Study Title	Transparent Modeling of Collision Risk for Three Federally Listed Bird Species in Relation to Offshore Wind Energy Development
Report Title	SCRAM 2: Transparent Modeling of Collision Risk for Three Federally Listed Bird Species in Relation to Offshore Wind Energy Development
Report Number(s) (OCS Study)	BOEM 2024-057
Completion Date of Report	August 2024
Number of Pages	80
Award Number(s)	BOEM Intra-Agency Agreement No. M19PG00023
Sponsoring OCS Region or Office	Atlantic
Applicable Planning Area(s)	North and mid-Atlantic
Fiscal Year(s) of Study Funding	FY2022-2024
Costs by Fiscal Year	FY2022-2024 $265,353
Cumulative Project Cost	$538,727
Project Manager(s)	Pamela H. Loring
Affiliation of Project Manager(s)	Division of Migratory Birds, Northeast, U.S. Fish and Wildlife Service
Address of Project Manager(s)	50 Bend Rd, Charlestown, RI 02813
Principal Investigator(s)	Holly F. Goyert, Evan M. Adams, Andrew Gilbert, Pamela H. Loring, and Kathryn A. Williams
Keywords	Offshore wind, Atlantic Outer Continental Shelf, *Sterna dougallii*, *Charadrius melodus*, *Calidris canutus rufa*, bird, collision, collision risk model, web application, SCRAM

ABSTRACT: A stochastic collision risk model and online web application was released in 2022 to estimate risk of avian collisions with offshore wind energy turbines in the United States (US). This decision support tool, called the Stochastic Collision Risk Assessment for Movement (SCRAM; Adams et al. 2022), uses movement data from automated radio telemetry studies to characterize collision risk in three federally-protected bird species: the Red Knot (*Calidris canutus*), Piping Plover (*Charadrius melodus*), and Roseate Tern (*Sterna dougallii*). Phase 2 of the project (2023-2024) updates the SCRAM models and tool to incorporate new sources of data (e.g., satellite-based tracking technology), improve the models, and increase the functionality of the online platform. This report refers to SCRAM Version 2.1.6, available at https://briloon.shinyapps.io/SCRAM2/. The model code and user manual are also available at this link.

BACKGROUND: Collision risk models are used globally to estimate the risk of avian collisions with offshore wind energy turbines (e.g., Band 2012, Masden 2015, McGregor et al. 2018). Conventionally, avian density data derived from observational survey datasets inform such models, along with a suite of behavioral and site-specific variables that predict collision risk. However, offshore surveys in the US are

not designed to target listed species, which limits the sampling of Piping Plovers, Red Knots, and Roseate Terns. Therefore, movement models were developed using automated radio telemetry data (Loring et al. 2018, Loring et al. 2019, Loring et al. 2021) to estimate collision risk for these species across the U.S. Atlantic Outer Continental Shelf (OCS). SCRAM Version 1.0.3 (Adams et al. 2022) built on previous collision risk models and used species- and site-specific characteristics to inform estimates of collision risk at offshore wind facilities.

OBJECTIVES: Update the U.S. avian collision risk decision support tool for offshore wind energy development (SCRAM), using new data on the three federally protected bird species on the Atlantic OCS.

METHODS: SCRAM includes four main components: (1) movement modeling to estimate monthly occupancy rates of the study species across the U.S. Atlantic OCS; (2) calculation of the numbers of birds exposed to collision risk, using monthly population estimates in the study area; (3) flight height estimation (from Motus and satellite-based tracking data) to refine the proportion of the population expected to be at risk of collision; and (4) a collision risk model that uses density estimates at given flight heights, along with other species- and location-specific parameters, to estimate collision for a specified turbine array. SCRAM 2 is packaged into a web application accessible via the public user interface and GitHub code repository (see the SCRAM webpage at briwildlife.org/SCRAM).

Phase 2 of SCRAM included updates to all four of the above components, including the incorporation of new Motus and satellite tracking data (for Red Knots), updates to movement and flight height models, new estimates of regional monthly population size, and alignment of the collision risk model with the state-of-the-art in the United Kingdom (Caneco et al. 2022). The web application was also modified to include an option to run the Band (2012) collision risk model for migrants, in addition to the SCRAM model using movement data.

RESULTS: Updates to SCRAM and the inclusion of new Motus and satellite tracking data improved model performance and reduced both the variability and uncertainty of SCRAM 2.1.6 model results, relative to those originally published in SCRAM 1.0.3. Regional monthly population sizes were updated to use more detailed estimates of timing of bird use within the study area. New flight height models for Red Knots updated the estimated distribution of flight heights, though the proportion of birds estimated to occur in the rotor-swept zone did not substantially change between versions. Resulting collision risk estimates in SCRAM 2 varied by species and location relative to those in SCRAM 1.0.3 (Adams et al. 2022). These changes related to a combination of factors, including increased sample size, incorporation of satellite-based tracking data, improved model flexibility and fit, updates to the Red Knot monthly regional population size estimates, revised flight height estimates, and bug fixes. Alignment of the collision risk model with Caneco et al. (2022) also led to substantial speed improvements when running the web application.

CONCLUSIONS: Phase 2 of SCRAM is a substantial improvement over SCRAM 1.0.3 in all major aspects of the models and web application. While SCRAM 1.0.3 will remain publicly available, it should no longer be used to estimate collision risk now that SCRAM 2 has been released.

