

Leigh H. Fredrickson

TROPICAL WETLAND MANAGEMENT: INCORPORATING GEOMORPHIC SETTING, CLIMATE, AND TEMPORAL SCALE IN DECISION MAKING

Wetland loss and modification worldwide have been extensive and often result in the need for intensive management. Well-conceived management assures that processes associated with wetland biodiversity and productivity is maintained. In the past the historic approach to wetland management was driven by the availability of land, equipment, personnel, and funds for projects. Unfortunately management infrastructures and strategies were developed with little regard for the position of the managed site in time and space. In addition recognition of the degree to which processes and the physical condition of the site was modified by man was rare. Understanding abiotic conditions and how these conditions influence the distribution and abundance of plants and animals in wetland systems is essential for effective habitat management. Furthermore, identification of the chronology and requisites of life history events provides insight into the type and timing of management actions that benefit wetland dependent plants and animals. Incorporating these abiotic and biological factors with recognition of economic, political, social, and cultural conditions are an essential component of successful wetland management strategies.

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KAWAINUI MARSH RESTORATION PROJECT

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NATIVE WATER BIRD MONITORING AT HAMAKUA MARSH STATE WILDLIFE SANCTUARY-A SUMMARY OF HAWAIIAN STILT (*HIMANTOPUS MEXICANUS KNUDSENI*) AND HAWAIIAN MOORHEN (*GALLINULA CHLOROPUS SANDVICENSIS*) NESTING ACTIVITY AND HABITAT UTILIZATION, SPRING 2003

The Hamakua Marsh Ecosystem Restoration and Community Development Project was initiated in 2001. To date, over \$280,000 has been raised in support of habitat restoration for native Hawaiian water birds at Hamakua Marsh, Kailua, Oahu. The removal of approximately 4 acres of red mangrove (*Rhizophora mangle*) transformed the Hamakua Canal portion of the sanctuary from a forested wetland to an open floodplain, and improved monitoring opportunities for moorhen and stilts. Observations of nesting activity and habitat utilization by these two species were recorded between January and July, 2003.

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Jaap Eijzenga

IDENTIFYING KEY PREDATORS OF ENDANGERED HAWAIIAN STILT CHICKS.

The Kii unit of James Campbell National Wildlife Refuge is a long-term stronghold for waterbirds, including the Hawaiian Stilt (*Heamantopus mexicanus knudsenii*). However, despite control and exclusion of mammalian predators Stilt fledging success is very low. Stilt chicks are flightless for the first three weeks after hatching, and disappear within the first two weeks after hatching. In 2003 hatching success was 88% with a fledging success of less than 9%. To determine hatchling survival and identify key-predators we banded 24, 7-10 day-old Stilt chicks with a unique color combination of bands on the tibiotarsus, and outfitted them with small radio transmitters, that were glued directly onto the back. We found evidence of predation by a cat (*felis catus*), and Black-crowned Night Herons (*Nycticorax nycticorax hoactli*) and/or Cattle Egrets (*Bulbulbus ibis*), and identified Bullfrogs (*Rana catesbiana*) as a major predator. Other causes of mortality were entanglement and emaciation. We will continue and expand this study in 2004 to gather additional data that will be used to implement effective predator control strategies, and ultimately increase reproductive success of the Hawaiian Stilt.

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HERBICIDE TREATMENT METHODOLOGY FOR RED MANGROVE IN
HAMAKUA MARSH, OAHU.

The Wildlife Branch of the State Division of Forestry and Wildlife conducted a study to develop a methodology to address the encroachment on waterbird and wetland habitat by the introduced Red Mangrove (*Rhizophora mangle*). Guilbeaux and Mejia-Chang (1999) sited Mangroves as one of the factors involved in the population decline of the four endangered endemic Hawaiian waterbirds, through habitat modification. Garlon 4 herbicide was applied in different concentrations on various growth stages of Red Mangrove to ascertain its effectiveness, identify the optimal treatment concentration to achieve 90% efficacy or better without excessive herbicide use, and to identify any strengths and weaknesses of the methodology. Development of this technique was necessitated through limitations in existing resources with which to achieve management goals.

