

*Deepwater Horizon*

Louisiana Trustee Implementation Group

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**MONITORING AND ADAPTIVE  
MANAGEMENT ACTIVITY  
IMPLEMENTATION PLAN:**

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COASTWIDE COLONIAL WATERBIRD  
AERIAL PHOTOGRAPHIC NEST  
SURVEYS AND NEST DOTTING  
ANALYSES, LOUISIANA

June 2023





## Document Purpose

For the Monitoring and Adaptive Management (MAM) Activity “Coastwide Colonial Waterbird Aerial Photographic Nest Surveys and Nest Dotting Analyses, Louisiana”, this implementation plan (MAIP or Plan) is intended to address MAM priorities: address significant informational needs (e.g. relative abundance, diversity, distribution trends and breeding status) that will facilitate Trustees ability to evaluate restoration effectiveness, address potential uncertainties related to restoration planning and implementation, and provide feedback to inform future colonial waterbird restoration decisions. This MAM activity and associated Plan are consistent with the Deepwater Horizon (DWH or Spill) *Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (PDARP/PEIS; Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016) as it will “Provide for Monitoring, Adaptive Management, and Administrative Oversight to Support Restoration Implementation.” The Plan is intended to detail all proposed MAM activities, identify specific project metrics as well as identify Trustee roles and responsibilities.

## Introduction

Colonial waterbirds (CWB) incurred significant injuries throughout the northern Gulf of Mexico (nGOM) as a result of the Spill. One of the principle means by which Trustees documented these injuries was through the implementation of regimented CWB aerial photographic nest surveys and nest counting (“dotting”) analyses implemented in 2010 through 2013 (Colibri Ecological Consulting & R. G. Ford Consulting Company, 2015).

The Deepwater Horizon oil spill settlement (2016) provides Natural Resource Damage Assessment (NRDA) Trustees (Trustees) up to \$8.8 billion, distributed over 15 years, to restore natural resources and services injured by the Spill<sup>1</sup>. As described in the PDARP/PEIS, the Trustees identified a comprehensive, integrated ecosystem restoration approach as the most effective and representative means to address the broad and geographically-expansive resource injuries associated with the Spill. For birds, guidance documents (e.g., *Developing Guidance For Avian Habitat Restoration and Monitoring* (DIVER Project ID 248); *Strategic Framework for Bird Restoration Activities* (DIVER Project ID 74 (DWH NRDA Trustees, 2017)) describe potential restoration approaches and techniques, identify potential individual / synergistic restoration benefits, and highlight the importance of monitoring and adaptive management considerations.

The Louisiana Trustee Implementation Group (LA TIG) *Monitoring and Adaptive Management Strategy* (DIVER Project ID 121 (LA TIG, 2021)) outlines an approach to prioritize MAM activities in Louisiana for effective and efficient evaluation of the restoration of resources injured by the Spill. For birds, fundamental objectives and associated SMART Objectives<sup>2</sup> (Specific, Measurable, Achievable, Realistic, appropriate Timeline) were identified (Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8). This MAM activity addresses objectives 1 and 2, to restore, maintain, and enhance nesting; foraging; loafing habitat to support shrub and select ground-nesting birds. Once the *Regionwide*

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<sup>1</sup> PDARP/PEIS and information on the settlement with BP Exploration and Production Inc. (called the Consent Decree) are available at the Gulf Spill Restoration website.

<sup>2</sup> SMART Objectives are intended to assist resources managers to create, track, and assess achievement of short- and long-term goals.

*TIG Colonial Waterbird Monitoring* MAM activity (DIVER Project ID 257; also LA-2018-009; LA-2018-019) is complete, with data available from aerial photographic nest surveys and nest dotting analyses through 2021, existing data will be used to determine the appropriate starting point for trend analyses of target species. Information gained from this MAM activity (“Coastwide Colonial Waterbird Aerial Photographic Nest Surveys and Nest Dotting Analyses, Louisiana”) will also assist Trustees in the development of, and reporting on, draft SMART objective(s) for Louisiana TIG consideration and, represents one significant piece (amongst others, ref. “additional means” 1c and 2c, Table 8) that will directly inform MAM informational needs developed through consensus by Trustees in Louisiana (LA TIG, 2021).

This activity will collect and process coastwide Louisiana avian monitoring data for 2024, 2026, and 2028. In addition it will update all historic data (2010 – 2021) so that all data is geo-located. A front end web site will be developed to access, download, and summarize data.

## MAM Activity Overview

### Background

Birds were one of the natural resources injured in the *Deepwater Horizon* spill, and these species and their habitats continue to benefit from restoration throughout Louisiana’s coastal zone. Colonial waterbirds respond to the dynamic and ever-shifting spatiotemporal distribution of available breeding sites and foraging areas in Louisiana, both within and among seasons. Due to the large geographic scale of the DWH restoration effort within the Louisiana Restoration Area, and the capabilities of CWB to move across broad and diverse landscapes, Trustees require a holistic approach to document effects of CWB restoration projects. The effects of these projects extend across both unrestored and NRDA-funded restored bird islands and other rookeries. Further, information gained from this MAM activity will provide Trustees with greater insight as to the need and benefit(s) of correction factors for detection and visibility among bird species (e.g. herons and egrets) and habitats (“additional means”; 1c and 2c – see Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8) with the potential to assist in the development of draft SMART objective(s) for TIG consideration, and thereby further understanding of bird benefits generated by NRDA-funded restored bird islands and other rookeries (see [Louisiana Colonial Waterbird Monitoring](#) (Project ID 178), [Queen Bess Island Restoration Project](#) (Project ID 83), (Project ID 84), [Louisiana Outer Coast Restoration](#) (Project ID 35), and [RW TIG – Colonial Waterbird Monitoring](#) (Project ID 257). [Rabbit Island Restoration Project](#) (Project ID 84).

