NOAA Restoration Center

Implementation Monitoring

Guidance for proposing and Conducting Tier 1 Monitoring

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Overview

The NOAA Restoration Center (RC) provides funding and technical assistance to help communities restore coastal habitats. Through our fisheries restoration grant programs (e.g. Community-based Restoration Program), the RC has identified the four most common project types: removal of barriers to improve passage of sea-run or other migratory fish; restoration of coral reefs; hydrologic restoration of wetlands, estuarine, and riverine systems; and restoration of native oyster reefs. Standardized implementation metrics (Tier 1) have been identified for these project types to consistently evaluate the implementation and basic success of the project. These metrics provide quality assurance for project construction, and are required for all funded projects within these four project types. This monitoring occurs within the context of the RC's monitoring and evaluation framework. Tier 1 metrics for each project have quantitative "success" targets defined before project implementation. Typically, data are collected using the same methods pre- and post-implementation and compared with the target value.

All award recipients are expected to develop three monitoring-related documents during the course of their award—a Monitoring Plan, a Data Management Plan, and a final progress report, including monitoring results.

1. MONITORING PLANS AND REPORTING

1.1 Monitoring Plan Development

A description of planned monitoring should be included in your project application. A formal monitoring plan will be discussed during award negotiations with the expectation that a formal plan would be submitted to NOAA within the first quarter of an award. The plans are intended to document how applicants will measure and report metrics focused on evaluating if the project was implemented as designed, and the basic success of the project. For the four most common project types, plans should include the standardized Tier 1 monitoring metrics listed in Section 3. NOAA staff, including Technical Monitors[1], can help applicants or recipients develop monitoring plans.

Plans should include socioeconomic performance measures to capture the project's socioeconomic benefits. It is important to check the Notice of Funding Opportunity (NoFO) to which you are applying to determine if socioeconomic performance measures are required to be included in the application, where they should be included, and which measures to include[2].

The only socioeconomic metrics required to be part of a monitoring plan for relevant proposals are those considered Tier 1 metrics for RC's most common project types, such as those that focus on public safety and/or community enhancement.

The Priorities for the Restoration Grants webpage provides guidance on how to develop socioeconomic performance measures beyond the Tier 1 metrics for a project and can be described in a project narrative instead of being included in the monitoring plan. Tier 1 socioeconomic metrics are the only metrics that are required, unless specifically identified in the NoFO to which you are applying.

1.2 Monitoring Plan Structure

Monitoring plans will document how pre-and post-construction metrics will be assessed and should be developed during award negotiation to ensure that monitoring costs and award length are established correctly. The monitoring plan will include the following:

- Goals and objectives of the project;
- List of implementation monitoring metrics;
- Methods to assess and analyze the required pre- and post-construction metrics;

[1] NOAA Technical Monitors are restoration experts who participate in project oversight during the award. NOAA identifies them during the award negotiation process.

[2] Not all Notice of Funding Opportunities (NoFOs) have the same monitoring requirements, including those related to socioeconomic metrics. NoFO priorities can be directed by Congressional direction and NOAA program priorities.

- Monitoring schedule (duration and frequency);
- Targets for each metric (or methods for determining targets); and
- References used to establish targets.

The most common project types, referred to as "strategies", include fish passage (e.g., removal of barriers to improve passage of sea-run or other migratory fish), restoration of coral reefs, restoration of native oyster reefs, and hydrologic reconnection (e.g., hydrologic restoration of wetlands, estuarine, and riverine systems). These restoration strategies represent our areas of expertise and offer the greatest opportunities to produce desired outcomes. Monitoring for these strategies should follow the guidance provided in Section 3 when defining the duration, frequency, and target for Tier 1 metrics.

All other projects that do not align with these restoration strategies are expected to develop a monitoring plan that includes the sections outlined above, and focused on demonstrating the restoration actions were carried out as designed.

The Restoration Center recently began to develop a fifth strategy called "Wetland Restoration", which includes the creation of, or direct physical manipulation of elevations within, coastal wetland habitat. The monitoring methods and parameters used to define this Strategy are still under development and as such the Wetland Restoration Strategy will not be listed in the 2024/2025 NOFOs. However, draft monitoring guidance for Wetland Restoration projects is included in Section 3.5. If your proposed project is characterized as "creating, or manipulating elevations within, coastal wetlands", consider incorporating these draft metrics into the monitoring plan.

Monitoring metrics should be sufficient, cost-effective, and project-appropriate, including the collection of pre-implementation data, when applicable. They should be able to assess if the project was implemented as designed by evaluating short-term structural changes at the project site (e.g. as-built surveys), and may include a basic measure of success (e.g., presence/absence of target species). All metrics should have clearly defined, preferably quantitative, targets that can be evaluated for success within approximately one year after project implementation.

Socioeconomic measures are important to develop as appropriate to help tell the story of the project's success, see Section 1.1. Monitoring Plan Development for resources.

Check the NoFO to which you are applying to determine if socioeconomic performance measures are expected to be included in your proposal, and if they should be included in the monitoring plan and therefore described in the monitoring plan page limit, or can be included as part of the overall project narrative that might have a longer page limit at the application stage. During the negotiation of selected applications, applicants will work with NOAA staff to determine the best place and the right level of socioeconomic performance measure detail to include in their final monitoring plan.

1.3 Reporting Monitoring Progress

Pre- and post-implementation data will be reported as part of the standard progress reporting schedule described in an award. The RC uses a progress report form that includes a narrative section and a table of Performance Measures, both of which may be used to report monitoring results. The final progress report should:

- describe the methods;
- interpret the monitoring data to determine whether the project was implemented as designed;
- provide an explanation/hypothesis regarding why the project didn't meet its targets;
- describe any deviations from the Monitoring Plan;
- include any recommendations for further investigation and monitoring; and
- include points of contact and data managers, in accordance with award conditions related to public access to data.

