

Southeast Coast Network

National Park Service
Inventory & Monitoring Program



Standard Operating Procedure (SOP) #1.3.6

Salt Marsh Elevation Monitoring

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Summary

The following Standard Operating Procedure (SOP) outlines the procedure involved using the rod surface elevation table (RSET) to monitor salt marsh elevation change. The following procedures have been adapted from the sampling method developed by Cahoon et al. (2002) and Folse and West (2004). The sampling methodology is also thoroughly explained on the USGS web site <http://www.pwrc.usgs.gov/set/>. These references give an excellent overview of how the sampling occurs, but note that the following standards are written for the collection of data as a part of the Southeast Coast Network Vital Signs Monitoring Program.

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1	22July2014	L. C. Baron	Minor organizational changes and updated for 2014.	For clarity and to address editors comments	1.1

Overview

The Southeast Coast Network (SECN) has implemented the use of the rod-surface elevation table (RSET) technique that has been developed by (Cahoon et al. 2002). The RSET is the preferred version of the SET and benchmarks will be established at specified locations in attached, herbaceous marsh and mangrove scrub/shrub ecosystems. The RSET method provides a non-destructive process which precisely measures the sediment elevation over a long period of time relative to a fixed subsurface datum (Figure 1). Briefly, a series of 4-ft. stainless steel rods are driven through the root zone, the organic matter, and any soft underlying materials until refusal is encountered from a driving force on the rod. Near the surface, a custom-made stainless- steel receiver is attached to the rod which is stabilized by a 6-in. diameter pipe that is cemented at the surface. This stainless steel receiver provides a constant horizontal reference plane as well as long-term repeatability as the RSET arm remains fixed for each sampling period. Detailed installation procedures are written in SOP 1.3.19 (Asper and Curtis 2012).

Data collection occurs by attaching a custom-made RSET arm (Figure 2) to the receiver and nine fiberglass pins are lowered through the RSET arm to the marsh surface. The height (measured in millimeters) that each pin extends above the arm is used to calculate vertical changes of the marsh surface over time. Using previously-collected data, the rate of change can be calculated to provide status and trends with respect to changes occurring between the surface and the bottom of the stainless steel rods.

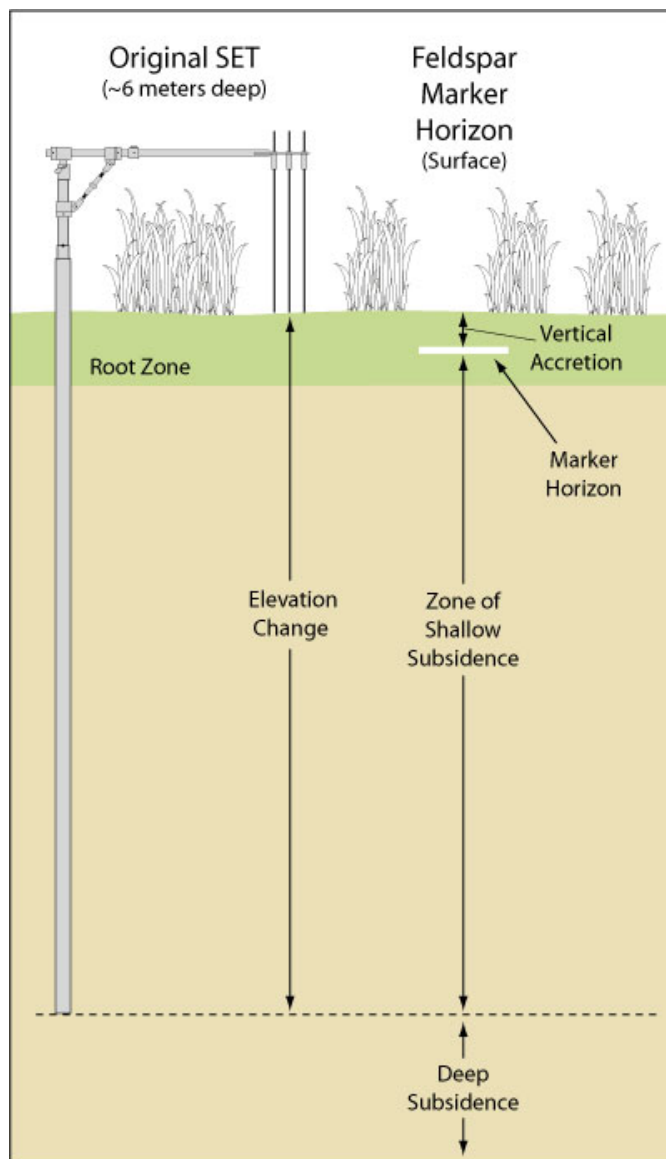


Figure 1. Conceptual diagram of SET Monitoring Station (Cahoon and Lynch 2005).

