Monitoring Plan for Common Bottlenose Dolphin Stocks across Louisiana Basins and Nearshore Coastal Waters

Deliverable 3 in support of Monitoring Approaches
for Common Bottlenose Dolphin Restoration in Louisiana

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1 Introduction

As part of the *Deepwater Horizon* (DWH) natural resource damage assessment settlement, the Louisiana Trustee Implementation Group (TIG) is collecting and analyzing data to inform the planning of restoration activities and tracking restoration activity effectiveness. The Monitoring and Adaptive Management (MAM) process is especially important for common bottlenose dolphin (*Tursiops truncatus*; hereafter referred to as "dolphins") restoration in Louisiana, as there are data gaps that limit our ability to estimate how specific restoration activities may or may not provide the desired benefits/outcomes. Therefore, we convened a group of subject matter experts (SMEs; see Appendix A for a list of contributors) to develop a plan that could fill these data gaps and provide the Louisiana TIG MAM group with critical information about how to assess the abundance, distribution, population structure, and habitat use patterns for dolphins across Louisiana over time. The SMEs met in-person in New Orleans, LA on April 4th and 5th of 2024, then developed this plan iteratively through 2025.

1.1 Purpose/goals

Restoration activities for dolphins in Louisiana could be developed over a variety of scales: a single project could focus on a specific stock of dolphins for a long time period, or a portfolio of projects could be implemented to provide benefits across all seven of the bay, sound, and estuary (BSE) stocks and the two coastal stocks. Given this range of possibilities, this plan attempts to provide recommendations on how to assess demographic information on each of the Louisiana dolphin stocks, and further, how to integrate those data into one or more population models across the state. Both approaches (stock-by-stock and cross-stock integration) will be necessary to make informed decisions about restoration planning and follow-on monitoring for stocks in isolation and as a portfolio. For example, wildlife population dynamics and recovery from disturbance are highly dependent on population structure and the potential interactions between adjacent populations (Wilson et al. 2023). Thus, studying a BSE stock and its neighboring coastal stock in isolation of one another may provide some information about how to plan/conduct separate restoration projects for each respective stock, but integrating the studies and understanding the overlap between the two stocks (e.g., their interaction rates and degree of genetic exchange) can help inform additional unique projects such as how to address disease transmission from the coastal stock to the BSE stock. Data on trends in dolphin abundance, distribution, population structure, and habitat use over time can

provide important context for how various stressors threaten each stock, and therefore how projects/activities to address such threats could provide benefits to Louisiana dolphins.

Where possible, the recommendations also identify areas of overlap, either in geographic space/time or the types of monitoring activities, so that 1) there is consistency in how each stock is evaluated and thus the data can be synthesized into a broader state-wide context and 2) the Louisiana TIG MAM group can organize efforts efficiently to save resources (e.g., time, personnel, and budget). The plan also provides some general recommendations on field survey/monitoring techniques and study design, equipment and staffing needs, and rough budgeting considerations to ensure that the activities are able to provide reliable scientific interpretations.

Different stocks require a different level of effort depending on past efforts (or lack thereof) and therefore have different recommendations for next steps. To keep the scope of this document reasonable and minimize the variety and number of "what if" scenarios, and given the nature of adaptive management, this plan will continue to be updated as a living document. Future activities based on these recommendations (and other complementary efforts) should be revisited and reevaluated in future iterations/versions. Thus, the group limited their recommendations to a five-to-ten-year timeline.

This document focuses on the recommendations for establishing baseline data (where needed) and monitoring Louisiana dolphin populations, with only the background information on each stock that is necessary to provide context for the suggested approaches. The following stocks are included in this document:

- Western Coastal Stock
- Northern Coastal Stock
- Sabine Lake Stock
- Calcasieu Lake Stock
- Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay Stock (Vermilion Stock)
- Terrebonne-Timbalier Bay Estuarine System Stock (TTBES Stock)
- Barataria Bay Estuarine System Stock (BBES Stock)
- Mississippi River Delta Stock (MRD Stock)
- Mississippi Sound/Lake Borgne/Bay Boudreau Stock (MSS Stock).

For more information on each stock, please reference National Oceanographic and Atmospheric Administration's (NOAA) Stock Assessment Reports at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock#cetaceans---dolphins.

This document is one in a series of deliverables to support decision-makers setting monitoring and adaptive management objectives for bottlenose dolphin restoration planning and monitoring restoration effectiveness in Louisiana waters. Please visit the Louisiana MAM Monitoring Approaches for Bottlenose Dolphin Restoration project website, which hosts all of these documents and serves as a user manual/data dictionary for the deliverables. For convenience, all of the documents, we reference each product by the following shorthand:

- LA BND Monitoring Plan, short for the: "Monitoring Plan for Common Bottlenose Dolphin Stocks across Louisiana Basins and Nearshore Coastal Waters"
- Human-caused Threats Review, short for the: "Characterization of Human-Caused Threats to Bottlenose Dolphins in Louisiana"
- Freshwater Strategy Report, short for the: "Freshwater Response, Scientific/Impact Assessment, and Decision-making Strategy Report"
- DCE Report and Assessment Plan, short for the: "Evaluating the Threats of Disease, Contaminants, and Environmental Hazards on Louisiana Dolphin Health: A Literature Review, Conceptual Model, and Health Assessment Plan".

The citations for all of these documents can be found in a spreadsheet: the LA BND Citation Inventory.

1.2 Approach/General recommendations

1.2.1 Organizing principles

At the onset of our discussions, the SMEs came to consensus about the scope and general approach for developing the plan, based on the best-available science, the specific needs with regard to restoration planning and monitoring, and what would be the most feasible and efficient means for implementing the likely recommendations. Some noteworthy conclusions included:

- Recommendations for each stock are critical, but the group should also identify overlapping topics among the stocks where coordinated activities would have benefits. In this way, decisions could be made based on what is best for an individual stock and what might be best in the context of a multi-stock/multi-project effort ("best" here meaning in terms of scientific knowledge gained and/or logistics/cost).
- Similarly, the group acknowledged that there may be limits to the resources available for the recommended activities. To help decision makers, SMEs identified potential alternatives to specific activities, where possible and appropriate, and then prioritized the list of recommendations.
- SMEs considered that there are ongoing activities similar and/or complementary to the recommendations herein. We decided, to the best of our knowledge at the time, to consider those other efforts and avoid duplicative recommendations. Where relevant in the rest of this document, we reference these other activities and how they influenced the recommendations here (See Section 1.4).

- Given the similarities in the general requirements/approaches for the techniques to assess abundance, distribution, population structure, and habitat use, the group suggested using the introductory sections of this document to provide overall recommendations that would otherwise be redundant if included in each section. If there are unique considerations for a given stock, then those details are provided in the respective stock's section. For example, experts recommended using a standard photo-identification (photo-ID) survey using a robust design (three primary sessions and three secondary sessions; Pollock et al. 1990) for several stocks, but occasionally, for stocks with very little information, they recommended starting with a single, exploratory primary session. The general photo-ID robust design details are provided in the introduction.
- The SME group discussed how integrating data from stranding network partners is key to monitoring efforts in Louisiana. Efforts to provide resources for enhancing the local stranding network are underway as part of DWH restoration activities and, thus, were only briefly mentioned during the workshop but are assumed to be moving forward.

Finally, the SME group had significant discussion about the best way to organize the document for the purposes of recommending monitoring activities for the Louisiana TIG MAM group to make restoration decisions. Various options included by demographic parameter, survey/data collection technique, stock or population, and how much is currently known for each stock or population. This led to an important guiding principle for the workshop and this plan:

> For Louisiana TIG MAM restoration planning and effectiveness monitoring, it is critical to integrate demographic data on Louisiana dolphins into population models that can provide the means for estimating/quantifying changes in population trends over time and help characterize specific stressors.

The models are also important for estimating/quantifying the potential benefits that projects can provide and track if those projects are meeting the desired outcomes. In other words, the population models provide the metrics that are crucial to the Louisiana TIG MAM process.

A reasonable template for such models has been developed for the BBES Stock (Schwacke et al. 2023), and the SMEs recommended using a similar approach for Louisiana TIG MAM purposes. However, the model does rely on a set of assumptions to provide appropriate and reasonable estimates/predictions, including an expectation that the dolphins included in a given model are a closed population (or that one can include a reasonable parameter for the immigration/emigration rate). This is especially important for designing field surveys, as analyses based on photo-ID often rely on re-sightings of individual animals and therefore should incorporate enough area to see the same dolphin even if it has moved (assuming it is a resident). Therefore, the recommendations in this plan reflect that data collection in this first five-to-ten-year period should focus on collecting data to help determine the appropriate set of population models required to reliably monitor Louisiana dolphins.

The SME group noted that there is not enough information about several of the stocks in Louisiana to currently recommend an individual population model for each stock, compared to

potentially combining two or more stocks into one model for the Louisiana TIG MAM goals. SMEs discussed the justifications and needs for different methods of grouping Louisiana dolphins, including: “stocks” (as geographically managed units) for the purposes of resource management, “demographically independent populations” (DIPs) for the purposes of estimating population trends (e.g., for restoration purposes), and “study units” for the purposes of conducting efficient field survey efforts (e.g., aerial line transect surveys that overlap multiple stocks). Based on the SMEs’ recommendations, we do our best to apply the appropriate unit to the recommendations herein with comments about why activities may be based on different groupings.

For example, based on the best available genetic data, seasonal sighting data, and satellite-linked telemetry data, dolphins in the MSS, MRD, Northern Coastal, and Western Coastal Stocks may all belong to a Northwest Inner Shelf (NWIS) DIP (Balmer et al. 2008, 2016; Hubard et al. 2004, Vollmer et al. 2017, 2021). It is currently unclear whether a single population model for the NWIS DIP or individual population models for each stock is most appropriate for the needs of Louisiana TIG MAM restoration efforts. Therefore, the recommendations herein suggest prioritizing collecting monitoring and genetic data to help inform this high-priority question. To this end, we often pool recommendations on the stocks currently associated with the NWIS DIP into one study unit, so that the techniques and data are consistent enough across management stocks to best address this data gap.

