

Appendix D. Example Adaptive Management Plan: E.B. Forsythe NWR Good Luck Point Marsh Restoration Adaptive Management Plan

The below document is modified from E.B. Forsythe NWR Good Luck Point Marsh Restoration Adaptive Management Plan and has been edited to reflect the needs of the Maryland Coastal Bay Marsh Restoration Projects. Based on the results of the ongoing Rum Pointe Marsh Project, Objectives, Metrics, Methods, Trigger Levels, and Responses may be altered.

BACKGROUND

The planned monitoring of all sites will occur before and after noting the baseline hydrology, vegetation, and elevation, as well as for some sites the biogeochemistry of soil and water and the presence of birds and nekton. This will ensure an understanding of the results of the project and allow for improvements in future projects. A current project, Rum Pointe, has extensive monitoring of the above and below characteristics. This project was purposefully designed to capture several overlapping data sets in order to compare and capture the most effective and most useful variables and protocols related to salt marsh restoration. At the completion of this project, summarized recommendations in the form of a report may lead to edits of the below framework; however, this document provides an overall baseline summary of objectives and goals for monitoring.

ADAPTIVE MANAGEMENT PLAN OBJECTIVES, DESIGN, AND FRAMEWORK

This plan is comprised of monitoring objectives measured by performance metrics, monitoring methods, and trigger point criteria. Possible management actions (potential responses) are listed at the end of the document and may occur based on results of monitoring and if trigger points are reached. Objectives are divided into three categories: Primary (metrics measured at all sites), Secondary (monitoring if funding or partnerships allow), and Dependent (metrics measured at trigger points).

Primary Objectives:

Objective 1: Restore tidal hydrology in altered areas

Monitoring Metrics:

- Measure surface inundation duration of megapools for 3 months before runnels and compare to areas without megapools; repeat for 2 years after runnels

Monitoring Methods:

- Continuous measurements of water level relative to marsh surface (U20L Hobo Water loggers)
- Calculations of extent of inundation using bare earth of the marsh surface from LiDAR and water level records

Expected Results

- Inundation duration on the marsh surface is greater before runnels than after runnels, stays consistent after runnels.

Trigger levels

- Inundation duration on the marsh increases or decreases in a manner that is more or less than is needed to meet project objectives. Project area data will be compared to reference sites (adjacent marshes and similar restoration projects) to determine significance of changes.

Objective 2: Re-establish native marsh vegetative communities 3 years post-implementation

Monitoring Metrics:

- Percent cover of *Spartina alterniflora*, *S. patens*, and other desirable macrophytes, as well as invasive species (e.g., *Phragmites australis*) for 1 growing season before runnels and 3 growing seasons after runnels

Monitoring Methods:

- Aerial Photography interpretation and comparison (DigitalGlobe) for 4 years (1 pre- and 3 post-construction)
- Vegetation surveys (per point intercept method) annually for 1 year pre-construction and 3 years post-construction
- Photopoints, recorded once each year for 3 years post-construction

Expected Results

- Increase in percent cover over 3 years by native plants within the project area, specifically megapools
- Minimal recruitment (less than 10%) of non-native, invasive species or unwanted, native plants

Trigger levels

- Native plant expanse on marsh platform has decreased or remained unchanged in areal extent
- Invasive or unwanted plant occupation of marsh platform increases by more than 10% in the project area.

Objective 3: Monitor elevation changes pre- and post-construction

Monitoring Metrics:

- Marsh surface elevation change

Monitoring Methods:

- Through a combination of RTK, Lidar, or other Remote sensing methods monitor elevation along several transects in project area pre-construction and for 3 years post-construction

Expected Results

- Marsh elevation increases from pre- to post-construction, to the extent specified by engineering plans
- Increase in elevation along project areas after construction remains constant or greater across years

Secondary Objectives:

Objective 4: Increase native faunal species use of habitat relative to pre-construction usage

Monitoring Metrics:

- Species abundance
- Species richness

Monitoring Methods:

- Nekton surveys
- Bird and associated vegetation surveys (SHARP)
- Crab and mussel surveys

Expected Results

- An increase in all species metrics in 3 years post-construction

Trigger levels

- Bird, nekton, and vegetation species abundance and richness decrease, remain unchanged or decrease from pre-resiliency project levels

Dependent Objectives:

Objective 5: Improve biogeochemistry in restoration area

Monitoring Metrics:

- Porewater sulfide concentration in megapools

- Soil (Carbon, Nitrogen, Organic Matter, Sheer strength)
- Observational data of presence/absence of vegetation and nekton in megapools

Monitoring Methods:

- See sections related to vegetation and fish
- IRIS Strips for indicating reduction of sulfides
- Soil Testing

