Sea duck telemetry analyses: Award # F20AC00012
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Background

The focus of this project was to continue efforts to synthesize and summarize multi-species sea duck telemetry data from the Atlantic and Great Lakes Sea Duck Migration Study, supplemented by tracking data from Pacific sea duck populations. An initial phase of this project (2017-2019) resulted in two summary manuscripts – a network analysis of annual-cycle sea duck movements and migration (Lamb et al. 2019, Ecological Applications) and a comparison of multi-species habitat use and partitioning (Lamb et al. 2020, Ecography). The project extension was intended to refine these analyses by developing single-species summaries of movement patterns, notably for black scoter; extending our previous network analysis to include Pacific coast sea duck populations; and evaluating effects of transmitters on behavior›

Summary of principal project objectives and current status

Objective 1: Discuss additional single-species objectives and analyses with Atlantic and Great Lakes Sea Duck Migration Study (AGLSDMS) Principal Investigators (PIs), obtain additional data from collaborators as required, complete writing and submission of relevant manuscripts

> We identified a need to synthesize data for black scoter from the eastern and Great Lakes population. In collaboration with several principal data holders and collaborators involved in the collection of black scoter tracking data (S. Gilliland, J.-P. L. Savard, P. Loring, G. Olsen, M. Perry, T. Bowman) we produced a comprehensive manuscript covering annual-cycle movement patterns and phenology for this species. This manuscript is currently **accepted pending minor revisions** by the Journal of Wildlife Management (2019 Impact Factor: 2.055) and is available upon request.

Objective 2: Coordinate with West Coast PIs to obtain telemetry data from previous tracking studies, establish shared objectives and data-sharing agreements, analyze continental-scale telemetry data following methods described in Lamb et al. 2019, write and submit final manuscript for publication.

> To date, we have developed a Memorandum of Understanding with Atlantic and Pacific collaborators, obtained a full continental tracking dataset for the three scoter species, and completed analyses of the full dataset. We are currently in the process of **drafting a manuscript summarizing results**, with a target submission date of August 2021 to Frontiers in Ecology and the Environment, a journal of the Ecological Society of America (2019 Impact Factor: 9.295).

Objective 3: Analyze existing state-space modeling results to assess short- and long-term behavioral effects of satellite transmitters, write and submit a manuscript detailing transmitter effects.

> This analysis is complete, and the **resulting manuscript has been published** in Ornithological Applications (2019 Impact Factor: 2.628) in August 2020. The full citation is provided at the end of this document. The article is open-access and has been viewed 1,068 times, downloaded 234 times, and cited twice.

Dissemination of results

In addition to preparing the manuscripts described above, we have presented our work and methods at several conferences, including at the 2019 Annual Meeting of the Pacific Seabird Group (February 2019, Kauai, Hawaii; network analysis); the North American Duck Symposium (August 2019, Winnipeg, Manitoba; network analysis and habitat selection); the 2019 Annual Meeting of the Waterbird Society (November 2019, Princess Anne, Maryland; habitat selection and partitioning); and the 2020 Annual Meeting of the Pacific Seabird Group (February 2020, Portland, Oregon; habitat selection and partitioning). We have also presented our work at local meetings of the Rhode Island Department of Environmental Management, at academic seminars, and at Sea Duck Joint Venture Continental Technical Team meetings.

Manuscripts from this project have so far received at least six citations in published literature and are being used by the U.S. Geological Survey and other agencies to identify hot spots and refine sea duck habitat management strategies. We have also participated in several training sessions directly aimed at introducing managers to our methods and findings. In December 2020, we participated in the Road to Recovery symposium, organized by the Smithsonian Migratory Bird Center and attended by over 600 wildlife practitioners, where we presented the network analysis project as a case study for multi-species management and participated in a panel discussion on management of declining migratory birds. We have also given webinars on this project to the U.S. Fish and Wildlife Service and the Canadian Wildlife Service.

