Supporting Siting of the Maine Research Array

– Marine Bird Use of the Area of Interest –

Prepared for:

Maine Department of Inland Fisheries and Wildlife

Maine Governor's Energy Office

Prepared by:

Wing Goodale, Ph.D.

Andrew Gilbert

Iain Stenhouse, Ph.D.

Biodiversity Research Institute

276 Canco Road, Portland, ME 04103

(wing_goodale@briloon.org)

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1 Summary

The State of Maine is going through a deliberate stepwise process of identifying a 16 square mile area for the Maine Research Array within a broader area of interest. The siting process includes locating areas with the least conflict with existing uses and natural resources, including birds. To support the siting process, Biodiversity Research Institute (BRI) conducted a desktop study using existing marine bird abundance models to identify areas of lower relative use of species that are vulnerable to collision or displacement and species of greater conservation concern. The results indicate that an area around "Mistaken Ground" has relatively lower use by vulnerable marine bird species, likely due to the areas distance from shore, water depth, and lack of significant underwater features.

2 Introduction

With offshore wind energy generation representing a significant opportunity for Maine's energy and economic future, the State has announced its intention to apply for the country's first offshore floating wind Research Array in the Gulf of Maine. Research will allow the State, the fishing industry, and many others to learn about potential impacts of floating offshore wind together, in order to ensure Maine develops this industry in a manner that capitalizes on our innovative technology and abundant resources, while protecting our interests, industries, environment, and values.[1]

To support the State in identifying a location for the Research Array within an area of interest that has the fewest conflicts with marine bird use, BRI conducted a desktop analysis using existing bird abundance models and a Maine specific vulnerability analysis. BRI presented the methods and received feedback from stakeholders during online workshops and reviewed the methods with the Maine Department of Inland Fisheries and Wildlife (MDIFW). Below, we provide an overview of the methods, a summary and interpretation of the results, and spatial outputs of the analysis.

3 Methods

A series of three maps were created that indicate spatial avian risk across three categories: population vulnerability (PV), collision vulnerability (CV), and displacement vulnerability (DV) for species believed to use the proposed Maine Research Array "Area of Interest", using version 2 of the Marine-life Data and Analysis Team (MDAT) marine bird relative density and distribution models (hereafter MDAT models; Curtice et al. 2016). Seasonal predictions of density were developed by NOAA for BOEM to support Atlantic marine renewable energy planning. Version 2 of these models are available directly from Duke University's Marine Geospatial Ecology Lab MDAT model web page[2]. The MDAT analysis integrated survey data (1978–2016) from the Atlantic Offshore Seabird Dataset Catalog with a range of environmental variables to produce long-term average annual and seasonal models.

[1] https://www.maine.gov/energy/initiatives/offshorewind/researcharray
[2] http://seamap.env.duke.edu/models/mdat/

Vulnerability rankings PV, CV, and DV risks were each independently evaluated for all possible species where data was available to support estimates. Researchers in Europe and the U.S. have assessed the vulnerability of birds to offshore wind facilities and general disturbance by combining ordinal scores across a range of key variables (Willmott et al. 2013, Furness et al. 2013, Wade et al. 2016, Fliessbach et al. 2019). The purpose of these indices is to prioritize species in environmental assessments (Desholm 2009), and provide a relative rank of vulnerability (Willmott et al. 2013).

The population vulnerability (PV) score was determined using Partners in Flight (PiF) "continental combined score" (CCSmax), a local "state status" (SSmax) using the maximum of state threatened and endangered status and "species of greatest conservation need" (SGCN) score, adult survival score (AS), and the regional population score (POP) – an annual measure of the population using the study area and the Marine-life MDAT models. This approach is based on methods used by Kelsey et al. (2018) and Fliessbach et al. (2019). Each factor included in this assessment (CCSmax, SSmax, AS, and POP) is added together (PV=CCSmax+SSmax+AS+POP) and rescaled 0–1.