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Amanda W.J. Demopoulos

MANGROVE FOREST ECOSYSTEMS

Mangroves were introduced to the Hawaiian Islands from Florida in 1902 to reduce coastal erosion. Following their introduction, red mangroves, *Rhizophora mangle*, have spread throughout the main Hawaiian Islands, maintaining abundant populations in low-energy coastlines as well as the banks of streams and drainage channels. *R. mangle* has

high dispersal capabilities and few natural enemies in Hawaii; as a consequence, mangrove habitats are expanding rapidly in Hawaii. To evaluate the impacts of introduced mangroves on Hawaiian coastal communities, we sampled mangrove and sandflat habitats on the islands of Oahu and Molokai. Sediment cores were collected to assess infaunal community structure and epifauna were quantified on mangrove roots and the sediment surface. A surround net and crab traps were used to collect larger invertebrates and fish. Our results demonstrate that mangrove roots provided a habitat for introduced encrusting fauna and mobile benthos, including the barnacles *Chthamalus proteus* and *Balanus reticulatus*, the Australian mullet (*Neomyxus leuciscus*), and the Samoan crab (*Scylla serrata*). Mangrove sediment infauna was dominated by deposit feeders, including oligochaetes and polychaetes. The non-mangrove sandflat community was dominated by suspension feeders, including a different suite of polychaetes and amphipods. Unexpectedly, we found greater infaunal species richness in mangrove sediment habitats, which may be a consequence of adaptive radiation and stress tolerant taxa. In conclusion, introduced Hawaiian mangroves appear to facilitate the establishment of opportunistic exotics, e.g., the Samoan crab and *Chthamalus proteus*, while concomitantly enhancing local species richness.

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Katina Dove Henderson

"THEY'RE NOT JUST FOR THE BIRDS: WETLANDS AND WATER QUALITY"

Wetlands are valuable resources that help maintain inland and coastal water quality. This presentation will outline some of the important benefits that natural and constructed wetlands can have for water quality. Decreased water quality can have many repercussions in the aquatic environment, including threatening the survival of native fish and invertebrates. The process of delineating wetlands based solely on the presence of migratory birds has recently been challenged, which has made many professionals reflect on the other aspects of wetlands. Recent court decisions and agency regulations that address wetlands and water quality will be briefly discussed in this presentation. Scientists, agencies, nonprofit organizations and community groups must work together to understand the array of benefits that wetlands provide in order to provide sufficient protection for these unique ecosystems.

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Chris Smith & Terrell Erickson

"WETLAND RESTORATION, ENHANCEMENT, & CREATION: CONSIDERING THE COMPONENTS"

In order to assess the probability of success of a wetland restoration, enhancement, or creation project, one needs to understand the components that comprise a wetland. We will discuss the attributes of each of these components (hydrology, soils, and vegetation), with specific examples of conditions in Hawaii.

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Eric Guinther

WETLAND RESTORATION IN KAWAI NUI MARSH

Kawai Nui Marsh is presently so overgrown with vegetation, both wetland and non-wetland in character, that habitat for aquatic species is limited to only a small percentage of this 850 acre wetland. Creation or restoration of open water habitat is necessary to make acreage available for aquatic species, some of which are endangered water birds, but include native aquatic fauna of both the marsh and its feeding streams in Maunawili Valley. The restoration project at Na Pohaku o Hauwahine has attempted to open up areas previously covered by accumulated peat, and replant the margins of ponds with native wetland species. Lessons learned from the process, including successes and potential problems with maintaining open water and native plant species, are discussed.

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Sharon Reilly

DUCKS UNLIMITED'S PRIVATE LANDS SAFE HARBOR PROGRAM: NEW
OPPORTUNITIES FOR THE RECOVERY OF HAWAII'S ENDANGERED
WATERBIRDS

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Megan Laut

STATE WATERBIRD SURVEY 1987-2003

Twice a year, the State Division of Forestry and Wildlife (DOFAW) conducts waterbird surveys on all islands. The last analysis of the statewide dataset was Engilis and Pratt's 1993 publication which summarized data from 1977-1987. This year, at the request of DOFAW and in collaboration with Michael Reed at Tufts University, the Hawaii Natural Heritage Program (HINHP) databased the existing waterbird data from the last 15 years. An agreement between the State and HINHP is currently being developed so that HINHP will be responsible for the entry and maintenance of the survey data in the future. I present the initial process we developed for the dataset, products that will be provided to the State, and recommendations for data management to ensure long-term data integrity and survivability.

