NOAA Restoration Center
Minimum Project Monitoring/Evaluation Requirements

In accordance with the Estuary Restoration Act of 2000 (ERA), Title I of the Estuaries and Clean Waters Act of 2000, the NOAA Restoration Center requires minimum elements of habitat restoration efforts be evaluated for success. This requirement is designed to minimize financial and labor resource needs while allowing for a quantitative evaluation of restoration results.

The evaluation requirements are as follows (see *Endnotes and Examples* for more information):

Before the project begins:

1. Develop at least one clearly stated goal (i.e., large scale, idealistic, long-term)[a].
2. Develop at least two objective statements related to the project goal; one each for *structural* and *functional* elements of the project (i.e., realistic, measurable)[b].
3. Select one parameter to be evaluated (i.e., thing to be measured) for each objective statement[c].
4. Define a target value for each parameter (i.e., a realistic value that represents success for the defined objective)[d].
5. Define a reference value for each parameter (i.e., a value that represents ideal conditions)[e].

To conduct the project evaluation:

1. Measure each selected parameters as often as necessary to meet the intent of the objective, including one sampling date before the beginning of the project work[f].
2. For each sampling date (minimum of one in addition to the pre-project sampling), indicate whether the target value was reached for each measured parameter[g].

When developing your restoration monitoring plan, please consult an expert and refer to *A Framework for Monitoring Plans under the Estuaries and Clean Waters Act of 2000* at: http://coastalscience.noaa.gov/ecosystems/estuaries/restoration_monitoring.html for more information.

A spreadsheet example of how this may be implemented/reported is shown on the last pages of this document.

Endnotes and Examples:

[a] Goal statements are aimed at identifying the overall intent of the habitat restoration effort. The goal(s) of a project may, in some cases, be long-term and exceed the life of the immediate available funding. They are typically written as alternative hypotheses, but at a minimum should indicate the DESIRED result of the project.

Examples:

The project will result in the control of Spartina patens.
The project will result in the re-establishment of fish passage.
The project will result in the re-establishment of a native mangrove forest.
The project will result in the enhancement of existing SAV beds.
The project will result in the increase in areal extent of existing native salt marsh.
The project will result in the increase in abundance of spawning redds.
The project will result in the decrease in shoreline erosion.
The project will result is the minimization of road-related delivery of coarse/fine sediment inputs to anadromous spawning and rearing habitat.

[b] Objective statements are aimed at specifically defining quantifiable targets during the awarded project period. At least one structural and one functional objective should be identified. A structural objective focuses on the DISTRIBUTION, ABUNDANCE AND PHYSICAL CONDITION of organisms or components of the environment; a physical aspect of individual components of a restoration effort. A functional objective focuses on aspects of the GROWTH AND RESPONSE of populations or complexes of the environment; related to a response or action by a population or system. An objective statement should include three elements, 1) the action or desired result, 2), a numerical target, and 3) the timing to reach the target.

Structural Examples ("a change in how something looks"):

Eliminate at least 50% of Spartina patens *in the main infestation area by 2007.*
Re-allow fish passage to at least 3.0 miles of essential fish habitat by 2006.
Restore bathymetric/topographic elevations and correct tidal flow to at least 85% of the project area by 2006.
Enhance SAV bed to have less than 30% open-space by 2007.
Re-establish native salt marsh vegetation diversity with at least 3 species by 2007.
Re-introduce at least 5.0 large woody debris structures per 400 meters by 2005.
Establish native salt marsh vegetation (density commensurate with local populations) behind a constructed sill along at least 500 meters of shoreline by 2006.
Remove (or stabilize) at least 1900 m^3 (or 1500 $meters^2$) of road-related fill subject to mass wasting or surface erosion of course/fine sediments into riparian habitat by 2006.

Functional Examples ("a change in what the habitat/population does"):

Reduce flowering/seeding of Spartina patens *to at least 20% of population by 2005.*
Re-establish the return of at least 65 returning coho one mile upstream from barrier removal by 2005.
Restore natural recruitment of native mangrove species on at least 75% of the project area by 2007.
Enhance water clarity by reducing turbidity by 30% in the SAV bed by 2007.
Discourage establishment of invasive species to less than 5% cover by 2007.
Increase pool:riffle ratio to 3:7 or greater (e.g., 1:1) in project area by 2006.
Encourage sediment accretion or stabilization (no more than 5.0 cm sediment erosion) by 2006.
Reduce incised drainage ditches in road-related area to less than 4 per 1000 meters by 2007.