Procedures

The following procedures of salt marsh elevation monitoring have been adapted from the sampling method developed by Cahoon et al. (2002) and Folse and West (2004).

Equipment and materials

- RSET unit (contains the RSET and components listed below) (Figure 2).
 - Rod surface elevation table arm
 - Insert collar
 - Nine fiberglass pins (numbered to correspond with numbered holes on arm, respectively)
 - Nine badge clips
 - Two spring clamps
 - Bull's eye level
- Aluminum or stainless steel metric ruler, capable of measuring in millimeters with the end being zero millimeters.
- Compass
- Digital camera
- Field form(s) (Appendix A)
- Field notebook
- Two 2 in. × 12 in. × 10 ft boards or expandable aluminum planks
- Kneeling pads
- Cleaning supplies (brushes, towels, WD40[®], etc.)
- Additional tools:
 - Vice grips
 - Files
 - Hex keys

Due to some variability between crucial equipment pieces, the same RSET unit will be used to take the initial reading and all subsequent measurements at a benchmark. Therefore, the unit used for the initial reading shall be documented on the Rod Surface Elevation Table (RSET) Field Form (Appendix A) to verify that the same unit was used at all data collections. The fiberglass pins are numbered 1 to 9 corresponding with the RSET arm holes, and fiberglass pins will be placed into corresponding holes during each data collection period further ensuring measurements remain consistent in the future.

Instructions

NOTE: No walking or stepping on the marsh surface is permitted; all work is performed from the boardwalk.

Accretion stations will be established on the same day as the first RSET reading and are to be sampled when the RSET measurements are taken using SOP #1.3.7 (Asper and Curtis 2013). Data from the previous RSET sampling should be downloaded from the database in order to

review notes about the surface on which pins were previously placed. This ensures consistent measurements between sampling efforts as much as possible.

When working in a marsh site, mud flat or tidal pond, it is preferred that the surface is not inundated. Exceptions can be made in cases such as erosion.

When possible, the same reader should read the RSET every time. Due to turnover of staff, this is not always possible. In these cases, it is preferable for a “Double-Reading” to occur (see Appendix D Double Reading Set).

1. Visually inspect the site and verify that the platform is in good shape. Repair if necessary.
2. Place one or two boards across the two existing boardwalks (Figure 3).

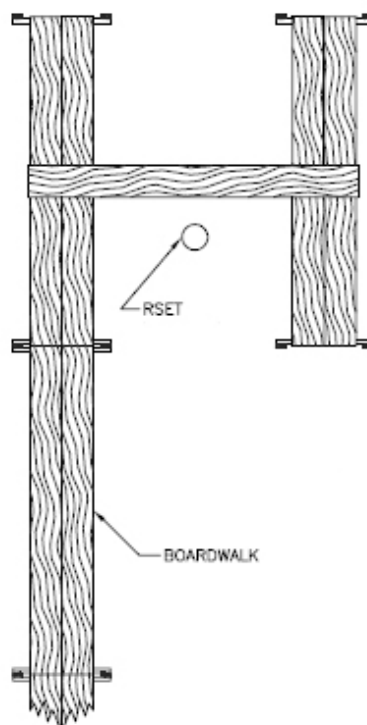


Figure 3. Diagram of board placement (modified from Folse and West 2004).

3. Move any material that has grown or accumulated on the receiver. This must be performed gently to ensure that the marsh surface is not disturbed.
4. Fill out the top of the field form (Appendix A) including: RSET ID number stamped on the instrument, RSET ID, Feature Name, sampling date and time, field personnel/organization's name, and establishment date and time.
5. Remove the cap from the receiver (Figure 4).



Figure 4. Deep rod benchmark / monument and receiver capped (left) and receiver uncapped (right from USGS Taking your SET readings page: <http://www.pwrc.usgs.gov/>)

6. Attach the insert collar to the receiver.
7. Using the locking wheel, lock the RSET arm into position 6 cm from the exterior edge of the pivot joint (Figure 5)..



Figure 5. RSET arm locked into position 6 cm from the exterior edge of the pivot joint.

8. One at a time, insert the nine fiberglass pins from the bottom into their corresponding numbered holes on the arm of the RSET (Figure 6) and secure them with badge clips so that the pins are just below the bottom of the RSET arm. Verify that the pin used matches the arm hole.



Figure 6. Fiberglass pins installed in RSET with badge clips.