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Andrew Engilis, Jr. & Maura Naughton

OVERVIEW OF THE *U.S. PACIFIC ISLANDS SHOREBIRD CONSERVATION PLAN – HAWAIIAN SUBREGION*

The U.S. Pacific Islands (USPI) are often overlooked as an important region for shorebirds largely due to its isolation, vast geography, and small land base. However, the USPI support a surprising number of birds and are important in maintenance of global shorebird populations. The USPI region is home to one endemic shorebird, the endangered Hawaiian Stilt (*Himantopus mexicanus knudseni*), and is an important wintering area for three species of Holarctic-Nearctic breeders: Bristle-thighed Curlew (*Numenius tahitiensis*), Pacific Golden-Plover (*Pluvialis fulva*), and Wandering Tattler (*Heteroscelus incanus*). The majority of these species' populations overwinter in the Pacific Islands, several of which are critical to the maintenance of these birds. The USPI are also of importance for the Ruddy Turnstone (*Arenaria interpres*). The plan is divided into four subregions, the Hawaiian Islands, Mariana Islands, American Samoa, and Central Pacific Islands. The Hawaiian Subregion is the most diverse and largest, supporting the highest numbers of shorebirds in the USPI. The USPI Plan is part of a national shorebird conservation effort coordinated by the U.S. Fish and Wildlife Service and the U.S. Shorebird Conservation Council.

Modern threats to shorebirds in the Hawaiian subregion include: loss of habitat to urban, industrial, military, agricultural, and recreational development; introduction of invasive, non-native plants, and non-native animals (e.g. predation, disease, competition); human disturbance; contaminants (e.g. sewage discharge, oil spills, radioactive wastes, pesticides). Wetlands, beach strand, and estuarine habitats are particularly vulnerable in Hawaii due to increasing development pressures, invasive plants, and already limited acreages. Modified habitats, such as pastures, urban grass parks, golf courses provide habitat for golden-plovers throughout. There is an over dependence on aquaculture and wastewater ponds by shorebirds in the state.

There is limited published literature on status, trends, and ecology of migratory shorebirds in this region. Basic concepts such as seasonal status, distribution and abundance, important migration stopover locations, and habitat requirements are poorly understood. Some data is synthesized for the first time in the USPI Plan. Monitoring and research needs include: assessment of population sizes and track population trends; assessment of the timing and abundance of birds at key wintering and migration stopover sites; assessment of habitat use and needs at wintering and migration areas; develop better understanding of the linkage between wintering, stopover and breeding areas; and refinement of habitat restoration and management techniques (through adaptive management strategy) to meet the needs of resident and migratory species.

Education and public outreach remains a critical component of this plan as most resources in the islands are currently directed towards endemic or endangered species but they should be expanded to include migratory birds. Recognizing the importance of migratory species as a component of the region's avifauna, and expanding public understanding of the need to protect such species, remains a primary challenge.

Coordination must be undertaken within the political framework of each island group. Resource management agencies of the U.S., Territorial, Commonwealth, and state

governments will need to work together with military, university, and non-governmental organizations to successfully implement components of this plan. The USPI plan is closely linked to the Alaskan Shorebird Conservation Plan and coordinated activities will ensure mutually beneficial and complimentary efforts. On a larger scale, coordination at the international level will be key to the conservation of vulnerable species, both migratory and resident.

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Dr. Michael Reed

MODELING WETLANDS AND HABITAT USE FOR ENDANGERED
WATERBIRDS IN HAWAII

I am engaged in two modeling projects for Hawaiian waterbirds, and will give a brief overview here. The first project is to determine optimal wetland designs for supporting single and mixed populations of the Hawaiian coot, Hawaiian stilt, koloa, and Hawaiian moorhen. This involves determining wetland characteristics (e.g., size, depth, salinity, emergent vegetation characteristics) that support breeding by each of the endangered waterbirds, and for a variety of wetland sizes, determining what designs would support the most individuals of each species, or combinations of two, three, or four species. We also will determine optimal designs if multiple wetlands are being managed or constructed (e.g., is it better to manage each pond for a single species or for some combination of species?). By next year we plan to have a software package from this project available for distribution. The other modeling project I will discuss is creating a GIS database of wetlands used by the endangered waterbirds. This database does not exist, and I am collaborating with the Hawaii Natural Heritage Program and others to create this database. The database will be used to analyze local and landscape factors associated with waterbird population sizes and trends.

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A STILT, A WETLAND AND A REFINERY

The Chevron Hawaii Refinery (Chevron) has been working with the U.S. Fish and Wildlife Service (Service) through a Cooperative Agreement since 1992 to implement proactive conservation activities to benefit the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*). Chevron has managed Rowland's Pond, as temporary nesting habitat for stilts during its breeding season (mid February – August) by conducting vegetation and water management, and by implementing predator control activities. Simultaneously, the Service conducted biological monitoring of stilts and other migratory bird species during the stilt breeding season and provided technical assistance to Chevron for waterbird management at the refinery ponds. As a result of this Cooperative Agreement, 341 stilt are documented to have fledged from this site from 1992 through 2002. Currently, Chevron is working with the State of Hawaii and Service to develop a Safe Harbor Agreement to continue its conservation activities for the stilt and the endangered Hawaiian coot (*Fulica alai*).