### Goals

1. Document select target CWB habitat utilization (photomosaic imagery and georeferenced nest dotting) of unrestored and NRDA-funded restored bird islands and other rookeries. These efforts (in conjunction with the *Developing Guidance For Avian Habitat Restoration and Monitoring* document) will assist in identifying beneficial CWB endpoints (habitat occupied by target species, diversity, trend in number of target species, etc.) that may be realized via the incorporation of specific habitat features within wetland, coastal and nearshore habitat projects (1a and 2a - see Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8));
2. Directly support baseline determination (pre and post spill) for restored or enhanced habitat occupied by target shrub and select ground-nesting bird species in conjunction with previously

collected Louisiana CWB datasets. Consistent and long-term data acquisition and synthesis activities (including recent efforts: *Regionwide TIG Colonial Waterbird Monitoring* MAM activity) that can facilitate established (e.g., habitat occupied by target species, trend analyses of target species abundance, diversity, etc.) and novel means to develop draft SMART objective(s) (see Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8) for TIG consideration and thereby generate a more comprehensive understanding of resource responses to ongoing and geographically-expansive restoration activities (1b and 2b - see Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8);

3. Provide Trustees with greater insight as to the need and benefit(s) of additional quantification correction factors (for example - “additional means” 1c and 2c – see Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8), with the potential to assist in the development of draft SMART objective(s) for TIG consideration, and thereby further refine understanding of bird benefits generated by TIG-approved restored islands;
4. Inform implementation need and effectiveness of adaptive management strategies for NRDA-funded restored bird islands and other rookeries in order to maintain or increase CWB project benefits generated over time (1a and 2a - see Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8), as prioritized in the LA TIG MAM Strategy (LA TIG, 2021).

Beyond stated project goals, this MAM activity will implement significant upgrades to the State of Louisiana’s previously collected CWB data collection and associated data delivery system. CWB data includes coastwide Louisiana colonies to determine combined/overall benefits across multiple restoration projects.

### **Upgrade previously collected (2010-2021) CWB data to “preferred standard”**

#### *Current Status*

- Historically raw data was high resolution photographs, but with low resolution screen grabs of the images including marked nests by species.
- Screenshots with located nests (low resolution) and source photos (high resolution) have *limited* dynamic utility due to their lack of georeferencing and spatial information.
- At current level of functionality, any new analysis at a scale smaller than colony *requires* the user to *manually sort through thousands of individual screen grabs* to generate any new representation of the data.

#### *Upgrade to “Preferred Standard”*

In this context, “preferred standard” refers to a set of specifications established as the acceptable requirements for data quality, accuracy, and usability. The imagery data need to support development of SMART objectives, align to CPRA datasets (i.e., BICM), and investigate spatial and temporal data. These requirements dictate that survey photos be a) georeferenced and b) in a consumable format such as an imagery service. For dotting point vector data, requirements specify that dotting features be geolocated (reside in a Cartesian space with an X, Y location relative to a defined coordinate system) and include attributes which detail a) observation type and b) speciation.

- Following upgrade of previously collected data (2010-2021) to “preferred standard”, data will be in a format to support direct analysis (e.g., linking to habitat types, weather, geomorphology or storm events, etc.) with a dotting geolocation accuracy (nests and birds) of *less than one meter* (Appendix C: Bird Quantification (i.e., Dotting) Protocol)
- The upgrade will *increase* data value and utility for end users, enabling additional self-service analytical capabilities such as the creation of dynamic data summaries 'on the fly' for selected geographic areas and time periods.
- *The upgrade will positively impact* efforts designed to *increase* data discoverability by providing a *direct* linkage (seamless transition) between a web interface presentation of the geospatially-enabled data and the source high-resolution images used to generate it.

### **Utilize existing Amazon Web Services (AWS) storage endpoint to develop a front-end web data delivery system.**

#### *Current Status*

A proof of concept was achieved within *Regionwide TIG Colonial Waterbird Monitoring MAM* activity (2021), where a dashboard was developed to provide the basic functionality necessary to interact with previously collected data (2010 – 2021) (*see Methods section*). However, the dashboard provides a static representation of available data and is *not dynamically linked* to high-resolution photographs and can only be displayed on predefined geographic extents.

#### *Upgrade*

A front-end web data delivery system will provide end users with a *seamless linkage* between primary data stored in AWS (high resolution photographs used to identify nests), the web accessible geolocated data (nests; either transferred from low-resolution dotted images or dotted directly onto the GIS web interface) and associated metadata (species, etc.). This system will directly support:

- Trustee’s ability to *develop and report* on SMART objectives and *inform* restoration project design and implementation.
- *Enhancement* of bird count data access (by species and year) for any defined geographic extent (project, island, and program), and value and overall experience for targeted end users (restoration practitioners, managers, planners, researchers with *emphasis placed on the general public*).
- Self-service analytical capabilities such as the creation of dynamic data summaries 'on the fly' for selected geographic areas and time periods.

### **Objectives**

This MAM activity will facilitate the Trustees’ ability to evaluate restoration effectiveness, address potential uncertainties related to restoration planning and implementation, and provide feedback to inform future colonial waterbird restoration decisions. It will also provide data and imagery that will inform MAM needs related to the restoration of colonial waterbirds throughout coastal Louisiana. This

is a specific objective identified within the LA TIG MAM Strategy (LA TIG, 2021).

- **MAM Fundamental Objectives (1 and 2):** To restore, maintain, and enhance nesting; foraging; loafing habitat across coastal Louisiana to support shrub and ground-nesting birds, including sufficient elevation for supratidal habitat and vegetation above the intertidal zone.
- **Scope:** This activity involves (1) aerial photographic nest data collection (2024, 2026, 2028), (2) bird identification ('geo-dotting') from photomosaic and georeferenced photographs to generate georeferenced individual nests (2024, 2026, 2028) within both unrestored and NRDA-funded restored bird islands and other rookeries in the Louisiana Restoration Area, (3) all raw and processed data organized, uploaded to AWS, searchable and available for download as raw data and as summary count databases, (4) development of draft SMART Objectives (Table 8, LA TIG MAM Strategy) report for TIG consideration, (5) upgrade previously collected (2010-2021) CWB data to georeferenced data to "Preferred Standard" (Appendix C: Bird Quantification (i.e., Dotting) Protocol), (6) leverage the existing AWS storage endpoint to create a front-end web data delivery system, and (7) summary reports for years 3 and 6.
- **Target species:** Shrub and ground-nesting birds (CWBs) documented during coastwide aerial photographic nest surveys and in data comparison, including but not limited to:
  - Shrub-nesting Birds: Brown Pelican, Reddish Egret, Little Blue Heron, Tricolored Heron, Black-crowned Night-Heron, Roseate Spoonbill and Great Blue Heron
  - Ground-nesting Birds: Royal Tern, Sandwich Tern, Caspian Tern, Gull-billed Tern, Black Skimmer, Laughing Gull and Forster's Tern.
- **Duration:** 6 Years
- **Geographic Range:** Louisiana
- **Implementation Team:**
  - Louisiana Coastal Protection and Restoration Authority (CPRA) is the Lead Implementing Trustee and will provide contract oversight as well as technical and administrative oversight.
  - Louisiana Department of Wildlife and Fisheries (LDWF) is the technical lead state agency
  - All other federal and state trustees of the LA TIG are included in the Implementation Team. DOI will provide technical and other necessary review as relevant, all other Trustees will be involved in SMART objective finalization and approval.
  - Contractor(s) will be identified by lead agencies to implement this work as required.
  - Expected level of effort of different partners is:  
Contractors ~85%  
State Trustees ~10% (including administrative oversight)  
Federal Trustees ~5% for strategic SME input and review
- **Outputs:**
  - Three sets of high-resolution imagery (2024, 2026, 2028) of unrestored and NRDA-funded restored bird islands and other rookeries within the Louisiana Restoration Area.
  - Three sets of nest dotting analyses (photomosaic and georeferenced nests) (2024, 2026, 2028) of unrestored and NRDA-funded restored bird islands and other rookeries within the Louisiana Restoration Area.

