Introduction to Part III
Examining wildlife distributions and abundance using boat-based surveys

Report structure

The chapters in this report represent a broad range of study efforts and goals. Some chapters are purely methodological in nature, while others present a variety of analyses and results. Generally speaking, however, chapters fall into two categories: efforts focused on population distributions, and those focused on individual movements (Figure I).

Part I of this report (the Executive Summary and Chapters 1-2) summarizes and synthesizes project results. The 25 subsequent chapters and their relationships to each other are shown in Figure I. In Parts II (Chapters 3-6) and III (Chapters 7-12), we describe methods and results for high resolution digital video aerial surveys and boat surveys, respectively. Part IV of this report (Chapters 13-19) combines data from both survey approaches to develop a comprehensive understanding of marine wildlife populations that use the mid-Atlantic study area. Part V (Chapters 20-25) focuses on individual movements and habitat use of focal avian species, tracked via satellite telemetry; and Part VI (Chapters 26-27) focuses on population-level migratory movements over the oceans, using several approaches for studying nocturnal avian migration. An additional study effort, which further explores statistical approaches for combining boat and aerial survey data to develop joint models of wildlife distributions and abundance, will be published as an addendum to this final report.

Part III: Examining wildlife distributions and abundance using boat surveys

Standardized boat-based surveys with distance estimation are a widely used and well-established method of obtaining density data for birds, sea turtles, and marine mammals. There are six chapters in Part III of this report, focused on the use of boat surveys to examine wildlife distributions and abundance:

Chapter 7.	Protocol for conducting boat surveys for wildlife.
Chapter 8.	Basic summary of boat survey observation data.
Chapter 9.	Scientific echo sounding study to obtain aquatic biomass data (includes data management and analysis protocols as well as a basic data summary).
Chapter 10.	Examination of spatial associations between feeding seabirds and aquatic biomass.
Chapter 11.	Development of a multi-species model for estimating seabird abundance and distributions.
Chapter 12.	Prediction of seabird densities across the study area by season, based on an incorporation of environmental data into the multi-species modeling approach.

The survey protocol (Chapter 7) explains our boat survey study design in detail, and is referenced throughout the following chapters (also see Figure II). Surveys were particularly optimized for avian species, and detected a wide variety of seabird species as well as raptors, passerines, shorebirds, and other avian taxa. Boat surveys also recorded marine mammals, sea turtles, rays, sharks, fish, and bats (Chapter 8). Data collected on boat surveys provided some substantial advantages in species identification over digital data collected from aircraft. Species-specific information can be important, as even closely related species often have differences in their conservation status, ecology, and habitat requirements.

While conducting surveys, we collected environmental covariate data in order to assess fine-scale patterns of environmental variables in relation to wildlife densities. In particular, fisheries sonar (a scientific echo sounder) was used to estimate relative biomass of aquatic prey in the same areas as boat survey observations (Chapter 9). These data were used to examine spatial associations between feeding seabirds and acoustically detected prey (Chapter 10). Identifying the spatial and temporal associations and lags between aquatic biomass and seabird behavior is helpful for understanding how these birds are making decisions in the marine environment, and the simultaneous collection of in situ data on seabirds and their prey can allow for a better understanding of the ecological drivers of seabird distributions (e.g., by allowing analysis of co-occurrence at very fine geographic and temporal scales, or linking predator distributions to specific prey species; Veit et al. 1993, Santora et al. 2010) Improving our understanding individual-scale decisions and movements in relation to prey may help managers to determine the behaviors or environmental conditions that present the highest risk of interactions between seabirds and offshore wind energy development, as well as determine the suitability of potential mitigation approaches. In this regard, the goals of Chapter 10 are in some ways more similar to the individual movement chapters in Part V of this report than to the other chapters in Part III (and most similar to the state-space model describing Northern Gannet foraging and movement patterns in Chapter 24).

A broader geographic and temporal scale of analysis is required to develop wildlife data appropriate for siting future development projects, or to fully assess exposure to wildlife from proposed projects. These goals also require correction of certain biases associated with boat survey data, such as distance bias, in which observers are less likely to see animals located farther from the survey vessel. Hierarchical Bayesian statistical approaches, as applied to survey data in Chapters 11-12, are useful for situations where distribution patterns or resource use vary with scale, and where species of interest are highly mobile and may be periodically unavailable for detection (Mordecai et al. 2011). These modeling methods allow distribution models to be chosen to fit the observed data (Gardner et al. 2008, Zipkin et al. 2010), and incorporate distance estimation and environmental covariates into the model structure, in order to predict animal distributions and abundance on a broad geographic scale.

Project collaborators first focused on the development of a community distance sampling (CDS) model for seabirds, using data from the first boat survey in April 2012 (Chapter 11). This is a novel multi-species approach for estimating seabird abundance and distributions that explicitly estimates detection as well as abundance parameters. By sharing information across species, this community model allows us to make inferences about abundance, distribution, and response to environmental variables of rare species for which there would not be enough data to run individual models.