Expected Results

- Decrease in sulfides along project areas after construction
- Increase in presence of vegetation and nekton in megapools
- Improvements of soil health

Trigger levels

- Fish kills or lack of vegetative response

Objective 6: Characterize water quality parameters at project site

Monitoring Metrics:

- temperature, salinity, pH, turbidity, dissolved oxygen (D.O.) nutrients (nitrogen, phosphorus)

Monitoring Methods:

- Continuous measurements of temperature
- Measurements of pH, temp, conductivity/salinity
- Monitor nearby buoys for water quality (i.e. continuous monitor sites-Coast Guard or NOAA)

Expected Results

- Water temperature, salinity, and nutrient concentrations change after construction

Trigger levels

- Fish kills or lack of vegetative response

POTENTIAL RESPONSES

Once construction is completed, a post-construction assessment will occur to ensure design standards are met, followed by monthly visits the first year and annual visits in year 2 and 3. Concerns include sediment loss, no changes in inundation, no changes in ecological life, or exacerbations of any of these preexisting challenges. If such failures occur, staff will evaluate the potential harm to the environment and project success, and act to reverse such harm within the means, methods, and resources available.

The first round of data collected pre-construction will be the baseline to which metrics will be compared to determine if expected results are met (in addition to the baseline collected immediately post-construction). During the first few years, material will settle and vegetation will vary depending on soil conditions. For example, *Salicornia* is known to colonize new sites, but areas may convert to other species as soils change. Therefore, we expect the 3-year timeframe to be considered the early stages of this long-term project.

As we collect data to understand and analyze the six objectives addressed in this document, we will regularly re-evaluate success of the project. This evaluation will occur twice each year. If expected results are not met or outcomes appear to be detrimental, staff will determine potential responses.

Below, we list potential responses that would be considered. It should be noted that not all triggers will require immediate action and may just require further analysis and study over time to understand the level of detriment occurring.

Types of Potential Responses:

- If marsh is too flooded, construct runnels or new ditches, or clean ditches to allow preferred run-off
- If invasive or unwanted plants occur at unacceptable levels, apply herbicide to reduce vegetation or reduce marsh elevation to improve tidal conditions
- If native vegetation does not recolonize the sites naturally or at an acceptable rate, plant plugs of native target plants
- If water quality decreases, re-evaluate the characteristics of the sediment placed on the marsh and sources of water quality contamination in upstream watershed
- If areas within the project area subside unacceptably over time, consider applying additional sediment on the sites (this may require a permit modification)
- If vegetation is not responding positively, conduct a stressor analysis to determine if underlying soil health is declining

SAMPLING PROTOCOLS

The project will use a variety of monitoring protocols, developed either by the USFWS or by partners. At the conclusion of the Rum Pointe Marsh Restoration Project, a more extensive outline of protocols will be compiled into a report. We recognize that technology is ever-changing regarding data collection and analysis. We may alter these protocols as affordable, state-of-the-art tools become available.

REFERENCES

- Amec. Foster Wheeler and EA Engineering, Science, and Technology, Inc. PBS. 2016. 37c Marsh Enhancement Final Study Report: Restoring Coastal Marshes in New Jersey Wildlife Refuges Design/Build for Marsh Enhancement Throughout the E.B. Forsythe National Wildlife Refuge, Oceanville, NJ: Amec Foster Wheeler.
- Ganju, N. K., M. L. Kirwan, P. J. Dickhudt, G. R. Guntenspergen, D. R. Cahoon, and K. D. Kroeger. 2015. Sediment transport-based metrics of wetland stability, *Geophys. Res. Lett.* 42:7992–8000,
- Loges B.W., Tavernia B.G., Wilson .AM., Stanton J.D., Herner-Thogmartin J.H., Casey J., Coluccy J.M., Coppen J.L., Hanan M., Heglund P.J., Jacobi S.K., Jones T., Knutson M.G., Koch K.E., Lonsdorf E.V., Laskowski H.P., Lor S.K., Lyons J.E., Seamans M.E., Stanton W., Winn B., and Ziemba L.C. 2014. National protocol framework for the inventory and monitoring of nonbreeding waterbirds and their habitats, an Integrated Waterbird Management and Monitoring Initiative (IWMM) approach. Natural Resources Program Center, Fort Collins, CO. This protocol is available from ServCat: [<http://ecos.fws.gov/ServCatFiles/Reference/Holding/40340>]
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Edwin B. Forsythe NWR Adaptive Management Plan
Brick “B” Site
PROJECT BACKGROUND