- Where appropriate coordinate with conservation partners to aggregate data from other existing or ongoing monitoring efforts, for potential cross comparisons and/or inclusion.
- All data organized, uploaded to AWS, searchable and available for download as raw data and as summary count databases.
- Development of draft SMART Objectives report for TIG consideration.
- Upgrade previously collected (2010-2021) CWB data to preferred standard.
- Develop front-end web data delivery system.
- Summary reports (Years 3 and 6).

## Methods

Coastwide aerial photographic nest surveys (Appendix B: Bird Colony Aerial Photography Protocol

High resolution, low altitude oblique aerial photographic surveys will be used to census waterbird colonies along the Louisiana shoreline based on previous colony photographic surveys (2010 to 2013, 2015, 2018, and 2021) following the DWH oil spill. The list of colonies visited will be informed based on the most recent survey. The list will be adjusted after each survey session, adding newly discovered colonies and removing any former colonies at small islands that are found to be under water. Colonies containing only cryptic beach nesting birds, such as least terns, are not included.

Colony photographic surveys will be carried out from a fixed wing aircraft configured so that two photographers can work simultaneously. Photographers will be familiar with both aerial survey protocols and colony counting methodology so that they can determine immediately whether or not photograph quality is adequate for purposes of counting. Digital SLR cameras equipped with 18-200 and 200-300 mm telephoto lenses will be used to acquire photographs. Aircraft waypoints and time will be recorded automatically at 5 second or shorter intervals. Photograph time (recorded as part of the JPG file) will be used to estimate the position of each photograph.

Crews will consist of a pilot, a navigator/data recorder, and two photographers. The navigator will coordinate the sequence of colony visits and optimal aerial approach to each colony with the pilot. One photographer will take 'context' photographs showing a relatively wide area view of the colony while the other photographer will concentrate on more detailed close-up shots that will be used for counting. If time allows, the context photographer also will zoom in to obtain additional close-up photographs. The navigator will record when the aircraft is approaching a colony, when it is leaving, and the range of frame numbers shot over that colony.

As the aircraft approaches a target colony, the crew will assess the spatial distribution of birds on the colony. Photographers, navigator, and pilot will confer to determine the best angle of approach and the ideal altitude for photographic census. Their decision will be based on the shape of the colony, the species present at the colony, the strength and direction of the wind, vegetation around the colony, and angle of the sun. While the approach altitude is variable, all photography will be carried out at an altitude between 750-1,000 ft Above (mean) Sea Level (ASL), adjusted so that birds present on the colony do not leave their nests. Multiple approaches from different directions or altitudes may be made if photographers determine they are not obtaining photographs of adequate quality or if birds appear to be responding to the presence of the aircraft.

A high altitude (1,500 to 3,000 ft ASL) overview photographic survey will also be implemented using an accepted method (Colibri 2022). Use of a gyroscopically stabilized fixed camera mount will result in an image that is taken at a near-perpendicular aspect relative to the ground. Further, GPS location of each photograph will be recorded to metadata using a commercial GPS receiver affixed to the camera.

All photograph files (JPGs) will be downloaded daily to an external backup device. Flash memory cards from the cameras will be labeled and stored when they are full. Photographs of each individual colony will be inspected for clarity, location within the colony, and extent of colony coverage. If better photographs are required for a particular colony and if survey logistics allow, a colony may be visited a second time during a survey session.) and nest dotting analyses (Appendix C: Bird Quantification (i.e., Dotting) Protocol

## Nest and Bird Enumeration (Dotting)

For most species, photographs from May surveys will represent peak breeding numbers and will be selected for future analysis. For some species, especially black skimmer, photos from June surveys will better represent peak numbers and will be used for analysis. Occasionally, especially for brown pelican, royal tern, and sandwich tern, well-developed colonies will be counted using May photographs, but additional large nesting groups that form after the May survey will be counted from June photographs and summed with May counts for a total number of nests.

All high altitude overview photographs will be inspected for clarity, location within the colony, and extent of colony coverage. Those best suited will be post processed using established georeferencing methods and mosaicked into a high resolution base mapping resource (Chapman and Wieczorek 2020). Representative low altitude aerial photographs will then be georeferenced using the high resolution, high altitude mosaic as an orientating layer thereby resulting in a singular imagery resource (a mosaic of high resolution photos for a given colony location) that is capable of supporting future analyses (i.e., nest dotting, characterizing bird / habit relationships, habitat evaluations, etc.).

Nest dotting analyses encompass the manual marking (dotting) of nests and birds (Ford 2010) within the mosaic of high resolution, low altitude oblique aerial photographs; an ArcGIS-based platform. Upon completion, all dotting results are automatically and displayed within a designated point count window. By design, the template standardizes both the feature domain and symbology of species and bird/nest delineations. Although the primary objective will be to determine number of nests, individual birds and chicks of each species will be counted in each photograph.

For brown pelican, nests will be categorized by their stage of development. These categories will include the following:

- Well-built nest (with attending adult and with or without chicks)
- Poorly built nest (pre-egg laying)
- Nest with chicks but without attending adults
- Abandoned nest (with eggs but unattended)
- Empty nest (early-season unattended without eggs or chicks)

- Brood (dependent chicks away from an obvious nest and not attended by an adult)

Together, these categories will provide numbers of pelican nests and breeding pairs at each colony based usually on a single aerial photographic survey even though egg-laying dates may span a period of months. For other species, all nests and territories will be marked more generally as “sites.” The detailed nest categories that will be used for brown pelicans are inappropriate for other species because of their small size (terns and gulls), scrape-nesting habits (terns and skimmers), or partial concealment by vegetation (waders and gulls).

