New Hampshire Volunteer Beach Profile Monitoring Program (VBPMP):

Implementation, Field Methods, and Data Processing

REPORT BY:

Larry G. Ward[1], Rachel C. Morrison[1], Alyson L. Eberhardt[2,3], and Wellsley J. Costello[2]

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[1]Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC)
University of New Hampshire
Durham, NH 03824

[2]NH Sea Grant and UNH Extension
University of New Hampshire
Durham, NH 03824

[3]Dept. of Biological Sciences
University of New Hampshire
Durham, NH 03824

CONTACTS: Larry.Ward@unh.edu, Alyson.Eberhardt@unh.edu

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VBPMP Volunteers

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Abstract

The New Hampshire (NH) Volunteer Beach Profiling Monitoring Program (VBPMP) monitors beach elevation profiles at multiple stations along the NH Atlantic coast on a near-monthly basis using the Emery method. The program grew from three monitoring stations in 2016-2017 to thirteen stations across six beaches in 2018, with an additional station added in 2022. The overarching goal of the VBPMP is to assess the stability of New Hampshire's Atlantic beaches over multiple years to determine seasonal changes and long-term trends using citizen science methods. Included in the assessment of beach stability are erosional or accretional trends, response to storms, and comparisons between beaches with differing morphology, sediments, and infrastructure (e.g., seawalls or dunes). Presented in this report are the methods used by the NH VBPMP for establishing profile stations, collecting beach elevation profiles based on the Emery method, recording, and uploading field data, and taking field photographs. The methods used for processing profile data after collection by volunteers is also described, including data review and quality assurance, datum corrections, plotting elevation profiles, sediment volume computation, and determination of mean profile elevations. Finally, examples of data products created for sharing with the public are presented.

Chapter 1: Introduction

NH VBPMP Background

New Hampshire's beaches and dunes are extremely dynamic systems that are constantly changing, particularly in response to storms, changes in sediment supply, anthropogenic impacts, and sea-level rise. Although beach systems have been extensively studied over the last half century, each system has a unique combination of controlling processes and environmental conditions. Therefore, there is a clear need for understanding beach systems at the local level in order to make sound management decisions and to predict the impact of storms and sea-level change. One way to accomplish this is by partnering with citizen science programs, which can facilitate long-term monitoring studies by increasing the capacity to collect data at lower costs while not compromising quality. A further benefit of this type of collaboration is the creation of relationships between scientists, the local community, and federal, state, and local government agencies charged with management, as well as increased volunteer knowledge about coastal processes and climate threats, connection to place, and motivation to take action (**Eberhardt et al., 2022**). All these factors help to build coastal resiliency.

The NH Volunteer Beach Profile Monitoring Program documents beach erosion and accretion, storm impacts, seasonal changes, and long-term trends of NH's Atlantic beaches. Volunteers collect beach elevation profiles using the Emery method (**Emery, 1961**), field photographs, and field observations at approximately monthly intervals. The Emery method is a low-cost, volunteer-friendly method for beach profiling that yields accurate and reproducible results (**Ward et al., 2021**). Data is processed by project analysts and shared with the public through a number of data products. The project workflow for the NH VBPMP is shown in **Figure 1-1.**

