Common Metrics and Protocols:

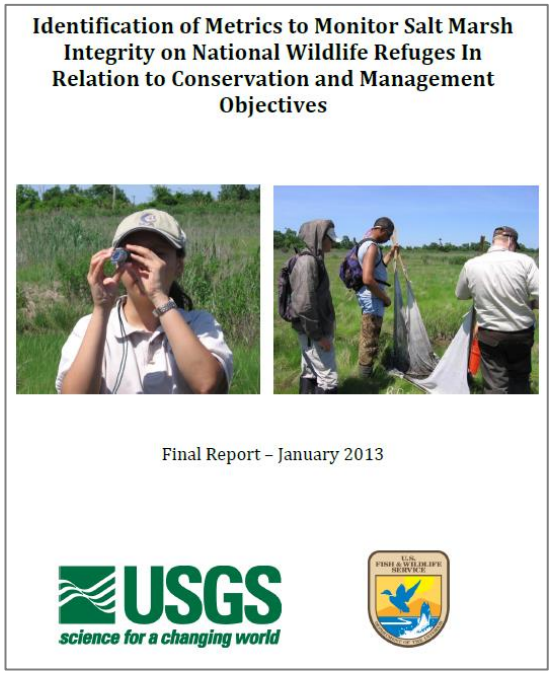
Assessing tidal marshes in National Wildlife Refuges & SHARP

- **Metrics**
- **Protocols**
- **Data management**

Greg Shriver, Whitney Wiest, Kelly Chadbourne

Hurricane Sandy Tidal Marsh Resiliency Coordination Workshop
USFWS Northeast Regional Office
Hadley, Massachusetts
December 8-9, 2014

1) SMI history / Metric testing



28 metrics total

Landscape = 10 metrics

Hydrologic / abiotic = 4 metrics

Vegetation = 9 metrics

Nekton = 3 metrics

Breeding birds = 2 metrics

Metric	Definition
Historical condition and geomorphic setting	
Landscape position	Landscape position: marine, middle-estuary, or upper-estuary
Shape	Marsh shape: expansive meadow or narrow fringing marsh
Fill fragmentation	Degree of fill/fragmentation: no, low, moderate, or severe
Tidal flushing	Degree of tidal flushing: well flushed, moderately flushed, or poorly flushed
Aquatic edge	Degree of aquatic edge: low, moderate, or high amount
Ditch density	
Ditch density	Ordinal ranking of ditch density: no, low, moderate, or severe
Surrounding land-use	
Ag relative	% agricultural land in 150 m buffer * (area of buffer/area of unit)
Natural 150m relative	% natural land in 150 m buffer * (area of buffer/area of unit)
Natural 1km relative	% natural land in 1 km buffer * (area of buffer/area of unit)
Ratio of open water area : vegetation area	
OW Veg withinUnit	Ratio of open water to emergent herbaceous wetlands within unit
Marsh surface elevation	
Elevation	Elevation referenced to NAVD88
Tidal range/groundwater level	
% flooded	% of time marsh surface was flooded during datalogger deployment
Mean Flood Depth	Mean Flood Depth (cm) during datalogger deployment
Salinity	
Rapid Salinity (surface water)	Salinity measured in surface water
Vegetation community	
Rapid Veg SpRich	Vegetation species richness using rapid point-intercept method in survey plots
Brack Terr Border	% cover of Brackish Terrestrial Border community (rapid survey plot method)
Open Water	% cover of Open Water (rapid survey plot method)
Pannes Pools Creeks	% cover of Pannes, Pools, & Creeks (rapid survey plot method)
High Marsh	% cover of High Marsh community (rapid survey plot method)
Low Marsh	% cover of Low Marsh community (rapid survey plot method)
Salt Marsh Terr Border	% cover of Salt Marsh Terrestrial Border community (rapid survey plot method)
Upland	% cover of Upland community (rapid survey plot method)
Invasive species abundance	
Invasives	% cover of Invasive Plant Species (rapid survey plot method)
Nekton community	
Nekton Density	Nekton density (ind m^{-2}) using throw traps and ditch nets
Nekton SpRich	Nekton species richness using throw traps and ditch nets
Fundulus Length	*Fundulus heteroclitus* length (mm) captured in throw traps and ditch nets
Breeding bird community	
Willet Abundance	Abundance of Willets counted per point during standard call-broadcast surveys
TMO Abundance	Sum abundance of tidal marsh obligate species per point during standard call-broadcast surveys: Clapper Rail, Willet, Saltmarsh Sparrow, Seaside Sparrow

