Gulf Coast Ecosystem Restoration Council Observational Data Plan (ODP) Guidelines Version 2.0

Table of Contents

Preface

This guidance is provided to support the Gulf Coast Ecosystem Restoration Council (RESTORE Council, or Council) member agencies in developing an Observational Data Plan (ODP).

This information is provided to assist in the development of appropriate ODPs for projects/programs administered by the RESTORE Council in order to ensure that any data collected as part of a project is collected in such a way that it can be utilized to (1) ensure that projects are compliant with financial award requirements; (2) determine whether projects are meeting, or are expected to meet, their intended objectives and outcomes; and (3) allow for future adaptive management (AM) actions, if warranted.

This guidance and supplementary appendices include:

- Detailed instructions for completing an ODP
- Template copies of the electronic ODP forms for projects/programs
- Examples of completed ODPs
- Guidance for monitoring and data management
- Recommendations and procedures for data quality assurance/quality control (QA/QC)

This guidance will be periodically reviewed and updated by the RESTORE Council Program Staff (Council Staff) in coordination with the Council Monitoring and Assessment Workgroup (CMAWG). The CMAWG includes representation from all Council Member agencies and will be making recommendations to the Council regarding monitoring parameter guidelines, monitoring plan formats, and reporting requirements.

The recommendations provided in this guidance build off of existing monitoring guidance documents and reports, including the Natural Resource Damage Assessment Monitoring and Adaptive Management Manual (NRDA, 2017), as well as the Council Monitoring and Assessment Program Reports (CMAP, 2020).

Council staff acknowledge that not all sections of this guidance may apply to a given project or program and exceptions may be appropriate for specific components contained in this guidance because of the wide range of project types (planning, implementation, ecosystem restoration, infrastructure, etc.) to be funded by the RESTORE Council. In such cases the ODP should include language explaining why a section does not apply, which will be considered during application review (see Section 2.0 for details).

For more information on any of the topics covered by this document please contact the Council staff point of contact for ODPs, Brie Bernik (brie.bernik@restorethegulf.gov).

1.0 Background

Under the *Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012* (RESTORE Act), the RESTORE Council (Council) is responsible for the administration of both the Council-Selected Restoration Component and the Spill Impact Component of the Gulf Coast Restoration Trust Fund. The RESTORE Act instructs the Council to implement projects/programs through the use of "best available science", a term defined in the RESTORE Act as science that "maximizes the quality, objectivity, and integrity of information, including statistical information; uses peer-reviewed and publicly available data; and clearly documents and communicates risks and uncertainties in the scientific basis." In the 2016 update to its Comprehensive Plan, the Council strengthened its commitment to applying best available science and adaptive management through common standards and monitoring protocols, identifying and reducing key uncertainties, and the development of indicators and metrics of restoration and conservation success by project, region and/or watershed.

The Council recognizes the importance of comprehensive planning for the collection and compilation of data (i.e., any data collected, compiled, or utilized as part of a RESTORE-funded project or program, including compliance, engineering and design [E&D], baseline, post-implementation assessment data, etc.) at both project-specific and regional scales. Ensuring comparability of these foundational data requires consistencies in the collection and management of data among projects to enable reporting at both the project- and program-specific scale, as well as future assessment across the Gulf.

To this end, RESTORE Council projects/programs are required to develop an Observational Data Plan (ODP) as part of the Council's current financial award process. The ODP provides the Council with information relevant to monitoring data collection, compilation, management, and delivery (i.e. activities undertaken to evaluate if funded projects are meeting or exceeding project goals and/or restoration targets, and to facilitate adaptive management). An ODP should clearly identify the goals and objectives of its project or program, as well as quantitative metrics and parameters by which the project or program will be assessed. An ODP also ensures that data is collected and managed properly for data comparison and compatibility, for immediate and long-term data access by the Council and the public, and to support necessary reporting requirements. Programs funded by the Council will be subject to the same requirements as projects, and should follow the same guidance provided for projects (see Section 3.1.6 for additional information on submitting program ODPs).

In addition, ODPs are necessary for RESTORE Council-funded projects to support the Council's compliance with the following federal laws and policies: GPRA Modernization Act (P.L. 111-352), OMB guidance (2 C.F.R. § 200.328), Foundations for Evidence-Based Policymaking Act of 2018 (P.L. 115-435), Open, Public, Electronic, and Necessary (OPEN) Government Data Act of 2018, the Council's Comprehensive Plan, and the best available science requirements of the RESTORE Act (Section 1603(t)(2)(C)(vii)(VII)(dd)).

Additional information on the Council's work to measure and deliver success can be found in the Council's Monitoring and Adaptive Management Guidelines.

2.0 ODP Overview

To ensure appropriate planning and provisions for observational data collection and management, *all approved projects/programs[1] will be required to submit an ODP following the information in this guidance as part of an application for Council staff review prior to being awarded funds.*

ODPs are developed for projects/programs administered by the RESTORE Council in order to ensure that sufficient pre- and post- implementation observational data is collected in such a way that it can be utilized to:

a. Assess if the project was constructed as designed;

b. Evaluate if the project has achieved, or is on track to achieve, the specific goals and objectives outlined in the project description;

c. Understand why the project has, or has not, performed as anticipated;

d. Inform potential AM actions; and

e. Improve the effectiveness and efficiency of implementation of future projects.

The Council recognizes that the projects/programs funded under the Council-Selected Restoration Component and the Spill Impact Component vary in scope and stage of project development, as well as by type. For example, some projects may be in the planning phase while others have completed E&D plans and are ready for implementation. Although the majority of Council-funded projects/programs conduct ecosystem restoration, others are economic or infrastructure-related. Regardless of scope, phase, or type, all projects/programs are required to provide ODPs[1]. It is understood that projects that have completed the planning and design process may be able to provide ODPs with a greater level of detail than projects initiating a planning effort. The ODP should be viewed as a living document that will be updated over the course of the project/program. The information provided in an ODP should therefore be based on the most-currently available information. Following an award, an updated ODP may be submitted at any time in order to ensure it remains current and accurate. In addition, the ODP must be reviewed annually as part of the programmatic reporting requirements outlined in the funding agreement. Throughout the duration of the project/program (including any post-implementation activities under the award), performance reports must include updated ODPs until all required information is provided and whenever revisions are needed to maintain the accuracy of the information (e.g., if additional monitoring is needed following an unforeseen event [see Section 5.0 for details]).

The information an ODP is required to provide may be updated or revised from what is described in this guidance document based on unique project/program components, guidance from the Council (including CMAWG input), coordination with existing local and regional programs, and/or other new information. Pending updates to this guidance, Council staff will work with applicants to communicate

[1] This excludes activities awarded through the Commitment and Planning Support (CPS) Funded Priorities List or Planning State Expenditure Plans (PSEP). The guidelines in this document do not apply to CPS and PSEP awards.

any such requirements during the submission process. Award recipients will be notified of any requests to revise or supplement existing ODPs when annual performance reports are reviewed.

3.0 Guidelines for ODP development

Based on the Comprehensive Plan goals and objectives that a project or program identifies, the ODP will provide metrics, parameters, and quantified targets by which the project/program's success may be assessed. Detailed guidance and recommendations on metrics, parameters, and monitoring methodologies can be found in Appendix F. All data collection, data management, and data delivery efforts are to be described in the ODP. This includes any data collection required by regulatory agencies for compliance (e.g., threatened and endangered species) and/or collection of E&D data (e.g., soil coring data) for planning purposes. This data can also be used to support the metrics being reported on in the Council's Program Information for Platform for Ecosystem Restoration (PIPER). Please note that no separate Data Management Plan (DMP) forms are required using the new ODP form.

Applicants will be expected to adopt, utilize, and reference applicable standard monitoring protocols (e.g., those used by appropriate Gulf resource agencies) and leverage ongoing monitoring efforts, as appropriate, to facilitate cross-program assessment of project performance within Gulf ecosystem recovery efforts (i.e., NRDA and NFWF programs). The adopted protocols should be clearly identified, and any deviations from the monitoring protocol standards should be explained.

ODPs are meant to act as stand-alone documents and will thus contain information found elsewhere in the grant application. As such, it is required that such duplicate information be explicitly re-stated in the ODP, rather than referenced as occurring in other sections of the grant application.

Any information that cannot be provided at the time of submitting the application should be designated TBD (for "to be determined"), with a timeframe and plan for providing updated information. As a reminder, recipients must deliver updated ODPs to the Council at least annually until *all* TBD values are provided and all information is complete.

Information provided in the ODP should apply to the phase of the project to be conducted under the application or award. For planning projects, the selected metrics and parameters will be tracked by observational data collected during the planning phase. Parameters commonly selected for planning projects include number of plans developed, environmental compliance certification(s), number of E&D packages developed, and any parameters for which data will be collected to provide baseline information (see Appendix F.7.1). For implementation projects, any observational data collection that will occur post-implementation under the award should also be described in the ODP. However, all data collected under a Council award must be made available to the Council prior to completion and close-out of that award (Section 5.2).

The Council acknowledges that additional guidance or exceptions may be appropriate for specific components of an ODP due to the wide range of project types (planning, implementation, ecosystem restoration, infrastructure, etc.). Such exceptions should be discussed with Council staff prior to submission of an ODP.

A fillable ODP form is available for download at the PIPER User Guides and Templates page. Example ODPs are provided in Appendices B-D. **Questions regarding the overall preparation of an appropriate ODP may be directed to Brie Bernik (brie.bernik@restorethegulf.gov).**

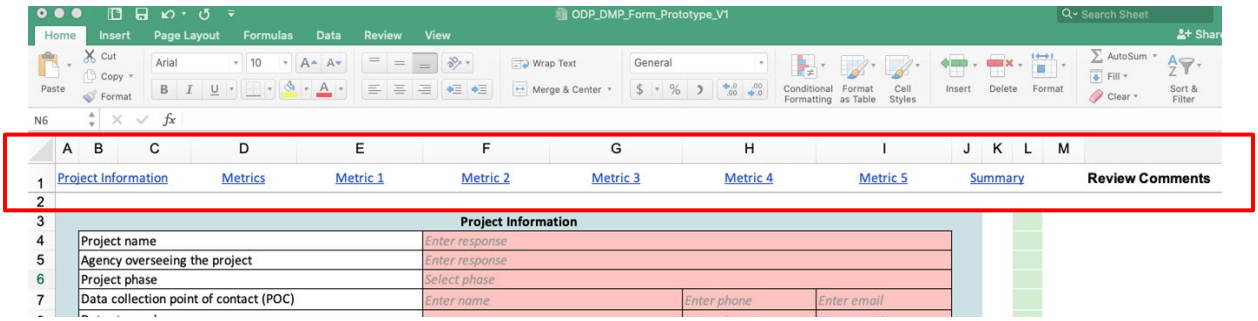
3.1 Filling out an ODP form

ODPs for RESTORE Council-funded activities are submitted by completing an Excel form and uploading the form under the "Uploads" tab in the PIPER Application Module. This form is available for download at the Council's Grants User Guides and Templates webpage. Additional information on submitting an application in PIPER can be found in the PIPER Application Module User Guide.

Sections 3.1.1-3.1.4 below provide guidance on completing and submitting the *Observational Data Plan Form* for a RESTORE Council project.

Section 3.1.5 provides additional guidance on completing and submitting the *Observational Data Plan Form* for a RESTORE Council program (i.e., activity with multiple projects under a program).

3.1.1 ODP form navigation



The *Observational Data Plan Form* is a Microsoft Excel spreadsheet that has been designed to allow for easy navigation between different sections. Upon opening the form in Excel, you will see a spreadsheet consistent with the screenshot above. At the top of the form are bookmarked links that allow you to navigate to the different ODP form sections:

- Project Information (Section 3.1.2)
- Metrics (1-5, as appropriate) (Section 3.1.3)
- Summary (Section 3.1.5)

The *Program Observational Data Plan Form* can similarly be navigated using additional links between project sections, found at the top of the form (Section 3.1.6).

3.1.2 Project information section

The Project Information section of the ODP form includes fillable fields that request the general project information, observational data budget, data consistency and compatibility, adaptive management, and data management.

Project Information			
Project name	*Enter response*		
Agency overseeing the project	*Enter response*		
Project phase	*Select phase*		
Data collection point of contact (POC)	*Enter name*	*Enter phone*	*Enter email*
Data steward	*Enter name*	*Enter phone*	*Enter email*
Expected data collection start and end dates	*Enter date*	*Enter date*	
Short description of the project location	*Enter response*		
Overall project goals and objectives	*Enter response*		
Specific goals and objectives of data collection	*Enter response*		

Project Information

1. Project name

   Enter the application project name. Please be sure to match exactly the name submitted in PIPER and GrantSolutions (and the project name in an approved FPL, if applicable).

2. Agency overseeing the project

   Enter the primary organization awardee.

3. Project phase

   Select from the drop-down menu the phase during which Observational Data will be collected ("Planning", "Implementation", "Planning and Implementation"). This should match the project phase described in the grant application. Information provided in the ODP should pertain only to this phase.

4. ODP point of contact (POC)

   Enter the name, phone number, and email address for the ODP POC. This is the person who will handle communication regarding the ODP and the data collection, data analysis, and data management activities described therein.

5. Data steward

   Enter the name, phone number, and email address for the data steward, i.e., the observational data management POC. This is the person who will be responsible for managing the project data and metadata. If the data steward is the same as the data collection POC please repeat the information rather than leave it blank.

6. Expected data collection start and end dates

   Enter the dates for the start and end of observational data collection, allowing a reasonable amount of time following submission/approval of the grant application. ***Ensure the data collection end date falls before the project end date given in the application***. You may provide

start and end date estimates such as “6 months post award” and “3.5 years post award”, but the response will be considered TBD until specific dates are entered as MM/DD/YYYY.

7. Description of the project location

   Provide a short description of the project location. This language typically can be pulled from the PIPER application for ease and consistency.

8. Overall project goals and objectives

   Provide a short description of the overall project goals and objectives. This language typically can be pulled from the PIPER application for ease and consistency. For example, you may list the primary and secondary Comprehensive Plan objectives selected in PIPER. Please do not reference Comprehensive Plan goals and objectives that are not already identified in the project proposal and PIPER application.

9. Specific goals and objectives of data collection

   Provide a description of the observational data collection (e.g. monitoring) goals and objectives for the project. This response should be more specific than the response for the overall project goals and objectives. For example, you may describe how monitoring is intended to demonstrate specific benefits related to the goals and objectives for the overall project.

Observational Data Budget	
Estimated total budget for observational data collection and	
Estimated total budget for data management	
Locations in the application budget	

Data Consistency and Compatibility	
List any consistent local or regional monitoring efforts,	
Describe potentially complementary datasets, if known and	

Adaptive Management	
Describe the extent to which adaptive management will be	

Observational Data Budget

10. Estimated total budget for observational data collection

    Provide an estimated total budget for observational data collection and reporting. This should encompass costs for all data collection activities captured in the ODP, as well as costs for preparing and submitting updated ODPs and reports. ***This value should resemble the estimate provided in the approved proposal (if applicable).*** For proposals submitted in PIPER, the budget tab includes an estimate of the percent of the total budget that will go towards monitoring and adaptive management.

11. Estimated total budget for data management

    Provide an estimated total budget for observational data management. Data management costs should include the costs associated with data storage, archiving, and making the data

publicly available, as appropriate. ***This value should resemble the estimate provided in the approved proposal (if applicable).*** For proposals submitted in PIPER, the budget tab includes an estimate of the percent of the total budget that will go towards data management.

12. Locations in the application budget

    Indicate where in the Grant application (e.g., Overall Project Budget, Budget Narrative or Milestones) the ODP costs are found (e.g., if a person's work is at approximately $30k in the Overall Project Budget, but ~$5k of their salary is on data collection/compilation, please indicate that in the ODP budget).

Data Consistency and Compatibility

13. List any consistent local or regional monitoring efforts, methods, or standards, if applicable

    This response should capture any anticipated compatibility between your data and existing datasets. Applicants are encouraged to explore and reference existing regional monitoring efforts discoverable through the Gulf Coast Monitoring and Assessment Portal, an inventory of Gulf Coast habitat monitoring, mapping, and water quality programs and assessments.

14. Describe potentially complementary datasets, if known and applicable

    For example, a dataset may be considered complementary because it includes additional parameters informative to the analyses described in the ODP. Applicants are encouraged to explore and reference existing regional monitoring datasets discoverable through the Gulf Coast Monitoring and Assessment Portal, an inventory of Gulf Coast habitat monitoring, mapping, and water quality programs and assessments.

Adaptive Management

15. Describe the extent to which adaptive management (AM) will be used

    Describe the extent to which AM will be used for the project/program, including any uncertainties that the observational data may help address to inform management moving forward. Potential corrective action for each parameter will be captured later in the form and does not need to be repeated here.

Data Management

Describe how data will be:	
Stored	
Archived	
Made available to the public and the Council	
Will DOIs be used?	

Data Management

All data management activities described in this of the ODP should be consistent with the guidance provided in Section 4.0.

16. Describe how data will be:

    a. Stored

        While in use, data should be stored in a known location and backed up to one or more offsite locations to avoid risk of data loss. At project/program closeout, all data should be stored in a public repository (see below).

    b. Archived

        Data archiving is different from data storage. Archiving is the practice of moving data to a long-term storage system (i.e., repository) where it can be located and retrieved as needed. Identify all repositories to be used and describe the archiving procedures that each repository will employ. Examples of public data repositories include: NOAA National Centers for Environmental Information (NCEI), Environmental Data Initiative, Dryad Digital Repository, and Open Science Framework.

    c. Made available to the public and the Council

        Data must be made available to the Council and the public in a format that will permit further analysis or reuse (for details including acceptable formats, metadata standards, and exceptions for restricted use data, see Section 4.0). Archiving data in a suitable public data repository (see above) provides a long-term means of access. In some cases, access can be provided via smaller data portals or websites hosted by grant recipients or their partners. ***Your response should be consistent with award requirements and reporting carried out under the award.*** The public must be given access to data no later than two years after the data are first collected and verified unless otherwise indicated in the ODP and approved by Council staff. Information on what data has been collected and how it can be accessed will be provided to the Council on a yearly basis as part of the PIPER performance reporting process (Section 5.2).

17. Will DOIs be used?

    A Digital Object Identifier (DOI) is a type of unique, persistent data identifier that is commonly used in the international scientific community. DOIs are assigned to a specific electronic data resource or product and are used for citation purposes. A DOI is permanently attached to a digital object, and does not change even if the physical location of a digital object does. This way, a properly managed DOI will always direct the end user to the current online location of that object. A DOI supports improved scientific integrity and reporting by providing access to the data, workflow, or software version used in the data creation, from which results and data location can be identified. While the Council does not require DOIs be used, they are encouraged.

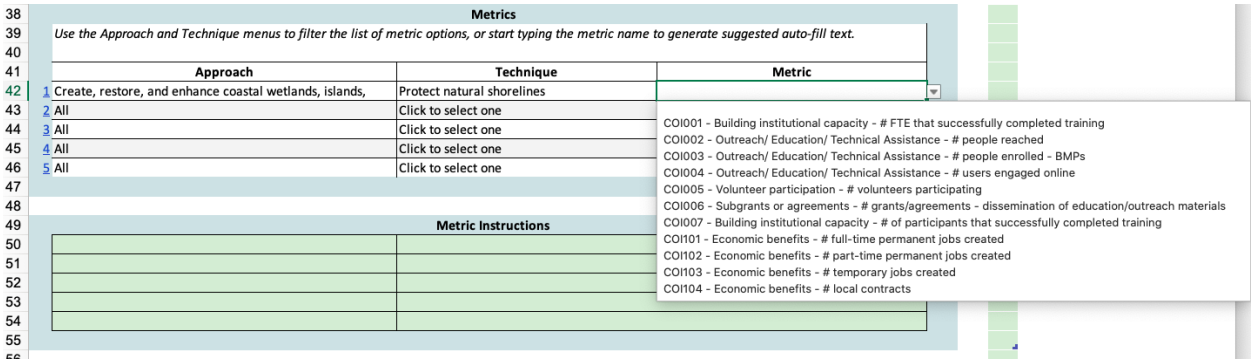
3.1.3 Metrics selection

For guidance on selecting project metrics, parameters, and monitoring methods, see Appendix F. Metrics and quantitative success criteria targets will need to be identified for each Comprehensive Plan

objective associated with a project or program. Each metric should be supported by one or more measurable parameters for which success criteria targets are also identified. Metric and parameter recommendations have been provided for each of the restoration techniques a project/program may employ to support its objectives (see Appendix F for details and recommendations). Projects/programs select objectives, techniques, and metrics at the proposal stage, which are carried forward to the application. This information is auto-populated in PIPER applications for FPL 3b projects/programs. Metrics included in the ODP should be consistent with the expectations set out in the proposal and should match metrics submitted in the PIPER application.

The Metrics section of the ODP form allows you to provide detailed information on the parameters that will be monitored to support project success for up to five metrics. If space is needed for additional metrics, parameters, data types, or other information, please contact Council Staff for a longer version of the ODP form.

To begin providing information on observational data that will be collected to support the project metrics identified in the PIPER application, use the drop-down "Approach" and "Technique" menus to filter the list of metric options or start typing the metric name to generate suggested auto-fill text.



Metrics

Use the Approach and Technique menus to filter the list of metric options, or start typing the metric name to generate suggested auto-fill text.

	Approach	Technique	Metric
1	Create, restore, and enhance coastal wetlands, islands,	Protect natural shorelines	HR002 - Shoreline restoration - Miles of
2	Improve science-based decision-making processes	Protect natural shorelines	PRM008 - Monitoring - Miles being monitored
3	All	Click to select one	
4	All	Click to select one	
5	All	Click to select one	

Metric Instructions

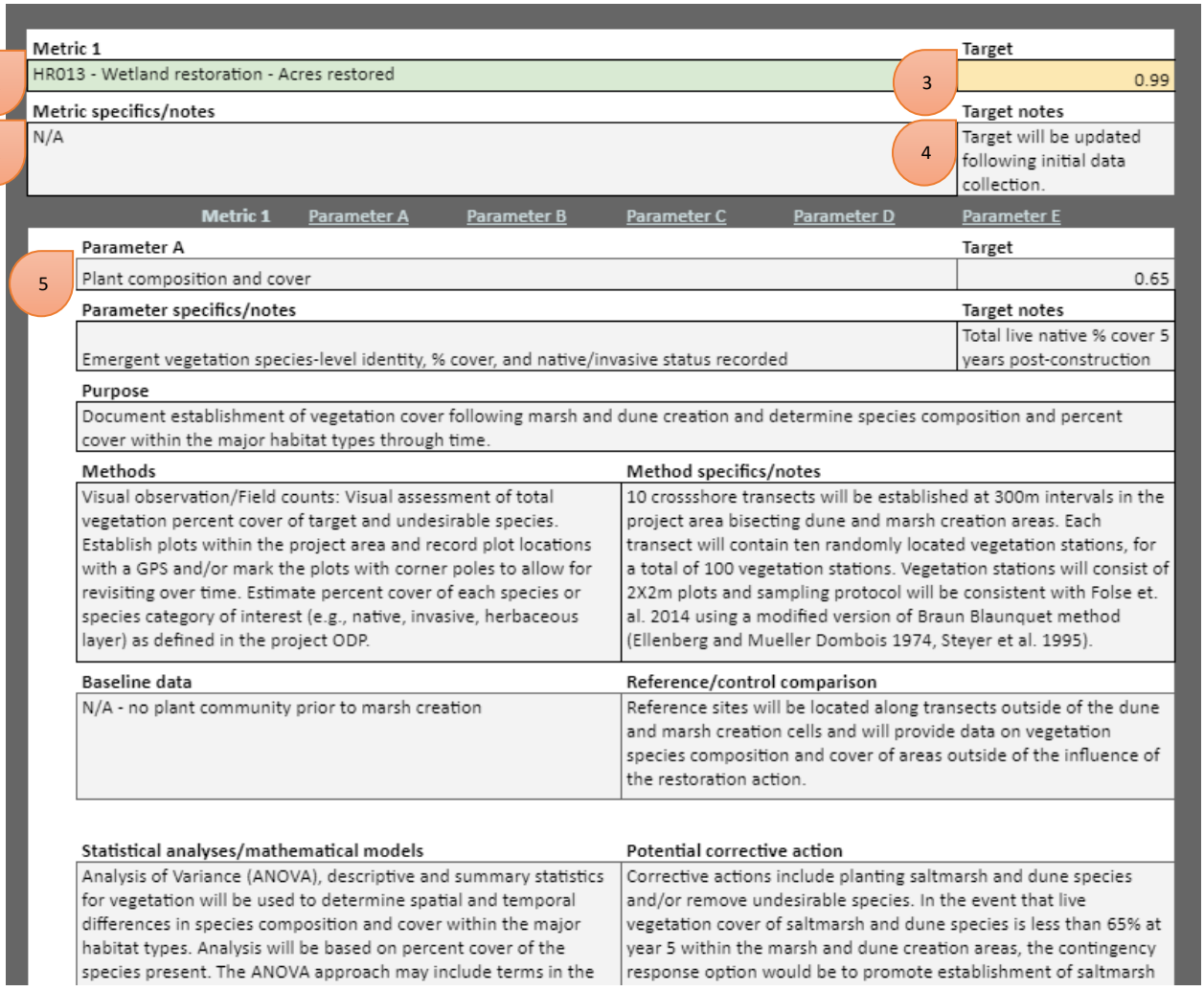
HR002 - Shoreline restoration - Miles of shoreline stabilized	Enter the miles of shoreline stabilized and restored. This should be selected and reported for
PRM008 - Monitoring - Miles being monitored	Enter the number of miles monitored as a direct result of the project. This metric should

After you have selected the appropriate metric(s) for your project, corresponding metric information will auto-populate throughout the ODP form.

3.1.4 Parameters and methodological details

For guidance on selecting project metrics, parameters, and monitoring methods, see Appendix F**.** Parameters are the data collected to support metrics. Statistical analyses of the supporting parameters enable reporting on a metric. Some metrics may require only a single parameter, while other metrics may require multiple parameters to enable reporting. It is often appropriate for a metric to be supported by a parameter with the same name or an 'activity completion' parameter. See Appendix F for details.

For each project metric, provide information on the parameters that will be tracked to support that metric. All data collection activities performed under an award should be captured by the parameter information provided in the ODP.



Metric 1		Target
HR013 - Wetland restoration - Acres restored		0.99
Metric specifics/notes		**Target notes**
N/A		Target will be updated following initial data collection.

Metric 1 | Parameter A | Parameter B | Parameter C | Parameter D | Parameter E

Parameter A	Target
Plant composition and cover	0.65
Parameter specifics/notes	**Target notes**
Emergent vegetation species-level identity, % cover, and native/invasive status recorded	Total live native % cover 5 years post-construction

Purpose

Document establishment of vegetation cover following marsh and dune creation and determine species composition and percent cover within the major habitat types through time.

Methods	Method specifics/notes
Visual observation/Field counts: Visual assessment of total vegetation percent cover of target and undesirable species. Establish plots within the project area and record plot locations with a GPS and/or mark the plots with corner poles to allow for revisiting over time. Estimate percent cover of each species or species category of interest (e.g., native, invasive, herbaceous layer) as defined in the project ODP.	10 crossshore transects will be established at 300m intervals in the project area bisecting dune and marsh creation areas. Each transect will contain ten randomly located vegetation stations, for a total of 100 vegetation stations. Vegetation stations will consist of 2X2m plots and sampling protocol will be consistent with Folse et. al. 2014 using a modified version of Braun Blaunquet method (Ellenberg and Mueller Dombois 1974, Steyer et al. 1995).
Baseline data	**Reference/control comparison**
N/A - no plant community prior to marsh creation	Reference sites will be located along transects outside of the dune and marsh creation cells and will provide data on vegetation species composition and cover of areas outside of the influence of the restoration action.
Statistical analyses/mathematical models	**Potential corrective action**
Analysis of Variance (ANOVA), descriptive and summary statistics for vegetation will be used to determine spatial and temporal differences in species composition and cover within the major habitat types. Analysis will be based on percent cover of the species present. The ANOVA approach may include terms in the	Corrective actions include planting saltmarsh and dune species and/or remove undesirable species. In the event that live vegetation cover of saltmarsh and dune species is less than 65% at year 5 within the marsh and dune creation areas, the contingency response option would be to promote establishment of saltmarsh

1. Metric 1

   The name will populate from the "Approach, Technique, Metric" table.

2. Metric specifics/notes

Provide the project-specific description of how the metric will be tracked.

3. Target

   Indicate the target for metric 1. ***This field will only accept a number.*** This number should match the metric target provided in PIPER.

   TBD targets should be entered as "0.99."

   A ***target range*** can be used by entering the midpoint of the range of values as the target and describing the range in the Target notes field.

4. Target notes

   Provide any additional information on the target success criteria (including potential ranges of target values and qualitative targets).

5. Parameter A

   Provide the name of the first parameter for which data will be collected under Metric 1.

For each parameter, provide the following information:

- Parameter specifics/notes

  Provide the project-specific description of how the metric will be tracked. If the parameter is 'Activity completion', provide the name of the specific activity completion parameter that will be tracked (see Appendix F.1.2.1).

- Target

  Indicate the target for the parameter. ***This field will only accept a number.*** This number should match the metric target provided in PIPER.

  TBD targets should be entered as "0.99."

  A ***target range*** can be used by entering the midpoint of the range of values as the target and describing the range in the Target notes field.

- Target notes

  Provide any additional information on the target success criteria (including potential ranges of target values and qualitative targets).

- Purpose

  Provide justification for the use of this parameter as a means of tracking the metric.

- Methods

  Enter or select the methodology to be used to collect parameter data. See Appendix F (Section F.8.0) for recommendations.

- Method specifics/notes

Specify methodological details. Methods selected from Appendix F (Section F.8.0) may include broad categories of methodologies; information on specific protocols, equipment, etc. should be described here.

- Baseline data

  Provide a description of baseline data collection, including timing and frequency, for Parameter A, if applicable. For planning projects, baseline data collection could include previously developed Engineering & Design documents, monitoring plans, or other reports. Any additional environmental data collected as part of planning to provide pre-implementation baselines should be included as a parameter in support of planning project metrics.

- Reference/control comparison

  Comparison with reference sites shows project impacts, or progress toward the desired state. Identify the reference sites/conditions that will be used to support assessment of the project/program impact. If the reference site will not be included in the data collection plans for each parameter, the lack of reference site should be explained and alternative data collection plans should be described.

  Be aware that baseline data (described above) can be used to show changes over time, but ***reference data is needed to control for impacts from external drivers***. Shifts from baseline conditions at a control site may be used to quantify external drivers affecting the project performance. For example, by referencing nearby marsh with similar characteristics, the benefits of a marsh restoration project in terms of land change rate (Appendix F, Section F.8.0) can be determined even after a storm reduces progress from the baseline by evaluating the difference in land change rate between the project and control sites.

- Statistical analyses/mathematical models

  Describe how data will be statistically analyzed in order to determine whether performance criteria are being met, objectives achieved, and uncertainties resolved. If applicable, also provide a description of any new/existing models being used for the project, including the approach that will be used to corroborate the accuracy and validate the utility of the model's performance.

- Potential corrective action

  Describe potential corrective actions that could be implemented to modify project performance if data indicate the project is not performing as expected.

- Schedule/timing

  Frequency of data collection (including before, during, and after project implementation where possible and appropriate).

- Sample size

  Indicate the parameter sample size.

- Sample sites

  Location of monitoring sites, including reference site(s) if appropriate (see above).

- Quality assurance/control (QA/QC)

  Description of the planned quality assurance/quality control (QA/QC) procedures/approach for the parameter. See Section 4.2.1 for additional information on QA/QC.

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Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
As-built vegetation cover will be surveyed approximately 90 and 180 days (summer and early fall) following completion of construction within the marsh and dune cells. Post implementation vegetation cover will be surveyed late summer/early fall of years 2 and 5. (Exact dates TBD and updated in a revised ODP provided with the first annual report).	100 randomly located stations will be established across the project site and surveys will be collected at each station.	Randomly selected locations will be established representing the full extent of marsh and dune creation areas of Golden Island.	Field QA: Vegetation cover estimates should reflect the independent professional judgement of at least two field personnel. If estimates differ by greater than 5 percent both individuals should independently re-estimate cover values until a consensus is reached. Office QA: Review plot photograph for data accuracy and/or identification errors. After data transcription is complete, review datasheets versus transcribed data for omissions, duplications, completion, and consistency with field collection.

6

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Plant surveys	% cover/species with status category (native/invasive)	Varies (biannual sampling during years 1, 2, and 5)	4 years	Relational database and .csv files	points

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum
John Smith	(123)456-7777	john.smith@dos.gov	UTM zone 17N	NAD83 (NSRS2007)

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation

6. Data Type 1

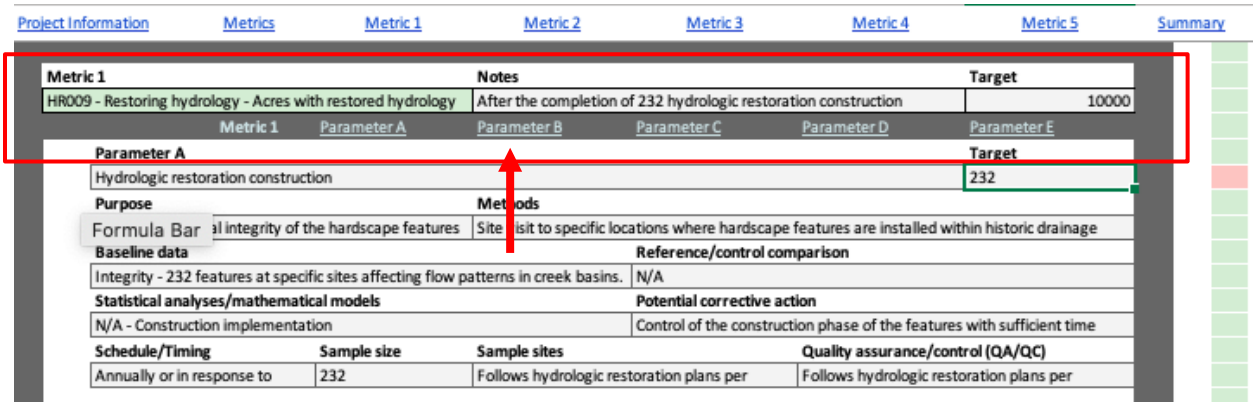
Describe the data type to be collected.

Provide information on the data types that will result from parameter data collection. If a data type is already captured under another parameter it can be selected from the dropdown menu. ODP data types should capture all raw data and derivative products produced under an award. For each data type, provide the following information:

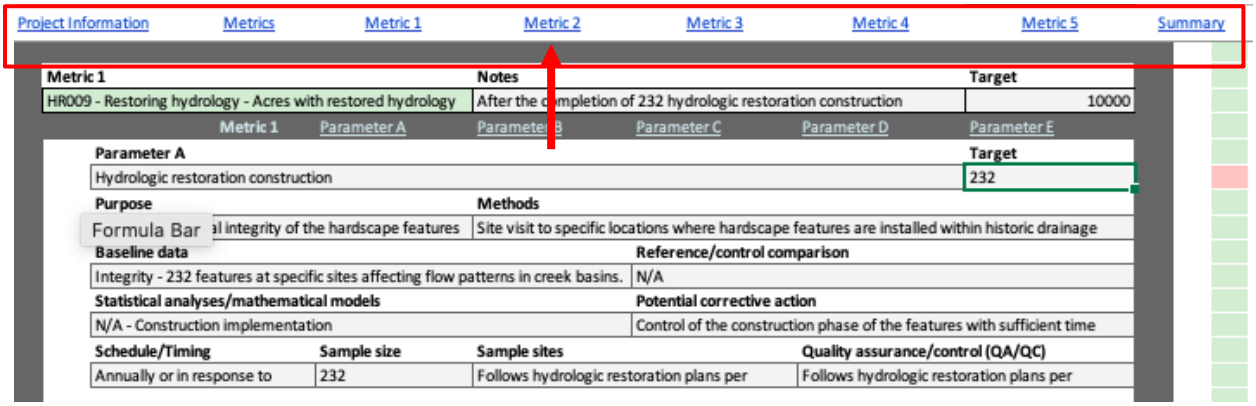
- **Units:** Describe the units of the data type.
- **Frequency:** Describe the frequency of data collection for the data type.
- **Duration:** Describe the duration of data collection for the data type.

- **Storage format:** Describe the format in which the data will be stored.
- **GIS Representations:** Provide the GIS representation for the data type, if applicable.
- **POC Name, Phone, Email:** Provide the contact information for the management of the data type.
- **Projection:** Provide the GIS projection for the data type, if applicable.
- **Horizontal and Vertical Datum:** Provide the GIS Horizontal and Vertical Datum for the data type, if applicable.

After you have completed providing the information for Parameter A, you may navigate to provide information for the next Parameter (Parameter B) to be tracked under Metric 1, if applicable, but using the Parameter navigation links highlighted by the red box below.



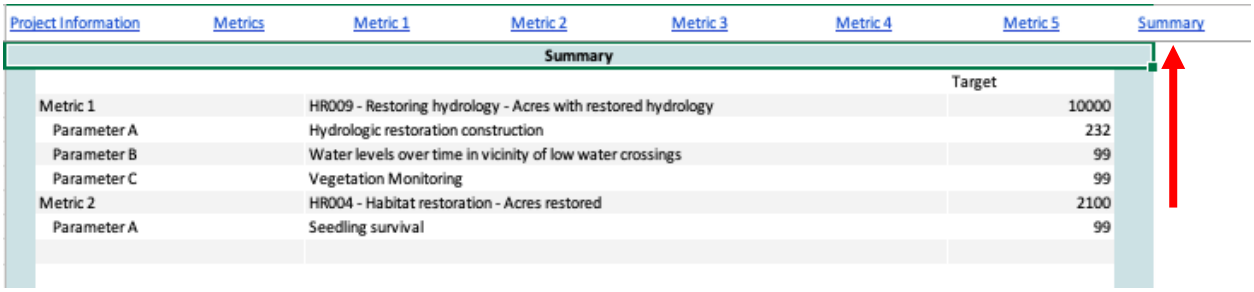
When there are no additional parameters to add under Metric 1, you may navigate to the next metric by using the Metric navigation links highlighted by the red box below.