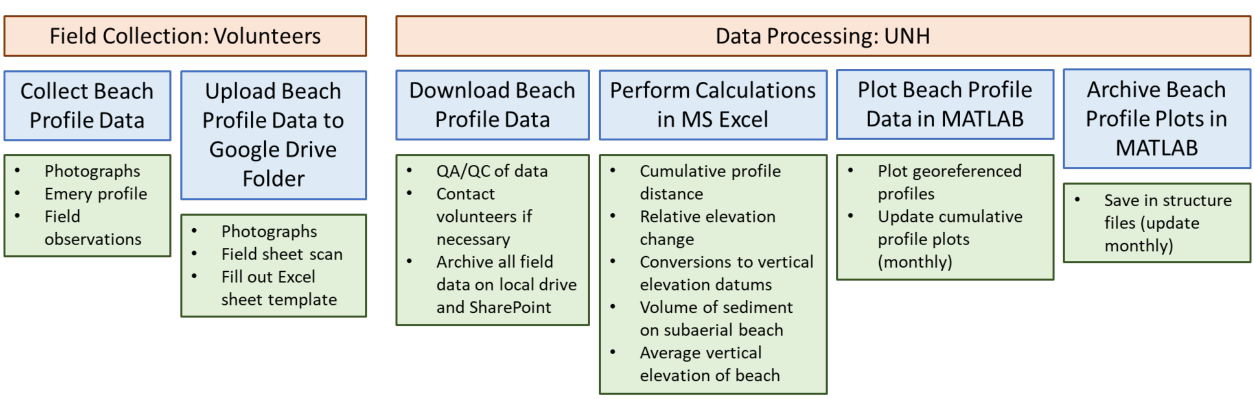


*Figure 1-1: Workflow used by the NH VBPMP describing collection, submission, and processing of the profile data each month (modified from **Eberhardt et al., 2022**).*

Development of the NH VBPMP began in early 2016 with three profile stations set up and measured by December. After a successful pilot year of collecting profile data, the program was expanded in 2018 to thirteen stations located across six beaches in order to attain more representative coverage of New Hampshire's Atlantic coast (**Figure 1-2**). A fourteenth station in the profiling network was added in spring 2022. Observations and data collected in this ongoing study provide coastal residents, beach visitors, local businesses, and municipal and state decision makers with up-to-date information on conditions and trends for guiding beach management.

Structure of the Report

This report is structured to provide a complete overview of each of the major steps used to establish the NH VBPMP station grid and field program, the field methods used, the data processing procedure, and publicly available data products. To accomplish this, each step is introduced and discussed in detail. However, in a number of instances more explanation is needed for a task than can be accommodated within the body of the report without disrupting the flow. Therefore, the report contains several appendices that provide more detail.

The following topics are presented:

Chapter 2: Implementation and Field Methods

- Selection and establishment of profile stations
- Leveling a station marker at a profile station
- Determination of profiling windows (dates and times)
- Volunteer roles for beach profiling
- Step-by-step procedure for measuring a beach profile (based on the Emery method)
- Advice on photographing the beach during each profiling period
- Procedure for uploading data and photographs for subsequent data processing

Chapter 3: Data Processing

- Downloading and archiving data
- QA/QC of data and photographs
- Calculating cumulative distance and elevation from values collected in the field
- Calculating datum adjustments of elevation values
- Calculating volume and elevation from adjusted values
- Uncertainty analysis of data

Chapter 4: Data Products and Summary

- Journal publication and reports
- Interactive website through the NHGS
- Beach Profile Report station summaries

Six appendices that include helpful checklists meant for profiling volunteers, information on how to construct profiling rods, and guidelines for taking high quality photographs of the beach.

