LOUISIANA RESTORATION AREA TRUSTEE IMPLEMENTATION GROUP
of the
DEEPWATER HORIZON TRUSTEE COUNCIL

In re: Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico
on April 20, 2010,
Civil Action Nos. 10-4536; 10-04182; 10-03059; 13-4677; 13-158; 13-00123 (ED. La.)
MDL No. 2179

Resolution # LA-2018-017

Trustee Funding for Fish Monitoring and Marine Mammal Monitoring

1. In accordance with the Oil Pollution Act of 1990 (OPA), the National Environmental Policy Act (NEPA), the *Deepwater Horizon* Oil Spill: *Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (PDARP/PEIS), and the *Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the Deepwater Horizon Oil Spill* (TC SOPs), the undersigned representatives of the Louisiana Trustee Implementation Group (LA TIG) hereby approve the monitoring activities set forth below to continue the restoration of natural resources and services injured or lost as a result of the DWH oil spill, which occurred on or about April 20, 2010, in the Gulf of Mexico.

2. The monitoring activities to be funded through this Resolution support restoration planning to carry out the restoration goals identified in the Final PDARP/PEIS. The tasks are also consistent with the Consent Decree resolving the civil actions referenced above.

3. It is resolved that, after due deliberation, extensive discussion, and review of the tasks, level of effort, and costs, through this Resolution and associated DWH Trustee Withdrawal Form, the LA TIG requests disbursement of up to $2,120,000 of Monitoring and Adaptive Management (MAM) funds from the Department of the Interior (DOI) Restoration Fund to the Louisiana Coastal and Protection Authority (CPRA) to accomplish the first year of the five-year Fish Monitoring Workplan (attached).

4. It is resolved that, after due deliberation, extensive discussion, and review of the tasks, level of effort, and costs, through this Resolution and associated DWH Trustee Withdrawal Form, the LA TIG requests disbursement funds from the DOI Restoration Fund to the National Oceanic and Atmospheric Administration (NOAA) to accomplish Barataria Basin Marine Mammal Monitoring, as described in the attached Scope of Work, as follows:

A. Up to $402,183 of MAM funds to NOAA to accomplish Task 1 (photo identification surveys), and

B. Up to $249,272 of Marine Mammal funds to NOAA to accomplish Task 2 (physiological and biological responses).

5. Funding allocations are anticipated to support efforts through July 16, 2019. Any and all funds remaining after July 16, 2019 will remain available to each respective Trustee for continued efforts as outlined in Paragraph 3 and Paragraph 4 of this Resolution without the need for further action by the Louisiana TIG.

6. Funds transferred from the DOI Restoration Fund to CPRA and NOAA may only be used for the activities authorized by this Resolution. Any other use of funds disbursed pursuant to this Resolution is prohibited. Any non-authorized use of disbursed funds must be reported to the full TIG immediately upon discovery of unauthorized use.

7. At the time this Resolution is signed, consultations and environmental compliance with federal regulations is still pending for the Fish Monitoring Workplan. The LA TIG Trustees agree that all applicable consultations and regulatory compliance activities must be completed and appropriately documented prior to utilizing LA TIG MAM funds to undertake these fish monitoring activities and that the terms and conditions of all federal and state permits must be complied with in the course of implementing these fish monitoring activities. The Fish Monitoring Workplan (attached) incorporates Best Management Practices.

8. Compliance for OPA and other relevant statutes and regulations (e.g., Marine Mammal Protection Act) have been considered by the TIG as described in the attached memo.

9. It is resolved that having reviewed these monitoring activities, the duly authorized officials for the Louisiana TIG authorize the commitment and release of these funds.

RESTORATION IN LOUISIANA TRUSTEE IMPLEMENTATION GROUP

JOHNNY B. BRADBERRY
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DATE OF LAST SIGNATURE: July 20, 2018

Draft Barataria Basin Marine Mammal Monitoring

Near-Term Data Collection (July 2018)

The following marine mammal near-term data collections efforts are designed (1) to support the understanding of baseline conditions that will be used to evaluate the implementation of DWH NRDA and other restoration projects and (2) to support understanding and restoration of bottlenose dolphins through the synthesis of existing data regarding the physiological effects of fresh water exposure. Products developed may inform analyses in the Mid Barataria Sediment Diversion (MBSD) Environmental Impact Statement (EIS) as well as plans for mitigation and monitoring. The data collected through the following two research projects will provide (1) updated population demography and (2) the spectrum of physiological responses to environmental change (i.e., salinity).

1. **Abundance, distribution, and density in the Barataria Basin**– Collection of current demographic parameters through basin-wide surveys.
2. **Assessment of physiological responses to Salinity impacts** – including the biological and physiological responses to, and potential impacts of, freshwater exposure on common bottlenose dolphins, using existing published data, synthesis of unpublished data, and expert elicitation.

Task 1: Vessel-based photo-identification surveys for abundance, distribution, density, and survival in the Barataria Basin

QUESTIONS:

The most recent abundance estimation is based on data collected in a portion of Barataria Bay from 2010 through 2014. This project will provide an updated abundance, distribution and density of dolphins in the Barataria Basin. Survival would provide information on how the population might be impacted by other stressors (e.g., DWH oil spill).

RATIONALE:

It is important to establish the abundance, distribution, and density of animals to evaluate the effect of Deepwater Horizon restoration on bottlenose dolphin stocks. The most recent abundance estimate for dolphins in Barataria Bay is over 4 years old (N=3150; McDonald et al. 2017), and NRDA modeling efforts suggested that the population may continue to decline up to around 9 years after the DWH oil spill, i.e., until 2019 (Schwacke et al. 2017). Therefore, it is important to obtain an updated abundance estimate for the current population. In addition, the northern reaches of the Basin were not systematically covered by the NRDA survey efforts and data in the northern reaches is currently limited. The proposed methods would establish an up-to-date abundance, distribution and density, utilizing the existing photo-ID catalog that was established during the prior survey efforts. Integrating this new survey with the existing catalog and continuing it in the future would allow for the assessment of current survival rates

and trends in the future and the degree to which the population is being impacted by stressors. Beginning with this catalog of known individual dolphins with multi-year sighting history would provide for an efficient analysis to establish current baseline status. In addition, applying previously established protocols for photo-ID surveys and mark-recapture modeling would allow for estimation of population survival rate and provide abundance estimates with necessary confidence to evaluate future project impacts. In addition to providing information on the current status and the biology of the population, this project would also contribute to any longer-term marine mammal monitoring.

APPROACH:

Photo-identification capture- recapture: Systematic and standardized vessel-based photo-identification studies, which identify specific individuals and allow those individuals to be tracked over time, is a well-established approach for estimation of survival rates in marine mammal populations. Vessel-based surveys are also the most appropriate method for estimating abundance and spatial distribution of dolphins for inshore areas (including bays), due to the high uncertainty and potential negative bias associated with aerial "count" surveys in these habitats. Furthermore, when conducted longitudinally, photo-ID studies allow for characterization of individual movements across seasons. The CMR surveys would follow the Robust Design model that has been applied in previous surveys of Barataria Bay and would allow quantification of abundance, survival, and movement among the various habitats within Barataria Basin.

Therefore, this study would conduct a photo-id capture-mark-recapture (CMR) study in Barataria Basin during the late winter / spring timeframe (March-Apr 2019).

ANALYTICAL OUTCOMES:

- Quantification of abundance and population survival rate
- Quantification of distribution and density

TIMELINE, DELIVERABLES:

CMR surveys: planning 4 months; survey effort 19 field days: winter/spring (Mar/Apr) 2019
Photo-ID analyses: Abundance, density, survival; 9 months post fieldwork
Abundance survey design and analyses and final report

Funding Source: LA TIG Monitoring and Adaptive Management

Budget: $402,183

Task 2: Physiological and biological responses and potential impacts to low salinity exposures

QUESTION:

What are the physiological and pathophysiological responses and potential direct impacts of decreased salinity on bottlenose dolphin health, survivorship and fecundity? What metrics are most important for evaluation and monitoring of impacts? What parameters in dolphins might be indicative of physiological and biological responses or potential health impacts?

RATIONALE:

Major habitat restoration projects coming online in Louisiana have the potential to significantly alter salinities across entire hydrologic basis. Concurrently, the LA TIG will be working to restore resources damaged by the Deepwater Horizon Spill, including bottlenose dolphins. The approach to and siting of dolphin restoration is dependent on an understanding of the physiological effects of fresh water exposure. This effort will support restoration planning for bottlenose dolphins by providing insight into physiological response of dolphins to freshwater exposure, which will help to focus restoration on areas that maximize future benefit.

As an example, outcomes of this task can inform the siting and level of effort for expanded marine mammal stranding networks. Changes to salinities may occur as projects across Louisiana are implemented. Changes in salinity may have physiological and other effects on dolphins, which could lead to reduced reproduction, illness, or death. Understanding physiological effects of fresh water on dolphins is the first step to understanding the extent and location of effects on dolphins resulting from changing salinity. This understanding informs restoration planning by allowing the trustees to appropriately budget and site stranding network efforts in coastal Louisiana. Stranding networks support dolphin restoration by providing for the rehabilitation and relocation of live stranded dolphins as well as by providing data on dolphin mortality that supports other dolphin restoration efforts.

APPROACH:

This project will identify previous work (published and unpublished) and samples that are available for review and analyses related to freshwater impacts and physiological responses from both wild and managed dolphin populations. This historical data, samples and information can help inform an assessment of the current state of knowledge on freshwater impacts and physiological responses. This information may be appropriate for use in environmental review and permitting. In addition, this synthesis could also be used to further inform future monitoring efforts. The report will focus on the effects or responses of dolphins to freshwater exposure and will not be a synthesis of impacts of the actions of any specific project nor will it make specific recommendations about mitigation for any specific project. It may, however, aid in identifying physiological responses that indicate a poor prognosis for an individual.

A number of studies have documented adverse health effects (e.g., skin lesions, electrolyte imbalance,

microbial infection, death) in bottlenose dolphins exposed to low salinity waters (Mullin et al. 2015, Chabanne et al. 2012, Barry et al. 2008, Ewing et al. 2017). In addition, data exists on physiological responses in dolphins when water salinity is varied in a controlled manner or as through natural events (i.e., hurricanes, floods, entrapments). These data may come from previous unpublished studies or exist in paper records, and thus will require mining of historic databases and records in order to compile and synthesize the information.

Specifically, under this task, unpublished data will be compiled from multiple sources, synthesized, summarized, and combined with data from published literature to describe the current state of knowledge of likely physiological responses and potential adverse outcome pathways with salinity/time combinations. In addition, the synthesis will identify the most appropriate parameters to evaluate those responses and effects in bottlenose dolphins following exposure to low salinity waters. Examples of the pathways of the spectrum of potential physiological responses from short term to adverse outcomes that might be explored include:

- exposure to hyposaline water (0 – 5 ppt) → electrolyte imbalances → neurologic impairment OR cardiopulmonary impairment → death
- prolonged exposure to low salinity water (5-10 ppt) → electrolyte imbalances → neurologic impairment → inability to effectively forage or avoid predators → decreased survival
- prolonged exposure to low salinity water (5-10 ppt) → gastrointestinal disturbance → diarrhea and electrolyte imbalances → weight loss → decreased survival
- prolonged exposure to low salinity water (5-10 ppt) → compromise integrity of integumentary system → epidermal lesions → septicemia → death

Such pathways will be identified for varying low salinity values and exposure times. However, due to the opportunistic collection of most of the existing data, significant data gaps are anticipated with insufficient data points to parameterize a *quantitative* dose response function that integrates salinity and time as the specified "dose." A formal expert elicitation (Martin et al. 2012), an approach that has recently emerged from research aimed at determining the Population-level Consequences of Acoustic Disturbance on marine mammals (Donovan et al. 2016), will be conducted to derive probabilistic distributions of effects for given salinity/time combinations for which actual observations are limited or non-existent. Prior to the expert elicitation, mechanistic models will be developed to guide the form of dose-response functions to be evaluated by the expert panel. In addition, the group will evaluate the appropriate metrics, such as percent of body with freshwater skin lesions or a body condition index, that would be used to monitor critical physiological parameters that will inform effect assessment and outcome prediction. Finally, this task may query the expert panel (following the expert elicitation workshop) to identify potential additional controlled studies that could fill critical data gaps in understanding pathways and the physiological responses and outcomes.

TIMELINE AND DELIVERABLES:

Compile data and information from published literature.

<u>Outline available information.</u>
Organize virtual meeting of potential data contributors (collaborators) to outline current information and knowledge of likely outcome pathways associated with hyposaline environment. Webinar with

presentations within first 2 mos. of project contract award.

Synthesize and summarize available information.
Compile data from various sources/contributors, synthesize and summarize current knowledge and likely outcome pathways. Deliverable: Host in person meeting of collaborators and technical experts with summary briefing document by 6 months of contract award date. Trustees will be provided with the document for review and comment.

Develop models
Develop mechanistic models to guide development of dose-response function. Deliverable: summary briefing document by 6 months post contract award date.

Use models to prepare for expert elicitation
Organize and prepare materials for formal expert elicitation to derive distributions for effects as related to freshwater exposures, guided by mechanistic models. Deliverable: briefing documents by 6-9 months post contract award date.

Expert elicitation
Conduct expert elicitation workshop and prepare report. Deliverable: final report by 12 months post contract award date.

Funding Source: LA TIG Marine Mammals

Budget: $249,272

Note* NOAA has initiated contract actions to support this work using $64,922 of agency funding. As of 6 July 2018, it is not yet certain if the contracting process will be completed in time to capitalize on this FY18 funding. Therefore, the total task costs are included in this budget and associated resolution. If contracting processes allow for the use of these funds, NOAA will return $64,922 to the LA TIG or repurpose for use as approved by the LA TIG.

