Culebra Sediment Trap Monitoring Work Plan

Developing a nearshore sediment trap monitoring program to evaluate changes in LBSP exposure in Culebra, Puerto Rico

1. Background

This monitoring work plan is a key component of Culebra's LBSP Ridge to Reef Monitoring Program aimed at providing standardized guidelines and methods to monitor changes in land-based pollutant loads, nearshore land-based pollutant exposure, and seagrass habitat responses across the island. These monitoring activities are spatially and temporally coordinated and represent the basis of Culebra's Integrated LBSP Monitoring and Evaluation Framework to successfully evaluate progress toward achieving NOAA's LBSP management goals and outcomes on Culebra.

2. Monitoring Objectives

This work plan outlines a sediment trap monitoring program to evaluate change in land-based sources of pollution (LBSP) exposure—terrigenous sedimentation—in the nearshore coastal environment over time, and it is aligned with the following NOAA LBSP management goals, outcomes, and evaluation questions below:

Management Goal:

- By 2030, improvements to Culebra's nearshore water quality and sedimentation.

Management Outcomes:

- Improve nearshore water quality.
- Reduce terrigenous sedimentation.

Evaluation Questions:

- Have nearshore water quality conditions improved?
- Has nearshore terrigenous sedimentation decreased?

This sediment trap monitoring program was also designed to:

1. Collect long-term data of sediment accumulation, composition, and distribution across the nearshore environment in Culebra.
2. Assess changes in terrigenous sediment fluxes at nearshore fixed monitoring stations adjacent to both managed and unmanaged coastal watersheds to evaluate the performance of implemented LBSP best management practices (BMPs).
3. Conduct outreach activities to inform and to engage both local community, federal, and Puerto Rican government officials in ongoing natural resource management, restoration, and conservation efforts on Culebra.

3. Monitoring Location and Frequency

Monitoring Locations

The nearshore sediment trap monitoring will occur at the 13 fixed nearshore water quality monitoring stations identified in Table 1 and Figure 1. These nearshore locations were selected based on a rigorous analysis of watershed hydrology and coastal hydrodynamics as well as the existing level of LBSP exposure and anticipated changes to LBSP exposure due to management actions (Appendix A: Identifying Priority Fixed-Site Monitoring Locations). A consideration was made, to include locations where baseline (pre-restoration watershed restoration activities) seagrass and water quality monitoring surveys had been completed in 2014.

In Figure 1, LBSP Restoration sites (blue) are locations where LBSP BMPs have been implemented and are therefore locations where LBSP management is occurring. LBSP Control sites (yellow, red, and green) are locations where there is presently no LBSP management occurring. These control sites were selected to represent a range of LBSP impairment, including Control (yellow) which have no known direct discharge of LBSP but are representative of the range of external factors (currents, wave and wind energy) that may be encountered at the treatment sites; a Negative Reference site (red) of significant LBSP impairment, as well as a Positive Reference site (green) of low LBSP impairment. Tracking changes in sediment accumulation rates and composition at both impaired and restored watershed points will contribute information about changes in the levels of exposure to LBSP impacts though time following the presence and implementation of installed LBSP BMPs.

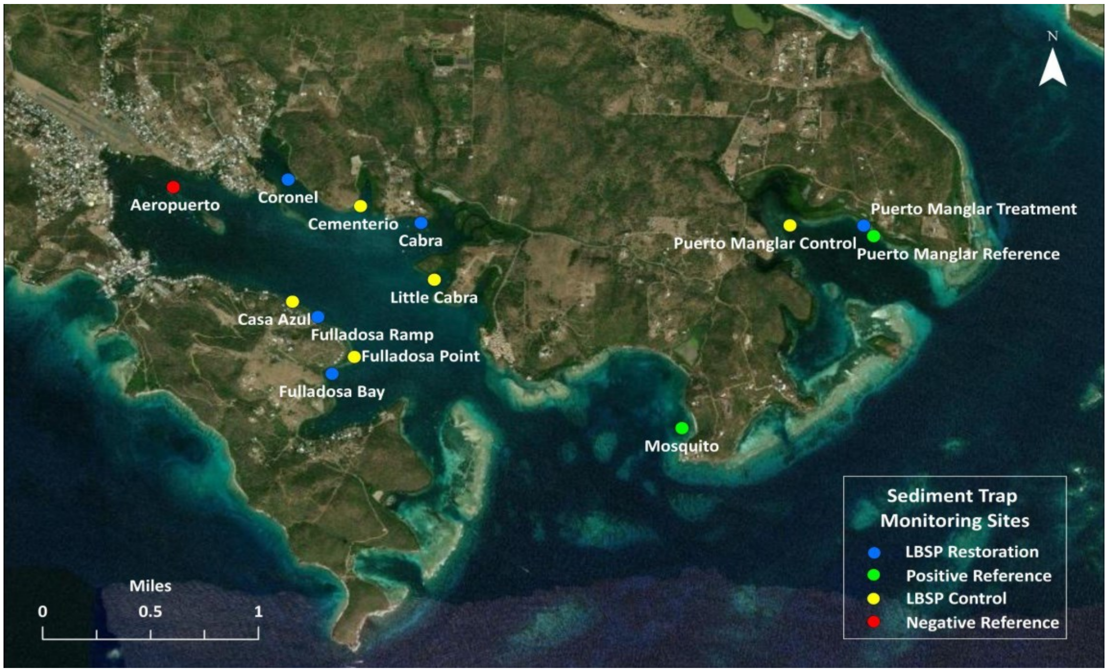

Figure 1. Nearshore sediment trap monitoring stations on Culebra.