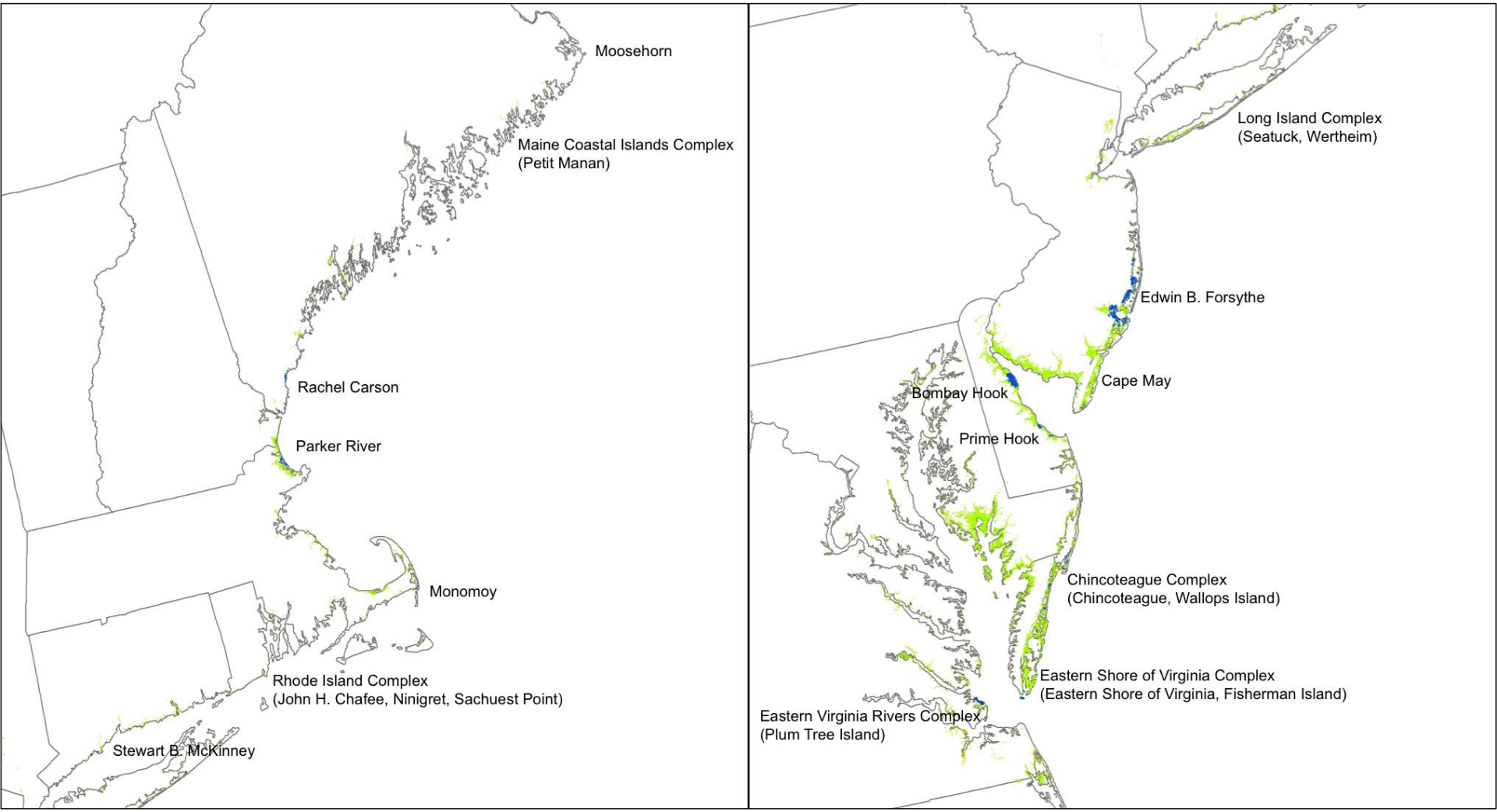
2) SMI Objectives

The overall objectives of the Salt Marsh Integrity Monitoring Protocol are to;

1) provide a baseline inventory of the condition of salt marsh units within each participating refuge that can be used as the foundation for monitoring the condition of the salt marsh unit over time, and

2) provide the methodology and reporting tools to determine the effects of management actions on salt marsh units.

3) Defining SMI units



Additional: Long Island Complex (Lido Beach WMA), Supawna Meadows

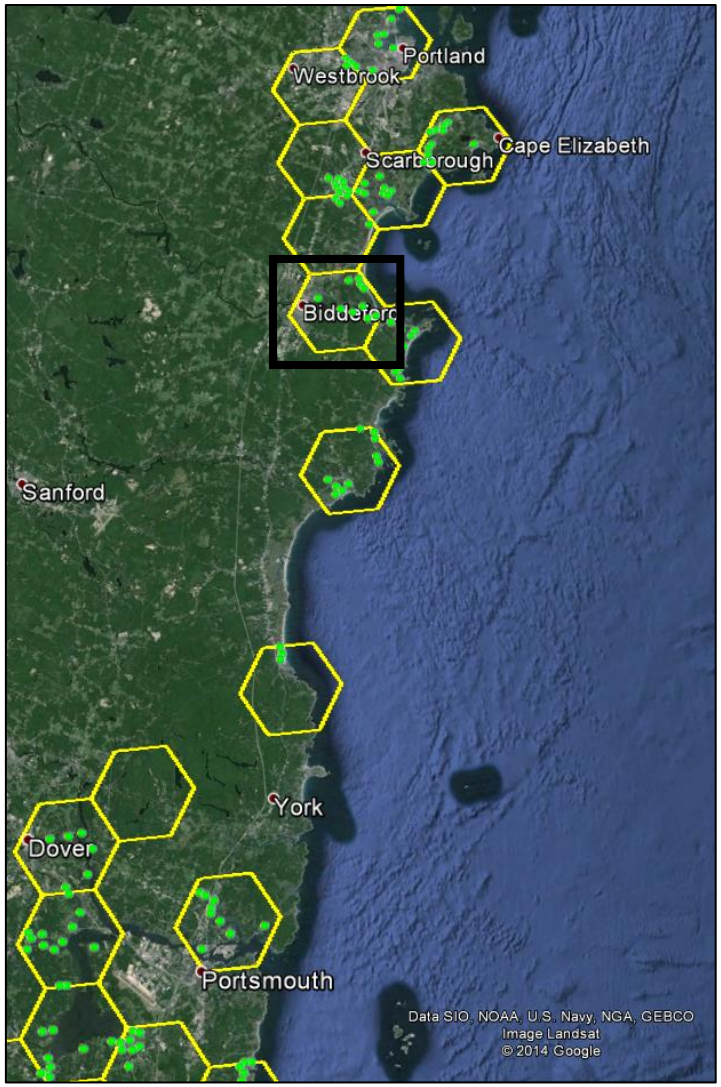
4) Point selection process – Integration with SHARP

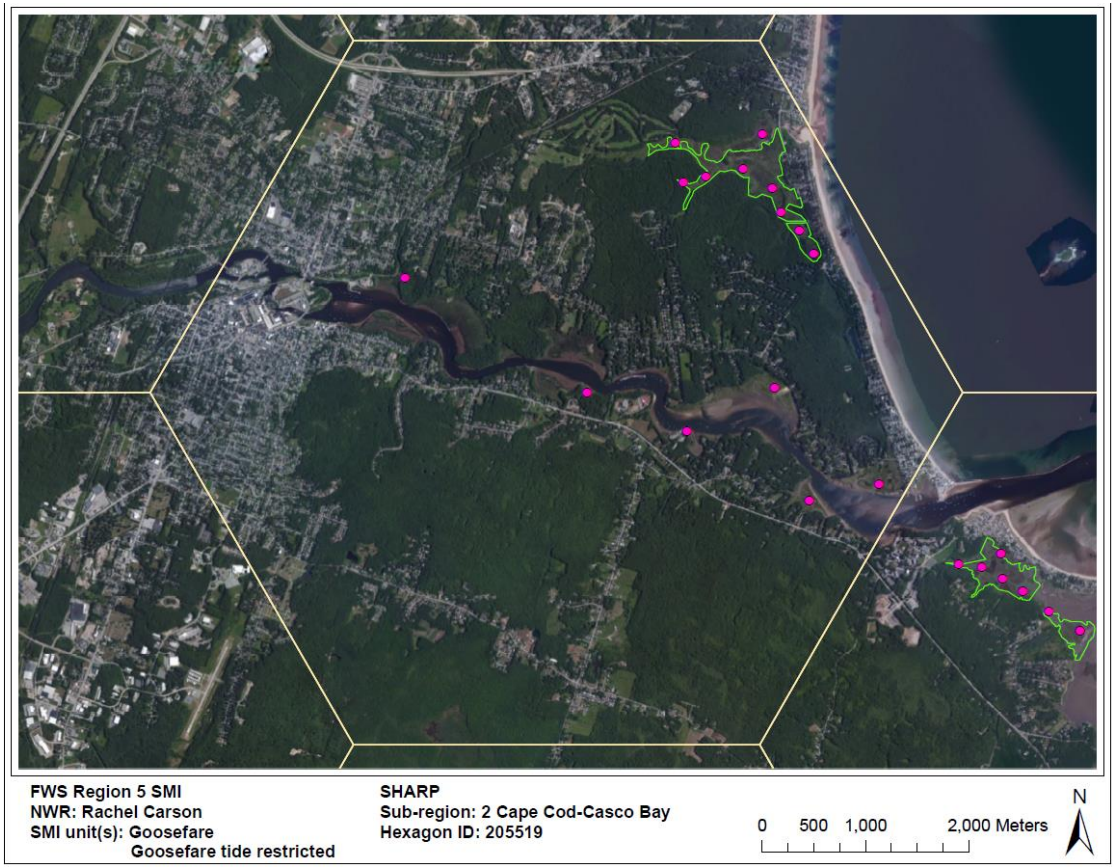
- R package ‘spsurvey’ to randomly select points within each refuge SMI unit.
- Points spaced 400 m in large units / 200 m in small (< 300 ha) units, to maximize the number of samples within each unit.
- These selected points are used for surveying birds, act as the central location for vegetation surveys, and provide the basis for nekton sampling.