[c] A parameter is to be selected that will indicate whether the selected objective was met (i.e., target achieved). The parameter chosen should relate to the objective statement. At least one structural and one functional parameter must be selected. In many cases, a single parameter may be used as either a structural or functional measure depending on the objective, but it cannot be used as both (i.e., a minimum of two parameters must be selected).

Structural Examples:	affects	*Functional Examples:*
% cover of healthy individuals	..... affects ..... ▶	*flower/seed productivity*
miles of re-opened fish passage	..... ▶	*responding fish presence*
areal extent of tidal influence	..... ▶	*natural recruitment*
ratio of vegetation to open space	..... ▶	*turbidity reduction*
species composition	..... ▶	*invasiveness*
debris structure density	..... ▶	*pool:riffle development*
areal extent of vegetation	..... ▶	*accretion/erosion*

For more information on developing monitoring plans or for examples of parameters that could be selected by habitat type, please see *A Framework for Monitoring Plans under the Estuaries and Clean Waters Act of 2000* at:http://coastalscience.noaa.gov/ecosystems/estuaries/restoration_monitoring.html

[d] A specified target value is to be selected for each parameter that realistically indicates the condition that the restoration efforts are attempting to achieve or surpass. This value does not represent an ideal, undisturbed condition (see next endnote), but rather a condition to be achieved based on the scope and funding of the project. Falling short of the specified target may indicate that methodology, stochastic events or lack of understanding could be an issue and that a gap in information/research may need to be addressed.

Target Examples:	*% cover of invasive*	*< 50%*
	miles of fish passage	*> 3.0 miles*
	appropriate tidal regime	*> 85% of project area*
	ratio of vegetation to open space	*> 7:3*
	species composition	*> 2 native salt marsh plant species*
	debris structure density	*> 5 per 400 meters.*
	areal extent	*> 500 meters of shielded shoreline*

[e] A reference value is to be selected for each parameter. This differs from the target value in that it represents an ideal or undisturbed condition. The reference value may be obtained from a literature source or previous sampling efforts of a nearby or similar site. If the initial reference value is selected from previous sampling efforts, the value may evolve if the parameter is also measured at the reference site each time the parameter is measured at the project site. In this case, the target value may be allowed to change in response to a potentially varying reference value.

Reference Examples:	*% cover of invasive*	*= 5%*
	miles of fish passage	*= 8.0 miles*
	appropriate tidal regime	*= 95% of project area*
	ratio of vegetation to open space	*= 10:1*
	species composition	*= 5 native salt marsh plant species*
	debris structure density	*= 8 per 400 meters.*
	areal extent	*= 1000 meters of shielded shoreline*

[f] How often each parameter is to be measured is dependent upon the objective and the parameter itself. For example, if percent cover of a perennial SAV is chosen, sampling once a year for three years during the growing season may suffice. If fish abundance following the removal of a passage barrier is chosen, then multiple sampling efforts in a short timeframe may be valid. Where possible, it is recommended to continue monitoring for at least five years.

Non-specific Examples:	*species composition – once a season for three years*
	debris structure density – once a year for two years
	fish presence – once a week during fish window for one year
	pool:riffle development – once a week in second October after debris installation
	accretion/erosion – once a season for two years

[g] Yes or No, did the measured parameter meet or exceed the selected target value.

