

Friedlander, A. M., E. K. Brown and M. E. Monaco. 2007. Coupling ecology and GIS to evaluate efficacy of marine protected areas in Hawaii. *Ecological Applications* 17(3):715-730.

Abstract:

In order to properly determine the efficacy of marine protected areas (MPAs), a seascape perspective that integrates ecosystem elements at the appropriate ecological scale is necessary. Over the past four decades, Hawaii has developed a system of 11 Marine Life Conservation Districts (MLCDs) to conserve and replenish marine resources around the state. Initially established to provide opportunities for public interaction with the marine environment, these MLCDs vary in size, habitat quality, and management regimes, providing an excellent opportunity to test hypotheses concerning MPA design and function using multiple discrete sampling units. Digital benthic habitat maps for all MLCDs and adjacent habitats were used to evaluate the efficacy of existing MLCDs using a spatially explicit stratified random sampling design. Analysis of benthic cover validated the a priori classification of habitat types and provided justification for using these habitat strata to conduct stratified random sampling and analyses of fish habitat utilization patterns. Results showed that a number of fish assemblage characteristics (e.g., species richness, biomass, diversity) vary among habitat types, but were significantly higher in MLCDs compared with adjacent fished areas across all habitat types. Overall fish biomass was 2.6 times greater in the MLCDs compared to open areas. In addition, apex predators and other species were more abundant and larger in the MLCDs, illustrating the effectiveness of these closures in conserving fish populations within their boundaries. Habitat type, protected area size, and level of protection from fishing were all important determinates of MLCD effectiveness with respect to their associated fish assemblages. Although size of these protected areas was positively correlated with a number of fish assemblage characteristics, all appear too small to have any measurable influence on the adjacent fished areas. These protected areas were not designed for biodiversity conservation or fisheries enhancement yet still provide varying degrees of protection for fish populations within their boundaries. Implementing this type of biogeographic process, using remote sensing technology and sampling across the range of habitats present within the seascape, provides a robust evaluation of existing MPAs and can help to define ecologically relevant boundaries for future MPA design in a range of locations.