Further reading and manuscript access

Abstracts for completed and in-progress manuscripts and DOIs for published manuscripts can be found on the following pages. A summary of the recent Road to Recovery workshop and a video recording of our presentation is available at http://marralab.com/r2rpart2/. Copies of published and draft articles are also available from juliet.lamb@cefe.cnrs.fr.

Manuscript abstracts

Lamb, J. S., P.W. C. Paton, J. E.Osenkowski, S. S. Badzinski, A. M. Berlin, T. Bowman, C. Dwyer, L. J. Fara, S. G. Gilliland, K. Kenow, C. Lepage,M. L.Mallory, G. H. Olsen, M. C. Perry, S. A. Petrie, J.-P. L. Savard, L. Savoy, M. Schummer, C. S. Spiegel, and S. R. McWilliams. 2019. Spatially explicit network analysis reveals multi-species annual cycle movement patterns of sea ducks. Ecological Applications 29:e01919. DOI: 10.1002/eap.1919.

Long-distance migration presents complex conservation challenges, and migratory species often experience shortfalls in conservation due to the difficulty of identifying important locations and resources throughout the annual cycle. In order to prioritize habitats for conservation of migratory wildlife, it is necessary to understand how habitat needs change throughout the annual cycle, as well as to identify key habitat sites and features that concentrate large numbers of individuals and species. Among long-distance migrants, sea ducks have particularly complex migratory patterns, which often include distinct post-breeding molt sites as well as breeding, staging and wintering locations. Using a large set of individual tracking data (n = 476 individuals) from five species of sea ducks in eastern North America, we evaluated multi-species habitat suitability and partitioning across the breeding, post-breeding migration and molt, wintering and pre-breeding migration seasons. During breeding, species generally occupied distinct habitat areas, with the highest levels of multi-species overlap occurring in the Barrenlands west of Hudson Bay. Species generally preferred flatter areas closer to lakes with lower maximum temperatures relative to average conditions, but varied in distance to shore, elevation and precipitation. During non-breeding, species overlapped extensively during winter but diverged during migration. All species preferred shallow-water, nearshore habitats with high productivity, but varied in their relationships to salinity, temperature and bottom slope. Sea ducks selected most strongly for preferred habitats during post-breeding migration, with high partitioning among species; however, both selection and partitioning were weaker during pre-breeding migration. The addition of tidal current velocity, aquatic vegetation presence and bottom substrate improved non-breeding habitat models where available. Our results highlight the utility of multi-species, annual-cycle habitat assessments in identifying key habitat features and periods of vulnerability in order to optimize conservation strategies for migratory wildlife.

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Long-distance migration presents complex conservation challenges, and migratory species often experience shortfalls in conservation due to the difficulty of identifying important locations and resources throughout the annual cycle. In order to prioritize habitats for conservation of migratory wildlife, it is necessary to understand how habitat needs change throughout the annual cycle, as well as to identify key habitat sites and features that concentrate large numbers of individuals and species. Among long-distance migrants, sea ducks have particularly complex migratory patterns, which often include distinct post-breeding molt sites as well as breeding, staging, and wintering locations. Using a large set of individual tracking data (N = 476 individuals) from five species of sea ducks in eastern North America, we evaluated multi-species habitat suitability and partitioning across the breeding, post-breeding migration and molt, wintering, and pre-breeding migration seasons. Species selected for common habitat features throughout the annual cycle; however, habitat selectivity and inter-species partitioning varied by season. Sea ducks partitioned shared breeding habitat according to climate conditions, landcover, and distance to water bodies. Wintering sea ducks displayed strong selectivity but weak habitat partitioning, and all species occupied shallow-water aquatic habitats with relatively high productivity, salinity, and temperatures. Selection intensity and partitioning were both strong during post-breeding migration and molt, but weak during pre-breeding migration, suggesting that availability

of preferred habitat features is particularly important during the post-breeding period. Our results highlight the utility of multi-species, annual-cycle habitat assessments in informing conservation strategies for migratory wildlife.

