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Research article

Collision and displacement vulnerability to offshore wind energy infrastructure among marine birds of the Pacific Outer Continental Shelf

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ABSTRACT

Marine birds are vulnerable to collision with and displacement by offshore wind energy infrastructure (OWEI). Here we present the first assessment of marine bird vulnerability to potential OWEI in the California Current System portion of the U.S. Pacific Outer Continental Shelf (POCS). Using population size, demography, life history, flight heights, and avoidance behavior for 62 seabird and 19 marine water bird species that occur in the POCS, we present and apply equations to calculate Population Vulnerability, Collision Vulnerability, and Displacement Vulnerability to OWEI for each species. Species with greatest Population vulnerability included those listed as species of concern (e.g., Least Tern [*Sternula antillarum*], Marbled Murrelet [*Brachyramphus marmoratus*], Pink-footed Shearwater [*Puffinus creatopus*]) and resident year-round species with small population sizes (e.g., Ashy Storm-Petrel [*Oceanodroma homochroa*], Brandt's Cormorant [*Phalacrocorax penicillatus*], and Brown Pelican [*Pelecanus occidentalis*]). Species groups with the greatest Collision Vulnerability included jaegers/skuas, pelicans, terns and gulls that spend significant amounts of time flying at rotor sweep zone height and don't show macro-avoidance behavior (avoidance of entire OWEI area). Species groups with the greatest Displacement Vulnerability show high macro-avoidance behavior and low habitat flexibility and included loons, grebes, sea ducks, and alcids. Using at-sea survey data from the southern POCS, we combined species-specific vulnerabilities described above with at-sea species densities to assess vulnerabilities spatially. Spatial vulnerability densities were greatest in areas with high species densities (e.g., near-shore areas) and locations where species with high vulnerability were found in abundance. Our vulnerability assessment helps understand and minimize potential impacts of OWEI infrastructure on marine birds in the POCS and could inform management decisions.

1. Introduction

Offshore wind energy development is a promising alternative energy source for coastal communities in the Western United States. The U.S. Bureau of Ocean Energy Management (BOEM) has recently considered renewable energy proposals within U.S. Pacific Outer Continental Shelf (POCS) waters off the coast of Oregon and California (Trident Winds LLC, 2016). Minimizing negative interactions of offshore wind energy infrastructure (OWEI) with marine species is an important step towards a sustainable offshore energy future (Musial and Ram, 2010). Marine bird species are among the most threated species of birds, due in part to their exposure to cumulative anthropogenic threats including fisheries bycatch, pollution, habitat loss, and invasive species at terrestrial nesting grounds (Croxall et al., 2012). The construction of OWEI could pose additional threats for marine birds including collision with infrastructure and/or displacement from important foraging, resting, and commuting habitats.

Herein, we quantified population, collision, and displacement vulnerability to OWEI for 81 marine bird species common to the California Current System portion of the POCS (i.e., not including Hawaii). The California Current System ecologically defines this marine region where these species breed, forage, and/or over-winter (Checkley and Barth, 2009, Fig. 1). The vulnerability values generated for these 81 marine bird species were based on species' life history traits, population sizes, demography, habitat use, disturbance sensitivity, and conservation status. The vulnerability values generated in this assessment can be used by resource managers to evaluate potential impacts associated with the construction and long-term operation of OWEI within the POCS.

This assessment was inspired by similar studies that evaluated bird

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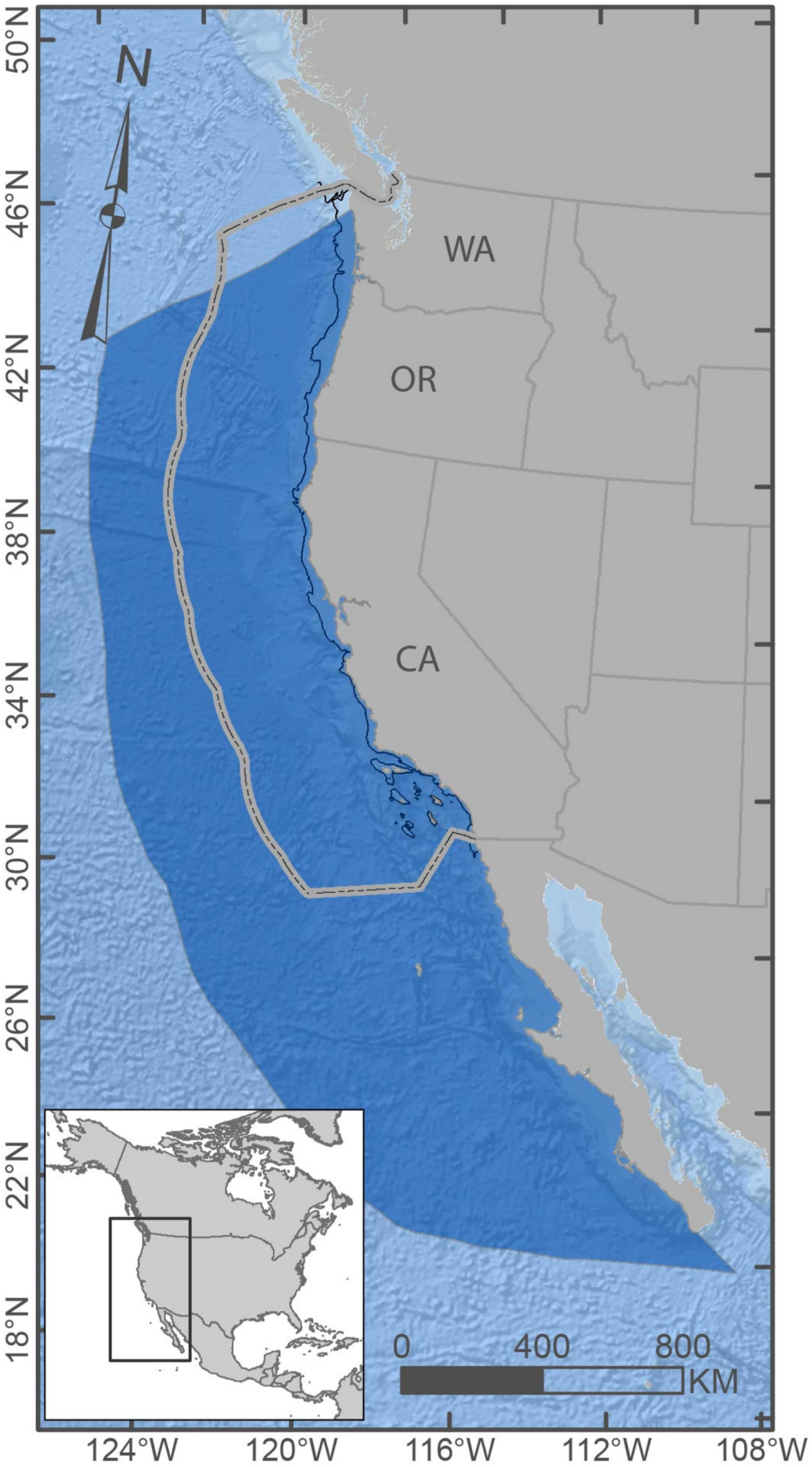

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