Introduction to Part II
Examining wildlife distributions and relative abundance from a digital video aerial survey platform

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 II: Examining wildlife distributions and relative abundance from a digital video aerial survey platform

High resolution digital video aerial surveys are a relatively new method for collecting distribution and abundance data on animals (Thaxter and Burton 2009, Buckland et al. 2012), and ours was the first study to use this method on a broad scale in the U.S. The technology used in this study, one of several different digital aerial survey methodologies, was developed by HiDef Aerial Surveying, Ltd., in the UK. Digital aerial survey approaches have largely replaced visual aerial surveys for offshore wind energy research in Europe, as their higher flight speeds and much higher flight altitudes make them safer to conduct than visual aerial surveys, and reduces or eliminates disturbance to wildlife compared to visual aerial or boat survey approaches. They also produce archivable data, which allow for a robust quality assurance and audit process. There are still limitations to this method, however, including difficulties identifying some species, and a lack of defined statistical approaches for utilizing the data for some purposes, due to the relative novelty of the survey method.

There are four chapters in Part II of this report, focused on the use of digital video aerial surveys to examine wildlife distributions and relative abundance:

Chapter 3.	High resolution digital video aerial survey methods.
Chapter 4.	Data management, video analysis, and audit protocols for digital video aerial surveys.
Chapter 5.	Summary of high resolution digital video aerial survey data.
Chapter 6.	Recommendations for further development of high resolution digital video aerial surveys in the U.S.

Methods and protocols

Chapter 3 briefly describes the survey methods employed for high resolution digital video aerial surveys, which are referenced throughout the following chapters. Surveys were flown in twin-engine Cessnas at 250 km/hr and an altitude of approximately 610 m, which is much higher than traditional visual aerial surveys. While analysis and management of video require substantial personnel time, the resulting data are quality-controlled and audited much more intensively than is possible with visual observation data (Chapter 4).

Results from mid-Atlantic digital video aerial surveys

Surveys detected a wide variety of taxa, including marine mammals, sea turtles, rays, sharks, fish, bats, seabirds, shorebirds, and raptors (Chapter 5). Some taxa were notable for their unexpected abundance within the survey dataset (e.g., Cownose Rays, *Rhinoptera bonasus*, and sea turtles). Other taxa were not expected to be observed in surveys at all (e.g., bats; Chapter 5; Hatch et al. 2013). Flight heights of flying animals could be estimated from the aerial video using parallax, or the movement of animals relative to the ocean background (Chapter 5; Hatch et al. 2013). This information may be helpful in understanding the potential for interactions between flying animals and offshore wind turbines. For example, 59% of all birds with estimable flight heights were observed within 0 and 20 meters above sea level, which is below rotor height for most turbine designs. This type of flight height data is often used alongside information on avoidance behaviors, turbine specifications, and other data in models that attempt to estimate avian collision risk for offshore wind energy projects in Europe (e.g., Band 2012), although there is still debate in the European literature regarding the factors that best predict this risk (e.g., Cook et al. 2012, Douglas et al. 2012, Langston 2013, Furness et al. 2013).

Identification of animals to species in the video aerial survey data was variable by survey, season, and taxon (Chapter 5). In part, this is likely due to variations in image quality and other factors.

Observational data from boat or visual aerial surveys are not replicable, however, and species identifications made by observers in the moment can seldom be verified after the fact. The exhaustive quality assurance and audit protocol followed by aerial video reviewers, as well as characteristics inherent to the video review process itself (such as the use of multiple levels of “certainty” criteria in identifications), ultimately lead to fewer definitive identifications than observational approaches (Chapters 13-14). However, this also recognizes the inherent uncertainty in the identification process, which can be difficult to account for in unrecorded visual surveys. This uncertainty is generally under-recognized or ignored, as it can be difficult to measure, but in some cases species misclassification in visual surveys may actually lead to less reliable density estimates than classifying animals as “unknown” (Conn et al. 2013).