CCSmax is included in scoring because it integrates various factors PiF uses to indicate global population health. *SSmax* is included to account for local conservation status, which is not included in the CCSmax. *AS* is included because species with higher adult survival rates are more sensitive to increases in adult mortality. The POP component was included as a metric for population use of the study area relative to the rest of the "population" based on MDAT model relative density estimates.

The collision vulnerability (CV) assessment includes scores for nocturnal flight activity, diurnal flight activity, avoidance, proportion of time within the rotor swept zone (RSZ), maneuverability in flight, and percentage of time flying (Willmott et al. 2013, Furness et al. 2013, Kelsey et al. 2018). The assessment process conducted here follows Kelsey et al. (2018) and includes proportion of time within the RSZ (RSZt), a measure of avoidance (MAc), and flight activity (NFA and DFA). All factors were added together (CV=RSZt+MAc+(NFA+DFA)/2) and rescaled to 0–1.

RSZt is included in the score to account for the probability that a bird may fly through the RSZ. The proportion of animals within the RSZ was estimated using methods similar to Johnston et al. (2014) by modeling flight heights using a smooth spline and integrating across the height range to estimate proportion of the animals using the RSZ. Flight height data was taken from the Northwest Atlantic Seabird Catalog (NWASC). The RSZ was assigned the values 25–250 m based on recent example turbine configurations. MAc is included to account for macro-avoidance rates that would decrease collision risk. The scores used in the assessment were based on Willmott et al. (2013), but updated to reflect the most recent empirical studies (Krijgsveld et al. 2011, Cook et al. 2012, 2018, Vanermen et al. 2015, Skov et al. 2018), and indices (Garthe and Hüppop 2004, Furness et al. 2013, Bradbury et al. 2014, Adams et al. 2016, Wade et al. 2016, Kelsey et al. 2018).

NFA and DFA include scores of estimate percentage of time spent flying at night (NFA) and during the day (DFA) based on the assumption that more time spent flying would increase collision risk. The NFA scores were taken directly from Willmott et al. (2013). The DFA scores were calculated from behavioral observations from the NWASC within 200 km of the research array study area. Per Kelsey et al. (2018), the NFA and DFA scores were equally weighted and averaged.

The displacement vulnerability (DV) assessment accounts for two factors: (1) disturbance from ship/helicopter traffic and the wind facility structures (MAd); and (2) habitat flexibility (HF; Furness et al. 2013, Kelsey et al. 2018). Empirical studies indicate that for some species, particularly sea ducks, avoidance behavior may change through time, and several years after projects have been built some individuals may forage within the wind facility. The taxonomic specific text indicates if there is evidence that displacement may be partially temporary. The displacement vulnerability scores (DV=MAd+HF) are rescaled to 0–1.

MAd is included to account for behavioral responses from birds that lead to macro-avoidance of wind facilities, and that have the potential to cause effective habitat loss if birds are permanently displaced (Fox et al. 2006). The MAd scores used in the assessment were based on Willmott et al. (2013), but updated to reflect the most recent empirical studies (Krijgsveld et al. 2011, Cook et al. 2012, 2018, Vanermen et al. 2015, Skov et al. 2018), and indices (Garthe and Hüppop 2004, Furness et al. 2013, Bradbury et al. 2014, Adams et al. 2016, Wade et al. 2016, Kelsey et al. 2018). The scores are the same as the MAc scores described above, but, following methods from Kelsey et al. (2018), are inverted. HF accounts for the degree to which a species is considered a habitat generalist (i.e., can forage in a variety of habitats) or a specialist (i.e., requires specific habitat and prey type). The assumption is that generalists are less likely to be affected by displacement, whereas specialists are more likely to be affected (Kelsey et al. 2018). The values for HF used in this assessment were taken from Willmott et al. (2013).