Table 1. Nearshore sediment trap monitoring locations.

Monitoring Station	Code	Watershed	LBSP Treatment Group	Latitude	Longitude
Aeropuerto	AP	Aeropuerto	Negative Reference	18.3083690	-65.2979940
Cabra	CA	Cabra	LBSP Restoration	18.3059370	-65.2813820
Casa Azul	CAZ	Culebra	LBSP Control	18.3006040	-65.2899960
Cementerio	CM	Cementerio	LBSP Control	18.3070770	-65.2854440
Coronel	CO	Coronel	LBSP Restoration	18.3088810	-65.2902890
Fulladosa Bay	FDB	Fulladosa	LBSP Restoration	18.2957150	-65.2873460
Fulladosa Point	FDP	Fulladosa	LBSP Control	18.2968560	-65.2858520
Fulladosa Ramp	FDR	Culebra	LBSP Restoration	18.2995720	-65.2882960
Little Cabra	LC	Cabra	LBSP Control	18.3020900	-65.2804920
Mosquito	MQ	Mosquito	Positive Reference	18.2920310	-65.2639030
Puerto Manglar Control	PMC	Puerto Manglar	LBSP Control	18.3057740	-65.2566650
Puerto Manglar Reference	PMR	Puerto Manglar	Positive Reference	18.3050480	-65.2510630
Puerto Manglar Treatment	PMT	Puerto Manglar	LBSP Restoration	18.3057570	-65.2517240

Sampling Frequency

Sediment trap monitoring at all 13 sites will be conducted by Protectores de Cuencas. Monthly inspections will ensure necessary corrective actions are performed in a timely manner to reduce sample loss. Deployed sediment traps will be recovered on a quarterly basis and replaced with new traps for at least one year.

4. Monitoring Parameters

Duplicate sediment traps will be installed at each nearshore water quality fixed monitoring station downstream from each coastal watershed drainage delivery point. Collected sediment samples will then be analyzed for constituent accumulation. Changes in pollutant exposure—corresponding changes in habitat response are being quantified using Seagrass monitoring transects—will be evaluated through comparisons of site-specific measurements of indicators at LBSP Restoration Sites over time, as well as with LBSP Control sites. If measures of indicators at Restoration sites are trending toward Control or Positive Reference sites this would suggest that pollutant exposures and habitat responses are 'improving' as a result of management actions. Therefore, the parameters selected for this monitoring work plan were: (1) indicators of sedimentation threats and (2) logistically feasible; and are outlined below:

- Indicators of sediment threats:
  - Accumulation rates—greater accumulation rates can smother bottom dwelling organisms or pose greater energetic demands for increased sediment removal.
  - Grain size—fine sediments (silt and clay) have protracted settlement rates compared to coarse sediments and are associated with increased turbidity and reduced light quality and quantity for photosynthesis.
  - Constituents—assess changes in terrestrial sediment contribution to the nearshore habitats.

5. Sediment Monitoring Methods

Trap Design Specifications

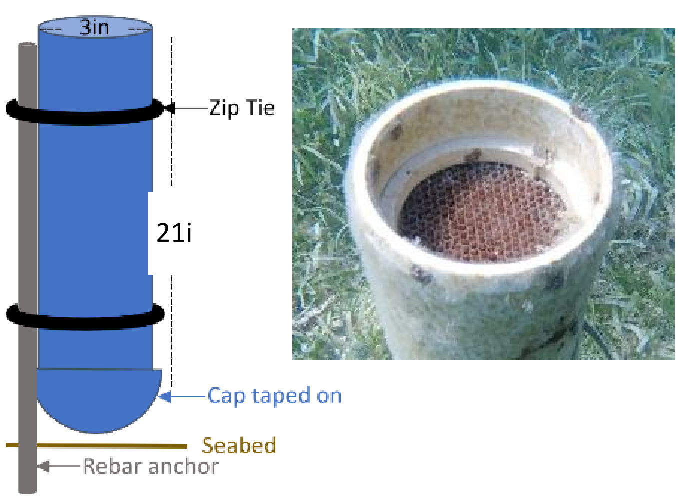

Figure 2. a) Sediment trap design features; b) honeycomb turbulence and bioturbation baffle.

Sediment traps will be constructed out of PVC pipes with dimensions recommended by Storlazzi et al. (2011) (Figure 2 and Table 2). Trap dimensions and deployment methods will be standardized across all fixed monitoring stations. The bottom cap will be permanently affixed to ensure settled sediments are retained in the trap. A honeycomb baffle will also be placed in the top of the trap to reduce the turbulence in the trap and prevent sample disturbance by aquatic organisms.

Table 2. Sediment trap design features.