1.2.2 General recommendations for established monitoring techniques

During the workshop, the SME group recommended that the number of different monitoring techniques and levels of effort be kept to a minimum, so that the resulting datasets are as compatible as possible and therefore could facilitate 1) comparisons across the stocks/populations and 2) aggregating data across the state for broader-scale analyses. In this section, we summarize those discussions and briefly describe four established monitoring techniques generally recommended by the SME group. These methods and study designs are then referred to in the later stock-specific sections.

Recommendations for the various stocks/populations generally followed this pattern:

1. If few data are available for the stock in question, conduct an exploratory photo-ID survey.
2. If there are some photo-ID data for the stock already available:
    a. conduct a robust design photo-ID survey to update the demographic estimates, and
    b. conduct remote biopsy sampling to establish or better define genetic signatures for the stock.
3. If photo-ID is logistically infeasible, conduct aerial line transect surveys and remote biopsy sampling where possible.
4. If the stock already has reliable demographic estimates (especially distribution/density) and/or funded and pending field efforts in the near future, consider beginning preliminary evaluations of habitat use.

Photo-ID via small vessel surveys using the robust design

Photo-ID studies allow for repeated observations of individual dolphins over time. When logistically feasible, photo-ID surveys using small vessels are generally considered the gold standard for estimating dolphin population metrics (e.g., abundance, density, distribution, and demographic parameters). In the southeastern U.S., these surveys are generally performed using “robust design” principles for capture-mark-recapture analyses (Rosel et al. 2011). Typically, one to three small boats (depending on the size of the study area) follow predetermined transect lines, and when dolphins are observed, photographers capture images of each animal’s dorsal fin (along with a variety of other data). The choice of boats for surveying BSE and coastal waters should consider the shallow water depth often encountered in Louisiana wetlands and the potential for sudden weather and wind in open water. Rigid-hulled inflatable boats (RHIBs), such as the Zodiacs used by the NOAA Southeast Fisheries Science Center (SEFSC), work well in a variety of conditions, but larger rigid hull vessels may be required for studies with coastal dolphins. After the surveys, researchers identify as many of the individuals as possible using the unique patterns of cuts and notches on the trailing edge of the dorsal fin. The collection of photographs of unique individuals are compiled into a photo-ID catalog for an area. Once established, the catalog is updated after each survey resulting in a temporal and spatial sighting history for each individual dolphin.

Under the robust design framework, a single complete survey of all transect lines in a study area is referred to as a “secondary” session. A small study area may only require one day for one boat to complete a secondary session; a larger study area may require multiple boats and several days to complete a secondary session (e.g., Garrison et al. 2020). A “primary” session refers to a collection of two to four secondary sessions all conducted within a short timeframe (typically less than a month). Primary sessions can be repeated periodically (e.g., annually or seasonally) to allow for analyses of trends over time. For the purposes of this Louisiana TIG MAM Monitoring Plan, the SME group recommended two types of photo-ID surveys, depending on the stock in question: an exploratory photo-ID survey effort or a robust design photo-ID survey effort.

For areas with very few existing data about dolphin abundance, density, and distribution, the group recommended performing an exploratory photo-ID survey effort, consisting of one primary session (with three to four secondary sessions) with the goal of gathering data to inform a more rigorous photo-ID survey at a later date. Without existing data, such a pilot survey would require defining a study area and transect lines based on anecdotal and environmental/habitat-based data. The study area could include a larger area with the hope of learning where dolphins are *not* found (or found at very low numbers), so that future efforts can be designed accordingly. Transects for an exploratory study may be spaced further apart (compared to surveys in established study areas) to focus on the overall population distribution and study area rather than a highly accurate abundance estimate. With these data in hand, future monitoring efforts could design a more typical robust design survey with better informed transect lines and an overall study area tailored to observations of the stock/population in question.

For areas with previous data about dolphin abundance, density, and distribution, the SME group recommended conducting robust design photo-ID surveys with three primary sessions separated by season or year, depending on the site and the highest priority monitoring-related questions. For a given primary session, a three-secondary session effort is a common survey design across Southeastern U.S. dolphin study sites and typically provides enough data for reliable estimates of abundance, density, survival, and distribution using spatial capture-mark-recapture analyses (preferred) or other analytical techniques (e.g., non-spatial capture-mark-recapture modeling). However, in some circumstances, the SME group recommended considering a fourth secondary session if the statistical variance around estimates is higher than desired (after the first three secondary sessions).

Although small-vessel photo-ID surveys usually focus on more protected BSE waters, on calm weather days survey teams can collect data along transect lines in coastal waters. Depending on the season, these transects often cover areas with both nearby resident BSE dolphins and transient/migratory coastal dolphins. The decision to purposefully include coastal transect lines in photo-ID surveys of BSE populations depends on the priority monitoring questions. If the goal is to specifically determine the resident BSE abundance, coastal transect lines might be avoided so that coastal migratory dolphins are excluded from the analysis. However, the SME group discussed that for the purposes of the LA BND Monitoring Plan, a high priority goal is to better understand the connectivity across the various stocks/populations of Louisiana dolphins–including between neighboring BSE stocks (e.g., the TTBES and BBES Stocks [Mullin et al. 2018], between individual BSE stocks and coastal stocks/the NWIS DIP, and among the various stocks within the NWIS DIP). Therefore, the SME group recommended that some of the photo-ID surveys (regardless of the number of primaries) include coastal transect lines that can be surveyed when weather and other logistical considerations permit.

Aerial line transect surveys

Surveys using small vessels are not always logistically feasible (e.g., for larger study areas, less protected bodies of water, or wetlands with extensive shallow waters). In these circumstances, planes with trained marine wildlife observers can conduct aerial surveys by following

predetermined transect lines and recording dolphin sightings. Abundance, density, and distribution can be estimated by analyzing the count and location data with distance sampling models. NOAA and their collaborators are currently planning to conduct aerial surveys as part of the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) II study funded by Bureau of Ocean Energy Management (BOEM; https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/GM-24-02.pdf), building on their previous efforts (Rappucci et al. 2023). The SME group suggested using the same survey techniques, general study design, level of effort (tailored to the specific study areas), and survey team for their recommendations of aerial surveys in the sections below. In a few cases, the group recommended adding to the current GoMMAPPS study area, to answer questions specific to Louisiana TIG MAM monitoring.

Members of the NOAA SEFSC serve on the Louisiana TIG MAM Monitoring Plan SME group and are collaborators on the GoMMAPPS II study and offered to act as liaisons to coordinate these activities. If it is not possible to use the same survey team, the SME group recommended at least trying to use the same type of plane–a high wing with four observation windows (e.g., three bubble windows and one belly window or four bubble windows) such as a DeHavilland DHC-6 Twin Otter plane–and observation team configuration (two teams).

In deeper waters of the northern Gulf of America (hereafter, Gulf), other small cetacean species can be found in the same areas as common bottlenose dolphins and, in some conditions, may be indistinguishable during aerial surveys. However, the ranges of these species are fairly well understood (Rappucci et al. 2023), so although coastal dolphin surveys may include some indistinguishable animals in the deeper waters of the common bottlenose dolphins' range, most of the animals sighted within the study areas relevant to the LA BND Monitoring Plan (waters shallower than 20m) can generally be assumed to be common bottlenose dolphins.

Remote biopsy surveys

Our current understanding of population structure in Louisiana dolphin stocks comes from analysis of DNA sequences from skin samples. By including the genetic signatures of dolphins from known locations/groups, we can use clustering algorithms to predict the location/group to which an unknown dolphin likely belongs. Skin samples can be collected opportunistically from stranded dolphins (dead or alive), but these animals are often from unknown locations/groups (sick or dead dolphins may swim/float from other locations prior to stranding). Catch-and-release health assessments offer an opportunity for collecting skin samples from dolphins that are likely resident to an area, but generally result in low sample sizes. Thus, remote biopsies of free-swimming dolphins represent a means of collecting a larger number of samples from individuals that likely belong to a specific location/group and that can be used to identify which clusters correspond to a given stock/population of dolphins.

For the purposes of the LA BND Monitoring Plan, the SME group prioritized efforts to improve our understanding of the connectivity across the Louisiana dolphin stocks/populations. A major component of this effort is to expand on recent genetic analyses conducted by NOAA (e.g., Vollmer et al. 2017 and 2021)–specifically to fill in data gaps on specific Louisiana stocks and to

improve the accuracy in distinguishing among various populations. Targeted remote biopsy surveys to increase the sample sizes for genetic analyses across Louisiana stocks/populations can achieve these goals.

Remote biopsy surveys require field biologists on small vessels (similar to those discussed for photo-ID): for smaller study areas a crew of four on one boat could suffice, but larger study areas may require multiple crews/boats. Examples of study designs and standardized methodologies can be found in manuscripts about previous remote biopsy surveys in Barataria Bay and Terrebonne-Timbalier Bays (Sinclair et al. 2015 and 2017). Preferably, each crew has experience in both photo-ID techniques (to assist with identifying preferred dolphins) and remote biopsy techniques. When an appropriate target animal is found, a biologist will collect a skin/blubber biopsy sample using a modified crossbow or rifle loaded with a specially designed and sterilized sampling dart. Upon retrieval of the sample, one of the crew members processes the sample on the boat, separating the skin and blubber and storing them in various preservation media and cold storage–depending on the analysis. For genetic analyses, skin samples should be stored in liquid nitrogen if possible, or else in DMSO in a cooler maintained at approximately 20°C. The safety of the crew and the dolphins is always paramount for field research with wild animals, and remote biopsy teams should carefully follow NOAA protocols and best practices for sterilizing equipment and collecting the samples (Sinclair et al. 2015, Ronje and Brechtel 2021, Van Cise et al. 2024).

Similar to the recommendations for photo-ID surveys, the SME group advocated for targeting both BSE resident dolphins and nearby coastal stock dolphins, specifically with the goal of comparing genetic signatures to 1) differentiate the two and 2) better understand the connectivity between individual BSE stocks and coastal stocks/the NWIS DIP. The paired field efforts (BSE and coastal surveys) may be performed together, but especially for larger study areas, it may be more logistically feasible to plan for two separate field efforts. Again, the size of the study area and the number of samples desired (likely determined by power analyses with the analytical groups running the models, e.g., NOAA SEFSC) will influence the number of days and boats necessary to complete the efforts in a safe but reasonable manner for the field teams. The SME group only recommended remote biopsy surveys for stocks where some density and distribution data are available, so that field crews can best design survey routes to meet the goals of genetic analyses for each stock/population (e.g., supplementing existing genetic data to increase sample size vs. collecting a suite of samples from an area without genetic data from known resident dolphins).