Building on the CDS model developed in Chapter 11, Chapter 12 examines survey data from 15 boat surveys to develop geospatial models that predict seabird densities by season. By incorporating remotely collected environmental covariate data into the hierarchical modeling structure in this expanded analysis, Chapter 11 predicts seabird abundance throughout the study area, including areas that were not directly surveyed. The seasonal abundance maps presented in Chapter 12, for both seabird communities and individual species, predict animal distributions and abundance on a broad geographic scale and are useful for identifying important habitat use areas and seasonal patterns. Unlike several chapters in Part IV of this report, which utilize approaches for combining boat and digital aerial survey data, Chapter 12 focuses on using data from a single, well understood survey method to do the best possible job of describing patterns of abundance. In this regard, though it builds directly from the CDS model development chapter (Chapter 11), Chapter 12's products may be most similar in potential application to the Bottlenose Dolphin Generalized Additive Model (GAM) presented in Chapter 16.

Implications

These survey results on the geographic distributions and relative abundance of wildlife in the mid-Atlantic are expected to be useful for minimizing impacts to wildlife populations from offshore wind energy development in that they:

- Inform the siting of future projects, by incorporating wildlife patterns into marine spatial planning and decision making, and by using exposure data as a first step towards defining relative risk by location;
- Inform the permitting process for projects, by contributing data towards National Environmental Protection Act (NEPA) and other regulatory requirements, and by helping to define target taxa or research priorities on which to focus on during site-specific pre- and post-construction monitoring studies; and

- Inform mitigation efforts and construction and operations plans, by presenting temporal data on community composition, distributions, and abundance that can be used to time certain activities to coincide with reduced potential for exposure of certain populations.

Boat survey data and analyses can also be used to assess changes to wildlife populations as a result of offshore wind energy development, climate change, and other factors. Results from this project represent a baseline that can be used for comparison with compatible future surveys, and to assess changes due to development or other causes. Future research to fill data gaps on hazards and vulnerability can be targeted towards species with high levels of exposure, as well as species most likely to be impacted due to their conservation status or life history.

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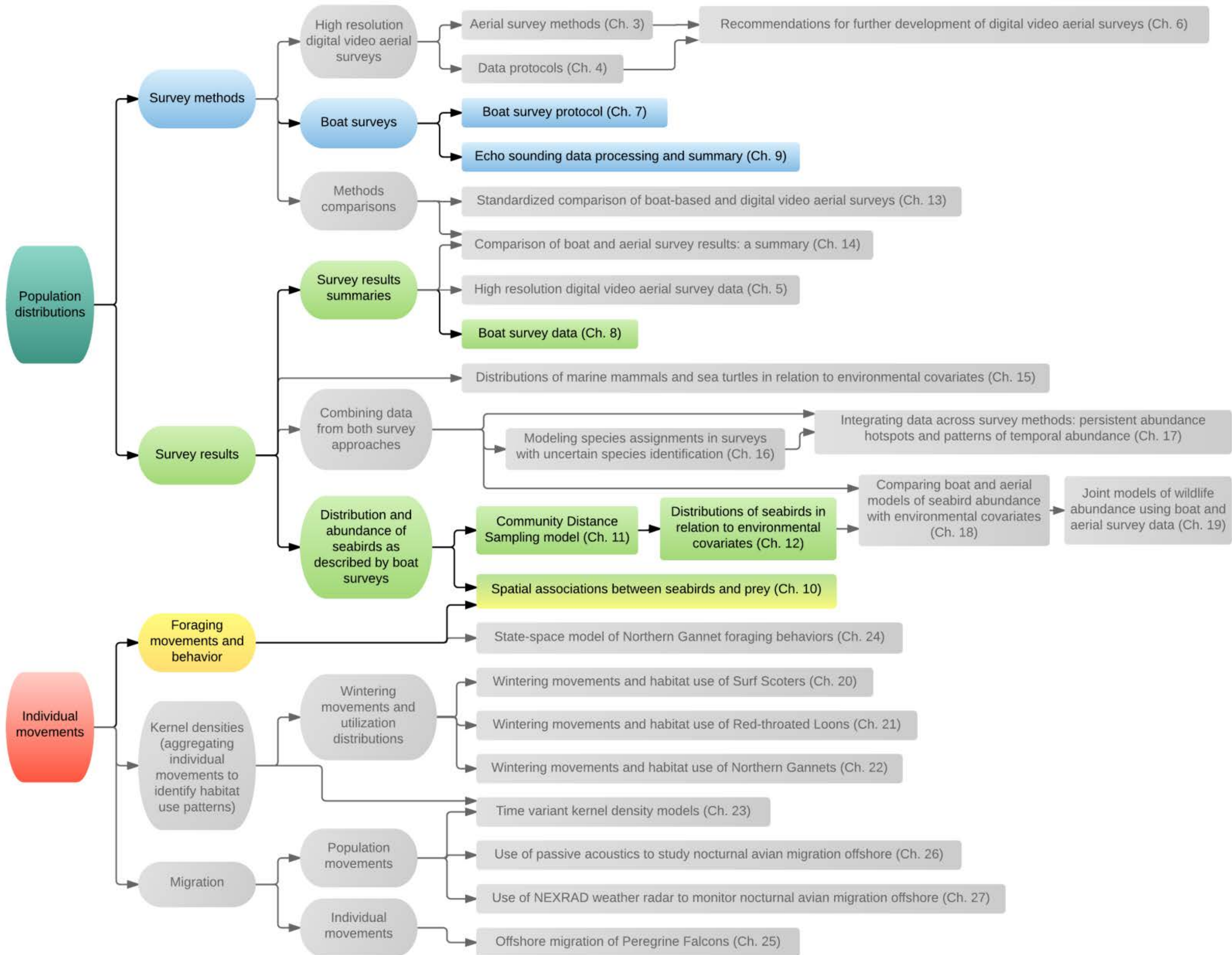