Where overlapping images are used to analyze portions of a colony, one or more lines will be drawn on the selected image to delineate the area to be counted using that image. Areas outside any such lines will then be counted using different images. This process will continue until the colony is counted completely with available photographs.

## Compiling Data

Manual nest dotting analyses are implemented and maintained within an ArcGIS-based platform. Tally of designated nest categories and related metadata are manually tabulated within a Microsoft® Access database.

## Assessing Colony Conditions

Each analyzed image will be evaluated to characterize conditions at each colony. Factors that will be considered will include the following:

- The stage of the breeding cycle (e.g., early-, mid-, or late-incubation; early chick-rearing,) for each species.
- Habitat occupancy (numerical and geographic extent to which each species occupied the habitat).
- Reproductive performance (e.g., pattern of abandonment, if any, chick production).

Information specific to a particular image will be entered into a notes field in the main data table in the Access database. Information concerning the colony as a whole will be entered in a separate data table in the same database.

) represent the State of Louisiana’s most comprehensive means towards documenting effects of colonial waterbird restoration within the Louisiana Restoration Area which encompasses unrestored and NRDA-funded restored bird islands and other rookeries. Coastwide aerial photographic nest surveys consist of two flights / year (mid-May and mid-June); the principal CWB nesting timeframe for Louisiana and the broader nGOM.

**Amazon Web Services:** Project deliverables (photography (multiple types), photomosaics, georeferenced nest dotting analyses, tabulated data summaries, etc.) from this MAM activity (along with previously collected information (2010 to 2021) will be hosted on AWS (due to expansive data hosting requirements); a significant investment made possible through RW TIG MAM funding. Prospective end-users can query these data directly online or download them at no charge. To ensure DWH information access and compliance, a direct linkage between the AWS server and NOAA's Data Integration Visualization Exploration and Reporting (DIVER) site is maintained. All activities have been developed in concert with NOAA DIVER and CPRA CIMS.

## Schedule

This MAM Activity will be completed within a six (6) year timeframe. The major elements are:

- Year 1 (2024): (1) establish appropriate contracts, (2) planning and implementing Louisiana coastwide 2024 aerial photographic nest surveys (May and June 2024), (3) commence updating of 2010-2021 data to the georeferenced preferred standard, (4) create photomosaics of 2024 surveys and identify nests and birds (geo-dotting) coastwide, (5) upload and manage 2024 raw photos and summary data onto AWS, (6) manage and maintain data in AWS, and (7) initiate discussion amongst Trustees on scoping SMART objectives based upon available data
  - Outputs accomplished
    - First set of high-resolution imagery for coastal Louisiana (2024)
    - First set of nest counts (dotting analysis) for coastal Louisiana (2024)
    - 2024 data uploaded and prepared to facilitate analysis
    - 30% of previously collected data (2010-2021) upgraded to georeferenced preferred standard
    - AWS data maintained with site upgrades where necessary
- Year 2 (2025): (1) continue update of 2010 – 2021 survey data to the georeferenced preferred standard, (2) carry out user surveys and stakeholder engagement to inform design and implementation of a front-end web data delivery system for all data, (3) manage and maintain data in AWS, (4) draft SMART objectives based on available data, (5) finalize analysis and management of 2024 survey data, and (6) make 2024 raw data and summary database available for download
  - Outputs accomplished
    - 60% of previously collected data (2010-2021) upgraded to the georeferenced preferred standard
    - 2024 data fully analyzed, uploaded and accessible
    - Initiate work and end user surveys for front-end web data delivery system
    - AWS data maintained with site upgrades where necessary
    - Draft SMART objectives developed
- Year 3 (2026): (1) planning and implementing Louisiana coastwide 2026 aerial photographic nest surveys (May and June 2026), (2) complete update of 2010 – 2021 data to the georeferenced preferred standard (3) build front-end web data delivery system to access 2010 – 2024 data based upon user surveys and stakeholder input, (4) commence creation of

- photomosaics of 2026 surveys and identify nests and birds (geo-dotting) coastwide, (5) commence upload and management of 2026 raw photos and summary data onto AWS, (6) develop data summary report, this may be an automated output of the web data portal, (7) working with Trustees, finalize SMART objectives based upon the web accessible data and summaries for 2010 – 2024 data and seek LA TIG approval (if finalized), and (8) manage and maintain data in AWS.
- Outputs accomplished
    - Second set of high-resolution imagery for coastal Louisiana (2026)
    - Second set of nest counts (dotting analysis) for coastal Louisiana (2026)
    - 2026 data uploaded and analysis commenced
    - 100% of previously collected data (2010-2021) upgraded to the georeferenced preferred standard
    - Work on end user surveys for front-end web data delivery system
    - AWS data maintained with site upgrades where necessary
    - Finalize SMART objectives
    - Summary data report (Year 3) delivered
  - Year 4 (2027): (1) finalize front-end web data delivery system, (2) work with Trustees to develop, finalize and seek LA TIG approval for SMART objectives, and (3) manage and maintain data in AWS
    - Outputs accomplished
      - Revise and finalize work and end user surveys for front-end web data delivery system
      - 2026 data fully analyzed, uploaded and accessible
      - Commence delivery of all data 2010 – 2026 in a spatially accessible format through the front-end web data delivery system
      - AWS data maintained with site upgrades where necessary
      - LA TIG approval for SMART objectives
  - Year 5 (2028): (1) planning and implementing Louisiana coastwide 2028 aerial photographic nest surveys (May and June 2028), (2) commence creation of photomosaics of 2028 surveys and identify nests and birds (geo-dotting) coastwide, (3) commence upload and management of 2028 raw photos and summary data onto AWS, and (4) update access of dashboard to include the 2028 survey data, and (5) manage and maintain data in AWS.
    - Outputs accomplished
      - Third set of high-resolution imagery for coastal Louisiana (2028)
      - Third set of nest counts (dotting analysis) for coastal Louisiana (2028)
      - 2028 data uploaded and analysis commenced
      - Complete and functional front-end web data delivery system with 2010-2026 data
      - AWS data and website data delivery site maintained with site upgrades where necessary
  - Year 6 (2029): (1) manage and maintain all CWB data (2010-2028) in AWS, (2) finalization of data processing and upload including a further round of edits and updates to the front-end web data delivery system, (3) multi-year data summary report.
    - Outputs accomplished
      - Multi-year summary data report delivered (Year 6)

- 2028 data fully analyzed, uploaded and accessible through the front-end web data delivery system
- AWS data and website data delivery site maintained with site upgrades where necessary

## Roles of the Implementation Team

The team described above will implement specific tasks associated with each of the major elements.