As listed in Section 3, some project types may require particular analyses (e.g. hydrographs) or photographs as part of the data interpretation, which can be submitted as separate attachments. Site maps showing sampling locations may also be requested.

2. DATA MANAGEMENT AND PUBLICATION SHARING POLICY

Environmental data and information collected and/or created under NOAA grants and cooperative agreements must be made visible, accessible, and independently understandable to general users, free of charge or at minimal cost, in a timely manner (typically no later than two (2) years after the data are collected or created), except where limited by law, regulation, policy or security requirements. Failing to share environmental data and information in accordance with your Data Management Plan may lead to enforcement actions and be considered by NOAA when making future award decisions.

More information about the Data Sharing Policy is available on NOAA's Environmental Data Management Committee website on the Data Sharing for NOAA Grants PD page.

This website includes:

- NOAA's Data and Publication Sharing Directive for Grants, Cooperative Agreements, and Contracts, including data management award conditions
- Frequently Asked Questions

NOAA's National Centers for Environmental Information (NCEI) is one option for publicly archiving data. Information about archiving data at NCEI is available on their Archiving your Data webpage.

2.1 Data Management Plan Guidance

Each proposal submitted to NOAA should contain a Data Management Plan. The Data Management Plan documents how the recipient intends to comply with their award conditions related to collecting and making data available to the public.

These plans should include:

- the types of environmental data and information expected to be created during the course of the project;
- the tentative date by which data will be shared;
- the standards to be used for data/metadata format and content, including a quality control process;
- methods for providing data access;
- approximate total volume of data to be collected; and
- prior experience in making such data accessible.

2.2 Data Management Plan Templates and Examples

Template
The [project name (award #)], implemented by [applicant name] will generate environmental data and information, including [type(s) of data that will be collected]. Datasets will include [additional detail regarding data collection methods, quality control and metadata]. Data will be collected by [person/group collecting data] according to the procedures described in [application/manual/published article], and stored [location/method of data storage]. The data will be available [where/how] starting on [date no later than two years after data collected/created]. In the past, we have shared similar data by [past data sharing methods, if any]. All future sub-awardees not identified in this plan will have as a condition of their contract acceptance of this data sharing plan. Contact [name] at [phone/email] for more information.

Template Example:
The Salt Marsh Restoration Project, implemented by We Heart Marshes, will generate environmental information, including pre- and post-restoration assessments of the number of acres/stream miles with improved tidal wetland hydrology. Topographic data will include pre- and post-restoration controlling bottom invert elevation, controlling top invert elevation, channel widths, and channel depths. Hydrographs documenting at least one full 28-day tidal cycle pre- and post-restoration will be collected. The number of acres/stream miles improved will be estimated by We Heart Marshes within one year of project implementation. Post-restoration topography data will be collected by the construction contractor or sub-contractor within one year of implementation. Topographic data will be collected via standard survey techniques and recorded electronically and in field notebooks. The hydrographs will be created using pressure transducers at locations upstream and downstream of the former tidal restriction. Measurements will be taken every 15 minutes.

Data collection will be supervised by We Heart Marshes' senior scientist, Mr. Spart Alterniflora. Our data collection and quality control processes are fully described within the proposal, and we will contact the National Centers for Environmental Information to confirm their ability to archive our data. The data will be available to the public by September 1, 2019. In the past, we have shared similar data through grant progress reports and presentations to our town Conservation Commission. Contact Spartina Alterniflora at s.alterniflora@weheartmarshes.org or 123-456-7890 for more information.

Real World Example:
The Mountain View Restoration Project, implemented by Ducks Unlimited, Inc., will generate environmental data and information, including data on sedimentation rates, vegetation cover, water quality, and fish. Datasets will include sedimentation rates; rate of vegetative colonization; water quality components such as dissolved oxygen, salinity, and specific conductance; and fish use of the newly restored site. Data will be collected by local researchers and compiled by the South Bay Salt Pond Restoration Project into an annual self-monitoring report. The data will be stored on the SBSP Restoration Project website (http://www.southbayrestoration.org/monitoring/). The data will be available to the public at this website no later than two years after it was collected, through 2050, or the end of the SBSP Restoration Project. Contact XXX (lead scientist for the project) at (phone number) or (email

address) for more information or to make a data request outside of what is provided on the webpage. In the past, the SBSP Restoration project has shared similar data that you can find at the website. All future sub-awardees not identified in this plan will have as a condition of their contract acceptance of this data sharing plan. Any additional data sharing stipulations for future sub-awardees may be outlined at that time and described in their contract

3. TIER 1 MONITORING GUIDANCE

3.1 Fish Passage Barrier Removal

Tier 1 monitoring for fish passage barrier removal projects applies to projects removing dams and removing or replacing culverts. The metrics are:

1) Site Passability: channel width, channel gradient, and jump height
2) Presence of Target Fish Species: presence/absence of diadromous fish species, life stage limited by barrier
3) Annual Operating, Maintenance, and Liability Costs: annual for next five-year period
4) Safety Hazard: describe hazard diminished or eliminated
5) Civic or Community Enhancement: changes to infrastructure, utilities or recreational facilities

What follows is basic guidance for conducting Tier 1 fish passage monitoring.