Recommendations for future use of digital aerial surveys in North America

Digital aerial approaches were developed in Europe, but the application of these technologies in North America demonstrates clear avenues for additional research and development (Chapter 6). The species composition of ecological communities in the western Atlantic varies considerably in some cases from what is present in the North Sea and Baltic Sea. Early indications suggest that digital aerial surveys may have distinct advantages over visual aerial or visual boat surveys for sea turtles, for example, a taxon of considerable interest in North America but that rarely occurs in Europe (Chapters 14-15; Normandeau Associates Inc. 2012). Even pan-Atlantic species may possess different characteristics in North America than in Europe. This is clearly seen in the large range of body sizes of Common Loons that winter in the mid-Atlantic U.S. (Barr et al. 2000, Gray et al. 2014), and the resulting difficulty in differentiating Red-throated Loons and Common Loons in aerial video in this study, a difficulty largely absent from observational data collected from boats (Chapter 16). Additional exploration of species identification capabilities—for example, by conducting test flights over known-species flocks—could aid the future application of this technology in the U.S. Identification rates in digital aerial surveys have also continued to improve with technological advances in the field; the current generation of cameras being used in Europe have much higher resolution and color rendition than the cameras used in this study, with better identification rates as a result (95% for all seabirds, on average; A. Webb pers. comm.).

In addition, there is a need to further the development of analytical approaches for digital aerial surveys. Because the cameras are pointed down towards the water’s surface (Figure II), providing a more vertical field of view than that from either visual aerial of boat surveys, digital aerial surveys avoid the common problem of distance bias; but, to date, other types of detection bias have not been addressed for digital aerial surveys. Further examination of detection rates (in relation to taxon, weather, sea state, time of day, and other factors) could be a fruitful avenue for methodological development (Chapters 6 and 13). Existing audit processes for object location in aerial video could be easily modified to incorporate a double observer approach and lead to more statistically rigorous, accurate, and reliable estimates of abundance for North American populations.

Implications

In addition to the four chapters in this section, the digital video aerial survey data are used in analytical efforts in Chapters 13-19. Several chapters focus on contrasting the two survey approaches (Chapters

13-14 and 18). In some cases, digital aerial survey data are used independently to analyze wildlife distributions and relative abundance (e.g., in the case of sea turtles, which were much more easily detected in video than from boat surveys; Chapters 15 and 17). In other cases, digital video aerial survey data and boat survey data are used jointly (Chapters 16-17 and 19) to describe distributions and abundance of animals across the study area.

Our application of these methods in the mid-Atlantic is expected to be useful for understanding wildlife populations and minimizing impacts to those populations from offshore wind energy development in several ways:

- First, this study has developed U.S.-based technological resources for future monitoring efforts, and explored technological advancements and assessment methods that could simplify or minimize the cost of environmental risk assessments. We also compare high resolution digital video aerial surveys to boat-based surveys, to better understand the potential uses of high resolution digital video aerial surveys in relation to offshore development in U.S. waters.
- Second, we identify species that are likely to be exposed to offshore wind energy development activities in the mid-Atlantic study area, along with their important habitat use or aggregation areas and temporal variation in distribution patterns. This information can be helpful for:
    - Informing 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;
    - Informing 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
    - Informing 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.
- Third, digital aerial surveys have some considerable advantages over traditional visual observation approaches, most notably in relation to survey speed and safety, but they also require some different analytical approaches than traditional surveys, which the scientific community is still in the process of developing. We explore statistical models aimed at improving our utilization of digital video aerial survey data to understand wildlife patterns.

