Gap Analysis of Collective Performance on Established Stakeholder Values by Contemporary Gulf of Mexico Bird Monitoring Programs

Final Report, Phase 2: Waterfowl Programs

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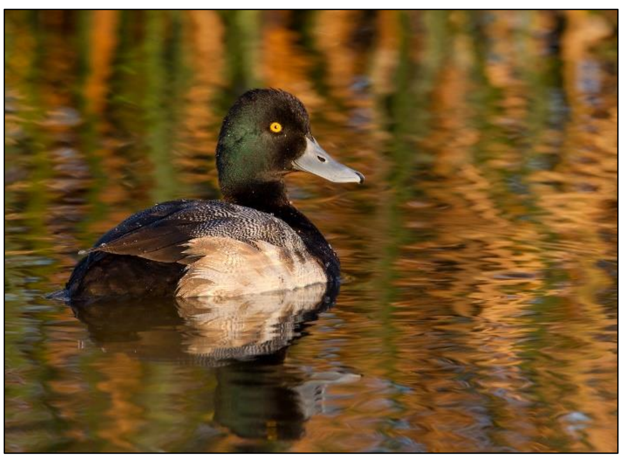
Ducks Unlimited



February 2022

Prepared in cooperation with the U.S. Fish and Wildlife Service for the Gulf of Mexico Avian Monitoring Network (GoMAMN).

DISCLAIMER: The presentation of results from the analyses herein are meant for summary and comparative purposes only. Monitoring programs included and evaluated herein represent independent, stand-alone efforts, each with specific governing bodies and/or oversight, each with different objectives and different levels of investment for monitoring, as well as which species are priorities for monitoring. As such the results from this gap analysis are not meant as value judgments for or against any individual monitoring program. Rather, the current effort and any future gap-related surveys will be used to gauge GoMAMN progress towards achieving the broader partnership goals/objectives over time.

For more information about the Gulf of Mexico Avian Monitoring Network (GoMAMN) or its information products, visit https://gomamn.org.

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Cover photos: (left) Lesser Scaup; (right) Mottled Duck. Photo credits: Ron Bielefeld, Florida Fish and Wildlife Conservation Commission.

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INTRODUCTION

Coastal habitats are increasingly impacted by an array of anthropogenic activities and climatic changes that occur at multiple spatial scales. In the Gulf of Mexico, bird populations face challenges with sea-level rise, extreme weather events, commercial and residential development, energy development, pollution, and other factors that often cross physical and political boundaries (Baldera et al. 2018, Burger 2018). Unfortunately, developing and implementing monitoring strategies that allow for strong inference of broad-scale impacts to bird populations is challenging due to the diversity of ecosystems, economic use, and decision-making jurisdictions (see Wilson et al. 2019a). A piecemeal approach to monitoring can have negative implications for the conservation of migratory birds, as exemplified by the paucity of baseline data that was critically needed (but largely unavailable) in the aftermath of the Deepwater Horizon oil spill in 2010, which impacted coastlines from Texas to Florida (Deepwater Horizon Natural Resource Damage Assessment Trustees 2016). A lack of comprehensive, integrated bird resource data prior to and following the spill slowed the mobilization of monitoring/response and prevented meaningful evaluation of on-the-ground response efforts (see Bjorndal et al. 2011, Love et al. 2015, Woodrey 2017). In the years since the spill, there has been an unprecedented focus on (and dedicated resources for) coastal recovery and restoration of injured resources, including birds (Deepwater Horizon Natural Resource Damage Assessment Trustees 2016, 2017).

In this context, a diverse group of partners across the northern Gulf coast with a shared interest in a comprehensive approach to bird monitoring established the Gulf of Mexico Avian Monitoring Network (GoMAMN). GoMAMN's purpose is to promote collaborative, integrated avian monitoring across the Gulf of Mexico, and the group utilized principles of decision theory and conceptual models to tackle this challenge (Fournier et al. 2021). Using a structured decision-making framework, partners and stakeholders have collectively identified the core values and concerns underpinning bird monitoring efforts in the Gulf of Mexico and used them to develop a set of fundamental objectives and sub-objectives (Wilson et al. 2019b, Fournier et al. 2021). These objectives serve as a framework for maximizing the utility of bird monitoring data to inform restoration and advance bird-habitat conservation across the northern Gulf of Mexico.

Understanding the current monitoring practices, knowledge gaps, and data needs is vital to maximizing the usefulness of bird data within an integrated framework (Adams et al. 2019). Having established a list of stakeholders' key values and objectives regarding bird monitoring, GoMAMN's next step was to determine how well the monitoring community of practice in the Gulf of Mexico is collectively addressing/meeting GoMAMN's objectives. With this goal in mind, we conducted a gap analysis of contemporary bird monitoring efforts (e.g., Schulz 2021) focusing on the three fundamental objectives identified by GoMAMN stakeholders during the SDM process: (1) maximize relevance of monitoring data, (2) maximize integration of bird monitoring efforts, and (3) maximize scientific rigor (Fournier et al. 2021). Additionally, stakeholders further broke down the topic of "relevance" into the following sub-objectives: (1.1) maximize monitoring of management effectiveness, (1.2) maximize monitoring of population and habitat status, and (1.3) maximize monitoring of ecological processes. Collectively, these sub-objectives help define the aspects of monitoring relevance, integration, and rigor that are most important to stakeholders.

METHODS

To better understand various aspects of current monitoring practices, it was necessary to compile a list of active waterfowl monitoring programs across the Gulf of Mexico. In the interest of limiting our analysis to programs that are truly collecting monitoring data, we defined "monitoring program" as "any currently-active effort where birds are repeatedly counted or surveyed with a duration of at least 5 years." Programs were required to collect at least one bird-specific parameter such as presence/absence, relative abundance, productivity, and/or the birds' locations.

An inventory of bird monitoring programs constructed for a gap analysis of Gulf monitoring programs (Love et al. 2015) served as the foundation for the current effort. Additional programs were added to the list as we were made aware of them, often with assistance from representatives for other programs and via GoMAMN Waterfowl Working Group members. It is common for monitoring programs to undergo changes over time, so program records were further evaluated via one-on-one conversations with points-of-contact (POC) for those programs, who confirmed if all information was accurate and up to date, and if not, where changes needed to be made.

Some programs in our inventory are organized as a collection of sub-components (e.g., refuge-scale Mid-Winter Waterfowl Survey efforts, which are local programs nested under the U.S. Fish and Wildlife Service's regional/flyway-organized Mid-Winter Waterfowl Surveys). We kept records of both "parent" and "child" programs in the inventory; however, we only included survey responses for "parent" programs (i.e., programs at their largest operational scale) in our analysis to avoid redundancy.

GoMAMN's stated objectives, and, in some cases, the specific metrics by which they can be measured, provide a means of evaluating current monitoring practices and identifying opportunities for improvement and integration. We developed a list of "parameters of interest" based on the 27 sub-objectives and priority needs as described within Fournier et. al. (2021) and the respective taxa-based chapter for waterfowl (DeMaso et al. 2019) within the Strategic Bird Monitoring Guidelines for the Northern Gulf of Mexico (Wilson et al. 2019a).

To understand how each monitoring program performs relative to each of these parameters, we designed a survey which, when completed by a representative from each program (hereafter "participant"), provided direct and indirect information about how each program performs relative to

GoMAMN's parameters of interest (Appendix A). Survey responses thus populated the data set used in this analysis. Since we are analyzing program data collectively in the interest of evaluating Gulf-wide performance on these parameters, we designed questions that allowed participants to describe the relevant aspects of their programs such that they could be summarized quantitatively and/or qualitatively (refer to Results section). Participants' responses to some questions can be used to gauge collective performance for the identified parameters collectively (e.g., species monitored, scale, etc.).

Questions were designed to evaluate most, but not all of the sub-objectives identified. Some sub-objectives focus on the "appropriateness" of certain project aspects (such as the appropriateness of survey design, stated objectives, and target taxa relative to the research question), and thus, are more useful in the context of evaluating individual project proposals. Other questions were deemed not relevant to this effort, either because they were simply too difficult to gauge a response or because they represented a value judgment for a specific monitoring program. Ultimately, we omitted five sub-objectives from the survey completely and replaced ten with questions that solicit descriptive information relevant to the topic. Additional basic data about programs (i.e., program lead, agency, state, etc.) were collected and served to uniquely identify each monitoring program. However, this information was not included in the analysis and is not considered further herein.

Surveys were requested following the updating of program records and received on a rolling basis during 2020 and 2021. As each survey was received, it was reviewed for completeness. At this time, any clarifications needed were addressed via phone or email contact with the monitoring program POC prior to converting the associated data into spreadsheet format. Once all survey records were deemed complete, we quality-checked the participants' data on a line-by-line basis to ensure that data entered matched data submitted. A small number of participants were contacted following this step to address any outstanding questions or issues.

We performed summary statistics (e.g., frequency, number or proportion, mean, etc.) for each question based on the survey results we received. For multiple-choice questions, this meant tallying how many programs chose each option for each question. Several questions were in open-response format, meaning participants could respond by submitting written responses in a text box provided. As expected, written responses showed a great deal of variation, so we reviewed responses collectively and summarized trends in responses relevant to each topic. Survey questions were arranged in a slightly different order from their order in Fournier et al. (2021); here to provide ease of interpretation for participants. Results presented herein (see below) represent the order of survey topics submitted to participants.

RESULTS

We sent the survey to representatives from 23 programs in the Gulf of Mexico that monitor waterfowl and received responses for 13 programs (57% response rate). We removed 2 responses from this data set because their programs either did not meet evaluation criteria (e.g., 5-year minimum, not a current waterfowl monitoring program) or because they were technically nested under a broader parent program (which may or may not have participated). However, two responses from programs that were considered "partially nested" (i.e., they constituted a sub-component of a broader program to which they contribute data, but also collect additional data to address local needs independently from the parent program) were included in the data set to represent the more local efforts, specifically. Thus, 11 total responses for waterfowl monitoring programs are included in this analysis (refer to Appendix B for complete list of participating programs).

Relevance of monitoring data

Population and habitat status: Nine of the 11 participating programs monitor at least one of GoMAMN's bird species of conservation concern (Wilson et al. 2019b; hereafter "priority species" for brevity). The other two programs monitor Wood Ducks specifically, which are not one of GoMAMN's priority species. Three programs (27%) monitor one priority waterfowl species, and six programs (55%) monitor >1 priority species (Figures 1-2). Eight (73%) programs focus on monitoring birds within a single taxa group (waterfowl) while three other programs cover birds representing 2-7 taxa groups, with one program monitoring species from all taxa groups (Figure 3).