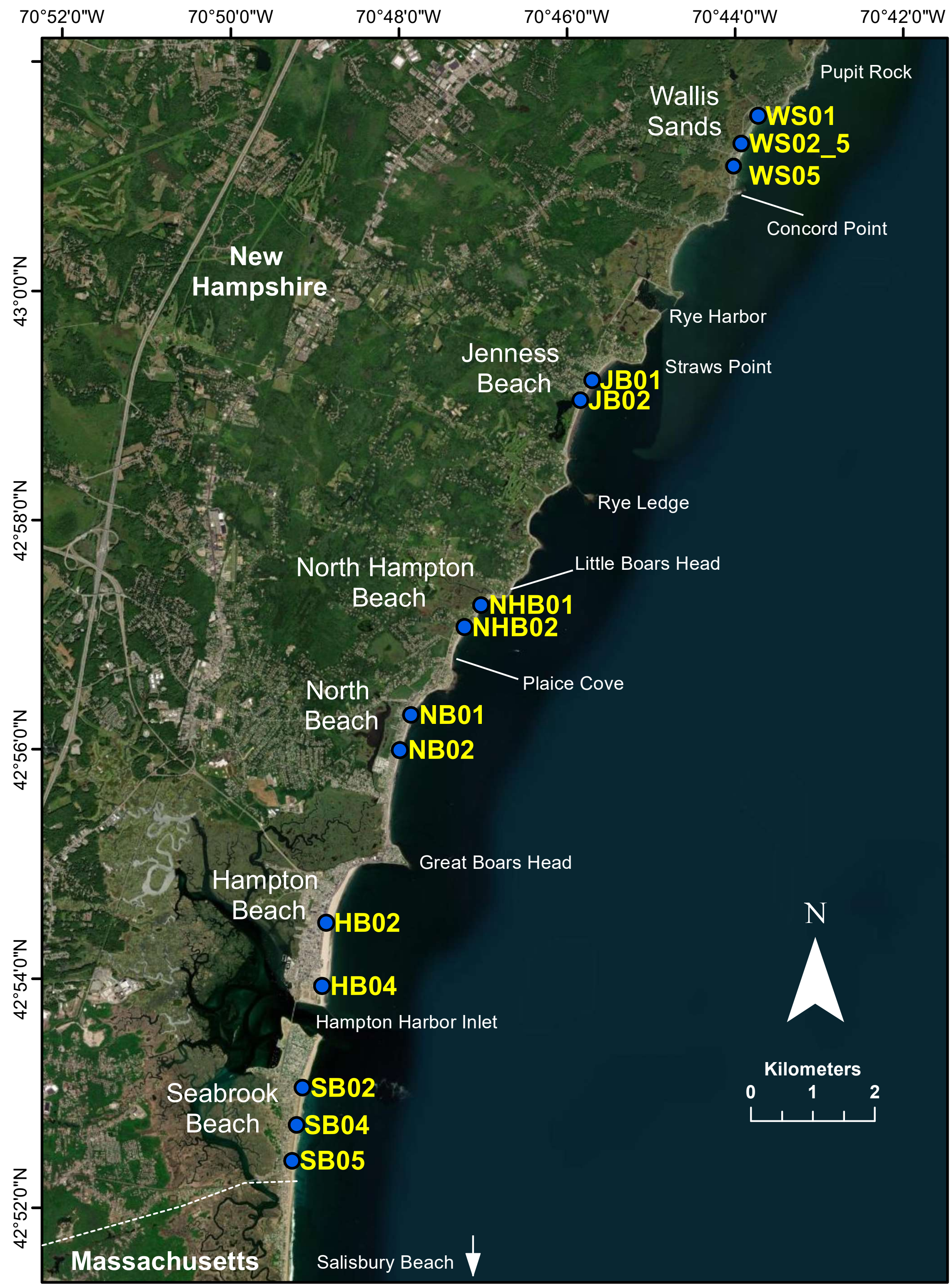


Figure 1-2: The fourteen profiling stations currently being monitored by the New Hampshire Volunteer Beach Profile Monitoring Program.

Chapter 2: Implementation and Field Methods

Determination of the locations of the NH VBPMP profiling stations was based on a number of factors including local geology and accessibility. Once stations were established and monthly profiling windows determined, volunteers collected beach profile elevation data, recorded observations about the beach, and took photographs at selected locations along the profile transect on a routine basis and periodically before and/or after storms (**Figure 2-1**).

Figure 2-1: Beach profiling using the Emery method at Seabrook Beach (upper) and Jenness Beach (lower), NH in 2018.

Establishing Profiling Stations and Field Preparation

The following chapter describes how station locations are chosen, how station markers and transects are located and established, how station markers are subsequently leveled and tied into datums, and how profiling windows are chosen (dates and times).

Selection of Beach Profile Stations

Many factors must be considered when selecting the location of profile stations. Since the number of locations that can be monitored for an extended period is limited, the needs of each beach in the study area must be considered. Factors such as use of the beach by the public, density of development adjacent to the beach, potential for storm damage to infrastructure, the impact of past erosive events (e.g., flooding), and the likely impact of sea-level rise all play a role in prioritizing locations to be studied. Along with the preceding list, the potential need for beach nourishment should be taken into consideration. Monitoring will help identify those beaches with the most urgent need for sand replenishment should opportunities arise.

Once the beaches have been prioritized for monitoring, morphologic and sediment types should play a role in locating the profile stations. Selected profile sites should be representative of the entire beach if possible. This includes considerations of wave refraction patterns (such as those that would occur next to headlands or shoreline protection structures), which may cause morphologic and sedimentologic differences at that specific location from the rest of the beach. Finally, it is important to ensure there are no offshore features (e.g., islands) that may obstruct the visibility of the horizon.

The previous paragraphs outline the research-motivated factors for selecting beach profile station locations. Final decisions, however, must be determined by considering accessibility by volunteers during all seasons, safety of the personnel, and availability of locations where permanent stations can be established and where permissions can be obtained from landowners, towns, or the state.