Vulnerability categories (PV, CV, DV) were used to weight annual MDAT modeled species density estimates to provide an annual estimate of total avian risk across the proposed Maine Research Array area. MDAT models were created for 47 avian species, but only 36 were used in this assessment, based on species detected within 200 km of the research area. To create a single annual risk map for each vulnerability metric, we first standardized each annual MDAT density models so total density for any species is one (1); weighted each species model by the vulnerability metric (0 to 1); and summed these weighted species models across all species to yield a final total risk model by vulnerability category for birds. Final maps were created using ArcMAP 10.8.1 (ESRI, Inc.).

4 Results and Discussion

4.1 Bird abundance and distribution maps

Results indicate that there may be lower potential risk to marine birds in specific portions of the study area. Models of marine bird density based solely on the unweighted MDAT model data (Figure 1) suggest construction of turbines within an area in the east-central portion of the Maine Research Array planning area, around the deeper waters of "Mistaken Ground" and extending east from there through Platts Basin for about 25–30 miles (40–50 km) provide the lowest potential risk to marine birds in general (areas in blue). In contrast, the shallower areas of the continental shelf tend to have higher concentrations of birds and likely greater potential risk to marine birds, as demonstrated by the two major banks (Jeffreys Ledge and Platts Bank) being clearly highlighted in red (Figure 1). Weighting the model results by population vulnerability (PV; Figure 2), displacement vulnerability (DV; Figure 3), and collision vulnerability (CV; Figure 4), all confirm that this central section provides the lowest risk to marine birds.

Risk, as demonstrated in this analysis, is mostly driven by marine bird abundance across the area (Figure 4), with elevated risk due to the potential for collision reducing the area of lowest risk to three smaller subareas in the east-central portion (Figure 3). The easternmost subarea overlaps with the wind exclusion area (red hatching), however, leaving the two remaining areas over Mistaken Ground as the likeliest areas to minimize potential conflict with marine birds.

4.2 Considering predictor variables in MDAT models

Since the MDAT models were developed using environmental predictor variables, a separate analysis of covariates in the area of interest was not conducted. The MDAT models used a suite of predictor variables as long-term climatologies, which were used to model relative avian density by species and season across the Atlantic OCS. However, the focus was not on determining the ecological relationship to species, but rather to develop the best predictive models with the least error, and as such, the relationships between predictors and modeled density are not always clear.

Six categories of predictor variables were employed in this work: survey, temporal, geographic, bathymetric, oceanographic, and atmospheric. Predictors accounted for the way data was collected, temporal change in density of species, spatial variation in density, bathymetric effects, as well as environmental factors that can influence ocean dynamics and productivity. Despite the inclusion of 40 predictor variables in the models, only some were consistently more important to the models across many species, including: survey transect, day and year, distance to land, depth, chlorophyll *a*, sea surface temperature, turbidity, and wind stress. The first predictors are related to spatial and temporal components of the models and clearly show change in distributions across space and time within and across years. Distance to land is typically correlated with depth, but also takes into account the raw distance from the coast and in some cases colonies for locally-breeding species. Some species are typically found coastally (e.g., Common Eider, Black Guillemot), whereas some species are found almost always in the offshore environment far from shore (e.g., Great Shearwater, Atlantic Puffin in winter), but in general species density tends to decrease with increasing distance from shore. Chlorophyll *a*, sea surface temperature, turbidity, and wind stress, may all relate directly or indirectly to prey availability and/or abundance. These factors are complex and may affect species differently depending on the season. Given the complexity of these relationship, BRI determined that an independent analysis of the variables would be challenging and would be unlikely to provide additional insight into marine bird use of the area of interest.