NRDA Resource Management and Assessment Program for Louisiana

Revised Draft Proposal 1:

The Coastwide Fish and Shellfish Monitoring Program

6/21/2018

1.0 Coastwide Fish and Shellfish Monitoring Plan

This is the first proposal by the State (CPRA) for the Louisiana Trustee Implementation Group (LA TIG) as part of the Natural Resource Damage Assessment (NRDA) settlement to Louisiana from the DWHOS. Funding under this proposal is requested for continuation of a portion of the coastwide fisheries-independent monitoring program (FIMP) conducted by the Louisiana Department of Wildlife and Fisheries (LDWF). Funding is also requested in this proposal to support several pilot projects that will collect necessary data for better quantification of fish and shellfish (collectively referred to as "fish" through proposal) relative abundances and densities, species composition and community/food web interactions, and habitat use within the coastal basins. The pilot projects are proposed to complement the current LDWF FIMP framework for better enumeration and a quantitative comparison among the monitoring gears that sample the fish life stages within the coastal wetlands, shallow shorelines, and more fresh water areas of the estuaries. The coastwide FIMP provides valuable data for the nearshore habitats and resources targeted for NRDA restoration, including coastal wetlands, oysters, nekton, and prey resources (e.g., shrimps, crab, fishes) for threatened and/or endangered species such as the gulf sturgeon, sea turtles, and marine mammals. The Louisiana Trustee Implementation Group (LA TIG) can use the data provided by the coastwide FIMP to assess changes in the fish, shellfish and their associated habitats (physical habitat with accompanying environmental data) in the basins over time, allowing for assessment of the influence of the comprehensive, integrated portfolio of restoration projects at a coastwide or regional-scale within the Gulf of Mexico (GOM) and relative to other drivers and long-term trends in the basins

The integrated restoration portfolio emphasizes the broad ecosystem benefits that can be realized through coastal habitat restoration in combination with resource-specific restoration in the ecologically interconnected northern Gulf of Mexico ecosystem (DWH Trustees 2016). Most of the planned restoration projects identified in the integrated restoration portfolio (DWH Trustees 2016) are concentrated in coastal Louisiana and in conjunction with the Louisiana Coastal Master Plan (LA CPRA 2017). More specifically the large-scale sediment diversions and a suite of marsh creation and ridge restoration projects are concentrated in Breton Sound and Barataria Basin (LA TIG 2018) and designed to restore connectivity with the Mississippi River, promote deltaic processes, and create and restore marshes for the region. Barataria Basin and the delta region experienced the highest degrees of shoreline oiling from the DWHOS (Nixon et al. 2015); heavy oiling and remediation efforts caused direct mortality and reduced growth of wetland vegetation and fauna associated with these habitats, as well as increased erosion rates of the already fragile and degrading marshes in Louisiana (DWH Trustees 2016).

The fish and shellfish data collected by the proposed coastwide FIMP, and the complementary pilot projects, will be used to track recovery of key coastal fish and invertebrates injured by the DWH spill by providing monthly catch per unit effort (CPUE) and size data for the suite of shrimps, crabs, pelagic and benthic fishes that depend on the coastal wetland habitats and shallow estuaries as nursery and foraging grounds. Nursery areas or habitats promote recruitment survival of young-of-year juvenile fish and shellfish by offering increased feeding (growth) opportunities and refuge from predation. The monthly species-specific CPUE and size data will be collected (continued for most proposed gears and sites) coastwide across a total of 778 sampling stations by multiple gear types in open waters from the freshwater reaches of rivers and creeks to the saltier bays, barrier island passes and near shore gulf waters, and over bottom

habitats including oyster reefs, non-vegetated bottom, and marsh edge and shallow vegetated bottom. The CPUE and size data provide important information on the species relative abundance, densities, biomass, growth and habitat use by life stage, as well as seasonal composition in relation to the available forage base and other species' life stages occurring in the coastal wetlands and estuarine habitats. All of these data are important indicators for ecosystem assessment and adaptive management of the DWH-related restoration projects included within the portfolio (DWH Trustees 2016, LA TIG 2018). These data also provide important information for initializing, calibrating and/or validating existing fish models of the region and greater GOM such as the habitat suitability index (HSI) models from the Louisiana Coastal Master Plan (e.g., Hijuelos et al. 2016), age and stage-structured fishery stock assessment and population models (e.g., West et al. 2016, West et al. 2017, Rose et al. 2017, see Rose and Sable 2013 for more examples), and food web and/or ecosystem models (e.g., Ainsworth et al. 2018, Lewis et al. 2017, Dynamic Solutions 2016). Any of these models or combinations of them will be differentially useful for evaluation of DWH-restoration related species recovery and ecosystem benefits in the GOM given future conditions and drivers. All of these models can benefit from additional testing, refinement and validation that can be performed using the proposed monitoring data. For example, the recent CASM and Ecopath with Ecosim (EwE) food web models of Barataria and Pontchartrain Basins used species-specific CPUE and size data from the LDWF FIMP gears to estimate species biomasses in $g*m^{-2}$ (or metric tonnes per km^2) of juvenile and adult life stages from the field for initialization and calibration of the monthly (CASM) and annual (EwE) predicted species biomasses from 1995 through 2010. The spatial CPUE, composition, and size data for fish and invertebrates in the estuarine habitats (with accompanying environmental data) will provide species biomass time series and spatial patterns, and better understanding of life stage use and species composition by habitat, for testing and validating the modeled seasonal patterns, habitat preferences and distributions, and potential food web interactions in relation to DWH-related restoration project scenarios and outcomes.

The LDWF has maintained the coastwide FIMP to track the relative abundance, status and trends, species composition and size distribution of key fish and shellfish within Louisiana's coastal basins for nearly fifty years. LDWF's primary focus of the long-term sampling program is to collect the data needed for managing the state's fisheries, such as setting the inshore commercial brown shrimp *(Penaeus aztecus)* and white shrimp (*Litopenaeus setiferus)* trawl seasons, and setting the size and daily catch limits for recreational species like red drum *(Sciaenops ocellatus*) and spotted seatrout (*Cynoscion nebulosus*). Therefore, in addition to providing information needed to monitor and adaptively manage DWH-related restoration actions, these data provide fisheries managers with necessary information for making management decisions, which could in turn further benefit the species being targeted for NRDA restoration. LDWF conducts all of the coastwide FIMP outlined in the proposal (and one pilot project), and LDWF will continue to fund the FIMP since the data are important to statewide (e.g., West et al. 2016, 2017) and gulf-wide fisheries assessments and management actions (e.g., GDAR 2013, SEDAR 2013).

With the opening of the Caernarvon Freshwater Diversion in 1992, and Davis Pond Diversion in 2002, the LDWF monitoring data within the respective receiving basins of Breton Sound and Barataria Basin became a primary source for evaluating of the relative abundance patterns and potential diversion effects on key fish and shellfish distributions over time. The LDWF and the

Louisiana Coastal Protection and Restoration Authority (CPRA) have maintained an inter-agency field monitoring and data sharing agreement for the two basins since the opening of the diversions. The most recent agreement between LDWF and CPRA initiated in October 2017 (CPRA 2017) further increased the number of monitoring stations as identified in CPRA's System Wide Assessment and Monitoring Program (SWAMP) to expand spatial sampling, and increase the frequency of sampling events, to enhance seasonal or within-year sampling of the key species (Hijuelos and Hemmerling 2016). The expanded, or enhanced, sampling design of the proposed FIMP developed by LDWF and CPRA provides important data to continue the long-term baseline data collection but also provides additional statistical power and rigor to better evaluate population responses to resource management actions, coastal restoration projects, and/or environmental changes caused by regional climatic factors, major storm events, and catastrophes such as the Deepwater Horizon Oil Spill (DWHOS). For example, a general increase in brown shrimp juvenile catch at the LDWF FIMP stations in the mid- and lower estuaries during the spring months is often evident within the data (Sable and Villarrubia 2011), however there exist a lot of variability in the station data making it difficult to relate brown shrimp distribution to environmental gradients or river flow down estuary (flow out of the estuary could prohibit brown shrimp post-larval migration up the estuary). Adding monitoring stations within the coastal basins increases spatial data to better detect changes in relative abundance or spatial distribution of brown shrimp over years based on different environmental conditions (e.g., high river stage and increased freshwater flow through diversions vs. wind events and tidal influence up the estuary).

The additional field samples within the enhanced LDWF FIMP also include stations that were added in 2010 in response to resource monitoring and assessment needed for the Deepwater Horizon Oil Spill (DWHOS). The added stations are maintained within the current FIMP sampling design in order to support the long-term population assessment and recovery monitoring for Louisiana's coastal fish and shellfish resources impacted by the spill. The proposed monitoring framework therefore includes an increased number of stations to provide spatiotemporal fish data (with accompanying water quality and physical habitat data) that is useful for evaluation of the DWH-related restoration projects and outcomes.

The proposed FIMP developed by LDWF and CPRA is also consistent with the robust fish and shellfish sampling design developed for the System Wide Assessment and Monitoring Program (SWAMP) to identify significant changes in nekton community composition and oyster biomass within the coastal basins and at a coastwide (i.e., regional) scale that may result from large-scale and/or cumulative coastal restoration and protection projects, environmental disturbances, changing climate, and other major drivers that impact the system (Hijuelos and Hemmerling 2015, 2016). The SWAMP was designed to provide the necessary environmental, ecological, and socioeconomic data indicative of system condition or status within all or part of a hydrographic basin as well as monitoring Louisiana's coastal zone as a whole (Hijuelos et al. 2013). The SWAMP power analyses (Hijuelos and Hemmerling 2015, 2016) determined the sample size and frequency of the ecosystem indicator variables needed to identify changes or shifts beyond the average long-term status and/or trends. For nekton community composition as an ecosystem indicator, the catch per unit effort (CPUE) data for key fish and shellfish life stages collected by the LDWF FIMP gear types (i.e., seines, trawls, and gill nets) from 2003-2013 was used to determine the number of sample sites and sampling frequency needed to detect a

significant change in the species abundance patterns over time. The final sample size selection was made by creating line graphs showing the relationship between the minimum detectable difference (percentage change) and sample size and visually identifying the threshold points in which increasing sample size resulted in minimal gain in change detecting abilities for the key species CPUE data (Hijuelos and Hemmerling 2015) The sample sizes at the threshold points were then compared to sample sizes required to detect differences among factors in order to make a determination of what could (or couldn't) be detected given a particular sample size. The Generalized Random Tessellation Stratified (GRTS) approach was used to place new sample sites within regions of each hydrographic basin if the number of samples by gear type were not sufficient for detecting a change in species patterns. The details of the power analysis and the GRTS approach for determining additional sample sites for the LDWF FIMP gear types in Barataria and Pontchartrain Basins are available in Hijuelos and Hemmerling 2015, 2016. These methods were followed to place additional sample sites for the gear types in the coastal basins to the west of Bayou Lafourche that are included in this proposal (CPRA, unpubl. data). The SWAMP sampling design for the fish monitoring was designed to be consistent with the DWH NRDA MAM framework (DWH Trustees 2017) and will support the planning, construction, and programmatic evaluation of restoration conducted within the Louisiana Restoration Area (Hijuelos and Hemmerling 2015).

The LDWF historically funded all, and more recently most (approximately 70% or greater), of the coastwide FIMP. The additional samples proposed for funding in the expanded coastwide FIMP have been funded primarily by CPRA for the past three years, and partially by BP after the DWHOS. Funding is requested for continuation of the enhanced or expanded portion of the FIMP, including the proposed pilot projects designed to complement and be used for comparison with the existing FIMP, over the next five years from the Louisiana Trustee Implementation Group (LA TIG) as part of the Natural Resource Damage Assessment (NRDA) settlement to Louisiana from the DWHOS. The requested funding covers approximately 30% of the total coastwide FIMP conducted by LDWF and outlined in this proposal. However, 100% of the coastwide FIMP (including the pilot projects) data will be available to the LA TIG and DWH Trustees for real-time assessment and evaluation of the DWH-related restoration activities and outcomes.

The LDWF FIMP is divided into subsections to describe the gear types and sampling strategies carried out by the field offices in the five coastal study areas (CSAs), or coastal basins, of Louisiana (Figure 1). LDWF divided Louisiana's coast into five CSAs that reflect similar hydrologic conditions based on freshwater influences and tidal influences from the gulf, and regional geomorphology and weather patterns. Although funding is requested to support different proportions of additional or enhanced numbers of samples based on the LDWF gear types, the entire coastwide sampling framework is described in the proposal to provide a complete understanding of the breadth and utility of the LDWF FIMP for supporting fisheries management, NRDA-targeted species assessment and recovery within basins and coastwide, and regional-scale evaluation of ecosystem benefits due to DWH-related habitat restoration for the GOM .

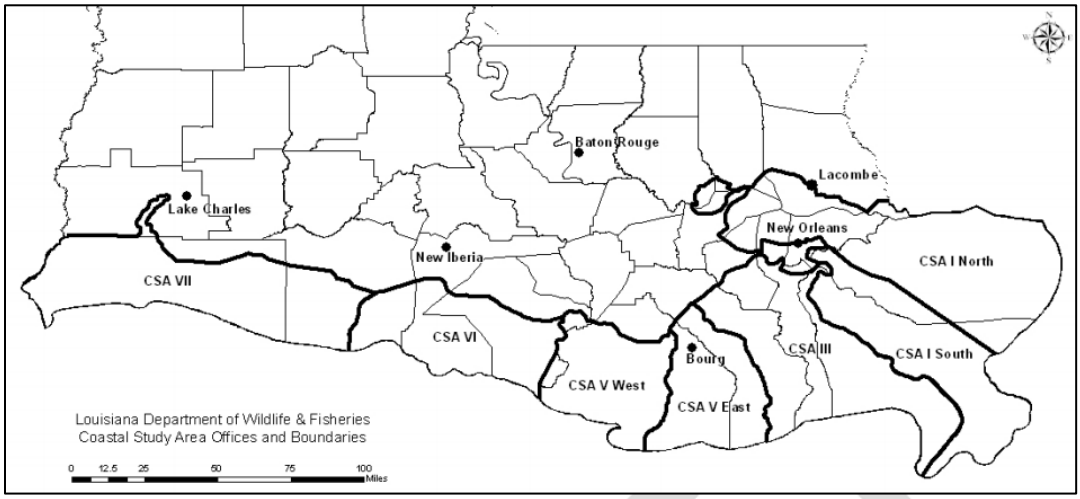

Figure 1. The boundaries for the coastal study areas (CSAs) with the LDWF offices. CSA I North and South = Pontchartrain Basin; CSA III = Barataria Basin; CSA V East and West = Timbalier and Terrebonne Basin; CSA VI = Vermillion Basin; and CSA VII = Calcasieu and Sabine Basin. Source: LDWF 2015.

1.1 Bottom Trawls (6-foot, 16-foot, and 20-foot)

LDWF uses 6' balloon otter trawls, 16' flat otter trawls, and 20' balloon otter trawls to sample penaeid shrimps, blue crab (*Callinectes sapidus*), groundfish, and several other species caught in high abundance within the CSAs and nearshore shelf waters. Per the existing monitoring agreement between LDWF and CPRA (CPRA 2017), CPRA funds 35% of the total 16' trawl sample program since CPRA uses the data to identify assemblages, relative abundance and seasonal patterns, and size distributions of the key species in the estuaries. Additionally, CPRA funds 100% of the 10 SWAMP 16' trawl stations in the Barataria Basin. Species CPUE from the trawl data have been evaluated spatially and over time with the salinity, temperature, turbidity and dissolved oxygen (DO) data collected concurrently in response to the opening of freshwater diversions and major hurricanes (e.g., Piazza and LaPeyre 2009 and 2010, Sable and Villarruia 2011a,b, O'Connell et al. 2014), the DWHOS (e.g., van der Ham and de Mutsert 2014, Ward et al., in review), and in relation to varying environmental conditions and differences in habitat (e.g., Chesney et al. 2000, Sable et al. 2010). The trawl data demonstrate seasonal patterns of species juvenile and adult life stages occurring within the estuaries and in relation to the mean monthly temperature and salinity measurements for the basin(s). The species CPUE data demonstrates varying relationships with salinity and turbidity within the estuaries, however no causative relationship between seasonal operational flows by the existing diversions (outside of the diversions being operated at full flow for nearly four months as a DWH oil remediation effort by the State) and salinity or turbidity differences among the trawl stations were evident. This cause-effect relationship, or rather the lack of one, was used to demonstrate the relative lack of influence the existing diversions have on controlling salinity (or Eastern oyster survival on the public seed oyster grounds) at the mid-Breton and Barataria station sites (Sable and Villarrubia

2011a,b). The proposed annual effort and cost estimates are provided for the portion of the 16' trawl samples currently funded through the CPRA contract agreement with LDWF. The sampling design for all three trawl gears are briefly summarized to provide the general context of the coastwide shrimp and groundfish trawl monitoring program.