GRAND TOTALS =
22 Refuges
130 Units
1,229 Sample Points (bird/veg)

24,461 ha of salt marsh!

4) Point selection process – Integration with SHARP





4) Point selection process – Integration with SHARP

FWS_R5_SMIbirdpts_20141120

NWR_code	Div_code	SMI_unit	local_ID	region_ID	refuge_	first_ye	POINT_X	POINT_Y	pt_history	SMI	SMI_pilot	USFWS_h	SHARP	Other_h	Rest
EBF	BRN	Good Luck Point	63237_p22	63237_p22	<null>	2013	-74.109006	39.930495	SMI	Y	N	N	N	N	N
RHC	GFB	Goosefare	OBSM04	205519_HRC023	<null>	2014	-70.390851	43.492473	SMI/USFWS_historic/SHARP	Y	N	Y	Y	N	N
RHC	GFB	Goosefare	205519_p22	205519_p22	<null>	2014	-70.393571	43.494769	SMI	Y	N	N	N	N	N
RHC	GFB	Goosefare	205519_p20	205519_p20	<null>	2014	-70.40088	43.49507	SMI	Y	N	N	N	N	N
RHC	GFB	Goosefare	205519_p21	205519_p21	<null>	2014	-70.398108	43.495031	SMI	Y	N	N	N	N	N
RHC	GFB	Goosefare	205519_p23	205519_p23	<null>	2014	-70.390639	43.490249	SMI	Y	N	N	N	N	N
RHC	GFB	Goosefare tide restricted	205519_p1	205519_p1	<null>	2014	-70.389173	43.488264	SMI/SHARP	Y	N	N	Y	N	N
RHC	GFB	Goosefare tide restricted	205519_p24	205519_p24	<null>	2014	-70.388261	43.485969	SMI	Y	N	N	N	N	N
RHC	GSR	Gooserocks channel	GOSM06	205912_HRC035	<null>	2015	-70.420255	43.398711	SMI/USFWS_historic	TBD	N	Y	N	N	N
RHC	GSR	Gooserocks channel	205912_p26	205912_p26	<null>	2015	-70.428155	43.394921	SMI	TBD	N	N	N	N	N
RHC	GSR	Gooserocks channel	205912_p24	205912_p24	<null>	2015	-70.423152	43.399961	SMI	TBD	N	N	N	N	N
RHC	GSR	Gooserocks channel	205912_p23	205912_p23	<null>	2015	-70.425668	43.40291	SMI	TBD	N	N	N	N	N
RHC	GSR	Gooserocks channel	205912_p25	205912_p25	<null>	2015	-70.425275	43.398493	SMI	TBD	N	N	N	N	N
RHC	GSR	Gooserocks tide restricted	205912_p20	205912_p20	<null>	2015	-70.414739	43.400997	SMI	TBD	N	N	N	N	N
RHC	GSR	Gooserocks tide restricted	205912_p21	205912_p21	<null>	2015	-70.416606	43.399785	SMI	TBD	N	N	N	N	N
RHC	GSR	Gooserocks tide restricted	205912_p22	205912_p22	<null>	2015	-70.419171	43.401062	SMI	TBD	N	N	N	N	N
RHC	GSR	Gooserocks tide restricted	BARI11	205912_HHO414	<null>	2015	-70.416806	43.402072	SMI/Other_historic	TBD	N	N	N	Y	N
PMN	GLB	Gouldsboro Bay	196100_p20	196100_p20	<null>	2012	-68.014541	44.48355	SMI	Y	N	N	N	N	N
PMN	GLB	Gouldsboro Bay	196100_p21	196100_p21	<null>	2012	-68.015414	44.481463	SMI	Y	N	N	N	N	N
PMN	GLB	Gouldsboro Bay	196100_p22	196100_p22	<null>	2012	-68.013792	44.482429	SMI	Y	N	N	N	N	N
PMN	GLB	Gouldsboro Bay	196100_p23	196100_p23	<null>	2012	-68.013646	44.479688	SMI	Y	N	N	N	N	N
RHC	LTR	Granite Point	GOSM01	36923_HRC030	<null>	2015	-70.391719	43.418745	SMI/USFWS_historic/SHARP	TBD	N	Y	Y	N	N
RHC	LTR	Granite Point	36923_p27	36923_p27	<null>	2015	-70.388315	43.416343	SMI	TBD	N	N	N	N	N
RHC	LTR	Granite Point	36923_p26	36923_p26	<null>	2015	-70.390748	43.41695	SMI	TBD	N	N	N	N	N
RHC	LTR	Granite Point	36923_p28	36923_p28	<null>	2015	-70.393425	43.413058	SMI	TBD	N	N	N	N	N

5) SHARP Standard Operating Procedures

www.tidalmarshbirds.net

Marsh Survey Protocols

- Interactive Map of Survey Locations
- Continental US EPA hexagon grid (gdb) (137)
- 40 km Atlantic Flyway Hexagon Grid (shp) (137)
- Vegetation Survey Protocol - 2013 (121)
  - Vegetation Survey Data Entry Spreadsheet - 2012 (343)
  - Example Vegetation Survey Datasheet 2012 (333)
- Callback Survey Protocol - 2012 (694)
  - Callback Survey Data Entry Spreadsheet (337)
  - Example Callback Datasheet 2012 (311)
- Region 1 (Maine north of Casco Bay)
  - Region 1 Callback Survey Datasheet - 2012 (pdf) (293)
  - Region 1 Callback Survey Datasheet - 2012 (excel) (286)
  - Region 1 Broadcast (mp3) (358)
- Region 2 (Casco Bay to Cape Cod)
  - Region 2 Callback Survey Datasheet - 2012 (pdf) (244)
  - Region 2 Callback Survey Datasheet - 2012 (excel) (253)
  - Region 2 Broadcast (mp3) (345)
- Region 3 & 4 (Long Island Sound, RI, and South Shore of Cape Cod)
  - Region 3 & 4 Callback Survey Datasheet - 2012 (pdf) (277)
  - Region 3 & 4 Callback Survey Datasheet - 2012 (excel) (265)
  - Region 3 & 4 Broadcast (mp3) (676)
- Region 5 & 6 (New Jersey & Delaware Bay)
  - Region 5 & 6 Callback Survey Datasheet - 2012 (pdf) (314)
  - Region 5 & 6 Callback Survey Datasheet - 2012 (excel) (280)
  - Region 5 & 6 Broadcast (mp3) (409)
- Region 7 & 8 (Delmarva Peninsula south of Delaware Bay)
  - Region 7 & 8 Callback Survey Datasheet - 2012 (pdf) (259)
  - Region 7 & 8 Callback Survey Datasheet - 2012 (excel) (246)
  - Region 7 & 8 Broadcast (mp3) (356)
- Region 9 (Western Shore of the Chesapeake Bay)
  - Region 9 Callback Survey Datasheet - 2012 (pdf) (253)
  - Region 9 Callback Survey Datasheet - 2012 (excel) (264)
  - Region 9 Broadcast (mp3) (325)
- Example Completed Datasheets
  - Example Callback Datasheet 2012 (311)
  - Example Vegetation Survey Datasheet 2012 (333)