9. Slide the RSET onto the insert collar, aligning the collar pins with the holes in the collar (Figure 7) such that the arm points in the direction as close to 0° as possible.



Figure 7. RSET insert collar mounted to receiver. Inset: insert collar close-up. (modified from USGS Taking your SET readings page: <http://www.pwrc.usgs.gov/>)

10. Identify four measurement directions.

NOTE: From a single RSET collar (Figure 8), there is a choice of eight directions (lines in Figure 8) from which to take readings. Take readings at four of the eight possible directions, starting with the direction closest to North (0°). Typically, the four directions are chosen so they are 90° from each other (i.e., as close to north, east, south, and west as possible), although other spatial patterns may be required for a particular site.

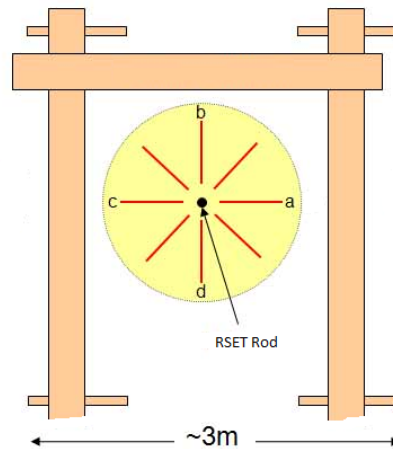


Figure 8. Permanent platform showing plot layout and potential directions for the RSET. (Modified from USGS Taking your SET readings page: <http://www.pwrc.usgs.gov/>)

NOTE: Unless later disturbed, directions of measurement remain consistent throughout monitoring. Extra directions can be used should a problem arise. For example, if the site receives storm damage in one of the sampling plots or there is now a deep horse hoof print. In these cases, start another baseline using one of the four remaining directions.

If a disturbance occurs that would alter a majority of the readings in a particular direction, the arm shall be rotated 45° from the initial direction to obtain new readings. Establishment of new directions should be well documented and subsequent readings should be taken from this position. Human disturbance and large-scale animal disturbances (muskrat mounds, alligator trails) are reasons to move directions. If the disturbance is not human induced and it affects all possible directions, continue to measure the RSET if possible.

11. Clamp the RSET to the insert collar using two spring clamps (Figure 9).



Figure 9. Clamp RSET to collar using spring clamps.

Level the RSET arm vertically and horizontally using the turn buckle and level bubble. Lock it into place with the locking wheel.

NOTE: The RSET arm should be perfectly level in order to get precise measurements. Make sure there are no plants or roots pushing on the pins or the arm when you level. If the table arm is bumped during data acquisition, re-level it.

12. Using the compass, determine the measurement direction from the center of the RSET and out along the arm.
13. Record the compass bearing on the Rod Surface Elevation Table (RSET) field form (Appendix A).
14. Using a metric ruler, measure the distance between the top of the pivot joint and the top of the cap in millimeters. Record the value on the field form (Appendix A).

NOTE: This value is recorded to account for any differences between the RSETs. If only one RSET is being used this value does not need to be recorded. The Southeast Coast Network is utilizing a number of SETs during data collection and although SECN plans to use the same RSET at a given site, recording this value will account for any variability in equipment.

15. One at a time, unclip the badge clip on each pin and lower it until it touches the surface (Figure 10), make sure the pin does not penetrate the marsh surface.



Figure 10. RSET with fiberglass pins being lowered to the marsh surface.

16. Place the clip back on the pin and repeat this for the other eight pins.
17. As the RSET pins are being placed on the surface, follow the list of placement recommendations and take notes as directed (see Appendix B-Guidelines for Placing Pins).
18. If there is something in the location where the pin touches the surface, note it on the field form using Appendix C-Pin Obstruction Abbreviations.
19. Recheck the bubble level to make sure the arm is still level. If the arm is no longer level, raise the pins, re-level the arm, and place the pins again.

Using a metric ruler, measure from the top of the RSET arm (Figure 11) to the top of the pin and record the distance in millimeters on the field form in the “Observed Pin Height (mm)” field. Read the nearest mm tick marker on the ruler visible in line with or above the top of the fiberglass pin.

NOTE: The measurer should make sure his/her eyes are level with the ruler. The person recording the measurements should verbally repeat the measurement back to the measurer to assure that the correct number was understood and recorded.

