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Strategic Bird Monitoring Guidelines for the Northern Gulf of Mexico

INTEGRATION AND COLLABORATION ACROSS THE GULF OF MEXICO

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Nelson's Sparrow (*Ammospiza nelsoni*) on marsh surface. Photo credit: Michael Gray

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Chapter 11

INTEGRATION AND COLLABORATION ACROSS THE GULF OF MEXICO

INTRODUCTION

THE GULF OF MEXICO AVIAN MONITORING NETWORK (GoMAMN) partners seek to develop and implement a Gulf of Mexico-wide, coordinated, and integrated avian monitoring program to inform and advance bird conservation, and evaluate restoration efforts in response to the Deepwater Horizon Oil Spill (Fournier et al. this volume, Burger 2017, Baldera et al. 2018). There are other models of coordinated monitoring and research efforts in North America, including: The Northeast Coordinated Bird Monitoring Program (Lambert et al. 2009), the Midwest Avian Monitoring Network (Roth et al. 2015) and the Saltmarsh Habitat and Avian Research Program (SHARP 2018). These organizations have similar goals to GoMAMN; they are trying to make research and monitoring efforts more collaborative and integrative to facilitate conservation successes and learning about the natural world at large spatial scales or across complex ecosystems.

There are many types of bird monitoring efforts in the Gulf of Mexico (GoM); ranging from small-scale, project-based assessments of habitat restoration to state-based surveys coastal bird of populations. Project leads range from those looking to answer scientific questions within a hypothesis testing framework to managers who want to know how many more birds use a newly created marsh island. Such a diversity of projects, objectives, and funding agencies presents the avian monitoring community with a real challenge for understanding population trends, the effects of management actions, and large scale ecological processes throughout the GoM.

COLLABORATION AND INTEGRATION BEFORE MONITORING

Integration

Large scale bird conservation depends on the integration of multiple datasets at the region-wide scale, which requires a community who are working in a coordinated and integrated way (Baldera et al. 2018, Fournier et al. this volume). To maximize the utility of individual monitoring projects, field data should be collected and managed in ways that facilitate timely Gulf-wide analyses that provide assessments of population status and trends, increase our understanding of management and restoration activities, and/or address scientific hypotheses related to ecological processes. Furthermore, it is imperative that data collection for use at the program-level be done in a manner to not diminish the utility of the data to project-level evaluation (NASEM 2017).

Integration is essential to bird conservation. Projects that are integrated with one another may not necessarily have the same objectives, but they are conducted in a complementary manner or allows data collected to be aggregated together. In the context of RESTORE Act-related activities in the Gulf of Mexico region, the integration across project-level monitoring is required to understand bird response at the program-level, or regional scale because of the extreme mobility of birds (Woodrey 2017). From a stakeholder value perspective (Fournier et al. this volume), effectively integrated monitoring projects will be:

Designed to support assessments or analyses that combine multiple project-level efforts to address questions at the program level. Such projects would be:

1. Aligned with existing monitoring priorities,
2. Collaborative and communicative with partners inside and outside of the project, and
3. Focused on data accessibility and data sharing.

The GoMAMN Community of Practice plays a critical role in integrating monitoring projects across a broad geographic scale. Through the sharing of ideas, expertise, methods, and data via the Community of Practice, Trustee Council members and their representatives will be able to reliably report the effects, at least for birds, of the billions of dollars being spent to make the GoM "whole again."

In this chapter, we describe how integrated monitoring efforts across the GoM inform not only the bird conservation community but also provide critical data to State Trustee Implementation groups, the RESTORE Trustee Council, federal, state, and non-governmental funding agencies, etc. to confidently report back to the citizens around the Gulf regarding the outcome of their restoration efforts. Further,

Grassland bird workshop. Photo credit: Mark Woodrey

we provide guidance for integrated bird monitoring across the region. Integration must occur both before and after a monitoring project begins and we use these two periods to structure our narrative and recommendations.

Alignment and Collaboration

Monitoring efforts in the GoM should be aligned with established regional priorities. The taxonomic chapters (Chapters 3-9) were written to identify and integrate priorities from across state and federal conservation plans throughout the Gulf. Sources include state wildlife action, joint venture, bird conservation region, Partners In Flight, and species specific plans (FWC 2012, TPW 2012, ADCNR 2015, Holcomb et al. 2015, MMNS 2015, PIF 2017). Consulting these plans as part of the study design process is essential to ensure integration of a particular project within a state-wide or regional context. Further, following these priorities directs monitoring practitioners to the selection of appropriate species and habitats, monitoring endpoints, and appropriate methods for data collection and storage. Following established priorities facilitates data from all monitoring projects to be integrated together to address larger scale questions.