Suggested Playback Equipment

Demographic Protocols

- *Interactive Map of Study Locations*
- *Adult bird procedures*
  - SHARP Mist-netting SOP (20)
  - Banding SOP (502)
    - 2014 Banding datasheet (17) (excel)
    - 2014 Banding datasheet (27) (pdf)
  - SHARP Adult Body Measurements SOP (434)
  - SHARP Body Condition Scoring SOP (1012)
  - SHARP Feather Condition SOP (282)
  - SHARP Plumage Scoring SOP (461)
  - SHARP Tissue Sampling SOP (659)
  - Molt Scoring SOP (to come)
  - SHARP Digestive Tract Preservation SOP (117)
- *Nest procedures*
  - SHARP Nest searching and monitoring SOP (32)
  - 2014 Nest card (excel) (15)
    - 2014 Nest card (pdf) (25)
    - 2014 Random vegetation sampling card (excel) (10)
    - 2014 Random vegetation sampling card (pdf) (18)
  - SHARP iButton SOP (34)
  - SHARP Egg-floating SOP (455)
  - SHARP Nestling Aging Guide (22)
    - 2014 Nestling measurements datasheet (excel) (9)
    - 2014 Nestling measurements datasheet (pdf) (16)
  - SHARP Nest Fate Assignment SOP (31)
    - SHARP Nest Fate Assignment Key (27)
  - SHARP Nest Vegetation Sampling SOP (34)
    - SHARP nest canopy disk (10)

5) SMI Standard Operating Procedures

SOP 1 Sample Point Selection*

SOP 2 Landscape Metrics*

SOP 3 Marsh Surface Elevation

SOP 4 Tidal Range Groundwater Level

SOP 5 Salinity

SOP 6 Vegetation*

SOP 7 Nekton

SOP 8 Breeding Birds*

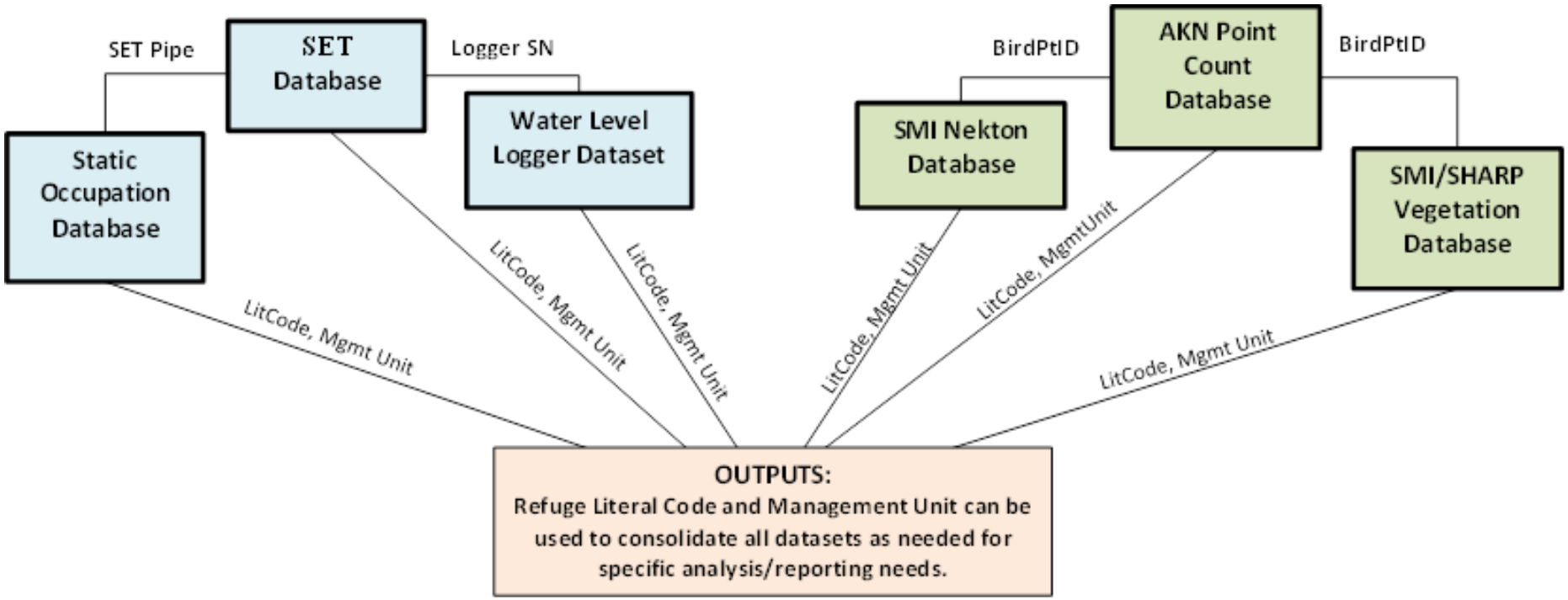
SOP 9 Data Entry / Data Management*

Table 6. Data collection schedule for Salt Marsh Integrity Monitoring Program metric SOPs.

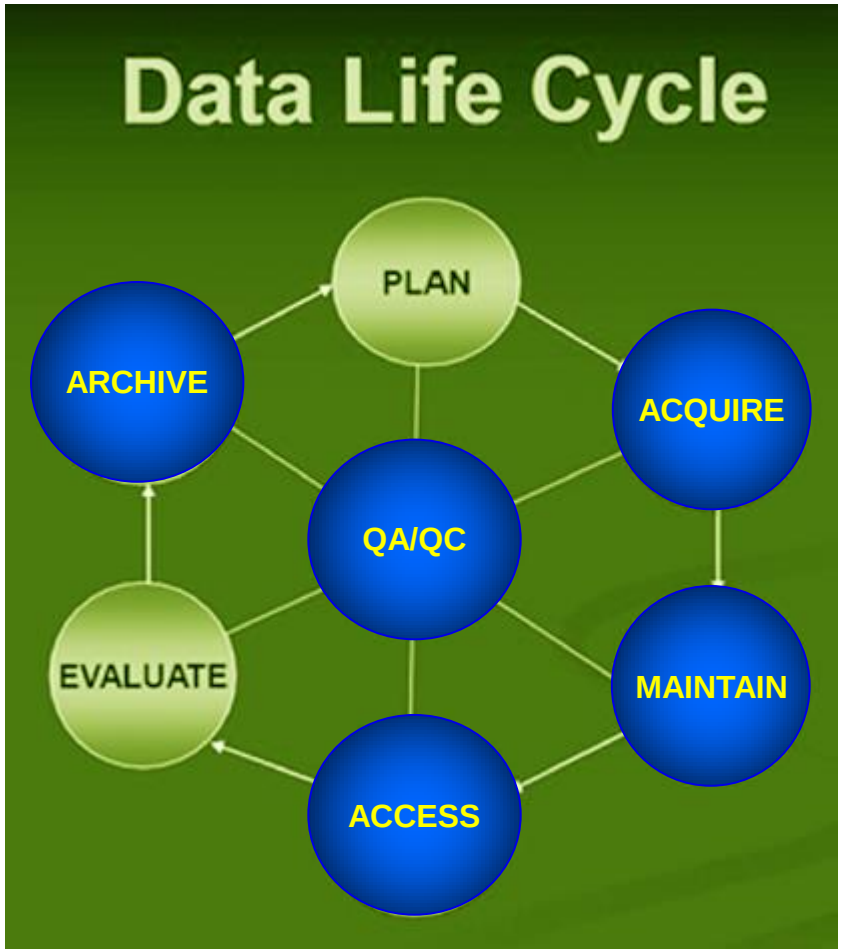
	Month											
Metric Category	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Field Reconnaissance												
Breeding birds												
SET elevation												
Water level and RTK elevation												
Nekton												
Salinity												
Vegetation												