Six-foot Trawls: The 6' balloon otter trawls are used to sample juvenile penaeid shrimp in the shallow marsh edge habitats and interior water bodies (Figure 2). They are used by LDWF to provide relative abundance and size distribution data for managing the inshore brown and white shrimp fisheries. The length distribution of brown shrimp caught within the 6' trawls is used to open the spring brown shrimp fishery by CSAs or regions by estimating when a sufficient proportion of the shrimp individuals will be $\geq$ 80 mm TL and catchable to the trawl fishery. The brown shrimp season is closed when the proportion of newly settled small white juvenile shrimp becomes a sufficient proportion of the catch in the 6' trawls to warrant closing the fishery in order to protect the newly recruiting white shrimp for the fall season. The white shrimp season opens in the fall when a sufficient proportion of larger juvenile white shrimp constitute the trawl catch and a date can be estimated when the shrimp will reach a catchable size for the fishery based on their growth rate and the juvenile size distribution.

Since LDWF uses the 6' trawl samples to manage the coastwide brown and white shrimp fisheries, outside funding is not requested. However the 6' trawl sampling design is listed in Table 2.1 to demonstrate the total coastwide trawl sampling program framework conducted by LDWF. The 6' trawls are sampled weekly from April through early May, and then semi-monthly in June through July for a total of nine sampling events per year (Table 2.1). There are 92 6' trawl stations across the CSAs, and a random number of stations are sampled for each sampling event from predefined salinity strata in each CSA (i.e., 12 of 22 stations in Pontchartrain; 10 of 26 stations in Barataria; 12 of 39 stations in Timbalier/Terrebonne; 5 of 5 stations in Vermilion; 0 stations in Calcasieu/Sabine). The 6' trawls are towed for 10 minutes over non-vegetated open waters (LDWF 2002) at each station. All brown and white shrimp collected in the trawl sample are counted and measured (in mm, total length).

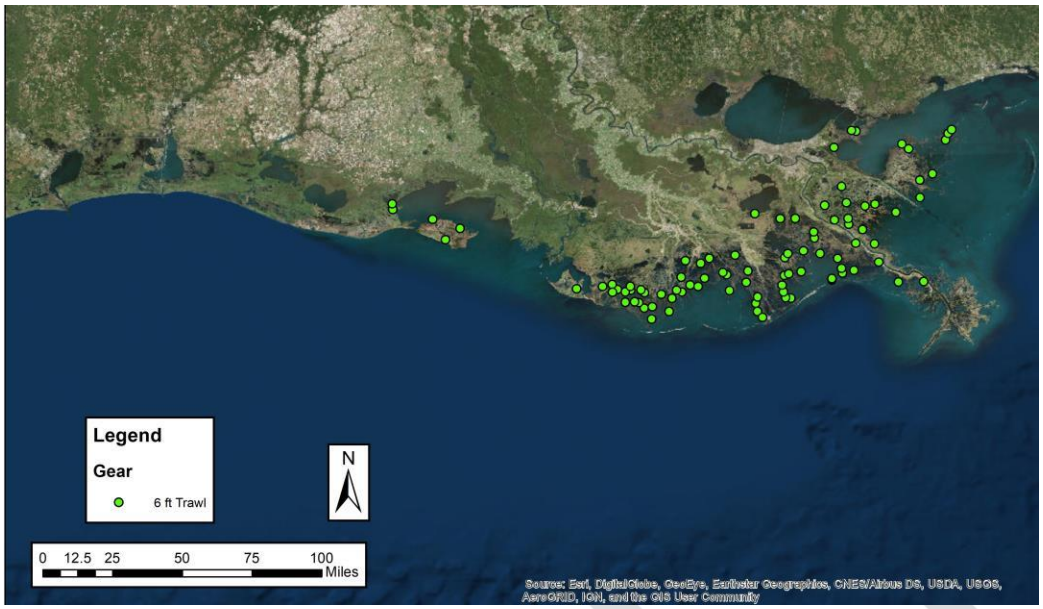

Figure 2. The six-foot trawl station locations sampled by the LDWF.

Sixteen-foot Trawls: The 16-foot trawls are used to collect juvenile and subadult fish and shellfish in the non-vegetated bottom habitat of larger bays and lakes of the CSAs (Figure 3). They are used by LDWF to provide relative abundance and size distribution data for managing the inshore brown and white shrimp fisheries, but are also used by CPRA and NOAA NMFS to determine long-term patterns in relative abundance, size distribution, and seasonal occurrence by life stage within the estuaries of several other key fish and invertebrate species in the coastal basins. The 16-foot trawl data are used to determine indices of relative abundance and recruitment of blue crab in Louisiana's estuaries (West et al. 2016). The data are also used to initialize and calibrate fish habitat suitability index models (Hijuelos et al. 2016a) and estuarine food web models (deMutsert et al. 2016; Dynamic Solutions 2016) used by the Louisiana Coastal Master Plan and large-scale coastal restoration projects for evaluation of potential species impacts and responses. The summarized trawl data in Figure 4 provides an example of how the species data were used to demonstrate which species were predominant in the trawl samples for the design of the CASM and Ecopath estuarine food web models in the Mississippi River Delta Management Project. As a general modeling rule of thumb, food web models should include all species that combined comprise at least 80-90% of the total species catch (or biomass) in the system to be realistically representing the trophic dynamics and energy cycling of the system and the potential species effects on the food web (Rose and Sable 2013). The plots show average species composition in the trawls over months from 1995 through 2010 for CSA I North, I South, and III. The most abundant species in the trawl catch are bay anchovy (*Anchoa mitchilli*), Atlantic croaker (*Micropogonias undulatus*), brown shrimp, white shrimp, spot (*Leiostomus xanthurus*), sea catfish *(Ariopsis felis*) and sand seatrout (*Cynoscion arenarius*). The average seasonal abundance trends for the species are also apparent in the trawl plots (Figure 4). For example, the May peak in subadult brown shrimp abundance, as well as the late

winter and early spring peak in Atlantic croaker juveniles, within the three coastal basins are evident within the plots. The additional trawl station data (Figure 3) will help to further identify similarities and differences in the seasonal trends of species that may occur coastwide (i.e., among basins by comparing species area plots in Figure 4) with DWH-related restoration efforts.

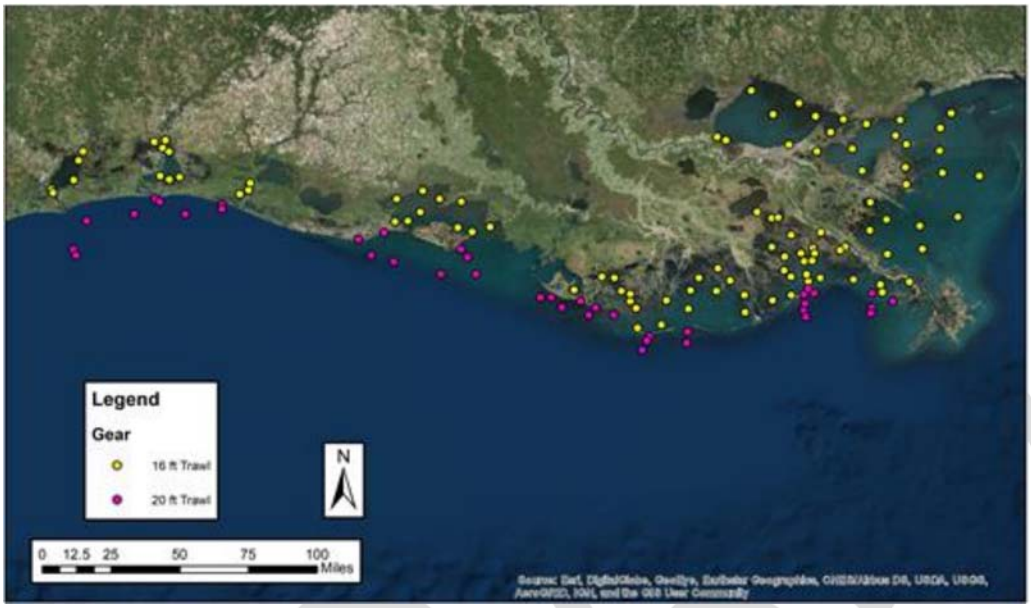

Figure 3. The sixteen-foot and twenty-foot trawl station locations sampled by LDWF.

The 16-foot trawls are sampled semi-monthly from April through July and in December, then monthly from August through November and January through March, for a total of 17 sampling events per year (Table 2.1). CPRA determined that a frequency of 17 sampling events per year, beyond the 11 sampling events deemed necessary by LDWF for management, would provide the temporal resolution necessary to appropriately manage the river diversion projects and provide input to Coastal Master Plan predictive models. CPRA has funded the additional six sampling events (35% of the 16' trawl sampling program) to maintain the required frequency for coastal restoration management and the predictive modeling. Additionally, CPRA currently funds 100% of the 10 SWAMP stations in the Barataria Basin. The 17 sampling events throughout the year are also consistent with the enhanced sampling design funded by BP after the DWHOS and therefore provide continued monitoring and assessment for the long-term recovery of the species. All 102 of the coastwide 16' stations are sampled at each event (Figure 3). The trawl is towed for 10 minutes and all species are counted with up to fifty individuals per species measured in 5 mm length groups (LDWF 2015).

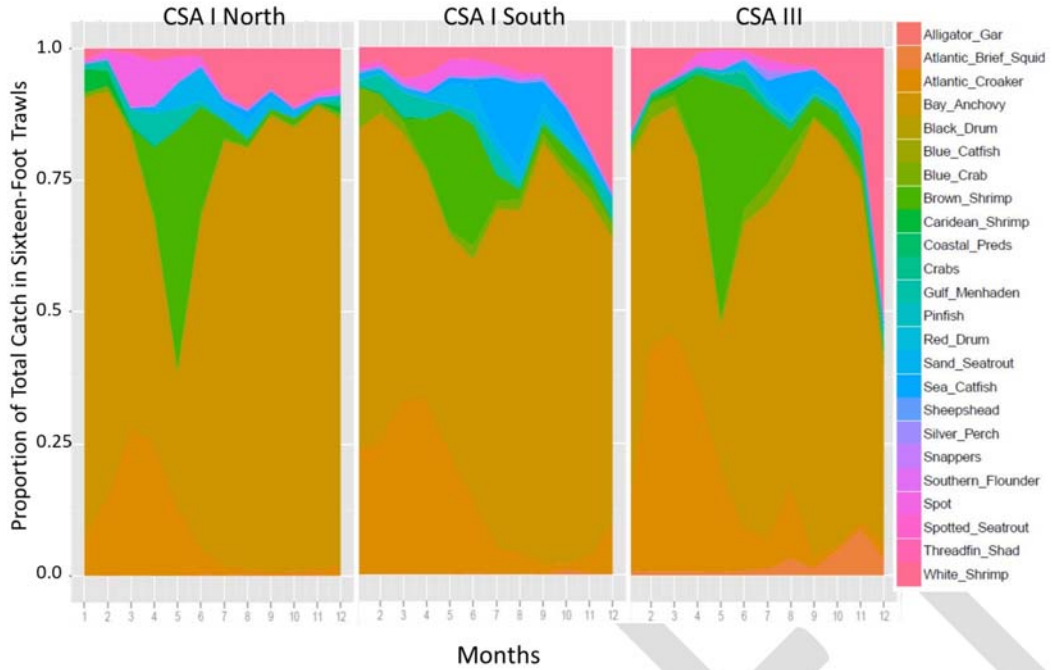

Figure 4. Monthly average proportion of species in total catch for the sixteen-foot trawls in CSA I North, CSA I South, and CSA III. Species are color coded with alligator gar starting from the bottom moving through white shrimp at the top of the plots.

Twenty-foot Trawls: LDWF began monitoring with the 20-foot balloon trawls in the nearshore shelf waters of Louisiana (Figure 3) in 2013. Nearshore stations previously sampled with 16' trawls were converted to 20' trawl stations, and additional 20' trawl sample stations were added by LDWF throughout Louisiana's offshore waters in order to better manage the brown and white shrimp fishery resources. The 20' trawls expand the coverage for monitoring shrimps, crabs, and groundfish in the shelf waters and provide indices of relative abundance and size distribution of the species for the region. LDWF uses the trawl data to open and close the inshore brown and white shrimp fishery seasons within the respective coastal basins.

Since LDWF uses the 20-foot trawl samples to manage the coastwide brown and white shrimp fisheries, outside funding is not requested. However the 20-foot trawl sampling design is listed in Table 2.1 to demonstrate the total coastwide trawl sampling program framework conducted by LDWF. The 20-foot trawls are sampled semi-monthly in April and in December, then once per month in January, March, May and November for a total of eight sampling events per year (Table 2.1). The trawl is towed for 10 minutes per sample event, and all individuals caught within the trawl are identified, counted, and up to 50 individuals per species are measured to the nearest 5 mm length group.

1.2 Marsh Edge and Finfish: Seines, Electrofishing, Drop Samplers, Gill Nets, Trammel Nets

Fifty-foot Seine: LDWF uses a 50 foot bag seine with ¼ inch bar mesh to sample the relative abundance and size distribution of small juvenile shrimps, crabs, and fish along the shoreline and shallow marsh edge habitats within the coastal basins (Figure 5). CPRA currently funds all seine sampling conducted by LDWF to monitor juvenile abundance in available marsh edge habitat, and the changes in each with changing environmental conditions and coastal restoration efforts (Figure 5). The importance of coastal wetlands to fishery species productivity via nursery habitat function providing foraging grounds for growth and predation refuge from mortality has been addressed in numerous independent field studies, modeling and meta-analyses (e.g., Minello 1999, Zimmerman et al. 2000, Minello and Rozas 2002, Minello et al. 2003, Rozas et al. 2005, Baker and Minello 2010, Roth et al. 2008, Rozas and Minello 2011, Leo et al. 2015, Sable and Rose, in review) and the seine data provide nearly 40 years of consistent monthly to quarterly spatial station data of juvenile relative abundance and distribution in the marsh edge and shallow vegetated habitats in Louisiana.