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Leilani Leach Takano

SEASONAL MOVEMENT AND HOME RANGE OF THE MARIANA COMMON MOORHEN (*GALLINULA CHLOROPUS GUAMI*) ON GUAM AND THE NORTHERN MARIANA ISLANDS.

Adult Mariana common moorhens were radio-marked on Guam (n = 25) and Saipan (n = 18) to determine home range, inter- and intra-seasonal space use, and movement patterns in 2000 and 2001. Birds were tracked throughout the dry and wet season. During the dry season, 48% and 11.1% of radio-marked adults on Guam and Saipan, respectively, dispersed from their capture site to another wetland site. During the wet season, 71.4% and 70% of radio-marked adults on Guam and Saipan, respectively, dispersed from their capture site to another wetland site. In 2001, Saipan moorhen surveys indicated juveniles dispersed during the onset of the rainy season. Thus, intra-island movement increased during the wet season. Similarly, inter-island movement occurred from Saipan to Tinian during the onset of the wet season. Among moorhens captured on Fena Reservoir (n =

9), Guam and that dispersed during the 2000 wet season, 66.6% returned to Fena Reservoir during the 2001 dry season. Guam moorhens were more likely to move greater average distances in the wet season than the dry season. During the wet season, the frequency of movement among sites was inversely proportional to the average distance between each site. Home-range estimates on Guam averaged 3.1 ha + 4.8 SD and did not differ significantly between sexes or seasons; however, during the dry season, females exhibited significantly smaller mean core areas than males. This study demonstrates the dynamic use of space and movement among moorhens within and across landscapes on multiple islands.

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THE PACIFIC COAST JOINT VENTURE AND WETLAND PROJECT FUNDING OPPORTUNITIES

The Pacific Coast Joint Venture (PCJV) is a partnership among federal, state and local governments, private conservation organization, corporations and individuals working toward the preservation and restoration of wetland habitats. PCJV boundaries included coastal northern California, Oregon, Washington, British Columbia, Alaska, and most recently Hawaii. Since its start, in 1991 PCJV partners have acquired 150,000 and restored 50,000 acres of coastal wetlands, through partner contributions of more than \$400 million. The three major funding sources for this partnership include the standard and small North American Waterfowl Conservation Act funds and the National Coastal Wetland Conservation Act fund. During the past year, Hawaiian partners competed successfully for four wetland projects under these grant programs. Total funds acquired for these projects came to more than \$2 million. This presentation will discuss the differences among these three funding mechanisms, and provide insight on how to pursue funding.

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ISSUES RELATED TO FERAL DUCK CONTROL ON OAHU

Feral ducks pose major ecological and sociological problems in Hawaii. Feral mallards are hybridizing with the federally-listed endangered Hawaiian Duck, or Koloa, thereby diminishing the genetic integrity of the species. Introduced duck species compete for food and habitat with Koloa in most of our urban wetlands. In some areas on Oahu, there are nuisance and human health problems associated with high densities of ducks. In a cooperative effort with the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife and the U.S. Fish and Wildlife Service, the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services program was hired to remove a small population of feral mallards and ducks from the Hamakua Marsh Wildlife Sanctuary. With the lessons learned from this small project, topics that need to be addressed are the regulatory issues involved, public education and outreach, criteria for identifying Koloa hybrids, acceptable and appropriate control methods, as well as addressing the human dimension of the problem.

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Andrew Engilis, Jr.

IDENTIFICATION OF HYBRID HAWAIIAN DUCK (KOLOA) X MALLARDS: AN AID TO THE RECOVERY OF KOLOA.

The endangered Hawaiian Duck (*Anas wyvilliana*) is one of only three endemic members of waterfowl existing in the Hawaiian Islands today. The decline of the Hawaiian Duck is directly related to the destruction of key wetland habitats in Hawai'i. In addition to habitat loss, predation from introduced mammals and sport hunting dealt a severe blow to the species. In addition to the above perturbations, the Hawaiian Duck is confronted with the modern threat of hybridization with feral Mallard (*Anas platyrhynchos*).

Hybridization remains the single most important threat facing the continued existence of Hawaiian Duck. Hybrid swarms now exist on O'ahu and Maui and hybrid birds have most recently been documented from Hawai'i and Kaua'i. By 2000, populations of genetically pure Hawaiian Duck existed only on Kaua'i and the upper elevations of Hawai'i Island (the latter a result of reintroduction through captive propagation and release).