Establishing a Profile Station: Transect, Station Marker, and Back Site

As discussed above, two key criteria for establishing a beach profile station are ensuring that a suitable profile transect can be established, and that volunteers have easy and safe access to the station. When using the Emery method for beach profiling, installing permanent station markers in suitable locations is extremely important since the beach profile will always originate at this point and all subsequent measurements are made relative to the marker. Station markers should be installed on the landward boundary of the beach (seawall or dunes) in an area that will be accessible year-round including following stormy periods. In addition, a permanent feature landward of the station marker is required that is visible along the entire transect from the dunes or seawall to the water line that when aligned with the station marker forms a shore-normal transect across the beach. Stations located at seawalls are often backed by roads and infrastructure, so the simplest point of reference is often a chimney, telephone pole, or some type of prominent structure (**Figure 2-2**). At dune stations, the reference point can be established by installing a second wooden stake landward of the station marker (**Figure 2-3)**. This second stake also acts as a backup marker in the event the seaward stake is lost during storms or due to vandalism.

The landward boundary of most NH Atlantic beaches is formed by seawalls (**Blondin, 2016**). The exception to this is the southern end of Hampton Beach and much of Seabrook Beach, which have extensive vegetated dunes. Therefore, two types of station markers are used for the NH VBPMP depending on the location.

Station transects with a seawall at the landward boundary are marked by painting a black circle (~ 5 cm) on the wall (**Figure 2-4)**. Preferably, the mark is placed on the top of the seawall, provided the wall is low enough to allow a beach profiler to have an accurate line-of-sight with the horizon from behind the wall to make the first measurement of the beach profile (**Figure 2-5**). It is often helpful to place a reflector stake (or similar object) at the marker location so that it is visible across the entire beach.

If a seawall is too high to have an accurate line-of-sight with the horizon from behind the wall, it will not be a suitable station marker (**Figure 2-6**). However, if there is a protrusion from the front of the wall (e.g., drainage grating), it may suffice as a station marker if the feature is stable, is at an elevation that allows line-of-sight with the horizon, has an identifiable back site, and if there is enough space for a beach profiler to stand behind and/or off to the side of the protrusion to make the first profile measurement. Similarly, if there is a stairwell in the seawall, then a marker can be placed on a column or railing (**Figure 2-6)**. In this case, the procedure is similar to using the top of the seawall. Again, there must be an accurate line-of-sight with the horizon from behind the column.

In some locations, beach erosion and accretion patterns can cause the sediment level to fluctuate dramatically at the station marker, particularly at seawall stations where natural sediment movement is hindered. These conditions can occasionally make it difficult to measure the distance from the station marker to the sand or gravel surface using only the height of a single profiling rod. At one station such as this (North Beach station NB02), the NH VBPMP has drawn a line on the seawall exactly 1 meter down from the station marker. This allows the volunteers to measure just the distance from the 1-meter mark down to the beach surface (and simply add 1 meter to this measurement) (**Figure 2-7)**.

When the landward station boundary is defined by dunes, a wooden stake is driven into the beach dune margin or foredune ridge (**Figure 2-3)**. The top of the wooden stake is defined as the station marker. The stake height must be low enough for the beach profiler to see over the stake to start the profile, and high enough so that it is accessible under both erosional and accretional conditions so that it will not become buried in sand (**Figure 2-8**).

Figure 2-2: Example of aligning a station marker and a "back site" point of reference at a seawall station. Left: the bottom arrow points to the station marker (black dot on wall) and the top arrow points to the back reference site (telephone pole). Right: the corresponding shore-normal transect down the beach resulting from the alignment of these two reference points. Note the reflector stake placed at the station marker for better visibility.

Figure 2-3: Example of aligning a station marker and a "back site" point of reference at a dune station, where the lower two circles mark the two dune wooden stakes (station marker and reference stake), and the upper circle marks an additional back site (chimney on house behind dunes).

Figure 2-4: Black painted circle on top of a seawall indicating the station marker location.