The seine data provide indices of species composition, relative abundance, seasonal and spatial distribution within the estuaries over time that are important for determining juvenile recruitment for penaeid shrimps and blue crabs. The seines also catch high abundances of juvenile bay anchovy, gulf menhaden, and Atlantic croaker using the shallow edge habitat as well as resident marsh fish species such as silversides, grass shrimp, and killifish all important prey in the food web. The habitat suitability index models for the Louisiana Coastal Master Plan (Hijuelos et al. 2016a) were updated by fitting polynomial models that describe the LDWF FIMP seine CPUE data for juvenile brown shrimp, white shrimp, blue crab, and spotted seatrout with salinity and temperature measurements. The summarized seine data were also used (e.g., Figure 4) to demonstrate which species were predominant in the marsh edge and shallow shoreline habitats for the design of the CASM and EwE estuarine food web models in the Mississippi River Delta Management Project. As a general rule, the models needed to include all species that combined comprise at least 80-90% of the total species catch (or biomass) in the system to be realistically representing the trophic dynamics and energy cycling of the system and the potential species effects on the food web (Rose and Sable 2013). Because juvenile life stages and small fishes (< 100 mm TL) are more abundant in the marsh and shallow shoreline habitats than adult life stages and larger fishes, the food web models needed to account for the differences in species composition and habitat use (vegetated habitat vs. open waters) since they were used to evaluate different marsh habitat restoration scenarios for the Delta Management Project. The CPUE from the seines for the juvenile species are combined with the length distributions (and species-specific length-weight relationships) to initialize and calibrate juvenile biomasses (in grams per meter^2) in the wetlands for the estuarine food web models (de Mutsert et al. 2016; Dynamic Solutions 2016). This was also done for the 16' trawl samples to estimate subadult and adult biomasses in the open waters for the estuarine food web.

A total of 102 seine stations are currently sampled monthly year-round across the CSAs by LDWF, and an additional 4 seine stations are proposed to be initiated in CSAs 6 and 7 (Table 2.1). The coastwide SWAMP analysis added stations to CSAs 6 and 7 in order to expand spatial coverage of the samples within the western basins to more effectively evaluate the coastwide patterns in species, and to determine when the relative abundance of the juvenile species might vary from their long-term mean abundances due to changing environmental conditions within basins. There are 30 stations in Pontchartrain, 22 stations in Barataria, 24 stations in Timbalier/Terrebonne, 13 stations in Vermilion with 2 additional stations proposed, and 13 stations in Calcasieu/Sabine with 2 additional stations proposed (Figure 5). The fifty foot seines are set 100 feet out from the vegetated shoreline and pulled inward to meet the edge. All individuals collected are identified and counted, and specific organisms are measured to the nearest millimeter (mm) in total length (TL) or carapace width (CW, blue crabs). CPRA and LDWF recently defined species of interest to be measured individually within the seines as:

All shark species	Alligator gar	Atlantic croaker	Black drum
Blue crab	Bluefish	Brown shrimp	All Centrarchids
Florida pompano	Gafftopsail catfish	Gulf kingfish	Gulf menhaden
Pink shrimp	Red drum	Sand seatrout	Sheepshead
Southern flounder	Southern kingfish	Spanish mackerel	Spot
Spotted seatrout	Striped bass	Striped mullet	White shrimp

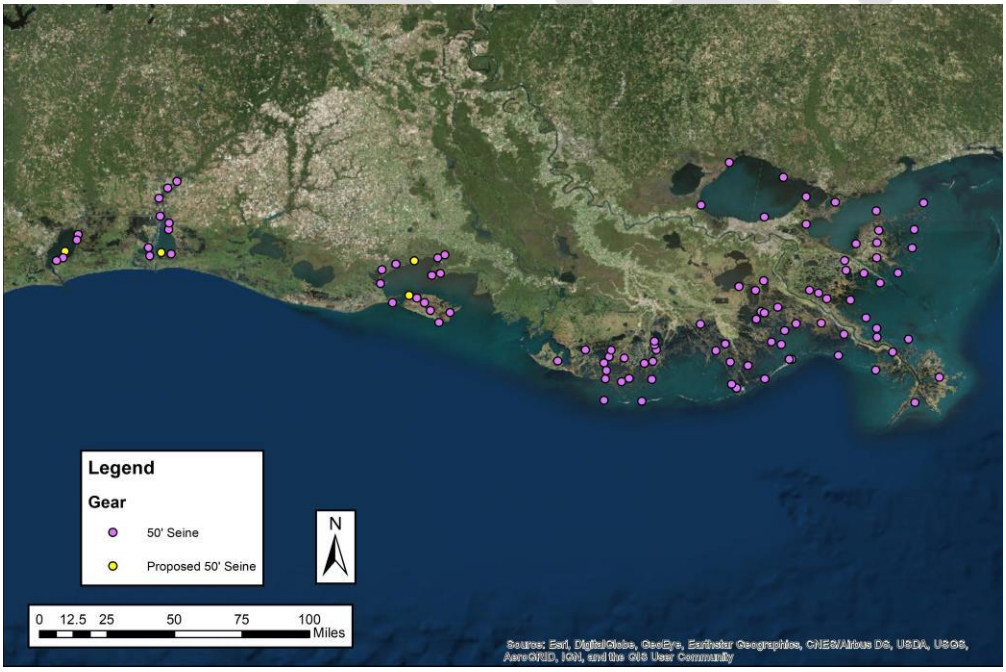

Figure 5. Fifty-foot bag seine station locations sampled by LDWF. The two additional seine station locations proposed to be initiated in Vermilion Bay and in Calcasieu and Sabine Lakes are shown in yellow.

Electrofishing: The coastal electrofishing sample framework is proposed as three independent pilot projects to be performed in selected coastal basins by a mix of LDWF field biologists and two graduate student research teams supported as LDWF sub-contracts to the local universities. The coastal electrofishing pilot projects are proposed alongside drop sampler pilot projects (see next subsection) to quantitatively compare electrofishing, drop sampling, and the LDWF seines for sampling small fish and invertebrates (< 100 mm TL) in the shallow vegetated habitats of the estuaries. The SWAMP power analysis indicated that the LDWF 50-foot seines were only effective for detecting changes that are greater than 25-30% per year for most species (Hijuelos and Hemmerling 2015, 2016). The authors cited that the results were likely due to the low and variable catch efficiency of the seine gear when sampling shallow shoreline and marsh edge habitats (Rozas and Minello 1997). Seine sampling is also labor intensive and it is important for LDWF to find a more efficient sampling methodology that can provide comparable or improved data for the shallow shoreline and marsh edge habitats in the estuaries (CPRA 2017). Electrofishing is less labor intensive and perhaps more effective at sampling the small marsh fish in the vegetated marsh edge, while also capturing a wider size distribution of fishes such as larger bass, drum, catfish and seatrout predators that feed in the shallow vegetated habitats but can outswim the seines (LDWF, unpubl. data).

Monthly electrofishing samples are proposed for 12 of the 22 seine stations in Barataria Basin, 8 of the 12 seine stations in Breton Sound, and 6 of 15 seine stations in Vermilion Bay plus two of four additional electrofishing stations set up for the eastern part of the bay (Figure 6). The electrofishing will be performed for a random subsample of the seine sites in each basin as a standard method for comparing and combining the species CPUE data between the three gear types for sampling the shoreline and vegetated marsh edge habitats of the estuaries. The four electrofishing stations set up in the eastern part of Vermilion Bay are proposed in addition to the six paired seine sites (Figure 6) because seining is not ideal in the predominantly fresh soft-bottom areas around the Atchafalaya River Delta. The monthly electrofishing samples will be performed in conjunction with the drop sampling (see next subsection) to quantitatively compare the species catch data for the two gear types. Since DWH-related habitat restoration projects aim to restore hydraulic connection with the Mississippi and Atchafalaya Rivers to progress deltaic processes and marsh creation, it is important to know if electrofishing will provide reliable species data in regions of the estuaries with more freshwater influence.

LDWF will perform the electrofishing samples for Barataria. LDWF has one electrofishing rig that was purchased in late 2017 for the Barataria Basin two-year pilot study. The Barataria electrofishing by LDWF commenced in April of 2018 under the existing agreement (CPRA 2017), so funding is proposed for its continuation through the end of July 2020. LDWF field biologists were able to collect about 60-70% of the electrofishing samples in April and 80% in May (LDWF, pers. comm). Although no data are available yet from the field station samples,

LDWF will include results from the 2018 electrofishing samples such as species composition and CPUE of the predominant fishes in its January 2019 report to CPRA per the existing contract agreement (CPRA 2017). LDWF and FWS are also working on a separate project to compare catch of the federally-listed topminnow in the 50-foot seine and electrofishing samples for Barataria (LDWF, unpubl. data).

LDWF and CPRA will support two graduate research projects to conduct monthly electrofishing in Breton Sound and Vermilion Bay (Figure 6). Funding is requested for two additional electrofishing rigs in order to perform the monthly sampling in proximity with the seine samples (and proposed drop samples) collected for Breton Sound and Vermilion Bay (Table 2.1). The pilot studies for Breton and Vermilion are proposed as graduate research projects since they are the most cost efficient and effective means for completing the proposed monthly sampling frameworks over two years. The graduate student research projects will provide student training and a collaborative opportunity with local universities to ensure the data are analyzed and delivery of scientific reports and/or manuscripts are applicable to the state's management and research needs. The two pilot studies for Breton and Vermilion would commence in July 2019 and run through July 2021 to provide sufficient time to purchase the electrofishing rigs and establish the sub-contract awards and detailed scopes of work with the local universities.

The pilot project for Breton and Vermilion are proposed in addition to the Barataria project as a means for expanding the coastwide monitoring framework and comparing the gears for sampling nekton in shallow shoreline and marsh edge habitats. Breton Sound is recommended for the electrofishing (and drop sampling) pilot projects because a concentration of DWH-related restoration projects in conjunction with the Louisiana Coastal Master Plan are planned for Breton thus it is important to understand the difference between the electrofishing and seine samples for enumerating fish and shellfish catch (and biomass) within the marsh. The physical habitat and environmental conditions of Breton will certainly change with the restoration projects, thus it is important for LDWF to find an alternative gear that can efficiently sample the marshes to determine impacts and for adaptive management of the restoration projects. Vermilion Bay is recommended for electrofishing (and drop sampling) pilot projects because the system experiences more natural freshwater flow and influences by the Atchafalaya River (Castellanos and Rozas 2001). The SWAMP coastwide power analysis (Hijuelos, unpubl. data) also added six seine stations to Vermilion to increase the number of sites needed to detect basin-level and coastwide changes in the relative abundance of key species (i.e., shrimp, blue crab, red drum, bay anchovy, gulf menhaden, largemouth bass). LDWF recommended using electrofishing rather than seines for the predominately freshwater region in eastern Vermilion Bay (Harry Blanchet, pers. comm.).

The CPRA 2017 agreement states that the estuarine electrofishing methodology described in Warry et al. 2013 will be followed by LDWF for sampling the paired seine stations in Barataria

Basin. For each paired seine and electrofishing sample event, one of the two sampling gears is randomly selected to be performed first, and a 50-meter buffer on either side of the first sampling track is set for sampling with the second gear (CPRA 2017). Three replicate sampling events (Table 2.1) of 90 seconds total "on-time" will be performed with the electrofishing rig, for a total of 270 seconds of electrofishing at each sample site. The total distance track for each 90 second replicate will be recorded with a GPS receiver. All individuals are to be identified and counted, with the same species to be measured individually as done for the seine samples. Additional lab work may be needed for some species identification, and samples in high abundance will be tagged in the field with a subsample brought to the laboratory for positive identification and/or enumeration. The same methodology for electrofishing sampling in Breton Sound and Vermilion Bay will be conducted by the graduate research team(s), however paired sampling with the LDWF seines on the exact days might not be possible. LDWF will work closely with the graduate research team(s) to select the monthly subsample of the fixed seine stations sites and the dates of the LDWF seine sampling ahead of time to conduct the timing of the paired gears as closely as possible.

LDWF, CPRA, and members of the LA TIG will be involved in the scopes of work and review of the data to ensure the data deliverables and project outcomes are useful for comparison of the three gear types, comparison of species data across coastal basins and habitats, and useful for regional-scale assessment of species-habitat recovery and responses to DWH-related restoration outcomes for the GOM. The graduate research teams, LDWF, CPRA and LA TIG will form a small work group with a kickoff meeting before September 2019 to outline the pilot project goals and objectives and discuss the scope of work including scheduling, data collection, QAQC, and deliverables, and the project reporting requirements. Annual full-day work group meetings will be scheduled in the late fall months of 2019, 2020, and 2021. The electrofishing teams (incl. LDWF) will present sample data and preliminary findings for review and comments by the work group. The two graduate research teams will submit annual progress reports within a month following the annual work group meetings based primarily on their presentations and feedback from the group.

At the end of the two-year pilot projects, LDWF and CPRA can determine which gear type will be implemented for monthly sampling of wetland and shallow shoreline habitats in the FIMP based on the comparison of species CPUE and biomass estimates compared to the drop samplers. The data outputs and comparison among the gear types will be presented to CPRA, LDWF and the LA TIG for review and recommendations on a path forward. It is expected that electrofishing will be the preferred sampling method for the reasons stated earlier. However, should electrofishing be removed from the FIMP at the end of the pilot project(s), the rigs could be used for inland and coastal research and resource management projects by the State.

Additional scopes of work and funding will need to be considered by the team determining the path forward at the conclusion of the pilot projects. If electrofishing replaces the seine sampling, then LDWF will conduct the monthly electrofishing for a random subsample of the seine stations in predefined salinity strata within Breton, Barataria and Vermilion because electrofishing all seine stations is not feasible for LDWF field offices. Additionally, a power analysis of the electrofishing data for key species will provide the number of monthly samples necessary to detect basin-level changes in species relative abundance and distribution (Hijeulos et al. 2015, 2016). Analysis of the relative abundance data for the numerically dominant species collected by both gears will determine the implications for switching gears in the long-term monitoring of the species (e.g., Rebstock 2002). An analysis of the relative abundance data for the gear change within the long-term monitoring program, and a coastwide power analysis of the electrofishing data will be considered by the team as part of the path forward. Additionally, the monitoring framework by LDWF for the seine stations in Pontchartrain North and west of Vermilion Bay (Figure 5) will need to be determined for transition from the seine to the electrofishing data for the coastwide FIMP. The coastwide electrofishing monitoring design will be described in the updated LDWF field operating procedures manual used by the coastal study areas (LDWF 2002) should electrofishing be implemented to the coastwide FIMP as part of the path forward.