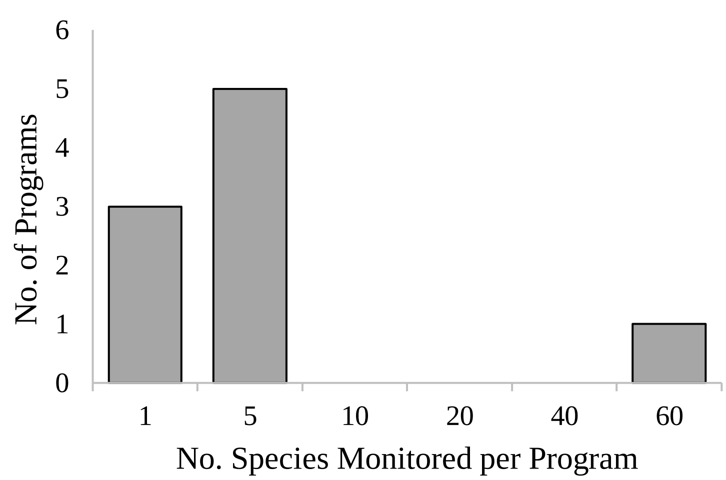

Figure 1. Number of priority species monitored by Gulf of Mexico waterfowl monitoring programs. Bars show number of species per program that are found on GoMAMN's list of bird species of conservation concern (see DeMaso et. al. 2019 for lists of priority waterfowl species).

Lesser Scaup and Northern Pintail, species that use the Gulf coast as migration and overwintering habitat, are each monitored by the same six programs (Figure 2). These programs include four local programs (one located in each Gulf state except for Texas), one multistate program which covers Louisiana, Mississippi, and Alabama, and one international program monitoring all avian species. Mottled Duck, representing 2 management populations (Florida population and Western Gulf Coast population; Bielefeld et al. 2020), are considered year-round 'residents' along the northern Gulf coast, and are monitored by nine programs, including the six programs monitoring Lesser Scaup and Northern Pintail, plus one multistate and two local programs that focus specifically on Mottled Duck.

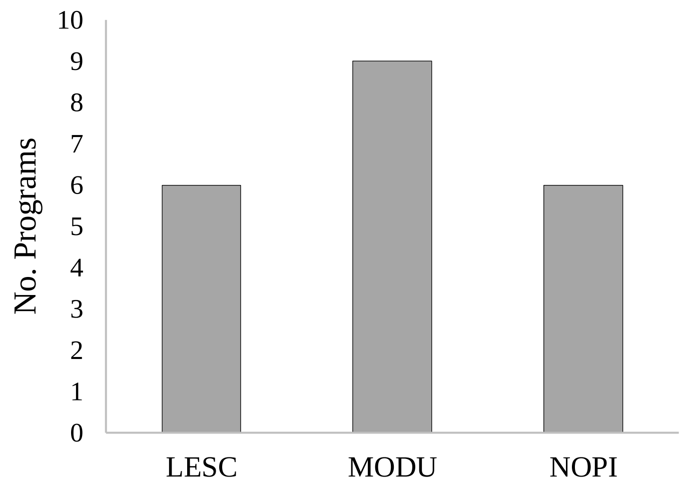

Figure 2. Number of programs monitoring each priority waterfowl species in the Gulf of Mexico. Four-letter codes on X-axis represent standardized species-specific "alpha" codes established by the AOU for use as shorthand. LESC = Lesser Scaup *(Aythya affinis)*, MODU = Mottled Duck *(Anas fulvigula)*, and NOPI = Northern Pintail *(Anas acuta)*.

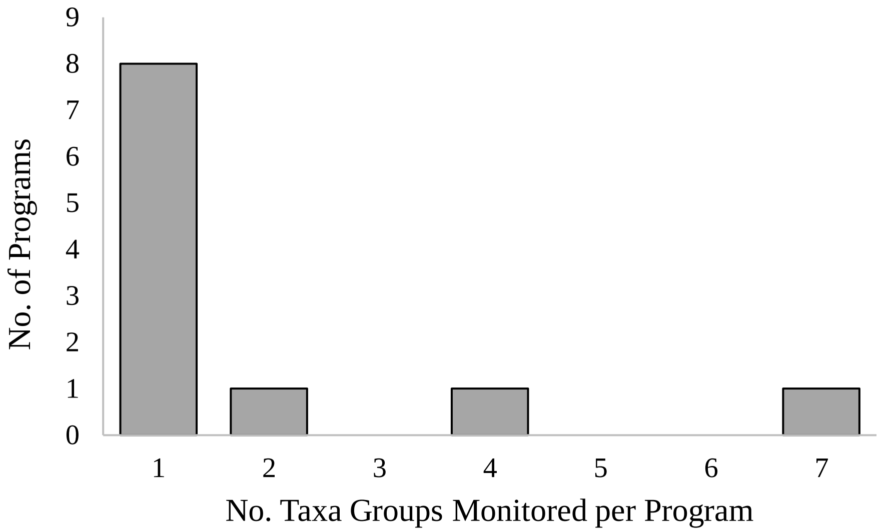

Figure 3. Number of avian taxa groups monitored per Gulf waterfowl monitoring program. Each priority bird species a program monitors falls into one of seven taxa groups (landbirds, marsh birds, raptors, seabirds, shorebirds, wading birds, waterfowl) identified in GoMAMN's Strategic Bird Monitoring Guidelines (Wilson et al. 2019). While all programs included in this analysis monitor waterfowl, some of these programs also monitor birds that fall into other bird taxa groups.

The duration of Gulf waterfowl monitoring programs ranges from 7-121 years (Figure 4). Only one program surveyed was initiated over the last decade, and while our duration criteria would have omitted programs initiated after 2016, we are not aware of any waterfowl programs that were initiated after 2016, that span ≥5 years, and remain currently active.

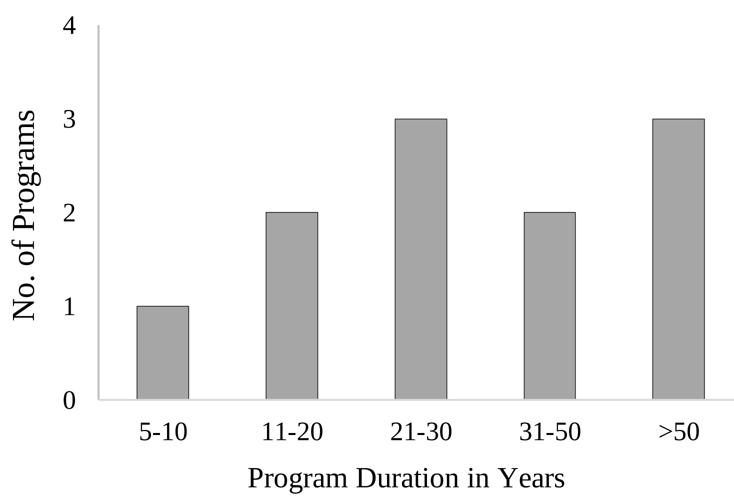

Figure 4. Monitoring duration of currently active Gulf waterfowl monitoring programs. Bars show the number of programs for which the duration of monitoring falls within the year ranges shown.

Gulf waterfowl monitoring programs occur at a wide variety of spatial scales (Figure 5). Several waterfowl monitoring programs surveyed (*n* = 5, 45%) currently monitor birds at a local scale, defined for our purposes as a footprint smaller than statewide relative to the species' range in that state. Examples of local-scale programs include those targeted at a single site (e.g., a National Wildlife Refuge, restoration site, city beach, etc.) or multiple sites that are clumped in relatively close proximity (i.e., not well-distributed across a species' statewide range). On the other end of the spatial-scale spectrum, one international program (program that conducts monitoring in the United States and at least one other country) that also includes waterfowl species operates in the GoM.

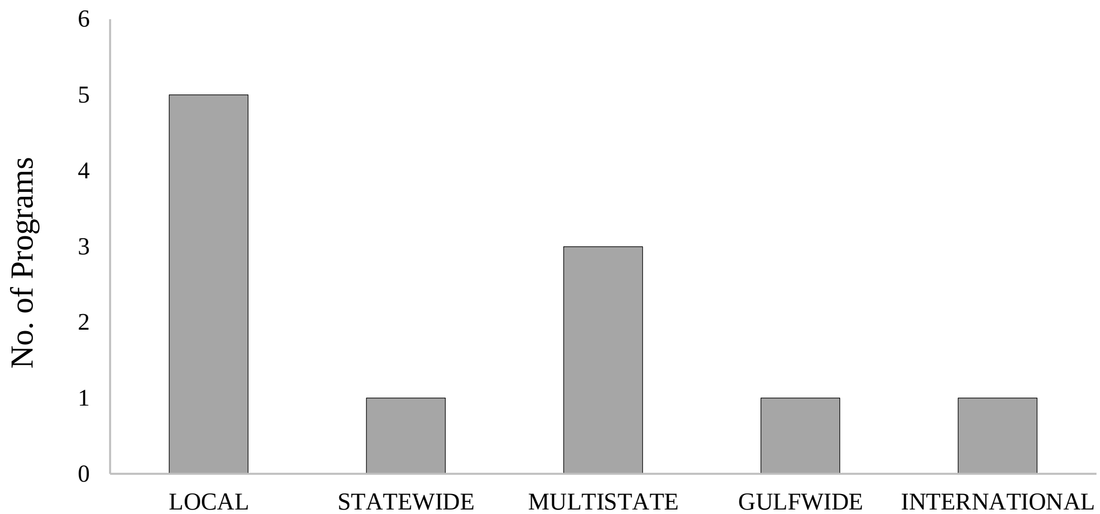

Figure 5. Geographic scale of Gulf waterfowl monitoring programs. Currently, 45% of programs occur at the local scale, e.g., individual sites or multiple sites not spread across a species' statewide range.

GoMAMN stakeholders value maximization of the spatial and temporal scope of habitat quantity and quality assessments (Wilson et al. 2019). We asked programs if they collect habitat quality data, what types of data they collect, and over what timeframe(s). Only one participant (9%) indicated that their respective program collects data about habitat quality, reportedly collecting the "type" or classification of wetland habitat at all survey sites.

Ecological processes: The GoMAMN waterfowl working group identified 10 key ecological process uncertainties for waterfowl (see Appendix C). Program leads were asked to refer to this table and select any/all uncertainties being addressed by their respective monitoring program. None of the uncertainties identified by DeMaso et al. (2019: table 9.3) is currently being addressed by the programs that participated in this survey. Two programs stated that they currently collect data about ecological processes, but they are not addressing the specific uncertainties as identified herein (Appendix C).

Management effectiveness: Of the 11 participating programs, 6 (55%) are monitoring birds in the context of understanding management or restoration actions. As with ecological process uncertainties, we asked program leads to refer to a table of specific uncertainties identified as "priorities" by the GoMAMN waterfowl working group (Appendix D) and list which uncertainties are addressed by their program. Leads for three programs stated that they monitor in the context of management/restoration uncertainty generally, but that their respective waterfowl monitoring programs do not explicitly address any of the uncertainties identified by GoMAMN (DeMaso et al. 2019: table 9.2). The other three programs each stated they are addressing between one and 13 uncertainties from the list.

Of the 21 uncertainties identified for waterfowl, 14 were identified as being addressed by existing waterfowl monitoring programs (Figure 6). The three most commonly addressed uncertainties (addressed by two programs each) are related to understanding the consequences of low/reduced water conditions, limited wetland availability, and drought-like conditions on reproductive success and various non-breeding metrics for Mottled Ducks, Northern Pintail, and other ducks across seasons (uncertainty codes 163, 164, and 178).