3.1.5 Project summary

As metric and parameter information is added to the ODP form, the data is summarized under the Summary table. Review this table to ensure all the appropriate metric and parameter information has been completed and that the Metric targets match those listed in the PIPER application.

This table can be navigated to by selecting the “Summary” link at the top of the ODP form.



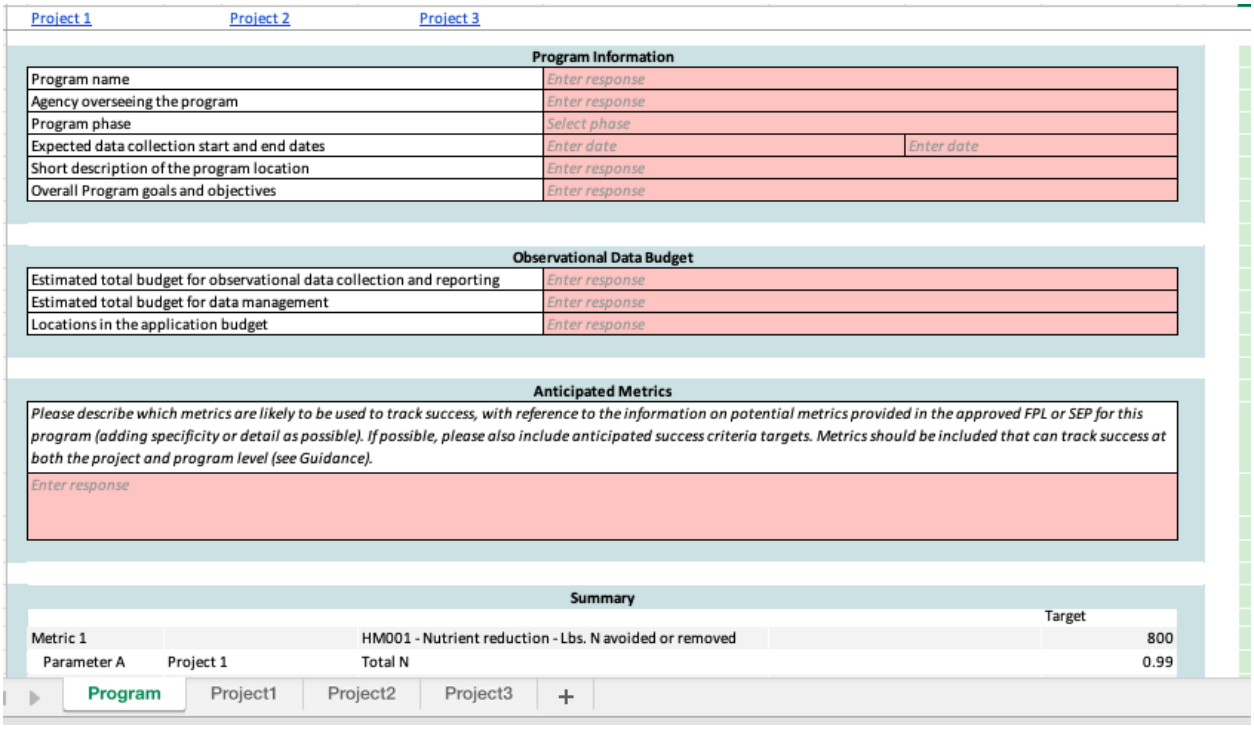
Project Information | Metrics | Metric 1 | Metric 2 | Metric 3 | Metric 4 | Metric 5 | Summary

Summary

		Target
Metric 1	HR009 - Restoring hydrology - Acres with restored hydrology	10000
Parameter A	Hydrologic restoration construction	232
Parameter B	Water levels over time in vicinity of low water crossings	99
Parameter C	Vegetation Monitoring	99
Metric 2	HR004 - Habitat restoration - Acres restored	2100
Parameter A	Seedling survival	99

3.1.6 Program ODP form

For Council-funded programs that will comprise multiple projects, applicants should use the *Program Observational Data Plan Form*. This form is similar in structure to the project ODP form detailed in Sections 3.1.1-3.1.4, but provides a section for program information and space to enter information on multiple projects successively within the same document. Links allowing navigation between projects are included in an additional header row along the top of the form. The Program Summary table summarizes overall metric and parameter information across the program and provides a breakdown of this information by project. The *Program Observational Data Plan Form* is available for download on the Council’s User Guide and Templates Webpage.



Project 1 | Project 2 | Project 3

Program Information

Program name	Enter response	
Agency overseeing the program	Enter response	
Program phase	Select phase	
Expected data collection start and end dates	Enter date	Enter date
Short description of the program location	Enter response	
Overall Program goals and objectives	Enter response	

Observational Data Budget

Estimated total budget for observational data collection and reporting	Enter response
Estimated total budget for data management	Enter response
Locations in the application budget	Enter response

Anticipated Metrics

Please describe which metrics are likely to be used to track success, with reference to the information on potential metrics provided in the approved FPL or SEP for this program (adding specificity or detail as possible). If possible, please also include anticipated success criteria targets. Metrics should be included that can track success at both the project and program level (see Guidance).
Enter response

Summary

			Target
Metric 1		HM001 - Nutrient reduction - Lbs. N avoided or removed	800
Parameter A	Project 1	Total N	0.99

Program | Project1 | Project2 | Project3 | +

When submitting an ODP for a program for which projects are yet to be identified, applicants should complete the information in the program section (i.e., Program Information, Observational Data Budget, and Anticipated Metrics).

1. Program Information

   Provide the overarching program information. In entering the expected data collection start and end dates, enter the expected data collection dates anticipated for the life of the program.

2. Observational Data Budget

   Provide the monitoring and data management information for the life of the program.

3. Anticipated Metrics

   In this field, describe which metrics are likely to be used to track success of the program, with reference to the information on potential metrics provided in the approved FPL or SEP for this program (adding specificity or detail as possible). Metrics should be included that can track success at both the project and program level. For programs with unspecified projects, metrics for the anticipated techniques should still be listed at the application stage. If possible, estimates should be provided for anticipated success criteria targets. A range of values may be described If it is difficult to estimate a specific value for a target. See Appendix F for details and recommendations.

Project Information

As individual projects are identified, the associated ODP information for the project should be added as detailed in Sections 3.1.1-3.1.4.

4.0 Guidelines for data management

4.1 Background

Efficient and effective implementation of RESTORE Council-funded activities requires a clearly-defined strategy for management of the data collected during such activities to ensure data is available for the long-term and utilized to assess project success, to support future project selection, and to enable reporting to Congress and the public regarding how the Council has achieved its Goals.

4.1.1 Federal reporting requirements for data management

All federally funded projects are subject to federal reporting requirements for data management. Title II of the Foundations for Evidence-Based Policymaking Act of 2018 ("Evidence Act") , the Open, Public, Electronic, and Necessary (OPEN) Government Data Act of 2018 ("OPEN Government Data Act"), builds on long-standing principles underlying federal policies and data infrastructure investments supporting information quality, access, protection, and use and codifies many of the key aspects of the Federal Government's 2013 open data policy. The OPEN Government Data Act requires agencies to collect or create information in a way that supports downstream information processing and dissemination activities. This includes using machine-readable and open formats, as well as data and metadata standards, for all new information creation and collection efforts. The guidelines for data management

included here are intended to help facilitate the Council's compliance with these policies, as well as the following federal laws and policies: GPRA Modernization Act (P.L. 111-352), OMB guidance (2 C.F.R. § 200.328), and the requirements of the RESTORE Act (Section 1603(t)(2)(C)(vii)(VII)(dd)).

Over the life of the RESTORE Council, it is likely that data standards and protocols recommended herein will evolve with recommendations from the CMAWG and advances in data management technologies. Therefore, the guidance in this document is intended to be iterative and will be adapted as necessary. The principles and philosophy of this guidance will stay in place, but the specific recommended practices and standards will be reviewed periodically by Council staff and the CMAWG to ensure that the guidance is up to date.

4.2 Guidance for Council-funded data management[2]

4.2.1 ODP data review and QA/QC

Before being added to a publicly available repository, all data should go through the appropriate QA/QC process in accordance with the data management section of the ODP and any additional QA/QC documentation (such as a Quality assurance project plan [QAPP]) that may be applicable, and consistent with the process outlined below.

Step 1. Data Verification

1. Verify that the data are correctly entered and convert into a format that may be imported into the intended data repository, consistent with the data standards (Section 4.3.5).
2. Perform an initial validation check for suspected errors other than data entry/transcription errors (e.g., units, expected value range).
3. Address any suspected errors and document the changes made to correct actual errors and suspected errors that were found to be valid data.
4. Verify the metadata are in standard ISO format (see data standards described Section 4.3, Step 6) to the extent practicable and in accordance with individual agency requirements.

Corrections to errors should be made before the data are used for any analyses or distributed outside the agency. As needed, the initial data analysis may be conducted at this time in accordance with the SOW, QAPP, and/or ODP.

[2] Please see guidance on completing the ODP form (Section 3.1) for additional guidance on how to provide appropriate data management information in an ODP.

Additional Information

Transcription verification is a process where the entered data are checked to ensure they are transcribed accurately. There are two common approaches to transcription verification:

- Visual check – Have the entered/converted data visually inspected, preferably by a person who did not enter the data. This could be performed on the entire dataset or a portion of the dataset (e.g., 10%).
- Double data entry – Have two people independently enter the data and check for agreement. Any errors/corrections may be double-checked by the original data entry/conversion personnel or an independent reviewer. The robustness of the verification review may depend on the type of data, how the data were collected and recorded, the quantity of the data, and the required data quality (e.g., data quality objectives).

Step 2. Data Validation and Final QA/QC

In accordance with the ODP and/or QA/QC procedures, the project/program grant/IAA recipient is responsible for reviewing submitted verified data and verified processed data and checking for suspected non-data entry errors (e.g., units, expected value range, date/time, latitude/longitude). After any and all suspected errors are addressed, the data are considered to have gone through the QA/QC process.

Additional Information

Depending on the type of data, there are a number of checks that can be done when reviewing the transcription-verified data to ensure the data are accurate and complete. Some examples include (adapted from https://www.usgs.gov/products/data-and-tools/data-management/manage-quality):

- Check units.
- Compare values to expected value ranges (e.g., existing datasets, reports).
- Check date and time.
- Perform geospatial checks (e.g., coordinates).
- Ensure data columns and rows line up properly.
- Look for missing or irregular data entries.
- Look for blank entries.
- Note any data qualifiers.
- Perform statistical summaries.

Check for outliers. This can be done by creating graphs (e.g., normal probability plots, regression, scatterplots), creating maps, or performing additional data analysis (e.g., subtract values from the mean).

Step 3. Information Package Creation

The project/program grant/IAA recipient is responsible for creating an information package for public release, which should include the following documents, if applicable:

- Geospatial metadata following the Council's Metadata template (see data standards, Section 4.3, Step 6).
- Additional project/program metadata following the Council's ISO-compliant metadata template (see data standards, Section 4.3, Step 6).
- Data dictionary (defines codes and fields used in the dataset; see data standards, Section 4.3, Step 6).
- README file (e.g., how data were collected; QA/QC procedures; other information about data such as meaning, relationships to other data, origin, usage, and format – can reference other documents; see data standards, Section 4.3, Step 6).
- Prior to upload and release of the monitoring data and associated metadata, the project/program grant/IAA recipient should confirm that the package is ready for public release.

4.2.2 ODP data storage and accessibility

The project/program grant/IAA recipient will ensure that data is stored in a secure location and in such a way that public accessibility is guaranteed, following the standards and protocols set forth in the Federal OPEN Government Data Act. However, some ODP data may be exempt from the OPEN Government Data Act due to protection from public disclosure under other regulatory authorities (e.g., Privacy Act). All data should be accessible in a digital, machine-readable and non-proprietary format unless it is restricted access. No data release can occur if it is contrary to Federal or State laws.

Recipients will provide ODP data and information to a publicly available data platform as soon as possible and no more than two years from when data are collected. If it will not be possible to add data within that timeframe, an estimated timeframe of when to expect the data after they have been collected should be provided in the data management component of the ODP. Annual reports on data collection are also required as part of the PIPER performance reporting process (see Section 5.0).

4.3. Data standards

These data standards reflect the guidelines developed by the Council and the CMAWG. The CMAWG developed these data standards to increase consistency in the way data are described and recorded. Specific recommended practices and standards will be reviewed periodically by Council staff and the CMAWG to ensure that the guidance is up to date.

1. **Data collection:** Field data should be collected with standardized datasheets or project-specific datasheets electronically on digital tablets, where feasible, or on hard copy datasheets.

- Field datasheets should include standard data fields (described below) identified by the CMAWG.
- Agreed-upon standard units of measure should be used, if available.

2. **Document revision**: If a data file is revised after it has been published to a publicly available data repository, the original datasheet should be preserved and changes to electronic data files should be tracked.

3. **Sample/data transfer**: Transfer of samples or data should be properly documented (e.g., chain of custody form, README file).

4. **Document/data retention, storage, and accessibility:** All documents (e.g., photographs, original hardcopy datasheets, notebooks) and electronic data files should be stored and managed in a secure location in such a way that the recipient is guaranteed to have access to all versions of the data for at least as long as agency retention requires. All original and revised data files should be retained.

   If an outside party is conducting the monitoring, the data submission to the project/program grant/IAA recipient should occur at least yearly during the years when monitoring is being conducted.

5. **Data description:** The data descriptions should be consistent with data standards developed by the CMAWG. This includes the type of data file, standard data fields, and the units of the data.

6. **Metadata:** The data should have properly documented metadata (which may include geospatial metadata), a data dictionary, and/or a README file, as appropriate. Metadata, or 'the documentation of data,' makes data discoverable, usable, and understandable. A metadata standard establishes a common way of structuring and understanding metadata, and includes principles to guide its use.

   - Geospatial metadata should follow the Council's Metadata Template, available for download through PIPER.
   - Metadata records for additional ODP data should use the International Organization for Standardization (ISO) metadata standards (ISO, 2014)[3] to the extent practicable and in accordance with individual agency requirements. To assist in meeting this requirement the Council has developed an ISO-compliant metadata record creation tool, the Council MEtadata Record and Library Information Network (MERLIN). Additional information on Merlin including a User's Guide is available on the Council's website.

[3] In accordance with the Council's 2017 approval of the adoption of the ISO-19115 metadata standard (and the associated series of standards) for Council-funded activities.

- The data dictionary defines codes and fields used in the dataset.
- The README file should include information on how the data were collected, the QA/QC procedures, and other information about the data (e.g., meaning, relationships to other data, origin, usage, format). The README file can reference different documents, if applicable.

7. **Data QA/QC and review:** All data should undergo proper QA/QC protocols and be reviewed, following the process outlined in Section 4.2.1.
8. **Data submission:** Data should be submitted to a publicly available repository within two years of data collection, unless otherwise specified in the ODP Plan. Annual reporting on data collection is required during the Council's annual performance reporting period.
9. **Data sharing**: All data should be made publicly available, in accordance with the federal OPEN Government Data Act, through a publicly available data repository acceptable within two years of when the data collection occurred, unless otherwise specified in the ODP Plan. If ODP data are protected from public disclosure under other regulatory authorities, policies, or security measures, these reasons should also be explained, and any such limitations will be identified in the ODP.

Standard data fields may include:

- Date
- Time
- Site
- Site name
- Station name/identification (ID)
- Latitude
- Longitude
- Sample ID
- Sample measurement
- Sample unit of measurement
- Field team leader
- Field team members.

Examples of commonly used digital formats:

- Excel spreadsheets (.xls)

- Access databases (.mdb)
- CSV files (.csv)
- Point, line, or polygon shapefiles (.shp)
- Rasters/imagery, such as TIFFs (.tif), ESRI grids, ASCII grids (.asc), ERDAS (.img), ENVI imagery, DEMs, and HDF
- Photographs, such as TIFFs (.tif), JPEGs (.jpg), or PNGs (.png)
- Geodatabases
- Web mapping services
- Google maps (kml, kmz).

5.0 Guidelines for ODP reporting and closeout

5.1 Annual reporting

Grant/IAA recipients provide annual performance reports on project/program performance in PIPER. Information on award metrics should be updated annually as part of the Annual Performance Report. Instructions on how to update metrics information in PIPER during performance reporting are available in the PIPER Performance Report Module User Guide.

As part of performance report submission, recipients should also update the project's ODP to include any plan details listed as "Not available (N/A)" or "To be determined (TBD)", or that are in other ways left unspecified in the current version of the ODP. Updated plan details should include specific start and end dates that accurately reflect the period of observational data collection. The recipient must deliver updated plans to the Council at least annually until all "N/A", "TBD", or otherwise unspecified items are provided and to correct any inaccuracies until all information is final.

When information in the ODP is revised for accuracy, changes to data collection details should be explained by appending information to the original response. Information should only be deleted or replaced if does not materially alter observational data collection and management plans. *Note: Not reaching the original success criteria targets does not necessarily reflect negatively on project/program performance.* Any adaptive management strategies or other factors that alter the anticipated metric/parameter completion values can be captured narratively via performance reporting.

Updated OPD forms should be uploaded in PIPER as part of the Annual Performance Report. Instructions on uploading ODP forms are available in the PIPER Performance Report Module User Guide.

5.2 Observational Data Closeout Report

An Observational Data Closeout Report is required as part of closing out all RESTORE Council awards. Some of the questions included in the Observational Data Closeout Report may be somewhat

duplicative of the questions asked in the PIPER Performance Report form. Council staff encourage recipients to use the Observational Data Closeout Report to provide more specific details regarding data collection activities and results than those requested in the Performance Report Form.

To complete your Observational Data Closeout Report, please fill out and submit the Google form linked here.

This form is accessible without a Google account. Please note that the only way to save your responses between sessions is to submit the form. When you have submitted your form, you will receive an email confirmation containing your submission. This email will also contain a link where you may edit your responses.

Following award closeout, the data management points of contact (POC) will notify RESTORE Council staff of any new publications or reports resulting from data collected under the award. POCs will also be responsible for keeping metadata records up-to-date, identifying new points of contact as needed, ensuring that data and metadata records remain accessible to the public, and carrying out any other provisions for long-term data management as described in the ODP.

5.2.1 Observational Data Closeout Report questions

Section 1

1. **Email address:** Please enter the email address of the observational data steward completing the Observational Data Closeout report.
2. **Project Name:** Please enter the full name of your award. Be sure to match this name with the title recorded in PIPER.
3. **Project observational data closeout report submission date**: Enter the date of completion for this data closeout report, at which time all project activities should be considered complete.
4. **I have verified to the best of my knowledge that the current values of metrics are up-to-date in PIPER and can be considered final as of the submission of this report.** Check box. See the Final Metrics Information instructions for additional information on final metrics reporting.
5. **I verify to the best of my knowledge that the latest Observational Data Plan (ODP) uploaded to PIPER contains no inaccuracies, missing details, or TBD items, and may be considered final as of the submission of this report.** At award closeout, the final version of the ODP should be uploaded along with the final Performance Report. See the Final Uploads instructions for additional information on uploading ODP documents.
6. **Have you completed observational data collection of all metrics and measures as of the submission of this report?** At award closeout, the observational data collection described for metrics and measures identified in the ODP using award funds should be completed. However, additional data collection may occur following closeout using funds outside of the award (see Question 7 below).

7. **If you anticipate ongoing observational data collection beyond closeout of this award, please describe these activities as well as plans for subsequent data management.** Please describe any observational data collection expected to take place following award closeout. For example, this could include a long-term monitoring plan to be implemented using leveraged funds.

8. **I verify to the best of my knowledge that the latest Data Management Plan (DMP) uploaded to PIPER contains no inaccuracies, missing details, or TBD items, and may be considered final as of the closeout date.** If you are using the ODP form template released in the ODP Draft Interim Guidance, you are required to submit a separate DMP form. At award closeout, the final version of the DMP should be uploaded along with the final Performance Report. Projects using the electronic ODP form released in 2021 will not have a DMP form and should select the second response option. See the Final Uploads instructions for additional information on uploading ODP documents.

9. **I have made restricted-use data available to the Council in a digital, machine-readable and non-proprietary format as of the closeout date.** All Council-funded activities are required to make their award data publicly available in a digital, machine-readable, and non-proprietary format, unless it is restricted-use. Any restricted-use data should be provided to the Council before award closeout. Select "Not applicable" if there is no restriction on the use of data related to this project.

10. **I have made all other data related to my project publicly available in a digital, machine-readable, and non-proprietary format as of the closeout date.** See explanation for Question 9.

11. **For each data type listed in your DMP, please describe how to access the data, providing links if possible. Data collected for each ODP measure should be included.** Projects using the electronic ODP form released in 2021 will not have a DMP form and should instead reference each of the data types from the electronic ODP. These data types should capture all data and derivative products generated under this award. Please provide a permalink for each data type, or if one is not available, provide as much detail as necessary to allow each data type to be readily retrieved based on your description.

12. **If you have not yet made portions of your data publicly available, please explain why and describe when and how it will be shared.** If any data or derivative products generated under this award are not publicly available, please list them (excluding restricted-use data that has been made available to the Council, per Question 9) and provide an explanation for each. Because all Council-funded activities are required to make their data publicly available in a digital, machine-readable, and non-proprietary format, we recommend that projects not able to do so prior to closeout reach out to coordinate with Council staff in advance of submitting this closeout report.

13. **I have made metadata for my project publicly available in ISO-19115 Format.** Council-funded activities are to provide award metadata in an ISO-19115 format (Section 4.3, Step 6).

14. **Please describe how to access your metadata, providing a link if possible.** To assist with meeting the Council's metadata standard requirements, the Council provides an ISO-19115 compliant metadata record creation tool called MERLIN. Details about creating and editing

metadata records in MERLIN are available at: https://restorethegulf.gov/merlin-landingpage. Please reach out to merlin@restorethegulf.gov for additional questions about accessing MERLIN or editing metadata records.

15. **Please list any papers, reports, or publications that make use of data related to this project and describe how they may be accessed.** Note: This question is duplicative of a question on the final performance report for awards. Please use this section of the Observational Data Closeout Report to provide reference details (e.g., citations) for these items as well as for any additional papers, reports, or publications that may not have been uploaded to PIPER.

Section 2

Project measures - I

For each of the measures listed in the award Observational Data Plan please provide the following information:

1. **Measure name**
2. **Were the success criteria met? (e.g. targets)**
3. **What was the completion value?** Units must match the units described in the ODP.
4. **Please briefly describe any related results or findings, if applicable.**
5. **Is there an additional project measure?** By selecting "Yes" to this question, the Observational Data Closeout Report form will indicate that additional project/program measures are to be reported. Selecting "No" indicates that there are no additional project/program measures to report on. When there are no more additional project/program measures to report on, please proceed to the Observational Data Closeout Summary section of the Observational Data Closeout Report form.

Observational Data Closeout Summary

1. **Based on your observational data, please provide a statement summarizing project achievements (including benefits supporting the project goals and objectives).** Provide a long-form, narrative response to this question.
2. **Please describe any lessons learned (including lessons learned from the results of your data or data collection activities) not already captured in your closeout reporting.** Provide a long-form, narrative response to this question, if applicable.
3. **Are there any other "next steps" that may be appropriate with regard to this or similar data collection efforts moving forward?** Provide a long-form, narrative response to this question, if applicable.

Observational Data Closeout Report Submission

When you have filled out all of the required questions (marked with red asterisks) in your Observational Data Closeout form, click the "Submit" button. This will save your responses and provide you with a copy via a confirmation email. To revise your responses, use the link provided in the confirmation email

to reopen the form, and remember to click “Submit” to save any changes. You may repeat this process as needed.

Once you are satisfied with the responses in your confirmation email, please upload a PDF copy to PIPER. To do so, save the email as a PDF by opening the print menu and selecting "save as PDF" from the printer options. If you are unable to save, please request a PDF copy from Council staff that you may upload to PIPER.

6.0 References

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Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards. 2 C.F.R., 200. Subtitle A, Chapter 2, 2014. https://www.govinfo.gov/app/details/CFR-2014-title2-vol1/CFR-2014-title2-vol1-part200.

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Appendix A. Observational Data Plan (ODP) Templates

The following ODP templates are available for download at the Council's Grants Users Guides and Templates webpage:

Observational Data Plan Form

Program Observational Data Plan Form

Appendix B. EXAMPLE Ecosystem Restoration Implementation Project ODP

Application summary: The Golden Island Restoration project is composed of both dune and marsh creation tasks. The dune creation phase of the project will extend for 2800m along the Gulf of Mexico shoreline raising the supratidal, intertidal, and subtidal environments to dune and supratidal elevations on Golden Island. The marsh creation phase will elevate subtidal and intertidal areas directly behind the dune to intertidal and supratidal elevations.

Planning Framework technique: Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands: Sediment placement

Project Information

Project name	Golden Island Restoration		
Agency overseeing the project	Department of Success		
Project phase	Implementation		
ODP point of contact (POC)	John Smith	(123)456-7777	john.smith@dos.gov
Data steward	Andrea Brown	(123)456-7777	A.Brown@dos.gov
Expected data collection start and end dates	3 months post award	10 years post award	
Short description of the project location	An island 30 km south southwest of Pascagoula, FL in the Gulf of Mexico		
Overall project goals and objectives	Restore, enhance, and protect habitats (primary) Restore and enhance natural processes and shorelines (secondary)		
Specific goals and objectives of data collection	To demonstrate that sustainable dune and marsh morphology was created using earthern containment dikes and dredged sediment, resulting in a diversity of restored terrestrial and aquatic habitat.		

Observational Data Budget

Estimated total budget for observational data collection and reporting	$165,000
Estimated total budget for data management	$15,000
Where are these funds included in the application's allocated budget?	$150,000 in Milestone 3 (post implementation monitoring) $30,000 in Milestone 4 (data management and reporting)

Data Consistency and Compatibility

List any consistent local or regional monitoring efforts, methods or standards, if applicable	This project was developed through the Florida Barrier Islands Restoration Program (FBIRP) and proposed observational data types and methods are consistent with FBIRP standards. Protocols are also consistent with those used by the DoS Florida Gulf Long-Term Barrier Island Monitoring Program (2011-2021).
Describe potentially complementary datasets, if known and applicable	NOAA National Data Buoy Center meteorological and oceanographic data from a nearby station.

Adaptive Management

Describe the extent to which adaptive management will be used	Observational data will inform corrective actions (see corrective actions).

Data Management

Describe how data will be:	
Stored	Data along with corresponding ISO-compliant metadata will be stored on the Department of Success's public website. Web content is hosted on dedicated agency's servers, which are serviced with live remote backup.
Archived	Data archiving is performed by agency web services. At the completion of the project, final project data and metadata will be submitted to the National Centers for Environmental Information (NCEI) for archiving.
Made available to the public and the Council	Downloadable data will be publicly available on the DOS website. In addition, the applicable GIS data layers will be service-enabled and made available for consumption through the Golden Island Restoration Online Mapping Application.
Will DOIs be used?	No

Metrics

Use the Approach and Technique menus to filter the list of metric options, or start typing the metric name to generate suggested auto-fill text. You do not need to enter an approach or technique to select a metric. If an appropriate metric is not shown, you may enter a custom metric for consideration (if possible, please coordinate this with Council staff in advance). Invalidation warnings indicate that the metric, technique, and approach do not match, but may be ignored.

	Approach	Technique	Metric
1	Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands	Sediment placement	HR013 - Wetland restoration - Acres restored
2	Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands	Sediment placement	HR014 - Habitat restoration - Land change rate
3	All	Click to select one	
4	All	Click to select one	
5	All	Click to select one	

Metric Instructions

HR013 - Wetland restoration - Acres restored	Enter the number of acres restored, including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.
HR014 - Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.

Metric 1	Target
HR013 - Wetland restoration - Acres restored	0.99
Metric specifics/notes	**Target notes**
N/A	Target will be updated prior to construction, following baseline data collection

Metric 1 | Parameter A | Parameter B | Parameter C | Parameter D | Parameter E

Parameter A	Target
Plant composition and cover	0.65
Parameter specifics/notes	**Target notes**
Emergent vegetation species-level identity, % cover, and native/invasive status recorded	65% total live native % cover 5 years post-construction

Purpose
To track the success of habitat restoration over time based on plant community establishment.

Methods	Method specifics/notes
Visual observation/Field counts: Visual assessment of total vegetation percent cover of target and undesirable species. Establish plots within the project area and record plot locations with a GPS and/or mark the plots with corner poles to allow for revisiting over time. Estimate percent cover of each species or species category of interest (e.g., native, invasive, herbaceous layer) as defined in the project ODP.	10 crossshore transects will be established at 300m intervals in the project area bisecting dune and marsh creation areas. Each transect will contain ten randomly located vegetation stations, for a total of 100 vegetation stations. Vegetation stations will consist of 2X2m plots and sampling protocol will be consistent with Folse et. al. 2014 using a modified version of Braun Blaunquet method (Ellenberg and Mueller Dombois 1974, Steyer et al. 1995).

Baseline data	Reference/control comparison
N/A - no plant community prior to marsh creation	Reference sites will be located along transects outside of the dune and marsh creation cells and will provide data on vegetation species composition and cover of areas outside of the influence of the restoration action.

Statistical analyses/mathematical models	Potential corrective action
Analysis of Variance (ANOVA), descriptive and summary statistics for vegetation will be used to determine spatial and temporal differences in species composition and cover within the major habitat types. Analysis will be based on percent cover of the species present. The ANOVA approach may include terms in the model to adjust for station locations and elevation. This ANOVA will allow for the analysis and long term documentation of vegetative coverage changes on the Golden Island from time 0 (i.e., as-built) through year 5 of the project.	Corrective actions include planting saltmarsh and dune species and/or remove undesirable species. In the event that live vegetation cover of saltmarsh and dune species is less than 65% at year 5 within the marsh and dune creation areas, the contingency response option would be to promote establishment of saltmarsh and dune species through vegetative planting.

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
As-built vegetation cover will be surveyed approximately 90 and 180 days (summer and early fall) following completion of construction within the marsh and dune cells. Post implementation vegetation cover will be surveyed late summer/early fall of years 2 and 5. (Exact dates TBD and updated in a revised ODP provided with the first annual report).	100 plots (1 per station)	Sampling will be conducted at randomly established stations representing the full extent of marsh and dune creation areas of Golden Island.	Field QA: Vegetation cover estimates should reflect the independent professional judgement of at least two field personnel. If estimates differ by greater than 5 percent both individuals should independently re-estimate cover values until a consensus is reached. Office QA: Review plot photograph for data accuracy and/or identification errors. After data transcription is complete, review datasheets versus transcribed data for omissions, duplications, completion, and consistency with field collection.

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Plant surveys	% cover/species with status category (native/invasive)	Varies (biannual sampling during years 1, 2, and 5)	4 years	Relational database and .csv files	points

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum
John Smith	(123)456-7777	john.smith@dos.gov	UTM zone 17N	NAD83 (NSRS2007)

Parameter B	Target
Area of habitat types	0.99
Parameter specifics/notes	**Target notes**
Emergent and submerged habitats including beach and dune, intertidal flats, wetlands, and upland/scrub shrub.	TBD post-construction. Maintain 77% of emergent habitat 10 years post construction relative to project completion acreage.

Purpose
Document changes in habitat diversity and acreage of terrestrial and aquatic habitats over time. Data will include area restored (i.e., project footprint).

Methods	Method specifics/notes
Remote sensing: Project and habitat boundaries can be mapped based on aerial imagery collected by airplane, helicopter, unmanned aerial systems (UAS); high-resolution satellite imagery; or other appropriate remote sensing platforms.	High resolution aerial photography will be used to map emergent habitats on Golden Island using the technical framework established by the USFWS National Wetlands Inventory (NWI) Classification of Wetlands and Deepwater Habitats (Cowardin et al. 1979). Aerial photography will occur once per year beginning with pre implementation (year 0), and will continue post implementation (years 1, 2, 5, and 10). Aerial photography will be analyzed and mapped as part of this observational data collection effort. Field investigations will be conducted to groundtruth various geomorphic and vegetation habitats in the field with corresponding signatures on aerial photography. Near vertical color infrared (CIR) digital aerial photography will be the primary data source for information on wetland and associated environments. Photo interpreters will use stereo heads up display to determine habitat classification, including the location and extents of wetlands, upland, and seagrass habitats from the imagery. Habitat categories will consist of a combination of NWI and Anderson Land Use/Land Cover Classification Systems, as well as special modifiers to characterize critical habitat for the identified species of interest. Historically, 15 NWI habitat classes comprise the majority of the barrier island land area in Florida. With respect to aquatic habitat, intertidal, tidal flats, beaches and bars will be mapped. Those habitats will be classified then further collapsed into a subset of classes for use by the program. All habitat photo interpretation will follow protocols and standards described in Cowardin et al. (1979). Uplands are derived from a land use and land cover classification system for use with remote sensor data (Anderson et al., 1976). The digital mosaic of the high resolution color infrared aerial photography project area is brought into ESRI ArcMap Software (Redlands, CA.) where photo interpretation begins. Habitat types are delineated by overlaying project area boundaries onto the imagery and editing features. Ancillary data sets from 1998 through 2012, with similar resolutions, are utilized to help classify areas that may be difficult to identify. Imagery of the project area is also viewed on screen in stereo which helps determine vegetation height and proper habitat classification.

Baseline data	Reference/control comparison
A habitat classification was conducted in 2012 for Golden Island through the FBIRP (See Golden Island Habitat Analysis Map 2012). The historic classification includes the entire project and reference area boundary for this project. The project area consisted of supratidal, intertidal and subtidal habitats. This imagery will be used to help determine historic acreages and habitat diversity.	The entire Golden Island will not be influenced by the restoration project, therefore areas outside of the project boundary will be used as reference conditions for habitat composition.

Statistical analyses/mathematical models	Potential corrective action
TBD. Comparisons will be made on data from aerial photography and habitat composition maps to assess habitat composition and acreage changes over time.	Perform operational corrections to achieve the required target elevation range including adding sediment and/or regrading.

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
Data collection will begin with pre implementation (year 0) and will continue post implementation (years 1, 2, 5, and 10). Habitat classification data will be made available within 12 months of acquisition of digital aerial photography and satellite imagery.	Five (i.e., once each for planning year 0 and post implementation years 1, 2, 5, and 10)	Randomly selected locations will be established representing the full extent of marsh and dune creation areas of Golden Island.	A field verification process will be conducted using photo signature verification of cover types and checking problematic areas by field personnel at the request of the photo interpreters during the quality control phase of the mapping. After completion of habitat classifications, the photo interpreter will perform a Quality Assurance selfcheck. In addition, a second photo interpreter will perform a final in house Quality Control, assuring accuracy and data integrity.

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
High-res digital aerial photography	N/A	Varies (1-5 years)	10 years	DOQ, mosaic dataset	NA (raster)
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	
John Smith	(123)456-7777	john.smith@dos.gov	UTM zone 17N	NAD83 (NSRS2007)	

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation
Habitat classification maps	N/A	Varies (1-5 years)	10 years	geoTIFF	NA (raster)
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	
John Smith	(123)456-7777	john.smith@dos.gov	UTM zone 17N	NAD83 (NSRS2007)	

Metric 2	Target
HR014 - Habitat restoration - Land change rate	0.99
Metric specifics/notes	**Target notes**
Annual land change rate will be calclated	TBD post-construction, such that target maintains 77% as-built area after 10 years

Metric 2 | Parameter A | Parameter B | Parameter C | Parameter D | Parameter E

Parameter A, Metric 2	Target
Land change rate	0.99
Parameter specifics/notes	**Target notes**
Acres/year	TBD post-construction, such that land loss rates approximate reference sites 10 years post construction.

Purpose
To measure the persistence of created habitat area over time.

Methods	Method specifics/notes
Permanent reference markers: Establish permanent base stakes along the length of the shoreline at least 10 m inward of the marsh edge and determine the GPS coordinates of each base stake. Measure the linear distance from the base stake to the marsh edge along an established compass direction. The marsh edge is defined as the lower/seaward extent of the emergent marsh vegetation. Import and analyze the data using spatial analysis software. Determine the shoreline loss/gain in meters per year. See Steyer and Llewellyn (2000) for more information on this method.	Specifics are TBD. Details including any deviation from established methods will be updated when known.

Baseline data	Reference/control comparison
N/A - no land area prior to marsh creation	The entire Golden Island will not be influenced by the restoration project, therefore areas outside of the project boundary will be used as reference conditions for rates of land loss.

Statistical analyses/mathematical models	Potential corrective action
Rates of land loss will be compared between the restored site and reference site. Details on tests of significance TBD.	Perform operational corrections to achieve the required target elevation range including adding sediment and/or regrading.

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
Data collection will begin with pre implementation (year 0) and will continue post implementation (years 1, 2, 5, and 10). Shoreline position will be measured along transects biannually.	20 transects	Transects will be regularly spaced to represent the full extent of restored and reference shoreline of Golden Island.	Data will be compared for consistency with habitat mapping based on aerial photos. Additional QA/QC details TBD.

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Land change rates	acres/year	Varies (biannual sampling during years 1, 2, and 5)	10 years	TBD	TBD

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum
John Smith	(123)456-7777	john.smith@dos.gov	UTM zone 17N	NAD83 (NSRS2007)

Summary

		Target
Metric 1	HR013 - Wetland restoration - Acres restored	0.99
Parameter A	Plant composition and cover	0.65
Parameter B	Area of habitat types	0.99
Metric 2	HR014 - Habitat restoration - Land change rate	0.99
Parameter A	Land change rate	0.99

Appendix C. EXAMPLE Training/Jobs Corps Implementation Program ODP

Application summary: The GYVCC Program will establish a regional workforce training program to benefit local veteran and youth communities and support Gulf Coast restoration implementation. Trainees will help to execute priority restoration projects selected for implementation by the agency.