3.1.1 Site-Passability

Recipients are requested to provide project designs to NOAA Technical Monitors before implementation. The pre-implementation measurements for passability metrics (channel width, gradient, and maximum jump height) should reflect existing conditions at the site and the target ranges should be based on project design plans that reflect regionally appropriate fish passage criteria as follows:

West Coast: All projects should be designed to meet appropriate criteria defined in NMFS West Coast Fish Passage Guidance

Northeast and Southeast: Although there is not a single standard in the Northeast, recipients must describe and document how their design criteria for the target species were established, citing references if appropriate, and how their design meets these criteria. Design criteria should include flow velocities as they relate to the swimming abilities of the target species (including burst and sustained swimming speeds), jump heights, flow depths, channel width and gradient. If necessary, hydraulic modeling should be used to verify whether the design will meet these criteria.

Passability Metrics

Channel width should be determined by taking the average of three measurements of the active channel width immediately within the barrier removal site. For culverts, these should be taken pre- and post-implementation just under the crossing and immediately upstream and downstream. For dams, pre-implementation measurements should be taken immediately upstream and downstream of the dam and across the spillway crest and repeated at these

locations post-removal. Although channel widths are reported in progress report Section B "Performance Measures" as averages for each time period, the three measurements contributing to each average should be reported in the final progress report narrative described in Section 1.

Channel gradients should be determined by taking a longitudinal profile through the project reach, defined by the extent of barrier influence on channel and/or water surface slope. Determine the *average channel gradient* from just upstream of the influence of the barrier to just downstream of its influence (i.e. below any scour pools). As such, pre- and post-implementation average channel gradients should be the same. Areas of *maximum channel gradient* pre- and post-implementation should be identified visually from plotted longitudinal profiles and then computed. Maximum channel gradients should be identified and computed for channel distances greater than 5-10 feet (based on plot resolution). Significant changes in channel elevation over shorter distances should be considered as jump heights (see below).

Maximum jump height is the largest abrupt discontinuity in the channel gradient that would require a fish to jump to transit the site. In the case of a dam removal, the dam itself would very often be the maximum jump height for the pre-implementation condition. Maximum jump heights should be identified visually from the pre-and post-implementation longitudinal profile plots and then measured.

Frequency/Duration of Sampling

A pre-implementation survey should be conducted at the site to document conditions before barrier removal. The post implementation survey should be conducted soon after project implementation to document as-built conditions.

3.1.2 Presence of Target Fish Species

Presence/absence metrics

Select one diadromous species and its life stage (*juvenile or adult*) that, if able to pass through the site, would represent adequate passage for all other species in the area. For example, if two diadromous species are likely to use the site, choose the species and life stage with the poorest swimming or jumping abilities. Use one of the following survey techniques to identify presence or absence for either adults or juveniles upstream of the project site, based on state or regional protocols for fish surveys[3]. For this metric, your target will be presence upstream after removal.

- Adults – upstream weirs, mark-recapture, spawner surveys, snorkel counts, videography at barrier location.
- Juveniles – mark-recapture, migrant traps, snorkel counts, electroshocking, videography at barrier location.

[3]If unknown then refer to the following document: Roni, P. (Editor) 2005. Monitoring stream and watershed restoration. American Fisheries Society, Bethesda, Maryland, 350 p.

Applicants may propose additional monitoring methods to confirm presence of fish target species, such as eDNA, that will be considered on a case-by-case basis. When proposing alternate methodology, please provide sufficient detail to allow for comprehensive review by NOAA technical staff, including a description of the data collection (sample size, sample location/distribution, sample frequency), sample processing methods (e.g. filtration and sequencing methods, for eDNA), and proposed ground-truthing or verification methods (if using remote sensing or eDNA).

If a pre-implementation survey is not possible, report whether the barrier is a known full barrier or partial barrier for the target diadromous species. If no recent biological information is available, include surrogate information (e.g. last time the target species was seen above the barrier, a description of "completeness" of barrier, etc.).

Frequency/Duration of Sampling

The frequency and duration of sampling should be related to the life history of the target species. At a minimum, this metric should be monitored once post-implementation, and at a maximum it could be monitored on an annual or seasonal basis.

- Monitoring for this measure is likely to yield meaningful results in the first 3 years after project implementation, although in some situations it may be valuable to monitor for the first 5 years.
- Once target fish presence is detected upstream of the project site post-implementation, monitoring for this measure is complete.

3.1.3 Operating, Maintenance, and Liability Costs

Changes in annual operations, maintenance and/or liability costs associated with the barrier removal should be documented.

- Pre-implementation: Calculate the expected average annual operating, maintenance, and/or liability costs over the next 5 year period if the barrier were to remain in place. Periodic or less frequent costs that may occur during this period (e.g. structural upgrades to meet safety or regulatory requirements) may be incorporated into the estimate.
- Post-implementation: Calculate the expected average annual operating, maintenance, and/or liability costs over the next 5 year period with the barrier removed.

3.1.4 Safety Hazard

Improved public safety associated with the barrier removal, if applicable.

- Pre-implementation: Describe the safety hazards caused by the barrier and how they will be eliminated or diminished through removal. Safety hazards may include barriers

that serve as attractive nuisances and present swimming and boating dangers. Also, barriers that are structurally deficient, in danger of failure, or cause flooding may be considered public safety hazards

- Post-implementation: After implementation, confirm that the identified public safety hazard has been eliminated or diminished.

3.1.5 Civic or Community Enhancement

Local civic enhancement projects associated with the barrier removal, if applicable.

- Pre-implementation: Determine whether or not there will be a local community, civic enhancement project associated with the barrier removal project. Local civic enhancement projects may include, but are not limited to, adjacent recreation enhancement, park development, and/or riverfront revitalization.
- Post-implementation: Confirm that the enhancement project(s) associated with the barrier removal was completed.