Trap Design Feature	Measurement
Pipe Diameter (D)	3 inches
Trap Height (H)	21 inches
Aspect Ratio (H:D)	7:1
Volume	82.2 oz
Volume	2.4 L

Trap installation

As aforementioned, the sediment trap deployment locations are co-located with the Nearshore Water Quality Fixed Monitoring Stations and Seagrass Monitoring Transects. Sediment traps will be installed on anchored rebar supports hammered into the substrate to establish a permanent monitoring station. Rebar anchors are to be installed in an area devoid of living coral within at least one meter from the anchor in all directions, and at a depth no shallower than 7 feet deep at low tide. For proper trap function, the length of the water column above the trap aperture, or opening of the PVC pipe, must be between 2–3 times the pipe length (Storlazzi et al. 2011). For this monitoring, the length of the water column above the trap aperture should be between: 3.5–5.3 ft (i.e., 42–63 inches or 1.1–1.6 m). Traps are to be mounted as close to the sea floor as possible and all traps should be installed the same height above the seafloor across all monitoring sites**.** Sediment traps should be oriented vertically, with the trap aperture placed higher than the rebar anchor (Figure 2) to ensure the trap accumulation rate is not artificially influenced by turbulent wakes caused by the structure. Additionally, this orientation allows for top cap placement prior to detaching traps from rebar anchors during trap recovery. Sediment traps can be secured to the anchors using industrial grade zip-ties or with stainless steel hose clamps. Duplicate traps are placed at least 10 pipe diameter lengths from one another, or no closer than 30 inches, to prevent trap settling interference (Storlazzi et al. 2011).

Trap Recovery Procedure

Check: Section 8. "*Before and Trap Deployment Checklist*" at the end of this document. Sediment traps will be recovered underwater on SCUBA. Trap recovery and redeployment field metadata will be recorded in the Sediment Trap Monitoring Field Sheet (see section 9 below).

During trap collection, the diver will:

1. Inspect the integrity of the trap and look at the interior of the trap with a flashlight to ensure there are no organisms (e.g., octopus, crabs) or undesired materials in the trap.
2. Secure the upper cap to the top of the sediment trap to preserve the sample prior to disturbing the environment by suspending any biological material that may have collected on the outside of the trap.
3. Check to make sure the bottom cap is still tightly secured to the sediment trap.
4. Measure length of the water column above the trap aperture and record in the Sediment Trap Monitoring Field Data Sheet—one per monitoring station.

5. Measure length from bottom of trap to seafloor and write in the Sediment Trap Monitoring Field Sheet—one per monitoring station.
6. Clean the outside of the trap using the Nemo Impact Driver with its brush adapter or any other appropriate tool.
7. Unscrew the hose clamps securing the trap to anchoring rebar with the Nemo Impact Driver or a manual screwdriver. Bring heavy-duty metal snips or pliers to cut hose clamps in case a screw is stuck.
8. Carefully lift the trap out of the water and gently place it in the storage crate, taking caution to ensure the trap remains oriented upright, with the top cap facing up until they are delivered to the wet lab for analysis.
9. Label the trap with the appropriate site code and replicate number (e.g., AP-1, CAZ-2). Need to identify rebars as replicate 1 and replicate 2 to always place replicates in the same location.
10. Secure trap caps with tape to prevent leaking.
11. Identify new empty traps and install to replace the recovered ones.
12. Sediment Trap Monitoring Field Data Sheet—one per monitoring station, indicating date of trap recovery, and detailing any field notes which may impact analytical outcomes, such as if traps had been noticeably disturbed, damaged, tipped over, or became dislodged prior to recovery.

6. Sample Analysis

Collected sediment samples will be pre-processed in the Protectores de Cuencas wet laboratory on Culebra and packed for transport to the Center for Applied Tropical Ecology and Conservation (CATEC) Laboratory at the University of Puerto Rico in Rio Piedras to complete the analysis using standard dry weight and loss on ignition procedures. All analysis data will be recorded in the Nearshore Sediment Trap Composition Analysis Datasheet (see below) Results generated by completing this analysis include:

1. Total dry sediment mass.
2. Trap accumulation rate.
3. Sample composition (percent organic, carbonate, and terrigenous).

Sediment sample pre-processing

Sample pre-processing consists of wet-sieving the collected sediment sample to separate it into two fractions: 1.) coarse (i.e., sand: >63 µm) and 2.) fine (i.e., silt and clay: <63 µm). This separation will be conducted using a Gilson wet sieve shaker (Figure 3). Both fractions will be stored separately in 32 oz. plastic containers for transport to the laboratory where grain size and composition analysis will be completed (Figure 4). Only one sediment trap replicate will be separated into coarse and fine fractions and tested for total sediment mass and sample composition. The other replicate will not be fractioned to coarse and fine and will only be used to quantify total dry sediment mass and to have as a backup in case of problems with the other sample.

Figure 3. Gilson wet sieve shaker.