Evaluating habitat use

The SME group identified data gaps in demographic estimates and population structure for most of the Louisiana dolphin stocks. Even for the BBES Stock, which was studied intensively after the DWH oil spill, no photo-ID (or other types of) surveys have been conducted since 2019. Thus, recommendations for the first 5-10 years of Louisiana TIG MAM monitoring focus on addressing those data gaps. However, the group discussed preliminary approaches for evaluating habitat use for stocks with reliable density and distribution information, including:

- Spatial modeling exercises: a relatively low effort option is to overlay spatial density/distribution data for a given stock with GIS layers of coastal marine habitat data from other sources. The group specifically discussed NOAA's Environmental Sensitivity Index maps, which provide spatial information about potential prey species, shoreline habitats/ecosystems, potential sources of threats/stressors to dolphins, and other data pertinent to response planning for coastal emergencies, which are available at: https://response.restoration.noaa.gov/resources/environmental-sensitivity-index-esi-maps
- Tagging: satellite-linked telemetry tags can help establish dolphin ranges and daily movements through remote tracking over periods of months (e.g., Balmer et al. 2014 and 2016, Wells et al. 2017, Takeshita et al. 2021) and can provide a more detailed spatio-temporal picture of habitat use compared to more sporadic, aggregated photo-ID sightings across years. Direct tracking of satellite-linked tags with UHF beacons or of VHF tags can provide even finer-scale resolution but require the tracker/observer to be within line-of-sight range of the dolphins. Other types of tags such as digital acoustic recording tags [DTAGs] can provide behavioral details for deployments of about 1 day). Applying tags to small cetaceans typically requires hands-on time with the animals during catch-and-release or stranding response efforts, but a new technique has been developed to attach tags to free-swimming animals under specific circumstances (Moore et al. 2024). The pole-mounted Tag Attachment Device (TADpole) has been used successfully to attach standard satellite-linked tags to the dorsal fins of bow-riding dolphins, precluding the need for catch-and-release. However, bow-riding behavior is rare with BSE dolphins (but may be more feasible for coastal dolphins in Louisiana).
- Focal animal behavioral follows (focal follows): surveys where a crew of field biologists systematically document longer periods of detailed observation for single identifiable dolphins (or single groups of dolphins) can provide data on habitat use and behavior. These observations are, by nature, generally limited in sample size and less likely to capture the variation across a stock/population/study area. However, in some circumstances it can be the only way to answer very specific questions about habitat use, socialization, and behavior. The consistent, systematic approach to data collection allows comparisons across time for the same individuals, across dolphins, and across sites.

The SME group briefly discussed the importance of monitoring and understanding how stocks/populations interact with regional-specific fisheries, however the monitoring recommendations herein likely would not change drastically for fisheries-specific questions and the relative threats to each stock from each fishery are discussed in the Human-caused Threats Review. As a result, we do not further address monitoring of fisheries interactions in our recommendations below.

1.3 Techniques to consider in the future

During the workshop, we discussed a variety of emerging technologies/approaches to address specific monitoring questions for Louisiana dolphins. Given our approach to focus on the first 5-10 years of a monitoring plan, we decided to limit recommendations to well-established and wide-spread techniques that would not require additional research or ground-truthing to

Louisiana TIG MAM monitoring. However, many of the emerging technologies discussed at the workshop are in-use in other monitoring contexts and should be re-evaluated for integration into the monitoring plan as the field progresses and techniques become more feasible. The SME group repeatedly discussed that studies recommended herein may provide ideal opportunities to conduct two techniques (one more established and one emerging) at the same time and compare the results, and this should be considered for informing future activities in this plan. We briefly summarize some of the emerging methodologies here.

1.3.1 Presence, abundance, density, and distribution

eDNA

Environmental DNA (eDNA) refers to the DNA scientists can isolate from cells that an organism has shed into its environment (e.g., gastrointestinal cells in feces, skin cells, or immune cells in mucus). For example, if scientists find dolphin-specific DNA signatures in a water sample, they know that a dolphin was nearby recently, even if they did not see the individual. eDNA therefore represents a powerful monitoring tool, especially for marine wildlife species that spend significant time beneath the surface of the water. eDNA monitoring efforts for dolphins and other marine mammals are currently in progress, but there are not currently standardized approaches or methodologies. Analysis techniques for integrating water flow, tides, and currents, as well as the stability of cells/DNA molecules in various environmental conditions, are all in development. In order to implement eDNA monitoring for the purposes of Louisiana TIG MAM monitoring, it will likely be important to have reliable hydrodynamic models in the study areas of interest– currently only Barataria Bay and some of the NWIS DIP areas have such products. However, with the continued development of passive water samplers that can run the eDNA detection assays remotely, this technique is especially enticing for efficient monitoring of remote, hard-to-access areas across Louisiana BSEs. Importantly, although techniques are progressing quickly, there are not wide-spread, established eDNA methods for identifying dolphins at an individual level, which means current approaches only allow for presence/absence monitoring of a target species.

Acoustics

Cetaceans use a variety of clicks, whistles, and other sounds to communicate and during foraging. Scientists can record these sounds using underwater microphones and use these acoustic data to estimate the presence, abundance, density, and distribution of different species of dolphins and whales. These techniques are especially useful in deeper parts of the open ocean, to collect data in areas where it is infeasible/inefficient to repeatedly send field teams and where sightings at the surface may be insufficient. However, acoustic arrays could be deployed in shallower waters like the BSE and coastal waters of Louisiana. By using multiple microphones, and with the assistance of powerful data processing algorithms, scientists can filter out reflected sounds from the seafloor and water surface and determine whether multiple vocalizations are the product of one vociferous individual or several individuals communicating at the same time. Given the relatively shallow depths of Louisiana waters, and the convenience of small boat vessel surveys, the SME group recommended focusing on photo-ID surveys in the

first 5-10 years of the LA BND Monitoring Plan, but acknowledged that acoustics may be a preferable strategy for monitoring remote, hard-to-access areas across Louisiana waters. Similar to eDNA, acoustics data are not commonly used to identify individual dolphins remotely, but efforts are being developed at other sites such as Sarasota Bay, Florida, to monitor resident dolphins remotely by means of their individually specific signature whistles (Sayigh et al. 2022), as recorded by a network of underwater listening stations distributed around the bay.

Drones/photographic surveys

Even experienced photo-ID field or stranding response teams can find small vessel-based surveys for dolphins in Louisiana wetlands challenging due to the complicated coastlines and remote locations. Integrating drones with cameras into these surveys can provide a means for quickly surveying a large area with less maneuvering of the boat. This is especially appealing for more efficient surveying for stranded or moribund dolphins, either living or dead, but could also potentially assist photo-ID survey teams. However, challenges with integrating drones into dolphin monitoring activities remain. Especially for the turbid waters of Louisiana, drone cameras may not detect dolphins underwater. More work also needs to be done to determine the best way to consider the level of effort for drone-based surveys compared to traditional photo-ID surveys. Finally, there is the potential that the logistics and current limitations of drone surveys may not yield the theoretical efficiencies or effectiveness required for monitoring analyses. Ground-truthing pilot studies need to be done in Louisiana wetlands to better understand how well this new technique will work in such a unique environment. Drones have not yet been used, to our knowledge, to capture photographs of dorsal fins for identifying individuals.

Citizen science

Several coastal research groups implement citizen science projects, where individuals from the general public can report marine mammal observations to scientists via a hotline, website, or phone application. In theory, this provides an opportunity for expanded spatial and temporal resolution for monitoring efforts, unlimited by schedules and logistics of research field teams. In addition to benefits for scientific research, citizen science programs also play an important role in community engagement and education. The SME group considered whether promoting a citizen science effort in Louisiana BSEs, primarily with recreational fishers, may bolster monitoring efforts, but we identified several significant challenges. Although there is an active fishing and recreational community in Louisiana BSEs, many of the areas with the highest dolphin-monitoring needs are still quite remote and infrequently used by the public. Data from citizen science participants can be difficult to work with and integrate into rigorous scientific analyses, because there is often no way to verify reports or correct observations for the level of effort and there is a wide variation in the abilities of individual observers. Although the SME group acknowledged that a citizen science effort may be beneficial from an education and outreach perspective, and possibly as a source of anecdotal information, we do not recommend that the data be integrated into monitoring efforts at this time.

Next-generation sequencing and epigenetics

Genetic assignment of dolphins to specific stocks/populations is currently mostly done using a relatively limited number of nuclear microsatellite and mitochondrial DNA markers. In some preliminary analyses of genetic assignments to stocks, SMEs suggested that there may be cases where microsatellite data alone may not provide the resolution necessary to differentiate among groups of dolphins. However, next generation sequencing (NGS) techniques that produce a larger number of genome-wide markers (e.g., RADseq, a reduced representation sequencing technique resulting in 1000's of markers per individual) or even whole genomes provide the statistical power to differentiate among populations at fine-scales with fewer sampled individuals needed. Furthermore, epigenetic techniques (i.e., examining DNA methylation patterns) have recently been used successfully to estimate age and characterize population health of wild dolphins (Barratclough et al. 2024). There is the potential for certain epigenetic markers to be used to discern distinct populations. Both NGS and epigenetic methodologies are becoming more accessible to wildlife scientists and decision makers, both in terms of cost and the data pipelines necessary to make reasonable interpretations with these large datasets. SMEs discussed how both NGS and epigenetics could supplement existing microsatellite genotyping to provide more detailed information about population structure, but both methods are still in the early stages of adaptation specifically to wild dolphins. Thus, in the first five-to-10-years of the plan, the SME group recommends that the LA BND Monitoring Plan include a small exploratory effort to determine if NGS and epigenetic signatures could be used to supplement the microsatellite data to improve the models' abilities to differentiate groups.

1.3.2 Habitat use and health

Satellite-linked telemetry tags

Photo-ID surveys provide observational data of individual dolphin locations. For the efforts recommended by the SME, these observations are limited to the days that field teams are actively surveying; likely, one to two weeks per year or season. However, if researchers can attach a satellite-linked telemetry tag to a dolphin, they can monitor an animal's location remotely for up to several months. It also allows scientists and veterinarians to track dolphins after releasing an animal after an intervention. As discussed above, these tags can be applied during temporary catch-and-release efforts (including hands-on intervention scenarios) and remotely on free-swimming, bow-riding dolphins by means of the TADpole (Moore et al. 2024). The TADpole approach may be useful for coastal dolphins, but is likely not applicable to BSE dolphins in Louisiana.