Figure I. Organization of chapters within this final report.

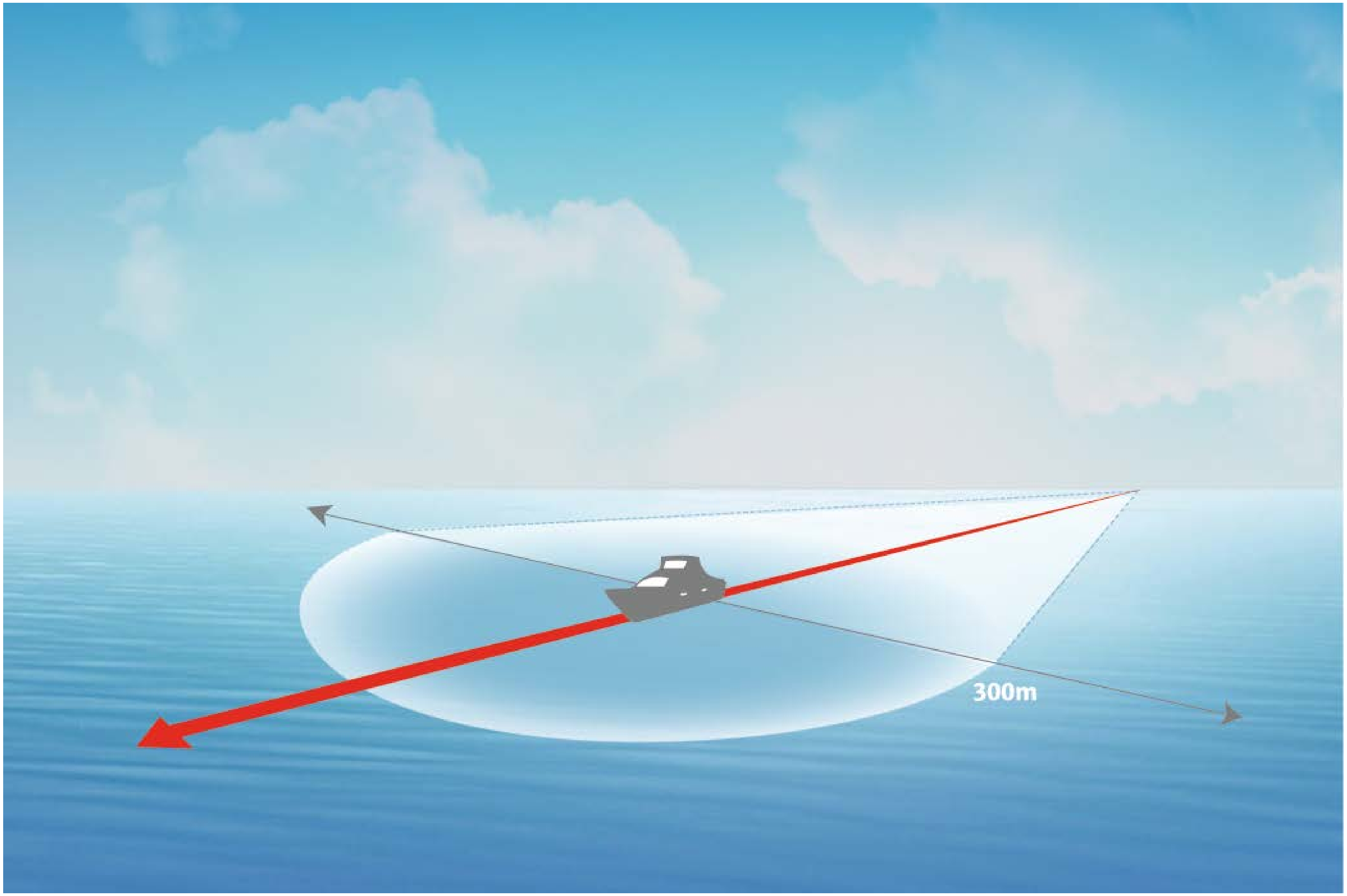

Figure II. Diagram showing the field of view available during boat surveys. The boat transect had an intended minimum strip width of 300 m on one side of the vessel, although observations of animals were generally recorded from both sides of the vessel and up to 1,000 m away.