Identification of hybrids must start with identification of the parental species. Plumage characteristics of Mallard are well documented, but they are poorly understood in Koloa. The differences of Alternate vs. Basic plumage in male Koloa has only recently been elucidated (A. Engilis). Hybrids are variable and there are no consistent features to aid in the identification of hybrids in the wild; some birds are obvious others not so. However there are features that prove to be reliable in separating Koloa from Mallard and most hybrids. These include wing chord measurements, Bill:Culmen ratio, breast pattern, chin pattern, flank pattern, and body mass. The confusion arises with 1st alternate Koloa, which retains some Mallard features that can resemble hybrids. However, the metrics (overall wing, bill, and weight measurements) should help to determine if the bird in question is a Koloa or hybrid. The following table highlights differences (adopted from Engilis et al 2003):

	Hawaiian Duck <i>n</i> males = 11 <i>n</i> females = 12	Mallard (nominate) <i>n</i> males = 10 <i>n</i> females = 14	Hybrids <i>n</i> males = 9 <i>n</i> females = 13
Culmen Length			
Male	41.4 – 56.4	48.7 – 58.1	46.5 – 51.6
Female	40.4 – 50.6	48.3 – 55.8	41.4 – 49.8
Nares Bill Width			
Male	15.5 – 19.3	19.3 – 22.2	18.0 – 22.5
Female	13.8 – 18.2	18.3 – 20.8	13.3 – 20.8
Bill Nail (l x w)		Mean meas.	
Male	8.6 x 6.6	11.1 – 7.5	9.26 x 7.27
Female	8.5 x 6.0	10.5 – 7.5	9.02 x 6.80
Wing Chord			
Male	213 – 238	267 – 292	239 – 260
Female	220 – 232	252 – 272	224 – 256
Culmen:Tarsus			
Male	1.25	1.21	1.11
Female	1.23	1.19	1.14
Wt (small sample size for Koloa)	< 650 grams	> 650 g, males exceed 1 kg	> 650 grams < 1 kg
Chin pattern	Speckled both sexes	Light speckling - unspeckled	Light speckling - unspeckled
Breast Pattern	chevrons	Spots and small streaks	Spots mixed with chevrons or spots
Flank	Well developed chevrons, 2 or more per feather	Chevrons developed one per feather	Chevrons variable

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Dr. Christopher F. Puttock & Laura Crago

RIPARIAN RESTORATION PLANT INTERACTIVE KEY

The Bishop Museum has been working on an interactive plant key for riparian restoration with native Hawaiian species. The need for this project was identified by the working group of “Riparian Vegetation for Soil Bioengineering in Hawaii (April 2003)”. In the initial phase we are building the framework of characters and attributes of the riparian habitats, along with comprehensive data on at least 20 native Hawaiian plants used in restoration projects of these habitats. With the use of the powerful interactive database system, Lucid Professional, each plant species will be linked by its attributes to its habitat characteristics. When completed each of the species in the database will have photographs and a detailed description of the taxon, favored habitat attributes, names and synonyms, and trials with success and failure information from the field.

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STATE OF HAWAI‘I AQUATIC INVASIVE SPECIES (AIS) MANAGEMENT PLAN

Aquatic invasive species (AIS) are nonnative species in marine and inland waters whose introductions cause or are likely to cause economic or environmental harm, and/or harm to human health. AIS are a serious problem in Hawai‘i, posing a significant threat to Hawaii's native plants, animals, and associated native ecosystems, as well as to Hawaii's residents and visitors.

The purpose of the State of Hawai‘i Aquatic Invasive Species (AIS) Management Plan is to act as a tool to help identify and enhance the coordination of current management efforts, identify remaining problems areas and gaps, and recommend additional actions which are needed to effectively address AIS issues in Hawai‘i.

The Federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, amended by the National Invasive Species Act of 1996, calls for the development of such State management plans. The State of Hawai‘i AIS Management Plan is a multi-agency effort that was coordinated by The Nature Conservancy of Hawai‘i, through a partnership with the Division of Aquatic Resources, Department of Land and Natural Resources (DAR, DLNR). Using guidelines from the Federal Aquatic Nuisance Species Task Force, as well as input from numerous representatives of State and Federal

agencies, non-governmental organizations, industry, and other stakeholders, this plan has been developed in a collaborative fashion to address AIS issues throughout the State.

For further information on the State of Hawai'i AIS Management Plan, please contact Bill Devick at DAR (William.S.Devick@hawaii.gov) or Mark Fox at The Nature Conservancy (mfox@tnc.org).

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