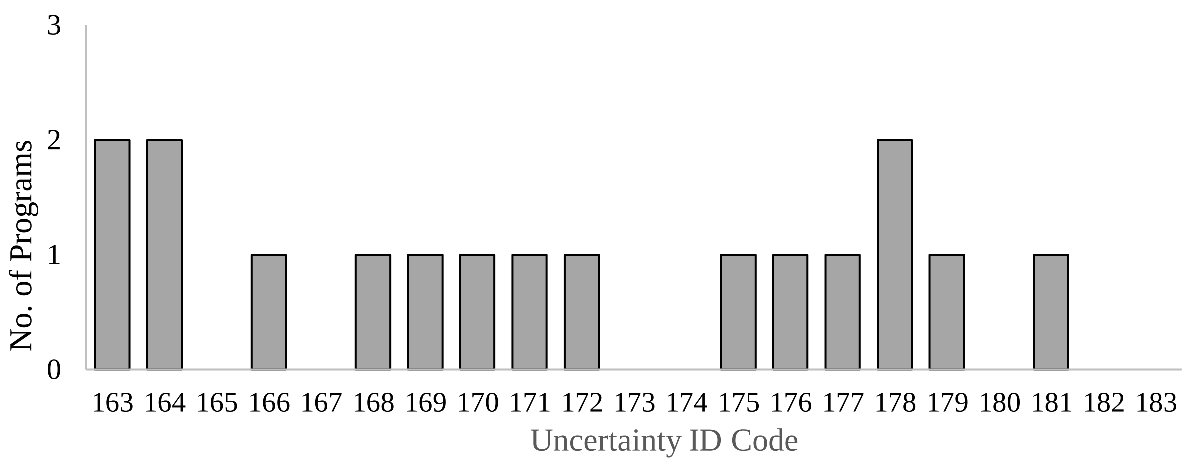

Figure 6. Management uncertainties addressed by current Gulf waterfowl monitoring programs. Each bar represents the number of programs addressing a specific ecological process uncertainty, which is indicated by the uncertainty ID code below it. These codes correspond to the uncertainty descriptions in Appendix D (Table D1).

Six management/restoration uncertainties regarding waterfowl remain unaddressed. Currently, none of the programs surveyed are aimed at understanding potential effects of declines in rice acres and production on breeding Mottled Ducks and/or wintering waterfowl (uncertainty code 165), effects of human disturbance on wintering waterfowl body condition/migration departure dates (167), effects of wind energy development on overwinter survival (173) and body condition (174) of Redheads, effects of reduced water availability on breeding season survival of adult female Mottled Ducks (180), or the effects of grassland habitat loss and fragmentation on breeding Mottled Ducks (182 and 183).

We asked participants a series of questions to determine whether they are monitoring birds in the context of adaptive management. These questions were distilled from key concepts about adaptive management as defined by Williams et al. (2009). Thus, definitions used are consistent with GoMAMN's terminology (Wilson et al. 2019a, Fournier et al. 2021). Based on the responses we received, no current waterfowl program is explicitly following adaptive management per the definition ascribed in Williams et al. (2009). However, several programs are very close to meeting these criteria (refer to Table 1 below). Of the programs monitoring in the context of understanding management/restoration action, one would qualify as "(conducted in the context of) adaptive management" under our criteria *if* decision makers and other stakeholders identified a key uncertainty about the management action that impedes decision-making, and one would qualify *if* monitoring were associated with a conceptual model or set of hypotheses about how management actions affect birds.

Table 1. Adaptive management tenets met by current monitoring programs. Questions below are from the survey form used by participants (Appendix A). Percentages shown are relative to the subset of programs that are monitoring in the context of understanding the effects of management actions (n = 11).

Survey question	**# of programs that answered "YES"**
a: "Is monitoring linked to an explicit management objective?"	5 (45%)
b: "Is/are the management action(s) being monitored associated with iterative decisions?"	5 (45%)
c: "Have decision makers and other stakeholders identified a key uncertainty about the management action that impedes decision making?"	3 (27%)
d: "Is monitoring associated with a conceptual model or set of hypotheses about how the management action/decision impacts birds?"	2 (18%)
e: "If 'yes' to question d, are multiple conceptual models being considered and compared, as in a multi-model framework? AND if so, is there an explicit (formal) process for updating model/hypothesis weights to reduce uncertainty and inform decision-making?"	2 (18%)

Integration of bird monitoring efforts

As currently defined in Fournier et al. (2021), the six sub-objectives in this field serve primarily to guide decision-makers in the context of choosing where to allocate resources among multiple monitoring project proposals and are thus outside the scope of this particular effort. However, we are interested in knowing current program performance related to these objectives. We did not address two sub-objectives that were less relevant to the scope of this analysis ("*Broad Impacts*" and "*Leverage*") and replaced two ("*Data Sharing*" and "*Alignment*") with simple descriptive questions as a means to improve our understanding of existing monitoring programs.

Existing priorities: Participants were asked if their program addresses established priorities in any existing conservation plans (e.g., North American Waterfowl Management Plan, state wildlife action plans, etc.). If a participant chose "Yes," they were prompted to explicitly identify which existing conservation plan(s) were linked to their programs' monitoring efforts. This follow-up question was framed as an open response, so participants could answer as they deemed appropriate. As a result, response formats varied and were more qualitative than quantitative in nature, challenging interpretation. Six programs claimed they do not address priorities in any existing national, regional, or state-specific bird monitoring plans. Three participants gave us the exact titles of conservation plans with priorities addressed by their programs. The remaining two programs responded that they do address existing plans/priorities, but other than mentioning harvest management/support plans, did not provide explicit linkages to specific plans. The following plans were each identified by one program: Texas Waterfowl Strategic Plan, Mississippi's State Wildlife Action Plan, East Coast Gulf Coastal Plain Joint Venture Implementation Plan, and North American Waterfowl Management Plan.

Partners and alignment: Current programs range widely in the degree of partnership/collaboration involved in waterfowl monitoring efforts. All participants stated that they partner with at least one other organization for their monitoring efforts, listing anywhere from one to over 900 partners (Figure 7). However, the median of that range is two, so the data are heavily skewed toward two or fewer partners.

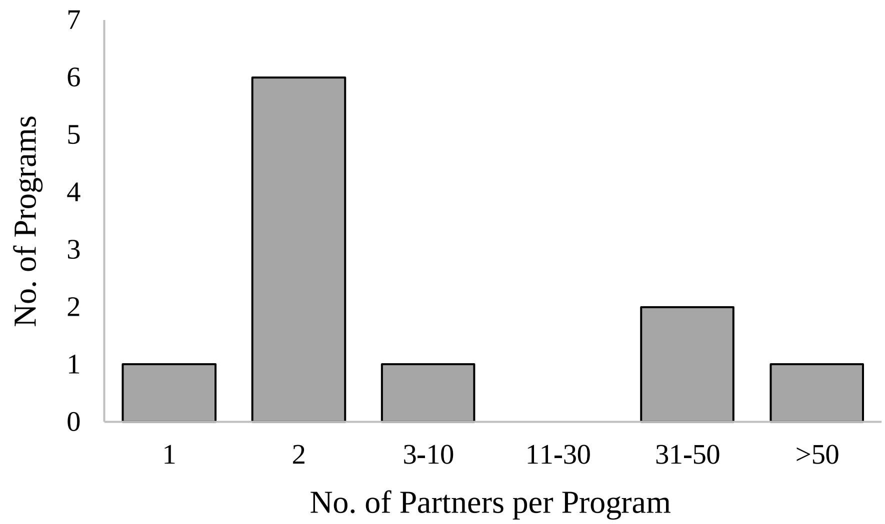

Figure 7. Chart showing the variation in the number of organizations participants identified as partners on their monitoring programs. All programs partner with at least one organization, and 91% claimed to have two to 900+ partners.

Of the 10 monitoring programs that partner with $\geq$1 organization, all have more than one type of partner. Federal government agencies were the most common partner (82%), followed by state government agencies (64%) and academic institutions (36%). Non-governmental organizations and private companies also served as program partners (27% and 9%, respectively). Twenty-seven percent percent of programs also claimed "other" (unspecified) types of partners. Three participants (27%) stated that their monitoring is generally in alignment with other monitoring programs while four (36%) said theirs is not, and four (36%) were unsure if their monitoring is or is not in alignment with other programs.

Data sharing and storage: Data collected by the vast majority of programs are generally not restricted from being shared, at least officially. Only 9% of programs (n = 1) are officially restricted from sharing data, potentially because the data include sensitive information (e.g., locations of sensitive species, personally identifying information, etc.). We did not specifically ask participants to explain their reason(s) for data sharing or not. Approximately 36% of the programs surveyed (n = 4) have not established a formal plan to share their data with the broader scientific community in any specific timeline, or do not intend to share waterfowl monitoring data. Of the 64% that have established timelines for sharing, all (n = 7) plan to share within 1 year of project completion.

Participants were asked where their monitoring data was currently stored (or would be stored in the future) and given options to choose from in the form of a dropdown menu. If their storage location was not on that list, or if they use more than one repository for data storage, they were able to provide that response in a separate field. Eight programs (73%) reported that their data were not stored in a shared location but stored locally in a manner not accessible to others (may include options such as physical datasheets, electronic files stored on a local hard drive, etc.). However, two of those programs do share *some* of their data (related to the Mid-Winter Waterfowl Survey) via the U.S. Fish and Wildlife Service (USFWS) Migratory Bird Data Center. The Christmas Bird Count and USFWS National Wildlife Refuge System ServCat databases were also used by a single program each. See Table 2 for a summary of data storage responses.

Table 2. Data repositories currently in use by waterfowl monitoring practitioners in the northern Gulf of Mexico.

Data Repository	**Program Count**
Data stored locally/in-house (i.e. not in shared repository)	8
Christmas Bird Count	1
USFWS Migratory Bird Data Center	2
USFWS NWRS ServCat database	1
USGS Bird Banding Laboratory	2

Scientific Rigor

As written, all eight sub-objectives under this fundamental objective are somewhat outside the scope of this analysis; some more so than others. Rather than ask questions about certain aspects of monitoring programs that do not provide relevant insight regarding existing monitoring programs (*"Target Taxa," "Statistical Rigor*," *"Budget,"* and *"Timeline"* as defined in Fournier et al. 2021), we replaced the remaining sub-objectives (below) with descriptive questions to enable us to loosely summarize responses and evaluate for commonalities if they existed.

Monitoring objectives: Ten of the 11 programs surveyed (91%) self-identified as having a clearly stated/defined monitoring objective or hypothesis. Participants were asked to state these objectives/hypotheses in a free-response field. In the context of evaluating individual proposals, GoMAMN recommends that proposals should construct objectives/hypotheses that are clearly defined and also appropriate to answer the research questions at hand (Adams et al. 2019). For the purpose of this analysis, we are instead interested in identifying any 'trends' in the stated objectives of current monitoring programs. We identified some broad categories of objectives based on priorities identified by GoMAMN stakeholders and added some others based on common practices (Table 3). We then reviewed participants' responses to both the objectives/hypotheses question and the question about response variables and determined how many programs could be ascribed to each category. Most programs had more than one objective and several categories overlap topically, so programs could potentially be assigned to multiple categories.