Hoop-net temporary catch-release efforts

Health assessments on free-swimming small cetaceans generally involve surrounding one to four animals with a net in five feet or shallower water. Investigating the health of individual animals is important for understanding population dynamics, and these hands-on efforts also offer the opportunity to attach a variety of tags to dolphins for understanding habitat use and movements. The SME group discussed the possibility of using hoop nets in deeper waters for catch-release of coastal dolphins, a technique that Dr. Randall Wells and his team have been

using with dolphins over the West Florida Shelf (Wells 2024). Similar to the TADpole device, this approach requires bow-riding dolphins to surface such that a break-away net loosely attached to a metal frame can be slipped over the animal, and the animal is then secured by swimmers and brought aboard a boat.

Stomach contents

To better understand where and why dolphins use specific habitats, scientists can catalog the prey found in dead, stranded dolphins' stomachs. For example, Bowen-Stevens et al. (2021) reported on the stomach contents of 37 dolphins that stranded in Barataria Bay, finding seasonal trends in anchovies, mullet, and seatrout and demonstrating that BBES dolphins forage along the seafloor. However, the SME group discussed the relatively low number of recovered carcasses across Louisiana coastlines, making it difficult to gather a large enough sample size to make meaningful inferences. Thus, we recommend that stomach content analysis should not be a priority monitoring effort, but should be considered if unique situations arise (e.g., unusual mortality events). Also, gastric lavage can provide samples for analysis during catch-and-release health assessments.

Stable isotope and fatty acid analyses

Where a dolphin spends time and what food it eats can influence the specific isotopic signatures of carbon and nitrogen in their tissues. By measuring stable isotopes from skin and/or blubber samples, researchers can infer a dolphin's habitat use and diet across both geographic space and time (e.g., Cloyed et al., 2021). Similarly, some fatty acids can only be derived from the food we eat, and are incorporated into our cells without significant modifications. Thus, fatty acid signature analysis can be used to identify an animal's diet, by comparing their fatty acid profile to those of various potential prey species. While there are examples of scientists using each of these techniques to study the habitat use and diet of dolphins, the SME group recommended prioritizing abundance, density, and distribution in the first 5-10 years of the LA BND Monitoring Plan.

Epigenetics and microbiomics

In addition to epigenetics (discussed above), the evaluation of what bacterial communities are associated with animals (e.g., microbiomics) can provide information about an individual's health and life history/habitat use, but both methods are still in the early stages of adaptation specifically to wild dolphins. Thus, although they may be useful in future aspects of the LA BND Monitoring Plan, the SME group recommends keeping track of new studies but not integrating epigenetics or microbiomics as priority monitoring activities for habitat use and health in the first 5-10 years of the plan. However, if opportunities arise to supplement other efforts, outside of this plan, to collect and analyze these data, they could be cost-efficient and useful additions to the monitoring plan.

1.4 Complementary monitoring efforts beyond this plan

The recommendations by the SME group were influenced by our collective understanding of other similar and potentially overlapping efforts related to the monitoring of Louisiana dolphins. Where possible, the recommendations herein avoid redundant activities and attempt to identify opportunities for coordination (both at a technical level and a logistic level). The specific efforts discussed included:

- The Mid-Barataria Sediment Diversion (MBSD) Monitoring Plan: currently in progress but the Consensus Building Institute (CBI) produced a Mid-Barataria Monitoring Workshop Discussion Summary document (April 2024) to summarize individual perspectives on what could go into the Monitoring Plan. The plan will focus almost entirely on the BBES Stock, and therefore the SME group limited their recommendations for additional monitoring efforts in Barataria Bay as part of this LA BND Monitoring Plan to specifically fill any potential data gaps or address potential delays in the MBSD monitoring activities. The MBSD Monitoring Plan may include some combination of:
    - Photo-ID studies for capture-mark-recapture analysis every one or two years
    - At least one hands-on health assessment with satellite-linked telemetry tag deployment
    - Active stranding surveillance
    - Remote biopsy surveys and genetic analysis for stock structure
    - Small vessel surveys to monitor potential freshwater-related skin disease
- Mid-Breton Sediment Diversion EIS: Currently on hold (more information available at: https://www.mvn.usace.army.mil/Missions/Regulatory/Permits/Mid-Breton-Sediment-Diversion-EIS/)
- Other DWH restoration efforts (more information available at: https://www.gulfspillrestoration.noaa.gov/restoration-areas), including enhancing the Louisiana stranding network.
- BOEM-funded 2nd round of aerial transects as part of GoMMAPPS II (2025-6)
- Water quality monitoring, including salinity, and developing spatiotemporal models for integration into population modeling
    - The SME group felt that others, likely including the State of Louisiana, are already producing/updating/developing such models, but if those products are not ideal for marine mammal population modeling, they recommended including the development of such products as part of this LA BND Monitoring Plan.

2 Overarching planning needs

In order to best monitor the dolphin populations across Louisiana and use that information for making decisions about restoration strategies and management, the SME group emphasized that there is a set of required activities that must be done in a coordinated fashion to integrate the monitoring data across all of the stocks/populations. A holistic approach will address data gaps about population dynamics across stocks and geographic areas that are necessary for decision makers to best plan monitoring and adaptive management activities.

2.1 Population modeling

The SME group emphasized the importance of using population modeling as the unifying framework around which all future Louisiana monitoring be built. As discussed in Section 1.2.1 above, population models provide the means for converting the data collected during field efforts into metrics for monitoring population trends and for quantifying the effectiveness of restoration efforts. As such, population modeling efforts are crucial to the Louisiana TIG MAM process, and resources need to be specifically designated for modeling activities.

The complexity of a population model depends on the quality and quantity of input data and parameters available. For example, several of the SME group members helped develop the relatively complex dolphin population models used in the DWH injury assessment (Schwacke et al. 2017 and 2022) and the environmental impact statement for the MBSD project. However, simpler models can be implemented for other stocks where less information is available. Regardless of the approach taken for the different BSEs, the SME group was clear that a cohesive set of statistical models is needed to describe and predict dolphin population dynamics and trajectories across all of Louisiana. They also underscored the necessity of a centralized group of statisticians and marine mammal biologists to coordinate decisions about which modeling approaches to use, what data can and should be collected to develop the best models, and how to best integrate models to evaluate dolphins across Louisiana and not just on a stock-by-stock basis. Such a group would facilitate clear communication among the scientists planning and doing the data collection, the scientists designing and running population models, and the decision makers in the Louisiana dolphin MAM process.

2.2 Centralized dorsal fin photo-ID matching

Photo-ID studies of BSE dolphin populations are often limited to a single estuary system, where new photographs of dorsal fins are compared to catalogs of images from only their local area. However, important questions about the movements and relationships among multiple stocks/populations can be answered by including photo-ID catalogs from more than one geographic area in fin matching analyses (e.g., Mullin et al. 2018). The Gulf of Mexico Dolphin Identification System (GoMDIS; https://sarasotadolphin.org/gomdis/) is a collaborative effort to help facilitate cross-catalog comparisons, providing scientists with a centralized repository for their catalogs across the region. It currently includes 45 catalogs from researchers and stranding response groups from the U.S., Mexico, and Cuba.

The SME group strongly recommended that all photo-ID activities associated with the Louisiana MAM process be submitted into GoMDIS. This is especially important to enable scientists to evaluate the frequency with which dolphins move between coastal and BSE stocks, adjacent BSE stocks, and from Louisiana waters to other Gulf states. Interpopulation dynamics represent a significant data gap discussed by the SME group, and a better understanding would be an important component to further improve genetic analyses of population structure across Louisiana.

To date, NOAA uses the FinBase database system (https://www.fisheries.noaa.gov/national/marine-mammal-protection/finbase-photo-identification-database-system) to curate all of their photo-ID catalogs in the Southeast U.S. and the National Marine Mammal Foundation also uses FinBase to curate the BBES catalog (and others throughout the region). We recommend that any new catalogs in Louisiana also use FinBase to facilitate consistency in data management, analysis, and sharing with GoMDIS.

2.3 Population structure using genetic markers

The SME group relied heavily on studies using genetic markers (e.g., Vollmer et al. 2021) for the recommendations in this Monitoring Plan. However, the experts emphasized that more genetic data and analyses could further address remaining data gaps to inform monitoring and adaptive management decision-making. Thus, the SME group strongly recommended that the Monitoring Plan include an effort to compare genetic markers from dolphin samples across all of Louisiana and include nearby populations from Mississippi, Texas, and coastal waters, including any prospective samples included in the remote biopsy efforts recommended below and additional selected retrospective samples already in hand with NOAA and their partners. It may also be worth conducting analyses with additional genetic markers or whole genomes using NGS and/or epigenetic markers, which may facilitate better separation of distinct groups of dolphins.

2.4 Standardized strandings response and data collection

The Marine Mammal Health and Stranding Response Program (MMHSRP) coordinates and manages the Marine Mammal Stranding Network, including the only Louisiana stranding network partner: Audubon Aquarium Rescue at Audubon Nature Institute. MMHSRP protocols, datasheets, and recommendations for veterinary/laboratory analyses ensure that data, whenever possible, are collected in a standardized and rigorous manner so that data can be synthesized and compared across the entire program. In Louisiana, it is difficult to ensure that all areas of the coastline receive equal attention for marine mammal stranding response, especially due to the remote nature of many of the estuaries and marshes, as well as the surge of activity in specific areas following the DWH oil spill. The SME group discussed how stranding data can be as important to monitoring efforts as surveys for abundance, density, and distribution, especially in areas where typical small-vessel-based surveys may prove difficult and there are no current data about marine mammals. The SME group suggested that monitoring activities could support standardized stranding response and data collection in such areas, particularly the MRD Stock area. If such stranding data were available in multiple areas, the SME group recommends working with MMHSRP to synthesize the data across Louisiana and into the population modeling effort, as appropriate.