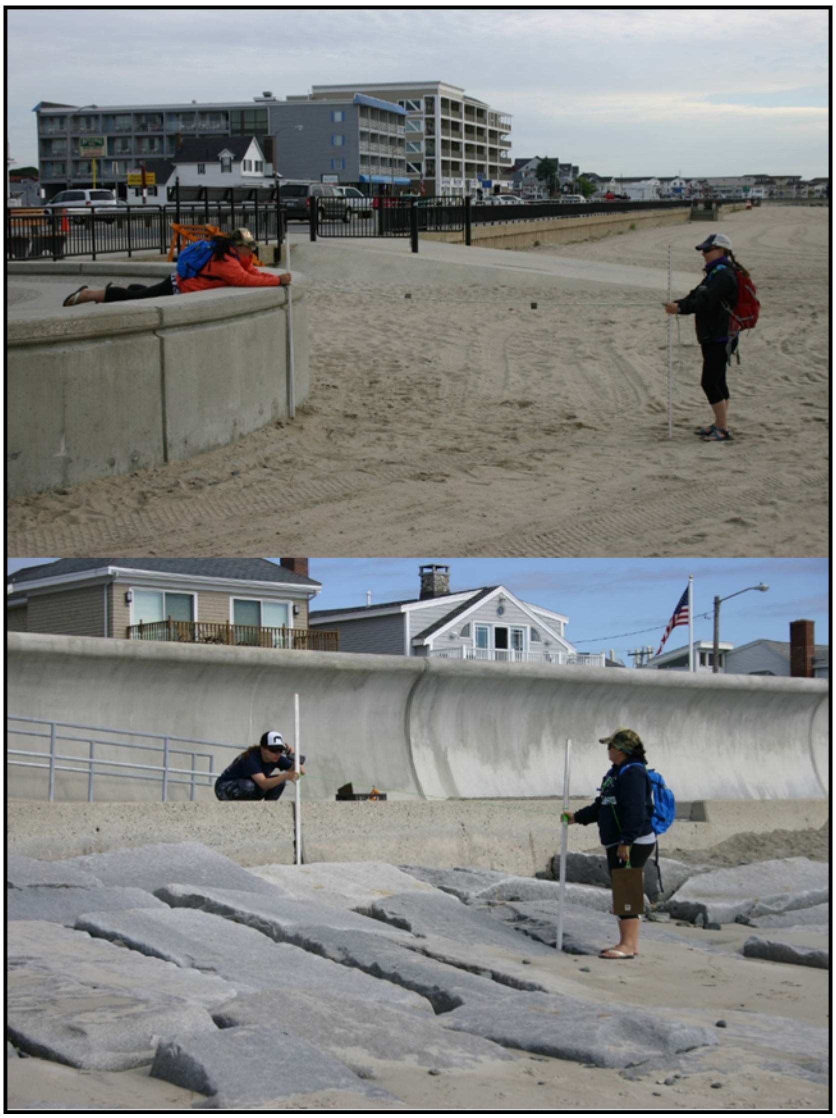


Figure 2-5: Profilers completing the first jump of a profile, which begins at the station marker (e.g., seawall). The station marker must be placed somewhere where the landward profiler will always have sufficient line of sight over the top of the marker, whether that is on top of a permanent seawall, or above the top of a stake in the dunes.

Figure 2-6: Example of a location where the seawall is too high to place a station marker (the seawall shown above is at North Beach, NH). In this case, a staircase at the base of the wall provides a good alternative to place a marker (see yellow arrow in bottom figure, which is pointing to a black mark on the corner of the concrete staircase). As seen in the lower figure, there is also enough space behind the edge of the wall to create a line-of-sight with the horizon for the first measurement.

Figure 2-7: To facilitate measurements at a station where the sand surface height changes significantly (and becomes too low to measure with a single profiling rod), the NH VBPMP has added a 1-meter mark on the seawall (arrow). The volunteers measure only from this line down to the sand.

Figure 2-8: First measurement at a dune station starting from the wooden stake in the foredune ridge. The stake is low enough for the profilers to see over the top, but high enough that it does not become buried in sand deposited in the dunes. The profile rod is placed against the wooden stake (arrow) by the landward profiler.

Leveling Station Markers

Once a suitable profile transect is located, a station marker established, and a back site identified, the position and elevation of the station marker must be determined. Accurately knowing the station location (e.g., latitude and longitude) allows the beach profile to be placed in spatial or coordinate reference systems. When the station marker is tied into a standard elevation datum, the relative elevation changes measured using the Emery beach profile method can be converted to standard elevation datums such as NAVD88, MLLW or the WGS84 or IGS08 ellipsoid. Additionally, accurately determining the position and elevation allows the station marker to be recovered and reestablished if it is lost due to storms or vandalism.