This section describes the activities associated with the major elements and the entities responsible for each activity (Table 1).

**Table 1. Activity Roles and Responsibilities**

<b>Activities by Major Element</b>	<b>LA</b>	<b>DOI</b>	<b>NOAA</b>	<b>EPA</b>	<b>USDA</b>	<b>Contractor</b>
<b>Management, Administration, and Oversight</b>						
Develop, Execute and Manage Contract	X					X
Facilitate Trustee Planning, Coordination, and Technical Review						X
Manage Data and DIVER reporting	X					X
Provide Technical Review of Documents and Reports	X	X	X	X	X	
Data Management (DIVER team to add a link, not responsible for data hosting or management)	X		X			X
<b>Implementation</b>						
Aerial Photographic Nest Surveys						X
<b>Data Analyses</b>						
Trustee Data Review and Development of Data Comparison Methodology	X	X	X	X	X	X
Nest geo-dotting analysis of newly collected data						X
Upgraded previously collected (2010-2021) CWB data to preferred standard	X					X
Nest dotting analysis of 2024, 2026, 2028 data (photomosaic and georeferenced nests)						X
Upgrade existing AWS to a front-end web data delivery system	X					X
Development of draft SMART objectives report for TIG consideration	X	X	X	X	X	X

<b>Activities by Major Element</b>	<b>LA</b>	<b>DOI</b>	<b>NOAA</b>	<b>EPA</b>	<b>USDA</b>	<b>Contractor</b>
LATIG engagement in years 3 and 4 to finalize and approve SMART objectives	X	X	X	X	X	
Relative abundance, distribution trends and breeding status analyses	X	X				X
Draft and Final Multi-year data summary and report writing	X					X
Review and Approval of interim and Multi-year data summary and report writing	X	X	X	X	X	X

## Budget

The anticipated budget for the MAM activity “Coastwide colonial waterbird aerial photographic nest surveys and nest dotting analyses, Louisiana” is provided (Table 2).

Table 2. Anticipated budget for “Coastwide colonial waterbird aerial photographic nest surveys and nest dotting analyses, Louisiana”

High level activity	LA LDWF	LA CPRA		DOI	Totals
		CPRA Staff	Contractors		
Management, Administration and Oversight	\$226,555	\$60,000		\$41,644	\$328,199
Coastwide flights, Nest Dotting and AWS Data Hosting, and summary report development			\$3,030,455		\$3,030,455
Develop draft SMART Objectives			\$386,300		\$386,300
Upgrade previously collected data (2010 to 2021) to current standard			\$1,622,655		\$1,622,655
Upgrade existing AWS to a front-end web data delivery system			\$416,290		\$416,290
<b>Total cost</b>	<b>\$226,555</b>	<b>\$60,000</b>	<b>\$5,455,700</b>	<b>\$41,644</b>	<b>\$5,783,899</b>

### Management, Administration, and Oversight

**Roles:** LA and Implementation Team

**Description:** Activity planning and coordination will be conducted prior to the launch of the activity and during the activity. This work will involve LA and the Implementation Team, and will be conducted via teleconferences and webinars. LA will oversee implementation during the entire duration of the activity via regular teleconferences to ensure that the deliverables are met on schedule and in a timely fashion. LA will submit information to the DWH DIVER Portal for annual reporting. All LA trustees will review the draft and final annual report in DIVER.

### Implementation

**Roles:** Contractor, with oversight by LA and DOI

**Description:** LA will coordinate the activities of the Contractor. LA will coordinate with the Implementation Team. The Contractor will perform aerial photographic nest surveys according to the Methods described above and in Appendix B.

### Data Analyses

**Roles:** Contractor, with oversight by LA and DOI, Implementation Team

**Description:** LA will coordinate the activities of the Contractor. LA will coordinate with the Implementation Team. The Contractor will perform data analyses according to the Methods described above and in Appendix C.

## Data Management and Reporting

A data management plan will be developed and will be updated as relevant. It will include data documentation standards, quality assurance and quality control procedures, and long-term maintenance and data archiving policies, that are consistent with the guidance provided in the Monitoring and Adaptive Management Procedures and Guidelines Manual (DWH NRDA Trustees, 2021) and the Trustee Standard Operating Procedures (DWH NRDA Trustees 2016b).

The LA Trustees will submit annual reports to the publicly available DWH DIVER Portal. LA in coordination with Implementation Team, will prepare a final summary report synthesizing the findings of the Activity, including inferences and recommendations regarding priorities for CWB restoration.

## Consistency of MAM Activity with the PDARP/PEIS

The PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016) establishes goals to restore and protect birds by facilitating additional production and/or reduced mortality of injured bird species, restoration, and protection of habitats on which injured birds rely and restoring injured birds by species where actions would provide the greatest benefits within geographic ranges that include the GOM (PDARP/PEIS Section 5.5.12.1). This MAM Activity is intended to facilitate future restoration planning and implementation activities for colonial waterbirds. Information gained from this MAM Activity will directly benefit the Trustees' ability to effectively restore colonial waterbird populations within the broader, future DWH Birds Restoration Type projects and potentially projects of other restoration types such as Wetlands, Coastal and Nearshore Habitats. Therefore, this MAM activity is consistent with the PDARP/PEIS, including the Monitoring and Adaptive Management Framework, as described in Section 5.5.15.2, and the *Strategic Framework for Bird Restoration Activities* (DWH NRDA Trustees, 2017), Module 4: Considerations for Restoration - Monitoring and Adaptive Management Considerations (see [Louisiana Colonial Waterbird Monitoring](#) (Project ID 178), [Queen Bess Island Restoration Project](#) (Project ID 83), [Rabbit Island Restoration Project](#) (Project ID 84), [Louisiana Outer Coast Restoration](#) (Project ID 35), and [RW TIG – Colonial Waterbird Monitoring](#) (Project ID 257)).