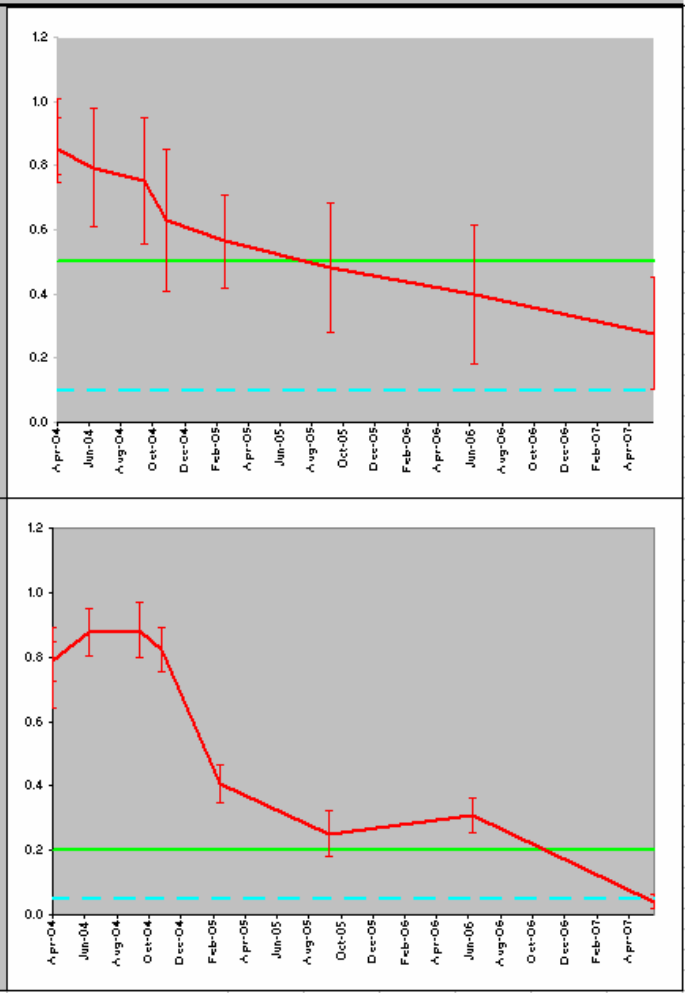
Spreadsheet Example (not required) – includes data presentation and data entry pages.

White cells should be completed prior to the start of the project work.
Grey cells are filled in automatically as data is entered in the Data Entry pages.

DATA PRESENTATION

Standard Deviation Multiplier ---> 1.96

Goal *stated as testable hypothesis*	Objective *with action/result, numerical target and timing*	Measured Variable	Structure *or* Funcure	Sampling Date	< *or* >	Target Value	Reference Condition	Mean of Measured Value	Standard Deviation of Measured Variable	Target Met?	Reference Met?	Performance Curves
Project will result in the control of *Spartina patens*	Eliminate at least 50% of *S patens* in the main infestation area by 2007	% cover of living *S patens*	S	10-Apr-04	<	0.50	0.10	0.89	0.12	No	No	
				11-Apr-04	<	0.50	0.10	0.85	0.10	No	No	
				19-Jun-04	<	0.50	0.10	0.79	0.19	No	No	
				23-Sep-04	<	0.50	0.10	0.75	0.19	No	No	
				04-Nov-04	<	0.50	0.10	0.63	0.22	No	No	
				23-Feb-05	<	0.50	0.10	0.56	0.14	No	No	
				16-Sep-05	<	0.50	0.10	0.48	0.20	No	No	
				17-Jun-06	<	0.50	0.10	0.40	0.22	Yes	No	
				28-May-07	<	0.50	0.10	0.28	0.17	Yes	No	
	Reduce seeding of *S patens* to at least 20% of individuals by 2005	% of *S patens* producing seed	F	10-Apr-04	<	0.20	0.05	0.77	0.12	No	No	
				11-Apr-04	<	0.20	0.05	0.79	0.06	No	No	
				19-Jun-04	<	0.20	0.05	0.88	0.07	No	No	
				23-Sep-04	<	0.20	0.05	0.88	0.09	No	No	
				04-Nov-04	<	0.20	0.05	0.82	0.07	No	No	
				23-Feb-05	<	0.20	0.05	0.41	0.06	No	No	
				16-Sep-05	<	0.20	0.05	0.25	0.07	No	No	
				17-Jun-06	<	0.20	0.05	0.31	0.06	No	No	
				28-May-07	<	0.20	0.05	0.04	0.02	Yes	Yes	



(example spreadsheet available in.xls format from NOAA Restoration Center at: http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/partners_funding/submitproposal.html)

White cells can be completed after each sampling effort/date.
Grey cells are filled in automatically.

