United States Department of the Interior

FISH AND WILDLIFE SERVICE
Southeast Region – National Wildlife Refuge System
Division of Strategic Resource Management
Inventory & Monitoring Branch

28 January, 2016

Dear Dr. Cadotte:

We are pleased to submit our manuscript "Spatiotemporal modeling of sea duck abundance: implications for marine spatial planning" for consideration as a standard paper in the Journal of Applied Ecology. This submission has been approved by all authors, and all those entitled to authorship have been so named. We have not previously submitted this manuscript and thus have not been able to modify it in accordance with previous reviewers' comments.

We demonstrate a model-based approach to predict animal distribution and abundance. In North America, there is a pressing need to develop spatially-explicit abundance estimates of marine birds to guide marine spatial plans and help assess potential impacts of planned offshore wind energy developments (OWED). Specifically, we predict sea duck distribution and abundance in Nantucket Sound, Massachusetts, USA from aerial transect survey data using generalized additive models and recent extensions in a gradient descent boosting framework. This approach provided spatially-explicit insights into the covariates associated with sea duck abundance and its variability. The boosting algorithm accommodated the inclusion of various effect types (e.g., linear, smooth, spatial, and spatiotemporal effects) and correlated covariates, identified the most relevant subset among potentially many covariates, and evaluated competing representations of continuous covariates (e.g., linear vs. nonlinear effects of covariates).

Spatiotemporal effects (i.e., geographic location and time of season) were the dominant explanatory features in abundance estimates, although sea duck occupancy associated more with intermediate monthly sea surface temperatures and in areas with coarser sediments; the effects of covariates on sea duck abundance were less consistent among species. Our fine-scale, spatially-explicit models suggested that a planned OWED in Nantucket Sound could displace some sea ducks from potential foraging habitat; however, the largest concentrations of sea ducks were in areas away from the proposed OWED. This approach could be used by local and regional planners to prioritize key habitats and areas used by marine birds and other fauna that should be protected from anthropogenic stressors such as OWED. Because of our approach and our new findings, we believe that our study will appeal to a broad ecological audience.

Some of the data presented here have been previously published in Flanders et al. (2015; Key seabird areas in southern New England identified using a community occupancy model approach; Marine Ecology Progress Series 533: 277-290). However, the Flanders et al. publication represented a larger-scale community occupancy (presence/absence) model in Nantucket Sound and nearby Rhode Island Sound, whereas our manuscript demonstrates a new modeling framework as applied to the problem of generating high-resolution spatiotemporal estimates of sea duck distribution and abundance. Moreover, we consider temporal changes in sea duck distribution and abundance and a considerably larger suite of potentially relevant biophysical covariates.

We recommend the following as reviewers: Beth Gardner (formerly North Carolina State Univ., now Univ. of Washington), Brian Kinlan (NOAA), Emily Silverman (US Fish & Wildlife Service), and Elise Zipkin (Michigan State Univ.).

Thank you for considering our manuscript.

Sincerely,

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