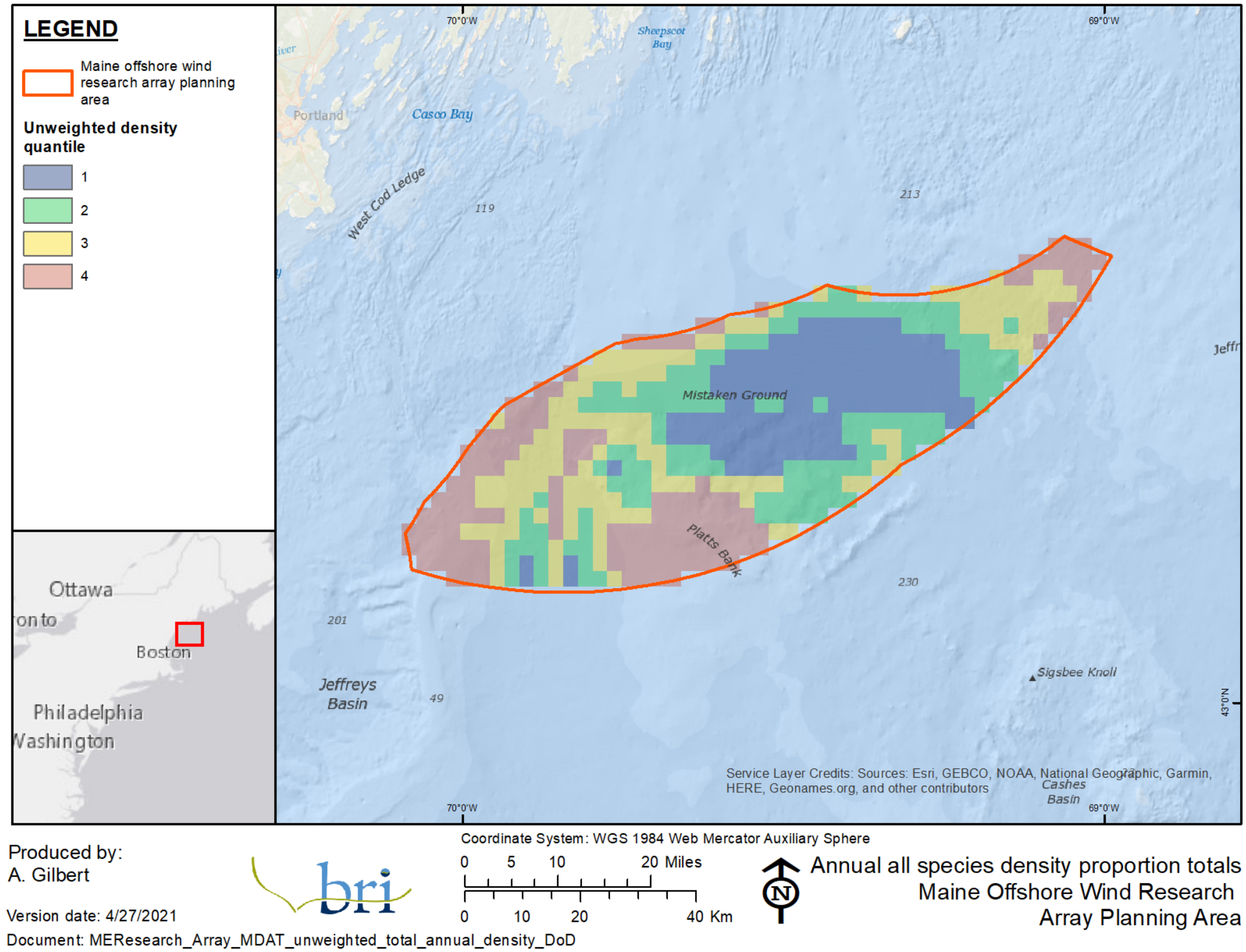

Figure 1. Unweighted MDAT models. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