Planning Framework techniques: Promote natural resource stewardship and environmental education; Restore and revitalize the Gulf economy; Habitat management and stewardship

Project Information

Project name	Gulf of Mexico Youth and Veteran Conservation Corps (GYVCC)		
Agency overseeing the project	National Agency		
Project phase	Implementation		
Data collection point of contact (POC)	Ellie North	555-534-6576	e.north@na.gov
Data steward	Ravi Drake	555-823-7447	r.drale@na.gov
Expected data collection start and end dates	3/X/2025	12/X/2027	
Short description of the project location	Project activities will take place in National Parks across the 5 Gulf States. Training for corps recruits will take place in coordination with the Department of Veteran Affairs (VA), local existing conservation groups, state labor offices, and community colleges in coastal areas of the Gulf.		
Overall project goals and objectives	Restore and revitalize the Gulf economy (primary goal) Promote natural resource stewardship and environmental education (primary objective) Restore, enhance, and protect habitats (secondary objective)		
Specific goals and objectives of data collection	To demonstrate the success of the program at providing veterans and other citizens with restoration implementation training, tracking the size of the specialized regional workforce and its success improving habitat.		

Observational Data Budget

Estimated total budget for observational data collection and reporting	$160,000
Estimated total budget for data management	$15,000
Where are these funds included in the application's allocated budget?	$160,000 - the project budget for subrecipients and contractors $15,000 - salaries and fringe benefits in project budget summary

Data Consistency and Compatibility

List any consistent local or regional monitoring efforts, methods or standards, if applicable	Restoration monitoring protocols will be consistent with agency standards, and existing regional datasets. Details and consistency with existing training program datasets are TBD and will be updated in a future ODP.
Describe potentially complementary datasets, if known and applicable	N/A

Adaptive Management

Describe the extent to which adaptive management will be used	Subsequent iterations of this program may seek funding to continue this work. Data on program success may be used to improve implementation of future outreaching, training, and restoration activities.

Data Management

Describe how data will be:	
Stored	The project data along with corresponding ISO-compliant metadata will be stored on an agency server and backed up regularly to an offsite location
Archived	ellie.north@na.gov
Made available to the public and the Council	Data will be made available to the Council and the public via the agency's restoration website: www.examplerepository.gov
Will DOIs be used?	Yes

Metrics

Use the Approach and Technique menus to filter the list of metric options, or start typing the metric name to generate suggested auto-fill text. You do not need to enter an approach or technique to select a metric. If an appropriate metric is not shown, you may enter a custom metric for consideration (if possible, please coordinate this with Council staff in advance). Invalidation warnings indicate that the metric, technique, and approach do not match, but may be ignored.

	Approach	Technique	Metric
1	Restore and revitalize the Gulf economy	Restore and revitalize the Gulf economy	COI103 - Economic benefits - # temporary jobs created
2	Protect and conserve coastal, estuarine, and riparian habitats	Habitat management and stewardship	HR004 - Habitat restoration - Acres restored
3	All	Click to select one	
4	All	Click to select one	
5	All	Click to select one	

Metric Instructions

COI103 - Economic benefits - # temporary jobs created	Enter the number of temporary jobs created that are directly attributable to the project or program implementation. These may be full-time or part-time jobs.
HR004 - Habitat restoration - Acres restored	Enter the number of acres restored. Habitat included in this metric has been restored to original (or target) habitat and ecosystem function. This metric should be used for non-wetland habitats that span outside (or occur beyond) riparian zones, such as upland forests.

Metric 1	**Target**
COI103 - Economic benefits - # temporary jobs created	500
Metric specifics/notes	**Target notes**
Number of 1-year full time restoration positions filled	

Metric 1	Parameter A	Parameter B	Parameter C	Parameter D	Parameter E

Parameter A	Target
Number of positions filled	500
Parameter specifics/notes	**Target notes**
Number of 1-year full time restoration positions filled	Tracked in units of 1-year positions filled, but 2-year terms are offered to trainees.
Purpose	
To track the benefit of the program to the restoration workforce.	

Methods	Method specifics/notes
Maintain roster	Maintain a record of positions filled over the course of the program.
Baseline data	**Reference/control comparison**
0	N/A
Statistical analyses/mathematical models	**Potential corrective action**
Data will be compiled in the GVYCC database, and mathematical and budgetary analyses will be completed in Excel.	Implement outreach with local or regional groups, beyond those groups historically involved in conservation, to engage groups experienced in education and training.

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
Ongoing following initial outreach	N/A	N/A	Review and verify list of restoration activities, positions offered, and positions filled by trainees for the duration of the activity.

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Employment records	TBD	Quarterly	33 months	.xls	0.99
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	
Ellie North	555-534-6576	ellie.north@na.gov	0.99	0.99	

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Data Type 3	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Metric 1	Parameter A	Parameter B	Parameter C	Parameter D	Parameter E

Parameter B	Target
Number of trainees	300
Parameter specifics/notes	**Target notes**
Trainees will be categorized as veterans or youths as applicable	200 youths, 100 veterans
Purpose	
To evaluate corps contribution to the youth and veteran communities	

Methods	Method specifics/notes
Maintain roster	Compile list of youth and veteran participants who enroll in the program and successfully complete the initial training. PII information will be removed following agency protocols. Total trainees will exceed 2-year positions created (250) due to turnover. Although training is desired, efforts will be made to minimize turnover.
Baseline data	**Reference/control comparison**
0	N/A
Statistical analyses/mathematical models	**Potential corrective action**
Data will be compiled in the GVYCC database, and mathematical and budgetary analyses will be completed in Excel.	Implement flexible working hours and projects to accommodate participation.

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
Ongoing following initial outreach	N/A	N/A	Review and verify list of participants for accuracy and completion

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Trainees	TBD	N/A	33 months	.xls	0.99
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	
Ellie North	555-534-6576	ellie.north@na.gov	0.99	0.99	

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Data Type 3	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Metric 2	Target
HR004 - Habitat restoration - Acres restored	50
Metric specifics/notes	**Target notes**

Metric 2	Parameter A	Parameter B	Parameter C	Parameter D	Parameter E

Parameter A, Metric 2	Target
Activity completion	0.99
Parameter specifics/notes	**Target notes**
Acres of management types	50 acres planted; acres per other activities TBD
Purpose	
To track restoration efforts completed.	

Methods	Method specifics/notes
Ground surveys/In situ data collection: Ground surveys can be used to map an area for smaller projects.	The restoration activity performed in an area will be recorded. GPS surveying will be used to map the area over which each activity is performed. Details TBD and updated in a revised ODP within 3 months of project identification.
Baseline data	**Reference/control comparison**
0 acres restored (per activity)	N/A
Statistical analyses/mathematical models	**Potential corrective action**
TBD	Review of training methods, restoration protocols, and on the ground conditions affecting implementation of management activities.

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
TBD and updated in a revised ODP within 3 months of project identification	TBD and updated in a revised ODP within 3 months of project identification	TBD and updated in a revised ODP within 3 months of project identification	TBD and updated in a revised ODP within 3 months of project identification

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Acres restored	acres/restoration activity	Once	N/A	geodatabase	polygons
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	
Ellie North	555-534-6576	ellie.north@na.gov	TBD	TBD	

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Data Type 3	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Parameter B, Metric 2	Target
Plant Composition and Cover	0.99
Parameter specifics/notes	**Target notes**
N/A	TBD and updated in a revised ODP within 3 months of project identification
Purpose	
To evaluate GVYCC benefit to habitat restoration	
Methods	**Method specifics/notes**
Visual observation/field counts: Establish plots within the project area and record plot locations with a GPS and/or mark the plots with corner poles to allow for revisiting over time. Determine species composition. Typical plot sizes for herbaceous vegetation are 1 to 4 m2 plots and for trees, 50 to 100 m2 plots or greater, but will be project-dependent.	Details TBD and updated in a revised ODP within 3 months of project identification.

Baseline data	Reference/control comparison
Not collected	TBD
Statistical analyses/mathematical models	**Potential corrective action**
TBD and updated in a revised ODP within 3 months of project identification	Review of training methods, restoration protocols, and on the ground conditions affecting implementation of management activities.

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
TBD and updated in a revised ODP within 3 months of project identification	TBD and updated in a revised ODP within 3 months of project identification	TBD and updated in a revised ODP within 3 months of project identification	Review of training methods, restoration protocols, and on the ground conditions affecting implementation of management activities.

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Plant surveys	% cover/species with status category (native/invasive)	TBD	TBD	Relational database and .csv files	points

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum
Ellie North	555-534-6576	ellie.north@na.gov	UTM zone 17N	NAD83 (NSRS2007)

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum

Data Type 3	Units	Frequency	Duration	Storage format	GIS Representation

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum

Summary

		Target
Metric 1	COI103 - Economic benefits - # temporary jobs created	500
Parameter A	Number of positions filled	500
Parameter B	Number of trainees	300
Metric 2	HR004 - Habitat restoration - Acres restored	50
Parameter A	Activity completion (acres of management types)	0.99
Parameter B	Plant composition and cover	0.99

Appendix D. EXAMPLE Infrastructure Planning Project ODP

Application summary: The state agency will complete engineering and design for a public fishing pier, which will be informed by environmental surveys conducted under the award.

Planning Framework techniques: Restore and revitalize the Gulf economy; Improve science-based decision-making processes: Develop tools for planning and evaluation

Project Information

Project name	Dauphin Island Public Pier		
Agency overseeing the project	AL		
Project phase	Planning		
Data collection point of contact (POC)	Todd East	555-534-6576	Toddeast@adcnr.alabama.gov
Data steward	Jamie West	555-478-9999	jamie.west@adcnr.alabama.gov
Expected data collection start and end dates	3/16/2024		3/16/2026
Short description of the project location	This is a planning project for a fishing pier in Dauphin Island, AL. Dauphin Island is in Mobile County. No construction will occur during the course of this funding cycle.		
Overall project goals and objectives	Restore and revitalize the Gulf economy (primary goal) Improve science-based decision-making processes (primary objective)		
Specific goals and objectives of data collection	To conduct investigations of shoreline morphology and sediment composition needed to successfully carry out E&D.		

Observational Data Budget

Estimated total budget for observational data collection and reporting	$240,000
Estimated total budget for data management	$70,000
Where are these funds included in the application's allocated budget?	$240,000 in the costs indicated for Milestones 1-4 $70,000 represented in the costs indicated for Milestone 5

Data Consistency and Compatibility

List any consistent local or regional monitoring efforts, methods or standards, if applicable	Data will be compatible with profile data available from the Bureau of Beach and Coastal Systems at http://www.dep.state.al.us/beaches/data/data.htm
Describe potentially complementary datasets, if known and applicable	TBD during planning

Adaptive Management

Describe the extent to which adaptive management will be used	Observational data, including research studies, reported as part of this project will be used to inform adaptive management actions, including corrective actions listed below, and to inform planning for future restoration efforts, as applicable.

Data Management

Describe how data will be:	
Stored	Data will be stored on an agency cloud-based server environment. This system includes separate cloud backup and storage on two separate network attached storage arrays at different locations.
Archived	At the completion of the project, final project data and metadata will be submitted to the National Centers for Environmental Information (NCEI) for archiving.
Made available to the public and the Council	Data will be made available to the public via AL's data portal as well as the NCEI data archive.
Will DOIs be used?	yes

Metrics

Use the Approach and Technique menus to filter the list of metric options, or start typing the metric name to generate suggested auto-fill text. You do not need to enter an approach or technique to select a metric. If an appropriate metric is not shown, you may enter a custom metric for consideration (if possible, please coordinate this with Council staff in advance). Invalidation warnings indicate that the metric, technique, and approach do not match, but may be ignored.

	Approach	Technique	Metric
1	Improve science-based decision-making processes	Develop tools for planning and evaluation	PRM009 - Research - # studies reported to mgmt.
2	Any (Planning)		PRM011 - Restoration planning/design/permitting - # E&D plans developed
3	All	Click to select one	
4	All	Click to select one	
5	All	Click to select one	

Metric Instructions

PRM009 - Research - # studies reported to mgmt.	Enter the number of studies completed whose findings are reported to management. Value should include published data (either via your institution or by others using your data), metadata sets made available and published/unpublished datasets.
PRM011 - Restoration planning/design/permitting - # E&D plans developed	Enter the number of E&D packages developed. The number of plans should equal the number of completed packages, not the number of documents.

Metric 1	**Target**
PRM009 - Research - # studies reported to mgmt.	2
Metric specifics/notes	**Target notes**
Studies to be conducted: (1) beach and nearshore profile assessments, (2) Construction site sediment analysis	

Metric 1 | Parameter A | Parameter B | Parameter C | Parameter D | Parameter E

Parameter A	**Target**
Elevation	0.99
Parameter specifics/notes	**Target notes**
Beach and nearshore profile data. Activity completion parameter not included because all tracking activities are captured.	N/A
Purpose	
To develop an erosion and scour report supporting E&D.	

Methods	Method specifics/notes
Topographic profiles: Topographic profiles can be done to measure land elevation by using RTK GPS surveys. Elevation is measured at evenly spaced distances along transects or on a grid, and interpolated using spatial analysis software to create a Digital Elevation Model (DEM).	A high-resolution digital elevation models (DEM) with a 1-m grid size will be created from topographic data collected using a three-dimensional terrestrial laser scanner along the 150-m-long focus site at seasonal time intervales and following at least one significant storms event.
Baseline data	**Reference/control comparison**
Profile data is available from the Bureau of Beach and Coastal Systems at http://www.dep.state.al.us/beaches/data/data.htm	N/A
Statistical analyses/mathematical models	**Potential corrective action**
Beach profile data will be transferred into Regional Morphology Analysis Package (RMAP). RMAP is part of the Coastal Engineering Design & Analysis System developed by the U.S. Army Corps of Engineers. RMAP will be used to analyze beach profile characteristics, interpolate data points at equal intervals, and calculate volumes above different contours.	N/A

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
Monitoring will be conducted every 3 months for one year, and following 1 significant storm event.	0.5 m grid spanning 200m of shoreline	Proposed pier construction site	TBD and updated in a revised ODP within 3 months of contracting subrecipient to ensure all data elements are accounted for in QA/QC

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Beach and Nearshore Profile	NA	Every 3 months	1 year	DEM files	Raster
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	
Jamie West	555-478-9999	jamie.west@adcnr.alabama.gov	UTM zone 17N	NAD83 (NSRS2007)	

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Data Type 3	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Metric 1	Parameter A	Parameter B	Parameter C	Parameter D	Parameter E

Parameter B	Target
Sediment classification/composition	0.99
Parameter specifics/notes	**Target notes**
	N/A

Purpose
Construction site sediment analysis will be documented to inform construction plans (pier design and building methods).

Methods	Method specifics/notes
Laser analysis: Method of determining the soil particle size distribution via laser diffraction.	Vibracores will be collected in the field and cut lengthwise in the lab to record descriptions of sediment grain-size content, color, and characteristics such as bedding types, bioturbation, shells and shell fragments, and any other qualitative descriptions. Grain-size data will be obtained by using the Beckman Coulter LS 32 Laser counter variable-speed fluid module plus. Laser diffraction is correlated to the standard mesh size of each of the sediment sample grains, the distribution, and the volume of each grain mesh size.

Baseline data	Reference/control comparison
N/A	N/A

Statistical analyses/mathematical models	Potential corrective action
Data can be extracted from the analyzer in phi, mesh size, and in statistical formats of mean, standard deviation, kurtosis, cumulative size fractions, and percent. Any appropriate statistical analyses will be conducted in developing Draft construction plans. Statistical analyses to be used will either be included here or designated "N/A" in a revised ODP within 3 months of contracting subrecipient.	N/A

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
Completed 4 months after receiving funding.	100 sediment cores to be analyzed	Proposed pier construction site	Field replicates (two separate samples collected at the same time and position) will be analyzed to assess error variability.

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
Sediment Classification Assessment	sample depth (m), mean grain size (phi units, 1952), standard deviation, and percent sand, silt, and clay in each subsample	Once	N/A	.xlsx	points

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum
Jamie West	555-478-9999	jamie.west@adcnr.alabama.gov	UTM zone 17N	NAD83 (NSRS2007)

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum

Data Type 3	Units	Frequency	Duration	Storage format	GIS Representation

POC Name	POC Phone	POC Email	Projection	Horizontal and Vertical Datum

Metric 2	Target
PRM011 - Restoration planning/design/permitting - # E&D plans developed	1
Metric specifics/notes	**Target notes**

Metric 2	Parameter A	Parameter B	Parameter C	Parameter D	Parameter E

Parameter A, Metric 2	Target
Number of Engineering and Design plans developed	1
Parameter specifics/notes	**Target notes**
	N/A

Purpose
To support development of Order of Magnitude Construction Estimate Projection

Methods	Method specifics/notes
Incorporate data from field surveys and analysis reports to develop design and building plans using best management practices	E&D plans will be informed by the assessments collected and described in Metric 1

Baseline data	Reference/control comparison
Draft construction plans to be developed during planning stage	N/A
Statistical analyses/mathematical models	**Potential corrective action**
Any appropriate statistical analyses will be conducted in developing Draft construction plans. Statistical analyses to be used will either be included here or designated "N/A" in a revised ODP.	N/A

Schedule/Timing	Sample size	Sample sites	Quality assurance/control (QA/QC)
Plans will be completed 6 months following completion of data collection and analysis.	N/A	N/A	Certified plans will be reviewed by agency supervisors.

Data Type 1	Units	Frequency	Duration	Storage format	GIS Representation
E&D Package	N/A	Once	N/A	PDF	N/A - Project footprint
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	
Todd East	555-534-6576	todd.east@adcnr.alabama.gov	N/A	N/A	

Data Type 2	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Data Type 3	Units	Frequency	Duration	Storage format	GIS Representation
POC Name	**POC Phone**	**POC Email**	**Projection**	**Horizontal and Vertical Datum**	

Summary

		Target
Metric 1	PRM009 - Research - # studies reported to mgmt.	2
Parameter A	Elevation	0.99
Parameter B	Sediment classification/composition	0.99
Metric 2	PRM011 - Restoration planning/design/permitting - # E&D plans developed	1
Parameter A	Number of Engineering and Design plans developed	1

Appendix E. Development of measurable project goals and objectives

Guidance on the formulation of project-level objective statements will be provided during a future update to the Observational Data Plan Guidelines.

Appendix F. Recommendations for project-level metrics and parameters

F.1.0 Appendix overview

This appendix is intended to provide guidance to the grant/IAA applicants as they develop ODPs for restoration projects. Specifically, it provides:

- A brief summary of the Restoration Approaches identified by the Council's 2019 Planning Framework and the particular restoration techniques that each approach may employ in support of the Comprehensive Plan goals and objectives (F.1.1).
- A review of metric and parameter requirements (F.1.2).
- Recommendations on metrics and parameters appropriate for supporting project objectives based on the technique being employed (F.2.0 - F.6.0).
- Recommendations on metrics and parameters appropriate for planning phase activities and activities that support other objectives (F.7.0).
- Guidance on appropriate methodologies for carrying out monitoring of recommended parameters (F.8.0 -F.9.0).
- A reference table of detailed instructions for using each metric (F.10.0)

Where appropriate, metrics, parameters, and methodologies should follow the recommendations laid out in this appendix to promote consistency and comparability among datasets (see 1.0 ODP Background and 2.0 ODP Overview for more information on the purpose of the ODP). However, the guidance provided in this appendix should not be considered exhaustive or final. The recommendations provided may be revised as new monitoring needs, parameters, methods, and technologies are identified and/or developed. Applicants may choose to use metrics, parameters, or methodologies that are not included in the recommendations, but which are consistent with the overall monitoring guidelines provided.

F.1.1 Priority approaches and techniques

The Council's restoration goals and objectives can be met through actions called "priority approaches". Priority approaches are themselves achieved by various kinds of restoration activities termed "techniques" that can provide particular ecological benefits. Within the 2019 Planning Framework, the Council identified priority approaches and techniques that support the Comprehensive Plan goals and objectives. The Planning Framework identified techniques based on relevance to particular Comprehensive Plan goals and objectives, potential for cascading benefits, scientifically-supported reliability and impact, broad geographic applicability, and unique ability to meet specific regional challenges and achieve desired outcomes.

Details on each of the selected priority approaches, including corresponding techniques, can be found in Section 2.2 of the Planning Framework. The five priority approaches under this Planning Framework are:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
- Protect and conserve coastal, estuarine, and riparian habitats
- Restore hydrology and natural processes
- Reduce excess nutrients and other pollutants to watersheds
- Restore oyster habitat

The following two Comprehensive Plan objectives are-cross cutting. They can support the other Comprehensive Plan objectives and can be supported by all of the priority approaches and techniques:

- Promote natural resource stewardship and environmental education
- Improve science-based decision-making processes

The development of the Planning Framework has provided a new tool to help communicate how RESTORE Council-funded projects/programs support the goals and objectives set forth in the Comprehensive Plan. At the time of proposal submission, a project or program identifies its primary goal and objective, as well as any secondary goals and objectives, and the restoration technique(s) that it will employ. The Planning Framework provides guidance on which techniques are most suited to supporting different Comprehensive Plan goals and objectives (Figure F.1.1). For programs, all projects within that program share the same primary goal and objective, but may use different techniques (from one or more approaches) to support that goal and that objective.

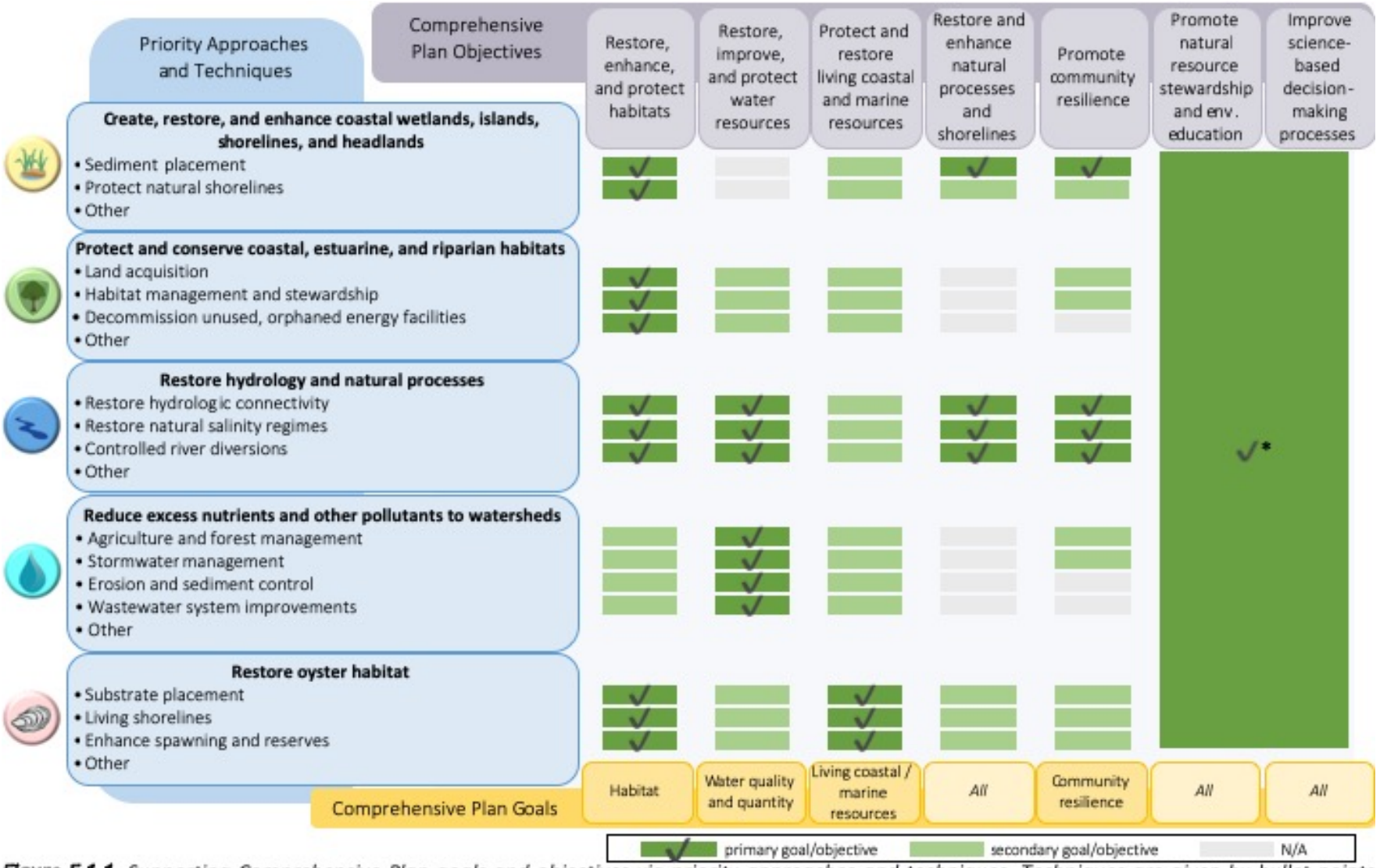


Figure F.1.1. *Supporting Comprehensive Plan goals and objectives via priority approaches and techniques. Techniques are given by bullet points beneath priority approaches. Adapted from the Council's 2019 Planning Framework.*

F.1.2 Metric and parameter recommendations

Metrics are monitored for the assessment of progress toward both short-term and long-term desired outcomes (i.e., planning, compliance, E&D, construction, operations, maintenance, and monitoring). Parameters are the data collected to support metrics. Statistical analyses of the supporting parameters enable reporting on a metric.

Based on the Council's Proposal Submission Guidelines, metrics and quantitative success criteria targets must be identified for each Comprehensive Plan goal and/or objective associated with a project or program. This includes the primary goal and objective, which all projects identify, as well as any secondary goals and objectives. Each metric should be supported by one or more measurable parameters for which success criteria targets are also identified.

Initial guidance developed around the Planning Framework on metric selection organizes metrics by the approaches and techniques with which they are most likely to be employed (Section F.10.0). This guidance also provides detailed instructions on the use of each RESTORE Council metric.

The additional guidance developed in this appendix provides metrics and parameters appropriate for supporting different primary and secondary objectives based on the restoration technique employed. The recommendations make use of the following 'parameter type' designations:

- **Core parameters**: parameters that are appropriate for a technique regardless of the project objectives. Core parameters may serve to support some objectives better than others but are typically highly relevant to tracking the success of the activity.
- **Objective-specific parameters:** parameters that may be used to evaluate progress toward a particular objective. Objective-specific parameters are widely used for monitoring the likely habitat(s), are likely to capture impacts of the restoration technique, and/or are particularly suited to tracking progress of the activity.
- **Additional parameters**: parameters that may characterize project impacts in greater detail or may be important to understanding the ecosystem processes affecting the success or failure of a project. The additional parameters may be needed to support contingency planning or adaptive management around particular objectives that have greater uncertainties.

F.1.2.1 Activity completion parameters

Because parameters are used to enable reporting on metrics, the ODP provides information on observational data collection activities at the parameter level. Metrics that do not require calculation from multiple parameters can often be tracked using a parameter of the same name. For example, the metric 'acres restored' can be tracked by collecting data on the parameter 'acres restored'. However, such parameters may not be sufficient to characterize benefits to selected Comprehensive Plan goals and objectives. If a parameter tracks the completion of a planned activity rather than the resulting benefits, it is called an *activity completion parameter*. Activity completion parameters can be used to track metrics but other parameters are needed to support selected Comprehensive Plan goals and objectives. For example, 'acres restored' typically is considered an activity completion parameter because it is used to track the area over which restoration activities are implemented. Parameters such

as ‘plant composition and cover’ would be needed to demonstrate the positive impact of restoration on habitat. Activity completion parameters may characterize construction, repairs, enhancements, or management actions (e.g., buildings constructed, asphalt removed, trail repaired, acres planted).

For more information, see the activity completion entry in Appendix F.9.0. Metric-specific guidance on tracking metrics, including use of activity completion parameters, can be found in Appendix F.10.0.

F.2.0 Restoration approach: Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands

F.2.1 Restoration techniques

Restoration techniques are specific restoration actions the Council identified for each of the 2019 Planning Framework Restoration Approaches. Restoration techniques may be used individually or in combination. The following are restoration techniques included in the Planning Framework for the restoration approach, *Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands*. This list should not be considered exhaustive; additional restoration techniques may be developed and/or identified.

1. Sediment placement
2. Protect natural shorelines

F.2.2 Restoration technique metrics and parameters

F.2.2.1 Restoration technique: Sediment placement

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	S	P	P	
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Land change rate, HR014						
Land change rate		✔			✔	✔
Wetland and shoreline acres restored, HR013						
Activity completion*		✔		✔	✔	
Area of habitat types		✔			✔	
Elevation		✔			✔	
Plant composition and cover		✔			✔	
Chlorophyll		+			+	
Conductance/salinity		+			+	
Plant density		+			+	
Plant survivorship/mortality		+			+	
Sediment classification/composition		+			+	
Subsidence/accretion		+			+	
Water level		+			+	
Species abundance				✓		
Species composition				✓		
Species density				✓		
Number of facilities benefitting, RES003						
Number of facilities benefitting						✓

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

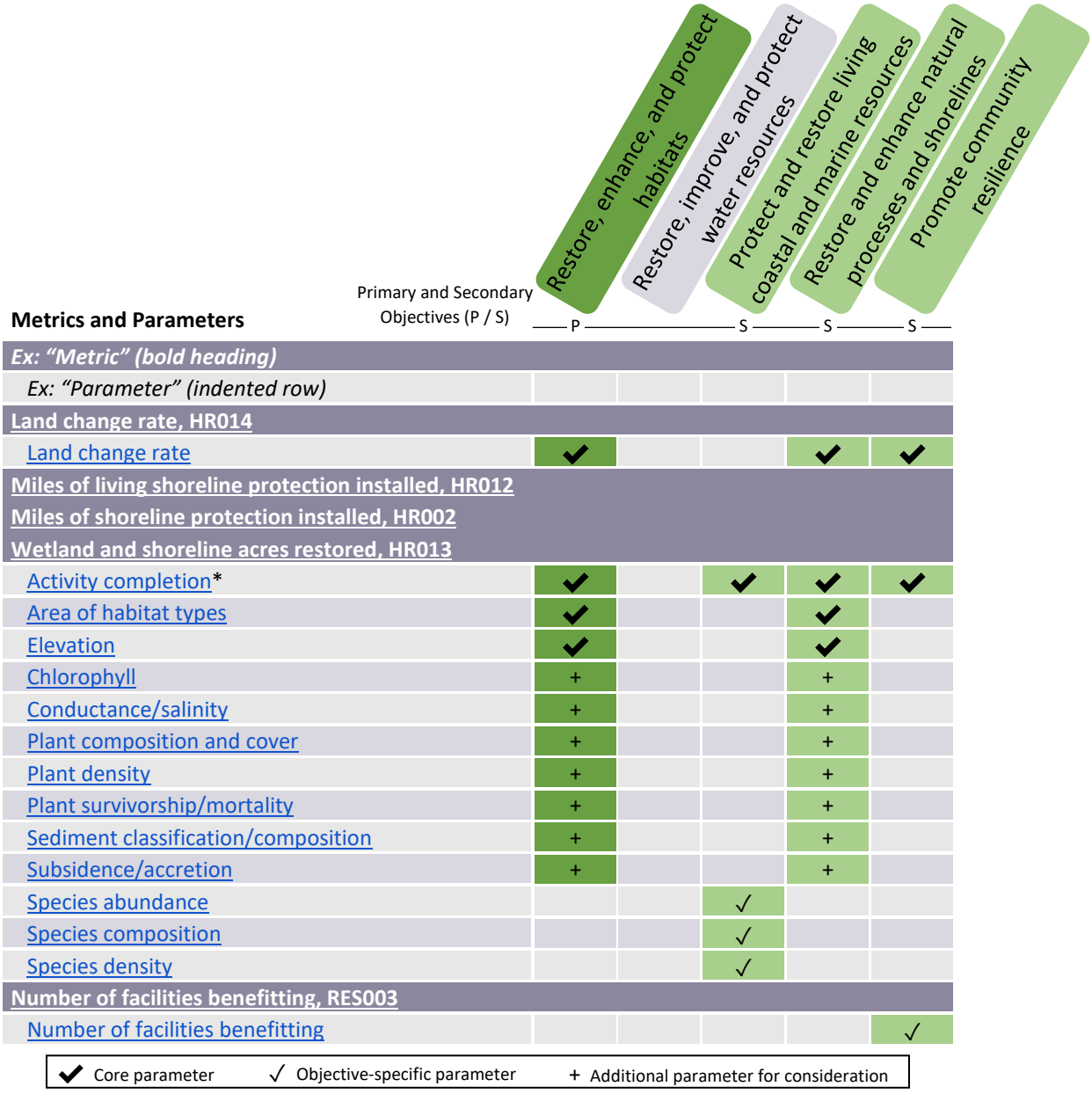
Figure 2.2.1 Recommended metric and monitoring parameters are shown for projects/programs employing the *Sediment placement* technique to *Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 2.2.1). The core parameters—activity completion (e.g., acres over which restoration activities

were implemented), area of habitat types, elevation, plant composition and cover, and land change rate—are likely to be relevant for tracking the impacts of projects employing the *Sediment placement* technique regardless of the selected objectives. For sites with high rates of relative sea level rise, the additional parameter subsidence/accretion can provide valuable information on processes affecting the trajectory of habitat benefits. Many of the additional parameters may act on other parameters as external drivers, such as changing conductance/salinity influencing plant composition and cover, and should therefore be considered for monitoring in order to understand and appropriately manage project impacts. Species-specific parameters are recommended for projects that identify *Protect and restore living coastal and marine resources* as a secondary objective.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.2.2.2 Restoration technique: Protect natural shorelines



Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	S	S	S	
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Land change rate, HR014						
Land change rate		✔			✔	✔
Miles of living shoreline protection installed, HR012 **Miles of shoreline protection installed, HR002** **Wetland and shoreline acres restored, HR013**						
Activity completion*		✔		✔	✔	✔
Area of habitat types		✔			✔	
Elevation		✔			✔	
Chlorophyll		+			+	
Conductance/salinity		+			+	
Plant composition and cover		+			+	
Plant density		+			+	
Plant survivorship/mortality		+			+	
Sediment classification/composition		+			+	
Subsidence/accretion		+			+	
Species abundance				✓		
Species composition				✓		
Species density				✓		
Number of facilities benefitting, RES003						
Number of facilities benefitting						✓

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

Figure 2.2.2 Recommended metric and monitoring parameters are shown for projects/programs employing the Protect natural shorelines technique to Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 2.2.2). The appropriate metric(s) will vary depending on the methods used to enhance shoreline protection, ranging from 'green' to 'grey' technologies, as well as the objective(s) of the project. The

core parameters—land change rate, activity completion, area of habitat types, and elevation—are likely to be relevant for tracking the progress and impacts of projects employing the *Protect natural shorelines* technique regardless of the selected objectives. Additional parameters for monitoring shoreline habitat may be used to further characterize project impacts or understand external drivers affecting project success. Species-specific parameters are recommended for projects that identify *Protect and restore living coastal and marine resources* as a secondary objective.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.2.3 Additional guidance documents

Additional monitoring guidance for restoration activities implementing a *Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands* approach can be found in the following guidance documents:

1. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.4, "Create, Restore and Enhance Coastal Wetlands: Monitoring Guidance" (NRDA 2019).
2. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.5, "Create, Restore and Enhance Barrier and Coastal Islands and Headlands: Monitoring Guidance" (NRDA 2019).
3. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.6, "Restore and Enhance Dunes and Beaches: Monitoring Guidance" (NRDA 2019).
4. Inventory of Gulf Coast Habitat Monitoring, Mapping and Water Quality Programs and Assessments (NOAA and USGSb, 2019). This is tool, available at http://restorethegulf.gov/cmap, is a searchable inventory of habitat monitoring, mapping and water quality activities taking place in the Gulf of Mexico. The inventory is designed to improve discovery and accessibility of existing monitoring data and ensure collected information supports management decision-making.
5. Council Monitoring and Assessment Program (CMAP): Common Monitoring Program Attributes and Methodologies for the Gulf of Mexico Region (NOAA and USGSa, 2020).
6. Council Monitoring and Assessment Program (CMAP): A Framework for Using the Monitoring Program Inventory to Conduct Gap Assessments for the Gulf of Mexico Region (NOAA and USGSb, 2020).

F.3.0 Restoration approach: Protect and conserve coastal, estuarine, and riparian habitats

F.3.1 Restoration techniques

Restoration techniques are specific restoration actions the Council identified for each of the 2019 Planning Framework Restoration Approaches. Restoration techniques may be used individually or in combination. The following are restoration techniques included in the Planning Framework for the restoration approach, *Protect and conserve coastal, estuarine, and riparian habitats*. This list should not be considered exhaustive; additional restoration techniques may be developed and/or identified.

