

E.10. Restore Oyster Reef Habitat: Monitoring Guidance



This guidance is intended to promote consistency in data collection among similar types of projects and allow for future analysis across TIGs and Restoration Types, (Section 10.6.2 of SOP; DWH NRDA Trustees, 2016). This guidance may also assist the TIGs by providing recommended methodologies for monitoring restoration projects, saving time and money spent developing suitable monitoring protocols for individual restoration projects. If adjustments from this monitoring guidance are needed for a particular project, these adjustments should be described in the project-specific MAM Plan and agreed to by the TIG (Section 10.6.3 of SOP; DWH NRDA Trustees, 2016). Project teams within each TIG will identify parameters applicable to the objectives for each individual restoration project when developing the project MAM Plan. In addition to the project monitoring guidance identified in this Manual, specific monitoring may be required to comply with permits granted by regulatory agencies. The TIGs are not restricted from adding additional parameters, and other project monitoring that may be needed for specific projects should be determined by the TIGs.

The Cross-TIG MAM work group developed this monitoring guidance by following the process described in the Monitoring and Adaptive Management Procedures and Guidelines Manual Version 1.0 (MAM Manual Version 1.0; DWH NRDA Trustees, 2017). This new guidance is being released as a supplement to MAM Manual Version 1.0.

This guidance is intended to assist the TIGs in developing MAM Plans for restoration projects, as appropriate. Specifically, it provides:

- Examples of Restoration Techniques
- Guidance on example restoration objectives, example drivers, and example uncertainties
- Guidance on core performance monitoring parameters for projects within the Restoration Approach
- Guidance on supplemental performance monitoring parameters for specific restoration objectives

The monitoring parameters identified within a Restore Oyster Reef Habitat project MAM Plan should be consistent with the recommended monitoring defined within this guidance document, wherever appropriate. Depending on the nature of the restoration project, TIGs may also choose not to include some of the elements described in this guidance document (e.g., drivers, uncertainties). If adjustments from the monitoring guidance are needed, these adjustments should be described in the project-specific MAM Plan and agreed to by the TIG (Section 10.6.3 of SOP; DWH NRDA Trustees, 2016b). The guidance provided in this document should not be considered exhaustive. Therefore, TIGs may develop project-level objectives, drivers, uncertainties, and monitoring parameters that have not been previously identified. The TIGs will develop MAM objectives and monitoring parameters that pertain to their restoration activities, and will determine the frequency and duration of monitoring and the associated budget they

deem appropriate. This guidance may change as new monitoring parameters, methods, and technologies are identified and/or developed. Additional guidance may be found in the Strategic Framework for Oyster Restoration Activities (DWH NRDA Trustees, 2017).

The monitoring parameters recommended in this guidance document are further detailed in Attachment E Section E.3, which includes a complete list of core- and objective-specific monitoring parameters identified by the Cross-TIG MAM work group and guidance on measurement unit(s) and monitoring methods. Guidance on monitoring locations, frequencies, durations of sampling and potential analyses is also provided where appropriate.

E.10.1. Restoration Techniques

Restoration Techniques are specific restoration actions the Trustees identified for each of the Restoration Approaches. Restoration Techniques may be used individually or in combination. See Appendix 5.D of the PDARP/PEIS (DWH NRDA Trustees, 2016a). The following are example Restoration Techniques included in the PDARP/PEIS for this Restoration Approach. This list should not be considered exhaustive; additional Restoration Techniques may be identified and/or developed.

1. Restore or create oyster reefs through placement of cultch in nearshore and subtidal areas.
2. Construct living shorelines.
3. Enhance oyster reef productivity through spawning stock enhancement projects such as planting hatchery raised oysters, relocating wild oysters to restoration sites, oyster gardening programs, and other similar projects.
4. Develop a network of oyster reef spawning reserves.

E.10.2. Example Project-Level Restoration Objectives

Project-level restoration objectives should be specific to the resource injuries and clearly specify the desired outcome(s) of the restoration project (15 CFR § 990.55(b)(2)). See Section 2.4.1 of the MAM Manual Version 1.0 for guidance on establishing restoration objectives. The following are example project-level restoration objectives that may apply to one or more of the above-mentioned Restoration Techniques. This list should not be considered exhaustive; additional objectives may be developed and/or identified.

- Increase reef height and/or area through cultch placement
- Establish new or increase capacity of existing shell recycling programs to increase amount of shell available for restoration
- Reduce wave energy reaching the shoreline
- Create substrate for colonization by oysters and other reef organisms
- Provide shelter for reef-dwelling organisms
- Re-establish ecological connections at the land-water interface
- Increase density of spawning-size oysters
- Create spawning reserves that are protected from harvest
- Enhance survival, growth, and reproduction of oysters

E.10.3. Example Drivers

Drivers are outside forces, natural or anthropogenic, that have the potential to influence the outcome(s) 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). See Section 2.4.2 of the MAM Manual Version 1.0 for guidance on establishing the conceptual setting for a MAM Plan, including identifying drivers. The following are example drivers that may be

applicable to this Restoration Approach. This list should not be considered exhaustive; additional drivers may be identified.

