A community distance sampling model for estimating seabird abundance and distribution

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Abstract: Distance sampling is a widely used framework for studying the abundance of wildlife that can be observed directly. Hierarchical distance sampling allows linking abundance at a sample site to site-specific covariates. Using this framework, we developed a community distance sampling (CDS) model. In this model, information is shared across species by assuming a common underlying distribution for abundance and detection parameters, whose hyperparameters are estimated as part of the model. This enables us to include species with sparse data sets into the community analysis.

We applied the CDS model to shipboard distance sampling data of 15 seabird species, collected in April 2012 off the coast of Maryland, USA, within a project to inform future placement of offshore wind farms. Our model included random species effects of salinity and sea surface temperature on abundance; and a random species effect and a fixed effect of sea state on the scale parameter of the half normal detection function, σ. We fit both Poisson and negative binomial abundance models and assessed model fit using Bayesian p-values. The negative binomial model fit the data adequately while the Poisson model failed to capture the spatial variability in seabird abundance. Sea state had a negative effect on the detectability of seabirds. Species specific scale parameters for detection were consistently between 200 and 300 m. Seabird abundance was negatively correlated with both salinity and water temperature. Salinity had a significantly negative effect on the abundance of six species, while temperature only affected one species significantly negatively. The CDS model allowed us to make inference on the distribution and abundance of 15 seabird species, ten of which did not yield sufficient data to

be modeled individually. Thus, the CDS shows promise for many distance sampling applications to improve estimation of detection and abundance of a suite of species.