*SOP also used in SHARP and USFWS restoration project areas.

Data Management



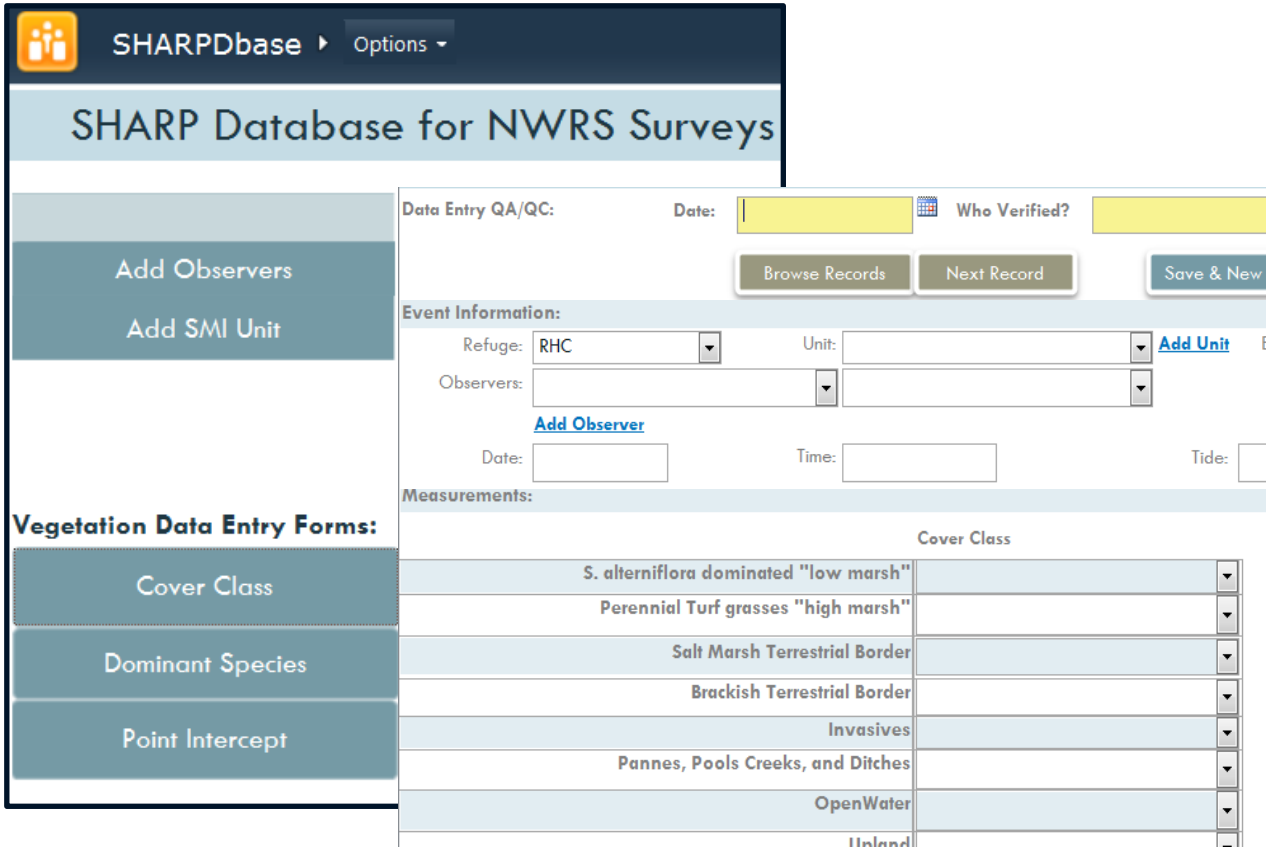
USFWS DATA LIFE CYCLE



- Web Databases
- Refuge QA/QC
- Clean Data is Exported
- Regional QA/QC
- Weekly Backup Schedule
- Yearly Archival to ServCat

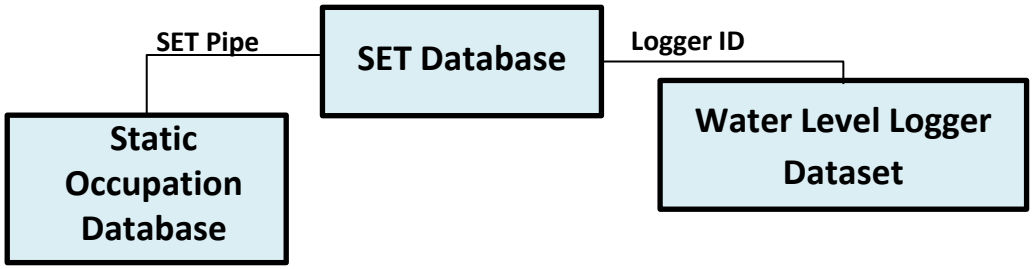
Data Management: Acquire/Maintain/QAQC/

- Move away from Distributed Databases and inherent inefficiencies
- Refuges enter Data into Centralized Database
- QA/QC a single Dataset



https://fishnet.fws.doi.net/regions/5/nwrs/im/SMI/SMINektonVegDbase/

Data Management: Abiotic



Surface Elevation Table (SET) Monitoring Database

- Distributed Access database (National SET Protocol)

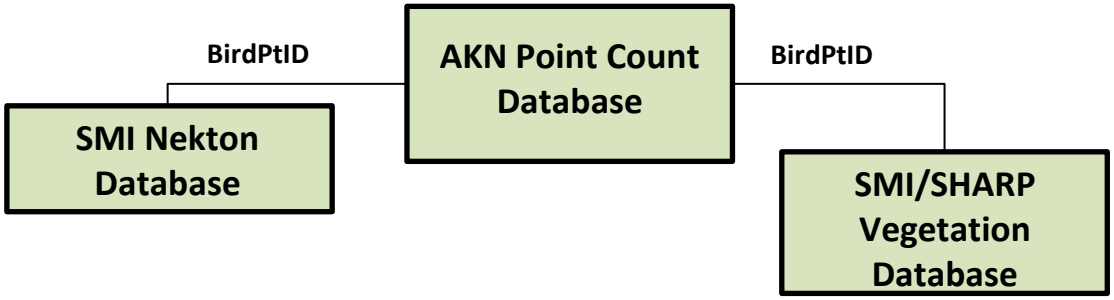
Static Occupation WEB Database:

- GNSS surveys conducted to obtain fixed positions
- https://fishnet.fws.doi.net/regions/5/nwrs/im/StaticOccupations/
- Online to FWS Personnel

Water Level Logger/Elevation Data

- Water level logger elevation
- https://fishnet.fws.doi.net/regions/5/nwrs/im/SMI/WellElevation/
- Online to FWS Personnel

Data Management: Biotic



SMI Nekton WEB Database

- SMI Ditch Net and Throw Trap survey data
- https://fishnet.fws.doi.net/regions/5/nwrs/im/SMI/SMINektonVegDbase/
- Online to FWS Personnel

Avian Knowledge Network Landbird / Marshbird Database:

- Point Count Database http://data.prbo.org/science/biologists/
- FWS Personnel and Collaborators

SMI/SHARP Vegetation WEB Database

- SMI/SHARP Dominant Cover Type, Dominant Species, and Point Intercept Vegetation data
- https://connect.doi.gov/fws/Portal/SHARP/ (also available through SMI Fishnet Site)
- Online to FWS and Non-FWS Personnel

End.

Additional Information

5) Standard Operating Procedures

SOP 1 Sample Point Selection

Draft version – April 10, 2014

Standard Operating Procedure 1: Bird Sample Point Selection

Whitney A. Wiest, Elizabeth L. Tymkiw, & W. Gregory Shriver, University of Delaware

Version 1.0, April 2014

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Description: This SOP provides a step-by-step guide for selecting bird survey points for the Salt Marsh Integrity (SMI) Monitoring Project. This SOP consists of 3 components: 1) generating new random bird survey points; 2) deleting new bird survey points with overlapping buffers; and, 3) naming final bird survey points. A working knowledge of ArcMap and Program R is required.

Required Programs and Files:

- ArcMap 10.0
- Shapefiles (files should be located in the same folder):
  - **Refuge salt marsh management unit boundaries** - Refuge units should be merged into one shapefile with each unit appearing as a single polygon feature.
  - **Existing marshbird survey points at your refuge**
  - **Point_selection_universe.shp*** - Existing marshbird survey points on non-refuge marsh; note, the points universe layer is likely to contain your existing refuge marshbird points as well, so the above existing refuge points layer may not be necessary.
  - **Northeast_E2EM.shp*** - National Wetland Inventory (NWI) estuarine emergent marsh data.
  - **Hex_40km_atflyway_.shp*** - Hexagon grid of the Atlantic Flyway

  *Obtain shapefiles from the Natural Resources Division - Inventory & Monitoring Program

- Program R, version 2.15.3
- RStudio (optional; the program has a more user-friendly interface for working with Program R)
- "spsurvey" package, version 2.5

5) Standard Operating Procedures

SOP 2 Landscape Metrics

Metric	Definition
Historical condition and geomorphic setting	
Landscape position	Landscape position: marine, middle-estuary, or upper-estuary
Shape	Marsh shape: expansive meadow or narrow fringing marsh
Fill fragmentation	Degree of fill/fragmentation: no, low, moderate, or severe
Tidal flushing	Degree of tidal flushing: well flushed, moderately flushed, or poorly flushed
Aquatic edge	Degree of aquatic edge: low, moderate, or high amount
Ditch density	
Ditch density	Ordinal ranking of ditch density: no, low, moderate, or severe
Surrounding land-use	
Ag relative	% agricultural land in 150 m buffer * (area of buffer/area of unit)
Natural 150m relative	% natural land in 150 m buffer * (area of buffer/area of unit)
Natural 1km relative	% natural land in 1 km buffer * (area of buffer/area of unit)
Ratio of open water area : vegetation area	
OW Veg within Unit	Ratio of open water to emergent herbaceous wetlands within unit

Standard Operating Procedure 2: Landscape Metrics

Version 1.0,

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

The following landscape metrics can be done in the office using aerial photos of your salt marsh units (SMUs). Google Earth will work if you are familiar with the boundaries of your SMUs, otherwise, GIS with shapefiles of your SMUs should be used.

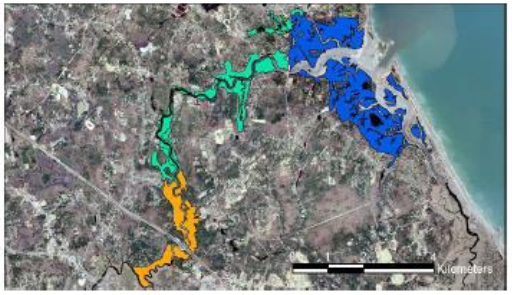
Landscape position

Classify the salt marsh study unit into either a marine dominated, middle estuary, or upper-estuary system.

Marine-dominated salt marshes are typically located behind barrier beaches, islands, and rocky headlands or are located in the mouths of estuarine rivers and have wide exposure to and are very strongly influenced by marine waters and processes.

Middle estuary marshes are typically located along coastal rivers, streams and ponds and are strongly influenced by both the marine and freshwater sources of the watershed. These systems are typically more interspersed and interconnected with both the terrestrial watershed and the coastal landscape.

Upper estuary marshes are located farthest from the marine sources and high on tidal rivers, streams and ponds where freshwater influence is significant. The occurrence of brackish species such as *Typha angustifolia* and *Scirpus validus* increases considerably in these upper estuary marshes especially at the upland edges. The terrestrial landscape dominates with the coastline often many kilometers away.



Landscape position example; marine-dominated marshes shown in blue, mid-estuary in green, upper-estuary in orange

5) Standard Operating Procedures

SOP 3 Marsh Surface Elevation

Metric	Definition
Marsh surface elevation	
Elevation	Elevation referenced to NAVD88

Protocols for measuring and understanding wetland elevation change

Natural Resource Report NPS/NCBN/NRR ---- in prep

Authors:
James C. Lynch
Philippe Hensel
Donald R. Cahoon

USGS
science for a changing world

Patuxent Wildlife Research Center

Fire Island NS, NY USA

A: SET concepts and Theory:
- Surface Elevation Table
- Marker Horizons
- Shallow Subsidence

B: Types of SET devices:
- Original SET
- Rod SET (deep, shallow)

C: Installation of SET:
- Platforms
- Benchmarks:
  - Original SET
  - Deep RSET
  - Shallow RSET
  - Benchmark Tools
- Marker Horizons

D: Taking Measurements:
- SET and RSET
- Marker Horizons

E:SET Researchers
- List of users

F:Publications

Surface Elevation Table (SET)

by Donald R. Cahoon, Ph.D and James Lynch

The Surface Elevation Table (SET) is a portable mechanical leveling device for measuring the relative elevation change of wetland sediments. This website presents information on the purpose, design, and use of the SET. The website is specifically designed to be a forum for researchers in wetland science who use or might use the device and to offer more information about the proper use of the SET and interpretation of its data. But we encourage anyone who wants to learn more about research techniques and their development to visit the site as well.