Lamb, J. S., P.W. C. Paton, J. E.Osenkowski, S. S. Badzinski, A. M. Berlin, T. Bowman, C. Dwyer, L. J. Fara, S. G. Gilliland, K. Kenow, C. Lepage,M. L.Mallory, G. H. Olsen, M. C. Perry, S. A. Petrie, J.-P. L. Savard, L. Savoy, M. Schummer, C. S. Spiegel, and S. R. McWilliams. 2020. Evaluating short- and long-term effects of coelomic-implanted satellite transmitters in sea ducks. Condor 122:duaa029. DOI: 10.1093/condor/duaa029

Studies of the effects of transmitters on wildlife often focus on survival. However, sublethal behavioral changes resulting from radio-marking have the potential to affect inferences from telemetry data and may vary based on individual and environmental characteristics. We used a long-term, multi-species tracking study of sea ducks to assess behavioral patterns at multiple temporal scales following implantation of intracoelomic satellite transmitters. We applied state-space models to assess short-term behavioral patterns in 476 individuals with implanted satellite transmitters, as well as comparing breeding site attendance and migratory phenology across multiple years after capture. In the short term, our results suggest an increase in dispersive behavior immediately following capture and transmitter implantation; however, behavior returned to seasonally average patterns within ~5 days after release. Over multiple years, we found that breeding site attendance by both males and females was depressed during the first breeding season after radio-marking relative to subsequent years, with larger relative decreases in breeding site attendance among males than females. We also found that spring and breeding migrations occurred later in the first year after radio-marking than in subsequent years. Across all behavioral effects, the severity of behavioral change often varied by species, sex, age, and capture season. We conclude that, although individuals appear to adjust relatively quickly (i.e. within 1 week) to implanted satellite transmitters, changes in breeding phenology may occur over the longer term and should be considered when analyzing and reporting telemetry data.

Lamb, J. S., S. G. Gilliland, P.W. C. Paton, J. E. Osenkowski, J.-P. L. Savard, T. Bowman, P. H. Loring, G. H. Olsen, M. C. Perry, and S. R. McWilliams. In review. Annual-cycle Movements and Phenology of Black Scoters in Eastern North America. Journal of Wildlife Management.

Sea ducks exhibit complex movement patterns throughout their annual cycle, as most species utilize distinct molt and staging sites during migration, in addition to disjunct breeding and wintering sites. Although research on black scoters (Melanitta americana) has investigated movements and habitat selection during the winter, little is known about their annual cycle movements. We used satellite telemetry to identify individual variation in migratory routes and breeding areas for black scoters wintering along the Atlantic Coast, and to assess migratory connectivity between wintering, staging, breeding, and molting sites. Black scoters occupied wintering areas from the Canadian Maritimes to the South Atlantic Bight with males using on average 2.5 distinct winter areas compared to 1.1 areas for females, with within-winter movements averaging 1256 km per individual. Individuals utilized on average 2.1 staging sites during spring migration, with almost all tagged birds detected in the Gulf of St. Lawrence. Most individuals occupied breeding areas west of Hudson Bay in the Barrenlands, which previously was unknown as a nesting area. Males arrived earlier and departed earlier than females from breeding sites. During fall migration, females took approximately 25 fewer days than males to migrate from breeding sites to molt and staging sites, and then wintering areas. Most birds utilized molt sites in James and Hudson Bays before migrating directly to coastal wintering sites, which took approximately 11 days and covered 1524 km. Males tended to arrive 10 days before females to wintering areas. There was weak connectivity between breeding and wintering sites, however females exhibited higher fidelity (4.5 km) to previously-used breeding sites compared to males (60 km). Our results show that the Atlantic Coast population of the black scoter is more dispersed in the winter, but more concentrated during migration than other species of sea ducks. These results could have implications for future survey efforts designed to assess population trends of black scoters.