3.2 Coral Recovery

The Restoration Center works to recover corals through three types of restoration actions: reducing land-based sources of pollution; removing invasive species; and the propagation and/or transplanting of corals in response to physical impacts and/or to recover and enhance populations of endangered or threatened coral species. There are nine potential metrics for coral projects, described below. They are listed here by project type.

Land-based Sources of Pollution Reduction:

- Management plan actions implemented - 3.2.1
- Civic or community enhancement - 3.2.2
- Number of target species (plants) - 3.2.3
- Percent survival (plants) - 3.2.4
- Presence/absence of ungulates - 3.2.5
- Fence installed - 3.2.6

Invasive Species Removal:

- Management plan actions implemented - 3.2.1
- Civic or community enhancement - 3.2.2
- Number of target species (urchins released) - 3.2.3
- Percent cover (plant/algae, before/after) - 3.2.7
- Tons of algae removed - 3.2.8
- Density of urchins - 3.2.9

Active Propagation/Physical Impact Response & Restoration:

- Management plan actions implemented - 3.2.1
- Civic or community enhancement - 3.2.2
- Number of target species (corals transplanted/outplanted) - 3.2.3
- Percent survival (of corals, including detachment rates) - 3.2.4
- Density of urchins - 3.2.8

3.2.1 Management Plan Actions Implemented

Techniques
Identify the name of the plan, include a web link for the plan, and work with the NOAA Technical Monitor to identify the number of actions the project will address. Clearly state the type of plan the actions are from, the specific actions to be addressed within the plan, and the number of actions the project will address. For example, an endangered species recovery plan, a watershed management plan, a conservation action plan, a regional plan, or a local plan.

Frequency/Duration of Sampling
The actions implemented should be assessed within 90 days of post-restoration.

Targets
The target is "Yes" actions from a management plan were implemented.

3.2.2 Civic or Community Enhancement

Local civic enhancement projects associated with coral recovery, if applicable.

- Pre-implementation: Determine whether or not there will be a local community, civic enhancement component associated with your project. Local civic enhancement projects may include education and outreach, recreational infrastructure, or green infrastructure. For each type of community enhancement, count the number of enhancements that will directly benefit the community. Below are examples for each category, and the metrics for which targets should be developed. The specific target will depend on the project, and will be used to assess the "success" of the project post-implementation. If you have questions on what to monitor for your project, contact the NOAA Technical Monitor.
    - Education and Outreach - workshops, seminars, trainings, K-12 educational opportunities, signs, and manuals or brochures
        - Estimate the number of attendees or outreach material recipients
    - Recreational Infrastructure - park development or enhancement, road, trail, or walkway development or enhancement, or access to recreational opportunities
        - Record the length and width of the area to be stabilized
        - Describe the recreational opportunity to be implemented
    - Green Infrastructure – rain gardens, constructed wetlands, or

bioretention systems
    - Describe the design details for each component to be implemented.
- Post-implementation: Confirm that the enhancement project(s) associated with coral recovery was/were completed. Report the final numbers for each applicable enhancement metric in the bi-annual report and final report for the project.
    - Education and Outreach - workshops, seminars, trainings, K-12 educational opportunities, signs, and manuals or brochures
        - Record the number of attendees or outreach material recipients
    - Recreational Infrastructure - park development or enhancement, road, trail, or walkway stabilized, or access to recreational opportunities
        - Record the length and width of the area stabilized
        - Describe the recreational opportunity as implemented.
    - Green Infrastructure – rain gardens, constructed wetlands, or bioretention systems
        - Describe each component as it was implemented, noting differences between implementation and design.

3.2.3 Number of Target Species (Released or Planted)

Techniques
As individuals are released or planted[4] in the upland, coastal, or marine environment, they should be counted and recorded by the scientific name (lowest reasonable taxon) of flora or fauna.

Frequency/Duration of Sampling
The individuals should be recorded by species as they are released or planted.

Targets
The target should be set to meet the purpose of the project. If you are unsure how to determine this, contact the NOAA Technical Monitor.

3.2.4 Percent Survival (Plantings and Transplantings)

Techniques
Permanent monitoring locations are preferred. Acceptable techniques include line-point intercept, belt transects, or quadrats to estimate survival over the project area. Consult the NOAA Technical Monitor for additional guidance.

Frequency/Duration of Sampling
This should be assessed at 90 days post-restoration.

[4] NOAA RC only supports releasing or planting species native to the local geographic area, and from a verified source

Targets
Minimum target is 80% survival. The final target will be defined in the final design plans for the project. If the project area is hit by a disease outbreak or a natural disaster, such as a major storm or hurricane, work with the NOAA Technical Monitor to reassess project metrics.

3.2.5 Presence/Absence of Ungulates

Techniques
Select one ungulate species (e.g. goats, pigs, etc.) and its life state (juvenile or adult) that if absent represents restoration of the project area. For example, projects focused on the removal of goats or pigs should choose the species and life stage with the greatest digging and jumping abilities. Ungulates can be detected using visual surveys (e.g. haphazard or random walk or aerial survey) of the project area for individual animals, scat, digging at the fence, or other animal signs or baited stations.

Frequency/Duration of Sampling
This should be completed prior to project implementation and once at 90 days post-restoration. If possible, it would be valuable to monitor the area on a regular basis over the first year to ensure the target species remains absent.

Targets
The target will be absence.

3.2.6 Fence Installation

Techniques
Fencing is used to restrict access to vegetated areas. Ungulates, and primarily goats, cause significant damage to coral reefs when they eat all of the vegetation. Without vegetation, bare soil is easily washed into the nearshore environment causing stress to coral reefs.

Frequency/Duration of Sampling
The length of the fence should be recorded at the end of the project.