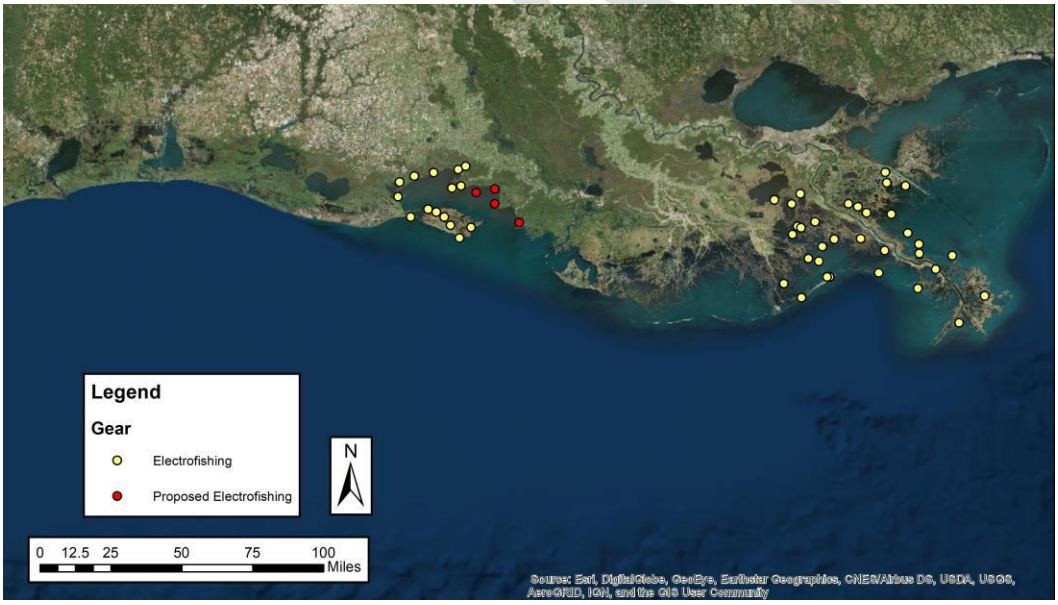

Figure 6. Electrofishing station locations proposed to be sampled by LDWF in Barataria, and through graduate research projects in Breton Sound and Vermilion Bay. The four additional electrofishing stations not paired with seine station locations in Vermilion are shown in red.

Drop Sampling: The drop sampling methodology is proposed as three pilot projects to be performed in Barataria Basin, Breton Sound and Vermilion Bay by graduate research teams supported as sub-contracts through LDWF and CPRA. Enclosure samples (i.e., drop samples, throw traps) are the superior method for sampling small fish and invertebrates (< 100 mm TL) in shallow vegetated and non-vegetated habitats and flooded marsh edge (Rozas and Minello 1997), however enclosure sampling is labor intensive and not ideal for monthly coastwide monitoring. As such, the LA TIG suggested (after first review of this proposal draft) to include enclosure sampling as part of the proposed two-year pilot project(s). The SWAMP report (Hijuelos and Hemmerling 2015) also recommended the LDWF seines be supplemented with a quantitative gear like drop samplers to provide improved species density/biomass estimates for better evaluation of restoration outcomes and that can be used directly by the existing fishery and ecosystem models that track biomasses and/or concentrations of fish, shellfish, and prey resources by habitat or for regions in the GOM (e.g., Atlantis, CASM, EwE). The drop samplers will be conducted in close conjunction with the LDWF seines and electrofishing (Figure 6) to provide a quantitative comparison of seasonal nekton species composition and CPUE within the shallow shoreline and marsh edge habitats of the estuaries (DOI, pers. comm.). The drop samples will be used as the standard of comparison for the seines and electrofishing in terms of catch efficiency for the predominant species caught by the gear types. This comparison to the drop samples will enable LDWF to conclusively determine whether electrofishing is a reliable method for sampling marsh nekton, and if it is better than seining (J. Tirpak, pers. comm.).

The six bi-monthly drop samples will be performed in conjunction with all electrofishing samples (see previous subsection, Figure 6) to quantitatively compare the species catch data for the two gear types (and the LDWF seines). Drop sampling every other month is realistically the most feasible frequency that can be performed over two years. Drop sampling is physically demanding and requires a full field set up for collecting and preserving samples, but also requires considerable time for processing the samples in the laboratory (J. Doerr, pers. comm.). The bi-monthly drop samples are proposed for 12 of the 22 seine stations in Barataria Basin, 8 of the 12 seine stations in Breton Sound, and 6 of 15 seine stations in Vermilion Bay plus two of four additional electrofishing stations set up for the eastern part of the bay most influenced by the Atchafalaya River (Figure 6). Castellanos and Rozas (2001) previously quantified monthly nekton (fish and decapod crustaceans) densities in flooded marsh edge, SAV, and non-vegetated habitats of three islands in the Atchafalaya River Delta using 1-m^2 throw trap. They reported a total of 33 species of fish and 7 species of crustaceans collected by the throw traps around the delta island habitats, demonstrating the importance of the predominately freshwater region (usually around 0.5 ppt salinity) for supporting nekton production and prey resources for coastal and estuarine predators.

A 1-m2 drop sampler (Zimmerman et al., 1984) will be used to collect 2 replicate samples in the flooded marsh edge at each of the selected paired seine and electrofishing stations. The replicate

drop samplers will be set approximately 25-50 feet of linear marsh edge from each other in order to sample a distance of the marsh edge comparable to what the seines and electrofishers will sweep. The drop sampling methodology will follow the NOAA NMFS drop sampling protocol used for over thirty years to collect marsh nekton in shallow estuaries of Louisiana, Texas and Florida (e.g., Zimmerman et al. 1984, Rozas and Reed 1993, Minello and Webb 1997, Baltz et al. 1998, Rozas and Minello 1998, Rozas and Zimmerman 2000, Rozas et al. 2005, Mace and Rozas 2015). Summarizing Rozas et al. 2005 which sampled Breton Sound before and after spring releases by the Caernarvon Freshwater Diversion, the drop sampler is 1.14-m-diameter cylinder and dropped from a boom attached to a shallow-draft boat. The cylinder is released on the marsh edge (~1-m from shoreline) and then water depth, distance to shore, and environmental measurements are taken from inside the sampler. The nekton trapped in the drop sampler are collected with dip nets and by filtering water pumped out of the sampler through a 1-mm net. Any animals remaining in the sampler after being drained are removed by hand. All animals are preserved in 10% formalin and returned to the laboratory for processing. All individuals in a sample are identified to the lowest possible taxon and measured in mm TL (mm CW for crabs) and weighed to the nearest 0.1 g. The NMFS SEFSC Galveston Laboratory and the USGS Wetlands Research Center in Lafayette have 1-m^2 drop samplers that could be used for the pilot studies. J. Doerr at NMFS Galveston and J. Nelson at ULL have been collecting drop samples in Barataria and Terrebonne Basins to evaluate growth and use of Spartina marsh versus mangroves (https://www.st.nmfs.noaa.gov/ecosystems/habitat/funding/projects/project16-030). Both scientists were consulted on the efficacy of collecting and processing monthly drop samples at the seine and electrofishing sites in the three coastal basins. Thus drop samplers and shallow-draft boats are available through at least two and very likely more institutes in Louisiana. Supplying the boat and drop sampler will be part of the matching requirement by the university or research laboratory in the sub-contract agreement for the pilot project(s).

The drop samples will be used as the standard of comparison for numerically dominant species CPUE, and we will estimate species composition and biomass from the gears using the product of total numbers of species caught with their size (weights (in grams), lengths using length-weight curves if weight not possible). The methodology for estimating the species composition, CPUE and biomass estimates determined from the initial spring pilot project to compare the gears will be used to estimate the same composition, CPUE and biomass outputs from the data collected by the seines, electrofishers and drop samplers across the pilot projects. Consistent CPUE and areal biomass estimates across the gear types are important for 1) determining if electrofishing is better than seine sampling and how to transition from the seines to electrofishing for coastwide sampling; 2) enumeration and evaluation of species composition, relative abundance, and biomass supported within the shallow estuarine habitats and marshes; 3) evaluation of regional-scale habitat restoration impacts and outcomes using quantifiable species data from (2); and 4) areal CPUE (density) and biomass estimates for species for direct inputs and comparison with predictions from the existing fish, food web, and ecosystem models in the

GOM that track species densities, concentrations, or biomass (Roth et al. 2008, Walters et al. 2008, Ainsworth et al. 2015, Dynamic Solutions 2016, Leo et al. 2016, Rose et al. 2017).

The three pilot studies would commence in July 2019 and run through July 2021 to directly overlap with two of the proposed electrofishing pilot projects and provide enough time to initiate the sub-contract awards and more detailed scopes of work with the local universities. The electrofishing samples by LDWF in Barataria will extend through July 2021 in order to provide two full years of data from the three gears for comparison. LDWF, CPRA, and members of the LA TIG will be involved in the scopes of work and review of the data to ensure the data deliverables and project outcomes are useful for comparison of the three gear types, comparison of species data across coastal basins and habitats, and useful for regional-scale assessment of species-habitat recovery and responses to DWH-related restoration outcomes for the GOM. The graduate research project teams, LDWF, CPRA and LA TIG will form a small work group with the first meeting in Fall 2019 to work through the pilot project goals and objectives, and discuss the scope of work including the scheduling, data deliverables, and project reporting requirements. Annual half-day work group meetings will be scheduled in the mid to late fall months of 2019, 2020, and 2021. The electrofishing teams (incl. LDWF) will present data and preliminary findings from their field projects for review and comments by the work group. The three graduate research teams will submit annual progress reports to the work group that are based largely on their presentations and feedback from the group within a month following the annual meeting.

An additional short-term pilot project is proposed to be conducted in Spring 2019 by CPRA and LDWF in Barataria Basin to directly compare the gear catch efficiencies of the LDWF 50-foot seine, electrofishing, and drop sampler for enclosed areas of flooded marsh edge in a saline region (≥ 15 ppt), a brackish region (5 – 15 ppt), and a freshwater region (0 – 3 ppt). The direct comparison of the gear types for the three salinity zones in Barataria will permit quantification of the gear catch efficiencies and provide estimates for enclosed or semi-enclosed samples that can be used for better quantification and comparison of species CPUE and biomass estimates among the gears collected during the pilot projects. Originally this short-term pilot project was proposed as a “pre-study” to support the 2-year pilot projects. However, it is possible that a short-term drop sampler project might be done in lieu of the 2- year comparison studies since it could provide valuable data for a direct gear comparison, and provide quantitative data to better estimate species density and/or biomass for the seines and electrofishers going forward in the FIMP.

The three gears can be deployed within relatively small and semi-enclosed marsh ponds (still accessible by boat), or else by enclosing a 50-m distance of marsh edge to the extent practicable using stop nets set up from the marsh edge out into the water to stop lateral fish movement outside of the enclosed edge area. Two drop samplers will be deployed within the 50-m distance

of marsh edge to determine the lateral variation in species density and biomass. Two drop samplers will be deployed in the flooded marsh edge and two drop samplers will be deployed 2-m from the marsh over shallow non-vegetated bottom. All drop samples at the distance increments to the marsh edge will be equidistant to each other and the 50-m panels on either side enclosing the area. The electrofisher will sample the entire 50-m linear distance of the marsh edge and sweep the same area swept by hauling the seine 100 feet towards the marsh shoreline. The pilot project can be performed over the course of three to five days by three to four LDWF field biologists and a few staff persons at the Water Institute of the Gulf currently supported under the CPRA SWAMP task. A technical report will be prepared by LDWF and CPRA (through CPRA sub-contract to S. Sable through the Water Institute of the Gulf SWAMP contract) describing the sampling methodology, primary data outputs, and results of the gear comparison. The technical report and a presentation will be prepared for review and comment by the LA TIG, and for the kickoff meeting for the pilot projects by the graduate research teams scheduled for Fall 2019.

Gill Nets: LDWF uses a 750-foot monofilament gill net composed of five panels of differing mesh sizes to sample larger subadult and adult finfish (e.g., spotted seatrout, Gulf menhaden, red drum) in the open waters of the estuaries (Figure 7). The gill net data are used by LDWF and NOAA NMFS to estimate fisheries-independent indices of age-1+ relative abundance and size distribution for fishery stock assessment of gulf menhaden (SEDAR 2013), striped mullet (West et al. 2013), spotted seatrout (West et al. 2016), and red drum (Powers et al. 2010). The gill nets also provide species composition, relative distribution, and ancillary life history information on selected species for population assessment and initialization and testing of the existing CASM and EwE estuarine food web models.

The gill nets are sampled monthly from October through March, with bi-monthly samples taken in April and September, for a total of 18 sampling events within the year (Table 2.1). There are currently 107 gill net stations in coastal Louisiana (Figure 7), with 52 stations randomly selected by basin per sample event (Table 2.1). The coastwide SWAMP analysis added stations to CSAs 6 and 7 in order to expand spatial coverage of the samples within the western basins to more effectively evaluate the coastwide patterns in species, and to determine when the relative abundance of the subadult and adult species might vary from their long-term mean abundances due to changing environmental conditions within basins. These four additional stations are added to the current fixed station locations (Figure 7) with one extra random sample per event for each of the two basins (Table 2.1). The number of random stations per basin are 15 of 32 stations in Pontchartrain, 14 of 25 stations in Barataria, 5 of 24 stations in Timbalier/Terrebonne, 10 of 15 stations in Vermilion, and 10 of 15 stations in Calcasieu/Sabine. The gill nets are set and then strike sampled by LDWF driving the boat around the net in three tightening circles to drive the fish into the nets (LDWF 2002). All individual fish caught by the gill nets are identified, counted, and measured to the nearest mm in length.

LDWF fully intends to use best management/monitoring practices specifically for the gill and trammel nets for the benefit of protected species. For example, prior to deploying gill nets, the field biologists will carefully observe the area for the presence of any protected species (e.g., sea turtles). If they observe any protected species, sampling will not occur until the animals leave the area on their own volition (i.e., without prompting from the field team). Once the net is set and fishing, if any protected species are observed in the area, fishing will cease and the net retrieved immediately. Sampling will not resume until the animals leave on their own volition.

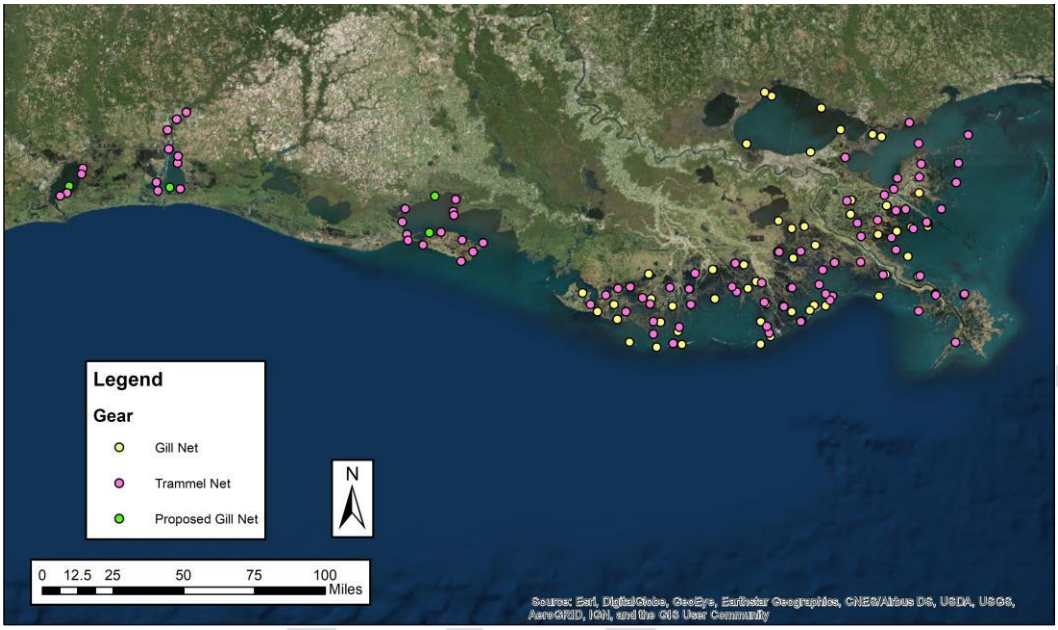

Figure 7. Gill net and trammel net station locations sampled by LDWF. Note many of the stations are the same for the two gear types with the trammel symbol on top. The two additional gill net station locations proposed in Vermilion Bay and in Calcasieu and Sabine Lakes are shown in green.