The station marker locations and elevations for the NH VBPMP were determined using the Global Navigation Satellite System (GNSS) tracked with a standard high precision receiver and antenna. (**Figure 2-9**). Raw data were post-processed with Continuously Operating Reference Stations (CORS) differential correction data. The CORS located in either Salisbury, MA or Durham, NH were used for the NH VBPMP stations. The elevations were determined in reference to the ellipsoid (WGS84) and adjusted to NAVD88, Mean Water Level (MWL), and Mean Lower Low Water (MLLW) referenced to NAD83 (1986) using VDatum (NOAA NOS, accessed January 2023; http://vdatum.noaa.gov/).

Figure 2-9: Leveling of a dune stake station marker (bottom arrow points to the wooden stake in the dunes) using GNSS antenna and receiver systems (top arrow).

Determining Profiling Windows

To maximize beach exposure and ease of running elevation profiles, field work is scheduled based on several criteria. First, ideal days for field work are during periods when low tides are at the lowest point of the month (typically spring low tides). The second requirement is that there is sufficient daylight for profiling and clearly seeing the horizon. Third, the profile should be collected when the beach is not so crowded that running the transect is difficult (e.g., due to sunbathers in the profile path interfering with measurements). It is important not to disrupt the users of the beach, so avoiding this conflict is the best option. Finally, the profile needs to be run within one hour before or after low tide. Despite these restrictions, several days each month can usually be identified that meet the standards. However, if some of these conditions are not possible, then the best tides available should be used. These options for profiling days (windows) should be provided to the volunteers to allow some flexibility in scheduling (usually within a period of 3 to 5 days).

Additional profiling times should periodically be identified if major storms, flooding, or washover events are predicted or have recently occurred (e.g., before and after significant events). In these cases, the best times available should be used even if the criteria presented above cannot be met as it is important to document potential erosional events when possible. Scheduling additional times has to be balanced against availability and interest of the volunteers.

The criteria for selecting sampling windows, times, and frequency described above has worked well for the NH VBPMP. The profiling days and times or "profile windows" are determined using NOAA's Tides and Currents predictions tool (NOAA CO-OPS, accessed January 2023; https://tidesandcurrents.noaa.gov/).

Measuring a Beach Elevation Profile

The Emery method measures an elevation profile of the beach from the foredunes or seawall to the low water line along a shore-normal transect. Two calibrated rods and the horizon are used to determine relative elevation changes from the starting point (station marker) to the end of the profile (**Figure 2-10)**. The first measurement is the vertical distance from the station marker to the beach surface directly below. Subsequently, the relative difference in elevation (topographic change) between the profile rods is determined for each movement of the rods or "jump" from the starting point to the low water line. The cumulative sum of distance and relative changes in elevation defines the beach elevation profile. Since the station marker's position and elevation datum have been determined, the beach profile can then be tied into a datum by adjusting the first elevation.

Roles of the Personnel Running an Emery Profile

Ideally, measurement of beach elevation profiles when using the Emery method is conducted by three volunteers. Experience has shown that most volunteers prefer to perform the same task for each session, although all volunteers should be trained to be able to perform all tasks. This is important in the event a team member is absent and only two people are able to run the profile or if an inexperienced substitute is used who does not know the full routine. During field days with a full team, one volunteer handles the landward profile rod and is responsible for correctly placing the profile rod in the right position for each jump. The seaward profiler places the seaward rod in line with the station marker and back site to be certain the profile is "on the transect". The third volunteer is responsible for recording data, ensuring that the profiling rods are perpendicular to the beach surface, the rope is taut during measurements, and the profile remains on the transect. It is critical for QA/QC that the data recorder is vigilant in checking all these criteria consistently to ensure high quality data collection. The data recorder also generally collects the photographs. If only two profilers are available on a given day, the data can be recorded by either the landward or seaward person. See **Appendix 1** for complete descriptions of team roles.

Figure 2-10: Volunteers profiling using the Emery method. Note that profile rods are vertical, and the rope is pulled taut.