To complete the sediment sample pre-processing follow the steps below:

1. Identify the sediment trap replica that will be sieved and the one that will just be used to quantify total weight and used as backup.
    a. Replicate #1 will be separated into coarse and fine fractions and tested in the lab for total dry sediment mass, and sample composition.
    b. Replicate #2 will be stored in the plastic storage containers without being fractionated—only undesired >2 mm material is discarded—and will only be used to quantify total dry sediment mass.
2. Assemble sieve shaker:
    a. Place vibrator on top of the notched bucket.
    b. Place sieves on vibrator in the following order from bottom to top:
        i. Sieve #230 (mesh size 63 µm)
        ii. Sieve #10 (mesh size 2 mm)
3. Pour entire trap contents of Replicate #1 in the wet-sieving shaker.
4. Cover the sieve pan with its lid.
5. Turn on vibrator for 5–10 minutes.
6. Label storage containers and corresponding lids with a piece of masking tape with the following information:
    a. Site ID and Trap replicate number - *for example: CAZ-1; PM-2*
    b. Date of pre-processing
    c. Sediment fraction size: coarse (sand) or fine (silt and clay)
    d. Storage container number. (i.e., 1 of 4; 2 of 6, etc.)
        i. This is to maintain a control of how many storage containers per sample or per sample fraction size we have.
    e. Only replicate #1 should have containers labeled for coarse and fine fractions.
        i. Example of label for replicate #1: *CAZ-1 - coarse fraction - 1 of 2 - Feb- 8-2023*
        ii. Example of label for replicate #2: *PM-2 - 1 of 5 - Feb- 8-2023*
7. Turn off vibrator, remove the lid and discard undesired materials (i.e., gravel-size shells and other organisms) collected by sieve pan #10.

8. Place Sieve Pan #10 on top of the funnel and rinse so that any sediment that passes the sieve mesh is washed into a storage container properly identified for coarse sediment. Use the fine brush to assist in the process.
9. Rinse sediment that passed the sieve pan #230 (rinse only under the mesh) so that it washes into the notched bucket. Use the fine brush to assist in the process.
10. Place sieve pan #230 on top of funnel and rinse so that sediment that did not pass the sieve mesh (coarse sediment fraction) is washed into a storage container properly identified for coarse sediment. Use the fine brush to assist in the process. Repeat this step until all coarse sediment is collected in the storage container. Use as many storage containers as needed.
11. Using the funnel transfer the contents from the notched bucket (fine sediment fraction) into as many storage containers as needed. Rinse the bucket and funnel and make sure all sediment is transferred to the storage containers.

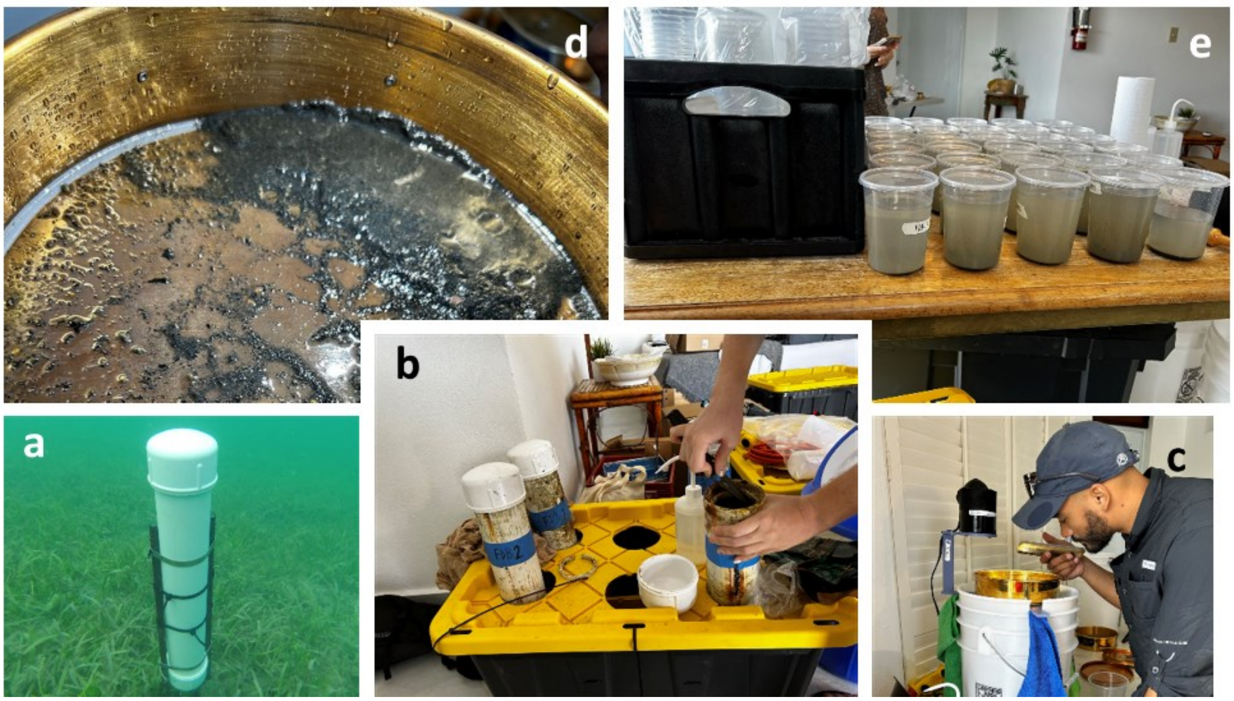

Figure 4: Photo collage illustrating the sediment trap sample pre-processing steps; from left to right: a) Underwater image of capped sediment trap ready for retrieval. b) Laboratory staff removing sediment trap from the storage/transport crate to initiate sediment sample pre-processing. c) Laboratory staff operating the Gilson wet sieve shaker. d) Coarse sand material retained on the sieve #230 (mesh size 63 µm) after wet sieving. e) Pre-processed samples in storage jars ready for shipping to CATEC Laboratory to complete the composition analysis using standard dry weight and loss on ignition procedures.