3 Northwest Inner Shelf Demographically Independent Population

3.1 Introduction

Recent genetic studies indicate that the BSE dolphin stocks in the eastern part of Louisiana may be part of a genetically contiguous intermixing population that also includes at least portions of the Western and Northern Coastal Stocks (Vollmer & Rosel 2017, Vollmer et al. 2021, Garrison et al. 2024). For the purposes of the SME group's discussions about identifying monitoring activities for dolphins across Louisiana, we used the terminology in Vollmer and Rosel (2017) to describe this larger, overlapping set of stocks/dolphins: the Northwest Inner Shelf Demographically Independent Population (NWIS DIP).

Dolphins in the MRD Stock were not sampled as part of the genetic analyses that first identified the NWIS DIP, but studies suggest that they may also be a part of the NWIS DIP. While the SME group recognized that the existing stock boundaries and definitions continue to be useful and relevant for management purposes, they also recognized that if the dolphins using each of the geographically defined stock areas are not demographically independent but are treated as such, stock-by-stock abundance estimates and trend analyses will be unreliable metrics of the true dynamics within this region and therefore of the true impacts of restoration efforts. Others have suggested that a redefinition of stock boundaries in this area, based on both genetic and movement studies, should be considered (Vollmer & Rosel. 2017, Vollmer et al. 2021, Lohoefener et al. 1987, Hubard et al. 2004, Miller et al. 2013, Mullin et al. 2017). To better understand the genetic and demographic structure within the area covered by the NWIS DIP and to more clearly delineate its boundaries, more samples and additional analyses are needed across Louisiana BSEs and coastal waters. It is in this context that we make our recommendations for this portion of the LA BND Monitoring Plan.

In addition to adhering to the current best available science concerning the demographic structure of this area, grouping the stocks that potentially fall within the NWIS DIP (MSS, MRD, and the Northern and Western Coastal Stocks) makes logistic sense since the SME group recommended similar activities for all of them given their similar monitoring limitations, considerations, and needs. Additionally, the additional data needed to increase our understanding of dolphin abundance, density, distribution, and population structure within the NWIS DIP will require coordination across these stocks.

The most recent abundance estimates covering this area were derived from aerial surveys conducted as part of GoMMAPPS I (Rappucci et al. 2023; Garrison et al. 2021). Surveys were conducted in the summer of 2017, and the winter and fall of 2018, and covered the entire U.S. portion of the continental shelf within the Gulf–although not all areas were surveyed in all three seasonal surveys. Similar surveys had previously been conducted in 2011-2012 in association with the DWH oil spill. Survey protocols and tracklines are well established and validated. Within

the NWIS DIP area, most of these surveys were conducted along track lines that run perpendicular to the shoreline and were spaced approximately 20 km apart. In the Mississippi Sound area, finer-scale surveys were conducted with tracklines spaced approximately 5 km apart. These finer scale tracklines covered Bay Boudreau, but excluded Lake Borgne and Lake Catherine. In Chandeleur Sound, tracklines were 20 km apart. Aside from areas within Mississippi Sound, the GoMMAPPS I and DWH-associated surveys did not cover BSE waters.

The current critical monitoring needs across the NWIS DIP are:

1. updated abundance estimates,
2. additional data to inform population structure and connectivity, and
3. data to determine the geographic extent of the DIP.

Given the broad areas and open waters associated with the two coastal stocks, as well as the logistical difficulties associated with small vessel surveys of the MRD Stock area and the Louisiana portion of the MSS Stock area (e.g., Bay Boudreau and Lake Borgne), the SME group recommended focusing on aerial surveys for updated abundance estimates. New BOEM-funded coast-wide surveys are planned for 2025/2026 (GoMMAPPS II) and will be modeled after the 2017-2018 GoMMAPPS I surveys. Our monitoring recommendations, therefore, assume that abundance surveys will be conducted as part of the BOEM effort (using the same track lines) and do not need to be part of this plan with a few exceptions noted below.

Finer-scale information about the population structure and the geographic extent of the NWIS DIP can be accomplished with targeted remote biopsy and satellite-linked tagging efforts, and should be coordinated with the other BSE stock monitoring efforts discussed in this Monitoring Plan. Data on Louisiana dolphin genetic differentiation and spatial movements will be especially crucial for assigning dolphins to either resident BSE populations or more transient coastal populations (e.g., Northern Coastal, Western Coastal, and/or the NWIS DIP). The SME group also discussed that NGS/epigenetics may be of particular use as complementary data for the genetic analyses associated with the NWIS DIP. Additionally, although not a primary focus of this section, using photo-ID survey data for social structure analysis within other BSE stocks (and including the transient animals from the NWIS DIP stocks) could provide important information about potential threats from disease transmission. In each of the stock sections below, we outline the specific recommendations for each sub-area.

3.2 Mississippi Sound Stock

The MSS Stock occupies the eastern waters of Louisiana as well as the entire Mississippi coast and the western portion of Alabama (to Mobile Bay). Within Louisiana, it includes Bay Boudreau and Lake Borgne and is adjacent to Chandeleur Sound (within the Northern Coastal Stock geographic boundaries). Historically, dolphins from this stock also used Lake Pontchartrain and The Rigolets inlet, but few dolphins have been reported in this area in recent years, likely due to the decreased salinity (J. Fallon/G. Vasquez, pers. comm). Within the Louisiana waters of the MSS Stock area, the SME group recommends targeted remote biopsy surveys, additional fine-

scale aerial surveys (beyond what is currently planned for the BOEM-funded surveys), and exploratory photo-ID surveys.

Because the previous and future planned aerial surveys do not include Lake Borgne and Bay Boudreau, we recommend conducting fine-scale aerial surveys in this area that follow the same protocols used in the GoMMAPPS I surveys of Mississippi Sound (e.g., 5 km spacing of transect lines). Ideally, these efforts would be integrated into or closely coordinated with the GoMMAPPS II aerial survey efforts in 2025 and 2026, with NOAA SEFSC personnel (who were also part of our SME group) taking the lead on integrating the results into their abundance estimates both by existing stock and with regard to the Louisiana TIG MAM restoration priorities herein. If possible, the surveys specific to Lake Borgne and Bay Boudreau should be timed with consideration for annual trends in freshwater runoff to better understand any potential seasonal population dynamics (e.g., one survey in a late fall or early winter when freshwater influx is lowest and another survey in spring when freshwater influx is highest).

To better understand the extent to which dolphins use the areas just outside of Lake Pontchartrain, we recommend conducting a limited number of exploratory boat-based photo-ID surveys in the waters of The Rigolets, Chef Menteur Pass, Lake Catherine, Bay Jaune, and the southeastern-most area of Lake Pontchartrain.

Remote biopsy samples should be collected from dolphins in Bay Boudreau and Lake Borgne to 1) provide additional genetic information about the population structure within this relatively under-studied section of the NWIS DIP area and 2) provide data on the extent to which these dolphins are genetically and demographically connected to other stocks in the northern Gulf. Vollmer and Rosel (2017) emphasized that additional samples, especially in areas where no (or few) genetic samples have been collected to date, are critical to continue to clarify genetic differentiation across the relatively large area covered by the NWIS DIP. A better understanding of the dolphins in this area is especially important given the recent UMEs related to freshwater, cold temperatures, and extreme weather events in the Bay Boudreau and Lake Borgne area.

Given that the majority of the MSS Stock area is located outside of Louisiana, any data collected in this area for the purposes of Louisiana TIG monitoring should be integrated with data collected in Mississippi and Alabama (and Florida, where appropriate). This includes aerial survey data collected for abundance estimates, fisheries interactions and stranding data, as well as genetic sampling (i.e., from remote biopsies). Thus, the fine-scale aerial surveys should be coordinated with the GoMMAPPS II surveys such that dolphins using Lake Borgne and Lake Catherine can be included in the most up-to-date abundance estimates. Stranding data should also be aggregated across stranding networks. As per best practices and as has been done previously (e.g., Vollmer & Rosel. 2017, Vollmer et al. 2021), genetic data should be analyzed in the context of not only other NWIS DIP samples, but also samples from Texas, Mississippi, Alabama, and Florida.

3.3 Mississippi River Delta Stock

The MRD Stock area encompasses the many named lakes and bays lying on the east side of the Mississippi River Delta, including Breton Sound. The area is characterized by a high density of gas and oil infrastructure but little is known about the impacts of this infrastructure and related activities on the dolphins using this area due to low historic stranding survey effort. GoMMAPPS I aerial survey tracklines did not include this area. Remote biopsy samples have not been collected from dolphins in this stock. Thus, while genetic analyses suggest that the dolphins from the MRD Stock may be part of the NWIS DIP, more data are needed.

To address the paucity of data from this area and increase our understanding of its place within the NWIS DIP, we recommend a multi-pronged approach to future monitoring:

1. Since previous abundance surveys have not included this area, fine-scaled aerial surveys (tracklines spaced 5 km apart) should also be conducted in this area, supplemented by boat-based surveys where aerial surveys are infeasible. As with MSS, these surveys should be incorporated into, or coordinated with, the GoMMAPPS II surveys to take place in 2025 and 2026 and would ideally be conducted in four seasons: winter, spring, summer, and fall.
2. Given the density and age of oil and gas infrastructure here, standardized surveillance and documentation of strandings and other human-caused impacts should be undertaken via expansion of existing stranding networks. Given the level of human development along the coast in this area, our SMEs believe that acquiring data on strandings and human impacts in this area is possible, but will require additional resources to develop partners in the area and ensure they are well trained to collect high-quality, consistent stranding data.
3. Because we lack information on the residency patterns of the dolphins using this area, satellite-linked tag deployments will also be critical. Both males and females should be tagged to better understand the extent to which MRD dolphins also use the adjacent waters of Mississippi and Chandeleur Sounds.
4. The coordinated remote biopsy effort that we recommend across the NWIS DIP should include dolphins from this area to give context to the data collected from tagged animals and yield information about longer-term broader-scale connectivity patterns among the stocks within the NWIS DIP. Ideally, at least some tagging with satellite-linked tags would be conducted prior to remote biopsy surveys in order to use the movement data to inform the remote biopsy sampling design, but not at the risk of delaying any biopsy efforts.