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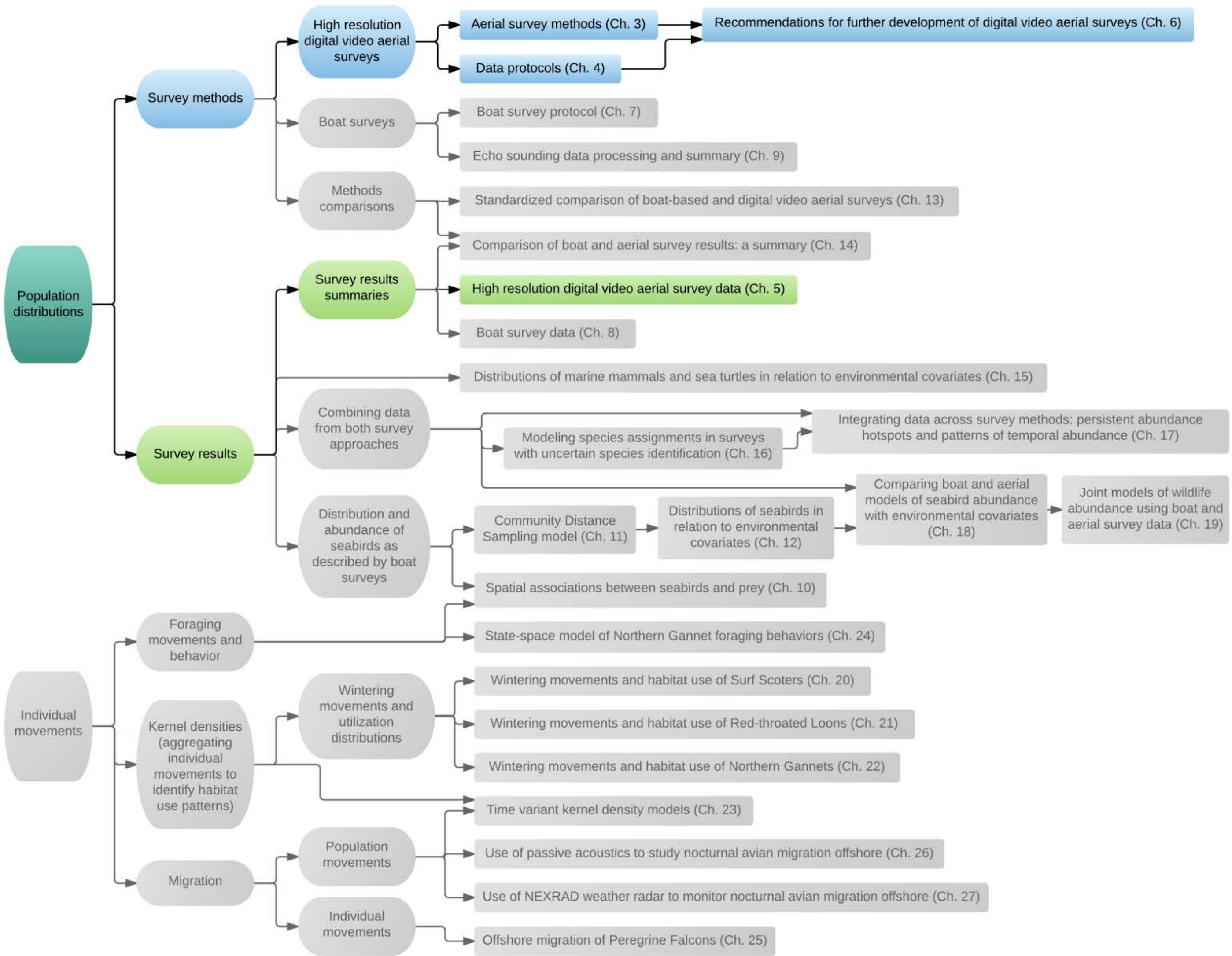

Figure I. Organization of chapters within this final report.