Precise measures of sediment elevation in wetlands are necessary to determine rates of elevation change, particularly relative to sea level rise, and to gain an understanding of the processes responsible for elevation change. The SET provides a nondestructive method for making highly accurate and precise measurements of sediment elevation of intertidal and subtidal wetlands over long periods of time relative to a fixed subsurface datum. This technique overcomes many of the limitations of methods currently used to estimate elevation such as sedimentation pins, and precision surveying.

There are 2 types of SET. The original SET designed by Boumans and Day (1993) and Cahoon et al. (2002a), and the Rod SET (RSET) designed by Cahoon et al. (2002b). The Rod SET can be attached to either deep or shallow benchmarks. This flexible design allows it to be used to to monitor elevations across different depths of the soil profile. The Rod SET is the recommended instrument to use in new SET installations.

Type of SET	Depth (m)
Original SET	~2 to 9
Rod SET - Deep	~2 to 25
Rod SET - Shallow	<1 to 2

5) Standard Operating Procedures

SOP 4 Tidal Range Groundwater Level

Metric	Definition
Tidal range/groundwater level	
% flooded	% of time marsh surface was flooded during datalogger deployment
Mean Flood Depth	Mean Flood Depth (cm) during datalogger deployment

Standard Operating Procedure 4: Tidal range / Groundwater level

Prepared by James Lynch, National Park Service
Modified by S. C. Adamowicz, USFWS, 2012

Version 1.0, January 2013

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Below are instructions for deploying SOLINST water level recorders.

Supplies needed:

1) Water level sensor – 3001 LT Levelogger Gold 3001, M5/F15 (~$600) Records changes in pressure due to atmospheric and water level. Also records water temperature.
2) Barometric sensor – 3001 LT Barologger Gold 3001, M1.5/F5 ((~$500) Records changes in atmospheric pressure. Also records air temperature.
3) Slotted pipe – 2" PVC pipe with slots cut into it plus end caps and fittings.
   Slotted pipe is purchased from Atlantic Screen & MFG. Inc; 142 Broadkill Rd, Milton DE 19968; (Tel. 302-684-3197). (http://www.atlantic-screen.com/). Item No: 2screen: 2"x36"x0.10xPoint for $13/ea.

5) Standard Operating Procedures

SOP 5 Salinity

Metric	Definition
Salinity	
Rapid Salinity (surface water)	Salinity measured in surface water

Standard Operating Procedure 5: Salinity

Protocol adapted from:
M.J. James-Pirri and C.T. Roman. 2005. Monitoring Salt Marsh Vegetation (revision #1): A protocol for the National Park Service's Long-Term Monitoring Program, Northeast Coastal and Barrier Network.

Modified by:
Hilary Neckles, Glenn Guntenspergen, and Jessica Nagel,
USGS, Patuxent Wildlife Research Center
Date: May 2009

Modified by:
Whitney A. Wiest and W. Gregory Shriver
University of Delaware
Date: April 2014

Version 1.0, April 2014

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Introduction:
Water salinity is measured in conjunction with nekton sampling points as an ancillary environmental variable. Salinity is measured at each throw trap and ditch net sampling station at the time of sampling using either a hand-held optical refractometer or a YSI-meter. This SOP outlines the steps to measure salinity using the hand-held refractometer.

Equipment:
1) Hand-held refractometer kit, including eyedropper (Fig. 1)
2) Filter paper (cut-up coffee filters can be used)
3) Plastic squeeze bottle with freshwater to rinse and calibrate refractometer
5) Used water bottle with freshwater to rinse eyedropper
4) Nekton survey datasheet

Fig. 1. Hand-held refractometer kit.

5) Standard Operating Procedures

SOP 6 Vegetation

Metric	Definition
Vegetation community	
Rapid Veg SpRich	Vegetation species richness using rapid point-intercept method in survey plots
Brack Terr Border	% cover of Brackish Terrestrial Border community (rapid survey plot method)
Open Water	% cover of Open Water (rapid survey plot method)
Pannes Pools Creeks	% cover of Pannes, Pools, & Creeks (rapid survey plot method)
High Marsh	% cover of High Marsh community (rapid survey plot method)
Low Marsh	% cover of Low Marsh community (rapid survey plot method)
Salt Marsh Terr Border	% cover of Salt Marsh Terrestrial Border community (rapid survey plot method)
Upland	% cover of Upland community (rapid survey plot method)
Invasive species abundance	
Invasives	% cover of Invasive Plant Species (rapid survey plot method)

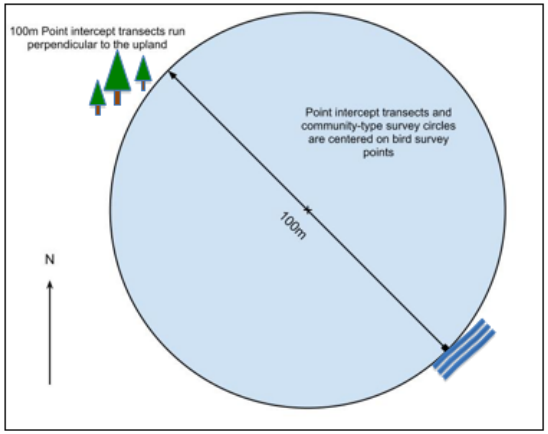


Fig. 1. Bird survey point with 50-m radius buffer used to define the vegetation survey plot for the Community-type Percent Cover method. A 100-m transect that bisects the survey plot is used for the Point Intercept method.

Standard Operating Procedure 6: Vegetation

Adapted from:
Rapid Method for Assessing Estuarine (Salt) Marshes in New England, Version 1.4, Oct. 2006
by Bruce Carlisle & Marc Carullo, Massachusetts Office of Coastal Zone Management
Jan Smith, Massachusetts Bays National Estuary Program
Cathleen Wigand, Richard McKinney, & Mike Charpentier, US EPA Atlantic Ecol. Div.
Deborah Fillis, Yale University
Mark Stolt, Univ. of Rhode Island

Modified by:
Hilary Neckles and Glenn Guntenspergen
USGS, Patuxent Wildlife Research Center
Date: May 2009

Modified by:
Susan C. Adamowicz, Jordan Kramer
US FWS, Rachel Carson NWR
Date: July 2012

Modified by:
Whitney A. Wiest, W. Gregory Shriver
University of Delaware
Date: April 2014

Version 1.0, April 2014

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Please read through this entire SOP before proceeding.