3.4 Northern Coastal Stock

Within Louisiana, the Northern Coastal Stock area covers the coastal waters (seaward of shoreline, barrier island chains, and outer bay boundaries to the 20 m isobath) to the east and south of the MSS and MRD Stock boundaries. The stock area also extends beyond Louisiana waters, stretching east along the coasts of Mississippi, Alabama, and western Florida (to 84°W longitude). Chandeleur Sound comprises most of the Louisiana portion of the stock area and will

be the primary focus of our monitoring recommendations herein. GoMMAPPS I aerial abundance surveys covered the Northern Coastal Stock area using 20 m spaced transects. Relatively few genetic samples have been obtained from Chandeleur Sound.

Genetic analyses indicate that Northern Coastal and MSS dolphins are all part of the NWIS DIP, but significantly more information is needed from Chandeleur Sound and the MRD to better understand the genetic structure and boundaries of the DIP and the role that transients play in potential cross-DIP mixing and disease transmission. To fill in these data gaps, genetic samples should be obtained throughout Chandeleur Sound from remote biopsy surveys. We also recommend deploying satellite-linked tags on a number of Chandeleur Sound dolphins to understand movement patterns within coastal waters and between coastal waters and adjacent BSE waters. Tagging dolphins in the MRD and MSS Stocks may yield information about what dolphins are using Chandeleur Sound, but if intermixing across these stocks is more limited, satellite telemetry within the Sound will be necessary. However, given the challenges of tagging in coastal waters, use of newer tag deployment methods, such as the TADpole, will likely be required here. Because very few photo-ID data are available within Chandeleur Sound or the MRD stock, the tagging data are critical to understanding the ratio of transients versus residents and will inform population modeling efforts and yield important information about potential disease transmission patterns. Aerial survey efforts to assess abundance should be continued in this area and are currently planned for 2025 and 2026.

3.5 Western Coastal Stock

The area covered by the Western Coastal Stock includes coastal waters (seaward of shorelines, barrier islands, and outer bay boundaries to 20 m isobath) from the western side of the Mississippi River Delta (and abutting the MRD and Northern Coastal Stock boundaries at the southern tip of the Delta) west to the Texas-Mexico border. The Western Coastal Stock lies adjacent to and south of the Louisiana BSE stocks of Barataria Bay, Terrebonne-Timbalier, and Vermilion, and covers coastal waters outside Calcasieu and Sabine Lake BSEs. GoMMAPPS I aerial surveys covered the entire Western Coastal Stock area with 20 m spaced tracklines. Dolphin stranding data are relatively abundant from this stock, but the geographic distribution of the stranding data is patchy due to limited effort in less developed coastal areas. Genetic samples from remote biopsy surveys have been collected across the east-west range of this area, but given its size, more genetic samples are needed to fully characterize the genetic and demographic structure within the Western Coastal Stock and its connection with the other stocks identified within the NWIS DIP. Because of its adjacency to Vermilion, Timbalier, and Terrebonne Bays, some remote biopsy efforts should be focused in the coastal waters south of these areas to better inform our understanding of the demographic and genetic distinctiveness of the NWIS DIP from these western Louisiana BSE stocks as well as the potential for disease transmission.

Everything we recommend for the NWIS DIP/Northern Coastal Stock generally applies to the Western Coastal Stock, except that the entirety of the Western Coastal Stock has been covered by GoMMAPPS I aerial surveys, so no additional survey effort is required in the planned

surveys of 2025 and 2026. As discussed in Section 1.3.2, future monitoring efforts could include offshore health assessment efforts using hoop net capture techniques, but for the purposes of the present five-to-ten-year LA BND Monitoring Plan, the SME group recommends focusing on aerial surveys and remote biopsies.

The SME group specifically recommends pairing BSE photo-ID efforts with efforts for remote biopsy in the coastal waters of the Western Coastal Stock immediately south of each respective BSE in western Louisiana. These data, taken together, would enrich the analysis of genetic stock assignments, inform potential disease transmission, and facilitate social interaction analyses especially with regard to immigration/emigration and seasonal transient patterns.

4 Western Louisiana BSEs

4.1 Introduction

The remaining Louisiana BSE stocks fall west of the Mississippi River Delta and include (from east to west) Barataria Bay, Terrebonne/Timbalier Bays, Vermilion Bay, and the smaller and more isolated Calcasieu and Sabine Lake stocks. The stocks in this area of Louisiana demonstrate the extremes of our knowledge and understanding about the abundance and demographic structure–from Barataria Bay with its abundance of studies and information to Vermilion Bay, Calcasieu Lake, and Sabine Lake with very limited available information. We group these stocks under the Western Louisiana heading solely from a geographic perspective and not, as with the NWIS DIP, because of their demographic interconnectedness. Dolphins residing in Barataria Bay have been shown to be genetically distinct from dolphins using the adjacent Western Coastal Stock waters (Rosel et al. 2017), and photo-ID and satellite-linked tagging data indicate very little exchange between the BBES Stock and the adjacent Western Coastal and TTBES Stocks (Mullin et al. 2018, Wells et al. 2017). Less is known about the genetic and demographic structures of the stocks further west (i.e., Vermilion, Calcasieu, and Sabine). Given this range of available information, the stock-specific recommendations below vary from exploratory pilot studies designed to gather the most basic information for determining future monitoring plans, to detailed study designs aimed at refining existing knowledge. Because of the lack of information from the westernmost BSEs, our recommendations are necessarily limited and should be considered a starting point rather than a complete plan for the next 5-10 years.

4.2 Barataria Bay Estuarine System Stock

The BBES Stock area covers the shallow waters (average depth of 2 m) shoreward of the barrier islands just west of the Mississippi River Delta, south of New Orleans, and eastward of Bayou Lafourche. The central part of the BBES Stock area is surrounded by salt marsh. Abundant data exist from photo-ID surveys, satellite-linked tag deployments, remote biopsy efforts, stranding reports, and health assessments that have informed our understanding of the BBES Stock's population status, demographic rates, genetics, social structure, and movement

patterns. Multiple sources of evidence suggest that within the BBES Stock, dolphins exhibit spatial and social clustering and local site fidelity (Rosel et al. 2017, Wells et al. 2017, Takeshita et al. 2021, Speakman et al. 2022). A small number of dolphins move between the BBES and TTBES Stock areas, spending most of their time within Bayou Lafourche (Wells et al. 2017, Mullin et al. 2018).

As noted above, extensive dolphin monitoring plans are being developed for the BBES as part of the MBSD project. As currently understood, the MBSD dolphin monitoring plan includes most of what would fall under the present LA BND monitoring plan; as a result, we do not recapitulate the monitoring plans included in the MBSD plan here. However, as noted above, the MBSD project may be delayed, in which case, we recommend the following high-priority monitoring be conducted until the MBSD monitoring efforts begin:

- Photo-ID surveys to allow for the continued estimation of survival and abundance estimates for the population and avoid a gap in data collection that would endanger the integrity of the existing long-term dataset.
- Additional remote biopsy surveys targeting dolphins using the east, southeast and central portions of the BBES Stock area to fill gaps in previous genetic sampling surveys that focused primarily in the western portion of the stock area.

The extensive base of knowledge about the BBES Stock as a result of DWH-related studies, makes the BBES an ideal location for applying some of the emerging technologies/approaches discussed above (Section 1.3), if they were under consideration for development for this Monitoring Plan. The BBES's close proximity to Louisiana's only inhabited barrier island, Grand Isle, also makes applying these approaches more logistically feasible here, relative to other Louisiana stocks. Drone surveys are currently under consideration in the MBSD Monitoring Plan. Epigenetic, habitat use, stomach content, and stable isotope analyses have all been done with BBES dolphins, but could be pursued further. eDNA is an intriguing option, especially with the availability of hydrodynamic models from the State of Louisiana.

One area adjacent to the BBES that is not currently included within the BBES or any other stock boundary is the southwest section of the Mississippi River Delta. Given its remote location and the logistical challenges of surveying here, little is known about the dolphins that may use this area, but they are likely part of the BBES, based on the discussion with the SME group. Collection of data in this area will likely not be part of the MBSD monitoring plan, but should be prioritized as part of a comprehensive Louisiana dolphin monitoring plan. Researchers from a consortium of universities are currently studying the Birdsfoot Delta to better understand current issues and help chart a path for its future. The results of this research could help inform future BBES planning.

4.3 Terrebonne-Timbalier Bay Estuarine System Stock

The Terrebonne and Timbalier Bays lie west of Barataria Bay and extend from Port Fourchon in the east to Bay Junop and Isles Derniere in the west, although the western boundary is not well-defined. Based on observations of dolphin use just beyond the barrier islands, the southern

stock boundary extends to 1 km seaward of the barrier island shoreline. The TTBES Stock area is similar to the BBES Stock area in that it is shallow (average depth of 2 m), has a central area surrounded by salt marsh, is separated from the larger Gulf by barrier islands, and has a decreasing salinity gradient south to north. Photo-ID surveys were conducted in summer 2016 and winter 2017 (Sinclair et al. 2017), and a brief effort of opportunistic surveys in response to a small oil/gas release was conducted in 2024 (Takeshita, pers. comm.). Stranding data are relatively sparse compared to Barataria Bay. Remote biopsy sampling was conducted as part of the summer 2016 small boat surveys. Recent preliminary genetic analyses of those biopsy samples (Vollmer, pers. comm.) indicate a higher rate of mixing with both dolphins of the BBES and Western Coastal Stocks than would be expected given findings from telemetry and photo-ID catalog assessments (Wells et al. 2017, Mullin et al. 2018). However, additional samples and analyses are necessary to better understand genetic diversity and dolphin movements in this area.

Given the lack of recent photo-ID surveys in the TTBES, photo-ID surveys should be prioritized here to provide updated abundance estimates. Our SMEs summarized the lessons learned from the previous photo-ID surveys and recommended the following sampling protocols be incorporated into future surveys:

- The surveys should be conducted using three boats rather than two to cover areas that were missed in the earlier surveys, especially to the west, where the habitat is complex, but a substantial number of dolphins were seen.
- Three robust design primary and four secondary surveys should be conducted to reduce uncertainty in the final abundance estimates.
- Relative to the 2016-2017 surveys, additional track lines are recommended, with special consideration for the shipping lanes between Port Fourchon and Cocodrie, where dolphins appear to congregate.
- Current data suggest that summer surveys provide reasonable abundance estimates, but additional analyses should be conducted with any new data collected to address the question of survey seasonality.
- While photo-ID surveys would yield superior data and demographic estimates, the SMEs acknowledged that, given the size and complexity of the TTBES, aerial abundance surveys would likely be feasible, and could be used if resources were unavailable to conduct photo-ID surveys.