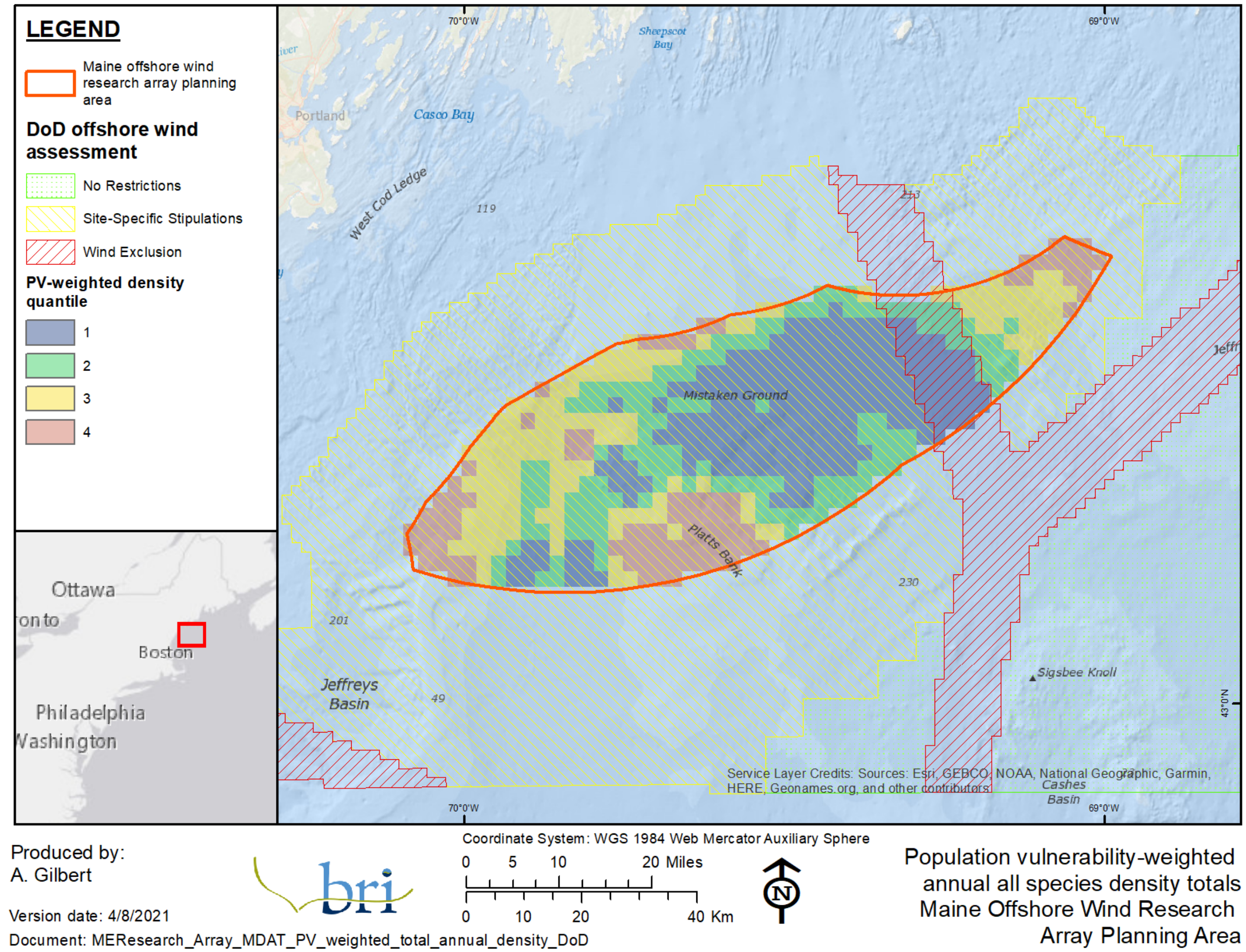

Figure 2. MDAT models weighted by population vulnerability. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