1. Land acquisition
2. Habitat management and stewardship
3. Decommission unused, orphaned energy facilities

F3.2 Restoration technique metrics and parameters

F.3.2.1 Restoration technique: Land acquisition

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	S	S		S
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres acquired in fee, HC003 **Acres under easement, HC001** **Miles of shoreline acquired, HC004** **Miles of shoreline under easement, HC002**						
Activity completion*		✔	✔	✔		
Area of habitat types		✔				
Plant composition and cover		✓				
Plant survivorship/mortality		✓				
Elevation		+				
Plant abundance		+				
Plant density		+				
Plant distribution		+				
Sediment classification/composition		+				
Subsidence/accretion		+				
Chlorophyll			✓			
Conductance/salinity			✓			
Currents			✓			
Dissolved oxygen			✓			
Light attenuation			✓			
pH			✓			
Substrate geochemistry			✓			
Turbidity			✓			
Water temperature			✓			

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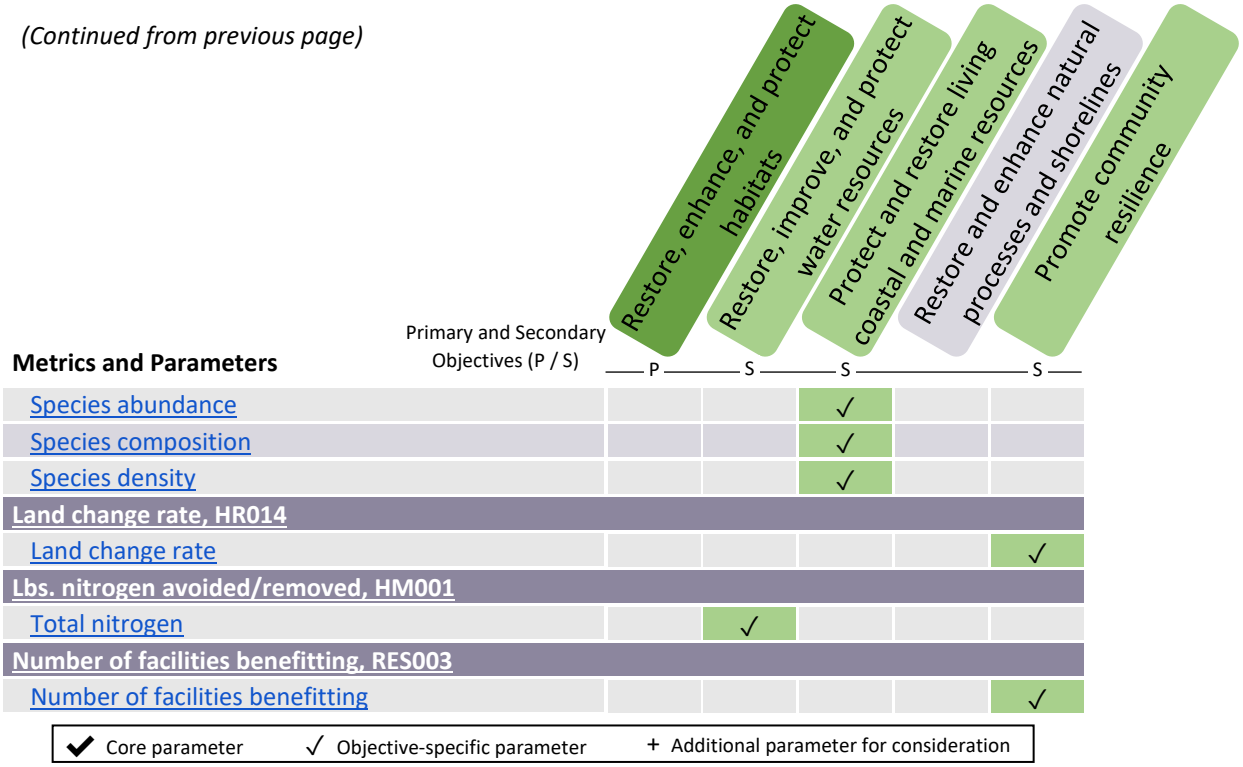

Figure 3.2.1 Recommended metric and monitoring parameters are shown for projects/programs employing the *Land acquisition* technique to *Protect and conserve coastal, estuarine, and riparian habitats*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. For more parameters able to support the objective *Restore, improve, and protect water resources*, see recommendations for the approaches *Restore hydrology and natural processes* and *Reduce excess nutrients and other pollutants to watersheds*.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 3.2.1). The appropriate metric(s) will vary depending on the methods used to conserve habitat. As described in the Planning Framework (and in the definitions of the above metrics), projects employing the *Land acquisition* technique should include habitat management activities.

The core parameters—activity completion (i.e., acres or miles brought under conservation) and area of habitat types—are likely to be relevant for tracking the progress and conservation benefits of projects employing the *Land acquisition* technique regardless of the selected objectives. Selection of appropriate objective-specific parameters will vary depending on management activities involved, but should typically include plant monitoring to support the primary objective. Additional parameters that may be useful for understanding project impacts are similarly provided for consideration based on project activities, objective(s), and other site-specific considerations. Potential species-specific parameters and parameters for tracking resilience benefits are recommended for projects that identify *Protect and restore living coastal and marine resources* or *Promote community resilience* as secondary objectives. For more parameters able to support the objective *Restore, improve, and protect water resources*, see

recommendations for the approaches *Restore hydrology and natural processes* and *Reduce excess nutrients and other pollutants to watersheds*.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.3.2.2 Restoration technique: Habitat management and stewardship

Metrics and Parameters	Primary and Secondary Objectives (P / S) — P	S	S	S
	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
Ex: "Metric" (bold heading)					
Ex: "Parameter" (indented row)					
Artificial reef acres created, HR005					
Activity completion*	✔				
Area of habitat types	✔				
Conductance/salinity	✓	✓			
Reef height	✓				
Sediment classification/composition	✓				
Water temperature	✓	✓			
Species composition			✓		
Species abundance			+		
Species density			+		
SAV acres restored, HR007					
Activity completion*	✔				
Area of habitat types	✔				
Conductance/salinity	✓	✓			
Dissolved oxygen	✓	✓			
Light attenuation	✓	✓			
pH	✓	✓			
Plant composition and cover	✓				
Plant density	✓				
Plant survivorship/mortality	✓				
Sediment classification/composition	✓				
Turbidity	✓	✓			
Water temperature	✓				

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Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	S	S		S
Wetland and shoreline acres restored, HR013						
Activity completion*		✔				
Area of habitat types		✔				
Conductance/salinity		✓				
Elevation		✓				
Plant composition and cover		✓				
Plant survivorship/mortality		✓				
Sediment classification/composition		✓				
Subsidence/accretion		✓				
Species abundance				✓		
Species composition				✓		
Species density				✓		
Riparian acres restored, HR010 **Upland or other habitat acres restored, HR004** **Acres under BMPs, HM005**						
Activity completion*		✔	✔	✔		
Area of habitat types		✔				
Plant composition and cover		✓				
Plant survivorship/mortality		✓				
Elevation		+				
Plant abundance		+				
Plant density		+				
Plant distribution		+				
Sediment classification/composition		+				
Subsidence/accretion		+				
Conductance			+			
Currents			+			
Dissolved oxygen			+			
Light attenuation			+			

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Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	S	S		S
pH			+			
Substrate geochemistry			+			
Water temperature			+			
Species abundance				✓		
Species composition				✓		
Species density				✓		
Acres treated for exotic species, HR008						
Activity completion*		✔		✔		
Land change rate, HR014						
Land change rate						✓
Lbs. nitrogen avoided/removed, HM001						
Total nitrogen			✓			
Number of facilities benefitting, RES003						
Number of facilities benefitting						✓

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

Figure 3.2.2 Recommended metric and monitoring parameters are shown for projects/programs employing the *Habitat management and stewardship* technique to *Protect and conserve coastal, estuarine, and riparian habitats*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. For more parameters able to support the objective *Restore, improve, and protect water resources*, see recommendations for the approaches *Restore hydrology and natural processes* and *Reduce excess nutrients and other pollutants to watersheds*.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 3.2.2). The appropriate metric(s) and parameters will vary depending on the habitat type and methods used to manage habitat. Metrics typically should not be selected which overlap but see metric definitions for details. The core parameters—activity completion (i.e., acres or miles brought under conservation) and area of habitat types—are likely to be relevant for tracking the progress and management benefits of projects employing the *Habitat management and stewardship* technique regardless of the selected objectives. Objective-specific parameters are provided for habitat-specific and activity-specific metrics. Additional parameters are similarly provided for consideration based on project activities, objective(s), and other site-specific considerations. Parameters for tracking water quality,

species responses, and resilience benefits are recommended for projects to consider depending on their potential secondary objectives. For more parameters able to support the objective *Restore, improve, and protect water resources*, see recommendations for the approaches *Restore hydrology and natural processes* and *Reduce excess nutrients and other pollutants to watersheds*.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.3.2.3 Restoration technique: Decommission unused, orphaned energy facilities

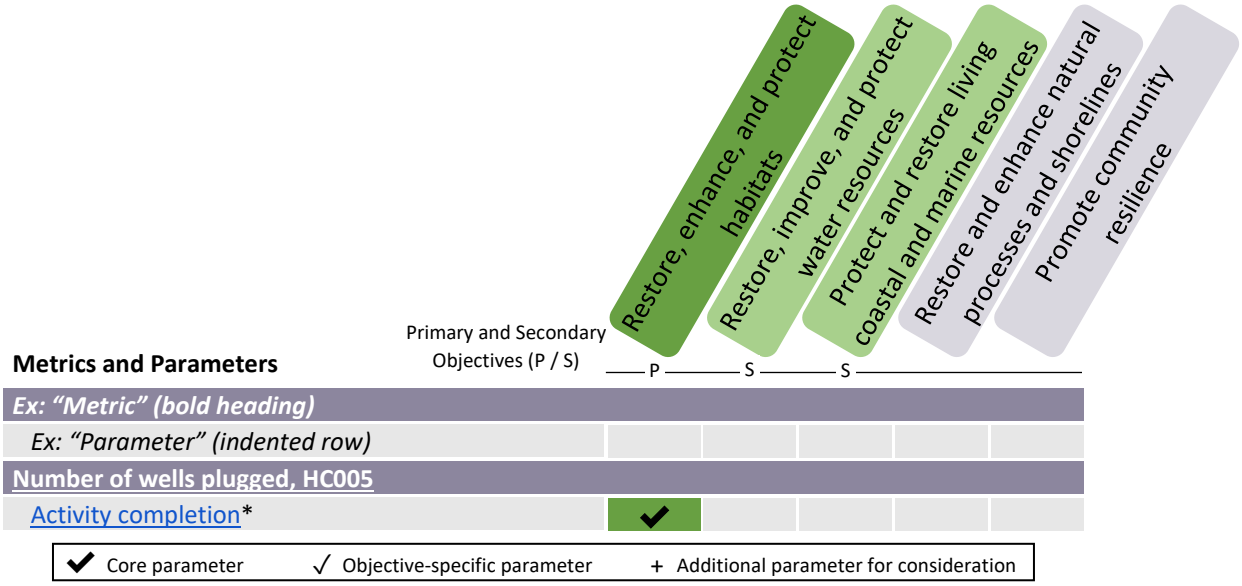

Figure 3.2.2 Recommended metric and monitoring parameters are shown for projects/programs employing the *Decommission unused, orphaned energy facilities* technique to *Protect and conserve coastal, estuarine, and riparian habitats*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. Projects that employ the technique *Decommission unused, orphaned energy facilities* should also employ the technique *Habitat management and stewardship*. See the *Habitat management and stewardship* technique for metrics and parameters to support the project objective(s).

The core parameter to support this objective is activity completion, which is not sufficient to solely support the project objective(s) (see activity completion in section F.8.1 for details). Projects that employ the technique *Decommission unused, orphaned energy facilities* should also employ the technique *Habitat management and stewardship*. See the *Habitat management and stewardship* technique for metrics and parameters to support the project objective(s).

F.3.3 Additional guidance documents

Additional monitoring guidance for restoration activities implementing a *Protect and conserve coastal,*

estuarine, and riparian habitats approach can be found in the following guidance documents:

1. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.7 "Protect and Conserve Marine, Coastal, Estuarine, and Riparian Habitats: Monitoring Guidance" (NRDA 2019).
2. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.9 "Restore and Enhance Submerged Aquatic Vegetation: Monitoring Guidance" (NRDA 2019).
3. Inventory of Gulf Coast Habitat Monitoring, Mapping and Water Quality Programs and Assessments (NOAA and USGSb, 2019). This is tool, available at http://restorethegulf.gov/cmap, is a searchable inventory of habitat monitoring, mapping and water quality activities taking place in the Gulf of Mexico. The inventory is designed to improve discovery and accessibility of existing monitoring data and ensure collected information supports management decision-making.
4. Council Monitoring and Assessment Program (CMAP): Common Monitoring Program Attributes and Methodologies for the Gulf of Mexico Region (NOAA and USGSa, 2020).
5. Council Monitoring and Assessment Program (CMAP): A Framework for Using the Monitoring Program Inventory to Conduct Gap Assessments for the Gulf of Mexico Region (NOAA and USGSb, 2020).

F.4.0 Restore hydrology and natural processes

F.4.1 Restoration techniques

Restoration techniques are specific restoration actions the Council identified for each of the 2019 Planning Framework Restoration Approaches. Restoration techniques may be used individually or in combination. The following are restoration techniques included in the Planning Framework for the restoration approach, *Restore hydrology and natural processes*. This list should not be considered exhaustive; additional restoration techniques may be developed and/or identified.

1. Restore hydrologic connectivity
2. Restore natural salinity regimes
3. Controlled river diversions

F.4.2 Restoration technique metrics and parameters

F.4.2.1 Restoration technique: Restore hydrologic connectivity

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	P	S	P	P
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres with restored hydrology, HR009						
Activity completion*		✔	✔	✔	✔	✔
Area of habitat types		✔	✔		✔	
Elevation		✔			✔	
Plant composition and cover		✔			✔	
Water level		✔	✔		✔	✔
Plant abundance		+			+	
Plant density		+			+	
Plant distribution		+			+	
Sediment classification/composition		+			+	
Discharge			✔		✔	
Conductance/salinity			✓		✓	
Chlorophyll			+		+	
Currents			+		+	
Dissolved oxygen			+		+	
pH			+		+	
Substrate geochemistry			+		+	
Total suspended solids			+		+	
Turbidity			+		+	
Water temperature			+		+	
Species abundance				✓		
Species composition				✓		
Species density				✓		

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Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	P	S	P	P
Miles of canals backfilled, HR011						
Activity completion*		✔			✔	
Land change rate, HR014						
Land change rate		✓			✓	✓
Lbs. nitrogen avoided/removed, HM001 **Lbs. nutrients avoided/removed, HM002** **Lbs. phosphorous avoided/removed, HM003**						
Total nitrogen and/or phosphorous			+		+	
Ammonia			+		+	
Number of facilities benefitting, RES003						
Number of facilities benefitting						✓

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

Figure 4.2.1 Recommended metric and monitoring parameters are shown for projects/programs employing the *Restore hydrologic connectivity* technique to *Restore hydrology and natural processes*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 4.2.1). The core parameters—activity completion, area of habitat types, elevation, plant composition and cover, water level, and discharge—are likely to be relevant for tracking the impacts of projects to *Restore hydrologic connectivity* regardless of the selected objectives. Objective-specific parameters characterize the land-water interface and may therefore be considered supportive of multiple potential primary objectives related to habitat, water resources, and/or shoreline processes. A number of additional parameters are indicated which may impact or be impacted by hydrologic connectivity projects and should be considered based on the relevance to particular sites, project activities, and objectives. Species-specific parameters are recommended for projects that identify *Protect and restore living coastal and marine resources* as a secondary objective.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.4.2.2 Restoration technique: Restore natural salinity regimes

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	P	S	P	P
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres with restored hydrology, HR009						
Activity completion*		✔	✔	✔	✔	
Area of habitat types		✔	✔		✔	
Conductance/salinity		✔	✔		✔	
Elevation		✔			✔	
Plant composition and cover		✔			✔	
Water level		✓	✓		✓	✓
Plant abundance		+			+	
Plant density		+			+	
Plant distribution		+			+	
Sediment classification/composition		+			+	
Chlorophyll			+		+	
Currents			+		+	
Discharge			+		+	
Dissolved oxygen			+		+	
Substrate geochemistry			+		+	
Turbidity			+		+	
Water temperature			+		+	
Species abundance				✓		
Species composition				✓		
Species density				✓		
Miles of canals backfilled, HR011						
Activity completion*		✔			✔	

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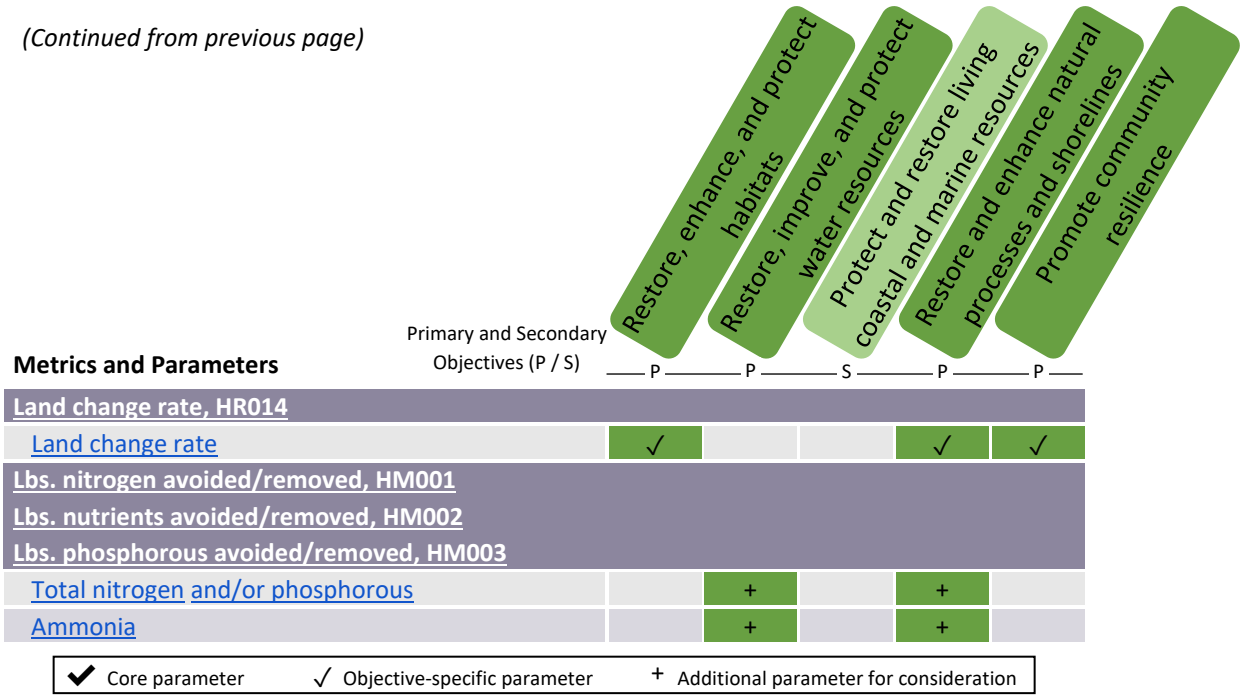

Figure 4.2.2 Recommended metric and monitoring parameters are shown for projects/programs employing the *Restore natural salinity regimes* technique to *Restore hydrology and natural processes*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 4.2.2). The metric acres with restored hydrology is likely to be used for activities employing the *Restore natural salinity regimes* technique. Other appropriate metrics will vary depending on the objectives and the specific activities performed. The core parameters, activity completion, area of habitat types, conductivity/salinity, elevation, and plant composition and cover—will be relevant for tracking the impacts of this technique regardless of the selected objectives. Other than the parameter activity completion, objective-specific parameters characterize the land-water interface and may therefore be considered supportive of multiple potential primary objectives related to habitat, water resources, and/or shoreline processes. A number of additional parameters are indicated which may impact or be impacted by projects to *Restore natural salinity regimes* and should be considered based on the relevance to particular sites, project activities, and objectives. Species-specific parameters are recommended for projects that identify *Protect and restore living coastal and marine resources* as a secondary objective.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.4.2.3 Restoration technique: Controlled river diversions

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	P	S	P	P
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres with restored hydrology, HR009						
Activity completion*		✔	✔	✔	✔	
Area of habitat types		✔	✔		✔	
Elevation		✔			✔	
Plant composition and cover		✔			✔	
Suspended sediment concentration		✓	✓		✓	
Water level		✓	✓		✓	✓
Plant abundance		+			+	
Plant distribution		+			+	
Sediment classification/composition		+			+	
Subsidence/accretion		+			+	
Conductance			✓		✓	
Discharge			✓		✓	
Total suspended solids (TSS)			✓		✓	
Chlorophyll			+		+	
Currents			+		+	
Dissolved oxygen			+		+	
Substrate geochemistry			+		+	
Turbidity			+		+	
Water temperature			+		+	
Species abundance				✓		
Species composition				✓		
Species density				✓		

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Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	P	S	P	P
Wetland and shoreline acres restored, HR013						
Activity completion*		✔		✔	✔	
Area of habitat types		✔			✔	
Elevation		✔			✔	
Plant composition and cover		✔			✔	
Plant density		✓			✓	
Plant abundance		+			+	
Plant distribution		+			+	
Sediment classification/composition		+			+	
Subsidence/accretion		+			+	
Species abundance				✓		
Species composition				✓		
Species density				✓		
Land change rate, HR014						
Land change rate		✓			✓	✓
Lbs. nitrogen avoided/removed, HM001 **Lbs. nutrients avoided/removed, HM002** **Lbs. phosphorous avoided/removed, HM003**						
Total nitrogen and/or phosphorous			+		+	
Ammonia			+		+	
Number of facilities benefitting, RES003						
Number of facilities benefitting						✓

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

Figure 4.2.3 Recommended metric and monitoring parameters are shown for projects/programs employing the *Controlled river diversions* technique to *Restore hydrology and natural processes*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 4.2.3). Projects employing the Controlled river diversions technique are likely to employ the metric acres with restored hydrology. Other appropriate metrics will vary depending on the objectives and the specific scope and location of the project. The core parameters, activity completion, area of

habitat types, elevation, and plant composition and cover—will be relevant for tracking the impacts of this technique regardless of the selected objectives. Other than the parameter activity completion, objective-specific parameters characterize the land-water interface and may therefore be considered supportive of multiple potential primary objectives related to habitat, water resources, and/or shoreline processes. A number of additional parameters are indicated which may impact or be impacted by *Controlled river diversions* and should be considered based on the relevance to particular sites, project designs, and objectives. For example, subsidence/accretion can provide valuable information on processes affecting the trajectory of habitat benefits, as river diversions increase rates of sediment deposition and land growth. Species-specific parameters are recommended for projects that identify *Protect and restore living coastal and marine resources* as a secondary objective.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.4.3 Additional guidance documents

Additional monitoring guidance for restoration activities implementing a *Restore hydrology and natural processes* approach can be found in the following guidance documents:

1. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.4, "Create, Restore and Enhance Coastal Wetlands: Monitoring Guidance" (NRDA 2019).
2. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.8, "Reduce Nutrient Loads to Coastal Watersheds & Reduce Pollution and Hydrologic Degradation to Coastal Watersheds: Monitoring Guidance" (NRDA 2019).
3. Inventory of Gulf Coast Habitat Monitoring, Mapping and Water Quality Programs and Assessments (NOAA and USGSb, 2019). This is tool, available at http://restorethegulf.gov/cmap, is a searchable inventory of habitat monitoring, mapping and water quality activities taking place in the Gulf of Mexico. The inventory is designed to improve discovery and accessibility of existing monitoring data and ensure collected information supports management decision-making.
4. Council Monitoring and Assessment Program (CMAP): Common Monitoring Program Attributes and Methodologies for the Gulf of Mexico Region (NOAA and USGSa, 2020).
5. Council Monitoring and Assessment Program (CMAP): A Framework for Using the Monitoring Program Inventory to Conduct Gap Assessments for the Gulf of Mexico Region (NOAA and USGSb, 2020).

F.5.0 Restoration approach: Reduce excess nutrients and other pollutants to watersheds

F.5.1 Restoration techniques

Restoration techniques are specific restoration actions the Council identified for each of the 2019 Planning Framework Restoration Approaches. Restoration techniques may be used individually or in combination. The following are restoration techniques included in the Planning Framework for the restoration approach, *Reduce excess nutrients and other pollutants to watersheds*. This list should not be considered exhaustive; additional restoration techniques may be developed and/or identified.

1. Agriculture and forest management
2. Stormwater management
3. Erosion and sediment control
4. Wastewater system improvements

F.5.2 Restoration technique metrics and parameters

F.5.2.1 Restoration technique: Agriculture and forest management

Metrics and Parameters	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
Primary and Secondary Objectives (P / S)	S	P	S		S
Ex: "Metric" (bold heading)					
Ex: "Parameter" (indented row)					
Acres under BMPs, HM005 **Acres restored for erosion control, HR001** **Riparian acres restored, HR010** **Wetland and shoreline acres restored, HR013** **Other habitat acres restored, HR004**					
Activity completion*	✔	✔	✔		
Sediment classification/composition	✓	✓			
Suspended sediment concentration		✓			
Total suspended solids (TSS)		✓			
Turbidity		✓			
Chlorophyll		+			
Substrate geochemistry		+			
Area of habitat types	✔				
Plant composition and cover	✓				
Plant density	✓				
Plant survivorship/mortality	✓				
Species abundance			✓		
Species composition			✓		
Species density			✓		
CFU reduction in bacterial loads, RES004					
Enterococci		✓			
Escherichia coli		✓			
Fecal coliforms		✓			

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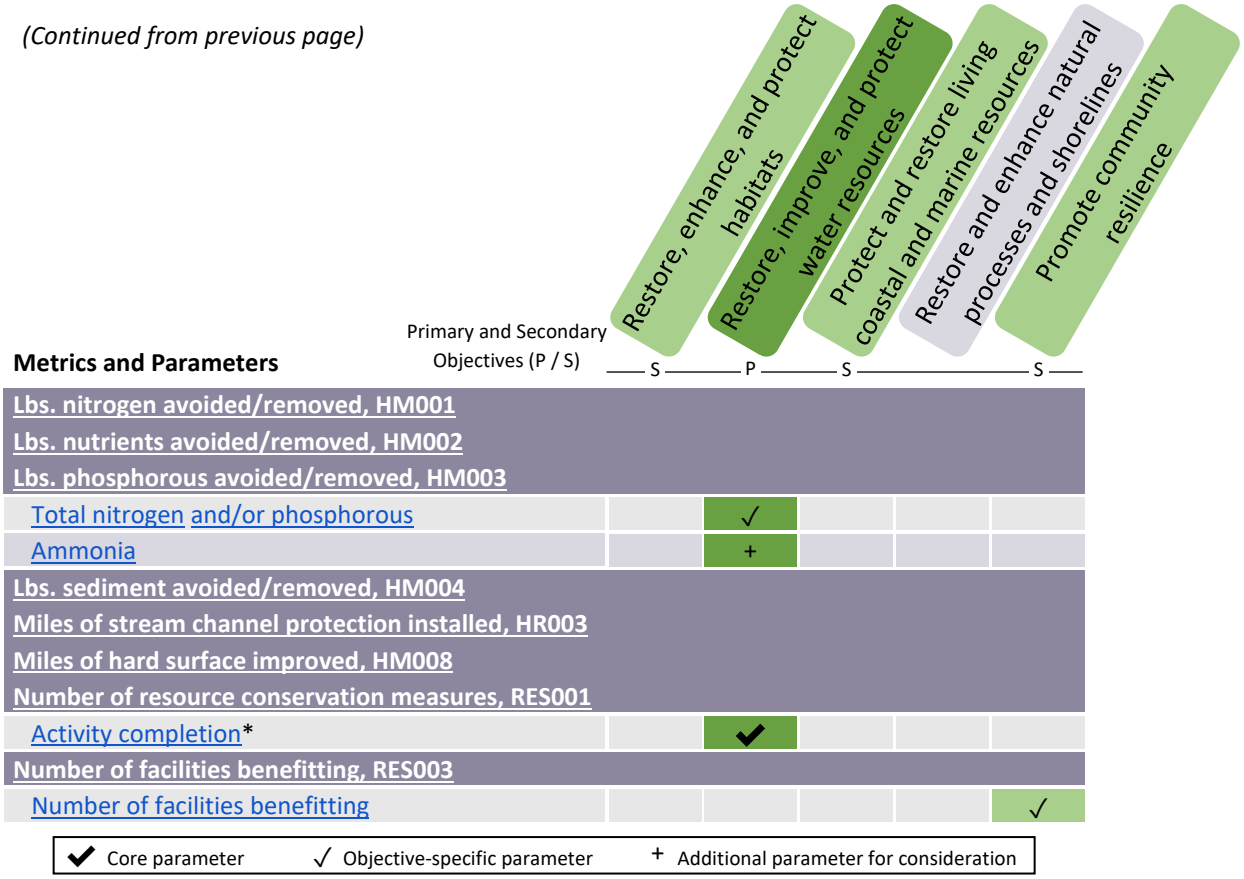

Figure 5.2.1 Recommended metric and monitoring parameters are shown for projects/programs employing the *Agriculture and forest management* technique to *Reduce excess nutrients and other pollutants to watersheds*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 5.2.1). The appropriate metric(s) will vary depending on the targeted pollutant and the methods used for remediation. The core parameters—activity completion and area of habitat types—will be relevant for tracking the impacts of this technique regardless of the selected objectives. Few core parameters are identified due to the fact that monitoring will depend on the pollutant stressors targeted for reduction, as well as the remediation activities. Instead, objective-specific parameters are provided which are likely to track the effects of pollutant reduction projects in support of the objective(s) of the project. Additional parameters that may further characterize or mediate the effects of *Agriculture and forest management* projects are provided for consideration based on project activities, objective(s), and other site-specific considerations. Parameters for tracking habitat, species, and resilience benefits are recommended for projects to consider depending on their potential

secondary objectives. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.5.2.2 Restoration technique: Stormwater management

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		S	P	S		S
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres with reduced impacts, PRM001						
Miles with reduced impacts, PRM002						
Riparian acres restored, HR010						
Wetland and shoreline acres restored, HR013						
Other habitat acres restored, HR004						
Number of stormwater system upgrades, RES002						
Activity completion*		✔	✔	✔		
Conductance/salinity			✓			
Discharge			✓			
Dissolved oxygen			✓			
Suspended sediment concentration			✓			
Total suspended solids			✓			
Turbidity			✓			
Water temperature			✓			
Chlorophyll			+			
pH			+			
Area of habitat types		✔				
Plant composition and cover		✓				
Plant density		✓				
Plant survivorship/mortality		✓				
Species abundance				✓		
Species composition				✓		
Species density				✓		

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Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	P	S	P	P
Lbs. sediment avoided/removed, HM004 **Miles of hard surface improved, HM008**						
Activity completion*			✔			
CFU reduction in bacterial loads, RES004						
Enterococci			✓			
Escherichia coli			✓			
Fecal coliforms			✓			
Lbs. nitrogen avoided/removed, HM001 **Lbs. nutrients avoided/removed, HM002** **Lbs. phosphorous avoided/removed, HM003**						
Total nitrogen and/or phosphorous			✓			
Ammonia			+			
Number of facilities benefitting, RES003						
Number of facilities benefitting						✓

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

Figure 5.2.2 Recommended metric and monitoring parameters are shown for projects/programs employing the *Stormwater management* technique to *Reduce excess nutrients and other pollutants to watersheds*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 5.2.2). The appropriate metric(s) will vary depending on the water quality stressors of concern and the methods used for stormwater management. The core parameters—activity completion and area of habitat types—will be relevant for tracking the impacts of this technique regardless of the selected objectives. Few core parameters are identified due to the fact that monitoring will depend on the pollutant stressors targeted for reduction, as well as the remediation activities. Instead, objective-specific parameters are provided which are likely to track the effects of pollutant reduction projects in support of the objective(s) of the project. Additional parameters that may further characterize or mediate the effects of *Agriculture and forest management* projects are provided for consideration based on project activities, objective(s), and other site-specific considerations. Parameters for tracking habitat,

species, and resilience benefits are recommended for projects to consider depending on their potential secondary objectives. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

F.5.2.3 Restoration technique: Erosion and sediment control

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		S	P	S		S
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres restored for erosion control, HR001						
Activity completion*		✔	✔			
Sediment classification/composition		✓	✓			
Suspended sediment concentration			✓			
Total suspended solids			✓			
Turbidity			✓			
Chlorophyll			+			
Conductance/salinity			+			
Dissolved oxygen			+			
Water temperature			+			
Area of habitat types		✔				
Plant composition and cover		✓				
Plant density		✓				
Plant survivorship/mortality		✓				
Species abundance				✓		
Species composition				✓		
Species density				✓		
Lbs. nitrogen avoided/removed, HM001 **Lbs. nutrients avoided/removed, HM002** **Lbs. phosphorous avoided/removed, HM003**						
Total nitrogen and/or phosphorous			✓			
Ammonia			+			
Lbs. sediment avoided/removed, HM004 **Miles of stream channel protection installed, HR003**						
Activity completion*			✔			

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

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Figure 5.2.3 Recommended metric and monitoring parameters are shown for projects/programs employing the *Erosion and sediment control technique to Reduce excess nutrients and other pollutants to watersheds*. Symbols

indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 5.2.3). Appropriate metric(s) and parameters to evaluate success of the *Erosion and sediment control* technique vary depending on the type of erosion and its drivers, the management activities employed, co-occurring water quality stressors of concern, and the objective(s) of the activity. Objective-specific parameters should be selected based on these considerations. The core parameters—activity completion and area of habitat types—will be relevant for tracking the impacts regardless of activity objectives and other factors. Additional parameters may further characterize and/or mediate the effects of *Erosion and sediment control* projects and should be considered for inclusion based on their potential relevance to the needs and impacts of the project. Parameters for tracking habitat and species-specific benefits are recommended for projects to consider depending on their potential secondary objectives. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.5.2.4 Restoration technique: Wastewater system improvements

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		S	P	S		S
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres with reduced impacts, PRM001 **Miles with reduced impacts, PRM002** **Wetland and shoreline acres restored, HR013** **Number of wastewater system upgrades, RES002**						
Activity completion*		✔	✔	✔		
Chlorophyll			+			
Conductance			+			
Dissolved oxygen			+			
pH			+			
Suspended sediment concentration			+			
Turbidity			+			
Total suspended solids			+			
Water temperature			+			
Area of habitat types		✔				
Plant composition and cover		✓				
Plant density		✓				
Plant survivorship/mortality		✓				
Species abundance				✓		
Species composition				✓		
Species density				✓		
CFU reduction in bacterial loads, RES004						
Enterococci			✓			
Escherichia coli			✓			
Fecal coliforms			✓			

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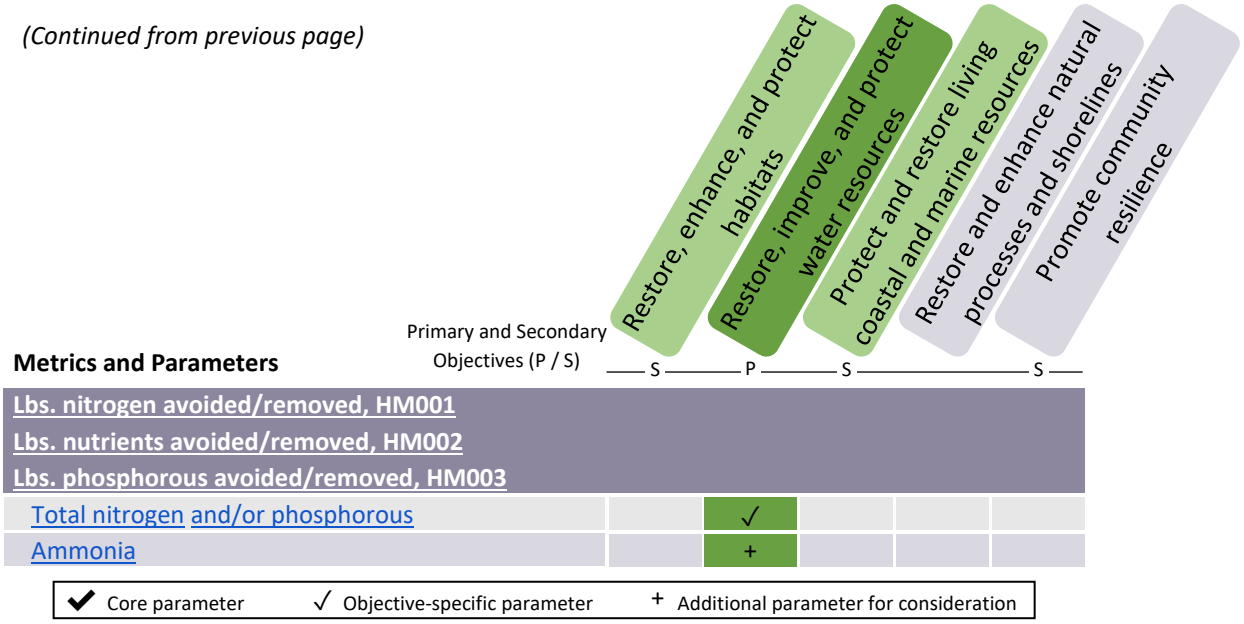

Figure 5.2.4 Recommended metric and monitoring parameters are shown for projects/programs employing the *Wastewater system improvements technique to Reduce excess nutrients and other pollutants to watersheds*. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 5.2.4). The appropriate metric(s) will vary depending on the water quality stressors of concern and the methods used to improve wastewater systems, as well as any secondary project objectives.

Appropriate metric(s) and parameters to evaluate success of the *Wastewater system improvements* technique vary depending on the water quality stressors of concern and the methods used to improve wastewater systems, as well as any secondary project objectives. Objective-specific parameters should be selected based on these considerations. The core parameters—activity completion and area of habitat types—will be relevant for tracking the impacts regardless of activity objectives and other factors. Additional parameters may further characterize and/or mediate the effects of activities employing this technique, and should be considered for inclusion based on their potential relevance to the needs and impacts of the project/program. Parameters for tracking habitat, species, and resilience benefits are recommended for projects to consider depending on their potential secondary objectives. For more parameters able to support the objective *Restore, enhance, and protect habitats*, see recommendations for the technique *Habitat management and stewardship*.

Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the activity objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.5.3 Additional guidance documents

Additional monitoring guidance for restoration activities implementing a *Reduce excess nutrients and other pollutants to watershed*s approach can be found in the following guidance documents:

1. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.4, "Create, Restore and Enhance Coastal Wetlands: Monitoring Guidance" (NRDA 2019).
2. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.8, "Reduce Nutrient Loads to Coastal Watersheds & Reduce Pollution and Hydrologic Degradation to Coastal Watersheds: Monitoring Guidance" (NRDA 2019).
3. Inventory of Gulf Coast Habitat Monitoring, Mapping and Water Quality Programs and Assessments (NOAA and USGSb, 2019). This is tool, available at http://restorethegulf.gov/cmap, is a searchable inventory of habitat monitoring, mapping and water quality activities taking place in the Gulf of Mexico. The inventory is designed to improve discovery and accessibility of existing monitoring data and ensure collected information supports management decision-making.
4. Council Monitoring and Assessment Program (CMAP): Common Monitoring Program Attributes and Methodologies for the Gulf of Mexico Region (NOAA and USGSa, 2020).
5. Council Monitoring and Assessment Program (CMAP): A Framework for Using the Monitoring Program Inventory to Conduct Gap Assessments for the Gulf of Mexico Region (NOAA and USGSb, 2020).

F.6.0 Restoration approach: Restore oyster habitat

F.6.1 Restoration techniques

Restoration techniques are specific restoration actions the Council identified for each of the 2019 Planning Framework Restoration Approaches. Restoration techniques may be used individually or in combination. The following are restoration techniques included in the Planning Framework for the restoration approach, *Restore oyster habitat*. This list should not be considered exhaustive; additional restoration techniques may be developed and/or identified.

1. Substrate placement
2. Living shorelines
3. Enhance spawning and reserves

F.6.2 Restoration technique metrics and parameters

F.6.2.1 Restoration techniques: Substrate placement, Living shorelines, and Enhance spawning and reserves

Metrics and Parameters	Primary and Secondary Objectives (P / S)	Restore, enhance, and protect habitats	Restore, improve, and protect water resources	Protect and restore living coastal and marine resources	Restore and enhance natural processes and shorelines	Promote community resilience
		P	S	S		S
Ex: "Metric" (bold heading)						
Ex: "Parameter" (indented row)						
Acres of oyster reef restored, HR006						
Activity completion*		✔	✔	✔	✔	✔
Area of habitat types		✔		✔		
Reef height		✔				
Conductance/salinity		✔	✔	✔		
Dissolved oxygen		✓	✓	✓		
Water temperature		✓	✓	✓		
Turbidity			✓	✓		
Oyster density, SP001						
Oyster density				✔		
Oyster survivorship/mortality				✔		
Settlement/recruitment				✓		
Size				✓		
Miles of living shoreline protection installed, HR012						
Activity completion*					✔	✔
Land change rate, HR014						
Land change rate					✓	✓
Number of facilities benefitting, RES003						
Number of facilities benefitting						✓

✔ Core parameter ✓ Objective-specific parameter + Additional parameter for consideration

Figure 6.2.1 Recommended metric and monitoring parameters are shown for projects/programs employing the techniques *Substrate placement*, *Living shorelines*, and *Enhance spawning and reserves* as part of the *Restore oyster habitat* approach. Symbols indicate core (✔), objective-specific (✓), and additional parameters (+) for particular objectives. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompass a range of potential parameters to track implementation, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0. For more parameters able to support the objective *Restore, improve, and protect water resources*, see

recommendations for the approaches *Restore hydrology and natural processes* and *Reduce excess nutrients and other pollutants to watersheds*.

Links to definitions and methodological guidance are provided for each of the metrics and parameters (Figure 6.2.1). The core parameters—activity completion (e.g., acres over which restoration activities are performed), area of habitat types, reef height, conductance/salinity, oyster density, and oyster survivorship/mortality—are likely to be relevant for tracking the progress and conservation benefits of oyster habitat restoration projects regardless of the selected objectives. Objective-specific parameters are provided which may track project effects in support of particular objectives (or which are likely to strongly mediate success meeting those objectives). Additional parameters may similarly mediate project benefits and should be considered based on project and site-specific details. In addition to water quality parameters, parameters related to shoreline and resilience benefits are recommended for consideration based on the potential secondary objective(s) of the project. For more parameters able to support the objective *Restore, improve, and protect water resources*, see recommendations for the approaches *Restore hydrology and natural processes* and *Reduce excess nutrients and other pollutants to watersheds*.

F.6.3 Additional guidance documents

Additional monitoring guidance for restoration activities implementing a *Restore oyster habitat* approach can be found in the following guidance documents:

1. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.10 "Restore Oyster Reef Habitat: Monitoring Guidance" (NRDA 2019).
2. Inventory of Gulf Coast Habitat Monitoring, Mapping and Water Quality Programs and Assessments (NOAA and USGSb, 2019). This is tool, available at http://restorethegulf.gov/cmap, is a searchable inventory of habitat monitoring, mapping and water quality activities taking place in the Gulf of Mexico. The inventory is designed to improve discovery and accessibility of existing monitoring data and ensure collected information supports management decision-making.
3. Gulf of Mexico Ecosystem Service Logic Models and Socio-Economic Indicators (GEMS) Phase I Report: Oyster Reef Restoration (Olander et al., 2020). The GEMS project aims to advance metrics of restoration success that look not only at the ecological success of projects, but also the socio-economic benefits of restoration activities. This report highlights potential socio-economic metrics of success for oyster restoration projects. More information about GEMS is available at https://nicholasinstitute.duke.edu/project/gems.

F.7.0 Other: planning phase activities and activities supporting other Comprehensive Plan goals and objectives

Metric and parameter recommendations provided for each Planning Framework technique (F.2.0-F.6.0) do not address all potential activities, or all Comprehensive Plan goals and objectives that may be met. This section provides metric and parameter recommendations for:

- Planning activities (F.7.1)

Recommendations are also provided for metrics and parameters that can be used to support the following goals and objectives:

- Promote natural resource stewardship and environmental education (7.2.1)
- Improve science-based decision-making (7.2.2)
- Restore and revitalize the Gulf economy (7.2.3)

F.7.1 Planning phase metrics and parameters

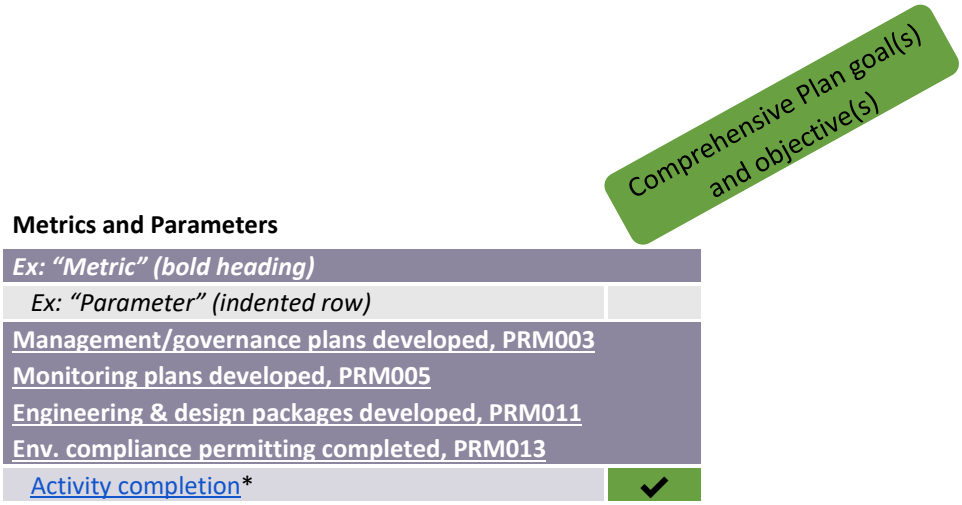

Figure 7.1 Recommended metrics and monitoring parameters are shown for projects/programs conducting planning activities. The bold check (✔) indicates a core parameter that can be used to support any corresponding Comprehensive Plan goals and objectives (see main text for details). Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompasses a range of potential parameters; metric-specific guidance can be found in F.10.0. For metrics and parameters able to support the objective *Improve science-based decision-making*, see F.7.2.2.

The recommendations provided for each restoration technique (F.2.0-F.6.0) are most applicable for projects/programs that will implement that technique. However, projects/programs can engage in planning activities that support Comprehensive Plan goals and objectives but require further action to produce observable impacts. Planning may be conducted preceding the implementation of a technique, to advance the science around particular techniques (7.2.2), and/or inform future decision-making more broadly (7.2.2).

Links to definitions and methodological guidance are provided for each of the metrics and parameters recommended for planning activities (Figure 7.1). For each of these metrics, an activity completion parameter is typically sufficient to support appropriately aligned objectives (i.e., objectives that the activity is likely to help achieve in the future). However, any observational data collected under the award must be included in the ODP. This includes any data collected for E&D, permitting, establishing baselines, or other research and analysis. If one of the objectives of the activity is to Improve science-based decision-making, or if the activity will produce a study or report, see also F.7.2.2 for metric and parameter recommendations.

F.7.2 Metrics and parameters supporting other Comprehensive Plan goals and objectives

Two Comprehensive Plan objectives are-cross cutting, in that any Planning Framework technique may be employed to achieve these objectives, and in doing so, may simultaneously support other Comprehensive Plan objectives. The cross-cutting objectives are:

- Promote natural resource stewardship and environmental education (7.2.1)
- Improve science-based decision-making (7.2.2)

The Planning Framework does not attempt to define techniques that could support these objectives given the potential for overlap with existing techniques, as well as the difficulty posed by creating an exhaustive categorization of the wide range of potential activities. Recommendations are therefore provided without distinction between potential techniques. As applicable, recommendations should be considered in concert with recommendations for any other technique (F.2.0-F.6.0), objective, or goal pertaining to the activity.

One of the Comprehensive Plan goals that activities may help achieve does not have a corresponding objective. It is also not considered under the Planning Framework because it is only applicable to SEP projects/programs using Spill-Impact Component funds (and does not apply to FPL activities using Council-Selected Component funds):

- Restore and revitalize the Gulf economy (7.2.3)

Like the cross-cutting objectives, this goal may be supported by techniques that simultaneously help advance other Comprehensive Plan objectives. In addition, activities not captured by the Planning Framework techniques may be employed to advance this goal. Recommendations on metrics and parameters to support this goal are therefore provided without reference to particular techniques. Instead, metric and parameter selections should be made giving consideration to the activities employed. As with the cross-cutting objectives, recommendations for any other technique (F.2.0-F.6.0), objective, or goal pertaining to the activity should also be considered.

F.7.2.1 Comprehensive Plan objective: Promote natural resource stewardship and environmental education

Metrics and Parameters

Ex: "Metric" (bold heading)	
Ex: "Parameter" (indented row)	
Number of employees trained, COI001 **Number of participants trained, COI007**	
Number of people reached	✓
Number of people trained	✓
Number of people enrolled for BMPs, COI003	
Number of people reached	✓
Number of applicants	✓
Number of people enrolled	✓
Number of people reached, COI002	
Number of people reached	✓
Number of reader impressions	✓
Number of users engaged online, COI004	
Number of people reached online	✓
Number of downloads	✓
Number of social media followers	✓
Web traffic	✓
Number of volunteers who participated, COI005	
Number of people reached	✓
Number of volunteers	✓
Number of full-time jobs created, COI101 **Number of part-time jobs created, COI102** **Number of temporary jobs created, COI103**	
Number of positions filled	✓
Conservation practices implemented, RES001	
Activity completion*	✓
Number of entities enrolled	✓
Improvements to recreational infrastructure, RES005	
Activity completion*	✓

(Continued next page)

Figure 7.2.1 Recommended metric and monitoring parameters are shown for activities supporting the objective *Promote natural resource stewardship and environmental education*. Checks (✓) indicate object-specific parameters that can be used to support this objective. Click on a metric to jump to additional guidance (F.10.0). Activity completion

(*) can encompasses a range of potential parameters, and may not be sufficient to solely support benefits to the objective (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and specific instructions are provided for each of the metrics recommended to support the objective *Promote natural resource stewardship and environmental education* (Figure 7.2.1). Methodological guidance is not yet available for parameters supporting this objective. The appropriate metric(s) and parameter(s) will vary depending on the activities employed. Metrics supported by the activity completion parameter should typically be selected with one or more other metrics to support the project objective(s) (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

F.7.2.2 Comprehensive Plan objective: Improve science-based decision-making

Metrics and Parameters	
Ex: "Metric" (bold heading)	
Ex: "Parameter" (indented row)	
New studies conducted, PRM009	
Studies conducted to inform management, PRM010	
Tools developed, PRM012	
Monitoring programs implemented, PRM004	
Number of streams/sites monitored, PRM006	
Acres monitored, PRM007	
Miles monitored, PRM008	
% increase in analytical capacity, PRM014	
Activity completion*	✓

Figure 7.2.2 Recommended metrics and monitoring parameters are shown for activities supporting the objective *Improve science-based decision-making*. The checks (✓) indicate object-specific parameters that can be used to support this objective. Click on a metric or parameter to jump to additional guidance (F.9.0, F.10.0). Activity completion (*) can encompasses a range of potential parameters; for the metrics shown, the activity completion parameter should be included alongside all parameters needed to fully capture observational data collected under the award. Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and methodological guidance are provided for each of the metrics and parameters recommended to support the objective *Improve science-based decision-making* (Figure 7.2.2). This objective can typically be sufficiently supported by including an activity completion parameter for any of the recommended metric(s) selected. However, it is important to also include any additional parameters that may be needed to capture all observational data collection activities under a project/program, including data used in research and analysis or tool development. See Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance.

Activities supporting the objective *Improve science-based decision-making* may be conducted alongside other techniques to inform management or advance science. As applicable, recommendations for this objective should be considered in concert with recommendations for any other technique (F.2.0-F.6.0), objective, or goal pertaining to the activity.

F.7.2.3 Comprehensive Plan goal: Restore and revitalize the Gulf economy

Metrics and Parameters	
Ex: "Metric" (bold heading)	
Ex: "Parameter" (indented row)	
Number of people reached, COI002	
Number of people reached	✓
Number of reader impressions	✓
Number of users engaged online, COI004	
Number of people reached online	✓
Number of downloads	✓
Number of social media followers	✓
Web traffic	✓
Number of full-time jobs created, COI101 **Number of part-time jobs created, COI102** **Number of temporary jobs created, COI103**	
Number of positions filled	✓
Number of local contracts, COI104	
Activity completion*	✓
Costs contracted locally, COI105	
Costs going to existing local organizations	✓
Acres acquired for recreation, RES006	
Activity completion*	✓
Improvements to recreational infrastructure, RES005	
Activity completion*	✓
Recreational use by visitors, RES007	
Number of visitors	✓
Transportation channel improved, COI107	
Activity completion*	✓
Sacks of oysters relayed for harvest, COI106	
Activity completion*	✓
Sacks of oysters harvested	✓

Figure 7.2.3 Recommended metrics and monitoring parameters are shown for activities supporting the goal *Restore and revitalize the Gulf economy.* Checks (✓) indicate object-specific parameters that can be used to support this objective. Click on a metric to jump to additional guidance (F.10.0). Activity completion (*) can encompasses a range

of potential parameters, and may not be sufficient to solely support benefits to the goal (see F.9.0). Metric-specific guidance on the activity completion parameter can be found in F.10.0.

Links to definitions and specific instructions are provided for each of the metrics recommended to support the goal *Restore and revitalize the Gulf economy* (Figure 7.2.3). Methodological guidance is not yet available for parameters supporting this objective. The appropriate metric(s) and parameter(s) will vary depending on the activities employed. Metrics supported by the activity completion parameter should typically be selected with one or more other metrics and/or parameters that can support the goal (see Activity completion in section F.9.1 for details, and the metric reference table in section F.10.0 for metric-specific guidance).

As applicable, recommendations for this objective should be considered in concert with recommendations for any other technique (F.2.0-F.6.0), objective, or goal pertaining to the activity.

F.7.3 Additional guidance documents

Additional monitoring guidance for restoration activities to advance the goals/objectives in this section (*Promote natural resource stewardship and environmental education*, *Improve science-based decision making*, and *Restore and revitalize the Gulf economy*) can be found in the following guidance documents:

1. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.11 "Enhance Public Access to Natural Resources for Recreational Use: Monitoring Guidance" (NRDA 2019).
2. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.12 "Enhance Recreational Experiences: Monitoring Guidance" (NRDA 2019).
3. NRDA Cross-TIG MAM Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0, Section E.13 "Promote Environmental Stewardship, Education, and Outreach: Monitoring Guidance" (NRDA 2019).
4. Inventory of Gulf Coast Habitat Monitoring, Mapping and Water Quality Programs and Assessments (NOAA and USGSb, 2019). This is a tool, available at http://restorethegulf.gov/cmap, is a searchable inventory of habitat monitoring, mapping and water quality activities taking place in the Gulf of Mexico. The inventory is designed to improve discovery and accessibility of existing monitoring data and ensure collected information supports management decision-making.
5. Gulf of Mexico Ecosystem Service Logic Models and Socio-Economic Indicators (GEMS) Phase I Report: Oyster Reef Restoration (Olander et al., 2020). The GEMS project aims to advance metrics of restoration success that look not only at the ecological success of projects, but also the socio-economic benefits of restoration activities. This report highlights potential socio-economic metrics of success for oyster restoration projects. More information about GEMS, including the availability of reports on other restoration techniques, is available at https://nicholasinstitute.duke.edu/project/gems.

F.8.0 All parameters

All of the parameters recommended in this guidance are listed below. Links are provided to the parameter definition and methodological guidance found in F.8.0.

Activity completion

Ammonia

Area of habitat types

Chlorophyll

Conductance

Currents

Discharge

Dissolved oxygen

Elevation

Enterococci

Escherichia coli

Fecal coliforms

Land change rate

Light attenuation

Number of facilities benefitting

Oyster density

Oyster size

Oyster survivorship/mortality

pH

Plant abundance

Plant composition and cover

Plant density

Plant distribution

Plant survivorship/mortality

Reef height

Sediment classification/composition

Settlement/recruitment

Species abundance

Species composition

Species density

Subsidence/accretion

Substrate geochemistry

Suspended sediment concentration

Total nitrogen

Total phosphorus

Total suspended solids

Turbidity

Water level

Water temperature

F.9.0 Methodological guidance

The range of recommended parameter methods (F.8.1) has been limited to just the most common methods reported in the CMAP Report *Common Monitoring Program Attributes and Methodologies for the Gulf of Mexico Region*. The NRDA MAM Manual was used to fill in additional information specific to the context of restoration monitoring. Existing RESTORE Council project ODPs were also used as a reference for potential monitoring methods. Please note that some methods are more accurate and precise than others, and your choice of method should be informed by the required precision and accuracy for your project.

The units suggested for consistency across RESTORE Council-funded projects/programs are indicated in parentheses for each parameter.

F.9.1 Parameter descriptions and methods

Activity completion

These parameters track completion of a planned activity rather than resulting benefits to the intended objective(s). Such parameters characterize what has been implemented, such as infrastructure constructed (e.g., artificial reef, educational facility) or enhanced (e.g., asphalt removed, trail repaired) and management actions taken (e.g., acres planted). Activity completion parameters typically do not satisfy the requirement to support the primary objective of the project/program with one or more metrics and supporting parameters. For example, acres restored typically is considered an activity completion parameter because it is used to track the area over which activities are conducted. Additional parameters to track impacts of restoration activities would be needed to support Comprehensive Plan goals and objectives.

Metric-specific guidance on the activity completion parameter can be found in Section F.10.0. Projects/programs using an activity completion parameter should provide a more specific parameter name and units. Names of activity completion parameters often match the selected metric name (e.g., number of upgrades to stormwater/wastewater systems) but may add detail (e.g., number of manhole covers replaced).

Primary objectives:

May be used for projects that select any of the Comprehensive Plan objectives, but is not sufficient to support the objective(s) without additional parameters tracking project benefits

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition

    - Habitat management and stewardship
    - Decommission unused, orphaned energy facilities
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvement
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods: Methods vary with the activity. Activity completion may be tracked using administrative documentation, such as as-built drawings, photographs, or other verification measures. Outputs required for closeout of the award may be tracked by standard oversight activities.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Ammonia (mg/L)

A common form of nitrogen (N) that exists in aquatic environments that can cause toxic effects on aquatic life. Ammonia (NH_3) is naturally produced through decomposition of organic matter, nitrogen fixation, as waste products from organisms, and other processes. This parameter includes data expressed as either ammonium (NH_4) ion or nitrogen mass per unit volume (mg/l), and includes the fractional results, dissolved (filtered), total (unfiltered), or suspended (unfiltered - filtered).

Primary objectives:

- Restore, enhance, and protect habitats

- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Reduce excess nutrients and other pollutants to watersheds
    - Erosion and sediment control
    - Wastewater system improvements
    - Agriculture and forest management
    - Stormwater management
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions

Potential methods:

- *Auto analyzer*: General term for laboratory instrumentation that is automated such as continuous flow analysis and flow injection analyzers.
- *EPA 350.1*: Environmental Protection Agency (EPA) Method Determination of Ammonia Nitrogen by Semi-Automated Colorimetry.
- *SM 4500 NH_3*: Standard Methods for the Examination of Water and Wastewater Nitrogen (Ammonia).
- *USGS OFR 93-125*: USGS Open-File Report Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory; determination of inorganic and organic constituents in water and fluvial sediments.

Monitoring location: Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Area of habitat types (acres)

The coverage of particular habitat(s) in terms of area. Habitat characteristics that may be used to distinguish boundaries include: vegetation composition, water level, conductivity/salinity, sediment classification/composition, substrate type, presence/absence of bottom cultch, and/or

living oyster reef. Area measurements over time may also be used in conjunction with other parameters (e.g., elevation, plant cover, and plant composition) to perform calculations and analyses such as: habitat type changes, shoreline change, land loss or gain, beach and dune profile change, volume change, bathymetric profile change, and sediment movement.

Primary objectives:

- Restore, enhance, and protect habitats
- Restore and enhance natural processes and shorelines

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship
- Reduce excess nutrient and other pollutants to watersheds
    - Agriculture and forest management
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Remote sensing:* Project and habitat boundaries can be mapped based on aerial imagery collected by airplane, helicopter, unmanned aerial systems (UAS); high-resolution satellite imagery; or other appropriate remote sensing platforms. Imagery used to map wetland boundaries should include true color and infrared bands, and have a spatial resolution of 1 meter (m) or less. For comparison of different remote sensing platforms commonly used for wetland mapping, see Klemas (2011) and Klemas (2013). For additional information on the use of UAS for wetland mapping, see Klemas (2015), Madden et al. (2015), Zweig et al. (2015), and Samiappan et al. (2017). Source imagery should be orthorectified [i.e., free from distortions related to sensor optics, sensor tilt, and differences in elevation; see Rufe (2014)]. Collected imagery should be imported to spatial analysis software to digitize the perimeter of the project footprint and the boundaries of habitat areas within the project footprint. Additional guidance on using aerial imagery can also be

found in Anders and Byrnes (1991), Crowell et al. (1991), Morton (1991), and FLDEP (2014). For coastal wetland projects, see Steyer and Llewellyn (2000) and Dahl and Bergeson (2009) for wetland habitat mapping procedures. The resulting data should be analyzed using spatial analysis software to calculate the area of habitat created, restored, enhanced, or protected. For coastal wetland projects, see Cowardin et al. (1979) for wetland classification standards.

    - *Orthophotography:* High-resolution aerial or satellite imagery that has been orthorectified (i.e., corrected for distortions). Any source that specifically mentions using orthophotos or orthorectified imagery is included in this category.
    - *Other satellite imagery:* Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).
    - *Sonar:* Sound navigation and ranging (Sonar) includes remote sensing instruments that use a sound transmitting and receiving system to characterize subaqueous settings. This category includes instruments used to estimate water depth and map the seafloor (e.g., single beam echosounder [SBES] and multibeam echosounder [MBES]), as well as those used to search for and detect objects on the seafloor (e.g., side-scan sonar) or characterize the sediment (e.g., sub-bottom profilers, sediment profile imagery).
        - For subtidal oyster reefs, the footprint may be measured using side-scan or multi-beam sonar (Baggett et al. 2014) or professional/survey grade echo sounder.

- *Ground surveys/In situ data collection*: Ground surveys can be used to map an area for smaller projects. Refers to any data collected directly in the field, including both elevation and non-elevation data. This category includes field data collected for the purpose of validating remotely sensed data (e.g., ground-truthing). Commonly listed data sources include RTK GPS, GPS data, vegetation percent cover, or other empirical characteristics. For example, a real-time kinematic Global Positioning System (RTK GPS) may be used to take continuous measurements while walking the perimeter of the project and along the boundaries of specific habitats within the project footprint. For wetlands, standard field wetland delineation techniques should be considered for areas where wetlands transition into non-wetland habitats (Federal Interagency Committee for Wetland Delineation, 1989). The resulting data should be analyzed using spatial analysis software to calculate the area of habitat created, restored, enhanced, or protected. For coastal wetland projects, see Cowardin et al. (1979) for wetland classification standards.
    - For intertidal oyster reefs, the footprint may be measured using a surveyor's measuring wheel, laser rangefinder, or transect tape (Baggett et al., 2014).

- For subtidal oyster reefs, the footprint may be measured using a sounding pole in conjunction with GPS (Baggett et al., 2014).

Monitoring location: Area of habitat built or enhanced should be determined for the entire project footprint. Some data, such as aerial photography, may be collected over larger areas. A reference and/or control site could be established, where appropriate and applicable.

Frequency and duration: In general, monitoring is proposed pre-construction, immediately after construction (as-built), and post-construction. A baseline pre-construction condition could be established based on data obtained during the E&D period. For beaches, dunes, and barrier islands projects, monitoring is proposed immediately after construction (as-built) and every 3 years up to 10 years post-construction. For coastal wetlands projects, monitoring is proposed immediately after construction (as-built), with at least 1–2 additional monitoring events over the monitoring period. For further guidance and recommendations on wetland monitoring frequency and duration, see Tiner (1999), Neckles et al. (2002), and NAS (2017). Funding for one additional contingency monitoring event could be included in the monitoring budget, which could be implemented as needed to account for storm impacts.

Analyses: Data should be analyzed using spatial analysis software to calculate the area of habitat created, restored, enhanced, or protected. For coastal wetland projects, see Cowardin et al. (1979) for wetland classification standards.

Chlorophyll (µg/L)

A green pigment that allows plants and algae to photosynthesize and can be used as a measure of the amount of algae or phytoplankton growing or the trophic condition of a waterbody. Since phytoplankton produce chlorophyll and contain chlorophyll within their cells, phytoplankton and chlorophyll are very closely related terms, differing often only by methodology. Chlorophyll data, analyzed by various methods, are generally expressed as a mass of chlorophyll per unit volume, where phytoplankton data may be expressed by total biomass, biovolume, cell count, or diversity. Within the restoration context chlorophyll-a may be tracked in addition to other water quality parameters, (e.g., Total N, Total P).

Primary objectives:

- Restore, enhance, and protect habitats
- Restore, improve, and protect water resources
- Protect and restore living coastal and marine resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement

    - Protect natural shorelines
- Protect and restore living coastal and marine resources
    - Land acquisition
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvement

Potential methods:

- *Fluorometer*: A instrument used to measure the fluorescence of chlorophyll.
- *SM 10200 H*: Standard Methods for the Examination of Water and Wastewater Spectrophotometric Determination of Chlorophyll.
- *EPA 445.0*: Environmental Protection Agency (EPA) Method In Vitro Determination of Chlorophyll a and Pheophytin a in Marine and Freshwater Algae by Fluorescence.
- *EPA 446.0*: Environmental Protection Agency (EPA) Method In Vitro Determination of Chlorophylls a, b, $c_1 + c_2$ and Pheopigments in Marine and Freshwater Algae by Visible Spectrophotometry.
- *SM 10300 C*: Standard Methods for the Examination of Water and Wastewater Periphyton.
- *Spectrophotometer*: An analytical instrument that uses the UV and visible regions to measures the wavelength of a compound.

Monitoring location: Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Conductance/salinity (psu, ppt, or g/kg)

Conductance is one of the most useful and commonly measured water quality parameters. It is an indicator of the ability of a solution like water to conduct electricity, as measured by the amount of charged ionic species in that solution. In addition to being the basis of most salinity calculations, conductivity is an early indicator of change in a water system toward increased or reduced salinity. Most bodies of water maintain a fairly constant conductivity that can be used as a baseline of comparison to future measurements.

For RESTORE success criteria targets, values are requested in terms of salinity. Specific conductivity values (µmhos/cm at 25°C) may be converted to the unitless Practical Salinity Scale (psu). Due to their near equivalence, values may also be reported in units of ppt or g/kg (absolute salinity, S_A). For projects aiming to restore salinity regimes, a parameter tracking the spatial extent (e.g., area of habitat types) should be included to facilitate comparisons.

Primary objectives:

- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Sensor*: Sensor is a generalized term used to describe a device that detects and responds to physical properties. There are many types of sensors which may be used to measure conductance and/or salinity. Measures may be sampled discretely with a probe or meter, or continuously using a sonde and data logger.
    - *Conductivity probe or meter*
        - *EPA 120.1*: Environmental Protection Agency (EPA) Method Conductance (Specific Conductance, µmhos at 25°C) by Conductivity Meter.
- *Other devices:*
    - *Hydrometer:* An instrument used to determine relative density based on buoyancy.
    - *Density meter:* An instrument used to infer density based on vibration principles.
    - *Refractometer*: A laboratory or field instrument used to check salinity by measuring the refractive index.

- *Salinometer*: A machine used to determine the salinity of water, typically by applying a combination of conductivity sensors and resistors.

- SM 2520: Standard Methods for the Examination of Water and Wastewater Salinity (includes conductivity and density methods).

Monitoring location: Details vary according to project design.

Frequency and duration: In general, monitoring is proposed pre-construction, immediately after construction, and post-construction. A baseline pre-construction condition could be established based on information obtained during the E&D. Recommend sampling immediately following construction (as-built) and annually thereafter.

If the parameter is linked to a success criterion target, it could be monitored until the criterion has been met and then sustained for three years. Otherwise, establish a monitoring period long and frequent enough to satisfy project objectives. This may involve capturing annual/inter-annual variability based on factors that could influence salinity at the project site (e.g., precipitation, freshwater inflow).

Analyses: Details vary according to project design.

Currents (cm/s)

The rate of movement in the water.

Primary objectives:

- Restore, enhance, and protect habitats
- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions

Potential methods:

- *Current meter*: An instrument used to measure flow velocity in feet or meters per second.

- *USGS TWRI 3*: A USGS published series of manuals titled the Techniques of Water-Resources Investigations Book 3 Applications of Hydraulics.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Discharge (m^3/s)

The volume of water through a channel (e.g., stream, river, or tidal creek) within a given time period, typically in units of cubic meters per second (m^3/sec) or cubic feet per second (cfs). In general, discharge is calculated by multiplying the velocity of the water (e.g., m/s) by the cross-sectional area (m^2).

Primary objectives:

- Restore, enhance, and protect habitats
- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions

Potential methods:

- *Calculated:* Term used to note that the discharge rate was the result of a calculation. Calculate discharge by multiplying the water velocity by the cross-sectional area (m2) of the channel.
- *Acoustic Doppler Current Profiler:* An Acoustic Doppler Current Profiler (ADCP) can be used to measure both water velocity and water depth within a stream. Typically, the ADCP is mounted to a small water craft and guided along the stream channel to take the measurements.
- *Acoustic Doppler Velocity Meters:* Installation of Acoustic Doppler Velocity Meters (ADVMs) at index-velocity stream gages. Discharge is calculated using the index velocity method (Levesque and Oberg, 2012). This approach is best to calculate discharge in reaches with unsteady streamflow that prevents the development of a stage-discharge relationship.

- *Stream Gage:* For streams where a stream gage is installed, the discharge can be calculated based on a stage-discharge relation. The development of a stage-discharge relation requires numerous discharge measurements at the given reach across all ranges of streamflow (Rantz et al., 1982; Turnipseed and Sauer, 2010). However, the stage-discharge relationship cannot be applied to tidally affected areas.
- *Flowmeter:* An instrument used to measure discharge by measuring the rate of flow past the flowmeter sensors.
- *USGS TWRI 3:* A USGS published series of manuals titled the Techniques of Water-Resources Investigations Book 3 Applications of Hydraulics.

Monitoring location: Discharge should be measured or calculated for channels within the project area that are an important component of the project design. If discharge is calculated by multiplying the water velocity by the cross-sectional area, these two measurements should be taken in the same area. A reference and/or control site could be established, where appropriate and applicable.

Frequency and duration: In general, monitoring is proposed pre-construction, immediately after construction, and post-construction. A baseline pre-construction condition could be established based on information obtained during the E&D. Sampling could be conducted pre-construction (once), immediately following construction (once), and annually thereafter. Additional sampling may be needed after large storm events.

For projects with tidal influence, if continuous recorders are used, data could be collected for two weeks or longer during a sampling event to be able to capture one lunar cycle of spring and neap tides, but longer time periods (e.g., 3–4 months or year-round) are preferred. For discrete measurements, the discharge could be assessed over several tidal cycles.

For projects with riverine influence, sampling events could be designed to capture both high- and low-flow events. If continuous recorders are used, data could be collected for two weeks or longer during high- and low-water conditions, but year-round data collection for one or more years is preferred to fully capture the seasonal variability in flow conditions. For discrete measurements, the discharge could be assessed over a few weeks during both high- and low-flow conditions.

Analyses: Details vary according to project design.

Dissolved oxygen (mg/L or ppm)

The amount of gaseous oxygen dissolved in water. Dissolved oxygen may be expressed as a concentration with units of mg/L or parts per million (ppm), which are equivalent. Low dissolved oxygen can be related to decay of excessive growth of vegetation caused by excess nutrients. Projects should also include a metric and/or parameter tracking the spatial extent (e.g., area of habitat types) to facilitate comparisons.

Primary objectives:

- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Sensor:* A DO meter, water quality sonde, or data logging system can be used to record measurement data taken with a DO sensor. Data collection and calibration procedures of data sondes will be determined by the respective instrument's QA/QC procedures. Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives. See USGS (2013).
    - *EPA 360.1:* Environmental Protection Agency (EPA) Method Dissolved Oxygen by Membrane Electrode.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Elevation (m)

Elevation of the created or restored area/habitat relative to geodetic and/or tidal datums.

Primary objectives:

- Restore, enhance, and protect habitats
- Protect and restore living coastal and marine resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats

    - Land acquisition
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions

Potential methods:

- *Topographic profiles*: Topographic profiles can be done to measure land elevation by using RTK GPS surveys. Elevation is measured at evenly spaced distances along transects or on a grid, and interpolated using spatial analysis software to create a Digital Elevation Model (DEM). See CPRA (2016) for an example protocol for conducting RTK GPS ground surveys within restoration projects.
- *Airborne topographic light detection and ranging or Laser Imaging Detection and Ranging (LIDAR)*: This is an optical remote sensing technology that can measure the distance to targets by illuminating the target with laser light and analyzing the backscattered light. Ground control points should be established to calculate accuracy and ground surveys may be needed to develop ecosystem-specific correction factors in densely vegetated marshes. For additional information on the use of LIDAR to monitor marsh elevations, see Brock et al. (2002), Schmid et al. (2011), Hladik and Alber (2012), Heidemann (2014), Buffington et al. (2016), and Medeiros et al. (2015).
- *Photogrammetic surveys along transects*: Collect elevation data using stereo aerial photogrammetry, coupled with control point elevation measurements collected with RTK GPS (Smith and Vericat, 2015; Smith et al., 2016).
- *Settlement compaction rates*: For more frequent measurements of elevation to determine sediment compaction rates, settlement plates may be installed during project construction (Dunnicliff, 1993). Elevation of the plates and top of the structure can be measured using advanced surveying instrumentation (e.g., RTK GPS) and as-built elevation compared to elevation in years post-construction.

For more information, please refer to existing standards documents for LIDAR data collection from the USGS (e.g., https://pubs.usgs.gov/tm/11b4) and the American Society for Photogrammetry and Remote Sensing (e.g., https://www.asprs.org/a/society/committees/standards/Combined_Procurement_Guidelines.pdf), and bathymetric data collection from NOAA (e.g., https://nauticalcharts.noaa.gov/publications/docs/standards-and-requirements/specs/hssd-2017.pdf).

Frequency and duration: For beaches, dunes, and barrier island projects, data collection could occur pre-construction, immediately after construction (as-built), and at an appropriate

frequency and duration relevant to project-specific conditions. A baseline pre-implementation condition could be established based on information obtained during the E&D.

For marsh restoration projects, monitoring could occur immediately after construction (as-built), and post-construction at an appropriate frequency and duration relevant to project-specific conditions. Funding could also be included for an additional contingency data collection, to be implemented as needed, in response to storm impacts.

Analyses: Regardless of method employed, the elevation should be measured relative to geodetic and/or tidal datums (Rydlund and Densmore, 2012). Vertical error should be summarized for all elevation measurements, regardless of the data collection method used. Remotely sensed Photogrammetry and Remote Sensing (ASPRS) standards, the general standards for gauging vertical error in DEMs.

For beaches, dunes, and barrier islands, additional potential analyses using elevation data include shoreline change, habitat change, beach and dune profile change, volume change, bathymetric profile change, volume change, and sediment movement. For marshes, elevation data could be used to support calculation of the area of habitat built or enhanced within a particular elevation zone and to calculate the sediment compaction rate.

For more information, please refer to existing standards documents for LIDAR data collection from the USGS (e.g., https://pubs.usgs.gov/tm/11b4) and the American Society for Photogrammetry and Remote Sensing (e.g., https://www.asprs.org/a/society/committees/standards/Combined_Procurement_Guidelines.pdf), and bathymetric data collection from NOAA (e.g., https://nauticalcharts.noaa.gov/publications/docs/standards-and-requirements/specs/hssd-2017.pdf).