The MAM Strategy suggested MAM activities to address each MAM need. This MAIP addresses many of them:

- 2024 sampling in addition to targeted previous sampling will be used to work with Trustees to *develop* draft SMART objectives.
- Use MAM activity in tandem with the *Developing Guidance For Avian Habitat Restoration and Monitoring* document as means to inform how incorporation of habitat features within project designs may benefit diversity of shrub-nesting and ground-nesting birds (1a and 2a).
- Synthesize monitoring data for target shrub-nesting and select ground-nesting species across available data sets in Louisiana, preferably with data for years pre-spill with due respect to detection probability considerations (1b and 2b).
- Once the *Regionwide TIG Colonial Waterbird Monitoring* MAM activity is complete, with data available from aerial surveys through 2021, use existing shrub-nesting and select ground-nesting bird data to determine appropriate starting point for trend analyses of target species abundance (e.g., pre-spill or just after spill). If aerial surveys are not sufficient for all target species, consider

information in the *Developing Guidance For Avian Habitat Restoration and Monitoring* document along with existing data to determine best abundance metric.

- Report on whether additional means (e.g. potentially including, but not limited to visibility correction factors) should be developed at the colony or species level to be used in correcting aerial survey nest counts for shrub-nesting and select ground-nesting birds (1c and 2c).
- Additional 2 years of LA coastwide monitoring will provide an initial reporting on and allow for *refinement* of draft SMART objectives.

## National Environmental Policy Act Review

### Introduction

Section 6.4.14 of the PDARP/PEIS considers the environmental consequence associated with activities including, but not limited to planning, feasibility studies, design, engineering, and permitting of conceptual projects. These activities can include a mixture of data collection into historical conditions, modeling of ecological response to the project, conducting surveys, and creating maps and scale drawings of potential project sites. These activities may also include minimally intrusive field activities. The MAM activities described in this MAIP fall within the scope described in the PDARP/PEIS. Upon review, the federal trustees of the LA TIG find the environmental conditions and NEPA analysis in the PDARP/PEIS current and valid. Therefore, this review relies on the analysis in Section 6.4.14 of the PDARP/PEIS, which is incorporated herein by reference and summarized below.

### Summary NEPA Review

For purposes of this NEPA review, activities to be performed (see Appendices A and B) are categorized as “office work” and “field work”. In this review, analysis of aerial photographs using counting software, compiling data, assessing colony conditions, and similar activities are considered office work and make up the preponderance of the work. These activities would not cause adverse impacts to any resource area and require no additional review.

Field work in this MAIP consists entirely of photographic surveys conducted by a four-man crew aboard fixed wing aircraft, or by other means appropriate. Crews will consist of a pilot, a navigator/data recorder, and two photographers. The navigator will coordinate the sequence of colony visits and optimal aerial approach to each colony with the pilot. As the aircraft approaches a target colony, the crew will assess the spatial distribution of birds on the colony. Photographers, navigator, and pilot will confer to determine the best angle of approach and the ideal altitude for photographic census. Their decision will be based on the shape of the colony, the species present at the colony, the strength and direction of the wind, vegetation around the colony, and angle of the sun. While the approach altitude is variable, all photography will be carried out at an altitude above 600’ ASL, adjusted so that birds present on the colony do not leave their nests. Multiple approaches from different directions or altitudes may be made if photographers feel that they are not obtaining pictures of adequate quality or if birds appear to be responding to the presence of the aircraft. After each day’s survey, a subset of photographs will be checked to ensure that the photographic quality is such that the photos are usable for counting. If better

photographs are required for a particular colony and survey logistics allow, a colony may be visited a second time during a survey session. For field work, the PDARP/PEIS states that temporary impacts on the biological and physical environment could include short-term, temporary disturbance of habitats and species, minor emissions from equipment and vehicles, and minor disturbance to terrestrial, estuarine, and marine environments. The intensity of field work described above (i.e., one airplane doing flyovers of any single nesting colony as often as 2 days per nesting season) is consistent with the PDARP/PEIS impact analysis for field work in support of project planning activities. Similar methods have been previously evaluated in DWH restoration plans and MAIPs, including [Louisiana Colonial Waterbird Monitoring](#) (Project ID 178), [Queen Bess Restoration Project](#) (Project ID 83), [Rabbit Island Restoration Project](#) (Project ID 84), [Louisiana Outer Coast Restoration](#) (Project ID 35), and [RW TIG – Colonial Waterbird Monitoring](#) (Project ID 257).

## Conclusion

No long-term adverse impacts would occur as a result of performing these MAM activities. Short-term, negligible to minor adverse impacts could occur to nesting birds from disturbance due to the presence of the aircraft, which in most cases will consist of one or more approaches of the plane during one overflight event per colony. No groundwork is planned. Beneficial impacts would result from increased understanding about the distribution of nesting colonial waterbirds to help ensure maximum restoration benefits during project planning across the northern GoM. The impacts fall within the analysis provided in Section 6.4.14 of the Final PDARP/PEIS which states that some planning activities would cause minor, direct, short-term impacts through associated fieldwork. Therefore, no further NEPA analysis for these MAM activities is required.

## Compliance with Other Environmental Laws and Regulations

The Louisiana TIG will ensure compliance with all applicable state and local laws and other applicable federal laws and regulations relevant to this MAM Activity (Table 3).

Federal environmental compliance responsibilities and procedures follow the Trustee Council Standard Operating Procedures (SOP), which are laid out in Section 9.4.6 of that document. Following the SOP, the Implementing Trustees will ensure that the status of environmental compliance (e.g., completed vs. in progress) is tracked through the Restoration Portal.

Documentation of regulatory compliance will be available in the Administrative Record that can be found at the DOI's Online Administrative Record repository for the DWH NRDA (<https://www.doi.gov/deepwaterhorizon/adminrecord>). The current status of environmental compliance can be viewed at any time on the Trustee Council's website: <http://www.gulfspillrestoration.noaa.gov/environmental-compliance/>.

Table 3. Status of federal regulatory compliance reviews and approvals for the proposed MAM Activity.