We selected three categories/themes because they were identified during GoMAMN stakeholder workshops as three primary needs underpinning Gulf restoration: (1) evaluation of restoration/management actions (including harvest management); (2) establishment of baselines (especially populations and habitat); and (3) understanding ecological processes. Additional topics that emerged from survey responses included: descriptive goals, e.g., tracking species diversity or habitat use on a refuge and identifying important sites for sensitive species; productivity, e.g., nest success, abundance of breeding pairs; spatial patterns, e.g., distribution, density, mapping; conservation support, e.g., stewardship of breeding areas or monitoring with a goal of explicitly inform conservation action; and objectives that require tracking of individual birds, e.g., site fidelity, movement, and survival. Examples of overlap between categories include objectives such as tracking marked ducks to estimate harvest and survival rates in an area over time, which could fall in both the “population assessment” and “evaluation of management/restoration” categories.

Table 3. Common objectives of current Gulf waterfowl monitoring programs. Participants’ self-described objectives were grouped into categories based on topic/theme.

Topic/Theme	**# programs**
Status Assessment - Populations	8
Evaluation of management/restoration	4
Spatial patterns/distribution	3
Tracking individuals	3
Productivity/Breeding metrics	1
Conservation support	1
Understanding Ecological Processes	1
Descriptive	0
Status Assessment - Habitat (Quan., Qual., Veg, Trash, etc)	0
Meeting mandated requirements	0

Sampling/survey design: Participants were asked to specify what kind of sampling/survey design they use. To demonstrate what kind of “design” we were looking for, we offered some examples, including “simple random, simple non-random, treatment/control (randomized or non-randomized), BACI (before-after/control-impact), and panel.” However, this was another “free-write” field, so participants could include whatever description they deemed appropriate. As such, we ended-up with a wide variety of responses. Our interest in this field is mostly descriptive, so we summarized common themes from the responses we received.

All programs (*n* = 11) surveyed responded to this question. Five participants simply named a formal survey design type, but the others briefly explained their approach/activities. Several programs performed mark-recapture or collected hunter harvest information voluntarily from hunters; not conducting "surveys" as typically defined. One large-scale program stated that survey methods vary among states.

We also reviewed the survey responses for survey design terms, including the examples we suggested. The following design terms came up $\geq$1in survey responses (number of times specified): "non-random" (3 responses), "transect" (3 responses), "systematic" (2 responses), "opportunistic" (2 responses), "simple non-random" (2 responses), "stratified random sample" (2 responses), and "systematic, non-random" (1 response).

In a separate question, we asked if a formal power analysis had been performed when designing (or revising) their study. Only 27% (*n* = 3) responded affirmatively. Three other participants were unsure if one had been done or not.

Data management: We asked participants a series of questions regarding specific aspects of data management strategies. Approximately 36% of programs (*n* = 4) have explicitly documented data management plans for managing waterfowl monitoring data. Over half (*n* = 6, 55%) of programs reported that they collect data in a standardized way (e.g., datasheets), but three (27%) were unsure. If data manipulation is necessary following its collection, only 9% of programs (*n* = 1) manipulate data in a way that such manipulation can be tracked/documented (e.g., using a program like SQL or R). Thirty-six percent of participants (*n* = 4) were unsure if this was the case for their program. Only one program (9%) follows documented metadata standards as part of its data management plans (36% were unsure, *n* = 4). A majority of programs (*n* = 7, 64%) perform QA/QC on their data before sharing (9%, n = 1 program was not sure).

DISCUSSION

The results of our survey are primarily descriptive, but they shed some light on the current status of waterfowl monitoring efforts in the northern Gulf of Mexico. Thanks to previous work drawing on the experiences of experts across the Gulf (Wilson et al. 2019a), we began this project with an understanding of specific knowledge gaps for waterfowl (see DeMaso et al. 2019). Ideally, resolving issues related to integration and scientific rigor will facilitate the relevance of bird monitoring programs and perceived gaps (Adams et al. 2019). Prior to this effort, we did not know the level of monitoring effort currently targeting these areas by programs monitoring this taxa group. Thus, we attempted to quantify the degree and scale at which important uncertainties are being addressed, as well as the scale/severity of various "process gaps" contributing to the "knowledge gaps"; that is to say, to what degree are monitoring programs integrating across both time and space, and what "best practices" are being implemented to address scientific rigor.

Relevance of monitoring data

Our results for contemporary waterfowl monitoring programs confirm several findings identified in the Love et al. (2015) report about Gulf bird monitoring. Most programs are aimed at assessing population size and trends over time. The longevity of Gulf waterfowl monitoring programs stands in contrast to seabird and shorebird monitoring programs. While almost half of contemporary seabird and shorebird programs have been initiated in the years following the Deepwater Horizon oil spill in 2010 (Schulz 2020), only one of the waterfowl programs we surveyed was initiated in the last decade (though we are aware of a handful of programs that were initiated post-spill but subsequently discontinued, thus were excluded from this analysis). The other programs range in duration from 12-121 years, providing for assessment of long-term population trends.

Programs we surveyed are currently only addressing one of the monitoring priorities identified in the Waterfowl Chapter (DeMaso et al. 2019) of GoMAMN's Strategic Bird Monitoring Guidelines (Wilson et al. 2019a). Most waterfowl programs we surveyed are generating estimates of population/abundance, including several programs that are focused on wintering waterfowl, a high-priority need. However, with the exception of the Mid-Winter Waterfowl Survey, most of these waterfowl monitoring efforts are relatively small in spatial scale or even conducted at site-scale. The Mid-Winter Waterfowl Survey has been criticized for inconsistency in survey methods and/or lack of a robust survey design (e.g., Eggeman and Johnson 1989, Heusmann 1999; see also Andersson et al. 2015) which limits both associated rigor and the value of associated data in decision-making, despite its relatively broad spatial scale application (see Soulliere et al. 2013). In addition, no programs we surveyed are employing the kind of telemetry techniques that allow for the detection of individual movement. If unsurveyed programs are similar to those included in this analysis, this apparent lack of rigorous, broad-scale abundance and local movement data inhibits our ability to answer the important question, "are we increasing populations or just moving birds around?" Furthermore, Mottled Duck banding that focuses on understanding survival of breeding adult females is not occurring (at least in our sample of programs), nor are any programs we surveyed looking at the survival of broods or young to fledging (though short-term efforts not included in this analysis, e.g., graduate projects, may focus on this topic). However, Mottled Duck banding for survival and harvest estimates is occurring, as are surveys designed to generate population estimates of breeding Mottled Ducks.

Status and trends information regarding habitat quantity/quality is generally not addressed aside from a single program that is documenting broad habitat types used by wintering waterfowl. Another major gap exists with regards to ecological process monitoring, as we found that none of GoMAMN's stated ecological process priorities are being addressed by current waterfowl monitoring programs. A few programs are geared at understanding management effectiveness, including harvest management. However, only three are addressing GoMAMN's priority uncertainties in this area. Interestingly, a single, local-scale program is addressing the majority of the uncertainties identified in DeMaso et al. (2019: table 9.2) (see Fig. 6). Two other programs are addressing one and three uncertainties respectively; the majority of programs do not address any.

Current programs are doing a good job at focusing monitoring efforts on priority species. Aside from two Wood Duck-focused programs, all programs are monitoring at least one of GoMAMN's priority waterfowl species (Mottled Duck, Northern Pintail, and Lesser Scaup). Three programs are Mottled Duck-specific, while the others collect data on $\geq$3 species. Generally, these programs are waterfowl-focused; eight programs collect data on waterfowl exclusively while three monitor two or more taxa groups. Wood Ducks, while not identified as a priority species by GoMAMN, remain an important species for monitoring due to their importance as a harvestable species.

None of the programs we surveyed are currently operating in a true adaptive management context (see Williams et al. 2009; see also Williams and Brown 2012). However, two programs reported that they are close (i.e., within one criterion) to meeting that standard. These programs both monitor waterfowl in the context of harvest management. Only one program is collecting data on waterfowl health metrics. However, data regarding contaminants, a management uncertainty gap identified by GoMAMN's Waterfowl Working Group, remains unaddressed by programs surveyed.

Integration of bird monitoring efforts

Generally, waterfowl monitoring programs show a low degree of integration. The majority of programs surveyed store data locally, although some share a portion of their data on publicly accessible sites or are willing to share data upon request. The majority also did not identify a single conservation plan priority addressed by their programs. It's possible that programs do address existing priorities that program leads are simply unaware of. For example, it could be argued that most (if not all) waterfowl monitoring programs would be in some way linked to the North American Waterfowl Management Plan, even if they do not explicitly acknowledge this as most states apply for and/or receive NAWMP funding or otherwise benefit (i.e., hunters benefit) from related plans and conservation efforts. Still, this seems like an opportunity for improvement.

Number of partnerships was generally low, as was the number of programs claiming that their work aligned with others'. While these metrics do not necessarily reflect the degree of program integration in every situation, it is possible there are opportunities for programs to coordinate between one another. How exactly to do this will vary by program and be up to program leads. In conversations, multiple leads expressed a lack of time and resources to dedicate to such efforts, indicating that increased attention and resources directed to on-the-ground monitoring may provide for future integration of monitoring. As waterfowl-specific programs tend to be fairly "siloed," it may also benefit Gulf monitoring to provide a resource for connecting with one another, such as a tool that elucidates who is doing waterfowl monitoring and where.

Several programs stand out as being fairly well integrated. The Christmas Bird Count is an international program that does not focus explicitly on waterfowl but collects data on all birds observed during a single-day survey annually (e.g., Nevin and Butcher 2011). This program, which provides for high-level population estimates for all species, is also the oldest program included here (~120 years). Of the waterfowl-specific programs, two that occur at larger spatial scales (thus, requiring more partnerships/integration) include two U.S. Fish and Wildlife Programs: Wood Duck Pre-season Banding and the Mid-Winter Waterfowl Survey. While these programs have a low number of organizational partners because they involve primarily USFWS staff, they require coordination between many Service-managed refuges across the Gulf. Despite the high level of coordination, the Mid-Winter Waterfowl Survey seems to be in a pattern of de-integration, as some refuges and even states (e.g., Florida) have ended their participation. The Western Gulf Coast Mottled Duck Breeding Population Survey has developed as a partnership between Louisiana Department of Wildlife and Fisheries, Texas Parks and Wildlife Department, Gulf Coast Joint Venture, and the USFWS that surveys breeding Mottled Ducks across Texas and Louisiana. This program has put considerable effort into designing a scientifically rigorous survey that provides for reasonably precise estimates (with associated region-specific VCFs; USFWS (2018)) of the Mottled Duck breeding population in the region.

Scientific Rigor

Data management is a key component of monitoring integration and rigor. GoMAMN emphasizes the importance of programs having a detailed data management plan that outlines the acquisition, development, storage, and transfer of data. Only 36% of programs surveyed claimed to have such a plan, including one of two programs that collect non-avian covariates. In addition, roughly half of programs collect data in a standardized way, and very few programs track their data manipulation or manage metadata. Improved data management practices would strengthen the value and applicability of waterfowl monitoring data.

It is beyond the scope of this project to evaluate the appropriateness of programs' monitoring objectives and response variables; anecdotally, however, response variables appeared to align with programs stated objectives.