A range of updates could further improve SCRAM. This Phase 2 report identifies how limitations or violations of SCRAM model assumptions could lead to over- and/or under-estimates of collision risk. Planned future updates to SCRAM in Phase 3 (2024-2026) include further advancement of the movement and flight height models (e.g., with new species and datasets), as well as sensitivity testing to

identify key parameters. Additional independent external review and collaboration with international subject matter experts are also being incorporated into the SCRAM development process.

STUDY PRODUCT(S):

1. **Model code:** Available at https://github.com/Biodiversity-Research-Institute/SCRAM2.

2. **Web application:** Stochastic Collision Risk Assessment for Movement (SCRAM). 2024. Version 2.1.6. Available at: https://briloon.shinyapps.io/SCRAM2/.

3. **User manual for web application:** Gilbert A, Adams EM, Goyert HF, Gulka J, Loring PH, Stepanuk JEF, and Williams, KA. 2024. User documentation for the Stochastic Collision Risk Assessment for Movement (SCRAM) version 2. Available at https://briloon.shinyapps.io/SCRAM2/. 36 pp. (Available via the book link at the header of the application user interface).

4. **BOEM study report:** Goyert HF, Adams EM, Gilbert A, Gulka J, Loring PH, Stepanuk JEF, Williams, KA (Biodiversity Research Institute, Portland, ME; U.S. Fish and Wildlife Service, Charlestown, RI). 2024. SCRAM 2: transparent modeling of collision risk for three federally listed bird species in relation to offshore wind energy development. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, VA. 80 p Obligation No.: M19PG00023. Report No.: BOEM 2024-057.

MAP OF STUDY AREA: Figure 2 of OCS Study BOEM 2022-071 (Adams et al. 2022).

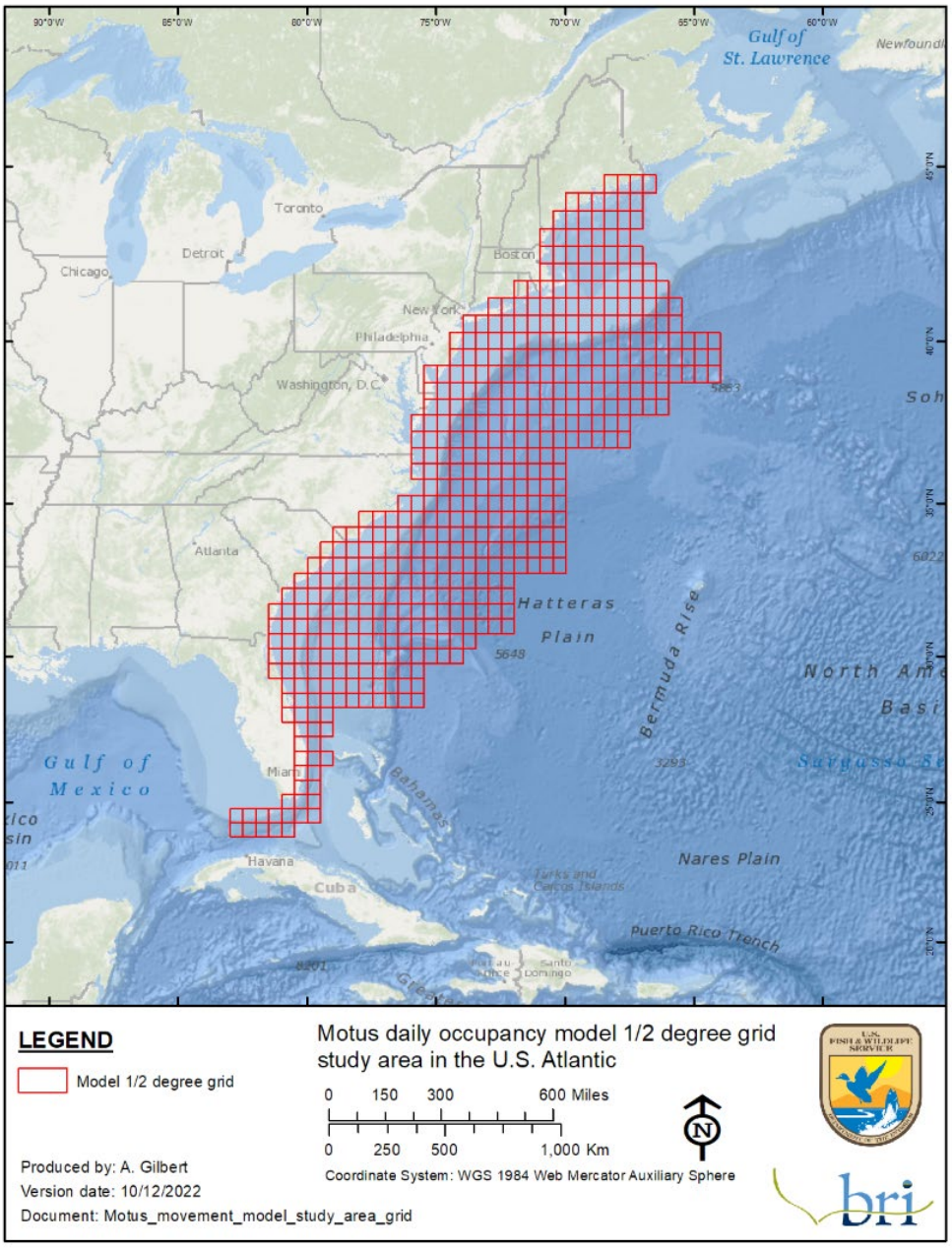

Figure 2. Map of the study area with a ½ degree grid throughout the U.S. Atlantic OCS study area.