<u>Trammel Nets:</u> The 750' trammel net is an inshore gear consisting of three layers of net panels grouped together in a sandwich-like fashion. The inner panel mesh is smaller and the outer panel mesh is large enough to allow the inner panel to be pushed through, causing a pocketing effect for tangling individual fish. Trammel nets capture a wider variety of size classes of finfish than the gill net. They have traditionally been used in Louisiana to capture higher trophic-level predators such as sheepshead and black drum. Many of the trammel net stations overlap or are the same as the gill net stations (Figure 7). The trammel net data are used as fisheries-independent indices of relative adult abundance in fishery stock assessments for red drum (Powers et al. 2010), Southern flounder (Davis et al. 2015a), sheepshead (West et al. 2015), and black drum (Davis et al. 2015b) in Louisiana's state waters.

The trammel nets are sampled monthly from October through March for a total of six sampling events within a year (Table 2.1). LDWF increased the number of gill and trammel net stations in 2010 following the DWHOS to improve spatial coverage of the sampling gear across the coast for evaluating relative abundance and size indices of late young-of-the year, subadult and adult finfish that are important to commercial and recreational fisheries. There are 90 trammel net stations in coastal Louisiana (Figure 7), with 45 stations randomly selected by basin for each sample event (Table 2.1). The number of stations randomly selected from each basin is 11 of 25 stations for Pontchartrain, 6 of 17 stations for Barataria, 12 of 22 stations in Timbalier and Terrebonne, 6 of 13 stations in Vermillion, and 10 of 13 stations in Calcasieu/Sabine. No additional trammel net stations are proposed nor is funding requested since LDWF uses the samples for fishery indices and management actions. The trammel net is set parallel to the reef or shoreline, or in a half moon shape, and then strike sampled by LDWF driving the boat around the net in three tightening circles to drive the fish into the nets (LDWF 2002). All individual fish caught by the gill nets are identified, counted, sexed and measured to the nearest mm in length.

As was similarly stated for the gill nets, LDWF fully intends to use best management/monitoring practices specifically for the gill and trammel nets for the benefit of protected species. For example, prior to deploying trammel nets, the field biologists will carefully observe the area for the presence of any protected species (e.g., sea turtles). If they observe any protected species, sampling will not occur until the animals leave the area on their own volition (i.e., without prompting from the field team). Once the net is set and fishing, if any protected species are observed in the area, fishing will cease and the net retrieved immediately. Sampling will not resume until the animals leave on their own volition.

1.3 Oysters: Square Meter and Dredge Sampling

LDWF has historically used two gear types to monitor the oyster resources at the basin-scale and coastwide. The square meter and oyster dredge samples are used to characterize oyster spat settlement, size distribution, and mortality for management and assessment of Louisiana's oyster fishery (LDWF 2015). The oyster data have also been evaluated for opening and operation of freshwater diversions (e.g, LaPeyre et al. 2009), the DWHOS (DWH Trustees 2016), and to estimate and compare long-term oyster production in the coastal basins (e.g., Lowe et al. 2017).

Oyster health and the population-level responses to changing estuarine conditions are major concerns for CPRA and resource damage assessments such as that performed for the DWHOS (DWH Trustees 2016). Oyster reefs can be covered by sediment from large-scale river diversion and habitat restoration projects, as well as by oil from catastrophic events such as the DWHOS. Contaminants on the reefs or ingested from the water column by filtering oysters can impact growth and survival. Previous studies have described habitat suitability in terms of salinity and temperature for oyster production in Louisiana's estuaries. Suitable habitat conditions include salinities above 8-10 ppt for optimal spat settlement, grazing and growth (Stanley and Sellers 1986, Shumway 1996, Melancon et al. 1998, Oyster Task Force 2012, Rybovich et al. 2014,

Lowe et al. 2017) but below 20 ppt to reduce mortality by marine predators such as the southern oyster drill and parasites such as *Perkinsus marinus* (Soniat et al. 2005, Miller et al. 2017). Too low temperatures over prolonged periods in the winter can cause mass mortalities, and too high temperatures with low salinities can increase disease prevalence (Oyster Task Force 2012) while high temperatures and salinities show an increased prevalence in parasitic *Perkinsus marinus* infection (Soniat et al. 2005, La Peyre et al. 2009). Spat settlement, oyster size distribution and mortality are important to monitor in the square meter and oyster dredge samples along with temperature, salinity, turbidity, dissolved oxygen, chlorophyll a, and sessile competitors and/or predators as planned coastal restoration projects like the large-scale river diversions will likely change these conditions and affect the oyster populations. Oyster habitat suitability is included in the predictive modeling for the Louisiana Coastal Master Plan (Soniat et al. 2013, Hijuelos et al. 2016b), used for oyster restoration and fishery management actions (Soniat et al. 2013, Lowe et al. 2017), and has been performed for determining the efficacy of using oyster reefs in the coastal basins for shoreline protection and as habitat for reef-associated species (Humphries and LaPeyre 2015, LaPeyre et al. 2015). The oyster data and habitat suitability functions were also used to initialize oyster biomass and parameterize habitat effects in the CASM and Ecopath food web models designed to evaluate fish and shellfish responses to the large-scale diversion scenarios for the Mississippi River Delta Management Project (de Mutsert et al. 2016; Dynamic Solutions 2016).

<u>Square-Meter Samples:</u> LDWF uses the square-meter samples to estimate the density (number per m^2) of alive and dead spat (< 1 inch), seed (1 to 3 inches), and sack (> 3 inches) oysters on the public seed oyster grounds within the coastal basins (Figure 8). The data are used to characterize oyster spat settlement, size distribution, and oyster mortality on the public oyster grounds. The spat recruitment, size distribution, and mortality estimates from the data are combined with estimates from the oyster dredge samples to produce annual values of the total available oysters on the public seed grounds by basin and coastwide (LDWF 2015). The data also provide counts or presence/absence data for reef-associated species such as gobies, crabs, shrimps, and fish predators like black drum and sheepshead (e.g., Humphries and La Peyre 2015) to help inform modeling of food web interactions and how the reefs can function as habitat to alter growth and survival of the species living on them.

LDWF takes five replicate samples at each of the 105 meter-square stations (3 replicate samples at 25 square-meter stations added in 2015 to Barataria) across Louisiana (Figure 8) once per year between late June and early July (Table 2.1). There are 48 stations in Pontchartrain, 34 stations in Barataria, 19 stations in Timbalier/Terrebonne, 11 stations in Vermilion, and 18 stations in Calacasieu/Sabine. LDWF additionally takes three replicate samples at the 48 Pontchartrain sites, and the 34 Baratataria sites, once in the spring (April/May) and once in the fall (September/October, Table 2.1) to provide additional seasonal data to support CPRA with evaluation and assessment of the oyster populations that likely will be affected by the large-scale

river diversion projects designed to divert freshwater, sediments, and nutrients into the basins. For each replicate sample, a $1m^2$ frame is laid on top of the oyster bed and a diver identifies all species and then counts the number of live and dead spat, seed, and sack oysters in the frame.

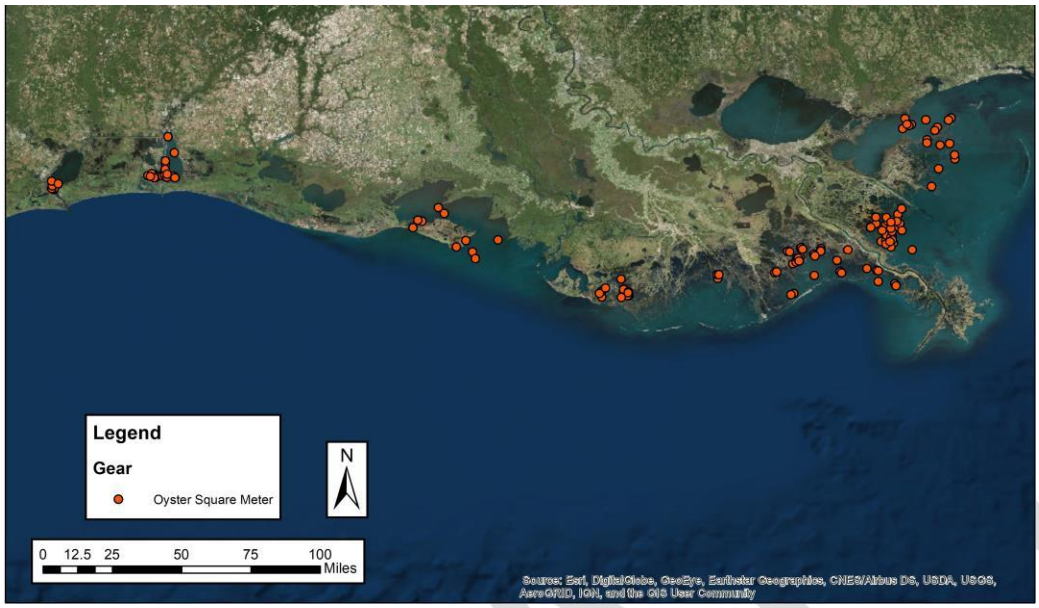

Figure 8. Oyster square-meter station locations sampled by LDWF.

<u>Oyster Dredge Samples:</u> A 24-inch-wide oyster dredge is used to sample oysters, fouling organisms, and other sessile organisms such as the oyster drill and hooked mussel. The gear is used to characterize oyster spat set, size distribution, and mortality of oysters throughout the year. The average monthly oyster sizes and mortality rates are estimated from the dredge samples and combined with the square meter data for LDWF fishery management actions (Banks et al. 2016) and the oyster stock assessment report (LDWF 2015) for the public oyster grounds in each basin and coastwide. The average spat settlement and the number of Southern oyster drill predators for the oyster grounds are also estimated from the dredge samples as an index of annual recruitment and predation mortality for the stock assessments (LDWF 2015). A newly published study uses the long-term dredge data to relate growth and mortality rates of spat, seed, and sack oysters on the public oyster grounds to seasonally interacting temperature and salinity (Lowe et al. 2017). The growth and mortality response curves to seasonal salinity and temperature provide updated and local information to better inform the habitat suitability indices as well as predict basin-scale and coastwide production potential for fishery management actions and coastal restoration impacts.

The oyster dredge samples are conducted semi-monthly in May and June, and in September and October, and then monthly from November through April and in August, for a total of 15 sample events within the year (Table 2.1). LDWF also samples weekly in April and May in order to

adaptively manage the oyster fishery within the basins. All 80 of the coastwide dredge station locations are sampled at each event (Figure 9), with two replicate dredge samples taken per site (Table 2.1). Each replicate dredge sample is pulled for three minutes. All live oysters and shells from recently dead oysters are counted and measured in 5 mm intervals. Shells from recently dead oysters are classified as "box" (both valves attached) or "valve" (one valve). Live gastropods, crabs, and mussels are counted (LDWF 2015).

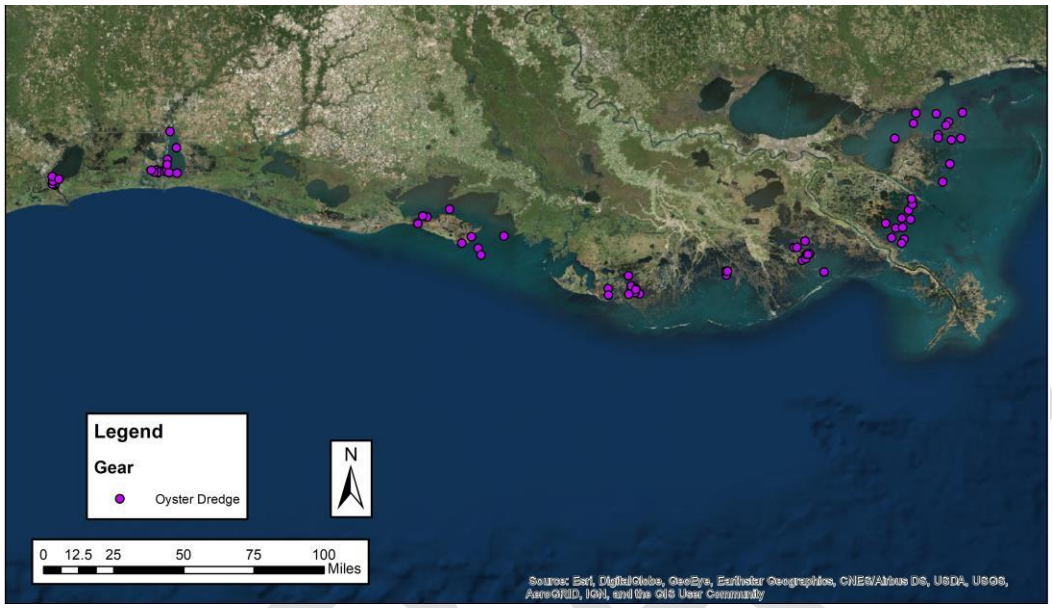

Figure 9. Oyster dredge station locations sampled by LDWF.

Table 2.1. Annual coastwide fisheries-independent monitoring program (FIMP) by LDWF. The number of stations sampled per event are randomly drawn from the number of fixed stations in each CSA. *Denotes the gear types that have been factored in for proposed funding because they provide data for continued population assessment and evaluation of species responses to DWH-related restoration. Note only portions of the total number of stations listed in column three are proposed for funding. The table does not include the pilot projects that are proposed as graduate research projects.