Federal Statute	Compliance Status
Bald and Golden Eagle Protection Act (USFWS)	Complete
Coastal Barrier Resources Act (USFWS)	Under Evaluation
Coastal Zone Management Act (USFWS)	--
Endangered Species Act (NMFS)	--
Endangered Species Act (USFWS)	Complete
Essential Fish Habitat (NMFS)	--
Marine Mammal Protection Act (NMFS)	--
Marine Mammal Protection Act (USFWS)	Complete
Migratory Bird Treaty Act (USFWS)	Complete
National Historic Preservation Act (USFWS)	Under Evaluation
Rivers and Harbors Act/Clean Water Act (CPRA)	--
National Environmental Policy Act (USFWS)	--

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Appendix A: Bird Restoration Type SMART objectives (LA TIG, 2021, Table 8)

High Level Objectives	Fundamental Objectives	MAM need to develop SMART Objective	Suggested MAM activity to address MAM need	SMART Objectives
Restore, maintain, and enhance nesting/ foraging/ loafing/stop-over habitats	1. Restore, maintain, and enhance nesting; foraging; loafing habitat to support shrub nesting birds, including sufficient elevation for supratidal habitat and vegetation above the intertidal zone	1.a. Understand how to incorporate features into wetland, coastal, and nearshore habitat restoration project designs that will benefit a diversity of shrub nesting birds	1.a. Use the <i>Avian Habitat Restoration and Monitoring Guidance Document</i> (DIVER Project ID 248; LA-2020-019)	Objective related to area of restored or enhanced habitat occupied by target shrub nesting birds to be developed based on current MAM need and activity 1.a., 1.b. and other potential related data sources  Objective related to diversity of shrub nesting birds to be developed based on current MAM need and activity 1.a. and 1.b.  Objective related to trend in number of target shrub nesting birds to be developed based on current MAM need and activity 1.b. and 1.c.
		1.b. Establish baselines for evaluating restoration in terms of abundance and diversity of shrub nesting birds	1.b. Synthesize monitoring data for target species across available data sets in Louisiana, preferably with data for years pre-spill with due respect to detection probability considerations  1.b. Once the <i>Regionwide TIG Colonial Waterbird Monitoring</i> MAM activity (DIVER Project ID 257; also LA-2018-009; LA-2018-019) is complete, with data available from aerial surveys through 2021, use existing data to determine appropriate starting point for trend analyses of target species abundance (e.g., pre-spill or just after spill). If aerial surveys are not sufficient for all target species, consider information in the <i>Avian Habitat Restoration and Monitoring Guidance Document</i> (DIVER Project ID 248; LA-2020-019) along with existing data to determine best abundance metric	
		1.c. Consider additional means (e.g., potentially including, but not limited to correction factors) that compare single-survey nest count estimates from aerial surveys to other “ground truth” nest count data at monitored colonies in Louisiana where counts occur more frequently throughout a nesting season	1.c. Report on whether additional means (e.g. potentially including, but not limited to visibility correction factors) should be developed at the colony or species level to be used in correcting aerial survey nest counts	
	2. Restore, maintain, and enhance nesting; foraging; loafing habitat to support ground nesting birds, including sufficient elevation for supratidal habitat and vegetation above the intertidal zone	2.a. Understand how to incorporate features into wetland, coastal, and nearshore habitat restoration project designs that will benefit a diversity of ground nesting birds	2.a. Use the <i>Avian Habitat Restoration and Monitoring Guidance Document</i> (DIVER Project ID 248; LA-2020-019)	Objective related to area of restored or enhanced habitat occupied by target ground nesting birds to be developed based on current MAM need and activity 2.a. and 2.b.  Objective related to diversity of ground nesting birds expected to benefit from the habitats to be developed based on current MAM need and activity 2.a. and 2.b.  Objective related to trend in number of target ground nesting birds to be developed based on current MAM need and activity 2.b., 2.c.
		2.b. Establish baselines for evaluating restoration in terms of abundance and diversity of ground nesting birds	2.b. Synthesize monitoring data for target species across available data sets in Louisiana, preferably with data for years pre-spill with due respect to detection probability considerations  2.b. Once the <i>Regionwide TIG Colonial Waterbird Monitoring</i> MAM activity (DIVER Project ID 257; also LA-2018-009; LA-2018-019) is complete, with data available from aerial surveys through 2021, use existing data to determine appropriate starting point for trend analyses of target species abundance (e.g., pre-spill or just after spill). If aerial surveys are not sufficient for all target species, consider information in the <i>Avian Habitat Restoration and Monitoring Guidance Document</i> (DIVER Project ID 248; LA-2020-019) along with existing data to determine best abundance metric	
		2.c. Consider additional means (e.g., potentially including, but not limited to correction factors) that compare single-survey nest count estimates from aerial surveys to other “ground truth” nest count data at monitored colonies in Louisiana where counts occur more frequently throughout a nesting season	2.c. Report on whether additional means (e.g. potentially including, but not limited to visibility correction factors) should be developed at the colony or species level to be used in correcting aerial survey nest counts	
	3. Restore, maintain, and enhance tidal and supratidal marshes (saline, brackish, intermediate, and fresh) used by Mottled Ducks and other marsh nesting birds	3.a. Understand how to incorporate features into wetland, coastal, and nearshore habitat restoration project designs that will benefit Mottled Ducks and a diversity of marsh nesting birds	3.a. Use the <i>Avian Habitat Restoration and Monitoring Guidance Document</i> (DIVER Project ID 248; LA-2020-019)	Objective related to area of restored or enhanced habitat occupied by Mottled Ducks and target marsh nesting birds to be developed based on current MAM need and activity 3.a. and 3.b.  Objective related to diversity of marsh nesting birds expected to benefit from the habitats to be developed based on current MAM need and activity 3.a., 3.b., and 3.c.  Objective related to trend in the number of Mottled Ducks and target marsh nesting birds to be developed based on current MAM need and activity 3.b., 3c.
		3.b. Consider whether restoration progress should be accounted for separately by marsh type (such as defined by salinity or vegetation composition)	3.b. Use the <i>Avian Habitat Restoration and Monitoring Guidance Document</i> (DIVER Project ID 248; LA-2020-019) and results from the <i>Louisiana Secretive Marsh Bird Habitat Relationships and Distributions in Selected Coastal Louisiana Marshes</i> MAM Project (DIVER Project ID 205; LA-2019-016)	
		3.c. Establish baselines for evaluating restoration, in terms of abundance and diversity for mottled ducks and other marsh nesting birds	3.c. Synthesize monitoring data for target species across available data sets in Louisiana, preferably with data for years pre-spill with due respect to detection probability considerations  3.c. Use existing data, the <i>Avian Habitat Restoration and Monitoring Guidance Document</i> (DIVER Project ID 248; LA-2020-019), and results from the <i>Louisiana Secretive Marsh Bird Habitat Relationships and Distributions in Selected Coastal Louisiana Marshes</i> MAM Project (DIVER Project ID 205; LA-2019-016) to determine most appropriate abundance metrics, including use of habitat suitability or related models as appropriate, and determine starting point for trend analyses of target species abundance (e.g., pre-spill or just after spill)	

## *Appendix B: Bird Colony Aerial Photography Protocol*

High resolution, low altitude oblique aerial photographic surveys will be used to census waterbird colonies along the Louisiana shoreline based on previous colony photographic surveys (2010 to 2013, 2015, 2018, and 2021) following the DWH oil spill. The list of colonies visited will be informed based on the most recent survey. The list will be adjusted after each survey session, adding newly discovered colonies and removing any former colonies at small islands that are found to be under water. Colonies containing only cryptic beach nesting birds, such as least terns, are not included.