Edwin B. Forsythe National Wildlife Refuge (Forsythe, refuge) is located in Ocean, Burlington and Atlantic Counties, NJ. The refuge includes over 47,000 acres of marsh, forest, beach, grassland, and shrub habitats. Healthy, productive and resilient coastal marshes are a priority for the Refuge. Monitoring, evaluating and adaptive management has been an ongoing Refuge task for many years. The opportunity to increase the marsh resiliency utilizing sediment enrichment has added an additional incentive for adaptive management. Although this adaptive management plan (Plan) is a required condition of permit #CENAP-OP-R-2017-00040 and outlines strategies to pursue if post-construction goals and objectives are not met over time, the refuge is aware that potential issues could arise post-construction (i.e., sediment from thin layer application breaching containment barriers and unforeseen issues) and is interested in monitoring its sites post construction to assess the effects of sediment enrichment on the marsh. The U.S. Army Corps of Engineers-Philadelphia District, National Oceanic and Atmospheric Association- National Marine Fisheries Office, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers Environmental and Research Development Center, and the New Jersey Department of Environmental Protection provided guidance to the U.S. Fish and Wildlife Service in the development of this Plan.

The Brick B restoration project is a part of the Hurricane Sandy Resiliency Project #37: Restoring Coastal Marshes in NJ NWRs. The project was funded in 2015 by the Disaster Relief Appropriations Act of 2013 in response to impacts on coastal communities by Hurricane Sandy, and will help prepare the affected areas for similar future weather events. This project aims to enhance the major functions of a portion of refuge tidal marsh that is exhibiting habitat degradation by increasing the marsh plain elevation. This goal will be achieved by applying sediment via thin layer deposition techniques.

The general project area, located in Brick Township is in the vicinity of the mouth of Reedy Creek. The project area encompasses about 143 acres of tidal marsh; however, sediment would be applied to no more than 67 acres. This management plan is intended to go into effect once construction is complete and all designs elements have been achieved (i.e., planned target elevations are achieved). However, we recognize that construction flaws or environmental conditions, such as storms, could result in site failures that may need to be addressed, such as leaky hay bales or coir logs. Those failures will be addressed immediately and in addition to monitoring tasks presented here.

ADAPTIVE MANAGEMENT PLAN OBJECTIVES, DESIGN, & FRAMEWORK

This plan is comprised of monitoring objectives measured by performance metrics, monitoring methods, and trigger point criteria. Possible management actions (potential responses) are listed at the end of the document.

Objective 1: Measure surface inundation duration and determine if it is equal to the reference benchmark for Forsythe Refuge Salt March Integrity (SMI) units over 4 years

Monitoring Metrics:

- Duration of inundation for each tidal cycle
- Data would be collected that addresses daily and monthly inundation

Monitoring Methods:

- Continuous measurements of water level relative to marsh surface (Solinst and Hobo water level loggers)
- Calculations of extent of inundation using bare earth of the marsh surface from LiDAR and water level records

Expected Results

- Inundation duration on the marsh surface does not increase or decrease in a manner that will negatively impact intended habitat post-construction (we may want an increase or decrease depending on topography and elevation)

Trigger levels

- Inundation duration on the marsh increases or decreases in a manner that is more or less than is needed to meet project objectives. Project area data will be compared to surrounding sites to determine how significant those changes are, and comparisons to similar projects will be made in that analysis

Objective 2: Re-establish native marsh vegetative communities supporting an increase in native vegetation such as short-form smooth cordgrass and salt meadow cordgrass over 4 years

Monitoring Metrics:

- Percent cover of *Spartina alterniflora*, *S. patens*, and other desirable macrophytes, as well as invasive species (e.g., *Phragmites australis*)

Monitoring Methods:

- Aerial Photography interpretation and comparison (DigitalGlobe) after 4 years
- Vegetation surveys (per SMI and SHARP protocols) annually for 4 years post-construction

- Photopoints, recorded in Spring and Fall each year for 4 years post-construction

Expected Results

- Increase in 25 percent cover over 4 years by native plants within the project area
- Minimal recruitment (less than 10%) of non-native, invasive species or unwanted, native plants over 4 years

Trigger levels

- Native plant expanse on marsh platform has decreased or remained unchanged in areal extent over 4 years
- Invasive or unwanted plant occupation of marsh platform increases over 4 years

Objective 3: Increase above- and below-ground biomass in restoration area over 4 years

Monitoring Metrics:

- Marsh extent
- Above-ground and below-ground biomass
- Plant community metrics
- Marsh Surface Elevation

Monitoring Methods:

- Calculations for aerial photography/remote sensing
- Unvegetated/vegetated ratio
- SMI surveys (Community type % cover, Dominant Species % Cover, Species Point Intercept)
- Surface Elevation Tables (SETs), measured in Spring and Fall each year for 4 years

Expected Results

- Increase in above and below ground biomass of the overall tidal marsh area
- Increase in marsh community cover, native tidal marsh dominant species cover, and native species point intercepts (SMI)
- Increase (mm/yr) of marsh elevation as recorded by SETs