Enterococci (CFU/100 mL)

Bacteria of a genus present in human and animal feces and used as an indicator of fecal pollution of water bodies. Enterococcus are highly tolerant to environmental variation in temperature, pH and salinity.

Primary objectives:

- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Wastewater system improvements

Potential methods:

- *IDEXX Colilert:* A laboratory procedure that uses a nutrient indicator to determine quantitative enterococci in 24 hours.
- *EPA 1600*: Environmental Protection Agency (EPA) Method Enterococci in Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-B-D-Glusoside Agar (mEI).
- *ADEM 2064*: Alabama Department of Environmental Management Water Quality Assessment and Listing Methodology Bacteriological Sample Collection.
- *USGS TWRI*: A USGS published series of manuals titled the Techniques of Water-Resources Investigations Book 9 Handbooks for Water-Resources Investigations.
- *SM 9230 D*: Standard Methods for the Examination of Water and Wastewater Fecal Enterococcus/Streptococcus Groups Fluorogenic Substrate Enterococcus Test.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Escherichia coli (CFU/100 mL)

E. coli are indicators of recent fecal matter contamination, and that pathogens dangerous to human beings may be present. *E. coli* are a large and diverse group of bacteria found in the environment, foods, and intestines and feces of people and animals and are used as an indicator of fecal pollution of water bodies.

Primary objectives:

- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Wastewater system improvements

Potential methods:

- *IDEXX Colilert*: A laboratory procedure that uses a nutrient indicator to determine quantitative *E. coli* in 24 hours
- *Coliscan Easygel*: A patented medium and procedure approved by the EPA for determination of Escherichia coli and other coliforms in a water sample.

- *SM 9223 B*: Standard Methods for the Examination of Water and Wastewater Enzyme Substrate Coliform Test Escherichia coli.
- *EPA 1603*: Environmental Protection Agency (EPA) Method Escherichia coli (E. coli) in Water by Membrane Filtration Using Modified membrane-Thermotolerant Escherichia coli Agar (Modified mTEC).
- *USGS TWRI 9* (see Conductance).

Monitoring location: Site determination for the data collection will be determined by the project-specific objectives.

Frequency and duration: Site determination for the frequency and duration will be determined by the project-specific objectives.

Analyses: Details vary according to project design.

Fecal coliforms (CFU/100 mL)

A subset of total coliforms, fecal coliforms are distinguished by their tolerance for warmer temperatures. The fecal coliform group includes Escherichia coli. The fecal coliform parameter is used as a broad indicator of environmental contamination by human or animal waste.

Primary objectives:

- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Reduce excess nutrients and other pollutants to watersheds
  - Agriculture and forest management
  - Stormwater management
  - Wastewater system improvements

Potential methods:

- *IDEXX Colilert*: A patented medium and procedure approved by the EPA for determination of Escherichia coli and other coliforms in a water sample within 24 hours.
- *Coliscan Easygel* (see Escherichia coli).
- *SM 9221 E:* Standard Methods for the Examination of Water and Wastewater Multiple-Tube Fermentation Technique, Fecal Coliform Procedure.
- *SM 9222 D*: Standard Methods for the Examination of Water and Wastewater Membrane Filter Technique for Members of the Coliform Group Thermotolerant (Fecal) Coliform Membrane Filter Procedure.

Monitoring location: Site determination for the data collection will be determined by the project-specific objectives.

Frequency and duration: Site determination for the frequency and duration will be determined by the project-specific objectives.

Analyses: Details vary according to project design.

Land change rate (acres/year)

This parameter is the change in the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, i.e., the location of the boundary between the land and water at a particular tidal elevation. This parameter can be calculated by multiplying the annual erosion rate by the length of shoreline monitored, converted to units of acres. Units of area are requested to better support reporting across projects/programs.

Primary objectives:

- Restore, enhance, and protect habitats
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Restore hydrology and natural processes
    - Controlled river diversions
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods: GPS survey data, or by measuring shoreline locations along established transects. Comparing shoreline position over time provides information on shoreline change. Any shoreline measurement may be tied to a relevant tidal datum [e.g., mean sea level (MSL), mean high water (MHW), mean low water (MLW)]. Shoreline change should be calculated between shorelines tied to the same tidal datum. For additional information on shoreline mapping methods, see Morton et al. (2005), Fearnley et al. (2009), Martinez et al. (2009), FLDEP (2014), and Guy (2015). Several references are available for calculating shoreline change over time (e.g., Moore, 2000; Ramsey et al., 2001; Boak and Turner, 2005; Morton et al., 2005;

Thieler et al., 2009; Gens, 2010; Rangoonwala et al., 2016). See also methods for *Area of habitat types.*

- *Orthophotography*: Delineate the shoreline based on orthophotography collected by aerial survey (see Area of habitat types and Elevation for methods). Aerial surveying is a method of collecting geomatics or other imagery by using airplanes, helicopters, UAS, or other aerial methods. Imagery acquired should be orthorectified (i.e., free from distortions related to sensor optics, sensor tilt, and differences in elevation). For guidance on collecting aerial orthoimagery please see Rufe (2014). Orthoimagery for monitoring shoreline change should have a spatial resolution of at least 1 m. Additional guidance on using aerial imagery can also be found in Anders and Byrnes (1991), Crowell et al. (1991), Morton (1991), and FLDEP (2014).
- *RTK GPS ground surveys*: Walk the shoreline while taking continuous measurements using an RTK GPS. Import the spatial information into ArcGIS and map the shoreline position. For wetlands, the shoreline is defined as the lower/seaward extent of the emergent marsh vegetation. Import and analyze the data using spatial analysis software. Determine the shoreline loss/gain in meters per year. See Steyer and Llewellyn (2000) for more information on this method.
- *Permanent reference markers*: Establish permanent base stakes along the length of the shoreline at least 10 m inward of the marsh edge and determine the GPS coordinates of each base stake. Measure the linear distance from the base stake to the marsh edge along an established compass direction. The marsh edge is defined as the lower/seaward extent of the emergent marsh vegetation. Import and analyze the data using spatial analysis software. Determine the shoreline loss/gain in meters per year. See Steyer and Llewellyn (2000) for more information on this method.

Monitoring location: The shoreline change should be determined for the entire project footprint. For some collection techniques, such as aerial photography, the data will be collected for a larger area. A reference and/or control site could be established, where appropriate and applicable, to calibrate and validate remote sensing data. Spatial variation in the direction and magnitude of shoreline displacement can be measured by selecting reference and/or control points that are surveyed repeatedly over time.

Frequency and duration: In general, monitoring should be conducted pre-construction, immediately following construction, and post-construction. A baseline pre-construction condition should be established based on data obtained during the E&D. For beaches, dunes, and barrier islands, data collection could occur immediately following construction (as-built) and frequently enough to satisfy project objectives. For coastal wetlands projects, data collection could occur immediately following construction (as-built) and one–two more times over the monitoring period, or longer. In some cases, sampling throughout the year may be useful to identify seasonal patterns in erosion or accretion. Funding for contingency data collection could be included to evaluate storm impacts, as needed. The duration will ultimately depend on site-specific conditions, project objectives, and the monitoring period identified in the ODP.

Analyses: Details vary according to project design.

Light attenuation (m^{-1})

Light attenuation refers to field methods which evaluate the penetration of ambient sunlight below the water surface. Light attenuation includes methods such as Secchi disk, and may involve measuring photosynthetic active radiation (PAR).

Primary objectives:

- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship

Potential methods:

- *Photometer:* An instrument used for measuring the electromagnetic radiation by converting light into an electrical current
- *Secchi:* A passive measurement of the penetration of sunlight below the surface of a body of water. Secchi disk measurements are used to evaluate the photic zone of a body of water
- *Transmissometer:* An instrument used for measuring the extinction coefficient of water by sending a laser through the aquatic medium

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Number of facilities benefitting (count)

Number of facilities benefitting in terms of reduced risks associated with storms and flooding.

Primary objectives:

- Promote community resilience

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines

- Enhance spawning and reserves

Potential methods:

- *Flood maps*: Determining the number of properties at different categories of risk based on FEMA's Risk MAP.
- *Standard or common methods are yet to be identified for this parameter.*

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Oyster density (oysters/m^2)

The number of oysters, including recruits, per unit area. The density of live and dead oysters should be calculated separately. The age or size of recruits is project-specific and should be clearly defined (e.g., > 10 mm). Projects should also include a metric and/or parameter tracking the spatial extent (e.g., area of habitat types) to facilitate comparisons.

Primary objectives:

- Protect and restore living coastal and marine resources

Restoration approaches and techniques:

- Restore oyster habitat
  - Substrate placement
  - Living shorelines
  - Enhance spawning and reserves

Potential methods:

- *Visual observation:* Field counts of organisms using repeated sampling, for example, along transects. Place a quadrat on the reef and excavate all live and dead oysters within the quadrat. For rigid structures, place a quadrat on the surface of the reef structure and excavate to a depth necessary to collect all live oysters within the quadrat. For reefs constructed of bagged shell, take random samples by removing a bag of shell; the area sampled is the aerial coverage of the bag. Convert densities to number per m^2. If placed along a shoreline, also report a number per linear meter of shore. Stratify samples as appropriate, such as by reef height, orientation to mainland, or distance from shore. For more information see Baggett et al. (2014).
- *Sample collection:* Use hydraulic patent tongs to sample the oyster reef. Like quadrats, they sample a known area and density can be calculated. For more information see Chai et al. (1992).

Monitoring location: Samples may be taken over the entire area of the reef. See Baggett et al. (2014) for guidance on the appropriate number of samples.

Frequency and duration: Monitoring is recommended pre-restoration (once, if applicable), and at least annually for 5 years after restoration. Sampling should be performed at the end of the oyster growing season in conjunction with sampling for oyster density. If possible, sampling should occur after newly settled oysters have grown to a size greater than 10 mm and can be confidently classified as recruits (Baggett et al., 2014).

Analyses: Details vary according to project design.

Oyster size (mm)

Oyster shell height measured from the umbo to the opposite edge of the shell. Projects should also include a metric and/or parameter tracking oyster density and the spatial extent (e.g., area of habitat types) to facilitate comparisons.

Primary objectives:

- Protect and restore living coastal and marine resources

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Instrument/tool measurement*: Measure the shell height (umbo to opposite edge) of each live and dead oyster collected.

Monitoring location: Samples may be taken over the entire area of the reef. Measure at least 50 oysters per sample, or enough oysters to equal 250 per reef (Baggett et al. 2014).

Frequency and duration: Pre-restoration (once, if applicable), and at least annually for 5 years after restoration. Sampling should be performed at the end of the oyster growing season in conjunction with sampling for oyster density. If possible, sampling should occur after newly settled oysters have grown to a size greater than 10 mm and can be confidently classified as recruits (Baggett et al., 2014).

Analyses: Details vary according to project design.

Oyster survivorship/mortality (%)

The proportion of dead oysters on a reef expressed as a percentage. Projects should also include a metric and/or parameter tracking the spatial extent (e.g., area of habitat types) to facilitate comparisons.

Primary objectives:

- Protect and restore living coastal and marine resources

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Visual observation*: Divide the number of dead oysters by the total number of live and dead oysters and express as a percentage.

Monitoring location: Samples may be taken over the entire area of the reef or control sites if appropriate habitats exist in the area. Control areas could consist of natural reefs, non-reef areas, or other restoration projects depending on the restoration goals. See Baggett et al. (2014) for guidance on the appropriate number of samples and "oyster density" above.

Frequency and duration: Pre-restoration (once, if applicable), and at least annually for 5 years after restoration. Sampling should be performed at the end of the oyster growing season in conjunction with sampling for oyster density. If possible, sampling should occur after newly settled oysters have grown to a size greater than 10 mm and can be confidently classified as recruits (Baggett et al., 2014).

Analyses: Details vary according to project design.

pH (Standard Units)

The negative logarithm of the hydrogen ion concentration of a solution that is used as a measure of the acidity or alkalinity of a liquid.

Primary objectives:

- Restore, improve, and protect water resources
- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats

    - Land acquisition
    - Habitat management and stewardship
- Reduce excess nutrients and other pollutants to watersheds
    - Stormwater management
    - Wastewater system improvements

Potential methods:

- *EPA 150.1:* Environmental Protection Agency (EPA) Method Determination of pH by Electrometric Method
- *EPA 150.6:* Environmental Protection Agency (EPA) Method pH of Wet Deposition by Electrometric Determination
- *SM 4500 H+B:* Standard Methods for the Examination of Water and Wastewater pH Value in Water by Potentiometry Using a Standard Hydrogen Electrode
- *Test kit:* General term for a quick result monitoring kit used to measure pH. The pH is typically measured with testing strips or testing drop

Monitoring location: Site determination for the data collection will be determined by the project-specific objectives.

Frequency and duration: The frequency and duration will be determined by the project-specific objectives.

Analyses: Details vary according to project design.

Plant abundance (# individuals)

A measure of the number of individuals of a species that exist within a community.

Primary objectives:

- Restore and enhance natural processes and shorelines
- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Habitat management and stewardship

Potential methods:

- *Benthic grab and sieve*: Instrumentation used to collect sediment and/or organisms living on or below the surface of the benthos. The sediment and/or organisms can then be sifted through and examined.

- *Calculation/extrapolation*: Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; can include inverse distance-weighted methods of spatial interpolation for distribution.
- *Instrument/Tool measurement*: An overarching term used to encompass several tools used to collect habitat monitoring information. This can include balances/scales, calipers, chain and tape, clinometers/extendable rods, densiometers, diameter tape, depth gauges, measuring sticks/tape, and rangefinders. These tools and instruments are used to collect a wide variety of information such as bulk density and moisture content of soil/sediment samples, biomass, plant/animal size, canopy cover, vertical relief of oyster or coral reefs, and substrate depth.
- *Photo/Video imagery*: An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *Point intercept method*: Method used to characterize species and community composition and structure as well as vegetation cover at specific intervals along a transect.
- *RTK GPS*: Real-time kinematic global positioning system (RTK GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument is used for many aspects of habitat monitoring, but a few examples include creating marsh shoreline profiles and/or surveying oyster reefs.
- *Satellite imagery*: Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).
- *Sonar:* Sound navigation and ranging (Sonar) includes remote sensing instruments that use a sound transmitting and receiving system to characterize subaqueous settings. This category includes instruments used to estimate water depth and map the seafloor (e.g., single beam echosounder [SBES] and multibeam echosounder [MBES]), as well as those used to search for and detect objects on the seafloor (e.g., side-scan sonar) or characterize the sediment (e.g., sub-bottom profilers).
- *Visual observation*: An overarching term used to encompass any estimates or observations made visually. This can involve field counts of organisms; estimates of cover; observations of soil/sediment type, and species composition, and density;

notations of mortality; survivorship; disease/bleaching; and settlement/recruitment of target organisms in a wide array of habitat types.

Monitoring location: Data could be collected throughout the entire project footprint and at a reference and/or control site, where appropriate and applicable.

Frequency and duration: In general, monitoring is proposed pre-construction, immediately after construction, and post-construction. A baseline pre-construction condition could be established based on information obtained during the E&D. Recommend sampling immediately following construction (as-built) and annually thereafter.

If the parameter is linked to a success criterion target, it could be monitored until the criterion has been met and then sustained for three years. Otherwise, establish a monitoring period long and frequent enough to satisfy project objectives. This may involve capturing annual/inter-annual variability based on factors that could influence salinity at the project site (e.g., precipitation, freshwater inflow).

Analyses: Details vary according to project design.

Plant composition (%)

The makeup or contribution of individual plant species, taxonomic groups, or specific vegetation layers in a sampling unit.

Primary objectives:

- Restore, enhance, and protect habitats
- Protect and restore living coastal and marine resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shoreline

Potential methods:

- *Photo/Video imagery:* An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.

- *Point intercept method:* Method used to characterize species and community composition and structure as well as vegetation cover at specific intervals along a transect.
- *Satellite imagery*: Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).
- *Visual observation/field counts*: Establish plots within the project area and record plot locations with a GPS and/or mark the plots with corner poles to allow for revisiting over time. Determine species composition. Typical plot sizes for herbaceous vegetation are 1 to 4 m2 plots and for trees, 50 to 100 m2 plots or greater, but will be project-dependent.

Frequency and Duration: In general, monitoring is proposed pre-construction, immediately after construction, and annually post-construction until performance criteria are met and sustained for three years. Baseline pre-construction conditions could be established based on information obtained during the E&D. Monitoring could occur pre-construction, immediately after construction (as-built), and then once a year at the peak of the growing season (mid- to late summer).

More frequent monitoring is proposed during the first five years following restoration to allow for the identification of problems and the implementation of adaptive management actions as needed. As the restoration project stabilizes, less-frequent monitoring may be appropriate. Monitoring should be conducted following disturbances to assess impacts and implement adaptive management actions, if needed.

While five years of monitoring is usually sufficient to demonstrate achievement of vegetation performance criteria for herbaceous vegetation, longer monitoring durations are generally needed for forested wetlands to demonstrate successful establishment of the plant community.

Analyses: Vegetation volume may also be calculated by estimating the percent cover (and of each species if also interested in Vegetation Species Composition) and multiplying by height to provide a measure of aboveground structure. Vegetation percent cover when used in conjunction with Vegetation Species Composition can also be used to assess biological diversity, species richness, and evenness. Community composition metrics include (see Matthews et al., 2009; Magurran and McGill, 2011; and references therein for more information on these metrics):

- Simpson’s diversity index
- Shannon-Wiener index
- Mean coefficient of conservatism
- Floristic quality index (FQI) or Forested floristic quality Index (FFQI)
- Community diversity index

Plant cover (acres; km; %)

A measure of the amount of area covered by organisms or substrate types within a given extent. Cover includes percent cover, acreage, and/or basal area measurements.

Primary objectives:

- Protect and restore living coastal and marine resources
- Restore, enhance, and protect habitats
- Restore and enhance natural processes and shorelines
- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Reduce excess nutrients and other pollutants to watersheds
    - Stormwater management
    - Agriculture and forest management
    - Erosion and sediment control
    - Wastewater system improvement
- Restore hydrology and natural processes
    - Controlled river diversions
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
- Protect and conserve coastal and marine riparian habitats
    - Habitat management and stewardship
    - Land acquisition
- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines

Potential methods:

- *UAS*: Unmanned aerial systems (UAS) include an unmanned aerial vehicle (UAV), as well as the ground control, camera system, and other required systems associated with the UAV.
- *GPS:* Global positioning system (GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument

can be used to characterize shoreline and/or reef height, area, and/or elevation as well as seagrass beds. This includes differential GPS measurements.

- *Laser line-scan technolog*y: Instrument used to characterize the seafloor using a solid-state laser and a rotating mirror to produce images that can then be constructed into mosaics for analysis. The resulting images can be analyzed for faunal cluster presence and area of habitat or colony clusters.
- *Photo/Video imagery*: An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *Point intercept method*: Method used to characterize species and community composition and structure as well as vegetation cover at specific intervals along a transect.
- *Satellite imagery*: Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).
- *Sonar*: Sound navigation and ranging (Sonar) includes remote sensing instruments that use a sound transmitting and receiving system to characterize subaqueous settings. This category includes instruments used to estimate water depth and map the seafloor (e.g., single beam echosounder [SBES] and multibeam echosounder [MBES]), as well as those used to search for and detect objects on the seafloor (e.g., side-scan sonar) or characterize the sediment (e.g., sub-bottom profilers, sediment profile imagery).
- *Visual observation/Field counts*: Visual assessment of total vegetation percent cover of target and undesirable species. Establish plots within the project area and record plot locations with a GPS and/or mark the plots with corner poles to allow for revisiting over time. Estimate percent cover of each species or species category of interest (e.g., native, invasive, herbaceous layer) as defined in the project ODP. See U.S. EPA (2011) for additional guidance on performing visual estimates of vegetation percent cover. Typical plot sizes for herbaceous vegetation are 1 to 4 m2 plots and for trees, 50 to 100 m2 plots or greater, but will be project-dependent. Data collected will vary based on the project but would typically include:
    - Percent cover of individual species by layer (e.g., herbaceous, shrubs, canopy), percent cover of native species, or percent cover of invasive species, if present.

For additional information on measuring and analyzing plant cover and composition, see Knapp (1984), Elzinga et al. (1998), Coulloudon et al. (1999), Bonham (2013), and Folse et al. (2014).

Monitoring Location: Vegetation percent cover should be measured throughout the entire project footprint. For hydrologic restoration projects, transects typically go from areas of higher hydrologic influence (such as close to creeks) to areas of lower hydrologic influence (such as interior marshes). A reference and/or control site could be established, where appropriate and applicable.

Frequency and Duration: In general, monitoring is proposed pre-construction, immediately after construction, and annually post-construction until performance criteria are met and sustained for three years. Baseline pre-construction conditions could be established based on information obtained during the E&D. Monitoring could occur pre-construction, immediately after construction (as-built), and then once a year at the peak of the growing season (mid- to late summer). More frequent monitoring is proposed during the first five years following restoration to allow for the identification of problems and the implementation of adaptive management actions as needed. As the restoration project stabilizes, less-frequent monitoring may be appropriate. Monitoring should be conducted following disturbances to assess impacts and implement adaptive management actions, if needed. While five years of monitoring is usually sufficient to demonstrate achievement of vegetation performance criteria for herbaceous vegetation, longer monitoring durations are generally needed for forested wetlands to demonstrate successful establishment of the plant community.

Analyses: Details vary according to project design.

Plant density (# individuals per m^2)

Abundance of vegetation in a given area (typically in units of number of individuals or objects per m^2). The term refers to the closeness of individual plants to one another. The number of organisms per unit area.

Primary objectives:

- Restore, enhance, and protect habitats
- Restore and enhance natural processes and shorelines

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardships
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management

- Stormwater management
- Erosion and sediment control
- Wastewater system improvements

Potential methods:

- *Calculation/extrapolation*: Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; can include inverse distance-weighted methods of spatial interpolation for distribution.
- *Photo/video imagery*: An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *Satellite imagery*: Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).
- *Visual observation*: Use a quadrat to estimate plant species density within a defined area (e.g., 1 x 1-m plots or 2 x 2-m plots).

Monitoring location: Details vary according to project design.

Frequency and Duration: In general, monitoring is proposed (pre-construction, immediately after construction, and post-construction). A baseline pre-construction condition should be established if possible. Data collections could occur pre-construction, immediately after construction (could be included in as-built), and every three years for the minimum monitoring period. One additional contingency data collection could be included in the monitoring plan to be implemented as needed to account for storm impacts.

Analyses: Details vary according to project design.

Plant distribution (mean %; m^2; # individuals/species)

Measures of how organisms are spread out over a given area.

Primary objectives:

- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes

Potential Methods:

- *Calculation/Extrapolation*: Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; can include inverse distance-weighted methods of spatial interpolation for distribution.
- *GPS:* Real-time kinematic global positioning system (RTK GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument is used for many aspects of habitat monitoring, but a few examples include creating marsh shoreline profiles and/or surveying oyster reefs.
- *Instrument/tool measurement:* An overarching term used to encompass several tools used to collect habitat monitoring information. This can include balances/scales, calipers, chain and tape, clinometers/extendable rods, densiometers, diameter tape, depth gauges, measuring sticks/tape, and rangefinders. These tools and instruments are used to collect a wide variety of information such as bulk density and moisture content of soil/sediment samples, biomass, plant/animal size, canopy cover, vertical relief of oyster or coral reefs, and substrate depth.
- *Laser line-scan technology*: Instrument used to characterize the seafloor using a solid-state laser and a rotating mirror to produce images that can then be constructed into mosaics for analysis. The resulting images can be analyzed for faunal cluster presence and area of habitat or colony clusters.
- *Photo/Video imagery*: An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.

- *Point-pattern analysis*: Method used to characterize spatial patterns over time and at different scales (i.e., the clumping, randomness, or dispersed distribution of stem-mapped trees).
- *Remote sensing*: Method that uses remotely collected data (e.g., aerial photography, video, satellite imagery) to characterize habitats.
- *Visual observation*: An overarching term used to encompass any estimates or observations made visually. This can involve field counts of organisms; estimates of cover; observations of soil/sediment type, and species composition, and density; notations of mortality; survivorship; disease/bleaching; and settlement/recruitment of target organisms in a wide array of habitat types.

Monitoring location: Details vary according to project design.

Frequency and duration: In general, monitoring is proposed (pre-construction, immediately after construction, and post-construction). A baseline pre-construction condition should be established if possible. Data collections could occur pre-construction, immediately after construction (could be included in as-built), and every three years for the minimum monitoring period. One additional contingency data collection could be included in the monitoring plan to be implemented as needed to account for storm impacts.

Analyses: Details vary according to project design.

Plant survivorship/mortality (%)

Survivorship: A measure of the number or proportion of individuals surviving to each life stage for a given species or group.

Mortality: A measure of how many organisms die over a given time frame. Mortality includes all measures related to mortality (i.e., mortality rate, percent recent mortality, and percent dead cover).

For consistency across RESTORE Council-funded projects/programs, please provide success criteria targets and other data in terms of standardized survivorship.

Primary objectives:

- Restore, enhance and protect habitats

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
  - Sediment placement
  - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
  - Land acquisition

    - Habitat management and stewardship
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements

Potential methods:

- *Calculation/Extrapolation*: Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; and can include inverse distance-weighted methods of spatial interpolation for distribution.
- *Photo/Video imagery*: An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *Visual observation*: An overarching term used to encompass any estimates or observations made visually. This can involve field counts of organisms; estimates of cover; observations of soil/sediment type, species composition, and/or density; and/or notations of mortality, survivorship, disease/bleaching, and settlement/recruitment of target organisms in a wide array of habitat types.
- *Instrument/Tool measurement*: An overarching term used to encompass several tools used to collect habitat monitoring information. This can include balances/scales, calipers, chain and tape, clinometers/extendable rods, densiometers, diameter tape, depth gauges, measuring sticks/tape, and rangefinders. These tools and instruments are used to collect a wide variety of information such as bulk density and moisture content of soil/sediment samples, biomass, plant/animal size, canopy cover, vertical relief of oyster or coral reefs, and substrate depth.

Monitoring location: Details vary according to project design,

Frequency and duration: In general, monitoring is proposed pre-construction, immediately after construction, and post-construction. A baseline pre-construction condition could be established based on information obtained during the E&D. Recommend sampling immediately following

construction (as-built) and annually thereafter. If the parameter is linked to a success criterion target, it could be monitored until the criterion has been met and then sustained for three years. Otherwise, establish a monitoring period long and frequent enough to satisfy project objectives. This may involve capturing annual/inter-annual variability based on factors that could influence salinity at the project site (e.g., precipitation, freshwater inflow).

Analyses: Details vary according to project design.

Reef height (m)

The elevation of intertidal or subtidal reef habitat. Projects should also include a metric and/or parameter tracking the spatial extent (e.g., area of habitat types) to facilitate comparisons. See also the elevation parameter for similar methodologies. **Primary objectives:**

- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Survey equipment*: Instrumentation used to determine reef height during oyster reef surveys. This can include level and rod or transit pole and self-leveling laser.
    - *Level/rod*: Instrument used to measure elevation along a transect in a variety of habitats. A stadia or leveling rod is carried along a transect starting at USGS markers with known elevations and pausing along the transect at each elevation change for readings.
    - *RTK GPS:* Used in shallow water to conduct a bathymetric survey.
- *Remote sensing*: Bathymetric surveys can be performed to collect elevation data by using sonar (e.g., echo sounder/single beam sonar, multibeam sonar, or interferometric side scan sonar [ISSS]).

For guidance on elevation (reef height) monitoring for oysters, consult Baggett et al. (2014). For potential guidance on RTK GPS and/or single-beam sonar, see Sallenger et al. (2003), Morton et al. (2005), Stockdon et al. (2009), Guy and Plant (2014), Heidemann (2014), and Smith et al. (2016). Elevation data acquired from remote sensing should have vertical error reporting and adhere to the ASPRS standards, the general standards for gauging vertical error in DEMs.

Monitoring location: Monitoring should provide coverage for the entire area occupied by the reef.

Frequency and duration: Data should be collected immediately after project implementation and annually for up to five years following implementation. Additional measurements could be taken after events that could alter reef height, such as storms, or extended periods of water quality detrimental to oyster survival (e.g., low salinity events).

Analyses: Data from side-scan sonar can be digitized into raster data and analyzed in ArcGIS or other software. Combining reef height and area information allows calculation of reef volume (area * mean height = reef volume).

Sediment classification/composition (% bedrock, % silt, etc.)

Measures of physical characteristics of sediment used for classification. Sediment classification includes bulk density, grain size, texture, moisture levels, soil type, and the makeup of the substrate in a given area (i.e., % bedrock, % silt, etc.).

Primary objectives:

- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines

Potential methods:

- *Visual and/or tactile observation:* An overarching term used to encompass any technique to describe soil/sediment type and/or grain size either visually or tactilely. Additionally, observations of soil/sediment subsidence, depth, and/or oxidation can be made.
- *Sieve analysis*: Method of using sieves to determine grain sizes of sediment samples by drying the samples in an oven and then passing the sample through sieves of varying sizes.
- *Instrument/Tool measurement*: Various tools used to collect a wide variety of information such as bulk density and moisture content of soil/sediment samples, and substrate depth.
- *Sediment logging:* A suite of techniques used to describe physical (e.g., stratigraphy) and chemical properties of sediment cores such as gamma ray attenuation or magnetic susceptibility.
- *Laser analysis*: Method of determining the soil particle size distribution via laser diffraction.
- *Photo/Video imagery*: measurement or observation made via photographic or video imagery.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Settlement/recruitment (spat/m^2)

Oyster settlement is defined as the point at which a larva attaches to the substrate or metamorphoses into benthic form (Wildish and Kristmanson, 1997; Baggett et al., 2014). This differs from recruitment, which includes settlement and some period of post-settlement survival (Baggett et al., 2014). Projects should also include a metric and/or parameter tracking the spatial extent (e.g., area of habitat types) to facilitate comparisons.

Primary objectives:

- Protect and restore living coastal and marine resources

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Visual observation*: Divide the number of dead oysters by the total number of live and dead oysters and express as a percentage.
    - *Settlement Plates or Shell Strings*: Deploy settlement plates or shell strings. Collect and replace plates every 3 or 4 weeks. More frequent replacement will yield finer-scale temporal patterns of settlement. Report as # of spat/m2 unit area per day.
    - *Quadrat*: Estimates of settlement may be obtained from quadrat samples used for density estimates. The number of oyster spat/quadrat should be expressed in #/m^2, per day if possible, so that density can be compared between project types and sites. If the project is a living shoreline or is designed to protect a marsh shoreline, then also report the number of spat per linear meter of shoreline.
    - *Shell Bags*: If sampling with mesh bags filled with oyster shell, bags should be placed adjacent to or directly on the site of interest. Record the number and volume of bags of cultch material. The area sampled is the coverage area of the bag. Report as #/m^2, per day if possible, but also record #spat/weight and/or bag of pre-deployed shell.

- *Oyster dredge:* For an oyster dredge, tow for a specified time and method (e.g., linear or circular tow direction, speed). Measure the dredge width and tow distance to calculate the area swept. Correct for dredge efficiency as appropriate. Use the area swept to estimate and report #/m^2 (per day if possible), but also record # spat/L of shell and/or average # spat/individual shell.

Monitoring location: Samples may be taken across the entire reef area as appropriate.

Frequency and duration: Deploy plates or shell strings annually beginning the first week of April. Collect and replace plates or strings at least every 3 or 4 weeks until the end of the known settlement season for the area. Quadrat, shell bag, and dredge sampling may be conducted annually, preferably after fall settlement.

Analyses: Details vary according to project design.

Species abundance (# individuals)

A measure of the number of individuals of a species that exist within a community. **Primary objectives:**

- Protect and restore living coastal and marine resources
- Restore enhance and protect habitats
- Restore, improve and protect water resources

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Protect natural shorelines
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Protect and conserve coastal, estuarine, and riparian habitats
    - Habitat management and stewardship
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements

Potential methods:

- *Benthic grab and sieve*: Instrumentation used to collect sediment and/or organisms living on or below the surface of the benthos. The sediment and/or organisms can then be sifted through and examined.
- *Calculation/extrapolation*: Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; can include inverse distance-weighted methods of spatial interpolation for distribution.
- *Instrument/Tool measurement*: An overarching term used to encompass several tools used to collect habitat monitoring information. This can include balances/scales, calipers, chain and tape, clinometers/extendable rods, densiometers, diameter tape, depth gauges, measuring sticks/tape, and rangefinders. These tools and instruments are used to collect a wide variety of information such as bulk density and moisture content of soil/sediment samples, biomass, plant/animal size, canopy cover, vertical relief of oyster or coral reefs, and substrate depth.
- *Photo/Video imagery*: An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *Point intercept method*: Method used to characterize species and community composition and structure as well as vegetation cover at specific intervals along a transect.
- *RTK GPS*: Real-time kinematic global positioning system (RTK GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument is used for many aspects of habitat monitoring, but a few examples include creating marsh shoreline profiles and/or surveying oyster reefs.
- *Satellite imagery*: Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).
- *Sonar:* Sound navigation and ranging (Sonar) includes remote sensing instruments that use a sound transmitting and receiving system to characterize subaqueous settings. This category includes instruments used to estimate water depth and map the seafloor (e.g., single beam echosounder [SBES] and multibeam echosounder

[MBES]), as well as those used to search for and detect objects on the seafloor (e.g., side-scan sonar) or characterize the sediment (e.g., sub-bottom profilers).

- *Visual observation*: An overarching term used to encompass any estimates or observations made visually. This can involve field counts of organisms; estimates of cover; observations of soil/sediment type, and species composition, and density; notations of mortality; survivorship; disease/bleaching; and settlement/recruitment of target organisms in a wide array of habitat types.

Monitoring location: Conway (2011) provides a discussion of survey site selection. The protocol recommends the establishment of permanent survey sites along a survey route.

Frequency and duration: In general, monitoring is proposed pre-restoration (once, if applicable) and annually for five years, or longer, after restoration.

Analyses: Details vary according to project design.

Species composition

The collection of species within an area. Can be expressed as a list of individual species or proportion of each species within a given area. The makeup or contribution of all the groups of organisms living together in the same area. Composition includes species and community composition. Data should be presented as density (individuals/m^2), wet weight (g/m^2), and length-frequency distributions per species.

Primary objectives:

- Protect and restore living coastal and marine resources
- Restore and enhance natural processes and shorelines
- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes

    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements

Potential methods:

- *Benthic grab/sieve*: Instrumentation used to collect sediment and/or organisms living on or below the surface of the benthos. The sediment and/or organisms can then be sifted through and examined.
- *Photo/Video imagery:* An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *Point intercept method:* Method used to characterize species and community composition and structure as well as vegetation cover at specific intervals along a transect.
- *Satellite imagery*: Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).
- *Visual observation*: An overarching term used to encompass any estimates or observations made visually. This can involve field counts of organisms; estimates of cover; observations of soil/sediment type, and species composition, and density; notations of mortality; survivorship; disease/bleaching; and settlement/recruitment of target organisms in a wide array of habitat types.

Monitoring location: Details vary according to project design.

Frequency and duration: Post-construction observations could be made immediately following construction (as-built) and annually for five years post-construction. Additional observations may be needed following extreme weather events. Intervals between monitoring could be predetermined by the risk associated with particular failure mechanisms, structural elements, foundation conditions, exposure conditions, and design criteria.

Analyses: Details vary according to project design.

Species density (individuals or objects per m^2)

The number of organisms per unit area.

Primary objectives:

- Protect and restore living coastal and marine resources
- Restore and enhance natural processes and shorelines
- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control

Potential Methods:

- *Calculation/extrapolation*: Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; can include inverse distance-weighted methods of spatial interpolation for distribution.
- *Photo/Video imagery*: An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *Satellite imagery*: Multispectral imagery that is collected from satellite sensors (e.g., Landsat, Sentinel-2).

- *Visual observation*: An overarching term used to encompass any estimates or observations made visually. This can involve field counts of organisms; estimates of cover; observations of soil/sediment type, and species composition, and density; notations of mortality; survivorship; disease/bleaching; and settlement/recruitment of target organisms in a wide array of habitat types.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Subsidence/accretion

Subsidence: The gradual caving in or sinking of an area of land. Physical processes influencing the coastal zone.

Primary objectives:

- Restore, improve, and protect water resources
- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship

Potential methods:

- *Calculation/Extrapolation*: Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; can include inverse distance-weighted methods of spatial interpolation for distribution.
- *Chalk block dissolution*: A proxy measurement of erosion rate wherein chalk blocks dissolution rates are measured in situ (i.e., in seagrass beds).
- *GPS*: Global positioning system (GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument

can be used to characterize shoreline and/or reef height, area, and/or elevation as well as seagrass beds. This includes differential GPS measurements.

- *GPS/Total station*: Instruments used to establish benchmark elevations for rod surface elevation table benchmarks to determine wetland elevation.
- *Level/rod*: Instrument used to measure elevation along a transect in a variety of habitats. A stadia or leveling rod is carried along a transect starting at USGS markers with known elevations and pausing along the transect at each elevation change for readings.
- *Photo/video imagery:* An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *RTK GPS*: Real-time kinematic global positioning system (RTK GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument is used for many aspects of habitat monitoring, but a few examples include creating marsh shoreline profiles and/or surveying oyster reefs.
- *SET*: Instruments used to determine land elevation. Surface Elevation Tables (SETs) are constructed from in situ benchmarks that horizontal leveling arms are attached to which pins can be raised or lowered to the surface of the sediment.
- *Total plot/station*: Instrument used to perform topographic surveys along transects that can allow for characterization of vertical accretion and/or subsidence.
- *Visual and/or tactile observation*: An overarching term used to encompass any technique to describe soil/sediment type and/or grain size either visually or tactilely. Additionally, observations of soil/sediment subsidence, depth, and/or oxidation can be made.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

***Vertical accretion*:** A measure of the accumulation of sediment over time. Within the CMAP application, vertical accretion is a parameter subgroup contained under the abiotic general parameter.