Limitations

Overall, our findings are limited in that a number of known and unknown waterfowl monitoring programs are missing from the data set due to time restrictions or lack of response to the survey. For example, our data set lacks any waterfowl programs occurring on National Wildlife Refuges in the state of Texas due to confusion about what programs are currently operating. Refuge programs in other states may be missing as well, but the complete lack of Texas programs limits our understanding of current efforts in a more systematic way. We continue to work toward adding these programs to GoMAMN's full inventory of monitoring programs, and future gap analysis efforts for waterfowl and other taxa groups should make every attempt to include missing programs to achieve the most complete data set possible.

One important program that is partially represented in our data set is the U.S. Fish and Wildlife Service's Mid-Winter Waterfowl Survey (MWWS). This is a national program which operates organizationally and functionally at the flyway scale. MWWS surveys in each of the four major U.S. migratory flyways is overseen by its own coordinator and data are compiled at the flyway level. Our intent for this project was to consider each of the three of the four flyways that cross the Gulf coast (the Central, Mississippi, and Atlantic flyways) as separate "programs." However, only the Mississippi Flyway program (covering Louisiana, Mississippi, and Alabama) is represented here. The Atlantic Flyway was omitted because Florida is the only Gulf state that is part of it, and that state ended its MWWS program around 2003. The Central Flyway includes Texas but is omitted here simply due to time constraints during data collection. The inclusion of this program should be a target for future gap analysis efforts.

Lessons Learned

These data likely form an inadequate "baseline" for future comparison. The size and completeness of the current data set almost certainly limits our understanding of current efforts. Because our data set is incomplete, as well as the small sample size, missing programs likely has an outsized effect on our results. For instance, some important large-scale monitoring programs that operate in the northern Gulf of Mexico, including the Central Flyway of the Mid-Winter Waterfowl Survey, the North American Breeding Bird Survey (BBS), and the MOTUS program, are missing from this data set. It also is likely lacking some local-scale programs that collect data for local needs, potentially in addition to participating in a larger parent program. It is hard to know what insights we are missing as a result.

The survey we designed could be easily repeated, and participants were informed of our intent to do so. Because the overall number of monitoring programs is small, it would be important for future surveys to include as many of the same programs as possible in the data set. For the parameters that are most relevant in "RFP-mode," we chose to avoid passing judgment on the "appropriateness" of elements like objectives, survey design, etc. at this time and instead see if common "themes" emerged from participants' responses that would help us describe current efforts in terms of these topics. This ad-hoc approach generated data that, while interesting, are too likely subjective to be used for comparison. The more quantitative data about how programs are currently operating (e.g., species being monitored, uncertainties being addressed, etc.) could hypothetically be compared to this data set. Still, several factors may make it difficult to directly compare those results.

Future integration of programs (which GoMAMN encourages) may complicate quantitative comparisons, as could leadership changes in programs that are not in the process of integrating. We approached survey responses collectively, summarizing the number of programs that responded in certain ways to our questions. Using this approach, the merging/replacement of programs represents a fundamental change to the study sample and will influence a direct comparison of these metrics, potentially in ways that appear “favorable,” at least superficially. In the likely event that personnel changes occur for some programs between surveys, variation in interpretation between past and current participants could result in within-program artifacts that could be difficult to account for given the small sample size. Thus, it will be important to look beyond the difference between survey results over time and look closely at the sources of these changes.

Ultimately, the value of these data as a “baseline” may depend on the comparison to be made and GoMAMN’s goals for each stakeholder fundamental objective or sub-objective/criterion. Because no specific goals or targets have been set for these objectives at the time of this writing, the concept of “progress” (unless defined as an increase in the number of programs that meet a certain criterion for these objectives) is currently ambiguous and difficult to measure. As mentioned above, a more effective way to measure progress over time might be to break the fundamental objectives and sub-objectives down into more specific goals (potentially by taxa group or other useful segments), define what “progress” would look like for those goals, identify critical obstacles, try various solutions, and conduct periodic assessments like this one to track progress and identify new obstacles. Using a “social psychology” approach to surveying program leads would be advantageous here, and we recommend exploring this option in more depth before attempting subsequent surveys. In the meantime, the sub-objectives that serve as criteria for integration and rigor are perhaps most useful in “RFP mode,” and less for obtaining a static measure of “how we are doing” right now or in comparison to another point in time.

Finally, we learned that the resource investment necessary to do this project well is greater than initially estimated. Construction of the program inventory and completion of the gap analysis (including data collection, analysis, and reporting for all seven taxa groups) was estimated to take six months. This project, as described in full in this report, ultimately took one person working 20 hours per week about three years to complete inventory updates for roughly half of the known monitoring programs and a gap analysis for three of the seven taxa groups. This does not include any of the additional time contributed by other GoMAMN colleagues in support of the project (see Acknowledgements). We also received feedback from several other programs doing similar types of projects, and they shared that it took at least 2-3 years for small teams to reach completion. Future plans to expand on this project, such as if

GoMAMN decides to expand the inventory and gap analysis to include the other four taxa groups, closer attention to the time and personnel required is warranted.

CONCLUSION

This snapshot of current waterfowl programs reveals more information about the Gulf monitoring community's strengths and weaknesses. In our conversations with program leads, we saw strong signals that monitoring practitioners in the Gulf are passionate about the birds they monitor and very much want to know that their efforts are contributing valuable data that serve conservation needs at local and population scales. Goals for waterfowl monitoring vary, as does interest in integrating efforts. While the programs surveyed predominantly focus on key metrics like abundance and distribution, critical information needs regarding ecological processes and management effectiveness relative to waterfowl remain unaddressed. Broadscale attention to monitoring relevance and data management is warranted. Members of the GoMAMN's Waterfowl Working Group have expressed an urgent need to conserve monitoring data sets for long-standing programs that have ended or are expected to end, which is a critical priority not captured in this data set.

GoMAMN is well-poised to facilitate future integration by learning more about the obstacles faced by these professionals, finding/assisting with solutions, and providing additional resources for practitioners. The high degree of between-program variation in objectives, scale, survey design, integration, jurisdiction, resources, and other factors (and the likelihood that program-specific challenges vary widely in nature as well) suggests that a qualitative approach to collecting this data will be advantageous, and that solutions coming from practitioners themselves may be more successful than a fully prescriptive approach.

Future efforts to understand "how we're doing" on stakeholder values and objectives would benefit from (1) more refined problem statements and clearer intentions for how the information will ultimately be used, and (2) a deeper dive into some of the integration- and rigor-specific objectives in GoMAMN's objectives hierarchy such that we clearly describe the values that underpin them and define the contexts in which they are relevant (i.e, "RFP-mode," gap analysis, baselines for comparison, etc.). Further exploration into ways of measuring progress for all objectives in various contexts would also be useful. Ultimately, these details can be used to guide recommendations, best practices, and support for monitoring practitioners, as well as track our collective progress toward a rigorous, integrated monitoring framework that enables practitioners to answer critical questions about natural processes and management decisions impacting priority species at the population level.

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APPENDIX A: Gap Analysis Survey Form

This section contains the survey form we designed to collect data from waterfowl monitoring practitioners in the northern Gulf of Mexico from January 2020 to August 2021. Following the construction of our inventory of monitoring programs, this form was emailed to the lead "point of contact" for each program with whom we had been in direct contact during the inventory update process. The responses we received from them formed the basis for our data set.

The seven-page survey, designed as a fillable pdf document for ease of completion, was preceded by the introduction page below.

GoMAMN Bird Monitoring Program Survey: 2020

PURPOSE: Your survey response contributes to two products.

- **MONITORING PROGRAM INVENTORY**. We are updating GoMAMN's inventory of current and past avian monitoring programs across the Gulf of Mexico, which will be soon be upgraded to a searchable web-based database. This inventory will serve as areference tool and facilitate connections and collaboration between bird monitoring professionals, researchers, and the greater GoMAMN community of practice. **The following responses will be included in this inventory and thus visible to anyonewho may look up your program on the web tool:**
  - **Responses in Section A: General Information**
  - **Responses in Section B, questions 1-4 and 13 ONLY**

  Note: you may be contacted for additional information to help us update your programrecord depending on what we have on file.

- **GOMAMN PROGRAMMATIC GAP ANALYSIS**. Questions 1-19 We are conducting a gap analysis to understand and show how contemporary avian monitoring efforts in the Gulf coast region are collectively performing in terms of their ability to meet and address GoMAMN stakeholder values (Wilson et al., 2019, in press). Subsequent analyses (conducted at five-year intervals) will enable the Gulf coast community of avian monitoring practitioners to track improvements over time and identify areas where opportunities for improvement still exist. Ultimately, our vision is for the gap analysis process to serve as a tool for evaluating GoMAMN's programmatic performance.

NOTE: We are not collecting actual monitoring data in the gap analysis process. Rather, the questions in the following pages will allow us to better understand broader topics including (butnot limited to) WHAT is being monitored, HOW monitoring is being conducted, and IF/HOW/WHEN monitoring programs plan to share data. The questions relate directly to the 27stakeholder values in GoMAMN's objectives hierarchy (Wilson et al., 2019).

Responses to survey questions 1-19 will be summarized and the results for the Gulf of Mexicoregion *as a whole* will be communicated to the GoM community of practice. NOTE: Responseswill NOT be used to judge/evaluate monitoring programs on an individual basis.

We recognize that completing this questionnaire is an extra demand on your limited time. As a member of the GoM avian monitoring community of practice, please know that we truly appreciate your time and your responses. The results of this gap analysis will benefit our collective monitoring efforts, and ultimately, the birds we monitor.

NEED HELP? If you have any questions or are unsure about how to respond to any part of thisquestionnaire, please contact Jessica Schulz at 978-302-1024 or jschulz@ducks.org.

GoMAMN Monitoring Program Inventory & Gap Analysis Questionnaire

***Section A*: GENERAL INFORMATION about Monitoring Program** *(red = required)*

Monitoring Program Name **Date**

Program Point-of-Contact Name **POC Organization/Company Name**

POC Phone **POC Email Address**

Alternative POC *(optional)* **Alt Phone** **Alt Email**

Program description (brief overview)

Program webpage (if applicable)

When did monitoring begin? (Month/Year)

Is this monitoring program current/ongoing?

◯ Yes ◯ No

If No, when did monitoring end? (Month/Year XX/XXXX)

If yes, is there a projected end date (or "funded-through" date)? (Month/Year XX/XXXX or "NA")

Does the total duration of monitoring (funded, projected, or and/or completed to date) equal 5 years or more?

◯ Yes ◯ No

To be included in the gap analysis, monitoring programs must involve repeated surveys, be currently active, and have a total duration of at least 5 years (including future monitoring if funding secured).

If your program meets these criteria, please complete questions 1-20 below.

If your monitoring program is not currently active and/or has a duration of fewer than 5 years, we only ask that you complete questions 1-4 and 13. We will not include your program in the gap analysis, but we can still include it in our online inventory of Gulf of Mexico avian monitoring programs.

SPECIES MONITORED AND METHODS

1. **Below is the full list of GoMAMN's Priority Bird Species. Which of these species are monitored in your program? Check all that apply.** (Please include only those species monitored specifically pertaining to your program objective, not species included opportunistically.)