Targets
The length of fence required to keep ungulates out of the restored area, and therefore reduce the stress of coral reefs by reducing the amount of sediment in the water should be determined before the project is implemented, and recorded in the final scope of work for the project.

3.2.7 Percent Cover

Techniques
Permanent monitoring locations are preferred. Acceptable techniques include line-point

intercept, belt transects, or quadrats. Consult the NOAA Technical Monitor for additional guidance.

Frequency/Duration of Sampling
Baseline percent cover should be assessed prior to restoration and assessed 90 days post-restoration.

Targets
Cover of invasive algae species should be 20% or less. Targets for all other species will be defined in the final scope of work.

3.2.8 Tons of Algae Removed

Techniques
Algae removed should be weighed wet. The weight should be reported to NOAA as metric tons. For reference, 1 metric ton=1.1 U.S. tons=1,000kg = 2,204.6 lbs. If it is not possible to weigh the algae wet, then consistently weigh the materials for your project as wet or dry and note in your report, if the weight reported is a wet or dry weight.

Frequency/Duration of Sampling
The material should be weighed wet immediately after removal or as soon as practical.

Targets
The target will be defined in the final scope of work for the project.

3.2.9 Density of Urchins

Techniques
For urchins, it is best to use a belt transect (25m x 1m). Individual urchins along the belt should be counted to determine the number or urchins per square meter.

Frequency/Duration of Sampling
The density of the target species should be assessed prior to release, as a baseline, upon release, and at 90 days post-restoration. If possible, it would be valuable to monitor the area on a regular basis over the first five years to ensure the target species remains.

Targets
Urchins should be released to achieve a target density of 1 urchin per m^2 across the restoration site at 90 days post-restoration.

3.3 Hydrologic Restoration

Tier 1 monitoring for hydrologic restoration projects applies to projects that restore water elevations and flows through fill removal, barrier removal/modification, levee and dike removal/setback, tidal restriction removal, and floodplain and off-channel habitat reconnection. Large-wood placement is one technique that can be used for floodplain and off-channel habitat reconnection. Large-wood placement for habitat complexity only, and not with the goal of reconnecting off-channel habitat, does not fit this hydrologic restoration strategy definition. The metrics are:

1) Land Elevations:
2) Water Levels: using hydrographs or photographs
3) Annual Operating, Maintenance, and Liability Costs: estimated for the next five-year period
4) Safety Hazard: describe hazard diminished or eliminated
5) Civic or Community Enhancement: changes to infrastructure, utilities, or recreational facilities

3.3.1 Land Elevations

Techniques

The RC will use restoration designs and post-construction as-built surveys or drawings to determine whether the restoration effort met its target elevations. Restoration designs should be prepared and stamped by a licensed professional engineer and show all relevant existing and proposed elevations and cross sections of structures, channels, wetlands, and floodplains. The as-built drawings should be prepared by a professional land surveyor and show the final elevations and cross sections of the structures (e.g. culvert invert elevations, target culvert width etc.), channels, and land installed or altered by the project. As-built drawings should be surveyed into a known elevation benchmark and referenced to a standard geodetic datum or the International Great Lakes Datum.

Frequency/Duration of Sampling

Only one post-restoration survey is needed. The survey can be immediately post-restoration, unless otherwise specified in the monitoring plan. This will be compared to engineered design plans.

3.3.2 Water Levels

Two basic methods of monitoring water levels are described, and the appropriate technique will depend on the project type. For project locations that are wetted at all times, such as tidal reconnection, lacustrine reconnection, and off/side-channel reconnection or creation projects, water levels will be monitored using data loggers to create hydrographs. When data loggers can't be deployed effectively, photographs and measurements at staff gauges can be used to document basic project effectiveness.

Techniques

Hydrographs - Pre-restoration and post-restoration hydrographs from both downstream and upstream of the project site should be obtained using data loggers. For tidal and lacustuary (Great Lakes) marsh restoration projects, recipients may need to purchase data loggers if they do not already have access to them. The only requirement is that the data logger collects water level information (usually a pressure transducer). Pre- and post-restoration hydrographs will be generated by collecting water elevations using at least three data loggers (upstream and downstream of water restrictions, and one to correct for atmospheric pressure) surveyed into the same elevation benchmark and datum as the as-built drawings and project plans. Nearby established water level gauges may be substituted for project-specific gauges with approval from NOAA. All loggers or gauges should be surveyed into the same elevation benchmark (and tidal datum if appropriate) as the as-built drawings and restoration designs.

For freshwater side/off channel reconnection or creation projects, the loggers will correlate the off/side channel feature inundation periods with the adjacent stream flow levels, and correct for atmospheric pressure, rather than measuring either side of a particular restriction.

Photographs - For freshwater floodplain reconnection projects, pre- and post-restoration photographs combined with measurements at multiple staff gauges will be used to show floodplain inundation extent throughout the project area during peak flows. Staff gauges and corresponding photo points along one or more transects should be surveyed. Flood elevations within the project area will be measured in tandem with existing gauges on an adjacent river.

Frequency/Duration of Sampling

Hydrographs - For tidal locations, each monitoring period will occur over a single 28-day tidal cycle, and measurements should be taken every 15 minutes.

For lacustrine locations, the monitoring period should record water surface elevations over at least 30 days and attempt to capture at least one short-period water level fluctuation event (e.g. storm events, seiching) during those times of the year when the proposed connection is planned to be fully open.

For freshwater side/off channel reconnection or creation, the post-project monitoring period should occur during the rainy season and should capture peak flows during the greatest extent of inundation, and may cover up to 8 months. Discuss whether there are benefits to conducting monitoring during a biologically relevant season for target fish species with your NOAA Technical Monitor.