Primary objectives:

- Restore, improve, and protect water resources

- Restore, enhance, and protect habitats

Restoration approaches and techniques:

- Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands
    - Sediment placement
    - Protect natural shorelines
- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship

Potential methods:

- *Ancillary data*: Refers to a pre-existing data source used to help collect or analyze a mapping parameter. This category includes everything from large national datasets (e.g., USGS National Hydrography Dataset, National Land Cover Database, soil datasets) to local and regional maps or datasets.
- *Calculation/Extrapolation:* Includes larger scale abundance, survivorship, substrate texture class, colony surface area, density, and biomass calculations and estimates based on observations in quadrats or measures of diameter at breast height, or sediment/soil samples; calculations of bulk density; estimates of subsidence/vertical accretion of shorelines; estimates of primary productivity based on biomass measures; can include inverse distance-weighted methods of spatial interpolation for distribution.
- *Dated Horizon:* Method of measuring vertical accretion of sediments.
- *Elemental analysis*: Term encompassing several methodologies aimed at characterizing or measuring the concentrations of various components of soil/sediment samples (i.e., organic pollutants, hydrocarbons, metals, organic matter, nutrients, and/or mercury).
- *GPS:* Global positioning system (GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument can be used to characterize shoreline and/or reef height, area, and/or elevation as well as seagrass beds. This includes differential GPS measurements.
- *GPS/Total station:* Instruments used to establish benchmark elevations for rod surface elevation table benchmarks to determine wetland elevation.
- *Isotopes/Stable isotope analysis*: Method of analysis used to characterize sedimentation rate and substrate geochemistry (i.e., to reconstruct temperature records from carbonate rock or to determine the origination point of samples).

- *LIDAR*: Light detecting and ranging (LIDAR) is a method of measuring bathymetric, topographic, or shoreline profile data using optical remote sensing technology.
- *Orthophotography*: High-resolution aerial or satellite imagery that has been orthorectified (i.e., corrected for distortions). Any source that specifically mentions using orthophotos or orthorectified imagery is included in this category.
- *Photo/Video imagery:* An overarching term used to encompass any measurement or observation made via photographic or video imagery at scales ranging from aerial surveys to repetitive photo sites. This may include any of the following: species or community composition of benthic or terrestrial ecosystems, observed instances of disease, coral bleaching, habitat distribution, habitat cover, density, size of organisms, records of survivorship, mortality, and characterized elevation.
- *RTK GPS*: Real-time kinematic global positioning system (RTK GPS) is an instrument that uses satellite-based positioning systems to characterize height and position (e.g., x, y, z). This instrument is used for many aspects of habitat monitoring, but a few examples include creating marsh shoreline profiles and/or surveying oyster reefs.
- *Surface elevation table (SET)*: Instruments used to determine land elevation. SETs are constructed from in situ benchmarks that horizontal leveling arms are attached to which pins can be raised or lowered to the surface of the sediment. This can also include rod surface elevation tables (RSET), level/rod, and feldspar methodologies/instruments.
- *Total plot/station*: Instrument used to perform topographic surveys along transects that can allow for characterization of vertical accretion and/or subsidence.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Substrate geochemistry

Measures related to the chemical composition of the sediment in a given area. Substrate geochemistry includes nutrient concentrations, redox potential, metal concentration, organic pollutants, and organic content.

Primary objectives:

- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats

        - Land acquisition
        - Habitat management and stewardship
    - Restore hydrology and natural processes
        - Restore hydrologic connectivity
        - Restore natural salinity regimes
        - Controlled river diversions
    - Reduce excess nutrient and other pollutants to watersheds
        - Agriculture and forest management

Potential methods:

- *Elemental analysis*: encompasses several methodologies aimed at characterizing or measuring the concentrations of various components of soil/sediment samples (i.e., organic pollutants, hydrocarbons, metals, organic matter, nutrients, and/or mercury).
- *Isotopes/Stable isotope analysis*: Method of analysis used to characterize sedimentation rate and substrate geochemistry (i.e., to reconstruct temperature records from carbonate rock or to determine the origination point of samples).
- *Loss on ignition*: Method used to determine the organic matter of soil samples by measuring the change in weight after combustion.

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Suspended sediment concentration (mg/L or ppm)

A measure of how much sediment is suspended and transported in a body of water. Suspended sediment concentration data are produced by measuring the dry weight of all the sediment from a known volume of a water-sediment mixture.

Primary objectives:

- Restore, enhance, and protect habitats
- Restore, improve, and protect water resources
- Protect and restore living coastal and marine resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *USGS TM 5-C1:* USGS Techniques of Water-Resources Investigations Laboratory Theory and Methods for Sediment Analysis

Monitoring location: Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Total nitrogen (mg/L or ppm)

The sum of organic nitrogen, nitrate (NO3), and nitrite (NO2), ammonia (NH3), and ammonium (NH4+). Excess nitrogen in aquatic environments can result in eutrophication, algal blooms, and low levels of dissolved oxygen. This parameter includes data expressed as either compound mass per unit volume or as nitrogen mass per unit volume, and includes the fractional results, dissolved (filtered), total (unfiltered), or suspended (unfiltered - filtered). TN and total phosphorus (TP) measurements are the United States Environmental Protection Agency's

preferred metrics for evaluating nutrient concentrations in waters of the United States (Stoner, 2011).

Primary objectives:

- Restore, enhance and protect habitats
- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Auto analyzer*: General term for laboratory instrumentation that is automated such as continuous flow analysis and flow injection analyzers.
- *EPA 351.1*: Environmental Protection Agency (EPA) Method Total Kjeldahl Nitrogen (Colorimetric, Automated Phenate) by Autoanalyzer.
- *EPA 351.2*: Environmental Protection Agency (EPA) Method Determination of Total Kjeldahl Nitrogen by Semi-Automated Colorimetry.

- *EPA 353.2*: Environmental Protection Agency (EPA) Method Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry.
- *SM 4500 N*: Standard Methods for the Examination of Water and Wastewater Nitrogen.
- *Spectrophotometer*: An analytical instrument that uses the UV and visible regions to measure the wavelength of a compound.
- *USGS I-3556-77*: USGS Test Method Total Nitrogen, water, unfiltered, calculated.
- *USGS OFR 00-170*: USGS Open-File Report Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory — Determination of ammonium plus organic nitrogen by a Kjeldahl digestion method and an automated photometric finish that includes digest cleanup by gas diffusion.
- *USGS OFR 93-125*: USGS Open-File Report Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory; determination of inorganic and organic constituents in water and fluvial sediments.

Monitoring Location: Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives. See the U.S. Geological Survey National Field Manual for the Collection of Water-Quality Data (https://water.usgs.gov/owq/FieldManual/).

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Total phosphorus (milligrams per liter [mg/L] or parts per million [ppm])

A measure of the sum of all phosphorus compounds. This parameter includes data expressed as either compound mass per unit volume or as phosphorus mass per unit volume, and includes the fractional results, dissolved (filtered), total (unfiltered), or suspended (unfiltered - filtered).

Primary objectives:

- Restore, enhance and protect habitats
- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship

- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *EPA 365.1*: Environmental Protection Agency (EPA) Method Determination of Phosphorus by Semi-Automated Colorimetry.
- *EPA 365.4*: Environmental Protection Agency (EPA) Method Total Phosphorus (Colorimetric, Automated, Block Digester AA II).
- *SM 4500 P*: Standard Methods for the Examination of Water and Wastewater Phosphorus.

Monitoring location: Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Total suspended solids (milligrams per liter [mg/L] or parts per million [ppm])

The dry weight of solids suspended in water that can be trapped by a filter. This can include silt, decaying plant/animal matter, sewage, industrial waste, etc.

Primary objectives:

- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *EPA 160.2*: Environmental Protection Agency (EPA) Method Residue, Non-Filterable (Gravimetric, Dried at 103-105oC).
- *SM 2540 D*: Standard Methods for the Examination of Water and Wastewater Total Suspended Solids Dried at 103-105oC.
- *USGS TWRI B5-A1*: A USGS published series of manuals titled the Techniques of Water-Resources Investigations Book 5 Water Analysis, A1 Methods for determination of inorganic substances in water and fluvial sediments.

Monitoring location: Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Turbidity (NTU)

A measure of relative clarity of a liquid. Turbidity is measured by illuminating the water with a light source of specific wavelength, the sensor measures the scatter of light, giving a light attenuation measurement that is independent of ambient light. Due to the specificity of the instrument's light source and sensor, turbidity measurement from different models of turbidity sensors can vary significantly.

Primary objectives:

- Restore, enhance, and protect habitats
- Restore, improve, and protect water resources
- Protect and restore living coastal and marine resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Protect and conserve coastal, estuarine, and riparian habitats
    - Land acquisition
    - Habitat management and stewardship
- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions
- Reduce excess nutrients and other pollutants to watersheds
    - Agriculture and forest management
    - Stormwater management
    - Erosion and sediment control
    - Wastewater system improvements
- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *EPA 180.1*: Environmental Protection Agency (EPA) Method Determination of Turbidity by Nephelometry.
- *SM 2130*: Standard Methods for the Examination of Water and Wastewater Turbidity by Nephelometric Method.
- *Test kit*: General term for a quick result monitoring kit used to measure turbidity.
- *Turbidimeter*: An instrument that measures the surface area of suspended particles to determine the clarity of a sample.
- *USGS I-3860-85*: USGS Test Method Turbidity, Nephelometric.

Monitoring location: Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design.

Water level (m)

The height reached by the water in a reservoir, river, etc. Water level measurements or estimates can be used to characterize the flooding regimes across the range of habitats restored, including the depth, frequency, and duration of flooding on the marsh surface and within any channels. When channels are an important feature of the project design, water level in the channel(s) should be measured or calculated at mean low tide to evaluate access to marsh surface for marine organisms.

Primary objectives:

- Restore, enhance, and protect habitats
- Restore, improve, and protect water resources
- Restore and enhance natural processes and shorelines
- Promote community resilience

Restoration approaches and techniques:

- Restore hydrology and natural processes
    - Restore hydrologic connectivity
    - Restore natural salinity regimes
    - Controlled river diversions

Potential methods:

- *Measuring stick*: A simple method of using a marked stick or rod to determine water level**.** Deploy multiple water level recorders to collect continuous measurements across the restored habitats.
- *USGS TWRI 3*: A USGS published series of manuals titled the Techniques of Water-Resources Investigations Book 3 Applications of Hydraulics.
- *Weighted line*: Field method of using a properly distance marked rope or lead line weighted at the end to determine water depth.
- Collect elevation/bathymetry data and install a single water level recorder to monitor the water surface elevation at one point, and calculate water levels across the marsh surface based on the elevation data. Assumes hydrologic connectivity is uniform across project area.
- Collect elevation/bathymetry data and utilize data from an existing permanently deployed water level recorder(s) within or near the project site to calculate water levels across the marsh surface based on the elevation data.
- Install staff gauges at specific locations and make measurements by visual inspection, in combination with installation of one or more continuous water level recorders.
- To evaluate water level in narrow channels, take in-situ measurements using water level loggers along the created channel during mean low tide, including the channel openings or on either side of culverts, or other features that could constrict flow.

Monitoring location: Spatial distribution of water level recorders will depend on the project type and the hydrologic characteristics of the project area. Potential locations for water level recorders include near the source of restored hydrologic flows, within the project boundary, near the edge of the influenced area, and outside the influenced area, if adjacent to other habitats. A reference and/or control site could be established, where appropriate and applicable.

Frequency and duration: Frequency and duration will be project-dependent based on objectives and the need for corrective actions, but in general monitoring is proposed pre-construction, immediately after construction (as-built), and annually post-construction.

If continuous recorders are used, data could be collected for two weeks or longer during a sampling event to capture one lunar cycle of spring and neap tides, but longer time periods (e.g., three–four months or year-round) are preferred. Frequency of measurement from continuous recorders (tide gauges and water level loggers) can vary from every five minutes to every hour, and could be selected based on the resolution needed to meet project objectives.

If discrete measurements are taken, the water level should be assessed over several tidal cycles.

For projects with riverine influence, sampling events could be designed to capture both high and low-flow events. If continuous recorders are used, data could be collected for at least two weeks during high- and low-water conditions, but year-round data collection for one or more years is preferred to fully capture seasonal variability in the water level. If discrete measurements are taken, the water level should be assessed over a few weeks during both high- and low-flow conditions.

Analyses: Bathymetric profile change, sediment movement, hydrologic connectivity, saturation of root zone, accessibility by fish or waterbirds, and meteorological events and conditions.

Water temperature (°C)

A measure of the warmth or coldness of water with reference to some standard value. Projects should also include a metric and/or parameter tracking the spatial extent (e.g., area of habitat types) to facilitate comparisons.

Primary objectives:

- Restore, improve, and protect water resources

Restoration approaches and techniques:

- Restore oyster habitat
    - Substrate placement
    - Living shorelines
    - Enhance spawning and reserves

Potential methods:

- *Sensor*: Can be obtained using a thermometer or temperature probe. Data collection and calibration procedures of detection instruments will be determined by the respective instrument's QA/QC procedures. Site determination for the data collection, as well as the frequency and duration, will be determined by the project-specific objectives. See also Wagner et al. (2006).

Monitoring location: Details vary according to project design.

Frequency and duration: Details vary according to project design.

Analyses: Details vary according to project design

F.10.0 Metric reference table

Table F.10.0. Metrics available for selection in PIPER, organized by Planning Framework approaches and techniques. Guidance provided in this table may be superseded by any updates made subsequent to the approval of this document. An up-to-date version of the table is available through the Council's website: https://restorethegulf.gov/files/PIPER-Metrics

Approach	Technique	Metric	Name	Description	Tracking the metric
Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands	*Sediment placement*	HR013	Wetland and shoreline habitat - Acres restored	Enter the number of acres restored (i.e., the project footprint), including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Other examples include cubic volume or mass of sediment deposited and number of vegetation plugs installed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support primary objectives for this technique.
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
	Protect natural shorelines	HR002	Shoreline protection - Miles of shoreline protection installed	Enter the miles of shoreline protection installed. This should be selected and reported for coastal habitat shoreline restoration projects that protect against erosion, including construction of foreshore rock dikes and reef breakwaters. Living shoreline projects should instead select HR012.	The activity completion parameter(s) should include miles of shoreline protection installed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR012	Shoreline protection - Miles of living shoreline installed	Enter the number of miles of living shoreline installed to buffer against shoreline erosion. Where applicable, use the notes field to indicate the width of the living shoreline (in feet). When conducting shoreline protection, always also select metric "HR014 - Habitat restoration - Land change rate."	The activity completion parameter(s) should include miles of living shoreline protection installed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR013	Wetland and shoreline habitat - Acres restored	Enter the number of acres restored (i.e., the project footprint), including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.	The activity completion parameter(s) should include acres restored (i.e., acres over which restoration activities were implemented). Other examples include number of vegetation plugs installed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. For activities that employ shoreline protection to reduce erosion, use pre-implementation data to update the metric baseline value in PIPER. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support primary and some secondary objectives for this technique.
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
Protect and conserve coastal, estuarine, and riparian habitats	*Land acquisition*	HC001	Conservation easements - Acres protected under easement	Enter the number of acres protected under long-term easement (permanent or >30-yr). Acres protected under easement should always be brought under improved management.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique.
		HC002	Conservation easements - Miles of shoreline protected under easement	Enter the number of miles under long-term easement (permanent or >30yr). This includes miles of shoreline in coastal streams or open coast (i.e., beaches). Miles protected under easement should always be brought under improved management.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed). If measures of area are not possible, miles may be used. Activity completion parameters are not sufficient to support the goals/objectives of this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HC003	Land acquisition - Acres acquired in fee	Enter the number of acres acquired in fee. Acres acquired in fee should always be brought under improved management.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique.
		HC004	Land acquisition - Miles of shoreline acquired in fee	Enter the number of miles acquired. This includes miles of shoreline in coastal streams or open coast (i.e., beaches). Miles acquired in fee should always be brought under improved management.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed). If measures of area are not possible, miles may be used. Activity completion parameters are not sufficient to support the goals/objectives of this technique.
		HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
	Habitat management and stewardship	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
		HM005	Agricultural BMPs - Acres under contracts/ agreements	Enter the number of acres under contract(s) or agreement(s) to implement BMPs on privately owned land. This is typically agricultural land, but may include silvicultural or other land use types. Each acre should be entered only once (i.e., enter the number of acres under the contract/agreement, not the acres under individual BMPs, which may "double count" acres). Always also select the metric for # people enrolled (COI003). Other metrics may be selected to capture specific restoration activities, but do not count acreage toward the habitat restoration metrics HR004 - HR007, HR010, or HR013 (in order to avoid double counting).	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique.
		HR004	Upland or other habitat - Acres restored	Enter the number of acres restored. Habitat included in this metric has been restored to original (or target) habitat and ecosystem function. This metric should be used for habitats that span outside (or occur beyond) habitats captured by other metrics, such as upland forests.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR005	Artificial reef - Acres created/restored	Enter the number of acres impacted by the addition of artificial reefs and other habitat enhancements to benefit offshore marine life.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR007	SAV habitat - Acres restored	Enter the number of acres of submerged aquatic vegetation restored.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR008	Removal of invasive species - Acres restored	Enter the number of acres restored to native vegetation through the removal of invasive exotics. Acres counted using this metric should not overlap with acres counted toward restoration of wetlands or other habitats (i.e., HR004 - HR007, HR010, HR013) in order to avoid double counting.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR010	Riparian restoration - Acres restored	Enter the number of acres of riparian habitat restored to improve water quality. This may include riparian lake habitat (e.g., for stormwater pond plantings). Do not include acres where activities are fully captured by erosion control metrics (e.g., HR001, HR003).	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR013	Wetland and shoreline habitat - Acres restored	Enter the number of acres restored (i.e., the project footprint), including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		OEB001	Other environmental benefits - Number of metric tons of greenhouse gas emissions reduced	Enter the number of metric tons reduced annually.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some the primary objective for this technique.
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
	Decommission unused, orphaned energy facilities	HC005	Decommissioning energy facilities - Number of wells plugged	Enter the number of abandoned oil and gas wells plugged during activity.	The activity completion parameter(s) should include number of well plugged. Projects/programs employing this technique should also employ the technique Habitat management and stewardship, which entails selecting one or more additional metrics and parameters to supported the selected objective(s).
Restore hydrology and natural processes	*Restore hydrologic connectivity*	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to provide additional support to some primary objectives for this technique.
		HM002	Nutrient reduction - Lbs. nutrients avoided or removed	Enter the total amount of nutrients removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	One or more nutrient-specific parameters should be used in lieu of Activity completion. These parameters can provide additional support to some primary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HM003	Nutrient reduction - Lbs. P avoided or removed	Enter the total amount of phosphorous removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	A parameter of the same name should be used in lieu of Activity completion. This parameter can provide additional support to some primary objectives for this technique.
		HR009	Hydrologic restoration - Acres restored	Enter the number of acres with restored hydrology. This can include wetlands and upland buffer/transition habitats. Implementation may include restoration activities such as sediment removal for tidal connections, sediment placement to modify hydrologic connections, excavation and re-grading to modify existing water features, creation of water conveyance systems, etc.	The activity completion parameter(s) should include acres restored. Other examples include number of culverts installed or repaired and acres of management types (i.e., acres over which different management activities are performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR011	Hydrologic restoration - Miles of canals backfilled	Enter the number of miles of canals backfilled. Use the notes field to provide the average width of the canals backfilled.	The activity completion parameter(s) should include miles of canals backfilled. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. For activities that employ this technique to reduce shoreline erosion, use pre-implementation data to update the metric baseline value in PIPER. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.
	Restore natural salinity regimes	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to provide additional support to some primary objectives for this technique.
		HM002	Nutrient reduction - Lbs. nutrients avoided or removed	Enter the total amount of nutrients removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	One or more nutrient-specific parameters should be used in lieu of Activity completion. These parameters can provide additional support to some primary objectives for this technique.
		HM003	Nutrient reduction - Lbs. P avoided or removed	Enter the total amount of phosphorous removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	A parameter of the same name should be used in lieu of Activity completion. This parameter can provide additional support to some primary objectives for this technique.
		HR009	Hydrologic restoration - Acres restored	Enter the number of acres with restored hydrology. This can include wetlands and upland buffer/transition habitats. Implementation may include restoration activities such as sediment removal for tidal connections, sediment placement to modify hydrologic connections, excavation and re-grading to modify existing water features, creation of water conveyance systems, etc.	The activity completion parameter(s) should include acres restored. Other examples include number of culverts installed or repaired and acres of management types (i.e., acres over which different management activities are performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR011	Hydrologic restoration - Miles of canals backfilled	Enter the number of miles of canals backfilled. Use the notes field to provide the average width of the canals backfilled.	The activity completion parameter(s) should include miles of canals backfilled. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. For activities that employ this technique to reduce shoreline erosion, use pre-implementation data to update the metric baseline value in PIPER. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.
	Controlled river diversions	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to provide additional support to some primary objectives for this technique.
		HM002	Nutrient reduction - Lbs. nutrients avoided or removed	Enter the total amount of nutrients removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	One or more nutrient-specific parameters should be used in lieu of Activity completion. These parameters can provide additional support to some primary objectives for this technique.
		HM003	Nutrient reduction - Lbs. P avoided or removed	Enter the total amount of phosphorous removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	A parameter of the same name should be used in lieu of Activity completion. This parameter can provide additional support to some primary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR009	Hydrologic restoration - Acres restored	Enter the number of acres with restored hydrology. This can include wetlands and upland buffer/transition habitats. Implementation may include restoration activities such as sediment removal for tidal connections, sediment placement to modify hydrologic connections, excavation and re-grading to modify existing water features, creation of water conveyance systems, etc.	The activity completion parameter(s) should include acres restored. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR013	Wetland and shoreline habitat - Acres restored	Enter the number of acres restored (i.e., the project footprint), including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. For activities that employ this technique to reduce shoreline erosion, use pre-implementation data to update the metric baseline value in PIPER. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.
Reduce excess nutrients and other pollutants to watersheds	*Agriculture and forest management*	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HM002	Nutrient reduction - Lbs. nutrients avoided or removed	Enter the total amount of nutrients removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	One or more nutrient-specific parameters should be used in lieu of Activity completion. These parameters may support or provide additional support to the primary objective for this technique.
		HM003	Nutrient reduction - Lbs. P avoided or removed	Enter the total amount of phosphorous removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HM004	Sediment reduction - Lbs. sediment avoided or removed	Enter the total amount of sediment removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	The activity completion parameter(s) should include lbs. of sediment avoided or removed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HM005	Agricultural BMPs - Acres under contracts/agreements	Enter the number of acres under contract(s) or agreement(s) to implement BMPs on privately owned land. This is typically agricultural land, but may include silvicultural or other land use types. Each acre should be entered only once (i.e., enter the number of acres under the contract/agreement, not the acres under individual BMPs, which may "double count" acres). Always also select the metric for # people enrolled (COI003). Other metrics may be selected to capture specific restoration activities, but do not count acreage toward the habitat restoration metrics HR004 - HR007, HR010, or HR013 (in order to avoid double counting).	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique.
		HM008	Pollutant reduction - Miles of hard surface improved	Enter the number of miles of roads or other hard surface improved to reduce runoff of sediment and other pollutants. This metric should not be used for roadway created or improved to increase recreational access.	The activity completion parameter(s) should include miles of hard surface improved. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR001	Erosion control - Acres restored	Enter the area over which restoration activities are performed to reduce surface and/or stream channel erosion. Do not include additional acres of watershed expected to achieve reduced sediment pollution. Do not include acres counted toward the riparian restoration metric (HR010). Possible restoration activities include plantings, regrading streambanks, gully repair, etc.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR003	Stream restoration - Miles of stream channel protection installed	Enter the miles of stream channel protection installed. This should be selected for streambank and streambed protection projects (e.g., using riprap) conducted to reduce erosion and resulting sediment pollution.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). If measures of area are not possible, miles may be used. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR004	Upland or other habitat - Acres restored	Enter the number of acres restored. Habitat included in this metric has been restored to original (or target) habitat and ecosystem function. This metric should be used for habitats that span outside (or occur beyond) habitats captured by other metrics, such as upland forests.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR010	Riparian habitat - Acres restored	Enter the number of acres of riparian habitat restored to improve water quality. This may include riparian lake habitat (e.g., for stormwater pond plantings). Do not include acres where activities are fully captured by erosion control metrics (e.g., HR001, HR003).	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR013	Wetland and shoreline habitat - Acres restored	Enter the number of acres restored (i.e., the project footprint), including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		RES001	Natural resource stewardship - Number of resource conservation measures implemented	Enter the number of resource conservation measures being implemented (or number of parties adopting each research conservation measure, if applicable). Resource conservation measures could include energy or water conservation measures, such as those resulting from an energy audit, renewable energy assessment, or water efficiency audit.	The activity completion parameter(s) should include number of resource conservation measures implemented (or number of parties adopting each resource conservation measure). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
		RES004	Pollutant reduction - CFU Reduction in bacterial loads	Enter the CFU reduction resulting from the activity.	One or more taxonomic-specific parameters should be used in lieu of Activity completion. These parameters may support the primary objective for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
	Stormwater management	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HM002	Nutrient reduction - Lbs. nutrients avoided or removed	Enter the total amount of nutrients removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	One or more nutrient-specific parameters should be used in lieu of Activity completion. These parameters may support or provide additional support to the primary objective for this technique.
		HM003	Nutrient reduction - Lbs. P avoided or removed	Enter the total amount of phosphorous removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HM004	Sediment reduction - Lbs. sediment avoided or removed	Enter the total amount of sediment removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	The activity completion parameter(s) should include lbs. of sediment avoided or removed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HM008	Pollutant reduction - Miles of hard surface improved	Enter the number of miles of roads or other hard surface improved to reduce runoff of sediment and other pollutants. This metric should not be used for roadway created or improved to increase recreational access.	The activity completion parameter(s) should include miles of hard surface improved. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR004	Upland or other habitat - Acres restored	Enter the number of acres restored. Habitat included in this metric has been restored to original (or target) habitat and ecosystem function. This metric should be used for habitats that span outside (or occur beyond) habitats captured by other metrics, such as upland forests.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR010	Riparian habitat - Acres restored	Enter the number of acres of riparian habitat restored to improve water quality. This may include riparian lake habitat (e.g., for stormwater pond plantings). Do not include acres where activities are fully captured by erosion control metrics (e.g., HR001, HR003).	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR013	Wetland and shoreline habitat - Acres restored	Enter the number of acres restored (i.e., the project footprint), including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		PRM001	Land management - Acres with reduced impacts	Enter the number of acres with reduced impacts from land use following implementation.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		PRM002	Land management - Miles with reduced impacts	Enter the number of miles with reduced impacts from land use following implementation.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). If measures of area are not possible, miles may be used. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		RES002	Watershed management - Number of upgrades to stormwater and/or wastewater systems	Enter the number of upgrades implemented to storm or wastewater systems. Upgrades could include activities such as taking septic systems offline, installing box culverts, upsizing drainage pipes, adding underground gravel storage, or creating groundwater recharge opportunities.	The activity completion parameter(s) should include # upgrades to stormwater and/or wastewater systems (per upgrade type). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
		RES004	Pollutant reduction - CFU Reduction in bacterial loads	Enter the CFU reduction resulting from the activity.	One or more taxonomic-specific parameters should be used in lieu of Activity completion. These parameters may support the primary objective for this technique.
	Erosion and sediment control	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HM002	Nutrient reduction - Lbs. nutrients avoided or removed	Enter the total amount of nutrients removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	One or more nutrient-specific parameters should be used in lieu of Activity completion. These parameters may support or provide additional support to the primary objective for this technique.
		HM003	Nutrient reduction - Lbs. P avoided or removed	Enter the total amount of phosphorous removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HM004	Sediment reduction - Lbs. sediment avoided or removed	Enter the total amount of sediment removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	The activity completion parameter(s) should include lbs. of sediment avoided or removed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HR001	Erosion control - Acres restored	Enter the area over which restoration activities are performed to reduce surface and/or stream channel erosion. Do not include additional acres of watershed expected to achieve reduced sediment pollution. Do not include acres counted toward the riparian restoration metric (HR010). Possible restoration activities include plantings, regrading streambanks, gully repair, etc.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR003	Stream restoration - Miles of stream channel protection installed	Enter the miles of stream channel protection installed. This should be selected for streambank and streambed protection projects (e.g., using riprap) conducted to reduce erosion and resulting sediment pollution.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). If measures of area are not possible, miles may be used. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
	Wastewater system improvements	HM001	Nutrient reduction - Lbs. N avoided or removed	Enter the total amount of nitrogen removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	Total nitrogen can be used as a parameter in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HM002	Nutrient reduction - Lbs. nutrients avoided or removed	Enter the total amount of nutrients removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	One or more nutrient-specific parameters should be used in lieu of Activity completion. These parameters may support or provide additional support to the primary objective for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		HM003	Nutrient reduction - Lbs. P avoided or removed	Enter the total amount of phosphorous removed from the system (in lbs) or prevented from entering the system (in lbs/year). Use the notes field to specify the units of measurement being used.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support the primary objective for this technique.
		HR013	Wetland and shoreline habitat - Acres restored	Enter the number of acres restored (i.e., the project footprint), including marshes, beaches, flooded forests, swamps, mudflats, estuarine habitats.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		PRM001	Land management - Acres with reduced impacts	Enter the number of acres with reduced impacts from land use following implementation.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		PRM002	Land management - Miles with reduced impacts	Enter the number of miles with reduced impacts from land use following implementation.	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). If measures of area are not possible, miles may be used. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		RES002	Watershed management - Number of upgrades to stormwater and/or wastewater systems	Enter the number of upgrades implemented to storm or wastewater systems. Upgrades could include activities such as taking septic systems offline, installing box culverts, upsizing drainage pipes, adding underground gravel storage, or creating groundwater recharge opportunities.	The activity completion parameter(s) should include # upgrades to stormwater and/or wastewater systems (per upgrade type). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		RES004	Pollutant reduction - CFU Reduction in bacterial loads	Enter the CFU reduction resulting from the activity.	One or more taxonomic-specific parameters should be used in lieu of Activity completion. These parameters may support the primary objective for this technique.
Restore oyster habitat	*Substrate placement*	HR006	Oyster reef - acres restored	Enter the number of acres of oyster reef restored. When conducting oyster restoration, always also select the population metric "SP001 - Population - Density (# individuals/acre) - Oysters."	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		SP001	Population - Density (Number of individuals/acre) - Oysters	Enter the density of oysters per acre for oyster reef restoration projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.
	Living shorelines	HR006	Marine habitat restoration - Acres of oyster reef restored	Enter the number of acres of oyster reef restored. When conducting oyster restoration, always also select the population metric "SP001 - Population - Density (# individuals/acre) - Oysters."	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR012	Shoreline protection - Miles of living shoreline installed	Enter the number of miles of living shoreline installed to buffer against shoreline erosion. Where applicable, use the notes field to indicate the width of the living shoreline (in feet). When conducting shoreline protection, always also select metric "HR014 - Habitat restoration - Land change rate."	The activity completion parameter(s) should include miles of living shoreline protection installed. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		HR014	Habitat restoration - Land change rate	Enter the land change rate (acres/year) at the conclusion of monitoring, i.e., the ratio of (land to water)/time. Land change rates are calculated using changes in shoreline position, or multiplying average landward movement distance by the length of shoreline monitored. For activities that employ shoreline protection to reduce erosion, use pre-implementation data to update the metric baseline value in PIPER. This metric should be selected for all projects that aim to reduce shoreline erosion, but is not exclusive to such projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
		RES003	Community resilience - Number of residential, commercial, and public facilities benefiting	Enter the total number of residential, commercial, and public facilities benefiting from the project once the community resilience project is implemented. An example of the type of project where this metric would apply is a project whose primary benefit is enhanced hurricane protection for the community.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some secondary objectives for this technique.
		SP001	Population - Density (Number of individuals/acre) - Oysters	Enter the density of oysters per acre for oyster reef restoration projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.
	Enhance spawning and reserves	HR006	Marine habitat restoration - Acres of oyster reef restored	Enter the number of acres of oyster reef restored. When conducting oyster restoration, always also select the population metric "SP001 - Population - Density (# individuals/acre) - Oysters."	The activity completion parameter(s) should include acres of management types (i.e., acres over which different management activities are performed) or acres restored (if only one management activity is performed). Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		SP001	Population - Density (Number of individuals/acre) - Oysters	Enter the density of oysters per acre for oyster reef restoration projects.	A parameter of the same name should be used in lieu of Activity completion. This parameter can be used to support some primary objectives for this technique.

Approach	Technique	Metric	Name	Description	Tracking the metric
Planning (any technique)		PRM003	Planning - Number of management/governance plans developed	Enter the number of plans developed that had input from multiple stakeholders for regional planning efforts.	The activity completion parameter(s) should include number of plans. This parameter may support objectives that would be achieved by implementation of the plan, or may be able to support the objective Improve science-based decision-making (depending on the type of plan). It is important to also select any additional parameters that may be needed to capture all observational data collected for the plan. Success criteria for such parameters may be considered 'not applicable'. For example, parameters for an invasive species control plan may include activity completion (number of plans), plant composition and cover, and species density.
		PRM005	Planning - Number of monitoring plans developed	Enter the number of monitoring plans developed. This metric captures the actual number of monitoring plans written, but not yet being implemented.	The activity completion parameter(s) should include number of monitoring plans. If the monitoring plan will be used to monitor the impacts of implementation-phase activities, this parameter may support the objective(s) to be achieved by implementation. This parameter may also be able to support the objective Improve science-based decision-making. It is important to also select any additional parameters that may be needed to capture all observational data collected to inform the monitoring plan and/or provide baseline data. Success criteria for such parameters may be considered 'not applicable'. For example, parameters for an invasive species monitoring plan that collects baseline data may include activity completion (number of monitoring plans), plant composition and cover, and species density.

Approach	Technique	Metric	Name	Description	Tracking the metric
		PRM011	Planning - Number of E&D plans developed	Enter the number of E&D packages developed. The number of plans should equal the number of completed packages (e.g., 100% design, certified), not the number of documents.	The activity completion parameter(s) should include number of E&D packages. This parameter may support objectives that would be achieved by implementation of the design. It is important to also select any additional parameters that may be needed to capture all observational data collected to inform E&D. Success criteria for such parameters may be considered 'not applicable'.
		PRM013	Planning - Number of environmental compliance documents completed	Enter the number of environmental compliance documents produced/compiled.	The activity completion parameter(s) should include number of environmental compliance documents. This parameter may support objectives that would be achieved by implementation of the activities for which compliance documents are being developed. It is important to also select any additional parameters that may be needed to capture all observational data collected to support the development of environmental compliance documents (e.g., species composition, area of habitat types). Success criteria for such parameters may be considered 'not applicable'.
Promote natural resource stewardship and environmental education		COI001	Building institutional capacity - Number of FTE that successfully completed training	Enter the number of full-time equivalents (FTE) days of training for trainees. FTE refers to the ratio of paid hours during a period to # working hours in that period. May consider adding up part-time equivalents if the total amount is considered significant (e.g., 100 individuals who provide 100 1/4 FTE = 25 FTE days).	The number of people trained should be used as a parameter in lieu of Activity completion. This parameter can be used to support the objective Promote natural resource stewardship and environmental education.
		COI002	Outreach/ Education/ Technical Assistance - Number of people reached	Enter the expected number of stakeholders in attendance at informational meetings, workshops, or events. Or, provide # of people who were directly involved in outreach, training and or technical assistance activities (this could be the number of participants in a workshop, classes, webinar, townhall, event, listeners, etc.).	The number of people reached and/or the number of reader impressions should be used as a parameter in lieu of Activity completion. These parameters can be used to support the objective Promote natural resource stewardship and environmental education.

Approach	Technique	Metric	Name	Description	Tracking the metric
		COI003	Outreach/ Education/ Technical Assistance - Number of people enrolled - BMPs	Enter the number of unique people enrolled to implement BMPs and expected to adopt tools and other improved management practices, etc., as a result. Always also select HM005 - Agricultural BMPs - acres under contracts/agreements.	The number of people enrolled should be used as a parameter in lieu of Activity completion. This parameter can be used to support the objective Promote natural resource stewardship and environmental education.
		COI004	Outreach/ Education/ Technical Assistance - Number of users engaged online	Enter the number of users engaged in twitter, Facebook, blogs and other social media tools used to disseminate information about the project (include the type of social media tool and number and frequency of users). Note the URL address for each site and the unique visitors or users only.	An appropriate parameter for tracking the metric should be used in lieu of activity completion. This parameter can be used to support the objective Promote natural resource stewardship and environmental education.
		COI005	Volunteer participation - Number of volunteers participating	Enter the number of volunteers involved in the project. A list of volunteers' names may help maintain a record of engagement. Where considered important, segmenting volunteers may be useful (e.g. age, gender, profession).	The number of volunteers should be used as a parameter in lieu of Activity completion. This parameter can be used to support the objective Promote natural resource stewardship and environmental education.
		COI006	Subgrants or agreements - Number of grants/agreements - dissemination of education/outreach materials	Enter the number of sub-grants or agreements to disseminate educational and outreach materials under the Council award. If possible, the metric for # people reached should also be selected (COI002).	