Landbirds

- ☐ Bachman's Sparrow
- ☐ Brown-headed Nuthatch
- ☐ Chuck-will's-Widow
- ☐ Common Ground-Dove
- ☐ Grasshopper Sparrow
- ☐ Henslow's Sparrow
- ☐ LeConte's Sparrow
- ☐ Loggerhead Shrike
- ☐ Louisiana Waterthrush
- ☐ Northern Bobwhite
- ☐ Painted Bunting
- ☐ Prothonotary Warbler
- ☐ Red-cockaded Woodpecker
- ☐ Red-headed Woodpecker
- ☐ Rusty Blackbird
- ☐ Swainson's Warbler
- ☐ Wood Thrush
- ☐ Yellow-throated Warbler

Marsh Birds

- ☐ American Bittern
- ☐ Black Rail
- ☐ King Rail
- ☐ Least Bittern
- ☐ Marsh Wren
- ☐ Nelson's Sparrow
- ☐ Seaside Sparrow
- ☐ Sedge Wren
- ☐ Yellow Rail

Raptors

- ☐ Bald Eagle
- ☐ Osprey
- ☐ Peregrine Falcon
- ☐ SE American Kestrel (state listed-FL)
- ☐ Short-eared Owl
- ☐ Swallow-tailed Kite

Seabirds (nesting and/or pelagic)

- ☐ Black Skimmer
- ☐ Brown Pelican
- ☐ Common Loon
- ☐ Gull-billed Tern
- ☐ Least Tern
- ☐ Northern Gannet
- ☐ Royal Tern
- ☐ Sandwich Tern
- ☐ Audubon's Shearwater
- ☐ Black-capped Petrel
- ☐ Band-rumped Storm-Petrel
- ☐ Magnificent Frigatebird
- ☐ Masked Booby
- ☐ Sooty Tern

Shorebirds

- ☐ American Oystercatcher
- ☐ Buff-breasted Sandpiper
- ☐ Dunlin
- ☐ Long-billed Curlew
- ☐ Marbled Godwit
- ☐ Piping Plover
- ☐ Red Knot
- ☐ Snowy Plover
- ☐ Western Sandpiper
- ☐ Wilson's Plover

Wadingbirds

- ☐ FL Sandhill Crane (state-listed-FL)
- ☐ MS Sandhill Crane
- ☐ Little Blue Heron
- ☐ Reddish Egret
- ☐ Snowy Egret
- ☐ Tricolored Heron
- ☐ Whooping Crane
- ☐ Wood Stork

Waterfowl

- ☐ Lesser Scaup
- ☐ Mottled Duck
- ☐ Northern Pintail

Passage migrants* ☐
*specifically during migration window

2. **Are you monitoring additional species not on this list? If yes, describe briefly… list up to five or give category/taxa group (Choose from the following taxa groups: Landbirds, Marsh Birds, Raptors, Seabirds, Shorebirds, Wadingbirds, Waterfowl)**

3. **Do you have a clearly stated/defined monitoring objective/hypothesis?**

◯ Yes ◯ No

3a. If yes, what is it? (Briefly/one sentence)

3b. What variables/parameters are you measuring?

4. **Pick the option that best describes the scale/footprint of this monitoring program.**
(For nested programs: Choose scale at which the overall program operates.)

◯ Local (smaller scale than statewide)

◯ Statewide (throughout most or all of one state)

◯ Multistate (multiple, but not all, Gulf states)

◯ Gulfwide (every Gulf state)

◯ Nationwide (throughout the U.S.)

◯ International (U.S. plus at least one other country)

5. **What kind of sampling/surveying design do you use?** *Some examples: simple random, simple non-random, treatment/control (randomized or non-randomized), BACI, Panel, etc.*

6. **Was a formal power analysis performed when designing the study (or more recently)?**

◯ Yes ◯ No ◯ Unsure

INTEGRATION

7. **Does this program address established priorities in any existing conservation plans, such as State Wildlife Action Plans?**

◯ No, don't know, or monitoring might address conservation plan priorities but was not specifically designed to do so.

◯ Yes, monitoring addresses a general priority in a specific plan(s) (e.g., support monitoring, a priority within the Louisiana Wildlife Action Plan)

If yes, which plan(s)?

8. **How many partners (organizations, not including yours) are involved in this project? (If zero partners, enter "0" and move to question 10. If one or more partners, please answer follow-up question 8a.)**

Partners

8a. What type(s) of organizations are partners on this project? *Check all that apply.*

- ☐ Federal gov.
- ☐ State gov.
- ☐ Local gov.
- ☐ Non-profit/NGO
- ☐ Private company
- ☐ Academic institution
- ☐ Other

9. **Is your monitoring in alignment with other monitoring programs?** *(e.g.: bird monitoring aligns with similar bird/sea turtle/etc monitoring at same site; partner/work closely with another group; maybe data sharing between programs. Example: individuals monitoring birds for this project opportunistically count sea turtles encountered for a separate project.)*

○ Yes ○ No ○ Unsure

DATA MANAGEMENT AND SHARING

10. **Do you have an explicitly documented plan for managing your monitoring data?**

○ Yes ○ No ○ Unsure

a. Are the data collected in a standardized way? (e.g., standardized hard-copy data sheets or digital collection data form)

○ Yes ○ No ○ Unsure

b. After data are collected, if data manipulation is necessary, is it performed in a way that can be tracked/documented (e.g., using a program like R or SQL)?

○ Yes ○ No ○ Unsure

c. Does your data management plan follow documented metadata standards? *(Examples: Ecological Society of America's Ecological Metadata Language (EML), other standards such as those established by Federal Geographic Data Committee (FGDC), International Standards Organization (ISO), or National Academies of Sciences, Engineering, and Medicine (NASEM))*

○ Yes ○ No ○ Unsure

d. Do/will you perform QA/QC on your dataset prior to sharing/storing?

○ Yes ○ No ○ Unsure

11. **Are the data for this project restricted from being shared (e.g., because it contains personally identifiable information or endangered species locations) or unrestricted?**

○ Restricted (uncommon) ○ Unrestricted

12. How soon do you plan to share this data with the broader scientific community once the project is complete/what is the time frame for sharing your data? Choose from below.

- ◯ within 8 years of project completion (or end date of funding agreement)
- ◯ within 5 years of project completion
- ◯ within 2 years of project completion
- ◯ within 1 year of project completion
- ◯ No timeline established/no plan to share data

13. Where are this monitoring program's data stored? Or, if there are concrete plans to share this data in the future, where will it ultimately be stored? (If using more than one storage site, list additional locations in 13a)

-choose one-

13a. If "Other," where?

STATUS & TRENDS

14. Does this monitoring program collect data about HABITAT QUALITY? *(ie: vegetation, water quality, prey base, etc)*

◯ Yes (answer a-c below) ◯ No (skip to question 15)

a. **If yes, what kind(s)?** *(e.g.: vegetation, water quality, prey base, etc)*

b. **Is habitat quality data collected more than once?**

◯ Yes ◯ No

c. **What is the total <u>duration</u> of time habitat quality data will be collected?** **(***Actual, planned, or currently funded; from beginning to end, in years)*

years

ECOLOGICAL PROCESSES

15. Does this project collect data about ECOLOGICAL PROCESSES that may impact your focal species? *(e.g., climatic processes, interactions between organisms, etc.)*

◯ Yes (continue to question 16) ◯ No (skip to question 17)

16. See accompanying table(s) for a list of current uncertainties regarding ECOLOGICAL PROCESSES, as identified per taxa group by GoMAMN. Which of these uncertainties are addressed by this monitoring program? List all applicable by ID code (column 1), separating multiple codes with commas. If none, enter "NA". (Note: uncertainties may be specific to certain species and/or seasons, as listed.)

MANAGEMENT ACTIONS

17. Are you monitoring birds in the context of understanding MANAGEMENT or RESTORATION ACTIONS? Answer yes if there is any intention and/or likelihood of using monitoring data for this purpose, from the perspective of those conducting monitoring and/ or management action.

◯ Yes (continue questions 18-19) ◯ No (skip to question 20)

18. See accompanying table(s) for a list of current uncertainties regarding MANAGEMENT ACTIONS, as identified per taxa group by GoMAMN. Which of these uncertainties are addressed by this monitoring program? List all applicable, by ID code (column 1, separating multiple codes with commas). If none, enter "NA". (Note: uncertainties may be specific to certain species and/or seasons, as listed.)

19. Are you monitoring this management action(s) in the context of adaptive management (see Williams et al 2009)? *(Determined by answers to a-e below.)*

a. **Is the monitoring linked to an explicit management objective(s)?** *(Example: build 100-acre marsh to benefit birds)*

◯ Yes ◯ No

b. **Is/are the management action(s) you are monitoring associated with an <u>iterative decision</u>?** i.e., is the management decision made on a regular temporal (monthly, annually, etc) or spatial interval (management action repeated in another area) which provides opportunity to use your monitoring data to inform decisions made repeatedly in the future for this management action? *(Example: If you are monitoring birds at a beach nourishment project, will your bird monitoring data be used to inform decisions about future beach nourishment projects, either at the same site or elsewhere?)*

◯ Yes ◯ No

c. **Have decision makers and other stakeholders identified a key uncertainty (about the management action) that impedes decision making?** *Example: do we know what elevation to build the island?* (If there is no uncertainty about management actions, there is no need for adaptive management.)

◯ Yes ◯ No

d. **Is monitoring associated with a conceptual model or set of hypotheses about how the management decision/action impacts birds?**

◯ Yes ◯ No

e. **If “yes” to above: Are multiple conceptual models being considered & compared, as in a multi-model framework? AND, if so, is there an explicit (formal) process for updating model (hypothesis) weights to reduce uncertainty and inform future decision making?** *(Example: adaptive harvest management for waterfowl - waterfowl abundance, habitat and harvest data collected annually then subsequently used to set harvest regulations for the next year.)*

◯ Yes ◯ No

Section D: Wrapping up

20. Is there anything else you’d like to share about your monitoring program?

End of survey. Thank you!

APPENDIX B: Participating Programs

Data for this gap analysis was provided by the following 11 programs via the survey form in Appendix A (in alphabetical order by program name). All of these programs were actively monitoring birds as of August 2021. For the complete inventory of program data collected on past and present waterfowl monitoring programs, contact the Gulf of Mexico Avian Monitoring Network or visit www.gomamn.org.