LDWF Gear	Primary Data Use	Sampling Frequency	Total Number of Sampling Events	Total Number of Stations	Number of Stations Sampled per Event
Trawl – 6 foot	Manage brown and white shrimp seasons	Weekly: April – early May Semi-monthly: June - July	9	92	39
***Trawl – 16 foot**	Monitor status and	Semi-monthly: April – July;	17	102	102

	trends of Peneaid shrimp, blue crab, groundfish in basin and coastwide Support fishery management	December Monthly: August – November; January - March			
Trawl – 20 foot	Monitor status and trends of Peneaid shrimp, blue crab, groundfish in basin and coastwide Support fishery management	Semi-monthly: April, December Monthly: January, March, May, November	8	39	39
***Seine – 50 foot bag**	Monitor status and trends of juvenile shrimp, crabs, small fish in marsh for basin and coastwide	Monthly	12	106	106
***Gill net – 750 foot**	Monitor status and trends of Age-1+ seatrout, menhaden, drums for fishery management	Semi-monthly: April – September Monthly: October - March	18	111	54
Trammel net	Monitor status and trends of Age-1+ drums, sheepshead, flounder for fishery	Monthly: October - March	6	90	45

	management				
***Electrofishing**	Monitor status and trends of juvenile shrimp, crabs, and small fish marsh edge by basin and coastwide Compare to seine samples	Monthly	12	12 in Barataria;	12 in Barataria;
***Oyster square-meter**	Count live and dead spat, seed, and sack oysters management and monitor status and trends Count oyster predators	Annual: Late June or Early July Bi-Annual: April and September	1 2	130 34 in Barataria; 48 in Pontchartrain	130 34 in Barataria; 48 in Pontchartrain
Oyster dredge	Count live and dead spat, seed, and sack oysters, measure size for fishery management and monitor status and trends Count oyster predators, mussels	Semi-monthly: May, June, September, October Monthly: November – April, August Weekly Adaptive Management: April through May	15	80	80

1.4 Data Management and Deliverables

Data management by LDWF includes all field data input, QAQC, and quarterly dissemination of electronic data to CPRA through an established sharepoint site. All data are logged on field data sheets by coastal biologists. The field data sheets are scanned as electronic pdf files and the

hardcopies are archived at the field offices. As field data sheets are collected, they are entered into computer data files and initially reviewed by the LDWF data management section for quality assurance. The final QAQC'd data maintained by the Fisheries Database Manager will be provided to CPRA on a quarterly (3 month) basis with an expected three month lag time from data collection to delivery on the sharepoint site. For example, the delivery in June will contain the LDWF FIMP data collected during January through March, and the data delivery in September will contain the QAQC'd data collected during April through June. All QAQC'd data files are delivered as csv files to the sharepoint site maintained between CPRA and LDWF. All csv files will be available to CPRA and members of the LA TIG. This data storage system will serve as the primary data storage platform for the LA TIG.

All QAQC'd data not protected from public disclosure by the State (LDWF FIMP data being protected from public disclosure is rare) will also be made available through the LA TIG for storage and public access on the DIVER Restoration Portal (Section 10.6.5 of SOP; DWH NRDA Trustees, 2016) in one year from when the data are collected. Before being added to the DIVER Restoration Portal, all data will go through the appropriate QA/QC process in accordance with the data management section of the MAM Plan and QA/QC procedures consistent with the process outlined in the DWH NRDA Monitoring and Adaptive Management Manual (DWH Trustees 2017). The data standards outlined in the DWH NRDA MAM (DWH Trustees 2017) for data sharing on the DIVER Portal will be followed including using the standard data format consistent with data standards developed by the Cross-TIG MAM work group, providing a data dictionary, and providing a README file that includes how the data were collected, the QA/QC procedures, and any other relevant information important to understanding the data (e.g., meaning, relationships to other data, origin, usage, format).

The data sharing protocol recommended by the DWH Trustees 2017 and facilitated by the sharepoint site and DIVER Portal will promote data exchange and collaborative analyses between the state management agencies involved in the LA TIG. For example, there is an opportunity for collaborative analytical work between LDWF and USFWS to evaluate the benefit of various CSA I Pontchartrain Basin habitats for Gulf Sturgeon. The FIMP stations provide important data on seasonal prey availability for juvenile Gulf sturgeon inhabiting CSA1. The connection between prey availability and seasonal occupancy of the juvenile sturgeon is key to understanding the relative importance of specific habitats to Gulf sturgeon in the Pontchartrain Basin (D. Reeves, USFWS, pers. comm.).

In addition to sharing of the electronic data files to the sharepoint site and the DIVER Portal, several analytical deliverables will be prepared and submitted for review and comment by the LA TIG. Some of the deliverables pertaining to the pilot projects are described in the proposal subsections. A list of all project deliverables is provided below with tentative dates for submission to the LA TIG based on an assumed a notice to proceed for September 1, 2018. We realize funding may not be available for all proposed components included in this draft and

further revisions with the LA TIG may be required. Therefore, the list of deliverables and tentative schedule are subject to change.

Proposed Project Deliverables:

1. LDWF will prepare an annual report on the coastwide FIMP conducted by the field offices. The report will cover each fiscal year (FY) of data collection and be submitted to CPRA by the end of October. The first report from LDWF is scheduled for October 2019. The annual report will be made available to the LA TIG after one round of review and revisions with CPRA. The summary report will briefly describe the data collection by gear type such as completeness for the samples, any missed samples, and observations or issues associated with the data that may impact the data or their interpretation. The summary report will also include any interpretation or insights into what the field biologist are seeing with the data collection. For example, reporting of normal vs. abnormal years, any significant changes in particular species, effects of drought or heavy rains in the late summer, or potential shifts in species abundance within the coastal basins are all conditions that are important to document. Simple summary statistics for key species caught by each gear type such as total summed catch, mean catch per unit effort (CPUE), and median size of individual species caught in each CSA will be reported in tables and figures to provide a record of species status, estuarine use within the year, and relative abundance (CPUE) over time for the five CSAs (e.g., Figure 10). Total, mean and median CPUE and size of key species within the LDWF gear types by CSA allow resource managers and coastal scientists to track the status and trends of species over time in relation to environmental conditions, habitat change and coastal restoration projects, and/or natural or anthropogenic stressors such as the DWHOS. Key species for annual reporting include but are not limited to brown shrimp, white shrimp, blue crab, gulf menhaden, spotted seatrout, red drum, largemouth bass (*Micropterus salmoides*), Eastern oysters (*Crassostrea virginica*), southern flounder (*Paralichthys lethostigma*), and Atlantic croaker (*Micropogonias undulates*).

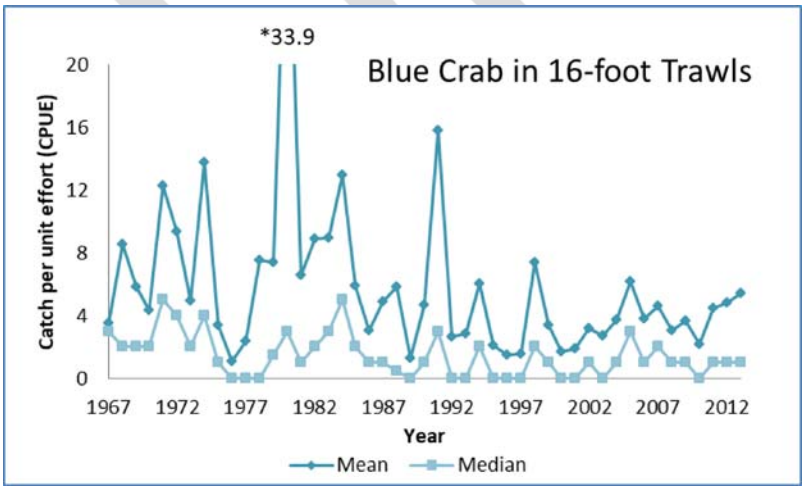

Figure 10. Annual mean and median CPUE of blue crab in 16-foot trawls for CSA 3 to demonstrate the long-term status and trend in blue crab catch for Barataria Basin. The low median annual values relative to the mean values indicate that most trawl samples in the year contain low numbers of blue crab.

2. The Water Institute of the Gulf will prepare a technical report describing the methods and results of the gear comparison study using the LDWF 50' seine, the LDWF electrofishing rig, and the drop sampler for collecting fish in enclosed marsh edge for three salinity for Barataria Basin. Discussion of the gear comparison and recommendations will be included in the report. The draft technical report will be submitted to LDWF, CPRA and the LA TIG for review and comments, with a final (revised) report submitted to the team in one month after agency revisions are received. The proposed gear comparison project in Barataria is tentatively scheduled for Spring 2019. If the field project is completed by May, then the draft technical report will be submitted to the team by August 2019 in time to be presented at the kickoff meeting with the five graduate research teams selected to perform the 2-year electrofishing and drop sampling pilot projects. The revised final report will be due to LDWF, CPRA and the LA TIG by November 2019. A powerpoint presentation will be developed from the report for viewing by the pilot project working teams, as well as for scientific presentations at conferences in 2019 and 2020. A scientific manuscript will also be prepared for submission to a relevant scientific journal.

3. Scopes of work will be prepared for the graduate research teams by The Water Institute of the Gulf, LDWF, CPRA and the LA TIG detailing the sampling methodology, standards for data collection and summarization, and reporting requirements. The scopes of work will be discussed with the candidate research teams, and the revised scopes of work will supplement the sub-contract agreements between the State and the graduate research programs. The scopes of work will be prepared after the spring pilot project for the gear comparison is completed and results become available to LDWF, CPRA and the LA TIG. The scopes of work will be available for team review and agreement with delivery of the draft technical report on the gear comparison by August 2019.

4. Annual full-day work group meetings will be scheduled in the late fall months of 2019, 2020, and 2021 that include the graduate research teams, LDWF, CPRA, and the LA TIG.

The first meeting will kick-off the projects to review the results from the gear comparison field project, the scopes of work and sub-contract agreements with the graduate research teams.

The graduate research teams will present their field sampling and laboratory progress, any issues such as missed field samples or changes in observations, and demonstration of sample data and preliminary findings for review and comments by the work group at the 2020 and 2021 meetings.

The five graduate research teams will submit annual progress reports within two months following the annual work group meetings (reports due for 2020 and 2021) based primarily on their presentations and feedback from the work group.

5. LDWF and CPRA, with support from the Water Institute of the Gulf, will determine which gear type will be implemented for monthly sampling of wetland and shallow shoreline habitats in the coastwide FIMP. A short technical report will be prepared to summarize the data from the pilot projects, and explain the methods and results for the comparison of species CPUE and biomass estimates (relative to each other and using the drop samplers as the standard for comparison). The technical report for the gear comparison and recommendations will provide documentation for the State coastwide FIMP.

The Water Institute will submit the draft report to CPRA, LDWF and the LA TIG for review and recommendations on a path forward by the final project meeting in late 2021.

The final revised report will be submitted by the Water Institute within a month of receiving the agency reviews and comments.

6. A final work group meeting among LDWF, CPRA, The Water Institute of the Gulf, and the LA TIG (as well as the graduate research advisors/subject matter experts) will be scheduled to take place over the course of 1 to 1.5 days in mid- November 2021 to mid-January 2022. The final meeting will serve to close out the pilot projects including assuring all data deliverables are transferred to the LA TIG for upload to the DIVER Restoration Portal. The team will discuss the results and recommendations from the draft technical report (Deliverable 5) comparing the seine and electrofishing samples, and the efficacy of continuing one gear in the coastwide FIMP. The team will also be charged with outlining a path forward for implementation of the gear(s) in the other coastal basins.

7. LDWF will update their coastwide field monitoring procedures manual based on changes to the marsh sampling framework that result from the project outcomes and recommendations accepted by the State and the LA TIG. The field monitoring procedures document is used by all coastal field offices at LDWF, and can be made available to CPRA and the LA TIG for informational purposes.

1.5 Budget and Budget Justification for Proposed Fish and Shellfish Monitoring

The total funding requested for 5 years of fishery-independent monitoring and pilot projects in support of NRDA in Louisiana is $10,481,568. The funding requested in this proposal will replace the current contract agreement between CPRA and LDWF (CPRA 2017) to continue the enhanced FIMP for the entire coastal Louisiana area. The proposed funding costs and sampling efforts provided below are beyond the existing CPRA agreement to include: 1) Four additional seine and four additional gill net stations west of Bayou Lafourche (two stations each in Vermilion, two station each in Calcasieu/Sabine) to satisfy the coastwide SWAMP requirements; 2) Six 2-year pilot studies using electrofishing and drop samplers at a random set of paired seine sites in Breton Sound, Barataria Basin, and Vermilion Bay (with four additional sites around the Atchafalaya River delta in E Vermilion). 3) An additional short pilot study to directly compare the three gear types for collecting fish and shellfish in marsh edge habitat for freshwater,

brackish, and more saline zones of Barataria Basin. The electrofishing and drop sampler pilot studies are designed to compare species catch metrics with the seines, with the expectation that electrofishing will provide a more complete collection of species, especially freshwater species and the larger carnivorous fishes (e.g., largemouth bass, drums, sheepshead, seatrout) foraging along the shoreline and marsh edge habitats.

Table 2.2 provides the breakdown of the number of sample events that LDWF will collect within a year to satisfy the coastal restoration impacts for CPRA and the DWH-related resource assessment needs by NRDA. Table 2.2 outlines all sampling covered by the current interagency agreement (CPRA 2017) plus the additional SWAMP samples and the pilot studies that are proposed for two years. The LDWF is responsible for funding all other coastwide sampling efforts, and all FIMP data are available and accessible to CPRA and the LA TIG.

Table 2.2. Estimated annual sampling effort by LDWF and the graduate research teams to conduct the enhanced coastwide fish and shellfish sampling outlined in the proposal and requested for funding.

LDWF Gear	Part of LDWF Monitoring Program	Total Number of Samples per Year
Trawl – 16 foot	6 of 17 events at 92 stations 17 events at 10 additional stations in Barataria	722
Seine – 50 foot bag	12 events at 106 stations	1272
Gill net – 750 foot	18 events at 1 additional random station in Vermilion, 1 additional random station in Calcasieu/Sabine	36
Electrofishing	12 events at 12 stations in Barataria, 8 stations in Breton, 8 stations in Vermilion 3 replicate samples per station	1008
Drop Sampling	6 events at 12 stations in Barataria, 8 stations in Breton, 8 stations in Vermilion 2 replicate samples per station	56
Gear Comparison Field Study	1 event at 3 mash pond sites in Barataria (fresh, brackish and marine salinity zone) 1 seines haul at 3 sites 2 replicate electrofishing samples at 3 sites 4 replicate drop samples at 3 sites	21
Oyster square-meter	1 event at 25 additional stations in Barataria (3 replicate samples) 2 events at 34 stations in Barataria and	567

	48 stations in Pontchartrain (3 replicate samples)	
Oyster dredge	15 events at 3 additional stations in Barataria (2 replicate samples)	90

Funding is requested to conduct 35% of the coastwide 16-foot trawl samples, and to conduct 100% of the 17 annual sample events at the ten additional 16-foot trawl stations added by CPRA in Barataria Basin (Table 2.2). Funding for all coastwide seine sampling is requested. Funding is also requested to cover the single monthly random gill sampling event for Vermilion and for Calcasieu/Sabine each year. Funding support is requested to cover the three electrofishing pilot studies and the three drop sampler pilot studies at a subset of paired seine sites for two years in Barataria Basin, Breton Sound and Vermilion Bay (Table 2.2). Funding is requested to perform a short field study to directly compare the seine, electrofisher, and drop sampler for collecting fish in the marsh edge for three salinity zones in Barataria. Funding is requested to cover the three replicate samples at the 25 additional sites in Barataria Basin for the annual (summer sampling event), as well as the three replicate samples per 82 sites within Barataria and Pontchartrain in the spring and fall of each year, that are collected for CPRA needs (Table 2.2). Funding is also requested to cover the fifteen sampling events at three additional oyster dredge station sites that were set up to address CPRA coastal restoration needs.