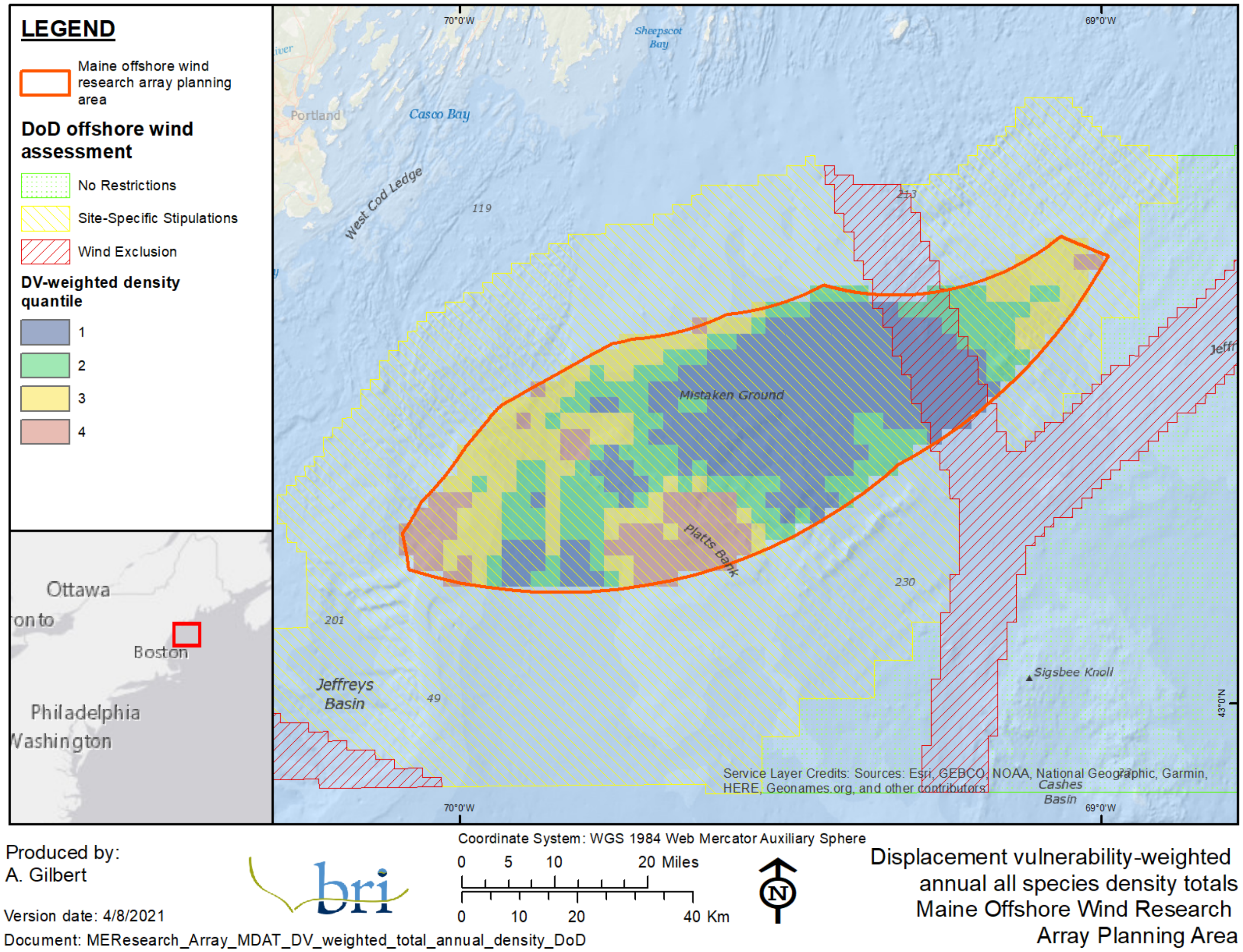

Figure 3. MDAT models weighted by displacement vulnerability. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