Additional genetic studies via remote biopsy could resolve questions about the level of genetic exchange that has occurred among the TTBES, BBES, and Western Coastal Stocks. Ideally, remote biopsy sampling would be conducted with two boats: one vessel covering inshore waters (focusing on the barrier islands and the 2 km outside of the barrier islands) concurrent with a second vessel covering coastal waters (~5-10 km offshore). If that optimal study design is infeasible, the highest priority for additional samples is near the southern stock boundary in the near-coastal waters seaward of the barrier islands.

The SMEs also suggested that NGS (Section 1.3.1) of existing genetic samples might help address some of the outstanding questions about the level of genetic exchange between the BBES and TTBES Stocks, but without additional coastal samples, it is unlikely to fully resolve them. Biopsy efforts can also yield important health information if samples are analyzed for persistent organic pollutants (POPs), hormones, and other contaminants/biomarkers. Such blood and tissue analyses yield basic health metrics that can be compared to similar samples taken from the BBES Stock to assess overall population health, and could be used to determine if a larger health assessment effort is warranted.

Deploying satellite-linked tags could help address some of the population and metapopulation structure questions and is recommended, with the caveat that such efforts can be logistically and financially challenging. The priority areas for tagging include the Port Fourchon area, where a high degree of intermixing of animals between the TTBES and BBES occurs, and in the western half of the stock area, where less is known about dolphin movement and use patterns. Such data could yield important information about the degree to which dolphins move between TTBES and BBES, whether intra-population spatial and social partitioning exists, and whether movement between TTBES and Vermilion Stocks occurs.

4.4 Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay Stock

The Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay Stock lies west of the Terrebonne and Timbalier Bays and is distinct from the areas to the east in that it is not bordered to the south by barrier islands, but is composed of a string of bays and open water with an intermix of larger islands. Salinity levels fluctuate drastically here, ranging from below 5 ppt in the spring to above 10 ppt from June through January. Because of the lack of beaches along the inner coast, and thus, lack of human visitors, stranding data are also lacking. Little is known about the dolphins that may use this area. The last survey of this area was conducted in 1992 as part of a large aerial survey effort that covered the south Atlantic coast and northern Gulf (Blaylock & Hoggard 1994). No dolphins were observed within the stock boundaries during that survey. Nonetheless, substantial anecdotal evidence exists indicating that dolphins use the bays here. It is unclear, however, whether these are dolphins from the NWIS DIP or TTBES Stock that occasionally use the bays to take advantage of seasonally high levels of fishing activities (especially shrimping) or if a resident population exists here.

Given the paucity of information for this stock, we recommend conducting an exploratory, wide-ranging boat-based survey that combines remote biopsy sampling with a scoping effort for future photo-ID surveys. Because of freshwater discharge from the Atchafalaya River in the eastern portion of the stock area, and therefore presumed lack of dolphin use, the scoping should focus mostly (but not exclusively) in West Cote Blanche Bay and Vermilion Bay to determine where photo-ID surveys could be conducted and at what density survey lines should be established. Given the variability in salinity, the scoping effort should be conducted in the fall, when salinity is at its highest and dolphins are most likely to be present. Once the exploratory phase is complete, an initial primary robust design survey should be conducted to determine if additional surveys are warranted. Ideally, future sampling would be conducted during both high

and low salinity periods to better understand how salinity may be affecting dolphin use patterns. Genetic analyses should be conducted on the remote biopsy samples collected during the initial scoping survey to determine what proportion of the dolphins here are part of the NWIS DIP, the TTBES Stock, or are residents, and to determine if more genetic sampling is needed.

4.5 Calcasieu Lake & Sabine Lake Stocks

The Calcasieu Lake and Sabine Lake Stocks are the westernmost in Louisiana, with Sabine Lake straddling the Texas-Louisiana border. Although they are separate and distinct stocks, we address them together here given their similarities in terms of our monitoring plan recommendations. The stocks are each delineated by their respective lake boundaries, each of which have relatively small outlets to the wider Gulf. Marshland exists between the two lakes and between Sabine Lake and Galveston Bay to the west, but these areas are generally inaccessible to dolphins. The most recent population estimate for Calcasieu Lake was derived from an aerial survey that was part of a large effort covering most of the northern Gulf in September of 1992. The resulting estimate was 0 individuals (Blaylock and Hoggard 1994), but a previous survey in the 1980's resulted in an estimate of 0 to 6 individuals (Scott et al. 1989). Sabine Lake and its nearby coastal waters were surveyed as recently as 2017 in both winter and summer via small-boat photo-ID surveys (Ronje et al. 2020). Its population was estimated at 162 (95% CI: 114-210) individuals, most of which were found near the main shipping channel, Sabine Pass, or in the Gulf just outside the Lake. This estimate excluded likely migratory or transient animals, but nonetheless included individuals who were also sighted in photo-ID surveys of Galveston Bay (Ronje et al. 2020). No genetic samples have been collected in either lake, thus limiting what we know about the connectedness of these two stocks to each other and to other Louisiana and Texas stocks.

While much more is known about the Sabine Lake Stock than Calcasieu, we lack important information from both areas that need to be addressed prior to establishing a long-term monitoring plan. The SMEs recommend prioritizing collection of biopsy samples for genetic analysis to determine if dolphins that use these areas form their own distinct populations, if they are part of one large population that also includes Galveston Bay, or if they are part of the NWIS DIP. To this end, genetic samples should be compared to samples from Galveston Bay, and all other Louisiana dolphin stocks. In terms of population abundance surveys, the SMEs recommend conducting an initial year of robust design boat-based photo-ID surveys, with one primary survey and four secondary surveys following the Ronje et al. (2020) survey lines but with additional tracklines as needed. These surveys would require one boat per lake, and should be conducted in the summer when salinity is likely at its peak within both lakes. The results of these surveys could then inform the need for and design of future surveys. Photo-ID catalogs from these surveys should be integrated with the photos collected by Ronje et al. (2020), and as done in that study, should be compared with the Galveston Bay photo-ID catalog. Based on how much overlap this cross-catalog comparison yields, telemetry efforts with satellite-linked tags could be focused in areas most used by individuals that transit current stock boundaries. The combination of genetic information on population-level connectivity collected via biopsy samples with tagging data on individual movements will yield important information

on population structure, the potential for disease transmission, and will allow for more robust abundance estimates.

5 Summary

The recommendations are generally provided based on the best available science and understanding of data gaps as of Apr 5, 2024 for each basin/groups of basins in isolation. Typically, little would change if one wanted to consider how to aggregate several, many, or all of these activities into one coherent plan across the state, but where there may be opportunities to reduce effort should resources (e.g., time, money, personnel) be limited, we try to capture those potential alternatives. In summary, the SME group recommends the following activities (Table 1):

1. Overarching planning needs
    a. Population modeling
        i. A cohesive set of statistical models is needed to describe and predict dolphin population dynamics and trajectories across all of Louisiana. A centralized group of statisticians and marine mammal biologists should coordinate decisions about which modeling approaches to use, what data can and should be collected to develop the best models, and how to best integrate models to evaluate dolphins across Louisiana and not just on a stock-by-stock basis.
    b. Centralized dorsal fin photo-ID matching
        i. The SME group strongly recommended that all photo-ID activities associated with the Louisiana MAM process be curated using FinBase and submitted into GoMDIS to facilitate cross-Stock comparisons, including other existing regional catalogs.
    c. Population structure using genetic markers
        i. There is a need to compare genetic markers from dolphin samples across all of Louisiana (both BSE and coastal areas) and including nearby populations from Mississippi and Texas, including prospective and retrospective samples. It may also be worth conducting analyses with additional genetic data from NGS and/or epigenetic markers.
    d. Standardized stranding response and data collection
        i. Monitoring activities could support standardized stranding response and data collection in areas with few data on dolphins, particularly the MRD Stock area. If such stranding data were available in multiple areas, the SME group recommends working with MMHSRP to synthesize the data across Louisiana and into the population modeling effort, as appropriate.
2. Northwest Inner Shelf DIP
    a. Generally, the current critical monitoring needs across the NWIS DIP are:
        i. updated abundance estimates by supporting and supplementing GoMMAPPS II aerial surveys,

ii. additional data to inform population structure and connectivity using a coordinated remote biopsy effort and genetic analyses of differentiation, and
iii. data to determine the geographic extent of the DIP using satellite-linked telemetry tags.

b. Mississippi Sound Stock (within Louisiana waters)
   i. We recommend fine-scale aerial surveys over Lake Borgne and Bay Boudreau that follow the same protocols used in the GoMMAPPS surveys of Mississippi Sound (e.g., 5 km spacing of transect lines). Ideally, NOAA SEFSC personnel would coordinate these efforts with the GoMMAPPS II aerial survey efforts in 2025 and 2026.
   ii. A limited number of exploratory boat-based photo-ID surveys in the waters of The Rigolets, Lake Catherine, Bay Jaune, and the southeasternmost area of Lake Pontchartrain would fill a current data gap and inform whether future effort needs to be focused on these areas.
   iii. Remote biopsy samples should be collected from dolphins in Bay Boudreau and Lake Borgne to 1) provide additional genetic information about the population structure within this relatively under-studied section of the NWIS DIP area and 2) provide data on the extent to which these dolphins are genetically and demographically connected to other stocks in the northern Gulf.

c. Mississippi River Delta Stock
   i. Fine-scaled aerial surveys (tracklines spaced 5 km apart) should also be conducted in this area, supplemented by boat-based surveys where aerial surveys are infeasible. These surveys should be incorporated into or coordinated with the GoMMAPPS II surveys to take place in 2025 and 2026 and would ideally be conducted in four seasons: winter, spring, summer, and fall.
   ii. Standardized surveillance and documentation of strandings and other human-caused impacts should be undertaken via expansion of existing stranding networks. SMEs believe that acquiring data on strandings and human impacts in this area is possible, but will require additional resources to develop partners in the area and ensure they are well trained.
   iii. Satellite-linked tag deployments will also be critical for this stock to better understand the extent to which MRD dolphins also use the adjacent waters of Mississippi and Chandeleur Sounds.
   iv. The coordinated remote biopsy effort that we recommend across the NWIS DIP should include dolphins from this area to collect genetic samples, and to give context to the data collected from tagged animals and yield information about longer-term broader-scale connectivity patterns among the stocks within the NWIS DIP. Ideally, at least some satellite-linked tagging would be conducted prior to remote biopsy

surveys in order to use the movement data to inform the remote biopsy sampling design.