The total requested budget is $10,481,568 for LDWF, the graduate research teams, and The Water Institute of the Gulf to perform the proposed (enhanced) FIMP over five years. Table 2.3(a) is the proposed annual budget summary for LDWF and the sub-contracts to collect the additional FIMP samples outlined in Table 2.2. Table 2.3(a) is based on the LDWF expenditure categories. Total expenditures from the last two years (2016-2017) were used with CPRA invoices from the inter-agency contract agreement (e.g., CPRA 2017) to estimate the level of proposed annual effort by LDWF administration and field biologists, and a portion to cover operating services, supplies, repairs and field equipment needed to conduct the coastwide FIMP. The "other charges" category in Table 2.3(a) includes the two electrofishing rigs in Year 1, the five graduate research project sub-contracts (for three years each beginning in Year 2), and costs for the Water Institute staff to perform the gear comparison study with LDWF in Spring 2019 (Year 1), and support LDWF, CPRA, and the LA TIG with the pilot projects and gear comparison for seines and electrofishing in Years 2, 3, and 4..

Table 2.3(a). Proposed budget summary for LDWF to conduct the enhanced or expanded FIMP necessary for evaluation of the DWH-related restoration outcomes, including data management and annual reporting requirements. The electrofishing rigs, five sub-contracts to fund the graduate research teams for the electrofishing and drop sample pilot studies, and a sub-contract to the Water Institute of the Gulf are entered under "Other Charges".

	Year 1 FY 18-19	Year 2 FY 19-20	Year 3 FY 20-21	Year 4 FY 21-22	Year 5 FY 22-23	Total

Salaries[1]	$785,000	$816,400	$849,056	$883,018	$918,339	$4,251,813
Related Benefits[1]	$314,000	$326,560	$339,622	$353,207	$367,336	$1,700,725
Operating Services	$50,000	$50,000	$50,000	$50,000	$50,000	$250,000
Supplies	$100,000	$100,000	$100,000	$100,000	$100,000	$500,000
Repairs	$12,000	$12,000	$12,000	$12,000	$12,000	$60,000
Equipment[2]	$427,000	$427,000	$346,000	$147,000	$103,000	$1,450,000
Other Charges[3]	$431,680	$596,450	$596,450	$644,450	$0	$2,269,030
Total	$2,119,680	$2,328,410	$2,293,128	$2,189,675	$1,550,675	**$10,481,568**

[1]The salaries and related benefits for the LDWF staff and their level of effort to the FIMP are detailed in Table 2.3(b); [2]The equipment items and annual costs are broken down in Table 2.3(c); [3]A general budget summary for the graduate research sub-contract(s) is provided in Table 2.3(d), and a time and cost estimate is provided for The Water Institute of the Gulf in Table 2.3(e).

The proposed budget summary in Table 2.3(a) includes the salaries and related benefits for LDWF staff needed to conduct the field monitoring plan, data management, inter-agency meetings and conference calls, and the annual reporting requirements as outlined in the proposal. The annual costs for salaries and benefits assume a 4% annual escalation rate. LDWF employees in the bottom quartile of the civil service job descriptions (e.g., Biologists 1-3, administrative support staff) receive a 4% annual increase in salary and related benefits. The annual increase is reduced to 3% and then 2% for higher-level biologist managers and administrators. Table 2.3(b) provides the detailed breakdown of the proposed LDWF staff to be supported under the enhanced FIMP. The percent efforts are based on the average percentage of annual effort spent working on the enhanced FIMP data collection and deliverables each year.

Table 2.3(b). Estimated number and percentage of time for LDWF staff persons to be supported under the proposed FIMP.

	Number of Employees	Time (%)
Biologist Administrator	1	< 5
Biologist Director	1	< 5
Biologist Program Manager	1	15
Oyster Program Manager	1	< 5
Biologist DCL-B	2	< 5
Biologist Manager	5	25
Biologist Supervisor	8	40
Biologist 1-3	51	40
Technician	2	40
Administrative Coordinator	4	25
Data Management Program Manager	1	< 5
Data Management DCL-B	1	< 5
Data Management DCL-A	1	< 5

LDWF calculated that roughly 40% of the total expenditures on operating services, supplies, and repairs in 2016-2017 for the coastwide FIMP were related to the enhanced FIMP conducted for CPRA and for long-term population assessment and recovery (CPRA 2017). Operating services (Table 2.3(a)) are expenditures for outside services that include labor related maintenance/repair and the cost of any associated parts. Examples include: equipment (vehicles, vessels, trailers, water quality monitoring equipment, etc.) maintenance/repairs; tire repair or replacement; oil changes; boat launch fees; training (SCUBA, etc.); and equipment rentals.

Examples of operating supplies in Table 2.3(a) include: sampling gear (nets, dredges, square meter frames); vehicle and vessel fuel and lubricants; parts and tools for equipment maintenance/repair; office supplies; and scientific sampling supplies such as re-sealable plastic storage bags, waterproof boots and waders, dive gear, foul weather gear, and ice chests.

Major repairs in Table 2.3(a) are those that extend the useful life of an asset and examples include: outboard engine lower unit replacement or overhaul; outboard engine powerhead replacement or overhaul; structural repairs to vessels; structural and/or suspension repairs to trailers, vehicle engine and/or drivetrain replacement or overhaul; vehicle suspension overhaul; and water quality monitor sonde, probes, or display unit replacement or overhaul.

The equipment costs under the proposed FIMP are listed in Table 2.3(c) and include the vehicles, boats, motors, and trailers used by LDWF Marine Fisheries to conduct the coastwide sampling. Each of the seven CSAs has their own fleet of boats and vehicles. Over the course of 5 years, LDWF assumes that they will have to replace some of the boats, motors, trailers and vehicles due to the high volume of use. Because these vessels and vehicles are used for other projects as well, LDWF has only requested replacement costs for a limited number of vehicles and only portions of some boats. Therefore the equipment costs do not include replacement of all vessels, motors, trailers or vehicles in all areas. Using vehicles as an example in Table 2.3(c), LDWF Marine

Fisheries has more than 30 trucks in the fleet. LDWF calculated that roughly 40% of the coastwide FIMP is related to the enhanced FIMP conducted for CPRA and for long-term population assessment and recovery (CPRA 2017). LDWF factored in 2 trucks per CSA over the course of 5 years, which is likely a conservative estimate given the distances to sampling locations vary among CSAs and the wear and tear on the vehicles over 5 years is substantial.

Table 2.3(c). Equipment cost for each year of the proposed FIMP estimated by LDWF.

LDWF Equipment Item	Cost	Year 1	Year 2	Year 3	Year 4	Year 5	Total Number	Total Cost
	(per item)	(Number)						
Vehicles	$28,000	4	4	2	2	2	14	$392,000
1/3 Cost of Net Boat w/Trailer	$25,000	2	2	1	1	1	7	$175,000
Outboard Motors	$22,000	3	3	3	3	1	13	$286,000
1/3 Cost of Trawl/Dive Boat w/Trailer	$80,000	1	1	1	0	0	3	$240,000
1/2 Cost of Trawl/Dive Boat w/Trailer	$119,000	1	1	1	0	0	3	$357,000
Total Cost		$427,000	$427,000	$346,000	$147,000	$103,000		$1,450,000

The two electrofishing rigs and the sub-contracts to support the five graduate research teams are included under "other charges" for the LDWF budget summary (Table 2.3(a)). LDWF cannot add the electrofishing equipment to the equipment category if the agency is paying through a university contract. The budget will need to be amended after the pilot studies are completed for LDWF to retain the electrofishing equipment and roll the sampling into the FIMP contract.

The estimated cost for a Smith-Root 9.0 GPP Electrofisher unit installed with rigging on a 16' to 20' custom heavy-duty (H) and extra-heavy duty (EH) electrofishing vessel (with outboard engine and trailer) is estimated at $110,000. Two electrofishing rigs are proposed for purchase in Year 1 (Table 2.3(a)). The rigs have been designed for a 4-person field crew and fully outfitted to safely and effectively traverse large coastal bays and lakes to access and sample the coastal electrofishing stations. The preliminary cost estimates were provided by a Smith-Root sales representative using a low end and a high end quote. The low quote was for a 16' H-haul model boat with a 63-gallon live well at $105,000. The high quote was for a 20' custom EH-haul model boat with a 63-gallon live well, a larger swim deck and HP outboard motor, and a kick motor for shallow waters, at $130,000. The 9.0 GPP units have the ability to shock in high salinity waters from 100 – 25,000 $\mu s/cm^3$.

The sub-contract awards for two electrofishing graduate projects and three drop sampling graduate projects are proposed to be initiated in August 2019 of Year 2 (Table 2.3(a)) in order to provide enough time for purchasing the electrofishing rigs and setting up the sub-contracts and scopes of work with the graduate programs. Funding is requested for three years to support the five graduate research projects and provide the M.Sc. student(s) time to complete all data collection and analyses, all required coursework and the graduate thesis, as well as support the annual data sharing and reporting requirements with LDWF, CPRA, and the LA TIG. Table 2.3(d) provides an annual budget summary to fund a M.Sc. graduate research project. One

month salary and benefits are included for the graduate advisor and a permanent research associate to assist with the field sampling, meetings with LDWF, CPRA, and the LA TIG, and writing requirements of the project (Table 2.3(d)). The proposed annual budget summary from Table 2.3(d) is multiplied by five in Years 2, 3, and 4 in Table 2.3(a).

Table 2.3(d). Annual budget table with estimates to support a M.Sc. graduate project.

				Requested Funds
A.	Senior Personnel Salaries and Wages			
	1	Graduate Advisor/Professor		$8,000
B.	Other Personnel Salaries			
	2	Research Assistant I/II		$15,000
	3	Graduate Assistants		$25,000
C.	Subtotal Salaries and Wages			$48,000
D.	Fringe Benefits			
	Regular Employees		48%	$11,040
E.	Subtotal Fringe Benefits			$11,040
F.	Total Salaries, Wages and Fringe			$59,040
G.	Travel			$0
H.	Supplies			$0
I.	Operating Services			$0
J.	Professional Services			
	1. Subcontracts			$0
K.	Equipment			$0
L.	Tuition Remission		35%	$8,750
M.	Total Direct Costs			$92,790
N.	Facilities & Administrative Costs			
@	42.00%	*Base for request =	$25,000	$10,500
O.	**Total Project Costs**			**$103,290**

A proposed budget summary has been added by the Water Institute of the Gulf (Table 2.3(e)) to conduct the gear comparison study with LDWF in spring 2019. Analysis and technical reporting of the spring gear comparison study is proposed to be conducted by the Water Institute staff. The budget summary also includes annual support for project management and analytical support of the proposed graduate research projects. The Water Institute will support LDWF and CPRA in the analysis of the gear comparison for the 2-year pilot projects conducted in Barataria, Breton and Vermilion, and support preparation of a technical memorandum describing results of the gear comparison and recommendations for selection of a gear to be implemented in the coastwide FIMP and preliminary information to support a transition between gear types. Project management and support with data management and analytical deliverables will assure all required data management protocols, work group meetings, and analytical deliverables listed in Section 1.4 are completed with LDWF, CPRA and the LA TIG under the proposed schedule.

Table 2.3(e). Proposed effort and costs for Water Institute of the Gulf (TWIG) staff to support the coastwide FIMP and pilot projects over the period of performance.

Proposed Project Component	Task	TWIG Staff	Annual Effort in Work Weeks	Period of Performance	Requested Funding
Spring gear comparison study in Barataria	Field work and laboratory processing of samples	Senior Fisheries Ecologist	4 includes preparing and conducting field work with LDWF, overseeing lab sample processing and data standards	Spring 2019	$32,000
		Lead Coastal Ecologist	4 includes preparing and conducting field work with LDWF, overseeing lab sample processing and data standards	Spring 2019	$29.600
		Coastal	2 includes preparing and		$37,080

		Scientist	conducting field work 5 includes processing of 21 drop samples and data entry and QAQC		
	Technical reporting and presentation of methods, results, discussion of outcomes and recommendations	Senior Fisheries Ecologist	6	June – Sept 2019	$48,000
		Lead Coastal Ecologist	6		$44,400
		Coastal scientist	4		$16,480
		GIS Analyst	1		$4,120
				Project Total:	**$211,680**
Pilot electrofishing and drop sampler projects	Project management including meetings, scopes of work, assuring data standards, project outcomes and deliverables	Senior Fisheries Ecologist	4	Annual estimated effort for year 2019, 2020, and 2021	$32,000
	Support data management	Senior Fisheries Ecologist	2		$16,000
	Advise research teams with data analysis	Senior Fisheries Ecologist	2		$16,000
	Review and revisions of annual reports with LDWF, CPRA, and LA TIG	Senior Fisheries Ecologist	2		$16,000

			Annual Total:	**$80,000**
Support LDWF, CPRA with gear comparison and technical report	Senior Fisheries Ecologist	6	Fall 2021	$48,000

Shaye Sable is proposed as Senior Fisheries Ecologist (as DSLLC sub-contractor to TWIG) for the TWIG sub-contract. Funding is requested to cover Shaye for ten weeks in order to complete the gear comparison field project, sample processing, data analysis and reporting requirements. An annual of budget of $80,000 is requested to support Shaye in 2019, 2020 and 2021 for the pilot project management, data management and analysis, and reporting. Six weeks of support is requested for Shaye at the conclusion of the 2-year field monitoring pilot projects to help LDWF and CPRA with the gear comparison analysis and technical report to satisfy the gear recommendation for implementation into the coastwide FIMP and for review in the path forward meeting with the LA TIG at the end of 2021. Shaye Sable is currently supported through a sub-contract with TWIG through the SWAMP contract funded by CPRA. She is currently drafting the proposals to the LA TIG with LDWF and CPRA. She has worked closely with CPRA and LDWF (USACE ERDC and MVN, USFWF, and NMFS) for more than ten years on LDWF FIMP data summarization and analysis for fishery management, evaluation of key species status and trends for detecting basin-level changes due to storm events and restoration projects, and statistical and numerical modeling analysis evaluating species population and food web dynamics in relation to changing environmental conditions including univariate and multivariate statistical models, Habitat Suitability Index models, individual-based and matrix project models, and the CASM ecosystem model.

Melissa Baustian is proposed as the TWIG Coastal Ecologist. Funding is requested to cover Melissa for ten weeks in order to complete the gear comparison field project, sample processing, data analysis and reporting requirements. Melissa has been with TWIG for five years and is currently supported on the SWAMP contract funded by CPRA. Melissa has over ten years of field and laboratory experience conducting water quality, plankton, benthic, and vegetation field monitoring studies to support evaluation of restoration outcomes.

Additional TWIG staff support is requested for conducting the week-long gear comparison field project in Barataria, and processing the drop sample data collected and preserved from the field. Staff are included for GIS spatial mapping needed for data visualization and technical reporting of results. Permanent research staff are included to support Sable and Baustian in the preparation of the technical presentations and reports.

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