Pre-Profiling Procedure

Prior to beginning the beach profile, the following steps must be complete to ensure accurate data collection:

1. **Confirm horizon visibility.** If the horizon is not clearly visible or is compromised ("false horizon"), the vertical elevation measurements will not be accurate, and the profile will be unusable. The profile should not be run in this case, and an alternative profiling window must be chosen. It is good practice to check the visibility of the horizon with online beach webcams if available before leaving for the field if conditions appear marginal (see section *Suggestions for Unexpected Beach Conditions*). However, final decisions must be made on site. Field photographs are used during the QA/QC process to confirm the horizon visibility during data processing.
2. **Prepare data sheet**. Basic information needed for collecting a profile should be filled out on the field data sheet to ensure all entries are completed. Basic metadata includes beach and profile station name, date, names of people profiling, horizon visibility, and profiling times (**Figure 2-11; see Appendix 2 for complete data sheet**).
3. **Measure distance between profile rods.** Experience has shown that the distance between profile rods should be verified before each profiling period. Although actual changes in the distance are extremely rare (the rope should not stretch), slippage of fasteners or knots can occur. The measurement is taken from the *front* of one rod to the *front* of the other profile rod (the length of the rope as well as the width of *one* rod). The rope should be pulled taut when measuring.
4. **Measure distance from the station marker to the beach surface**. It is critical that the distance between the station marker and the beach surface (directly below the marker where the profile will begin) is accurately measured and recorded (**Figure 2-12**). All measurements for the elevation profile are made relative to this point. If there is an error in this measurement, then the entire profile will be in error. The distance between the station marker and the beach surface can be measured with a tape measure or with a profiling rod (held upside down so the scale begins at zero on the sand surface) (**Figure 2-12)**. A clipboard or the other profile rod is a good tool for getting a level measurement relative to the station marker (**Figure 2-12**).
5. **Photograph station marker and elevation measurement**. Experience with data processing has shown that having a photograph of the station marker (showing the sand level at the base) and the measurement with the profiling rod or tape measure is extremely useful for the QA/QC process (**Figure 2-12**).
6. **Verify the location of the transect line**. In order to maintain the same transect line every profiling period, it is important to ensure that the station marker (seawall mark or seaward dune stake) is always in alignment with the respective landward reference point or back site when moving down the beach. A helpful tool on very wide or steep beaches (where the front and/or back site may become hard or impossible to see) is placing several temporary reflector stakes into the sand before beginning the profile (**Figure 2-13**). Be certain to carefully align all the stakes with the front and back sites.

Additional information and materials provided to volunteers can be found in the Appendix. These include descriptions of "Team Roles" (**Appendix 1**), a copy of the "Beach Profile Data Sheet" used in the field (**Appendix 2)**, instructions on how to create beach profiling rods (**Appendix 3**), a "Quick Beach Profiling Checklist" (**Appendix 4**), "Volunteer Position Descriptions" (**Appendix 5**), and a "Guidebook for Beach Profiling Photographs" (**Appendix 6**).

New Hampshire Volunteer Profile Network Log Sheet

Beach Name ____________________ Profile Station____________________ Date ________________

Team Member Names ____

Horizon visibility: Good [ ] Poor [ ] Start Time____________ End Time___________

For seawall sites:
Station marker to sand or gravel distance ______________ * this is the starting point
Use a clipboard or profile rod as an aid to ensure a level reading if needed.

For dune sites:
Measure both wooden stakes. landward/west________ seaward/east________

Vertical Units ____________ Horizontal Units __________ Rope length ___________
(With cord taut, measure from front side to front side of each profiling rod)

* If the landward rod is higher than the seaward rod (-)
* If the landward rod is lower than the seaward rod (+)

#	Horizontal	Vertical	Notes	19			
1				20			
2				21			
3				22			
4				23			
5				24			
6				25			
7				26			

Figure 2-11: Example of field data sheet used by volunteers in the NH VBPMP. The top of the data sheet is used for recording the beach name, volunteer names, date and times, whether or not the horizon is visible, and station marker heights. The bottom of the data sheet is used for recording horizontal and vertical measurements from the landward boundary to the water line.

Figure 2-12: Photograph showing how to measure the distance from the station marker to the beach surface. The inset shows the mark on the seawall indicating the station marker location. The rod is placed upside-down to measure the distance from the sand surface. The second rod is being used to create a flat surface on top of the seawall for an accurate measurement.