Photographs - For freshwater floodplain reconnection projects, the post project monitoring period should occur during peak flows or during the greatest extent of inundation, and may cover up to 8 months in order to capture high flow periods. Discuss whether there are benefits to conducting monitoring during a biologically relevant season for target fish species with your NOAA Technical Monitor.

Targets

Hydrographs - There is no set target for comparing the pre- and post-restoration hydrographs. Instead, the RC is looking for a change that indicates progress towards the project's overall goals.

Photographs - There is no set target for comparing the pre- and post-restoration photographs. Instead, the RC is looking for evidence that the new flooding regime is in line with the project's overall goals.

3.3.3 Operating, Maintenance, and Liability Costs

Change in operations, maintenance and/or liability costs associated with restoration.

- Pre-implementation: Calculate the expected average annual operating, maintenance, and/or liability costs over the next 5-year period if the project were not completed. Periodic or less frequent costs that may occur during this period (e.g. structural upgrades to meet safety or regulatory requirements) may be incorporated into the estimate.
- Post-implementation: Calculate the expected operating, maintenance, and/or liability costs over the next 5-year period once the project is completed.

3.3.4 Safety Hazards

Improved public safety associated with the restoration, if applicable.

- Pre-implementation: Describe whether restoration will eliminate or diminish a public safety hazard. Safety hazards may include flooding or safety risks posed by unsafe infrastructure. Describe the safety hazards caused by the characteristics of the current sites and how they will be eliminated or diminished through restoration.
- Post-implementation: After implementation, confirm that the public safety hazard has been eliminated or diminished.

3.3.5 Civic or Community Enhancement

Local civic enhancement projects associated with the restoration, if applicable.

- Pre-implementation: Determine whether there will be a local community, civic enhancement project associated with the restoration project. Local civic enhancement projects may include, but are not limited to, adjacent recreation enhancement, economic enhancement and/or infrastructure enhancement (e.g. enhanced fishing piers, kayak launches, boat ramps, educational signage, park development, and/or riverfront revitalization.
- Post-implementation: Confirm that the enhancement project(s) associated with the restoration project was completed.

3.4 Oyster Restoration

The RC restores bivalve shellfish through a variety of techniques involving reef and bed construction, and seeding when restoration potential is limited by the availability of larvae. A major focus of our work is oyster habitat restoration. The RC and partners developed the Oyster Habitat Restoration Monitoring and Assessment Handbook to increase consistency in monitoring. The RC's Tier 1 metrics are described in the Handbook as "Universal" metrics and environmental variables. The Handbook provides guidance for collecting the RC's Tier 1 metrics for both eastern (*Crassostrea virginica*) and Olympia (*Ostrea lurida*) oysters. The latter is the only native oyster species found on the west coast of the U.S.
These metrics are:

1) Reef areal dimensions
    a. Project/Site Footprint
    b. Reef Area
2) Reef height (minimum, mean, and maximum)
3) Oyster Density
    a. Mean live oyster density (including oyster recruits)
    b. Mean original (planted) seed density (if applicable)
4) Oyster Size Frequency Distribution (shell height) (recruit density may be extrapolated from these data)
5) Environmental Variables (annual minimum and maximum)
    a. Chlorophyll-a
    b. Dissolved Oxygen (subtidal reefs only)
    c. pH
    d. Salinity
    e. Turbidity
    f. Water Temperature

3.4.1 Reef Areal Dimensions

Techniques
The Handbook provides recommendations for techniques for both intertidal and subtidal reefs.

Frequency/Duration of Sampling
The "short-term" monitoring guidelines in the Handbook describe the appropriate sampling time frames for RC Tier 1 oyster restoration metrics. This includes pre-restoration monitoring, monitoring within 3 months of construction to document an as-built condition, and then a post-implementation monitoring point at one to two years post-construction to include at least two recruitment phases.

Targets
There are no targets or performance criteria for this metric, as changes in the reef footprint or area can be due to spreading of the original cultch material, rather than growth of the living

reef.

3.4.2 Reef Height

Techniques
Reef height is measured in comparison to the immediately surrounding substrate, not the shoreline. The Handbook provides recommendations for techniques for both intertidal and subtidal reefs.

Frequency/Duration of Sampling
The "short-term" monitoring guidelines in the Handbook describe the appropriate sampling time frames for RC Tier 1 oyster restoration metrics. This includes pre-restoration monitoring, monitoring within 3 months of construction to document an as-built condition, and then a post-implementation monitoring point at one to two years post-construction to include at least two recruitment phases.

Targets
Target setting guidelines are provided in the "performance criteria" sections of the Handbook; for any given area or region, recipients should also rely on published data (e.g. state reports, peer-reviewed papers) for their location or region to help determine targets. Valuable information about targets may also be obtained by talking to oyster biologists and oyster restoration practitioners who have conducted studies or restoration projects in the region previously.

3.4.3 Oyster Density

Techniques
Mean Live Oyster Density - This is the mean number of live oysters per square meter, including recruits.

Mean Original Oyster Seed Density (if applicable) - This is the mean number of live oysters per square meter planted onto the reef. The Handbook includes two methods for making this measurement.

Frequency/Duration of Sampling
Mean Live Oyster Density - The "short-term" monitoring guidelines in the Handbook describe the appropriate sampling time frames for RC Tier1 oyster restoration metrics—one to two years post-restoration, in order to capture two recruitment cycles. The Handbook recommends sampling annually, at the end of the oyster growing season when newly settled oysters have grown to a size greater than 10mm for eastern oysters and 3 mm for Olympia oysters.

Mean Original Oyster Seed Density (if applicable) - The density of planted oysters should be

determined within one week after deployment.