Trigger levels

- From SET data, marsh elevation decreases (mm/yr)
- Marsh cover decreases (SMI)

Objective 4: Promote marsh sustainability through vertical accretion that keeps up with local sea level rise (SLR) rates over 4 years

Monitoring Metrics:

- Marsh surface elevation change rate

Monitoring Methods:

- Surface Elevation Tables (SETs), measured in Spring and Fall each year for 4 years
- Remote sensing method of overall elevation change
- Estimated local rates of SLR (from NOAA gauge at Atlantic City, NJ)

Expected Results

- Rate of increase (mm/yr) of marsh elevation as recorded by SETs meets or exceeds the rate of SLR calculated from nearest NOAA tide gauge

Trigger levels

- From SET data, rate of marsh elevation increase (mm/yr) is less than rate of SLR

Objective 5: Increase native faunal species use of habitat relative to pre-construction usage over 4 years

Monitoring Metrics:

- Species abundance
- Species richness

Monitoring Methods:

- Nekton surveys with ditch and throw nets (SMI), 3 and 4 years post-construction
- Bird and associated vegetation surveys (SHARP), 3 and 4 years post-construction
- Crab and mussel surveys

Expected Results

- An increase in all species metrics in 4 years

Trigger levels

- Bird, nekton, and vegetation species abundance and richness decrease, remain unchanged or decrease pre-resiliency project levels

Objective 6: Characterize water quality parameters at project site over 4 years

Monitoring Metrics:

- temperature, salinity, pH, turbidity, dissolved oxygen (D.O.) nutrients (nitrogen, phosphorus)

Monitoring Methods:

- Continuous measurements of temperature and salinity
- Bi-monthly grab samples for nutrients and sulfides
- Bi-monthly *in-situ* measurements of pH, temp, conductivity/salinity
- Monitor nearby buoys for water quality (i.e. continuous monitor sites- NJDEP or NOAA)

Expected Results

- Water temperature, salinity, and nutrient concentrations in the culvert channel remain similar to Barnegat Bay values

Trigger levels

- Water temperatures and salinity remain similar to Barnegat Bay values
- Nutrient and sulfide concentrations remain similar to Barnegat Bay values

Potential Responses

Once construction is completed, refuge staff will regularly check to ensure design standards are met over time. The biggest concern would likely be failure of retention features, such as hay bales or coir logs, which could result in material transport to unwanted areas. If such failures occur, the refuge staff will evaluate the potential harm to the environment and project success, and act to reverse such harm within the means, methods and resources available.

The first round of data collected post-construction will be the baseline from which metrics will be compared to determine if expected results are met (in addition to the baseline collected pre-construction). During the first few years, material will settle and vegetation will vary depending on soil conditions. For example, *Salicornia* is known to colonize new sites, but areas may convert to other species as soils change. Therefore, we expect the 4-year timeframe to be considered the early stages of this long-term project.

As we collect data to support understanding and analyses of the six objectives addressed in this document, we will regularly re-evaluate success of the project. This evaluation would occur twice each year. If expected results are not met or outcomes appear to be detrimental, staff will determine potential responses.

Below, we list potential responses that would be evaluated in this process. It should be noted that not all triggers will require immediate action and may just require further analysis and study over time to understand the level of detriment occurring.

Types of Potential Responses:

- If marsh is too flooded, construct runnels or new ditches, or clean ditches to allow preferred run-off

- If invasive or unwanted plants occur at unacceptable levels, apply herbicide to reduce vegetation or reduce marsh elevation to improve tidal conditions
- If native vegetation does not recolonize the sites naturally or at an acceptable rate, plant plugs of native target plants
- If water quality decreases or does not mimic Barnegat Bay levels, re-evaluate the characteristics of the sediment placed on the marsh and sources of water quality contamination in upstream watershed
- If areas within the project area subside unacceptably over time, consider applying additional sediment on the sites (this may require a permit modification)
- If vegetation is not responding positively, conduct a stressor analysis to determine if underlying soil characteristics are impacting the site

SAMPLING PROTOCOLS

The refuge will utilize a variety of monitoring protocols, developed either by the USFWS or by partners. Appendix B summarizes the protocols that will be utilized to implement monitoring activities. We recognize that technology is ever-changing regarding data collection and analysis. We may alter these protocols as affordable, state-of-the-art tools become available.

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- Amec. Foster Wheeler and EA Engineering, Science, and Technology, Inc. PBS. 2016. 37c Marsh Enhancement Final Study Report: Restoring Coastal Marshes in New Jersey Wildlife Refuges Design/Build for Marsh Enhancement Throughout the E.B. Forsythe National Wildlife Refuge, Oceanville, NJ: Amec Foster Wheeler.
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