Collaboration is a second important consideration for any monitoring effort. Through a collaborative process, practitioners can increase the long-term sustainability of a project, reduce inefficiencies and redundancy in monitoring efforts, and maximize long-term conservation success at the GoM-wide scale. Projects involving several partners can work together towards a larger goal, and also leverage more resources to make a project more cost-effective. Such collaborations can be difficult to achieve as they take extensive time and coordination. To provide some assistance with promoting region-wide collaborations, the GoMAMN Community of Practice, regular meetings and website are designed to help monitoring practitioners identify potential project partners or collaborators as well as promote communication.

Study Design

Development of a rigorous, question-driven study design is a critical step in science-based conservation, including a robust monitoring program. Following this principle, we outline several explicit elements to be present in a study which would be statistically sound and maximize data integration (Figure 2.2). These include having a clear objective/hypothesis, appropriate sampling units, and focal species, standardized data collection practices, appropriate analysis outlined, and alignment with existing conservation priorities and monitoring endpoints (Figure 2.2). Because these are common elements of a rigorous study design, we do not go into detail here, as many other resources exist (e.g., Quinn and Keough 2002). We strongly recommend those designing new avian monitoring efforts around the GoM should consult the taxonomic chapters in this document (Chapters 3-9), consult the GoMAMN website, and engage the GoMAMN Community of Practice to assure alignment and integration with current monitoring priorities (see resources at: gomamn.org/products).

Response Variable Selection

Once a clear objective/hypothesis is defined, an appropriate sampling unit (be it a bird, a feather, a wetland, restoration

project, a county, a state, or a region) needs to be established. An effective sampling unit is one that not only provides the correct scale of inference for the respective question, but can also be rolled up to larger spatial contexts for integration with other datasets. At the same time, taxa-appropriate sampling frames, stratification, and randomization should be carefully incorporated when determining the correct sampling unit, to ensure that monitoring data from each project can be rolled up for larger scale inference.

A necessary component of coordinated and integrated bird monitoring is having agreed upon monitoring endpoints (Figure 2.2). Table II.4 in NASEM (2017) provides a recommended set of monitoring metrics for construction and performance monitoring, and the Bird Restoration Monitoring Chapter covers these topics in more depth. Baldera et al. (2018) provides a suite of 10 performance metrics that are applicable to multiple project types. While there are many endpoints a project might employ to measure the taxonomic group, the taxa specific chapters of this document (Chapters 3-9) provide specific recommendations related to both avian response metrics and non-avian covariates.

COLLABORATION AND INTEGRATION AFTER MONITORING

After monitoring has been implemented, the primary mechanism for collaboration and integration is data sharing. Over the past several decades the types and amounts of data that are available have increased dramatically. As a result data management has become even more important for post-monitoring project collaboration, with the usefulness of data sets being defined by its stability, understandability, and accessibility (British Ecological Society 2015, Broman and Woo 2017, White et al. 2013). Well-managed data sets have incredible power to answer questions and fuel collaborations but dedicated effort and expertise are required to maximize their utility to the larger GoM community. To this end, this section first describes the components of a healthy data management system then provides data management recommendations for the GoMAMN Community of Practice to maximize the integration goals of the group (Figure 2.2).

The role of data management is clearly valued by regional stakeholders and GoMAMN partners, and vital to achieving integration and collaboration to support large scale inference about birds at the program scale (Strasser et al. 2012, British Ecological Society 2015). Data management begins with data observation/collection and ends when the data are stored, stable, well-described by metadata, and available for other researchers to use (Strasser et al. 2012, Broman and Woo 2017, Borer et al. 2009, Hart et al. 2016).

The complete data life cycle comprises the following general steps:

1. Data collection and/or generation,
2. Metadata definitions and descriptions,
3. Quality assurance and quality control,
4. Data storage, and
5. Data sharing and accessibility.

While there are more aspects to data management than just these points (see NASEM 2017), this broadly framed data life cycle relates to GoMAMN stakeholder data management values (Figure 2.2). There are several broad recommendations that would benefit the GoMAMN Community of Practice. First, coordinating across project-level monitoring efforts, with others working with the same species or similar species suites, habitats or questions should be done whenever possible. Second, all data collection should have a data management plan to ensure availability to the broader scientific community in a timely manner. Third, for any given project, additional non-avian covariates (e.g., abiotic data, habitat information, survey conditions, prey availability, etc.) identified in the Taxa chapters (see Chapters 3-9) should be collected and properly stored wherever practicable.