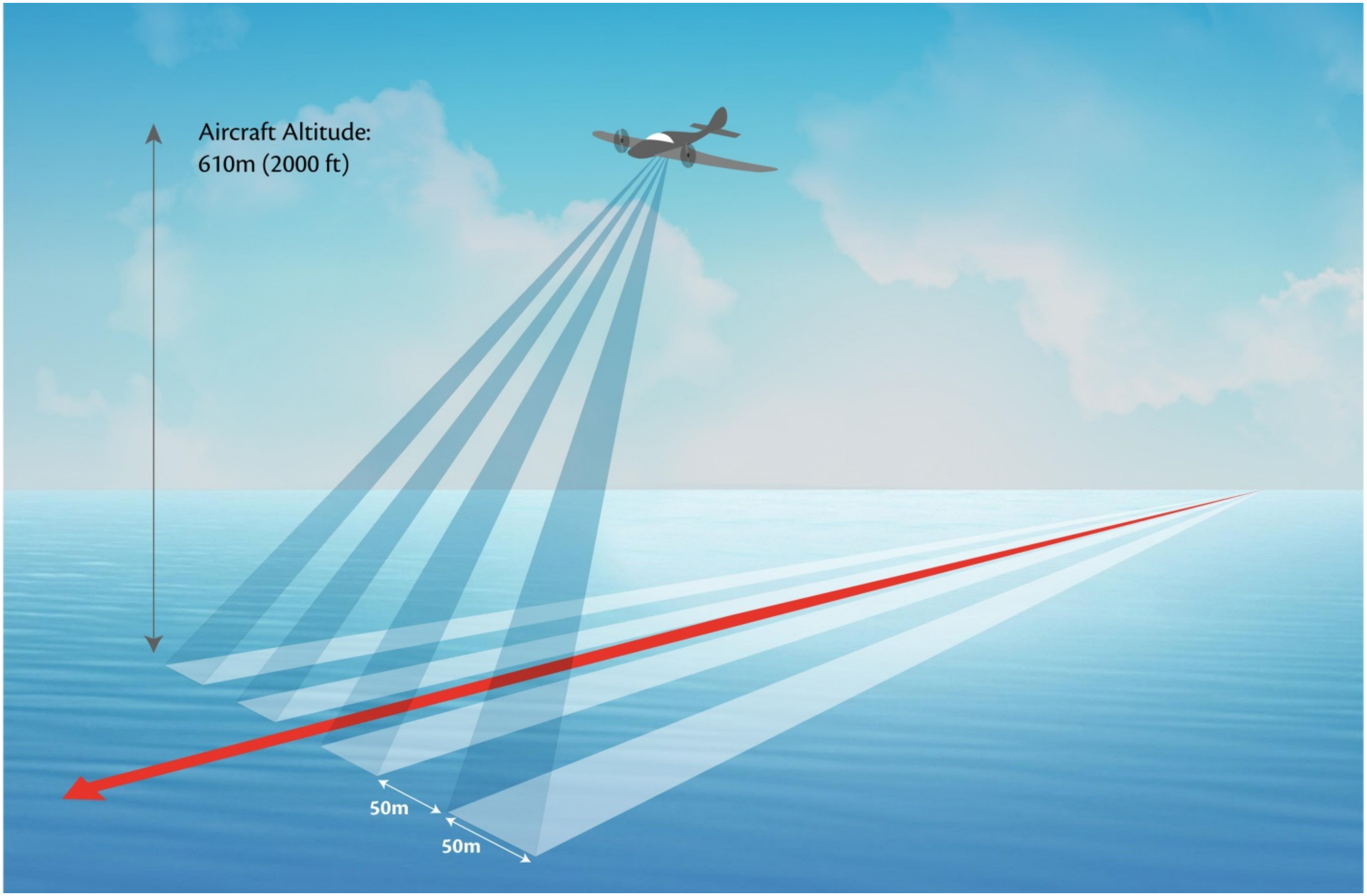

Figure II. Digital video aerial surveys were flown at 610 meters using a twin-engine aircraft with four belly mounted cameras. These cameras recorded non-overlapping 50 meter transect strips, for a 200 meter total transect strip width.