- Salinity
- Dissolved oxygen concentration
- Temperature
- Pollution
- Phytoplankton
- Harmful algal blooms
- pH
- Disease
- Larval transport (currents)
- Bottom hardness
- Sedimentation
- Wave exposure
- Tidal position
- Sea level rise
- Subsidence of cultch
- Commercial harvest
- Predation
- Competition for space or food
- Water management practices affecting local water quality
- Natural resource management policies

E.10.4. Example Uncertainties

Uncertainties or information gaps have the potential to affect adaptive management decisions for individual or multiple restoration projects. These decisions may include how to improve the likelihood of achieving favorable project outcomes or selecting corrective actions in the event a project is not performing as intended. See Section 2.4.3 of the MAM Manual Version 1.0 for guidance on identifying potential sources of uncertainty for a MAM Plan. The following are example uncertainties that may be applicable to this Restoration Approach. This list should not be considered exhaustive; additional uncertainties may be identified.

- Cultch availability and cost
- Freshet frequency and severity
- Illegal harvest
- Coastal acidification trends
- Adjacent land use
- Spatial (horizontal and vertical) effects from anoxia events
- Effects from local resource management, such as water or sediment diversions
- Most effective way to restore oysters

Guidance on Developing Parameters for Project-Level Performance

This section includes two types of monitoring parameters for consideration under the Restore Oyster Reef Habitat Approach:

1. Core performance monitoring parameters applicable to projects within a Restoration Approach (core performance monitoring parameters are those used consistently across projects in order to facilitate the aggregation of project monitoring results and the evaluation of restoration progress for each Restoration Type; Appendix 5.E.4 of PDARP/PEIS; DWH NRDA, 2016a).

2. Objective-specific performance monitoring parameters that are only applicable to projects with a particular restoration objective.

Additional adaptive management and/or validation monitoring parameters for consideration have also been identified. These additional parameters may be helpful for resolving uncertainties, explaining outside drivers, optimizing project implementation, supporting decisions about corrective actions and other adaptive management of the project, and informing the planning of future DWH NRDA restoration projects. Tables E.10.1 and E.10.2 should not be considered exhaustive, and other parameters may be considered, as appropriate. See the complete list of core- and objective-specific monitoring parameters for details on the core performance monitoring parameters including definitions, units, and other guidance.

Table E.10.1. Core performance monitoring parameters and additional parameters for consideration under the Restore Oyster Habitat Restoration Approach.

Category	Core performance monitoring parameters	Parameters for consideration (as appropriate)
Reef dimensions	<ul style="list-style-type: none"> Project footprint (m²) Reef area (m²) Reef height (m) Reef volume (m³) 	<ul style="list-style-type: none"> Low tide exposure Reef rugosity Reef patchiness Consolidation rate/subsidence of reef structure Substrate type, amount, and condition
Oyster demography	<ul style="list-style-type: none"> Density of live and dead oysters (# of oysters/m²) Size frequency distribution (shell height, mm) Mortality (%) 	<ul style="list-style-type: none"> Growth rates Recruitment Shell volume (for determination of shell budget) Dermo disease prevalence and intensity
Benthic predatory, pest, or competitive species		<ul style="list-style-type: none"> Presence, density, or percent cover of predatory, pest, or competitive species
Environmental conditions		<ul style="list-style-type: none"> Water temperature Salinity Dissolved oxygen pH Turbidity Total suspended solids Chlorophyll <i>a</i> Flow rate

Table E.10.2. Performance monitoring parameters and additional parameters for consideration for projects with specific restoration objectives. These would be measured in addition to the parameters listed in Table E.10.1.

Project-specific objective	Objective-specific performance monitoring parameters	Parameters for consideration (as appropriate)
Habitat enhancement for fauna	<ul style="list-style-type: none"> Species composition, density (# of individuals/m²) or catch per unit effort (CPUE), and size (length (mm), biomass (g), etc.) of target faunal species/groups 	<ul style="list-style-type: none"> None identified
Living shorelines	<ul style="list-style-type: none"> Shoreline position Shoreline loss or gain (m²/year, calculated) 	<ul style="list-style-type: none"> Shoreline elevation change Marsh vegetation species composition, density, and percent cover Wave height
Increased reef productivity	<ul style="list-style-type: none"> Oyster larval settlement (# of spat/m² per day or # of spat/m²) Density of "large" (defined based on local conditions) oysters (# of large oysters/m²) 	<ul style="list-style-type: none"> Gonad development status Sex ratio

References

DWH NRDA Trustees. 2016a. *Deepwater Horizon* Oil Spill: Final Programmatic Damage Assessment and Restoration Plan (PDARP) and Final Programmatic Environmental Impact Statement (PEIS). Available: <http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan>.

DWH NRDA Trustees. 2016b. Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the *Deepwater Horizon* (DWH) Oil Spill. Originally approved May 4, 2016; revised November 15, 2016. Available: <http://www.gulfspillrestoration.noaa.gov/sites/default/files/TC%20SOP%202.0%20with%20appendices.pdf>

DWH NRDA Trustees. 2017. *Deepwater Horizon* Oil Spill Natural Resource Damage Assessment: Strategic Framework for Oyster Restoration Activities. June. Available: <http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan>.

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