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Abiotic surrogates for temperate rocky reef biodiversity: implications for Marine Protected Areas

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Abiotic surrogates for temperate rocky reef biodiversity: implications for Marine Protected Areas

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In response to rising concerns over continued marine biodiversity loss, global development of marine protected areas (MPAs) has been pursued as an effective conservation strategy. However, decisions on MPA location, configuration and size have often been driven by social, economic or political processes rather than on available ecological knowledge. Therefore, in the absence of a firm ecological foundation, current MPAs may not be achieving their stated conservation objectives, potentially providing a false sense of protection. The issue with establishing MPAs using defined biodiversity criteria stems from constraints and costs involved in acquiring species and community-level biological data over broad (100's m-km) geographical areas. An alternate approach adapted from terrestrial reserve design is the use of surrogates, such as abiotic measures, to indirectly identify representative areas of biodiversity and infer the boundaries for protected areas. In this study we examined the potential of remotely sensed abiotic measures as surrogates for the abundance, diversity and community composition of temperate rocky reef fishes and sessile invertebrates. We used high-resolution bathymetric side-scan sonar imagery to quantify abiotic measures of rocky reef habitat and examined the relationship between abiotic measures and (1) sessile invertebrate abundance, (2) sessile invertebrate species richness, (3) total fish abundance, (4) fish species richness, and (5) Monacanthidae abundance using generalized additive mixed models (GAMMs). We chose GAMMs as the preferred statistical analysis to account for the spatial autocorrelation present in our data. We found a strong positive relationship between abiotic measures and sessile invertebrate abundance and diversity ($r^2 > 0.64$). By far the most important predictor was vertical relief within a 75 m radii seascape surrounding the faunal survey. Overall, abiotic measures were poor predictors of total fish abundance ($r^2 = 0.175$) and fish species richness ($r^2 = 0.276$), with minimum adequate models producing low explanatory power. Monacanthids exhibited a strong positive relationship with abiotic variables ($r^2 = 0.385$), with increased abundance associated with greater depth and distance from soft sediment. In conclusion, remotely sensed abiotic measures were important predictors in describing the spatial patterns of sessile invertebrate abundance and diversity and Monacanthid abundance. In contrast, abiotic variables were poor predictors of total fish abundance and diversity. Our results highlight the potential of habitat as a useful, cost-effective surrogate to determine areas of conservation value for certain temperate rocky reef assemblages. This information is valuable for future MPA development and design.