Program Name	Contact Name	Contact Organization	Start Year	Scale
Audubon's Christmas Bird Count	Kathy Dale	National Audubon Society	1900	INTERNATIONAL
Louisiana Mottled Duck Banding	Paul Link	Louisiana Department of Wildlife and Fisheries	1994	MULTISTATE
Louisiana Wood Duck Nest Box Monitoring	Larry Reynolds	Louisiana Department of Wildlife and Fisheries	1992	STATEWIDE
MDWFP Aerial Waterfowl Surveys	Houston Havens	Mississippi Department of Wildlife, Fisheries, and Parks	2005	LOCAL
Mid-Winter Waterfowl Survey - Mississippi Flyway	Dave Fronczak	U.S. Fish and Wildlife Service	1955	MULTISTATE
Migratory Gamebird Program, Alabama Wildlife & Freshwater Fisheries - Aerial Surveys for Waterfowl	Seth Maddox	Alabama Dept of Conservation and Natural Resources	1960	LOCAL
SELA NWR Complex's Mid-Winter Waterfowl Surveys	Barret Fortier	U.S. Fish and Wildlife Service (Southeast Louisiana National Wildlife Refuges Complex)	1990	LOCAL
Southeast Wood Duck Preseason Banding	Heath Hagy	U.S. Fish and Wildlife Service	1997	GULFWIDE
Texas Mottled Duck Lead Ingestion Survey	Stephen McDowell	Texas Parks and Wildlife Department	1985	LOCAL
West Florida Winter Waterfowl Survey	Dr. Phil Darby	University of West Florida	2014	LOCAL
Western Gulf Coast Mottled Duck Breeding Population Survey	Larry Reynolds	Louisiana Department of Wildlife and Fisheries	2009	MULTISTATE

APPENDIX C: Ecological Process Uncertainties

This table was adapted from DeMaso et al. 2019 (see Table 9.3). Unique ID codes were assigned to each uncertainty to ease the data collection process for participants.

ID CODE	Species	Seasons	Ecological Process Category	Question	Endpoint to Measure	Uncertainty Description
60	Mottled Duck	Breeding/ Wintering	Hydrological Processes (Altered Hydrology)	Are MODU populations influenced by wetland abundance, salinity, and inundation frequency?	Breeding propensity, re-nesting effort, estimating nest success, & brood survival estimates	Several previous studies suggested link between habitat conditions (precipitation) & breeding propensity, but data are generally sparse, & no data linking weather/habitat condition impacts on re-nesting or brood survival
61	Mottled Duck	Breeding	Hydrological Processes (Coastal Marsh Loss)	Does coastal marsh loss reduce wetland density (availability) thus, elevating salinity levels in remaining marsh/wetlands? Does coastal marsh loss negatively affect MODU productivity? If it does, what parameters are affected & what are the mechanisms?	Breeding propensity, re-nesting effort, estimating nest success, & brood survival estimates	Uncertain about effects of marsh loss, & sea-level rise more directly, on availability of nest sites, breeding propensity, probability of nest flooding (nest success), & brood survival
62	Mottled Duck	Breeding	Hydrological Processes (Coastal Marsh Loss)	Does coastal marsh loss reduce wetland density (availability) thus, elevating salinity levels in remaining marsh/wetlands? Does coastal marsh loss negatively affect MODU breeding season survival? If so, what are the mechanisms?	Adult female survival estimates during the breeding season	At least 1 study suggests breeding season survival decreases during drought, but this contrasts with what we know about MALL, for which drought reduces nesting propensity & thus, leads to reduced mortality

63	Mottled Duck	Breeding	Hydrological Processes (Altered Hydrology)	Does altered hydrology reduce wetland density (availability) thus, elevating salinity levels in remaining marsh/wetlands? Does altered hydrology negatively affect MODU breeding season survival? If so, what are the mechanisms?	Adult female survival estimates during the breeding season & during the molt	At least 1 study suggests breeding season survival decreases during drought, but this contrasts with what we know about MALL, for which drought reduces nesting propensity & thus, leads to reduced mortality
64	Mottled Duck	Breeding	Climatic Processes (Limited water available for wetland management)	Does low/limited water availability for wetland management negatively affect availability of low salinity marsh/wetlands during the spring & summer? Does low/limited water availability negatively affect MODU breeding propensity, re-nesting effort, nest success, & brood survival?	Breeding propensity, re-nesting effort, estimating nest success, & brood survival estimates	Several previous studies suggested link between habitat conditions (precipitation) & breeding propensity, but data are generally sparse, & no data linking weather/habitat condition impacts on re-nesting or brood survival
65	Mottled Duck	Breeding	Climatic Processes (Limited water available for wetland management)	Does low/limited water availability for wetland management negatively affect availability of low salinity marsh/wetlands during the spring & summer? Does low/limited water availability negatively affect MODU breeding season survival? If so, what are the mechanisms?	Adult female survival estimates during the breeding season	At least 1 study suggests breeding season survival decreases during drought, but this contrasts with what we know about MALL, for which drought reduces nesting propensity & thus, leads to reduced mortality
66	Mottled Duck	Breeding	Climatic Processes (Weather, i.e., precipitation)	Do dry/drought conditions reduce wetland availability & increase salinity levels in remaining marsh/wetlands? Do dry/drought conditions negatively affect MODU breeding propensity, re-nesting, nest success, & brood survival? If so, what are the mechanisms?	Breeding propensity, re-nesting effort, estimating nest success & brood survival estimates + adult female survival estimation during breeding season & the molt	Several previous studies suggested link between habitat conditions (precip) & breeding propensity, but data are generally sparse, & no data linking weather/habitat condition impacts on re-nesting or brood survival

67	Mottled Duck	Breeding/ Wintering	Climatic Processes (Weather, i.e., precipitation)	Do dry/drought conditions reduce wetland availability & increase salinity levels in remaining marsh/wetlands? Do dry/drought conditions negatively affect MODU breeding season survival? If so, what are the mechanisms?	Breeding propensity, re-nesting effort, estimating nest success & brood survival + adult female survival estimation during breeding season & molt; female body condition as a covariate for all parameters	At least 1 study suggests breeding season survival decreases during drought, but this contrasts with what we know about MALL, for which drought reduces nesting propensity & thus, leads to reduced mortality
68	Mottled Duck	Breeding	Interactions Between Organisms	Do dry/drought conditions, altered hydrology, & coastal marsh loss increase salinity levels in remaining marsh/wetlands? Does predation have a greater negative affect on MODU population dynamics in dry v wet years, in low v high altered hydrology sites, or in areas with low v high wetland availability (low salinity)?	Adult female survival estimates during the breeding season, estimating nest success & brood survival	At least 1 study suggests breeding season survival decreases during drought, but this contrasts with what we know about MALL, for which drought reduces nesting propensity & thus, leads to reduced mortality
69	Mottled Duck	Breeding	Natural Disturbance Regimes	Does coastal marsh loss reduce wetland density (availability) thus, elevating salinity levels in remaining marsh/wetlands? Does coastal marsh loss negatively affect MODU productivity? If it does, what parameters are affected & what are the mechanisms?	Breeding propensity, re-nesting effort, estimating nest success & brood survival + adult female survival estimation during breeding season & molt; female body condition as a covariate for all parameters	Uncertain about effects of marsh loss, & sea-level rise more directly, on availability of nest sites, breeding propensity, probability of nest flooding (nest success), & brood survival

70	Mottled Duck	Breeding	Natural Disturbance Regimes	Does coastal marsh loss reduce wetland density (availability) thus, elevating salinity levels in remaining marsh/wetlands? Does coastal marsh loss negatively affect MODU breeding season survival? If so, what are the mechanisms?	Breeding propensity, re-nesting effort, estimating nest success & brood survival + adult female survival estimation during breeding season & molt; female body condition as a covariate for all parameters	At least 1 study suggests breeding season survival decreases during drought, but this contrasts with what we know about MALL, for which drought reduces nesting propensity & thus, leads to reduced mortality

APPENDIX D: Management Uncertainties

This table was adapted from Demaso et al. 2019 (see Table 9.2). Unique ID codes were assigned to each uncertainty to ease the data collection process for participants.

ID CODE	Species	Season(s)	Management Category	Question	End-point to measure mgmt. performance	Uncertainty Description
163	Mottled Duck, Lesser Scaup, Northern Pintail, Gadwall, Blue-winged Teal	Winter, Migration, Breeding (MODU only)	Habitat and Natural Process Restoration (Freshwater Management)	What are the consequences of low water conditions, limited wetland availability, & drought-like conditions on breeding Mottled Ducks? Cross-seasonal effects? Annual variation?	Pre-departure body condition, peak departure date(s), overwinter survival, and food resource availability (covariate)- e.g., obtain survival estimates for sample of marked birds across the geography from birds in DRY v WET years	Research shows a link between indices of food abundance & body condition & cross-seasonal reproductive success at large spatial scales, but strength & consistency of the relationship is uncertain
164	Mottled Duck, Lesser Scaup, Northern Pintail, Gadwall, Blue-winged Teal	Winter, Migration, Breeding (MODU only)	Habitat and Natural Process Restoration (Freshwater Management)	What are the consequences of low water conditions, limited wetland availability, & drought-like conditions on wintering waterfowl? Cross-seasonal effects? Species-specific variation?	Pre-departure body condition, peak departure date(s), overwinter survival and food resource availability (covariate)- e.g., obtain survival estimates for sample of marked birds (LESC, NOPI, GADW, BWTE) across the geography in DRY v WET years	Research shows a link between indices of food abundance & body condition & cross-seasonal reproductive success at large spatial scales, but strength & consistency of the relationship is uncertain particularly for these spp. wintering in this geography
165	Mottled Duck, Northern Pintail, Blue-winged Teal	Winter, Migration, Breeding (MODU only)	Habitat and Natural Process Restoration (Habitat Management - Agriculture)	What are the effects of declines in rice acres & production on breeding Mottled Ducks & wintering waterfowl? Do reductions in availability of this habitat result in subsequent declines in pre-departure body condition (e.g., fat reserves)?	Pre-departure body condition & peak departure date(s)- e.g., obtain body condition measurements (+ food habits/diets) for a sample of birds (MODU, NOPI, BWTE) in areas of primarily rice agr & more coastal ref sites	Reductions in acres of high energy food resources (e.g., rice) on the wintering grounds may lead to decreased body condition & later departure dates resulting in cross-seasonal effects to reproductive effort & output

166	Mottled Duck, Lesser Scaup, Northern Pintail, Gadwall, Blue-winged Teal	Winter, Migration, Breeding (MODU only)	Site/Area Management (Disturbance)	Does human disturbance (hunting, ag operations, etc.) negatively affect wintering waterfowl body condition & delay spring departure date(s) due to increased movements (freq, duration, & total distance) & greater cumulative energy expenditure? Cross-seasonal effects?	Pre-departure body condition & departure dates- e.g., obtain body condition measurements throughout the Fall-Winter period (+ food habits/diet from sample collected by hunters) for sample of birds primarily using coastal estuarine habitats	Fairly certain that disturbance negatively affects energy expenditure, but uncertain about relationship between energy expenditure & body condition (i.e., how easily birds can compensate for greater energy expenditure)
167	Mottled Duck, Lesser Scaup, Northern Pintail, Gadwall, Blue-winged Teal	Winter, Migration, Breeding (MODU only)	Site/Area Management (Disturbance)	Does human disturbance (hunting, ag operations, etc.) negatively affect wintering waterfowl body condition & delay spring departure date(s) due to increased movements (freq, duration, & total distance) & greater cumulative energy expenditure? Cross-seasonal effects?	Pre-departure body condition & departure dates- e.g., obtain body condition measurements throughout the Fall-Winter period (+ food habits/diets from sample collected by hunters) for sample of birds using primarily inland palustrine habitats	Fairly certain that disturbance negatively affects energy expenditure, but uncertain about relationship between energy expenditure & body condition (i.e., how easily birds can compensate for greater energy expenditure)
168	Lesser Scaup, Redhead	Winter, Migration	Site/Area Management (Contaminants)	Does high anthropogenic nutrient inputs negatively affect wintering waterfowl food resources, i.e., seagrasses and mollusks? Are there then impacts to waterfowl via constraints on Fall-Winter energetics, pre-departure body condition, & delays in spring departure date(s)? Cross-seasonal effects?	Pre-departure body condition, departure date(s), overwinter survival & food resource availability (covariate)- e.g., obtain survival estimates from sample of marked birds (LESC, REDH) at known affluent sites & nearby ref sites. Also, tox. 'panel' of potential contaminants (e.g., Mg, Pb, Se, PCB, HCB, PAHs, etc.) from sample of collected birds	Research shows a link between indices of food abundance & body condition & cross-seasonal reproductive success at large spatial scales, but strength & consistency of the relationship is uncertain; particularly for these spp. wintering in this geography