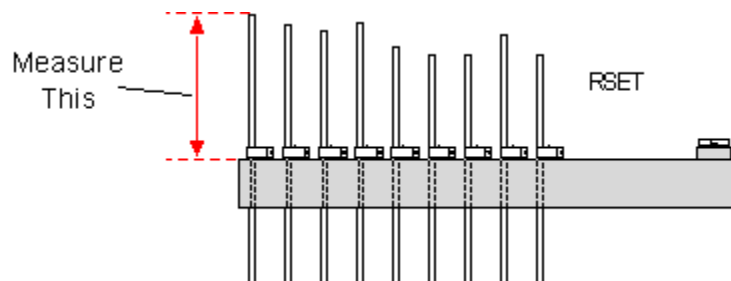


Figure 11. Diagram of pin measurement. (modified from from USGS Taking your SET readings page: <http://www.pwrc.usgs.gov/>)

20. After recording measurements, raise each pin about two-thirds of its length up and clip each with a badge clip so that the bottoms of the pins do not interfere with rotating the RSET arm.
21. Unclamp, lift, and rotate the RSET arm 90° eastward.
22. Repeat steps 11 through 23 until 9 pin measurements have been obtained at each of the four cardinal points. Table 1 is an example of how the data will be recorded in the field.

Table 1. Example of a field sample. Nine separate height measurements are collected at each of the cardinal points for a total of 36 measurements taken at each RSET location.

TIMU005A - February 14, 2012				
Direction	Pos 1	Pos 2	Pos 3	Pos 4
Bearing	NE 40°	SE 130°	SW 220°	NW 310°
Pin 1	121	132	122	134
Pin 2	120	129	140	121
Pin 3	120	133	125	119
Pin 4	123	133	122	128
Pin 5	125	132	141	115
Pin 6	119	126	139	149 S
Pin 7	128	101 H	133	119
Pin 8	131	122	126	125
Pin 9	130	121	123	128
SET read by: Tony Curtis, SET ID: SECN001				

23. Describe the condition of the RSET plot in the “Site Conditions” box at the bottom of the field form:
 - a. Water depth in the RSET plot. Measure in three or more locations and estimate average depth if marsh is flooded. If the marsh is not flooded, note whether it is wet or dry. Provide additional notes if it is very dry and cracked.
 - b. Vegetative health (healthy, stressed, dead). Also note dominant vegetation.
 - c. Description of the soil surface composition (organic or mineral) and if mineral, what kind of mineral (sand, silt, clay), if known. Type of mineral soil does not have to be selected. More than one mineral soil type can be selected.

- d. Disturbance to the RSET plot and the cause of the disturbance, if known (fire, grazing, other animal activity [trails, nests], human, other).
24. Take a digital picture of the RSET plot (above) from the long platform facing the RSET plot and the short platform.
25. Take a digital picture of the close up view of the marsh surface and base of dominant vegetation within the RSET plot that is representative of the site surface.
26. Verify the field form is complete, break down and store the RSET, replace the threaded cap, remove planks and proceed to the next site.

Literature Cited

- Asper, J. R. and A. C. Curtis. 2012. Salt Marsh Community Rod-Surface Elevation Table (RSET) Installation. Standard Operating Procedure NPS/SECN/SOP-1.3.19. Southeast Coast Network, Athens, Georgia.
- Asper, J. and T. Curtis. 2013. Accretion and erosion measurement with a feldspar marker horizon. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP-1.3.7. National Park Service, Athens, Georgia.
- Callaway, J. C., Cahoon, D. R., and Lynch, J. C. 2014. The surface elevation table-marker horizon method for measuring wetland accretion and elevation dynamics. In: Methods in biogeochemistry of wetlands. Soil Science Society of America. p. 901-917.
- Cahoon, D. R., J. C. Lynch, B. C. Perez, B. Segura, R. D. Holland, C. Stelly, G. Stephenson, and P. Hensel. 2002. High-precision measurements of wetland sediment elevation; II, The rod surface elevation table. *Journal of Sedimentary Research* 72:734-739.
- Folse, T. M. and J. L. West. 2004. A standard operating procedures manual for the Louisiana Department of Natural Resource's Coastal Restoration Division: methods for Data Collection, Quality Assurance/ Quality Control, Storage, and Products. Louisiana Department of Natural Resources, Baton Rouge, Louisiana.