Targets
Target setting guidelines are provided in the "performance criteria" sections of the Handbook; for any given area or region, recipients should also rely on published data (e.g. state reports, peer-reviewed papers) for their location or region to help determine targets. Valuable information about targets may also be obtained by talking to oyster biologists and oyster restoration practitioners who have conducted studies or restoration projects in the region previously.

3.4.4 Oyster Size Frequency Distribution / Mean Shell Height

Techniques
Report the mean shell height (mm) of live oysters, with SE. Submit size frequency distribution with final report as a chart.

Frequency/Duration of Sampling
0-3 months, 1 year, 2nd year if needed to catch a second recruitment cycle.

The "short-term" monitoring guidelines in the Handbook describe the appropriate sampling time frames for RC Tier 1 oyster restoration metrics; the minimum post-implementation monitoring time frame is one to two years post-construction and should include at least two recruitment phases.

Targets
Target setting guidelines are provided in the "performance criteria" sections of the Handbook; for any given area or region, recipients should also rely on published data (e.g. state reports, peer-reviewed papers) for their location or region to help determine targets. Valuable information about targets may also be obtained by talking to oyster biologists and oyster restoration practitioners who have conducted studies or restoration projects in the region previously. This is especially important for the Olympia oyster, which has a very different life history and environmental requirements than the eastern oyster. For example, Olympia oysters grow more slowly (only about 15 - 20 mm or ~1/2-3/4 inch per year) and have a smaller maximum size (about 75mm or 3 inches). The eastern oyster, in contrast, can reach 100 – 115 mm or ~ 4.0-4.5 inches during the first two years of life in the Gulf of Mexico and may attain sizes of 12 inches (35 cm) or more over 50 years in the Chesapeake Bay and the Gulf of Mexico.

3.4.5 Environmental Variables

These are the recommended variables to monitor:

- Chlorophyll-*a*
- Dissolved Oxygen (subtidal reefs only)
- pH

- Salinity
- Turbidity
- Water Temperature

Techniques
Please review the Oyster Habitat Restoration Monitoring and Assessment Handbook for suggestions regarding monitoring methodology.

Frequency/Duration of Sampling
Continuous data measurements are preferred, either from a monitoring station located near the project (ex: NOAA, USGS, EPA), or an in situ continuous monitor deployed by a practitioner. If continuous measurements are not possible, measurements may be made less frequently, with the understanding that as the frequency of measurements decreases, the usefulness of the data also decreases. To assess the limitations of the data, practitioners should report the frequency and timing (i.e., season, tidal stage, time of day) of sampling. Please see the Oyster Habitat Restoration Monitoring and Assessment Handbook for further information and suggestions when continuous monitoring isn't available.

Targets
There are no set targets for these Environmental Variables as they are meant to provide data to help explain potential impacts to the performance of restored reefs**.**

3.5 Wetland Restoration

NOTE: This Strategy is still under development and is not listed in the 2024/2025 NOFOs. The draft monitoring guidance below is considered to be part of a "pilot" effort to evaluate Wetland Restoration projects. If you think this strategy is applicable to your project based on the description below, consider incorporating these metrics into your monitoring plan.

Tier 1 monitoring for wetlands restoration projects applies to projects that provide habitat for wetland-dependent species and increase long-term habitat resilience and ecosystem services by rehabilitating, enhancing or creating a wetland. Wetlands Restoration projects are primarily focused on those involving creation of, or direct physical manipulation within (e.g. placement of fill) coastal wetland habitat to result in a change in the functioning of the habitat. These restored areas are within the coastal zone (with some exceptions), under tidal influence, and dominated by emergent vegetation and adjacent habitats that serve as foraging, nursery, and/or refuge purposes for fisheries. While the focus of the strategy is largely on estuarine emergent[5] wetlands (marshes and mangroves), actions involving living shorelines techniques can result in restoration of emergent wetland areas and are included in this strategy for monitoring of those

[5] For DARRP projects, data collection of implementation monitoring metrics can go beyond the estuarine emergent definition to include non-tidally influenced wetland habitats.

benefits. Biological changes to emergent wetland areas, such as invasive species removal and plantings, are considered where there are measurable benefits to wetland habitats.

The metrics for monitoring are:

1) Area
2) Land Elevations
3) Tidal inundation
4) Vegetation Percent Cover
5) Vegetation Percent Survival and Invasive Species Removal (planting projects only)
6) Civic or Community Enhancement: changes to infrastructure, utilities, or recreational facilities

3.5.1 Area

Techniques

The distribution and spatial extent of habitat types are fundamental aspects of any monitoring plan. The goal of habitat monitoring is to quantify changes in the extent and distribution of habitat types that result from restoration and to relate those changes to responses in hydrology, vegetation and fauna. Therefore several techniques can be employed to monitor these changes and resulting data can be used to calculate the area, including aerial photography, remote sensing, photo points, transects or other techniques as appropriate for the spatial scale of the project. The links above provide some guidance on how these techniques can be applied to quantify changes of spatial extent.

Frequency/Duration of Sampling

Before and After Control-Impact sampling is recommended for wetland restoration monitoring. Pre-restoration (baseline) monitoring should be conducted prior to implementation to define the distribution and spatial extent of habitat types of the defined project area to provide a basis with which to compare the system's response to restoration actions. Post-construction monitoring should be conducted within the first year post- construction (preferably within 3 months) to document an as-built condition of the area. Monitoring of a control (reference site) at similar time intervals is also recommended to be able to compare the control and impact sites and discern the effects of restoration on the impact site from natural variability, underlying trends(sea level rise and increases in water levels), etc.

Targets

Targets and performance criteria for this metric will be site specific, as changes in the wetland footprint or area will depend on the needs of each specific restoration action but the RC expects changes that indicate progress towards the project's overall goals.

