# TIE ENVIRONMENTAL PLANNING GRANT PROPOSAL

## Modeling optimal wetland design for multiple endangered Hawaiian waterbirds

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**Problem & Significance –** Hawaiian waterbirds depend on wetland availability, which currently is less than 30% of its original extent (Dahl 1990, Engilis and Pratt 1993). Human activities on Hawaii continue to fragment and reduce the wetland landscape, and as a consequence all of Hawaii's endemic waterbirds are endangered. Four species of endangered waterbird (Hawaiian stilt, Hawaiian coot, Hawaiian moorhen, Koloa) live on the main islands of Hawaii, and they differ significantly in their habitat requirements (e.g., one species requires dense emergent vegetation, another requires open ground). Therefore, it is not possible to manage a single wetland, or group of wetlands, to maximize numbers of all four species. Our long-term goal is to determine the best management practices for these endangered waterbirds, and to build a spatially explicit, GIS-based, population viability model as a tool for managing these species. We are requesting funding from TIE for a specific, critical part of this project – to develop an optimization model for wetland design for use by these endangered waterbirds.

This model would be used to evaluate existing wetland design, and during wetland creation and restoration, to determine which wetland design should result in the most birds of every species. It also will allow us to determine the wetland configuration that would maximize numbers of a single or multiple species, with constraints such as not allowing numbers of the other species to drop below a set target level. This model is a critical component of our statewide, viability and management model for these endangered species. One of us (Reed) has worked in this ecosystem for 10 years, and has been told by biologists for both the USFWS and the state of Hawaii that this project would be very important to their wetland management.

**Previous Research –** Population sizes of Hawaiian waterbirds depend on habitat availability, which has been determined largely by habitat conversion for housing and business, agricultural and aquacultural practices (taro, rice, sugar cane), and refuge construction (Broshears 1979, Griffin et al. 1989). The net result of human activities has been to fragment and reduce the wetland landscape (Shallenberger 1977, Coleman 1981, Griffin et al. 1989), causing disjunct distributions of waterbirds (Reed and Oring 1993, Engilis and Reid 1994, Reed et al. 1994).

Hawaiian waterbirds are thought to be limited by wetland availability (Griffin et al. 1989, Reed et al. 1998a), as are some of their congeneric relatives (e.g., Pierce 1986, Worthington 1998). Most individuals of these species live on managed refuges, except for the koloa (Swedberg 1967), but they are opportunistic foragers and breeders, taking advantage of ephemeral and permanent wetlands and newly created refuges (Pyle 1978, Reed et al. 1998b). Waterbirds in general are particular about habitat selection for foraging and breeding (Fog et al. 1982), and the same is true for Hawaii's waterbirds. In fact, although all four species might use the same wetland, microhabitat selection differs extensively among species (Engilis and Reid 1994). Although in many parts of the world multiple endangered species with different microhabitat requirements live in the same area, few attempts have been made at developing a protocol for multi-species management beyond the general practice of "maintaining" the ecosystem. Being able to design wetlands for multiple species with differing habitat requirements would be a boon to their management, and the approach could be mimicked for other species in other ecosystems. Multi-species management, particularly in wetlands, is a global issue (Fog et al. 1982, Helmers 1992), and the methods developed here and the specific results will be useful for wetland management elsewhere.

There has been research on the Hawaiian waterbirds that includes work on habitat use. These data are unpublished (mostly Pittman-Robertson reports and unpublished theses; e.g., Burke 1976, Ohashi and Burr 1977, Coleman 1981, Chang 1990). However, the work remains unsynthesized, even by the Draft Endangered Waterbird Recovery Plan (Engilis and Reid 2002). We will review these reports and use their data to design the field surveys for which we currently have funding. These data will form the basis for the optimization modeling.

We will create a model that allows us to determine multi-species maxima for wetlands for combinations of species on a single wetland. This involves integrating habitat requirements for each species to determine the mix of habitats that gives the maximum number of individuals of each species of interest. The model will allow a variety of pre-determined constraints for other biological, social, and economic needs. Another approach we will consider is to minimize the likelihood that any species disappears from an area (like an island). This is done by maximizing the collective viability of all target species in the area in question (e.g., Hof and Raphael 1993). Multi-species management is most common for waterfowl (e.g., Smith et al. 1989, Kadlec and Smith 1992), but optimization modeling is uncommon. For example, it has been used as a theoretical construct for maximizing numbers of multiple forest species where habitat constraints (e.g., timber production) were in place (e.g., Hof and Joyce 1993, Hof et al. 1994). However, the problem of multi-species management is readily addressed using this type of modeling.

**External Funding –** One of us (Reed) has already received commitment of $20,000 from the State of Hawaii to do a literature survey of the habitat requirements of the species, field surveys of habitat use. These data will form the basis of the wetland optimization model. This month we are submitting a proposal to the State of Hawaii to fund the optimization modeling. Available funding is insufficient to fund the optimization model, and we are requesting funding from TIE to supplement the proposal. Even if the State money is not received, the TIE money will be sufficient to complete the first stage of model development. We will use the results of this model to apply for funds from the USFWS, USDA, EPA, or DOD (some birds are on military bases), and from the National Fish and Wildlife Foundation, to test model predictions and expand the work to a statewide management model. We are identifying foundations to target that focus on Hawaii conservation, such as the Hewlett Foundation, with the help of John Schneider's office.

**Grant Funds & Time Line –** We plan to finish our evaluation of habitat requirements for the waterbirds this summer (HI State funding, already secured); starting this summer, Fefferman will begin creating the optimization model. TIE would fund Fefferman's summer salary, and our goal is to finish a draft model and user interface by the end of 2003. If this schedule holds, Fefferman and Reed will then travel to Hawaii to present the preliminary optimization model to resource managers to get feedback for model revision. This is <u>extremely</u> important, because these folks are the intended end-users of the product. During spring of 2004 we will revise the optimization model based on manager feedback. Reed will then return to Hawaii (on state funding) to present workshops for users. During this time, we will develop a proposal to test predictions of the model, and to expand the proposal to include incorporation of the model into a statewide species viability and land management model.

**Student Program of Study –** The research proposed to TIE for funding, and some of the subsequent proposed research, are a central part of Fefferman's Ph.D. research.

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