Appendix A – Field Form

Rod Surface Elevation Table (RSET) Field Form

RSET ID: _____ Feature Name: _____

Sample Date: _____ Time: _____ Establishment Date/Time: _____

Measured by: _____ Field Personnel / Organization: _____

RSET Equipment ID: _____ Height of arm above cap: _____

		Azimuth (And obstruction codes in second column)								
Pin	Pin Height (mm)		Pin Height (mm)		Pin Height (mm)		Pin Height (mm)		Comments (description that pertain to problems with reading)	
1										
2										
3										
4										
5										
6										
7										
8										
9										
Site Conditions (weather, water level related to marsh surface, dominant plant species, ect):										

****Obstruction Codes:** Descriptions of codes can be found in the Salt Marsh Elevation Monitoring SOP (SOP1.3.06)
 HU = Hummock, H = Hole, D = Depression, CB = Crab Burrow, CH = Chimney, ST = Stem, S = Shell, AP = Animal Print, F = Footprint

Site Photos: _____

RSET ID: park four letter code plus 3 digit site code plus one letter code, i.e., CUIS001A

Feature Name: Text from the GNIS data, a description of the water body site is located, such as Great Island Bay.

Sample Date: Date

Establishment Date/Time: Date/Military Time

Measured by: Name

Field personnel / Organization: Name of other field members and respective organization, up to six letter code, i.e., CUIS or SECN or SCA or GADNR.

RSET Equipment ID: Serial Number, alphaNumeric, 8 digit

Height of Arm above monument: This is the distance in millimeters between the top of the arm and the top of the receiver/monument.

Time: four digit military time

Azimuth: Compass degrees 1-360 (these are the four cells below the Azimuth title)

Pin height columns: millimeters, 4 digit (fourth digit to support growth, normally only three used)

Comments: Text notes

Site Conditions: Text notes

Site Photos: The first photo should be a photo of this form, followed by a picture taken from the access boardwalk, facing the RSET plot and short boardwalk. Another picture shall be taken providing a close-up view of the marsh surface (flash on) somewhere within the RSET plot that is representative of the site surface (below). The below picture should include the base of dominant vegetation if present. Other digital pictures should be taken of the marsh surface for all unusual or difficult pins.

Appendix B – Guidelines for Placing RSET Pins

Though it is near impossible to remove all subjectivity from the readings, the following guidelines help limit the level of subjectivity by creating a standard.

- Surface of marsh should not be inundated. Exceptions can be made in cases such as erosion.
- It is easiest to lower pins in order of the farthest from the reader to the closest to the reader.
- Push vegetation aside when necessary, but only if it does not affect the marsh surface at all.
- Use small bungee cords to hold vegetation aside.
- Detritus, leaves, and other materials on surface should be left untouched.
- Remove manmade materials in the gentlest manner possible if on site.
- If pin rests on an unusual surface, such as an oyster shell, branch, or crab hole, make a note in the data book using the list of abbreviations in Appendix B.
- If it is not possible to place the pins on the surface and the pin is on an un-representative surface for that site, record the pin height and mark an “X” to omit the pin. Include an explanation.
- Placing the pins on a dry surface is mainly accomplished visually.
- If water is on the surface, it may be necessary to place pins by “feel” using resistance.
- If it is necessary to take actions that are not outlined here, take notes in the “comments” section to explain actions. Note anything (shell, plants, obstructions, etc.) in the way of any pins. It is always better to make a note so we can decide to keep or discard the data. Also, if you step in the plot or drop the ruler in the plot, just make a note of it on the datasheet.
- Interpreting the surface can be subjective, take as many notes as is necessary for the methods to be repeatable.

Appendix C – Pin Obstruction Abbreviations

HU	Hummock - Transitional slope referring to a small knoll or mound above the rest of the marsh surface
H	Hole - Deep hole within the marsh surface and usually excluded from analysis.
D	Depression – Area below the rest of the marsh surface (not a hole or crab burrow) and usually included in analysis.
CB	Crab Burrow within the marsh surface
CH	Chimney - Crab burrow chimney within the marsh surface. Pin lands on the chimney of the crab burrow
ST	Stem - Pile of vegetation or stem that cannot be moved without compromising soil surface.
S	Shell
AP	Animal Print
F	Footprint

Appendix D – Double Reading the RSET

In an ideal situation, the same person should read the RSET from sampling to sampling. This approach will maintain a consistent sampling protocol when taking the readings and minimize sampling errors. But, with a high turnover of field personnel, this proves difficult. When possible, double reading the RSET is preferred. The other less desirable option is to develop a new baseline with the new reader, adjusting the data trends accordingly.

For example, suppose RSET reader #1 has been reading the data since the project started, but is leaving for a new job. RSET reader #2 is going to replace him/her. The best situation would be for both readers to go and sample the site together, i.e., a double reading. Reader #1 would collect data following steps 1-19 with the RSET. Then reader #2 would take a repeat set of readings following steps 4-19.

A double read is also necessary for switching pins. For example, if longer pins are necessary, a double reading with both sets of pins will account for the change. Take a final reading with the original pins and a baseline reading with the new pins.