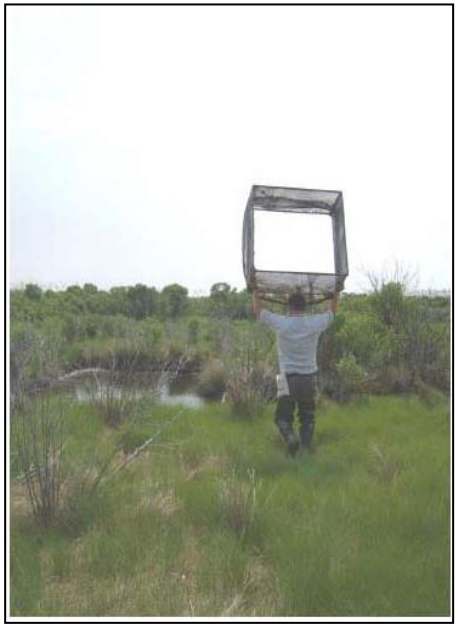
Vegetation will be measured in the field in two different ways. See Appendix C for a third additional vegetation survey option.

1. Point Intercept method: A fine scale measurement of species presence along a transect.
2. Community-type Percent Cover method: A broad scale visual estimate of plant communities and other land cover types in a circle.

5) Standard Operating Procedures

SOP 7 Nekton

Metric	Definition
Nekton community	
Nekton Density	Nekton density (ind m^{-2}) using throw traps and ditch nets
Nekton SpRich	Nekton species richness using throw traps and ditch nets
Fundulus Length	*Fundulus heteroclitus* length (mm) captured in throw traps and ditch nets



Standard Operating Procedure 7: Nekton

Protocol adapted from:
M.J. James-Pirri and C.T. Roman. 2005. Monitoring Nekton in Salt Marshes (revision #1): A protocol for the National Park Service's Long-Term Monitoring Program, Northeast Coastal and Barrier Network.

Modified by:
Hilary Neckles, Glenn Guntenspergen, and Jessica Nagel,
USGS, Patuxent Wildlife Research Center
Date: May 2009

Modified by:
Susan C. Adamowicz, Jordan Kramer
USFWS, Rachel Carson NWR
Date: July 2012

Version 1.0, July 2012

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Introduction:

This protocol describes the methodology used to sample nekton (fish and crustaceans) in shallow subtidal habitats (<1m) within salt marshes (e.g., creeks, pools) and shallow subtidal habitats immediately adjacent to salt marshes. Species composition and abundance of nekton responds to environmental changes (e.g., sea level rise, nutrient loading, invasive species colonization). Monitoring nekton over time will help evaluate natural and human-induced changes in estuarine nekton in the long-term and will advance our understanding of the interactions between nekton and the dynamic estuarine environment.

Nekton will be sampled using two different quantitative techniques (throw traps or ditch nets). Throw traps are used for shallow water salt marsh creeks, pools, whereas ditch nets are used for sampling narrow mosquito ditches. Sampling will occur in late July and early August . Nekton composition, density and the lengths of up to 15 individual *Fundulus heteroclitus* are recorded at each sampling station. For the Salt Marsh Integrity project, only salinity will be measured concurrently with nekton sampling.

5) Standard Operating Procedures

SOP 8 Breeding Birds

Metric	Definition
Breeding bird community	
Willet Abundance	Abundance of Willets counted per point during standard call-broadcast surveys
TMO Abundance	Sum abundance of tidal marsh obligate species per point during standard call-broadcast surveys: Clapper Rail, Willet, Saltmarsh Sparrow, Seaside Sparrow

Saltmarsh Integrity Monitoring Program Sequences (2012 - present)

National Wildlife Refuge	State	5 min	BLRA	LEBI	SORA	VIRA	KIRA	CLRA	AMBI	COMO	SOSP
Moosehorn	ME	X		X		X		X			
Maine Coastal Islands Complex	ME	X		X		X		X			
Rachel Carson	ME	X	X	X	X	X		X			
Parker River	MA	X	X	X	X	X		X			
Monomoy	MA	X	X	X	X	X	X	X		X	
Rhode Island Complex	RI	X	X	X	X	X	X	X		X	
Stewart B. McKinney	CT	X	X	X	X	X	X	X		X	
Long Island Complex	NY	X	X	X	X	X	X	X		X	
Edwin B. Forsythe	NJ	X	X			X	X	X			
Cape May	NJ	X	X	X		X	X	X	X		
Bombay Hook	DE	X	X	X	X	X	X	X	X	X	
Prime Hook	DE	X	X	X	X	X	X	X	X	X	
Chincoteague Complex	VA	X	X	X		X	X	X		X	X
Eastern Shore of Virginia Complex	VA	X	X	X		X	X	X		X	X
Eastern Virginia Rivers Complex	VA	X	X	X		X	X	X		X	

Standard Operating Procedure 8: Breeding Birds

Whitney A. Wiest, Elizabth L. Tymkiw, & W. Gregory Shriver, University of Delaware

Modified From Courtney Conway - Wildlife Research Report #2007-04

Version 1.0, January 2012

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

Objectives:

1. Determine distribution of marsh birds within an area.
2. Estimate / compare density of marsh birds among management units, wetlands, or regions.
3. Estimate population trend for marsh birds at local or regional scale.
4. Evaluate incidental effects of management actions on marsh birds.
5. Document habitat types / conditions that may influence marsh bird abundance or occupancy.

Survey Overview:

Each survey consists of a 5-minute passive period point count and a broadcast sequence where all birds seen and/or heard using habitat are recorded. The passive period is followed by a broadcasting of a series of secretive marsh birds calls, in which a 30-second call is broadcast into the marsh, followed by a 30-second window of silence. This broadcast process is repeated for each secretive marsh bird species included on the broadcast sequence. Broadcast sequences vary from area to area.

5) Standard Operating Procedures

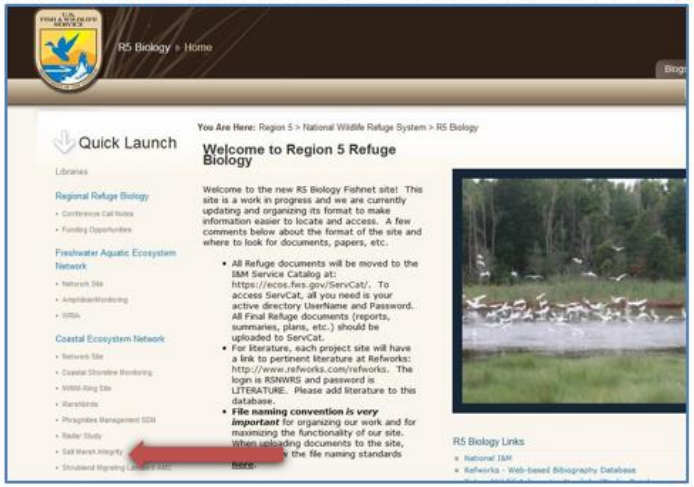
SOP 9 Data Entry / Data Management

SMI / SHARP Data Management Solutions for NWRS Region 5:

FWS personnel can access SMI / SHARP databases from the R5 Biology Fishnet site at:
https://fishnet.fws.doi.net/regions/5/nwrs/im/

Non-FWS Personnel can access pertinent databases from the DOI Connect SHARP site at:
https://connect.doi.gov/fws/Portal/SHARP/SHARPDbase/

1. Click <**Salt Marsh Integrity**> to open the associated Fishnet site and data management solutions.



2. Databases associated with SMI / SHARP can be found underneath the database heading.