The Coastal Habitats, Species Composition, Richness, and Temporal Variation of Haplochromine Cichlids in an African Great Lake: implications for biodiversity conservation

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Abstract

Freshwater parks and fisheries management zones in Lake Malawi are needed immediately but deficiencies in the underlying science prevents their design. In this dissertation I develop an empirical framework to enable aquatic conservation planning to proceed at the lake wide scale while taxonomic and species level ecology information remains incomplete. I investigate the effect of habitat discontinuities on the distribution of species to support the development of a habitat map for the entire lake that can infer the distribution of the main haplochromine cichlid assemblages. To better understand the ecology of the haplochromine species, I first examine how space, time, and environment (depth, substratum, temperature, total suspended solids) interact to influence the composition of haplochromine cichlids in rock, sand, and mud habitats in the southern basin of Lake Malawi. I studied 23 sites (0 – 125 m) using large samples collected biweekly or monthly for up to one year using SCUBA, seine nets, and benthic trawling. To better understand the richness of the assemblages I also studied the form of species accumulation and the temporal variation of the samples.

Complete survey of the coastal zone reveals the tectonic framework of the Malawi rift controls the distribution, slope, and scale of coastal habitat at regional and local scales. Rock or sand and vegetated shores alternate at up to 110 km spacing and reflect the dip polarity of half graben units that form the rift. Border faults form rock coasts whereas the shoaling margin of half grabens are sandy. Geomorphology is a good indicator of coastal zone composition; the length of coastal habitat for rock, sand, and sand/vegetation are significantly different among the geomorphologic settings bounding the lake. In the littoral zone, the depth of the rock/sand boundary also varies according to the geomorphology but rarely extends deeper than 40 m. The sand/mud boundary is abrupt and occurs at depths greater than 65 m, except where fluvial sediments are deposited and constrict the littoral.

The haplochromine assemblages can be reduced to three groups (i.e. rock, shallow water sand, deep water mud), not two as previously thought. The regional species composition of the rock dwelling mbuna on the mainland coast mimics the alternating

pattern of rocky border faults; endemism and tectonics appear to be linked. The species composition of the deep water haplochromine assemblage over mud is quite different from the adjacent species in shallow water (i.e. sand). The rock, sand (shallow water), and mud (deep water) assemblages exhibit two forms of ecological attributes that reduce to smooth and rough bottom assemblage types. The mbuna and non-mbuna on rock islands have asymptotic species accumulation curves, few rare species, and low temporal variation in species count statistics. The haplochromines inhabiting smooth bottoms have non-asymptotic curves, many rare species in water less than 30 m depth, a temporal variation of abundance that is 1.7 – 2.0 x the magnitude of the rock dwelling mbuna, and a changing species composition over time. Accordingly, space (i.e. distance) is a strong descriptor of changes in species composition for the mbuna. The importance of space is relatively low on the smooth bottomed habitats, and is least for the fishes in deep water over mud. The geographic range of the species pool on rock islands appears small and the fishes are sedentary; the concept of site richness applies readily to this group. The geographic range of the species pool for fishes of the smooth bottomed habitats appears much larger; this group is literally a moving and numerically variable target for conservation.

Results suggest that parks planning and fisheries management zones should be allocated regionally according to the distribution of rock, sand, and mud (i.e. deep water) within each of the 100 km long half graben units that comprise the rift. The relative size of the management units appear to ordinate as small, moderate, and large for the mbuna, shallow sandy (0 – 50 m), and deep mud (50 – 125 m) haplochromine assemblages. Richness of these assemblages cannot be compared directly due in part to a combination of large numbers of rare and mobile species in the sandy shallows that equates to incomplete sampling. The perimeter of parks for the rock dwelling species can mimic local distribution of rock, but the sand and mud habitats are extensive in size and the limited knowledge of these fish prevents an absolute size recommendation.