Approach	Technique	Metric	Name	Description	Tracking the metric
		COI007	Building institutional capacity - Number of participants that successfully completed training	Enter the expected number of participants that successfully attended and completed the training and attained restoration and conservation skills.	The number of people trained should be used as a parameter in lieu of Activity completion. This parameter can be used to support the objective Promote natural resource stewardship and environmental education.
		COI101	Economic benefits - Number of full-time permanent jobs created	Enter the number of full-time permanent jobs created that are directly attributable to the project or program implementation.	The number of positions filled should be used as a parameter in lieu of Activity completion. If the jobs involve environmental stewardship and/or education this parameter can be used to support the objective Promote natural resource stewardship and environmental education.
		COI102	Economic benefits - Number of part-time permanent jobs created	Enter the number of part-time permanent jobs created that are directly attributable to the project or program implementation.	The number of positions filled should be used as a parameter in lieu of Activity completion. If the jobs involve environmental stewardship and/or education this parameter can be used to support the objective Promote natural resource stewardship and environmental education.
		COI103	Economic benefits - Number of temporary jobs created	Enter the number of temporary jobs created that are directly attributable to the project or program implementation. These may be full-time or part-time jobs.	The number of positions filled should be used as a parameter in lieu of Activity completion. If the jobs involve environmental stewardship and/or education this parameter can be used to support the objective Promote natural resource stewardship and environmental education.

Approach	Technique	Metric	Name	Description	Tracking the metric
		RES001	Natural resource stewardship - Number of resource conservation measures implemented	Enter the number of resource conservation measures being implemented (or number of parties adopting each research conservation measure, if applicable). Resource conservation measures could include energy or water conservation measures, such as those resulting from an energy audit, renewable energy assessment, or water efficiency audit.	The number of entities enrolled should be used as a parameter. This parameter can be used to support the objective Promote natural resource stewardship and environmental education. One or more activity completion parameters may also be used, such as "quantity of shell recycled" for an oyster shell recycling program. Activity completion parameters are not sufficient to support the objective Promote natural resource stewardship and environmental education.
		RES005	Recreational improvements - Number of improvements to recreational infrastructure	Enter the number of improvements to recreational habitat/infrastructure resulting from the activity being completed as designed.	The activity completion parameter(s) should include number of each improvement type. Activity completion parameters are not sufficient to support the goals/objectives of this technique. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
Improve science-based decision-making processes	*Develop tools for planning and evaluation*	PRM009	Research - Number of studies conducted	Enter the number of studies completed whose findings are reported to management. Value should include published data (either via your institution or by others using your data), metadata sets made available and published/unpublished datasets.	The activity completion parameter(s) should include number of completed studies. This parameter can be used to support the objective Improve science-based decision-making processes. ODP information provided on this parameter should indicate the types of studies to be conducted. It is important to also select any additional parameters that may be needed to capture all observational data collected for the study. Success criteria for such parameters may be considered 'not applicable'. For example, if a hydrologic modeling study will be performed under a project/program, parameters may include activity completion (number of studies), discharge, area of habitat types, elevation, sediment classification/composition, and precipitation.

Approach	Technique	Metric	Name	Description	Tracking the metric
		PRM010	Research - Number of studies used to inform mgmt.	Enter the number of studies completed whose findings are used to adapt management/ inform mgmt. decisions.	The activity completion parameter(s) should include number of completed studies. This parameter can be used to support the objective Improve science-based decision-making processes. ODP information provided on this parameter should indicate the types of studies to be conducted. It is important to also select any additional parameters that may be needed to capture all observational data collected for the study. Success criteria for such parameters may be considered 'not applicable'. For example, if a hydrologic modeling study will be performed under a project/program, parameters may include activity completion (number of studies), discharge, area of habitat types, elevation, sediment classification/composition, and precipitation.
		PRM012	Tool development for decision-making - Number of tools developed	Enter the number of tools developed. For example, tools can include numerical models, computer models, GIS models, and decision support systems.	The activity completion parameter(s) should include number of each tool developed. This parameter can be used to support the objective Improve science-based decision-making processes. It is important to also select any additional parameters that may be needed to capture all observational data collected for tool development. Success criteria for such parameters may be considered 'not applicable'.
	Increase environmental monitoring capacities	PRM004	Monitoring - Number of monitoring programs implemented	Enter the number of monitoring programs established or underway. Monitoring programs include any program with a written monitoring plan that is intended to track something other than the project's benefits (which should be monitored for all RESTORE-funded projects).	The activity completion parameter(s) should include number of monitoring programs. This parameter can be used to support the objective Improve science-based decision-making processes. It is important to also select any additional parameters that may be needed to capture all observational data collected under the monitoring programs (e.g., such a "Total nitrogen" for a water quality monitoring program). Success criteria for such parameters may be considered 'not applicable'.

Approach	Technique	Metric	Name	Description	Tracking the metric
		PRM006	Monitoring - Number of streams/sites being monitored	Enter the number of streams/sites being monitored. This metric should only be used for monitoring intended to track something other than the project's benefits (which should be monitored for all RESTORE-funded projects).	The activity completion parameter(s) should include number of streams/sites being monitored. This parameter can be used to support the objective Improve science-based decision-making processes. It is important to also select any additional parameters that may be needed to capture all observational data collected at the streams/sites (e.g., such a "Total nitrogen" for a water quality monitoring program). Success criteria for such parameters may be considered 'not applicable'.
		PRM007	Monitoring - Acres being monitored	Enter the number of acres being monitored using standard mapping tools/GIS or other methods. This metric should only be used for monitoring intended to track something other than the project's benefits (which should be monitored for all RESTORE-funded projects). Specify monitoring method(s) in the notes field.	The activity completion parameter(s) should include number of acres monitored. This parameter can be used to support the objective Improve science-based decision-making processes. It is important to also select any additional parameters that may be needed to capture all observational data collected through monitoring (e.g., such a "Total nitrogen" for a water quality monitoring program). Success criteria for such parameters may be considered 'not applicable'.
		PRM008	Monitoring - Miles being monitored	Enter the number of miles monitored as a direct result of the project. This metric should only be used for monitoring intended to track something other than the project's benefits (which should be monitored for all RESTORE-funded projects). This metric should be selected for in-stream habitat restoration and shoreline restoration projects. Please indicate the width of the area being monitored in the notes field. For beach nesting birds, includes linear length of beaches or circumference of islands where suitable habitat has been confirmed.	The activity completion parameter(s) should include number of miles monitored. This parameter can be used to support the objective Improve science-based decision-making processes. It is important to also select any additional parameters that may be needed to capture all observational data collected through monitoring (e.g., such a "Total nitrogen" for a water quality monitoring program). Success criteria for such parameters may be considered 'not applicable'.

Approach	Technique	Metric	Name	Description	Tracking the metric
		PRM014	Restoration planning/design /permitting - Increased Capacity - % increase in analytical capacity	Enter the % increase in analytical capacity resulting from Project/Program implementation. Values are entered as percentages; enter whole number percentages representing anticipated increases over a baseline of zero (e.g., baseline is entered as zero percent, and target value is entered as a 30% increase over baseline). In the notes field, please indicate the type of analytical capacity being increased; additional details can also be provided regarding baseline and target values (e.g., Baseline for water quality analysis is 100 samples per month; anticipated target value represents an increase to 130 samples per month).	The activity completion parameter(s) should provide information needed to calculate the increase in analytical capacity (e.g., samples analyzed per month). Such parameters can be used to support the objective Improve science-based decision-making processes.
	Comprehensive planning		See Planning		
Restore and revitalize the Gulf economy	*Increase public access to natural resources and enhance recreational experiences*	RES005	Recreational improvements - Number of improvements to recreational infrastructure	Enter the number of improvements to recreational habitat/infrastructure resulting from the activity being completed as designed.	The activity completion parameter(s) should include number of each improvement type. Activity completion parameters are typically not sufficient to support the goal Restore and revitalize the Gulf economy. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.
		RES006	Recreational improvements - Acres acquired for public access/recreational use	Enter the total acres acquired for public access/recreational use.	The activity completion parameter(s) should include the acres acquired. Activity completion parameters are typically not sufficient to support the goal Restore and revitalize the Gulf economy. An activity completion parameter is not necessary if another selected parameter already captures the data collection activities needed to track the metric.

Approach	Technique	Metric	Name	Description	Tracking the metric
		RES007	Recreational improvements - Number of visitors increased	Enter the increase in public use as a result of the activity.	The number of annual visitors should be used as a parameter in lieu of Activity completion. This parameter may be able to support the goal Restore and revitalize the Gulf economy.
	Restore and revitalize the Gulf economy	COI002	Outreach/ Education/ Technical Assistance - Number of people reached	Enter the expected number of stakeholders in attendance at informational meetings, workshops, or events. Or, provide # of people who were directly involved in outreach, training and or technical assistance activities (this could be the number of participants in a workshop, classes, webinar, townhall, event, listeners, etc.).	The number of people reached and/or the number of reader impressions should be used as a parameter in lieu of Activity completion. These parameters may be able to support the goal Restore and revitalize the Gulf economy.
		COI004	Outreach/ Education/ Technical Assistance - Number of users engaged online	Enter the number of users engaged in twitter, Facebook, blogs and other social media tools used to disseminate information about the project (include the type of social media tool and number and frequency of users). Note the URL address for each site and the unique visitors or users only.	An appropriate parameter for tracking the metric should be used in lieu of activity completion. This parameter may be able to support the goal Restore and revitalize the Gulf economy.
		COI101	Economic benefits - Number of full-time permanent jobs created	Enter the number of full-time permanent jobs created that are directly attributable to the project or program implementation.	The number of positions filled should be used as a parameter in lieu of Activity completion. This parameter can be used to support the goal Restore and revitalize the Gulf economy.
		COI102	Economic benefits - Number of part-time permanent jobs created	Enter the number of part-time permanent jobs created that are directly attributable to the project or program implementation.	The number of positions filled should be used as a parameter in lieu of Activity completion. This parameter can be used to support the goal Restore and revitalize the Gulf economy.
		COI103	Economic benefits - Number of temporary jobs created	Enter the number of temporary jobs created that are directly attributable to the project or program implementation. These may be full-time or part-time jobs.	The number of positions filled should be used as a parameter in lieu of Activity completion. This parameter can be used to support the goal Restore and revitalize the Gulf economy.

Approach	Technique	Metric	Name	Description	Tracking the metric
		COI104	Economic benefits - Number of local contracts	Enter the number of contracts or agreements anticipated with individuals or companies that reside in, are headquartered in, or are principally engaged in business in a Gulf Coast State.	The activity completion parameter(s) may include number of local contracts and/or costs per local contract. These parameters may be able to support the goal Restore and revitalize the Gulf economy.
		COI105	Economic benefits - % costs contracted to existing local organizations	Enter the percentage of total program costs anticipated to be contracted with companies that reside in, are headquartered in, or are principally engaged in business in a Gulf Coast State.	The costs going to existing local organizations should be used as a parameter in lieu of Activity completion. This parameter may be able to support the goal Restore and revitalize the Gulf economy.
		COI106	Economic benefits - Sacks of oysters relayed	Enter the number of sacks of oysters relayed from donor sites to increase productivity on harvestable reefs.	The Activity completion parameter(s) should include sacks of oysters relayed. This parameter may be able to support the goal Restore and revitalize the Gulf economy. Other parameters that can be included to support the economic goal include sacks of oysters harvested and total annual sales.
		COI107	Economic benefits - Linear feet of transportation channel improved	Enter the linear feet of channel restored to design depths for transportation purposes.	The Activity completion parameter(s) should include linear feet of channel improved. This parameter may be able to support the goal Restore and revitalize the Gulf economy. Other parameters that can be included to support the economic goal include total shipping traffic, total cargo, and safely navigable days per year.

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Appendix G. Glossary of terms and units

G.1.0 Acronyms

ADCP: Acoustic Doppler Current Profile

ADVMs: Acoustic Doppler Velocity Meters

AM: Adaptive Management

ASCII: American Standard Code for Information Interchange

ASPRS: Remotely sensed Photogrammetry and Remote Sensing

CMAP: Council Monitoring and Assessment Program Reports

CMAWG: Council Monitoring and Assessment Workgroup

CPRA: Louisiana Coastal Protection and Restoration Authority

CSV: Comma-separated values

DEMS: Digital Elevation Model

DMP: Data Management Plan

DOI: Digital Object Identifier

DWH: Deepwater Horizon Oil Spill

E&D: Engineering and Design

EHWS: Extreme high water spring

ENVI: Environment for Visualizing Images

EPA: Environmental Protection Agency

ERDAS: Earth Resources Data Analysis System

ESRI: Environmental Systems Research Institute

Evidence Act: Foundations for Evidence-Based Policymaking Act of 2018

FGDC: Federal Geographic Data Committee

FLDEP: Florida Department of Environmental Protection

FPL: Funded Priorities List.

FQI: Floristic quality index

FFQI: Forested floristic quality Index

FTE: Full Time Equivalent

GEMS: Gulf of Mexico Ecosystem Service Logic Models and Socio-Economic Indicators

GPRA Modernization Act: Government Performance and Results Modernization Act of 2010

GPS: Global positioning system

HDF: Hierarchical Data Format

ISSS: Interferometric side scan sonar

ISO-19115: International Organization for Standardization Metadata Standard 19115

JSON: JavaScript Object Notation

MERLIN: MEtadata Record and Library Information Network

LIDAR: Light Detection and Ranging

MBES: Multibeam sonar (MBES):

MSL: Mean sea level

MHW: Mean high water

MLW: Mean low water

N/A: Not Available

NAS: National Academies of Sciences, Engineering, and Medicine

NFWF: National Fish and Wildlife Foundation

NOAA: National Oceanic and Atmospheric Administration

NRC: National Research Council.

(DWH) **NRDA**: Natural Resource Damage Assessment

NRDA Cross-TIG MAM: Natural Resource Damage Assessment Cross-Trustee Implementation Group Monitoring and Adaptive Management work group

ODP: Observational Data Plan

OMB: Office of Management and Budget

OPEN Government Data Act: Open, Public, Electronic, and Necessary Government Data Act of 2018

PAR: Photosynthetic active radiation

PIPER: Program Information Platform for Ecosystem Restoration.

POC: Point of Contact(s)

QA/QC: Quality assurance and Quality control.

QAPP: Quality assurance project plan

RESTORE Act: Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012

RESTORE Council or Council: Gulf Coast Ecosystem Restoration Council

RTK GPS: Real-time kinematic global positioning system

RSET: Rod surface elevation tables

SAV: Submerged aquatic vegetation.

SBES: Single beam echosounder

SEP: State Expenditure Plan

SETs: Surface Elevation Tables

SSS: Side Scan Sonar

Sonar: Sound navigation and ranging

TBD: To Be Determined

TIFFs: Tagged Image File Format

UAS: Unmanned aerial systems

UAV: Unmanned aerial vehicle

USGS: United States Geological Survey

XML: Extensible Markup Language

G.2.0 Glossary of terms

Abiotic: The non-living chemical and physical aspects of the environment that affect living organisms and the functioning of ecosystems.

Acoustic Doppler Current Profile (ADCP): A hydroacoustic current meter similar to a sonar, used to measure water current velocities over a depth range using the Doppler effect of sound waves scattered back from particles within the water column.

Activity: A general term used by the RESTORE Council that includes both projects and programs and may also be used to describe components of a project or program. For example, on the 2015 Initial FPL, all the funded projects and programs on the list could be referred to as restoration "activities."

Adaptive management: Adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty (Pastorok et al., 1997; Williams, 2011). Adaptive management is a science-based iterative process that integrates monitoring, evaluation of management actions with flexible decision-making, and consideration of best available science where adjustments are made to management approaches based on observed outcomes (NRC, 2004). Within the context of ecological restoration, adaptive management addresses uncertainties by linking science to restoration decision-making (Steyer and Llewellyn, 2000; Thom et al., 2005).

Agriculture: Land areas used for the cultivation or breeding of animals and plants to provide food, fiber, medicinal plants and other products to sustain and enhance life.

Approaches: The Council's restoration goals and objectives can be met through actions the Council has called "restoration approaches". Each restoration approach may be implemented by multiple associated restoration techniques. Presently, the RESTORE Council Planning Framework (2019) has the following priority restoration approaches: Create, restore, and enhance coastal wetlands, islands, shorelines, and headlands (Section 2.2.1); Protect and conserve coastal, estuarine, and riparian habitats (Section 2.2.2); Restore hydrology and natural processes (Section 2.2.3); Reduce excess nutrients and other pollutants to watersheds (Section 2.2.4); Restore oyster habitat (Section 2.2.5).

Artificial reef: An underwater structure built by humans to promote marine life.

Assessment: Process to understand the current state, condition and performance by comparing a feature or process of the environment among restored and reference sites before and after restoration. The evaluation or estimation of the water quality or habitat for a specific time period.

Barrier island: A long broad sandy island lying parallel to a shore that is built up by the action of waves, currents, and winds and that protects the shore from the effects of the ocean.

Basal area: The area of a given section of land that is occupied by the cross-section of tree trunks and stems at the base.

Baseline: Baseline refers to the condition of the natural resources and services that would have existed without intervention, and is typically measured prior to project implementation.

Bathymetric/Bathymetry: The submerged equivalent of “topographic”; detailed mapping or charting of subaqueous features (i.e., on the ocean floor/submerged terrain [e.g., spot water depth data, digital elevation models, and contour lines]).

Beach/dune: The area above the low-water mark extending across the backside of the associated sand ridges, which may/may not be vegetated.

Best Available Science (BAS): Definitions of Best Available Science vary across management agencies and within academia, but most include criteria emphasizing accuracy, reliability, and relevancy (Esch et al. 2018, Sullivan et al. 2006). Per the RESTORE Act, "best available science" (BAS) is defined as science that maximizes the quality, objectivity, and integrity of information, including statistical information; uses peer-reviewed and publicly available data; and clearly documents and communicates risks and uncertainties in the scientific basis for such projects.

Biomass: The total mass of organisms in a given area or volume.

Bleaching: Process whereby coral colonies or sea anemones lose their color, either due to the loss of pigments by microscopic algae (zooxanthellae) living in symbiosis with their host organisms (polyps/anemones) or because the zooxanthellae have been expelled.

Bulk density: The weight of soil/sediment in a given volume that depends on soil/sediment composition and degree of compaction.

Coral reef: Ecosystems held together by structures formed by the growth and deposition of calcium carbonate by coral.

Council-Selected Restoration Component: The Council has oversight of the expenditure of 60 percent of the funds made available from the Gulf Coast Restoration Trust Fund (Trust Fund). Under the Council-Selected Restoration Component (often called Bucket 2 in reference to the five "buckets" to which funds from the Trust are allocated), 30 percent of available funding (approximately $1.6 billion plus a portion of the interest accrued in the Trust Fund) is administered for Gulfwide ecosystem restoration and protection according to the 2013 and 2016 Comprehensive Plans developed by the Council.

Comprehensive Plan Goals: As stated in the 2016 Comprehensive Plan Update, the goals provide the overarching framework for an integrated and coordinated approach to Gulf Coast Region restoration and help guide actions at the local, state, tribal and federal levels. The Council has committed to the following five goals:

- Goal 1: Restore and Conserve Habitat: Restore and conserve the health, diversity, and resilience of key coastal, estuarine, and marine habitats.
- Goal 2: Restore Water Quality and Quantity Restore and protect the water quality and quantity of the Gulf Coast region’s fresh, estuarine, and marine waters.
- Goal 3: Replenish and Protect Living Coastal and Marine Resources: Restore and protect healthy, diverse, and sustainable living coastal and marine resources.
- Goal 4: Enhance Community Resilience: Build upon and sustain communities with capacity to adapt to short- and long-term changes.

- Goal 5: Restore and Revitalize the Gulf Economy: Enhance the sustainability and resiliency of the Gulf economy.

Comprehensive Plan Objectives: As with the 2016 Comprehensive Plan goals, the Council has identified objectives that best represent how to focus future Council funding decisions. The Comprehensive plan goals can be met by way of these objectives. The seven objectives are:

- Objective 1: Restore, Enhance, and Protect Habitats: Restore, enhance, and protect the extent, functionality, resiliency, and sustainability of coastal, freshwater, estuarine, wildlife, and marine habitats.
- Objective 2: Restore, Improve, and Protect Water Resources: Restore, improve, and protect the Gulf Coast region's fresh, estuarine, and marine water resources by reducing or treating nutrient and pollutant loading; and improving the management of freshwater flows, discharges to, and withdrawals from critical systems.
- Objective 3: Protect and Restore Living Coastal and Marine Resources: Restore and protect healthy, diverse, and sustainable living coastal and marine resources including finfish, shellfish, birds, mammals, reptiles, coral, and deep benthic communities.
- Objective 4: Restore and Enhance Natural Processes and Shorelines: Restore and enhance ecosystem resilience, sustainability, and natural defenses through the restoration of natural coastal, estuarine, and riverine processes, and/or the restoration of natural shorelines.
- Objective 5: Promote Community Resilience: Build and sustain Gulf Coast communities' capacity to adapt to short- and long term natural and manmade hazards, particularly increased flood risks associated with sea-level rise and environmental stressors. Promote ecosystem restoration that enhances community resilience through the re-establishment of nonstructural, natural buffers against storms and flooding.
- Objective 6: Promote Natural Resource Stewardship and Environmental Education: Promote and enhance natural resource stewardship efforts that include formal and informal educational opportunities, professional development and training, communication, and other actions for all ages.
- Objective 7: Improve Science-Based Decision-Making Processes: Improve science-based decision-making processes used by the Council.

Control site/reference site: A control site is a site (or other entity) that is similar to the site/entity to be restored before any restoration activities take place, but is left unrestored in order to evaluate the effectiveness of restoration treatments (NAS, 2016).

Data dictionary: A data dictionary defines the codes and fields used in the dataset for data uploads related to a restoration project.

Data management: The development, execution and supervision of plans, policies, programs, and practices that control, protect, deliver and enhance the value of data and information.

Data standard: Data standards include rules regarding how data are defined, organized, and structured to ensure maximum data interoperability and understanding of data.

Drivers: Drivers are outside forces, natural or anthropogenic, that have the potential to influence the outcomes of a restoration project. Drivers tend to be large-scale, long-term forces that are not easily controlled at the scale of a single restoration project (Harwell et al., 2016).

Emergent marsh: An area of low-lying land dominated by erect, rooted, herbaceous rather than woody plant species that is flooded in wet seasons or at high tide, and typically remains waterlogged at all times.

Estuarine: The Estuarine System is defined by salinity and geomorphology. This System includes tidally influenced waters that (1) have an open-surface connection to the sea, (2) are regularly diluted by freshwater runoff from land, and (3) exhibit some degree of land enclosure (FGDC, 2012). For more information see, https://www.cmecscatalog.org/cmecs/classification/aquaticSetting/2.html.

Forest: A large area dominated by trees, and can include upland (dry) and riverine forests and swamps.

Freshwater inflow: Freshwater inflow is the freshwater that flows into an estuary.

Funded Priorities List (FPL): A list of the projects/programs that the RESTORE Council has voted on to approve for funding as well as activities to be considered for potential future funding.

Habitat monitoring: Habitat monitoring refers to the collection of in situ measurements of various parameters with regards to the condition and/or state of habitats for broad categories such as, corals, oysters, plants, sediment, and other physical characteristics of the environment.

International Organization for Standardization (ISO)-19115 Metadata Standard: A variety of metadata standards and formats have been developed over time to support data discovery and data documentation. In June 2017, the RESTORE Council approved the adoption of the ISO-19115 metadata standard (and the associated series of standards) for Council-funded activities. The adoption of this standard is in line with the December 2016 Federal Geographic Data Committee (FGDC) Steering Committee endorsement of ISO standards and efforts to convert all Federal agencies to use the ISO standard. For more information, see https://www.fgdc.gov/metadata/benefits-of-iso.

Land use: Broad categories that convey how people use the landscape (e.g., development, conservation, mixed use, agriculture, etc.).

Light detection and ranging (LIDAR): Light detection and ranging (LIDAR) is a remote sensing method that is similar to SONAR, but instead uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses—combined with other data recorded by the airborne system— generate precise, three-dimensional information about the shape of the Earth and its surface characteristics. For more information see, https://oceanservice.noaa.gov/facts/lidar.html.

Machine-readable format: Data in a format that can be automatically read and processed by a computer, such as CSV, JSON, XML, etc. Machine-readable data must be structured data. For more information, please reference: https://www.data.gov/developers/blog/primer-machine-readability-online-documents-and-data.

Metadata: A record that provides information about data with regards to the location the data were collected, who created the data, why the data were collected, and how the data are organized. A variety of metadata standards and formats have been developed over time to support data discovery and data documentation. In June 2017, the RESTORE Council approved the adoption of the ISO-19115 metadata standard (and the associated series of standards) for Council-funded activities. To assist in meeting this requirement the Council has developed an ISO-compliant metadata record creation tool, the Council MEtadata Record and Library Information Network (MERLIN).

MEtadata Record and Library Information Network (MERLIN): MERLIN is an online metadata records application hosted on the Council's website. The RESTORE Council provides MERLIN as a tool to help its award recipients prepare and submit required ISO-19115 metadata records that describe observational data collected as part of RESTORE Council-funded activities.

Metadata Standard: A requirement which is intended to establish a common understanding of the meaning or semantics of the data, to ensure correct and proper use and interpretation of the data by its owners and users.

Metrics: Metrics are used to track success of a project or program. Each metric should be supported by one or more measurable parameters for which success criteria targets are also identified. A metric is evaluated by observing and analyzing its supporting parameter(s), which can include using a parameter of the same name as the metric. Without additional supporting parameters, metrics are often more indicative of project outputs than project benefits, such as completion of funded activities. Metrics may be used internally by the agency to assist with financial oversight of funded activities. Projects/ programs identify objectives, techniques, and metrics at the proposal stage, which are carried forward to the application.

Multibeam sonar (MBES): Multibeam (MBES) sound navigation and ranging (sonar) sensors — sometimes called multibeam acoustic sensors or echo-sounders — are a type of sound transmitting and receiving system used to estimate water depth and map the seafloor. These systems work by transmitting a sound pulse, called a ping, through a transmitter at a specific frequency, and then receiving that same pulse through a receiver placed very close to the transmitter. A computer determines how long it takes to receive the returning pulse which, when the transducers are pointed toward the seafloor, translates to depth. The more time it takes for the pulse to return, the farther away the object is.

Multispectral imagery: A type of imagery which captures information from across the electromagnetic spectrum; produced by sensors that measure reflected energy within several specific sections (also called bands) of the electromagnetic spectrum.

National Fish and Wildlife Foundation (NFWF): Non-profit organization focused on conservation of fish, wildlife and their habitats. NFWF was established by Congress in 1984 to support the U.S. Fish and Wildlife Service (FWS) mission to conserve fish, wildlife and plant species (see http://epw.senate.gov/foundat.pdf) Since then, NFWF and FWS have worked together to foster innovative partnerships with corporations, foundations, other federal agencies and non-profit organizations to generate new resources for conservation.

Natural Resource Damage Assessment (NRDA): NRDA is the process of collecting and analyzing information to evaluate the nature and extent of injuries resulting from an incident, and determining the restoration actions needed to bring injured natural resources and services back to baseline and make the environment and public whole for interim losses (15 CFR § 990.30).

Nitrogen: An essential nutrient for plant and animal growth and nourishment. Overabundance in water can cause a number of adverse health and ecological effects. Nitrogen assumes many forms: organic nitrogen, which includes proteins and amino acids, inorganic nitrogen, which includes nitrate (NO3), and nitrite (NO2), ammonia (NH3), and ammonium (NH4+). Nitrogen exists in compounds such as proteins or amino acids that have been produced through metabolic processes. Organic nitrogen is in an unoxidized form which cannot be readily consumed by most plants and animals. Nitrogen in its fully oxidized form (NO3), which is readily assimilated by plants and algae through photosynthetic processes. Excess nitrate in water can cause health problems in infants and contribute to eutrophication in water bodies. This parameter includes data expressed as either nitrate mass per unit volume or as nitrogen mass per unit volume, and includes the fractional results, dissolved (filtered), total (unfiltered), or suspended (unfiltered - filtered).

Nutrients: Molecules which are essential for the growth and nourishment of organisms within the environment.

(Primary or secondary) Objective: From Comp Plan (see). The Planning Framework identifies likely primary and secondary goals that each technique may support. Appendix F of the ODP Guidance carries this work forward by providing parameters that may support the primary and secondary objectives.

Observational data: Observational data may include, but are not limited to, any datasets or model results collected, compiled, or utilized under an FPL or SEP award, including all data and derivative products for metrics and parameters. Observational data may be generated during any phase or component of a project or program (including, but not limited to, planning, compliance, E&D, construction, as-built, baseline, post-implementation, and others). Observational data are most useful and effective when they are comparable across different temporal and spatial scales.

Organic content: Amount of plant material in a sediment sample; generally assessed by burning at 550℃.

Organic pollutants: The concentration of organic pollutants in the sediment, including oil contaminants.

Parameters: Parameters are the data collected to support metrics and track corresponding project benefits. Observation and statistical analysis of the parameters enables reporting on a metric. It also enables reporting on benefits related to each (primary and secondary) goal and objective identified for a project, such as habitat or water quality (see Comprehensive plan goals and objectives). Some metrics may require only a single parameter while other metrics may require multiple parameters to enable reporting. Appendix F provides guidance on parameter selection, identifying core, objective-specific, and additional parameters for consideration based on the project and its objectives.

(Project) Performance: Performance of RESTORE-funded activities is assessed through metrics, parameters, and targets, which are selected based on the Comprehensive Plan goals and objectives that a project or program identifies.

Photosynthetic active radiation (PAR): A passive measurement of the photosynthetically active range of sunlight. In water quality applications PAR can be used to delineate the photic zone of a body of water.

Phytoplankton: The term phytoplankton encompasses all photoautotrophic microorganisms in aquatic food webs. Phytoplankton serve as the base of the aquatic food web, providing an essential ecological function for all aquatic life. Phytoplankton are a diverse group, incorporating protistan eukaryotes and both eubacterial and archaebacterial prokaryotes. Note that phytoplankton and chlorophyll are very closely related terms, differing only by methodology. Chlorophyll results, analyzed by various methods, are generally expressed as a mass of chlorophyll per unit volume, where phytoplankton results may be expressed by total biomass, cell count, or diversity.

Program: A suite of intrinsically-linked restoration and/or conservation activities that must be implemented together in order to achieve the desired outcome. A program should generally be covered by one unified Council environmental compliance review and should have a common set of metrics and parameters to assess and measure outcomes. A program's sub-activities may be related by geography, environmental stressors, resources, restoration approach or techniques, and other aspects. A program can be separated into a "planning" or "implementation" phase or can include both. One or more Council members can conduct a program. For example, a single program might be a Gulfwide environmental monitoring effort.

Program Information Platform for Ecosystem Restoration (PIPER): a tool to facilitate collaboration, proposal development, program information submission, and review for RESTORE-funded activities.

Project: A single Council-funded FPL or SEP activity that is not readily separable into fundable stand-alone sub-activities. A project may be "scalable," meaning that its scope, size, and cost can be expanded or reduced as needed and appropriate. A project can be separated into a "planning" or "implementation" phase or can include both. One or more RESTORE Council members can conduct a project. For example, a single project might restore marsh in a specific geographic location. Another example of a project might be the planning, engineering, and design required to advance a marsh restoration proposal to a construction-ready status.

Protocol: A description of the survey or collection methodologies including the timing and nature of the data collection procedures. Protocols ensure continuity of quality data collection techniques for both the duration of collection and between projects/programs. A detailed protocol is required for others to analyze, interpret and assess the resulting data.

Quality assurance (QA): Proactive process employed to maintain data integrity and is a continuous effort to prevent (e.g., training, calibration, proper technique), detect (e.g. on-plot data review), and correct measurement errors (e.g., readjustments in response to data review). (http://aim.landscapetoolbox.org/learn-3/glossary/).

Quality control (QC): Reactive process to detect measurement errors after the data collection process is complete (http://aim.landscapetoolbox.org/learn-3/glossary/).

README File: A README file is a text file that provides context and narrative explanations for new users of a dataset. It can include information on the monitoring data (e.g., how data were collected; quality assurance/quality control procedures; other information about data such as meaning, relationships to other data, origin, usage, and format) and can reference different documents.

Redox potential: Oxygen-reduction potential, often used to quantify the degree of electrochemical reduction of wetland soils under anoxic conditions.

Reference and/or Control Site: A control site is a site (or other entity) that is similar to the site/entity to be restored before any restoration activities take place, but is left unrestored in order to evaluate the effectiveness of restoration treatments (NAS, 2016).

RESTORE Act: The Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (33 U.S.C. § 1321(t) and note): The Act calls for a regional approach to restoring the long-term health of the valuable natural ecosystems and the economy of the Gulf Coast Region. The Act dedicates 80 percent of civil and administrative penalties paid under the Clean Water Act, after the date of enactment, by responsible parties in connection with the Deepwater Horizon oil spill to the Gulf Coast Restoration Trust Fund) for ecosystem restoration, economic recovery, and tourism promotion in the Gulf Coast Region.

RESTORE Council: The Gulf Coast Ecosystem Restoration Council (i.e., "Council"); In addition to creating the Gulf Coast Restoration Trust Fund, the RESTORE Act established the Council. The Council is currently chaired by the Administrator of the U.S. Environmental Protection Agency and includes the Governors of the States of Alabama, Florida, Louisiana, Mississippi and Texas, and the Secretaries of the U.S. Departments of Agriculture, the Army, Commerce, Homeland Security, and the Interior.

Riverine: The Riverine System includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts of 0.5 ppt or greater (Cowardin et al., 1979). For more information see, https://www.fgdc.gov/standards/projects/wetlands/nwcs-2013.

Shoreline profile: A measure of the position or change in shoreline position.

Side Scan Sonar (SSS): Marine researchers commonly use side-scan sonar technology to search for and detect objects on the seafloor. Side-scan sonar requires three components—a towfish that sends and receives acoustic pulses, a transmission cable attached to the towfish that sends data to the ship, and the ship's processing computer. Side-scan sonar continuously records the return echo, thus creating a "picture" of the seafloor. Side-scan sonar does not usually provide bathymetric data (i.e., depth estimates). For more information, see http://oceanexplorer.noaa.gov/technology/tools/sonar/sonar.html.

Single Beam Sonar: Single beam sound navigation and ranging (sonar), sometimes called vertical beam echo sounding, sensors are a type of sound transmitting and receiving system used to estimate water depth and map the seafloor. Single beam sonar functions similar to MBES sonar, but the sound wave swath is singular and more narrow pinging directly below a ship and bouncing straight back.

Soil type: A classification or taxonomy of soils determined according to soil texture, color, organic content, and chemical composition. For more information, see https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/class/taxonomy/.

Spawning: The release of sperm, eggs, or planula into the water column by sessile aquatic organisms.

Spill Impact Component: As part of the RESTORE Act, the Spill Impact Component provides funding to the five Gulf Coast states (Alabama, Florida, Louisiana, Mississippi and Texas) for ecosystem restoration,

economic recovery, and tourism promotion in the Gulf Coast Region. The RESTORE Council oversees the Spill Impact Component, commonly referred to as "Bucket 3". Spill Impact Component funds are allocated among the Gulf Coast states according to a formula in the Council's December 9, 2015, Spill Impact Component Final Regulation (40 U.S.C. part 1800). To access funds, each state must first have an approved State Expenditure Plan (SEP). The Act lists the types of activities that can be contained in a SEP, including planning, ecosystem restoration, tourism promotion, and to a limited extent, infrastructure projects such as flood protection.

Stage: The height of the water surface above an established datum plane, such as in a river above a predetermined point that may or may not be near the channel floor.

State Expenditure Plan (SEP): In accordance with the RESTORE Act (33 U.S.C. § 1321(t)(3)(A)(i)), the plan that must be developed by a Gulf Coast state and approved by the Council that describes the projects, programs, and activities that will be implemented by the state under the Spill Impact Component of the RESTORE Act (commonly referred to as "Bucket 3").

Stressors: Stressors are the physical, chemical, or biological factors that directly cause ecological effects (Harwell et al., 2016).

Submerged aquatic vegetation (SAV): Benthic macroalgae and aquatic plants that grow to the surface of the water but do not emerge from it. Seagrasses are submerged monocotyledonous plants with narrow grass-like leaves often occurring in dense underwater meadows. Benthic macroalgae are large aquatic photosynthetic organisms attached to the benthos and often occurring in dense beds. Can occur in both freshwater and saltwater.

Success criteria (targets): The results a project aims to achieve and measure prior to closeout as a result of project activities. Success criteria targets are used to determine the success of restoration or the need for corrective actions. They may include structural, functional, temporal, and/or other demonstrable factors. Prior to commencing, projects set a quantitative target for each metric and supporting parameter. In addition to the target, projects may identify additional success criteria for each parameter.

Targets: Targets (i.e., success criteria targets) are the quantitative metric and parameter values a project aims to achieve and measure prior to closeout. Prior to commencing, projects set targets to indicate the intended results of project activities.

Techniques: Techniques are specific restoration actions identified for each of the restoration approaches that can be used to achieve Comprehensive Plan goals and objectives. Restoration techniques may be used individually or in combination. **Uncertainties:** Uncertainties are information gaps that may affect decisions for a project or groups of projects that are the main focus within the context of adaptive management.

Upland: Environment above the extreme high water spring (EHWS) (i.e., the highest level that spring tides may reach; Cowardin et al., 1979).

G.3.0 Glossary of units

Unit	Definition
acres/activity	acres per activity
acres/year	acres per year
°C	degree Celsius
CFU/100 mL	colony forming units per 100 milliliters
cm	centimeter
cm/s	centimeters per second
ft	foot
g/kg	gram per kilogram
g/m^2	grams per square meter
km	kilometer
lb	pound
lbs/year	pounds per year
m	meter
m^{-1}	reciprocal meter
m^2	square meter
mg/L	milligrams per liter
mm	millimeter
m/s	meters per second
m^3/s	cubic meters per second
m/y	meters per year
NTU	nephelometric turbidity unit
oysters/m2	oysters per square meter

# individuals/m^2	number of individuals per square meter
# individuals/acre	number of individuals per acre
# seed (spat/seed/sack)/m^2	number of spat/seed/sack per square meter
%	percent
ppm	parts per million
ppt	parts per thousand
psu	practical salinity unit
Standard Unit (SU)	Standard Unit for measuring pH
µg/L	microgram per liter

G.4.0 Glossary references

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