12. Find sediment trap replicate #2 and sieve by repeating steps 2–5, <u>but this time using only sieve pan #10</u> (i.e., 2 mm mesh size) to discard undesired materials (i.e., gravel-size shells and other material).
13. After discarding any undesired materials collected by the sieve pan, rinse it so that all sediment is washed into the notched bucket.
14. Transfer contents from the notched bucket into properly identified storage containers. Container label should include replicate number 2.

   a. *Sediment trap volume is 82.2 ounces. Storage container's volume is 32 ounces. Each sample should have at least 3 containers. Samples with larger amounts of sediment should use more storage containers due to the amount of water used for rinsing the sieves, funnels and buckets. Also, sample replicate #1 will tend to use more containers due to fractionation of sample.*

15. Make sure storage containers are tightly sealed and properly labeled. Store the storage containers in the storage box.
16. Transfer samples to the laboratory for further analysis.

Total Dry Sediment Mass

Total dry mass analysis will follow Edmunds & Gray (2014) and (Otaño-Cruz et al., 2017) outlined below:

1. Pre-processed samples should rest for at least 24 hours in order for sediment to precipitate. Observe samples, do not proceed to step 2 until sediment is completely precipitated.
2. Label and weigh 39 hand-made aluminum pans.
   a. Using a high-precision mass balance, weigh the aluminum pan(s)— This is the tare weight of the pan. Record this weight(s) in the lab notebook. This data will be needed to estimate the total dry sediment mass and accumulation rate below.
   b. Based on the matching storage container sample, aluminum pans may have three types of labels:
      i. Coarse Fraction (replicate #1)
      ii. Fine Fraction (replicate #1)
      iii. Total Sample (i.e., replicate #2)
3. From bullet # 1 discard sample supernatant using a vacuum pump.
   a. If sediment is disturbed during the vacuum process let the sample rest until sediment precipitates.
4. Process the resting sample in the centrifuge at 5,000 rpm for 5 minutes.
5. Remove any residual water from the sample using a pipette.
6. Transfer the sediment from the centrifuge tubes to the pre-weighed aluminum pans. Rinse the centrifuge tubes if any sediment sticks in the centrifuge tubes and transfer to the pre-weighed aluminum pans.
7. Repeat steps 3–6 until all the sub-samples from the storage containers are combined to individual samples (i.e., coarse, fine, full sample)
8. Preheat the oven to 105 °C
9. Dry the sediment samples overnight (between 12–24 hours) at 105 °C.
   a. Before getting samples out of the oven observe to assure there is no water or moisture in them.
10. Determine the dry sediment mass:
    a. Put aluminum pans in the desiccator and move them to the weighing area in the desiccator—samples will regain moisture from the atmosphere after removing from the oven.
    b. Weigh the aluminum pans in the high-precision mass balance.
    c. Subtract the aluminum pan's weight from the weight of the aluminum pan with the dry sediment to determine the weight of the dry sediment.
11. You can record your data the in a pre-formatted Nearshore Sediment Composition Analysis Datasheet (see section 9 below) to estimate the total dry sediment mass for the replica #1, as follows :
    a. **Total tare** weight (g) of the pans for coarse sediments (record in **cell 1**)
    b. **Total tare** weight (g) of pans for fine sediments (record in **cell 2**)

c. Total weight (g) of pans **with coarse sediment** after drying at 105 °C (record in **cell 3**)
d. Total weight (g) of pans **with fine sediments** after drying at 105 °C (record in **cell 4**)
e. Subtract the pan's tare weight from the pan's weight with the dry sediments to determine the mass of the dry sediment as follows:
    i. Total dry mass of coarse sediment: **cell 3** – **cell 1**
    i. Total dry mass of fine sediment: **cell 4** – **cell 2**
f. The total dry sediment mass for the replica #1 samples is the sum of the coarse-fraction mass and the fine-fraction mass

$$DW_{sample} = DW_{coarse} + DW_{fines}$$

g. Store the weighted sediment samples in the oven at 105 °C.

