provide better conditions for certain wood boring invertebrates.

Although I found some evidence of preferential habitat use of koa, this is one avenue of research that warrants further investigation. Although koa may be relevant for Maui Parrotbill, managers should also consider additional vegetation parameters, such as adequate levels of vegetation in the understory, subcanopy, and canopy, as well as a diversity of plant species and tree size classes as mentioned above, when assessing potential release sites or initiating restoration efforts for future reintroductions of this species. Parrotbill utilize a variety of plant species for foraging which may reflect temporal changes in invertebrate abundances. Thus maintaining forest diversity may be crucial to supplying adequate invertebrate food resources throughout the year.

Recovery efforts for the Maui Parrotbill would greatly benefit from systematic collection of data and hypotheses testing in response to well defined questions. Future research should include the following:

- Quantitative assessments of nesting and foraging habitat before, during, and after reintroduction/restoration efforts.
- Comparative assessments of foraging habitat, prey abundance, and territory size.
- Comparative assessments of foraging habitat for male, female and juvenile birds.
- Assessments of invertebrates and associated plant species throughout the year.

- Investigation into the potential impacts of non-native mammals, birds, and parasitoids on invertebrate prey species.
- Exploration of alternate release sites, and habitat restoration as necessary.
- Out-planting a diversity of plant species particularly ‘ākala, ‘alani, kanawao, kawa‘u, koa, kōlea, ‘ōlapa, and pilo in forest restoration efforts.

Habitat and food resource use are important avenues of research that have been little explored, but are necessary to further elucidate important limiting factors for this species. It is shortsighted to think that a species can be recovered or protected without an understanding of habitat and dietary requirements. Management of habitat in Hawai‘i is frequently cited as a primary objective for numerous species, yet in many cases little is known of a species’ actual habitat needs. Effective habitat management of existing areas and effective restoration of new areas can only be achieved by an in depth understanding of avian habitat requirements.

ACKNOWLEDGEMENTS

Funding for this project was provided by the National Park Service and was carried out under a cooperative agreement between the National Park Service and the Pacific Cooperative Studies Unit, University of Hawai‘i at Mānoa (Cooperative Agreement No. CA8047-A0-001). I am especially grateful to Laura Arnold and Emily Severson for assisting with data collection and data entry throughout the course of a difficult and challenging field project. The Resource Management Division at Haleakalā National Park provided invaluable logistical and administrative support. In particular, I would like to thank the following individuals: R. Nagata for approving this project and providing overall support. C. Bailey for providing NPS oversight and guidance. I thank T. Bailey, G. Plana, and T. Lind for logistical support and T. Rodrigues for assistance with numerous helicopter operations. S. Birney provided insight on GIS applications, and P. Welton and B. Haus provided guidance on plant identification. Windward Aviation provided helicopter transport to the field sites. D. Duffy, S. Conant, and J. Fragoso of the University of Hawai‘i provided guidance on study design. C. Bailey, D. Duffy, J. Foster, D. Leonard, and T. Pratt provided helpful comments to improve this manuscript.