A data management plan should address the acquisition, development, storage, and transfer of data, and include information about the management of metadata, including which metadata standard will be used. What follows are a description of recommendations for each of these areas of the data life cycle for the GoMAMN Community of Practice:

DATA COLLECTION: Data should be collected in a standardized way (i.e., using standard format hard copy field data sheets and standardized digital data entry formats) for the entirety of the monitoring project and among collaborative, or program-level projects. Once data are collected, free and open tools like R (www.r-project.org/) and SQL should be used to help track and organize any data manipulation that subsequently occurs. R and SQL allow for the documentation of data manipulation and management through scripts, which promotes transparent communication and reproducibility of these tasks. These scripts should be archived with data, and published with all papers and reports and take advantage of cloud-based code archiving in combination with version control through resources such as Github and BitBucket that support collaboration and documentation (Huang and Gonzalez 2016, http://swcarpentry.github.io/git-novice/). Resources such as the Data Carpentry Ecology Spreadsheet and R lessons are openly available for learning about data management practices for entering, and working with data in a reproducible and open way (Bahlai and Teal

2017, Michonneau et a. 2017, Martinez and Poisot 2017, datacarpentry.org/R-ecology-lesson/, datacarpentry.org/spreadsheet-ecology-lesson, datacarpentry.org/sql-ecology-lesson/). The GoMAMN Community of Practice, through its members, serve as a forum for the development of guidance for data management plans content and documentation. This guidance will ensure consistent, clear, and accessible data management plans across taxa as well as the region.

METADATA: Standardized and detailed descriptions of the data itself, notes regarding methodology used to collect the data, and other data-related comments, are all a part of metadata and are necessary to provide the appropriate context to future data users. There are many different metadata standards available for a variety of types of data (NASEM 2017); the most appropriate metadata standards will depend on the nature of the monitoring data and the needs of the monitoring practitioner. The Federal Geographic Data Committee (FGDC) and International Standards Organization (ISO) have commonly used metadata content standards for geographic data. For ecologically-oriented data the Ecological Society of America has developed an Ecological Metadata Language (EML) (Michener et al. 1997, https://knb.ecoinformatics.org/#tools/eml). While there are many options, it is important to identify which is the best for your project and determine what others in your community consistently use. Standards for consistently describing methodologies and concepts in a community (i.e., a controlled-vocabulary) are also considered metadata and are critical to successful communication with a scientific community (NASEM 2017).

QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC): All data collection protocols in the Gulf of Mexico should have QA/QC protocols to ensure data entry mistakes are minimized, and errors that do occur are detected and corrected before data are stored, analyzed, or shared. Necessary and sufficient QA/QC processes vary depending on the type of data and methodology used for data collection and management. The Environmental Protection Agency has a series of standards for measuring contaminants (epa.gov/measurements/resources-assessing-measurements) and the U.S. Integrated Ocean Observing System (IOOS) has described detailed procedures for standards in dealing with ocean data (http://www.earthobservations.org/geoss_dsp.shtml). It is important for QA/QC procedures to occur before data are submitted for long-term storage because errors will be more difficult to detect and correct as time passes.

DATA STORAGE: Considerations for both short and long-term data storage plans are needed for data security, stability, and standardization over the course of the project and beyond. A plan for managing physical data sheets is important to prevent damage, destruction, or misplacement. Onsite digital storage of data is also important to consider and should include digital backups on multiple physical drives or servers. Digital storage with backup protections is also important to ensuring that each individual storage device has the longest lifespan possible, and that data are stored in many places to ensure the lifespan of the data itself is as long as possible. There are many secure online data portals for storing ecological data for the GoM: the Gulf of Mexico Coastal Ocean Observing System (GCOOS), the Gulf of Mexico Initiative Information and Data Cooperative (GRIIDC), the Data Integration Visualization Exploration and Reporting (DIVER) tool, the Natural Resource Damage Assessment and the National Oceanic and Atmospheric Administration Environmental Response Management Application (ERMA), among many others (NASEM 2017). Choosing a data portal is a complex decision but several important characteristics should be considered, including selecting a portal that is reliable and accessible to the Community of Practice, can hold a wide variety of data types, and has sufficient documentation for ease of use as a data contributor as well as a data user.

DATA SHARING: All data collected should have a data sharing agreement that allow access to the data for the broader scientific community as quickly as possible. The quicker the data becomes available the quicker it can be used to inform GoM bird conservation. Once storage has been established, a plan for data sharing and long-term accessibility should be implemented. Program-level questions relating to conservation and management can only be met with robust data sets that are created with forward-thinking data sharing plans from each individual project. Clearly data storage and sharing are linked, particularly via online data portals, but data accessibility is only achieved through buy-in from individual project leaders. Data accessibility can vary depending on the source of the monitoring funds and the preferences of the principal investigators, but all data management plans need to account for sharing data among scientists and managers.