Trap Accumulation Rate

Use the equation below to compute the trap accumulation rate (Otaño-Cruz et al., 2017; Storlazzi et al. 2011): where: $\# \, days$ is the total number of days that the trap was deployed, DW is the dry weight of the sample, and r is the radius of the sediment trap aperture (1.5 in). Total deployment days can be gleaned from the Nearshore Sediment Composition Lab Analysis Datasheet.

$$Trap\ Accumulation\ Rate\ \left(\frac{g}{day\ in^2}\right) = \frac{DW_{sample}}{\#\, days \times \pi \times r^2}$$

Sample Composition: Sequential Loss on Ignition Analysis (LOI)

Sediment composition analysis will follow Heiri et al. (2001) and Edmunds & Gray (2014) and will only be conducted to sediment samples labeled as coarse and fine, not to sediment samples labeled as full sample. Replicate LOI analyses will be conducted based on the total dry mass of the sediment sample (coarse + fine) collected in the analysis trap. For sediment samples containing <4 g: only one replicate will be analyzed; two and three replicates will be analyzed for samples containing ~8 g and ~12 g, respectively. To complete the sequential loss on ignition analysis, follow the steps below:

1. Clean ceramic crucibles:
    a. All crucibles should be washed with soap and water, rinsed, and then dried for at least four (4) hours in the muffle furnace at 110 °C.
2. In preparation for the LOI analysis, pulverize the sediment samples in the RETSCH Mill grinder to homogenize the sediment sample.
    a. Transfer the sediment from the aluminum pan to the pulverizing container.
    b. Add the metal balls to the pulverizing container.
    c. Start pulverizing for a total of 60 seconds at a frequency of 17.0 1/s.
3. Re-dry sediment (if sample has been sitting out): Redry before or after homogenizing.
    a. If the bulk mass of the sample has just been determined and the sample has not been sitting out long, skip to the next step.
    b. Transfer approximately 4 grams (+/- 0.5 g) of each coarse and fine sediment sample (separately) to small evaporating dishes (no need to pre-weigh the dish)–Depends on size of sample as indicated above.
    c. cord the mass of the dish + sediment.
    d. Place the dish + sediment in a drying oven at 60 °C to dry for 1 hour.
    e. At the end of one hour of drying the sediment, reweigh the dish + sediment, and record the weight.

    f. If the weight changes by > 0.01 g, place the dish + sediment back into the oven and dry for 30 more minutes until the weight changes by less than 0.01 g.

4. Prepare crucibles:
    a. Remove the clean, dry ceramic crucibles from the muffle furnace and reset the temperature to 550 °C.
    b. Weigh the clean and dried ceramic crucibles and write down the weight of each in a lab notebook or directly into the Nearshore Sediment Composition Analysis Datasheet.
        i. One for coarse (record in **cell 5**).
        ii. One for fine (record in **cell 6**).
5. Add sediment to the crucibles:
    a. A maximum of three replicate sub-samples of the sediment's total dry mass weighing ~4 g each will be placed in the muffle furnace. Number of replicate sub-samples will be determined by the total sediment dry mass accumulated in the trap. Two replicates for samples totaling ~6–8 g and one replicate for samples totaling ~3–4 g.
    b. Use a metal spatula or spoon to transfer the calculated sediment weight from the aluminum pan to the crucible.
6. Reweigh the crucible + sediment and enter in **Cell 7** (coarse) and **Cell 8** (fines).
7. Combust organic matter:
    a. When the muffle furnace temperature stabilizes at 550 °C, put the sample-filled crucibles into the muffle furnace.
    b. Close the furnace door again, and allow the temperature to return to 550 °C.
    c. Record the time at which the oven reaches 550 °C.
    d. Combust the sample at 550 °C for three (3) hours.
        i. The timing of the three-hour ignition should be measured relative to the point at which the oven achieves a 550°C temperature following sample placement.
8. Remove and cool samples:
    a. Following exactly three (3) hours of ignition at 550 °C, carefully remove the crucibles from the muffle furnace using tongs.
    b. Transfer the hot samples to the 60°C drying oven for cooling.
    c. Allow at least one hour for sample cooling.
9. Reset the muffle furnace temperature to 950 °C.
10. Record new crucible weights:
    a. When the post-550 °C ignition samples have cooled enough for safe handling, record the new sediment and crucible weight.
    b. The samples must remain in the drying oven (when not in use) and therefore should be weighed "one-at-a-time".
    c. Enter these new weight values into **Cells 9** (coarse) and **10** (fine).
11. Combust carbonate matter:
    a. After recording all post-550 °C sediment and crucible weights, return the sample to the muffle furnace to evolve the carbon dioxide from the carbonate in the sample.
    b. Record the time at which the oven reaches 950 °C.
    c. Combust for three (3) hours at 950°C.
        i. The timing of the three-hour ignition should be measured relative to the point at which the oven achieves a 950°C temperature following sample placement.

12. Remove and cool samples:
    a. Following exactly three (3) hours of heating at 950°C, carefully remove the crucibles from the muffle furnace and transfer the ignited samples to the 60°C drying oven for at least two hours of cooling.
13. Record new crucible weights:
    a. When the post-950°C ignition samples have cooled enough for safe handling, measure and record the final crucible and sediment weight.
    b. Enter the values into **Cell 11** (coarse) and **12** (fine). After recording all values, discard the remaining ignited sample and be certain to wash the crucibles for additional usage.
14. The data sheet will automatically calculate the percent organic, carbonate, and terrigenous.