3.5.2 Land Elevations

Techniques

The goal of elevation monitoring is to quantify changes in topography that result from restoration. Multiple methods are used to measure elevation changes in tidal marshes and should be chosen based on restoration and monitoring objectives and site specific considerations. Some of the following techniques can be used for measuring elevation changes over a broad spatial scale: Ground-based topographic mapping with RTK, bathymetric mapping, and LiDAR (terrestrial or aerial). Restoration design elevations should be compared to post-construction as-built surveys or drawings to determine whether the restoration effort met its target elevations. Restoration designs should be prepared and stamped by a licensed professional engineer and show all relevant existing and proposed elevations and cross sections of structures, channels, wetlands, and floodplains. The as-built drawings should be prepared by a professional land surveyor and show the final elevations and cross sections of the structures. As-built drawings should be surveyed into a known elevation benchmark and referenced to a standard geodetic datum or the International Great Lakes Datum.

Frequency/Duration of Sampling

Only one post-restoration survey is needed. The survey can be conducted immediately post-construction unless otherwise specified in the monitoring plan. This will be compared to engineered design plans. Additional surveys may be warranted based on the expected settlement of wetlands creation project areas.

Targets

Targets are project-dependent and established by the engineered designs. The RC is looking for a change that indicates progress towards the project's overall goals.

3.5.3 Tidal Inundation

Two basic methods of monitoring water levels are described, and the appropriate technique will depend on the project type. For project locations that are wetted at all times, water levels could be monitored using data loggers to create hydrographs. When data loggers can't be deployed effectively, photographs and measurements at staff gauges can be used to document basic project effectiveness.

Techniques

Hydrographs - Pre-restoration and post-restoration hydrographs from both downstream and upstream of the project site should be obtained using data loggers. The only requirement is that the data logger collects water level information (usually a pressure transducer). Pre- and post-restoration hydrographs will be generated by collecting water elevations at multiple data

loggers surveyed into the same elevation benchmark and datum as the as-built drawings and project plans. Nearby established water level gauges may be substituted for project-specific gauges with approval from NOAA.

Photographs - For projects where hydrographs are not used, pre- and post-restoration photographs combined with measurements at multiple staff gauges will be used to show floodplain inundation extent throughout the project area during peak flows. Staff gauges and corresponding photo points along one or more transects should be surveyed. Where possible, the pre- and post-restored site can be documented using time-lapse photography. Ideally, the flood stage should be compared/corrected with a monitored reference point.

Frequency/Duration of Sampling

Hydrographs - Project-dependent, but likely at least multiple times to determine standard tidal cycle.

Photographs - Project-dependent, but likely pre- and post- restoration at a minimum

Targets

Hydrographs - There is no set target for comparing the pre- and post-restoration hydrographs. Instead, the RC is looking for a change that indicates progress towards the project's overall goals.

Photographs - There is no set target for comparing the pre- and post-restoration photographs. Instead, the RC is looking for evidence that the new flooding regime is in line with the project's overall goals.

3.5.4 Vegetation Percent Cover / Composition

Percent Cover: Percent of ground surface of restored area covered by emergent vegetation.

Vegetation Composition: the areal contribution of a species to the total vegetation composition expressed as a percentage.

The current and changing composition and condition of the vegetation community influences its spatial distribution and its use as available habitat. Vegetation composition and condition indicate the extent and location of tidal marsh habitats. Monitoring will denote potential sources of vegetative recruitment for restored areas. Areas serving as natural recruitment for vegetation (emergent areas adjacent or underlying proposed created marsh areas; sediment sources that may contain "seed bank") should be documented for comparison.

Techniques

Permanent monitoring locations are preferred. Species composition is generally expressed as a percent, so that all species components add up to 100%. Composition can be calculated with

measures of cover, density, weight or biomass. Acceptable techniques to calculate percent cover and vegetation composition include aerial photography, line-point intercept, belt transects, photoplots or quadrats. The technique used will depend on the extent of the restored area and scope of the project. Consult the NOAA Technical Monitor for additional guidance.

Frequency/Duration of Sampling
Baseline percent cover should be assessed prior to restoration and assessed 1 year post-restoration. Additional monitoring events could be performed at earlier intervals if warranted.

Targets
Target compositions will be project dependent. The RC expects changes that indicate progress towards the project's overall goals.

3.5.5 Percent Survival and Invasive Species Removal (For Projects Implementing Planting)

This metric applies only to projects in which the goal is to restore native plant populations by planting native plants and eradicating invasive plant species. Baseline and post-implementation monitoring will provide a more quantifiable measure of success of the project by providing insight into the relative effectiveness of different eradication and revegetation techniques.

Techniques
Permanent monitoring locations are preferred. Some techniques could include individual plant counts, line-point intercept, belt transects, photoplots or quadrats. The technique used will be dependent on project needs. Consult the NOAA Technical Monitor for additional guidance.

Frequency/Duration of Sampling
Newly restored areas should be monitored at 90 days for survivability. Additional monitoring events could take place as needed to assess when target cover is achieved.

Targets
Targets will be project and species dependent but in general 75% of native plant coverage would indicate plant establishment.

3.5.6 Civic or Community Enhancement

Local civic enhancement projects associated with the restoration, if applicable.

- Pre-implementation: Determine whether there will be a local community, civic enhancement project associated with the restoration project. Local civic enhancement projects may include, but are not limited to, adjacent recreation enhancement,

economic enhancement and/or infrastructure enhancement (e.g. enhanced fishing piers, kayak launches, boat ramps, educational signage, park development, and/or riverfront revitalization.

- Post-implementation: Confirm that the enhancement project(s) associated with the restoration project was completed.