There are several accepted categories of data sharing:

1. Open and fast - data are made available immediately after the project is completed, or perhaps even before the project is completed
2. Open after embargo - data are archived immediately after a project is completed, but an embargo is put on their accessibility to others for a set amount of time to allow the creator's first chance at publication,
3. Open to a select group - data are archived immediately after a project is completed but access to those data is only open to a select group of people,
4. Open with permission - data are archived immediately

Integration Recommendations

The stakeholders value integration of data sets for a variety of reasons, perhaps most importantly that this approach will allow scientists and managers to reduce uncertainty around hypotheses at both the project- and region-levels. Below is a list of stakeholder values with respect to study design, data collection, and data management and sharing. While these are mentioned in the previous sections, highlighting them here emphasizes both their importance and their broad applicability in this developing regional avian monitoring strategy. Adherence to this guidance will ensure an effective, efficient, and widely applicable framework to address regional concerns and questions.

★Communicate with the GoMAMN Community of Practice before the beginning of monitoring project to coordinate data collection and management.

★Have a written data management plan as a part of every monitoring project.

- Reference the NAS Gulf Monitoring document for specifics on data management and additional data management references (NASEM 2017).
- Include metadata standards as a part of every data management plan.

★Collect all monitoring data in a standardized way (i.e., using hard copy field data sheets and standardized digital data entry formats).

★Use the same sampling protocols as others in the Gulf of Mexico who work with the same species or similar communities, are addressing similar questions, or evaluating the same habitats in a different area of the Gulf.

★Enter data such that it is usable and readable by people and computers (learn how here: www.datacarpentry.org/spreadsheet-ecology-lesson).

★Use open access tools like R (www.r-project.org/) and SQL to help track and organize data manipulation (learn how here: Michonneau et a. 2017, www.datacarpentry.org/R-ecology-lesson/ www.datacarpentry.org/sql-ecology-lesson/).

★Discuss monitoring project ideas and designs with stakeholders, including the GoMAMN Community of Practice to coordinate and integrate critical study design and data management principles before embarking on a project (see resources at: gomamn.org/products).

★Archive all data as soon and openly as possible. The faster data become open and available, the faster we can apply these data to critical conservation questions regarding bird resources of the Gulf of Mexico.

★All published data sets using our stakeholder values should reference the group, the protocol used, and should include the data set, where applicable. This approach will allow researchers and land managers to more easily, openly and readily access the experience and practical knowledge of more seasoned researchers across the region.

While each of these recommendations are suggestions, the GoMAMN partners hope that these rules provide assistance for those who have not worked extensively in the field of data integration and management. If such guidelines are adopted consistently in the Community of Practice, then regional goals of estimating population status or understanding the effects of management actions will be more achievable.

after a project is completed, but are not accessible without first contacting the data collectors as obtaining permission, this would be appropriate for datasets that contain sensitive information about species, places or people.

The bird conservation stakeholders across the Gulf of Mexico strongly value an open and fast data sharing policy when every possible, because it provides the fewest impediments for evaluating and exploring time-sensitive program-level questions.

IDENTIFYING PROGRESS IN MONITORING INTEGRATION

Integration, just like reducing uncertainty around questions involving management actions and ecological process, is a goal to be worked towards. We note below several signs of progress, that would indicate integrated and coordinated bird monitoring in the Gulf of Mexico in five years.

★ **GoMAMN** Community of Practice meetings occurring on a regular basis with results from old projects and collaborations being used to develop and support for new projects.

★ **A GoMAMN** monitoring project self reporting portal is created and being actively populated by stakeholders, including the GoMAMN Community of Practice, such that all monitoring data collection efforts can be tracked and reviewed to better connect members of the community to promote collaboration more broadly and serve as the basis for reporting on our successes toward bird conservation in the Gulf region.

★ **Monitoring** data across species, taxonomic groups, habitats, and questions are being collected in a coordinated framework to support region wide analyses. Progress towards this goal will be evaluated during regular GoMAMN Community of Practice meetings. Many of our stakeholders view program-level analyses as being the most feasible in the next five years, as well as being highly valued.

★ **Data sharing** becomes a common ethos across our stakeholders, including the GoMAMN Community of Practice. Further, as individual monitoring projects are completed, data—along with their respective metadata — are being archived in suitable and supported repositories.

★ **Consensus** among stakeholders and the GoMAMN Community of Practice regarding the selection of a specific online data portal that is consistently used for storing and archiving all avian monitoring data in the Gulf region.

Coordinated, collaborative, integrated avian monitoring is essential to advancing bird conservation in the GoM, and to supporting full GoM ecosystem restoration in response to the Deepwater Horizon Oil Spill. By working together in a deliberate way GoMAMN partners can ensure that their data has the greatest possible value to the birds they monitor, as we work together to conserve bird populations at many scales and through many challenges.

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