7. Data Management

Data management is the practice of collecting, storing, documenting, and using data efficiently and cost-effectively. The goal of data management is to ensure data access, quality, and integrity. To prevent accidental data deletion/loss, redundant data storage will be utilized to ensure data resides in multiple places and in multiple media.

1. For this monitoring effort, data should be stored in at least two permanent repositories at all times:
    a. Durable Excel or paper field data sheets.
    b. Online Google Forms
2. A durable paper field datasheet (see section 9 below) must be filled out for the field sediment trap recovery and redeployment metadata.
3. The Nearshore Sediment Trap Monitoring Field Datasheet Google Form will be used to transcribe the trap recovery and redeployment metadata into digital media for cloud storage and can be filled out and submitted on cell phones or tablets in the field and in the lab.
4. Submitted data will be uploaded by the Data Manager to the corresponding data folder in the shared drive: Culebra Monitoring Folder > Data > Sediment
5. Populated field datasets must be signed by the sampling personnel and scanned.
    a. Hardcopies will be stored in a binder in the Protectores de Cuencas Laboratory. This binder is not to be taken to the field for sampling to prevent previous records from being damaged.
    b. Scanned field datasheets will be uploaded to the shared folder.
    c. It is also good practice to store pre- and post-sampling checklists (see below) in the data binder.
6. Sediment composition and sequential loss on ignition analysis data will be provided by the Center for Applied Tropical Ecology and Conservation analytical lab at the University of Puerto Rico. These data can be entered directly into a Sediment Composition Analysis Datasheet for cloud storage.
7. Once field and lab datasheets for each monitoring site and episode have been submitted, scanned, the Data Manager will upload them to the corresponding folder in the shared drive: Culebra Monitoring Folder > Data > Sediment
8. Together with the Data Manager, the Monitoring Coordinator will check the uploaded field and lab data for quality and integrity against the field/lab datasheets, and make modifications, corrections, and updates as appropriate. Any data changes should be communicated and discussed with the Data Manager prior to implementation.

8. Checklists

Before Trap Deploy/Recovery

Name: _________________________________ Date: __________________________

Sampling Equipment:

- ☐ Fresh water for rinsing traps
- ☐ GPS or phone with FieldMaps App
- ☐ Sharpie to mark traps
- ☐ Binder with datasheets
- ☐ Spare/replacement sediment traps
- ☐ Rebar anchors
- ☐ Hammer/pilon driver
- ☐ Zip ties
- ☐ Nemo Impact driver + bits
- ☐ Marine-grade long-nose pliers
- ☐ Marine-grade snips
- ☐ Heavy duty metal snips / Diagonal cutting pliers
- ☐ Trap top caps
- ☐ Trap carrying crate
- ☐ Measuring tape to measure length above trap and below trap
- ☐ 2 Underwater flashlights to inspect interior of sed trap
- ☐ Blue tape to secure caps of recovered trap
- ☐ Screwdriver
- ☐ Field datasheets

Personal:

- ☐ SCUBA equipment:
  - ☐ Mask
  - ☐ Snorkel
  - ☐ Fins
  - ☐ BCD
  - ☐ Regulators
  - ☐ Wetsuit
  - ☐ Gloves
- ☐ Sunscreen / hat / sunglasses
- ☐ Water
- ☐ Towel
- ☐ Disinfectant for hands

Signature: ______________________________________ Date: ______________________

After Sediment Analysis Checklist

Name: _________________________________ Date: __________________________

Laboratory Equipment Care and Storage:

- ☐ All laboratory equipment has been properly cleaned, dried, or disposed of:
  - ☐ crucibles
  - ☐ evaporating dishes
  - ☐ spatulas
  - ☐ beakers
  - ☐ filter funnels
  - ☐ filters
- ☐ Muffle furnace and drying oven are switched off
- ☐ PPE has been sanitized or properly disposed of
- ☐ All samples appropriately processed or stored for later processing

Datasheets and Data Management:

- ☐ All fieldnotes dictated and datasheets signed/dated
- ☐ All completed paper datasheets scanned and uploaded to database (CamScanner)
- ☐ All datasheets transferred to dry/secure binder
- ☐ Data inputted to appropriate data portals

Signature: ___________________________________ Date: ____________________

9. Field Datasheets

Sediment Trap Monitoring Field Datasheet

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Date______________ Time___________ Site ________________ Recorded by ______________

Tasks Completed? ☐Trap recovered ☐ Trap Deployed☐ Trap Labeled ☐ Pictures

Site Conditions:

Sea State (4 point) __________ Wind Direction (8 point) __________ Wind Speed__________ Could Cover (0-100) ______

Sediment Trap data:

Trap ID	Length of water column above of trap aperture at recovery (ft.)	Depth from bottom of trap to substrate at recovery (ft.)	Length of water column above of trap aperture at deployment (ft.)	Depth from bottom of trap to substrate at deployment (ft.)	Notes

Notes:

Sediment Composition Analysis Datasheet

Sediment Trap Composition Analysis Data Sheet				
Sample Metadata	**Value**			
Monitoring Station	LOCATION			
Date of deployment:	mm/dd/yyyy			
Date of collection:	mm/dd/yyyy			
Number of days tube collected sediment	#VALUE!			
Initials of analyst	JD			
Tube diameter (cm)	3			
Tube length (cm)	21			
		Value	**Value**	**Value**
Gross weight of sediment	**Data sheet cell number**	SiteCode-trap replicate 1	SiteCode-trap replicate 2	SiteCode-trap replicate 3
Weight of beaker for coarse sediment (g)	**Cell 1**			
Weight of beaker for fine sediment (g)	**Cell 2**			
Weight of beaker & coarse sediment after drying at 100C (g)	**Cell 3**			
Weight of beaker & fine sediment after drying at 100C (g)	**Cell 4**			
Calculated weight of dried coarse sediment (63um - 2mm) after drying at 100C (g)	**DWCoarse**	0	0	0
Calculated weight of fine, dried sediment	**DWfines**	0	0	0
Total dry weight of sample (g)	**DWtotal**	0	0	0
Trap accumulation rate (g/d-in2)	**TARate**	0	0	0
Loss on ignition				
Weight of crucible for coarse, no sediment	**Cell 5**			
Weight of crucible for fines, no sediment	**Cell 6**			
Weight of crucible + coarse sediment before baking	**Cell 7**			
Weight of crucible + fine sediment before baking	**Cell 8**			
Weight of crucible + coarse sediment after baking at 550C	**Cell 9**			
Weight of crucible + fine sediment after baking at 550C	**Cell 10**			
Weight of crucible + coarse sediment after baking at 950C	**Cell 11**			
Weight of crucible + fine sediment after baking at 950C	**Cell 12**			
Calculated values				
Weight of coarse sediment added to crucible		0	0	0
Weight of fine sediment in crucible		0	0	0
Weight of organic matter, coarse sediment		0	0	0
Weight of organic matter, fine sediment		0	0	0
Weight of carbonates, coarse sediment		0	0	0
Weight of cadrbonates, fine sediment		0	0	0
Weight of silicates, coarse sediment		0	0	0
Weight of siliates, fine sediment		0	0	0
% organic, coarse		0	0	0
% organic, fine		0	0	0
% carbonates, coarse		0	0	0
% carbonates, fine		0	0	0
% terrigenous, coarse		0	0	0
% terrigenous, fine		0	0	0
Total %, coarse		0	0	0
Total % fine		0	0	0
Create a datasheet for each monitoring station per collection period				

10. Estimated Costs

Category	Item Description	Cost per unit	Unit	Units / days	Days / Trips	# Persons	Per Year	Annual Total	Notes
Staff	Scientist	$35.00	hour	10	4	3	4	$16,800.00	Estimating 3 scientists; 4 trips a year (monthly sampling), for 3, 10-hr days and 2-half days to collect and preprocess sediment samples.
Staff	Scientist	$30.00	hour	8	5	1	4	$4,800.00	Sediment sample accumulation and composition laboratory analyses.
Travel	Ferry	$75.00	roundtrip / truck	1	1	1	4	$300.00	This accounts for costs of bringing one staff + pick-up truck with equipment. Also needed to transport sediment samples back to Yauco
Travel	Ferry	$10.00	roundtrip	1	1	2	4	$80.00	2 staff.
Travel	Gas	$150.00	truck / trip	1	1	1	4	$600.00	Estimated one pick-up truck fuel consumption from Yauco to Culebra roundtrip and within Culebra.
Travel	Lodging	$159.00	person / day	1	3	3	4	$5,724.00	Estimating that field biologists will arrive in Culebra the night before sampling, stay the night prior to the sampling and 2 nights of sampling, and then depart on the evening of the third work day.
Travel	Per diem	$105.00	person / day	1	3	3	4	$3,780.00	Estimating that field biologists will arrive in Culebra the night before sampling, stay the night prior to the sampling and 2 nights of sampling, and then depart on the evening of the third work day.
Travel	Per diem	$78.75	person / day	1	2	3	4	$1,890.00	Estimating that field biologists will arrive in Culebra the night before sampling, stay the night prior to the sampling and 2 nights of sampling, and then depart on the evening of the third work day.
Services	Vessel rental	$700.00	day	1	2	1	4	$5,600.00	Trap deployment and recovery 2 days needed.
Services	Boat captain	$30.00	hour	10	2	1	4	$2,400.00	Trap deployment and recovery 2 days needed.
Services	Scuba Tanks/refill	$50.00	day	1	2	1	4	$400.00	Trap deployment and recovery 2 days needed.
Equipment*	Laboratory equipment and supplies for sample preprocessing	$2,500.00	once	1	1	1	1	$2,500.00	Wet shakers, sieves, jars, etc.
Equipment*	Equipment Rental Fee (laboratory equipment)	$1,400.00	per sampling	1	1	1	4	$5,600.00	Sediment constituent analysis.
Equipment*	Replacement sediment trap supplies	$1,000.00	n/a	1	1	1	1	$1,000.00	PVC tubes, rings, honey comb mesh.
Total								**$51,474.00**	

* An itemized list of equipment, instruments, and supplies needed for each monitoring component can be accessed by clicking on this link (Appendix 1: Culebra LBSP Ridge to Reef Monitoring equipment, instrument, and supply budget list).

11. References

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