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Comparing Vegetation and Soils of Natural, Restored, and Created Coastal Lowland Wetlands

[A partial synopsis of the paper A COMPARISON OF THE VEGETATION AND SOILS OF NATURAL, RESTORED, AND CREATED COASTAL LOWLAND WETLANDS IN HAWAI'I by Meris Bantilan-Smith, Gregory L. Bruland, Richard A. MacKenzie, Adonia R. Henry, and Christina R. Ryder appearing in WETLANDS, Vol. 29, No. 3, September 2009, pp. 1023–1035.] Photos by Adonia Henry.

Hawaii's coastal lowland wetlands (CLW) support unique assemblages of flora and fauna, including several species of endangered endemic waterbirds. They play an essential role in maintaining water quality by protecting seagrass beds and coral reefs from sediments, nutrients, and pulses of freshwater during heavy rains. Alteration of these natural systems has resulted in huge wetland loses estimated at 31% of historical amounts. By the late 20th century, only 9,095 hectares (22,474 acres) remained within the state according to the U.S. Fish and Wildlife Service report, *Wetland Losses in the United States 1790's to 1980's*. National policies such as "no-net-loss" of wetlands and Section 404 of the Clean Water Act have resulted in restoration and creation of wetlands to replace lost natural wetlands.

Methods: To compare the functional equivalency of natural, restored, and created wetlands, vegetation and soil characteristics strongly associated with wetland function were examined by conducting a comprehensive assessment of CLW in Hawaii. The objectives of this study were to: 1) document the vegetative and edaphic attributes of CLW in Hawaii; 2) compare these attributes within sites across hydrologic gradients and among sites of different salinity classes and wetland status (i.e., natural, created, and restored wetlands).

Wetlands sampled during Spring 2007 were located below 100 meters in elevation on the islands of Hawaii, Kauai, Maui, Molokai, and Oahu. Vegetation and soil samples were collected at wetter, intermediate and drier hydrologic zones of wetlands classified as either hydrologically isolated from surface water bodies or hydrologically connected to stream or tidal creeks. Wetlands sampled spanned a range of salinities from 0.04 to 120 ppt.

Results: Of the 85 plants identified across 35 wetland sites only 16 (19%) were native to Hawaii. Three of the four most frequently observed species, *Urochloa mutica* (California grass), *Batis maritima* (pickleweed), *Paspalum vaginatum* (seashore paspalum) are exotic and highly invasive; *Bacopa monnieri* (water hyssop) is native. The effect of hydrologic zone and salinity class was more pronounced than the effect of wetland status in terms of vegetation characteristics. Freshwater and brackish sites had greater total wetland vegetation and total cover than hyper saline sites. Mean species richness was greater in freshwater sites compared to other salinity classes and greater in drier and intermediate zones than wetter zones. The only variable that significantly differed among wetland status was total vegetative cover, which was higher in natural and created wetland than in restored. Mean species richness was similar among all wetland status types.

Soil organic matter (SOM) was correlated with all of the soil properties sampled, including positive correlations with soil moisture, electrical conductivity, extractable phosphorus, total carbon, total nitrogen, % clay, and % silt, and negative correlations with bulk density, pH, and % sand. Generally soil properties showed more variability across wetland status categories than salinity classes or hydrologic zones. Natural wetlands had higher SOM, total nitrogen, and clay content and lower bulk density than created or restored. Created wetlands had greater pH than restored and natural and contained more sand than restored wetlands. Total carbon did not significantly differ between all three status types.

Discussion & Recommendations: The lack of significant differences in vegetation characteristics between wetland types and limited differences among wetland status may be due to alteration of vegetation communities resulting from prior land use practices and the encroachment of invasive plant species. The extensive occurrence of exotic species in natural (46 species), restored (28), and created (13) wetlands and lack of significant difference in exotic species cover between wetland types and among wetland status categories supports this conclusion. For these reasons, it is difficult to use vegetation to locate "reference" sites for restoration targets due to the pervasive nature of invasive species. Manual seeding or planting can jump-start the growth and production of native vegetation in a disturbed environment. Implementing invasive species controls immediately following restoration or creation and establishing long-term control plans are essential.

Trends toward higher bulk density and lower clay in created and restored wetlands may be the result of removal of fine-textured surface soils during site excavation and/or differences in location or parent material. Textural differences have important implications for the function of wetland restoration and creation projects as fine-textured soils have greater moisture and nutrient retention capacities. An effective method for reducing soil compaction is to use a chisel plow to mechanically rip both the topsoil and subsoil layers, prior to planting, to alleviate soil compaction.

Additionally, amendments such as compost, mulch, or other organic material are proven effective at increasing soil moisture, carbon and nitrogen, and decreasing bulk density. Although an effective method elsewhere, the use of organic amendments in Hawaii needs further research to determine what impacts it will have on the growth of exotic and invasive species.

Inadequate soil conditions can be detrimental to the growth of wetland vegetation and establishment of wetland hydrology. Soils are the medium for important biogeochemical processes but study results suggest that restored and created wetlands may not be performing such processes or only doing so at suboptimal levels. This study found that soil properties of natural wetlands in Hawaii are more similar to restored than created ones. Thus soils of restored wetlands are more likely to support wetland functions in a similar manner to natural wetlands. Restoration should therefore be the preferred mitigation option in Hawaii.

Long-term monitoring should be conducted to provide much-needed information on Hawaii's wetlands. A better understanding of wetlands in Hawaii will improve restoration design techniques, construction methods, adaptive management activities, and long-term sustainability of these vital resources.