**Comparing metrics of species distribution change across spatial scales with spatiotemporal models**

Lewis A.K. Barnett1\*, Eric J. Ward2, Sean C. Anderson3

1 Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E, Seattle, WA 98115, USA

2 Conservation Biology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, ­­WA 98112, USA  
3 Pacific Biological Station, Fisheries and Oceans Canada, 3190 Hammond Bay Rd., Nanaimo, BC, V6T 6N7, Canada

\* Corresponding author: [lewis.barnett@noaa.gov](mailto:lewis.barnett@noaa.gov)

**Abstract**

Species distribution models and environmental niche models used to understand how species change over space and time have rapidly evolved over the last decade, and these approaches have seen wide use in application to terrestrial and marine species. In addition to advances in modeling approaches, a number of summary statistics have been developed as metrics to quantify and communicate spatial change over the entire range of a species, including the center of gravity, area occupied, and extremes of the range where a species occurs. A limitation in all of these metrics is that change may not be heterogeneous. We develop a new modeling approach to explicitly estimate a spatial trend, alongside spatial (temporally constant) and spatiotemporal (time varying, random) components, to compare inferred spatial shifts to those indicated by conventional metrics. To demonstrate the utility of this new approach, we focus on the application of this model to a community of well-studied marine fish species on the U.S. West Coast (19 species, representing a wide range of presence-absence and densities). Results from conventional model selection indicate that the use of the model explicitly accounting for a spatial trend is justified in 17 of 19 cases. In addition to making more parsimonious and accurate predictions, we illustrate how estimated spatial fields (trend, intercept) from the spatial trend model can be used to classify regions within the species range where change is relatively heterogeneous or homogenous. Using cluster analysis to identify regions of homogenous change resulted in support for 2 or 3 regions for most species. Conventional summary metrics, such as center of gravity, can then be calculated on each region. We use this approach to illustrate that change is more nuanced than what is expressed via global metrics. Using arrowtooth flounder (*Atheresthes stomias*) as an example, the observed southward shift over time in the global center of gravity is not reflective of a uniform shift in densities, but decreasing density in the northern region and rapidly increasing density in the central region, at the range edge.

**Keywords:** spatiotemporal modeling, species distribution modeling, spatial management, monitoring

**Declarations**

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