Colony photographic surveys will be carried out from a fixed wing aircraft configured so that two photographers can work simultaneously. Photographers will be familiar with both aerial survey protocols and colony counting methodology so that they can determine immediately whether or not photograph quality is adequate for purposes of counting. Digital SLR cameras equipped with 18-200 and 200-300 mm telephoto lenses will be used to acquire photographs. Aircraft waypoints and time will be recorded automatically at 5 second or shorter intervals. Photograph time (recorded as part of the JPG file) will be used to estimate the position of each photograph.

Crews will consist of a pilot, a navigator/data recorder, and two photographers. The navigator will coordinate the sequence of colony visits and optimal aerial approach to each colony with the pilot. One photographer will take 'context' photographs showing a relatively wide area view of the colony while the other photographer will concentrate on more detailed close-up shots that will be used for counting. If time allows, the context photographer also will zoom in to obtain additional close-up photographs. The navigator will record when the aircraft is approaching a colony, when it is leaving, and the range of frame numbers shot over that colony.

As the aircraft approaches a target colony, the crew will assess the spatial distribution of birds on the colony. Photographers, navigator, and pilot will confer to determine the best angle of approach and the ideal altitude for photographic census. Their decision will be based on the shape of the colony, the species present at the colony, the strength and direction of the wind, vegetation around the colony, and angle of the sun. While the approach altitude is variable, all photography will be carried out at an altitude between 750-1,000 ft Above (mean) Sea Level (ASL), adjusted so that birds present on the colony do not leave their nests. Multiple approaches from different directions or altitudes may be made if photographers determine they are not obtaining photographs of adequate quality or if birds appear to be responding to the presence of the aircraft.

A high altitude (1,500 to 3,000 ft ASL) overview photographic survey will also be implemented using an accepted method (Colibri 2022). Use of a gyroscopically stabilized fixed camera mount will result in an image that is taken at a near-perpendicular aspect relative to the ground. Further, GPS location of each photograph will be recorded to metadata using a commercial GPS receiver affixed to the camera.

All photograph files (JPGs) will be downloaded daily to an external backup device. Flash memory cards from the cameras will be labeled and stored when they are full. Photographs of each individual colony will be inspected for clarity, location within the colony, and extent of colony coverage. If better photographs are required for a particular colony and if survey logistics allow, a colony may be visited a second time during a survey session.

## Nest and Bird Enumeration (Dotting)

For most species, photographs from May surveys will represent peak breeding numbers and will be selected for future analysis. For some species, especially black skimmer, photos from June surveys will better represent peak numbers and will be used for analysis. Occasionally, especially for brown pelican, royal tern, and sandwich tern, well-developed colonies will be counted using May photographs, but additional large nesting groups that form after the May survey will be counted from June photographs and summed with May counts for a total number of nests.

All high altitude overview photographs will be inspected for clarity, location within the colony, and extent of colony coverage. Those best suited will be post processed using established georeferencing methods and mosaicked into a high resolution base mapping resource (Chapman and Wieczorek 2020). Representative low altitude aerial photographs will then be georeferenced using the high resolution, high altitude mosaic as an orientating layer thereby resulting in a singular imagery resource (a mosaic of high resolution photos for a given colony location) that is capable of supporting future analyses (i.e., nest dotting, characterizing bird / habit relationships, habitat evaluations, etc.).

Nest dotting analyses encompass the manual marking (dotting) of nests and birds (Ford 2010) within the mosaic of high resolution, low altitude oblique aerial photographs; an ArcGIS-based platform. Upon completion, all dotting results are automatically and displayed within a designated point count window. By design, the template standardizes both the feature domain and symbology of species and bird/nest delineations. Although the primary objective will be to determine number of nests, individual birds and chicks of each species will be counted in each photograph.

For brown pelican, nests will be categorized by their stage of development. These categories will include the following:

- Well-built nest (with attending adult and with or without chicks)
- Poorly built nest (pre-egg laying)
- Nest with chicks but without attending adults
- Abandoned nest (with eggs but unattended)
- Empty nest (early-season unattended without eggs or chicks)
- Brood (dependent chicks away from an obvious nest and not attended by an adult)

Together, these categories will provide numbers of pelican nests and breeding pairs at each colony based usually on a single aerial photographic survey even though egg-laying dates may span a period of months. For other species, all nests and territories will be marked more generally as “sites.” The detailed nest categories that will be used for brown pelicans are inappropriate for other species because of their small size (terns and gulls), scrape-nesting habits (terns and skimmers), or partial concealment by vegetation (waders and gulls).

Where overlapping images are used to analyze portions of a colony, one or more lines will be drawn on the selected image to delineate the area to be counted using that image. Areas outside any such lines will then be counted using different images. This process will continue until the colony is counted completely with available photographs.

## Compiling Data

Manual nest dotting analyses are implemented and maintained within an ArcGIS-based platform. Tally of designated nest categories and related metadata are manually tabulated within a Microsoft® Access database.

## Assessing Colony Conditions

Each analyzed image will be evaluated to characterize conditions at each colony. Factors that will be considered will include the following:

- The stage of the breeding cycle (e.g., early-, mid-, or late-incubation; early chick-rearing,) for each species.
- Habitat occupancy (numerical and geographic extent to which each species occupied the habitat).
- Reproductive performance (e.g., pattern of abandonment, if any, chick production).

Information specific to a particular image will be entered into a notes field in the main data table in the Access database. Information concerning the colony as a whole will be entered in a separate data table in the same database.