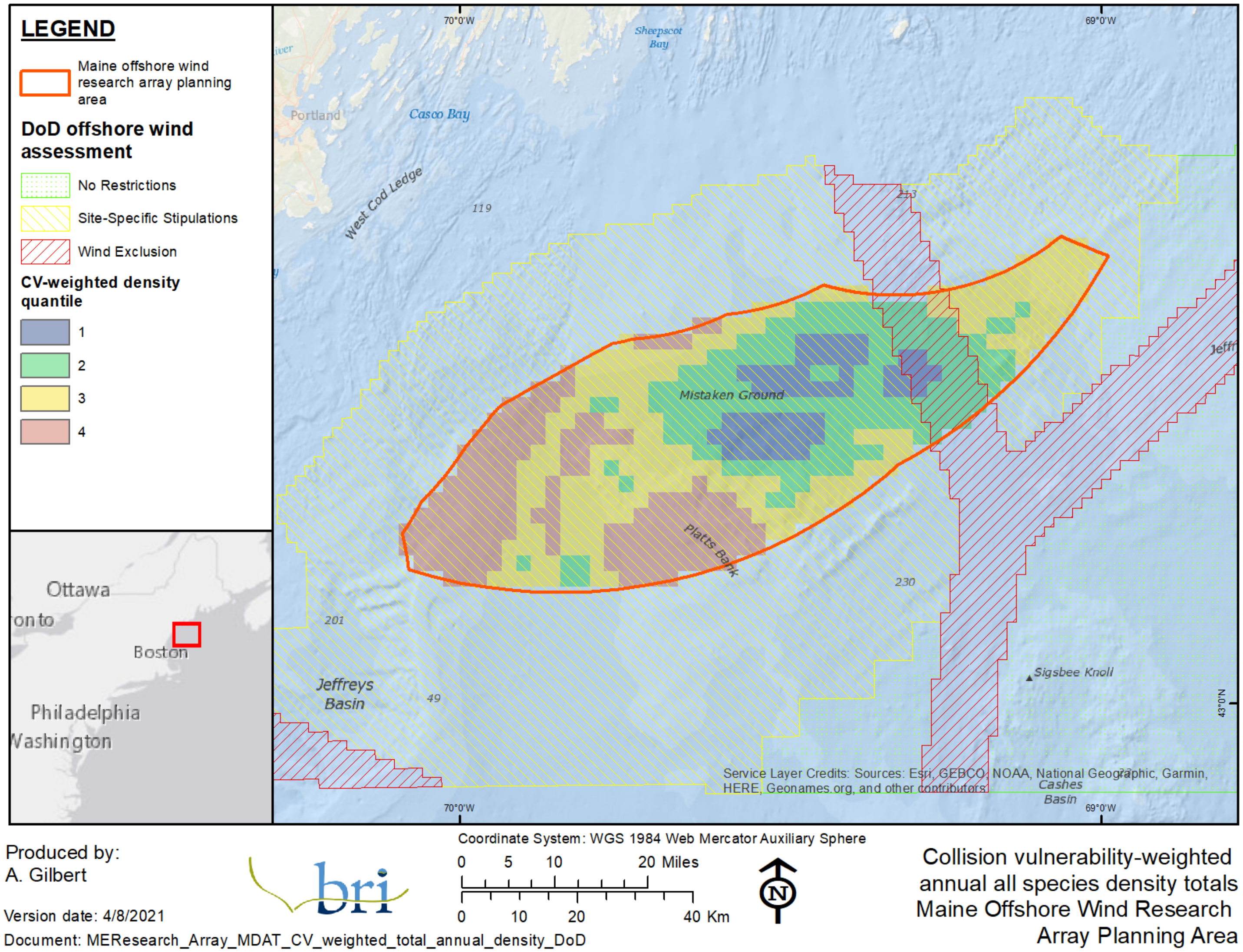

Figure 4. MDAT models weighted by collision vulnerability. Areas in blue indicate the lowest density of marine birds, thus have the least conflict.

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