d. Northern Coastal Stock
    i. Genetic samples should be obtained throughout Chandeleur Sound from remote biopsy surveys.
    ii. We also recommend deploying satellite-linked tags on a number of Chandeleur Sound dolphins to understand movement patterns within coastal waters and between coastal waters and adjacent BSE waters.
        1. However, given the challenges of tagging in coastal waters, use of newer tag deployment methods, such as the TADpole, will likely be required here.
e. Western Coastal Stock
    i. Everything we recommend for the NWIS DIP/Northern Coastal Stock generally applies to the Western Coastal Stock, except that the entirety of the Western Coastal Stock has been covered by GoMMAPPS I aerial surveys, so no additional survey effort is required in the planned surveys of 2025 and 2026.
    ii. The SME group specifically recommends pairing BSE photo-ID efforts with efforts for remote biopsy in the coastal waters of the Western Coastal Stock immediately south of each respective BSE in western Louisiana.
    iii. Future monitoring efforts could include offshore health assessment efforts using hoop net capture techniques, but for the purposes of the present 5-10 year LA BND Monitoring Plan, the SME group recommends focusing on aerial surveys and remote biopsies.

3. Western Louisiana BSEs
    a. Given the range of available information for each basin, the stock-specific recommendations below vary from exploratory pilot studies designed to gather the most basic information for determining future monitoring plans, to detailed study designs aimed at refining existing knowledge. Because of the lack of information from the western-most BSEs, our recommendations are necessarily limited and should be considered a starting point rather than a complete plan for the next 5-10 years.
    b. Barataria Bay Estuarine System Stock
        i. As currently understood, the MBSD dolphin monitoring plan includes most of what would fall under the present Louisiana TIG MAM monitoring plan; as a result, we do not recapitulate the monitoring plans included in the MBSD plan here. However, as discussed above, the MBSD project may be delayed, in which case, we recommend the following high-priority monitoring be conducted until the MBSD monitoring efforts begin:
            1. Photo-ID surveys would allow for the continued estimation of survival and abundance estimates for the population, and would avoid a gap in data collection that would endanger the integrity of the existing long-term dataset.

2. Additional remote biopsy surveys targeting dolphins using the east, southeast, and central portions of the BBES would fill gaps in previous genetic sampling that focused primarily on the western portion of the stock area.

ii. Collection of data in the southwest section of the Mississippi River Delta is likely not part of the MBSD monitoring plan, but should be prioritized as part of a comprehensive Louisiana dolphin monitoring plan.

c. Terrebonne-Timbalier Bay Estuarine System Stock
   i. Given the lack of recent photo-ID surveys in the TTBES, photo-ID surveys should be prioritized to provide updated abundance estimates, with updated protocols based on lessons learned from previous studies.
   ii. Additional genetic studies via remote biopsy could resolve questions about the level of genetic exchange that has occurred among the TTBES, BBES, and Western Coastal Stocks. Ideally, remote biopsy sampling would be conducted with two boats: one vessel covering inshore waters (focusing on the barrier islands and the 2 km outside of the barrier islands) concurrent with a second vessel covering coastal waters (~5-10 km offshore).
   iii. Deploying satellite-linked tags could help address some of the population and metapopulation structure questions and is recommended. The priority areas for tagging include the Port Fourchon area, where a high degree of intermixing of animals TTBES and BBES occurs, and in the western half of the stock area, where less is known about dolphin movement and use patterns.

d. Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay Stock
   i. Given the paucity of information for this stock, we recommend conducting an exploratory, wide-ranging boat-based survey that combines remote biopsy sampling with a scoping effort for future photo-ID surveys.
      1. Because of freshwater influx in Atchafalaya Bay in the eastern portion of the stock area, and therefore presumed lack of dolphin use, the scoping should focus mostly (but not exclusively) in West Cote Blanche Bay and Vermilion Bay to determine where photo-ID surveys could be conducted and at what density survey lines should be established.
      2. Given the variability in salinity, the scoping effort should be conducted in the late summer/early fall, when salinity is at its highest and dolphins are most likely to be present.
      3. Once the exploratory phase is complete, an initial primary robust design survey should be conducted to determine if additional surveys are warranted.
   ii. Genetic analyses should be conducted on the remote biopsy samples collected during the initial scoping survey to determine what proportion of the dolphins here are part of the NWIS DIP, the TTBES Stock, or are residents, and to determine if more sampling is needed.

e. Calcasieu Lake and Sabine Lake Stocks
    i. The SMEs recommend prioritizing collection of biopsy samples for genetic analysis to determine if dolphins that use these areas form their own distinct populations, if they are part of one large population that also includes Galveston Bay, or if they are part of the NWIS DIP. To this end, genetic samples should be compared to samples from Galveston Bay, and all other Louisiana BSE and coastal dolphin stocks.
    ii. In terms of population abundance surveys, the SMEs recommend conducting an initial year of robust design boat-based photo-ID surveys, with one primary survey and four secondary surveys following the Ronje et al. (2020) survey lines but with additional tracklines as needed. These surveys should be conducted in the late summer/early fall when salinity is likely at its peak within both lakes.

Table 1. A summary of the activities recommended by the SME group for monitoring Louisiana dolphins for restoration planning.

	Strandings network	**Photo-ID**	**Aerial Surveys**	**Remote Biopsies for Genetics**	**Satellite-linked Telemetry Tags**	**Notes**
All stocks associated with the Northwest Inner Shelf DIP*	Support ongoing efforts	Targeted surveys	Supplement GoMMAPPS II	Coordinated effort across NWIS DIP	Determine geographic extent of NWIS DIP	
Mississippi Sound	Ongoing	Exploratory surveys near Lake Catherine area	Add Lake Borgne and Bay Boudreau transects	Focus on Bay Boudreau and Lake Borgne	Include	
Mississippi River Delta	Develop resources to support dedicated surveillance here	Supplement aerial surveys, if needed	Add to GoMMAPPS II	Use telemetry data to inform sampling design	Identify potential overlap with MS and Chandeleur Sounds	
Northern Coastal	Ongoing	NA	Covered by GoMMAPPS II	Focus on Chandeleur Sound	Focus on Chandeleur Sound	
Western Coastal	Ongoing	NA	Covered by GoMMAPPS II	Coordinate with nearby BSE photo-ID efforts	Include	
Western Louisiana BSE Stocks						
Barataria Bay Estuarine System	Ongoing	Conduct if delays in MBSD monitoring	Not a priority	Conduct if delays in MBSD monitoring	Not a priority at this time	Collect data in SW MS River Delta
Terrebonne-Timbalier Bay Estuarine	Ongoing	Priority to update with new primary sessions	Not a priority	Pair BSE and coastal efforts	Focus on Port Fourchon and western half of stock area	
Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay	Ongoing	Exploratory surveys designed around salinity	Not a priority	Exploratory surveys designed around salinity	Not a priority at this time	
Calcasieu Lake	Ongoing	One primary survey	Not a priority	Compare to NWIS DIP/other BSEs	Not a priority at this time	
Sabine Lake	Ongoing	One primary survey	Not a priority	Compare to NWIS DIP/other BSEs	Not a priority at this time	

5.1 Concluding thoughts

- The recommendations herein focus on how to establish working population models for the Louisiana TIG MAM group to use to best plan restoration activities and monitor their effectiveness.
- Population models are critical to these efforts because they provide a reliable and meaningful way to calculate changes in dolphin populations over time (abundance, density, and population structure), and they can provide a framework for comparing these trends with or without restoration activities.
- To appropriately parameterize these models, data on dolphin spatial abundance/density and mortality/survival are necessary.
- To determine the correct number of models for given populations (based on model assumptions like closed populations), genetics and movement data are required.
- Therefore, the recommendations here focus on photo-ID/line transect surveys and remote biopsies, with recognition of the added benefits of satellite-linked telemetry and evaluations of habitat use.
- In particular, it is of critical importance to perform the cross-catalog/basin analyses for photo-ID fin matching and genetics across all locations discussed here, so that an accurate understanding of the potential overlap (or lack thereof) among stocks/populations can inform future activities and all elements of MAM for restoration of dolphins in Louisiana.
- The monitoring activities recommended herein may provide an ideal opportunity for comparing established techniques with emerging techniques, with the goal of identifying the most efficient methods for future monitoring activities in Louisiana.
- With the proposed monitoring data in hand, future reiterations and versions of this living document can more effectively inform future monitoring and restoration activities.

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8 Appendix A – List of Workshop Participants

In alphabetical order:

Matthew Bowers	Research biologist at NOAA Southeast Fisheries Science Center
John Fallon	Director Of Sustainability & Coastal Conservation Initiatives at Audubon Nature Institute
Lance Garrison	Research Fishery Biologist at NOAA Southeast Fisheries Science Center
Gina Himes Boor	Research Scientist for Conservation Medicine at the National Marine Mammal Foundation
Jeffrey Morris	Senior Ecotoxicologist and Co-Director of the NRDA Consulting Group at the Biodiversity Research Institute
Keith Mullin	Research Fishery Biologist at NOAA Southeast Fisheries Science Center
Brian Quigley	Charleston Field Station Manager and Field Biologist for Conservation Medicine at the National Marine Mammal Foundation
David Reeves	Louisiana Monitoring and Adaptive Management Lead for NOAA Office of Habitat Conservation
Carrie Sinclair	Research Fishery Biologist at NOAA Southeast Fisheries Science Center
Ryan Takeshita	Lead Scientist and Deputy Director of Conservation Medicine at the National Marine Mammal Foundation
Gabriella Harlamert	Stranding and Rehab Coordinator for Audubon Aquarium Rescue at Audubon Nature Institute
Nicole Vollmer	Associate Scientist (Affiliate) at NOAA Southeast Fisheries Science Center
Randall Wells	Vice President of Marine Mammal Conservation and Director of the Sarasota Dolphin Research Program at Brookfield Zoo Chicago