169	Lesser Scaup, Redhead	Winter, Migration	Site/Area Management (Disturbance)	Does human disturbance (hunting, comm & rec fishing, O&G operations, etc.) in marine environment negatively affect wintering waterfowl body condition & delay spring departure date(s) due to increased movements (freq, duration, & total distance) & greater cumulative energy expenditure? Cross-seasonal effects?	Pre-departure body condition, departure date(s), overwinter survival & food resource availability (covariate)- e.g., obtain overwinter survival estimates & body condition throughout the Fall-Winter period (+ food habits/diets for sample collected by hunters); primarily marine/estuarine habitats in "high" v. "low" disturbance sites	Fairly certain that disturbance negatively affects energy expenditure, but uncertain about relationship between energy expenditure & body condition (i.e., how easily can birds compensate for greater energy expenditure)
170	Lesser Scaup	Winter, Migration	Habitat and Natural Process Restoration (Freshwater Management)	Does altered hydrology increasing salinity thus, negatively affecting wintering waterfowl food availability & distribution, in particular bivalve/mollusks? Do these changes influence pre-departure body condition & delayed spring departure date(s)? Cross-seasonal effects?	Pre-departure body condition, departure date(s), overwinter survival & food resource availability (covariate)- e.g., obtain overwinter survival estimates & body condition throughout the Fall-Winter period (+ food habits/diets for sample collected by hunters); primarily marine/estuarine habitat in "high" v "low" altered sites	Research shows a link between indices of food abundance & body condition & cross-seasonal reproductive success at large spatial scales, but strength and consistency of the relationship is uncertain; particularly for this species wintering in this geography

171	Lesser Scaup, Northern Pintail, Redhead	Winter, Migration	Habitat and Natural Process Restoration (Freshwater Management)	Does altered hydrology result in increasing salinity thus, negatively affecting waterfowl food availability and/or quality, in particular bivalve/mollusk (LESC), SAV (NOPI), & seagrass (REDH)? Do these changes influence pre-departure body condition & delay spring departure date(s)? Cross-seasonal effects?	Pre-departure body condition, departure date(s), overwinter survival & food resource availability (covariate)- e.g., obtain overwinter survival estimates and body condition throughout the Fall-Winter period (+ food habits/diets for sample collected by hunters); primarily estuarine habitat in "high" v "low" altered sites	Research shows a link between indices of food abundance & body condition & cross-seasonal reproductive success at large spatial scales, but strength and consistency of the relationship is uncertain; particularly for these spp. wintering in this geography
172	Redhead	Winter, Migration	Habitat and Natural Process Restoration (Freshwater Management)	Does altered hydrology result in increasing salinity thus, negatively affecting preferred seagrass species distribution & abundance? Do these changes influence pre-departure body condition & delay spring departure date(s)? Cross-seasonal effects?	Pre-departure body condition, departure date(s), overwinter survival & food resource availability (covariate)- e.g., obtain overwinter survival estimates & body condition throughout the Fall-Winter period (+ food habits/diets for sample collected by hunters); primarily marine habitat in "high" v "low" altered sites	Research shows a link between indices of food abundance & body condition & cross-seasonal reproductive success at large spatial scales, but strength & consistency of the relationship is uncertain; particularly for this species wintering in this geography
173	Redhead	Winter, Migration	Site/Area Management (Energy Development)	Does the presence of wind energy development in proximity to freshwater wetlands negatively affect overwinter survival of wintering REDH? Direct mortality or indirect effects related to the presence of wind energy development?	Over-winter survival- e.g., obtain survival estimates on sample of marked birds using sites w/ wind energy development & nearby reference sites w/out wind energy development	Though recent research (Lange et al. 2018) has identified reduced use (based on counts) of wetlands in an area of wind energy development, overwinter survival in relation to the presence of wind towers is poorly understood in this geography

174	Redhead	Winter, Migration	Site/Area Management (Energy Development)	Is body condition of wintering REDH negatively affected by wind energy development through reduced access to inshore freshwater wetlands? What is/are the mechanisms that influence body condition of REDH in the presence of wind energy development?	Pre-migration body condition- e.g., obtain body condition measurements on sample of birds using sites w/ wind energy development & nearby reference sites w/out wind energy development	Though recent research (Lange et al. 2018) has identified reduced use (based on counts) of wetlands in an area of wind energy development, overwinter & pre-migration body condition related to wind energy development is poorly understood
175	Mottled Duck	Breeding only	Habitat and Natural Process Restoration (Freshwater Management)	Does altered hydrology result in increasing salinity thus, negatively affecting preferred food production, distribution, & availability? Do these changes negatively affect body condition & ultimately, breeding propensity, re-nesting effort, nest success, & brood survival?	Breeding propensity, re-nesting effort, estimating nest success & brood survival- 3 of the 4 require marked adult females (and ducklings); estimating nest success would also benefit from a marked sample, but is not a requirement per se	Several previous studies suggested link between habitat conditions (precip) & breeding propensity, but data are generally sparse, & no data linking weather/habitat condition impacts on re-nesting or brood survival
176	Mottled Duck	Breeding only	Habitat and Natural Process Restoration (Freshwater Management)	Does coastal marsh loss reduce wetland availability thus, increasing salinity levels in remaining wetlands? Does this negatively affect breeding propensity, re-nesting effort, nest success, & brood survival?	Breeding propensity, re-nesting effort, estimating nest success & brood survival- 3 of the 4 require marked adult females (and ducklings); estimating nest success would also benefit from a marked sample, but is not a requirement per se	Uncertain about effects of marsh loss & increasing salinity levels (marsh migration) on availability of nest sites, breeding propensity, nest success, & brood survival

177	Mottled Duck	Breeding only	Habitat and Natural Process Restoration (Freshwater Management)	Does reduced water availability constrain or limit wetland management capabilities to produce low salinity wetlands during breeding/nesting period & into brood-rearing? Does this ultimately affect breeding propensity, re-nesting effort, nest success, & brood survival?	Breeding propensity, re-nesting effort, estimating nest success & brood survival- 3 of the 4 require marked adult females (and ducklings); estimating nest success would also benefit from a marked sample, but is not a requirement per se	Several previous studies suggested link between habitat conditions (precip) & breeding propensity, but data are generally sparse, & no data linking weather/habitat condition impacts on re-nesting or brood survival
178	Mottled Duck	Breeding only	Habitat and Natural Process Restoration (Freshwater Management)	Does altered hydrology result in increasing salinity thus, negatively affecting waterfowl food availability and/or quality (SAVs) for pre-breeding, breeding, brood-rearing, & molting MODU? Do these changes negatively affect breeding season survival of adult female MODU?	Survival estimation of adult female MODU during the various annual life-history periods, including molt	At least 1 study suggests breeding season survival decreases during "drought", but this contrasts with what we know about MALL in which dry or drought conditions results in reduced nesting propensity & thus, higher adult female survival
179	Mottled Duck	Breeding ONLY	Habitat and Natural Process Restoration (Freshwater Management)	Does coastal marsh loss reduce wetland availability thus, increasing salinity levels in remaining wetlands? Does this negatively affect breeding season survival (MODU) of adult females (& their broods)?	Survival estimation for adult females during the breeding season- evaluate across the breeding range & compare period-specific survival estimates among years considered as WET v DRY w/ varying salinity levels of individual wetlands used by marked MODU	At least 1 study suggests breeding season survival decreases during "drought", but this contrasts with what we know about MALL in which dry or drought conditions results in reduced nesting propensity & thus, higher adult female survival

180	Mottled Duck	Breeding ONLY	Habitat and Natural Process Restoration (Freshwater Management)	Does reduced water availability constrain or limit wetland management capabilities to produce low salinity wetlands during breeding/nesting period & into brood-rearing? Does this ultimately affect breeding season survival of adult females (MODU)?	Survival estimation for adult females during the breeding season- evaluate across the breeding range & compare period-specific survival estimates among years considered as WET v DRY w/ varying salinity levels of individual wetlands used by marked MODU	At least 1 study suggests breeding season survival decreases during "drought", but this contrasts with what we know about MALL in which dry or drought conditions results in reduced nesting propensity & thus, higher adult female survival
181	Mottled Duck	Breeding ONLY	Habitat and Natural Process Restoration (Habitat Management)	Does the loss of nesting habitat (via various causes) affect the availability of suitable nest sites in proximity to low salinity wetlands? Does this situation result in lower productivity due to reduced breeding propensity, lower re-nesting probability, & lower nest success	Breeding propensity, re-nesting effort, & nest success- e.g., study design should account for spatial configuration at the landscape scale & site-scale variables; compare "high" quality wetland density (Experimental) & "low" quality wetland density (Control) sites (Krainyk and Ballard 2015)	Loss of nesting habitat is believed to have significant negative impact on productivity, but aspects of nesting habitat & particular effect sizes on productivity parameters is highly uncertain
182	Mottled Duck	Breeding ONLY	Habitat and Natural Process Restoration (Habitat Management)	Does loss & fragmentation of grassland nesting habitat quality (e.g., overgrazing, encroachment of woody vegetation) negatively affect breeding propensity, re-nesting effort, & nest success (MODU)?	Estimate nest success in conjunction w/ breeding season survival of adult females & brood survival from marked sample- e.g., study design should account for spatial configuration at the landscape scale & site-scale variables; compare "high" v "low" quality sites (Krainyk and Ballard 2015)	Fragmentation of nesting habitat is believed to have significant impact on productivity, but aspects of nesting habitat & particular effect sizes on productivity parameters is highly uncertain

183	Mottled Duck	Breeding ONLY	Habitat and Natural Process Restoration (Habitat Management)	Does loss & fragmentation of grassland nesting habitat quality (e.g., overgrazing, encroachment of woody vegetation) negatively affect breeding propensity, re-nesting effort, & nest success (MODU)?	Breeding propensity, re-nesting effort, & estimating nest success; consider breeding season survival of adult females & brood survival from a marked sample- e.g., study design should account for spatial configuration at the landscape & site-scale; predator v no predator removal sites	Degradation of nesting habitat believed to impact productivity through response by predators, but how particular aspects of fragmentation affect predator species composition & abundance not clear, & effect sizes are poorly understood for this species in this landscape