enter data here

STRUCTURAL DATA ENTRY (sampling date and measurements)

		Test Statistics --->	1.64		1.64		Measurement											
Mean	Standard Deviation	Variance	Target Z- Statistic	Target Met?	Ref. Z- Statistic	Reference Met?	Sampling Date	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	etc.	...
0.888	0.060	0.0036	21.3500	No	43.3500	No	10-Apr-04	0.78	0.89	0.90	0.78	0.98	0.90	0.90	0.89	0.90	0.90	0.95	
0.850	0.052	0.0027	22.5073	No	48.2299	No	11-Apr-04	0.78	0.86	0.87	0.77	0.94	0.89	0.84	0.80	0.85	0.85	0.90	
0.794	0.095	0.0090	10.2854	No	24.2964	No	19-Jun-04	0.75	0.70	0.80	0.65	0.90	0.81	0.79	0.80	0.85	0.70	0.98	
0.752	0.099	0.0099	8.3955	No	21.7313	No	23-Sep-04	0.65	0.70	0.77	0.77	0.91	0.84	0.66	0.70	0.92	0.70	0.65	
0.629	0.113	0.0127	3.7948	No	15.5535	No	04-Nov-04	0.55	0.40	0.73	0.63	0.82	0.72	0.57	0.66	0.68	0.61	0.55	
0.564	0.074	0.0054	2.8601	No	20.8380	No	23-Feb-05	0.57	0.56	0.59	0.59	0.75	0.56	0.50	0.54	0.46	0.51	0.57	
0.481	0.103	0.0107	-0.6119	No	12.2079	No	16-Sep-05	0.53	0.51	0.48	0.59	0.64	0.55	0.35	0.34	0.34	0.43	0.53	
0.398	0.111	0.0122	-3.0553	Yes	8.9476	No	17-Jun-06	0.50	0.35	0.25	0.44	0.55	0.51	0.34	0.22	0.33	0.39	0.50	
0.277	0.089	0.0079	-8.2891	Yes	6.5975	No	28-May-07	0.24	0.16	0.44	0.33	0.41	0.23	0.22	0.22	0.22	0.34	0.24	

FUNCTIONAL DATA ENTRY (sampling date and measurements)

		Test Statistics --->	1.64		1.64		Measurement											
Mean	Standard Deviation	Variance	Target Z- Statistic	Target Met?	Ref. Z- Statistic	Reference Met?	Sampling Date	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	etc.	...
0.767	0.063	0.0039	28.5852	No	36.1474	No	10-Apr-04	0.75	0.75	0.79	0.81	0.81	0.70	0.72	0.69	0.90	0.75		
0.787	0.032	0.0010	58.6674	No	73.6591	No	11-Apr-04	0.75	0.79	0.78	0.80	0.85	0.75	0.75	0.79	0.80	0.81		
0.876	0.038	0.0014	56.5960	No	69.1542	No	19-Jun-04	0.90	0.89	0.90	0.80	0.85	0.87	0.86	0.91	0.93	0.85		
0.884	0.044	0.0019	49.1365	No	59.9120	No	23-Sep-04	0.93	0.90	0.91	0.90	0.80	0.84	0.86	0.92	0.93	0.85		
0.823	0.036	0.0013	54.8521	No	68.0589	No	04-Nov-04	0.86	0.81	0.89	0.85	0.82	0.84	0.79	0.78	0.79	0.80		
0.407	0.031	0.0009	21.4138	No	36.9310	No	23-Feb-05	0.45	0.40	0.40	0.35	0.45	0.42	0.38	0.39	0.41	0.42		
0.252	0.036	0.0013	4.6284	No	17.9797	No	16-Sep-05	0.23	0.29	0.25	0.21	0.19	0.26	0.29	0.30	0.25	0.25		
0.308	0.028	0.0008	12.1084	No	28.9257	No	17-Jun-06	0.29	0.29	0.29	0.35	0.32	0.32	0.36	0.29	0.28	0.29		
0.041	0.012	0.0001	-41.9975	Yes	-2.3772	Yes	28-May-07	0.04	0.03	0.04	0.04	0.03	0.06	0.06	0.05	0.03	0.03		