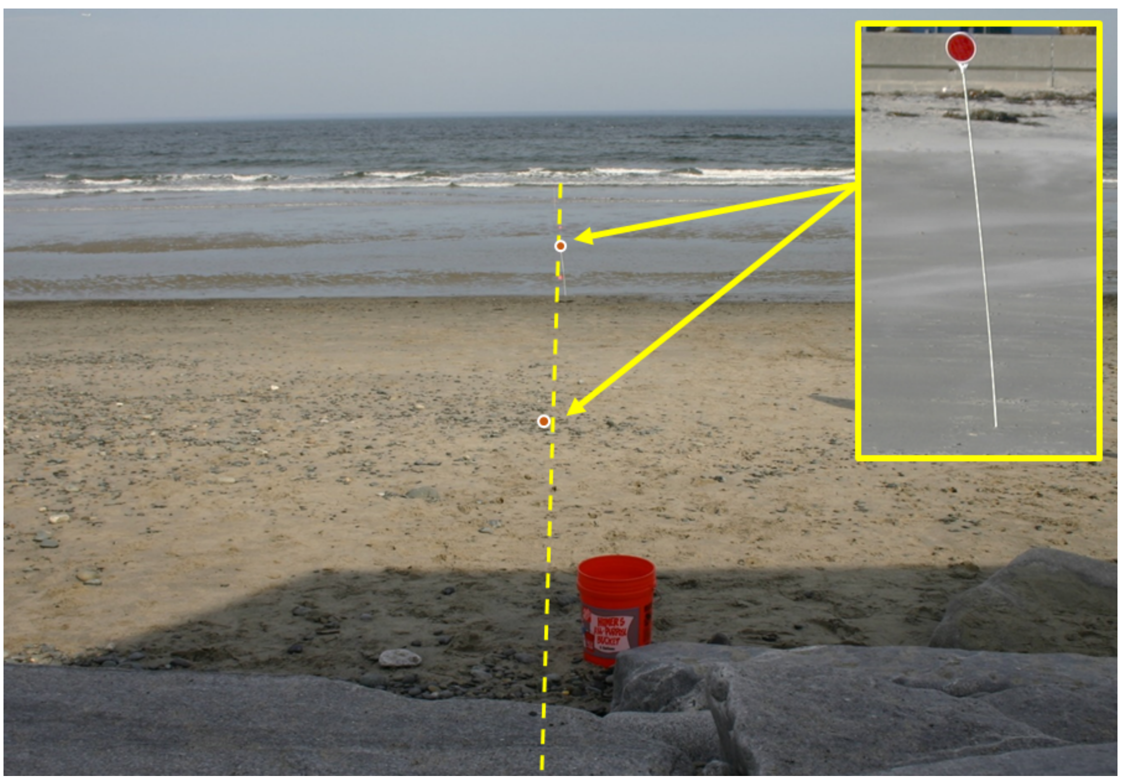


Figure 2-13: Reflectors placed at several locations along a transect at North Beach, NH before running an elevation profile. The reflectors were carefully aligned with the station marker and back site to define the transect as an aid for the profilers.

Step-by-Step Guide for Beach Elevation Profiling Using the Emery Method

The following steps outline the Emery method for beach elevation profiling. Suggestions are provided for collecting accurate profiles based on experiences from the NH VBPMP.

1. **Starting the profile at the station marker.** Once the distance from the station marker to the beach surface has been measured (as described in the **section *Pre-Profiling Procedure***), the landward profile rod should be placed on the beach directly below the station marker. The seaward rod is moved along the profile transect until the line (rope) connecting the profile rods is pulled taut (**Figure 2-14)**. The station marker and the back reference point (as well as the reflectors placed along the beach, if used) should act as a guide to stay on the transect. The profiling rods should always remain straight and perpendicular to the sand surface so the relative elevation differences between the rods is accurate. A bubble level can be attached to the profile rod to help with the vertical alignment.
2. **Measuring the relative elevation change of the first "jump."** The relative elevation change between the two profile rods is determined by sighting the plane formed by the horizon with the lower of the two profile rods and finding where this plane intersects the higher of the two profile rods. This value is the relative difference in elevation between the two profile rods and the relative change in elevation of the beach at that location. If the landward profile rod is higher than the seaward profile rod, then the beach is sloping downward, if the landward profile rod is lower than the seaward profile rod, then the beach is sloping upward, and if the rods and the horizon are all level, then the beach is flat. This is explained in more detail below and in **Figure 2-15.**
    a. ***When the landward profile rod is higher than the seaward profile rod (downward slope of the beach)***
    Standing behind the landward profile rod, the beach profiler lowers their eye level until the top of the seaward profile rod is level with the horizon. The imaginary line made by aligning the horizon with the top of the seaward rod will intersect the landward profile rod. The corresponding value read off the landward rod is the relative difference in elevation between the profile rods (and hence the beach) for that jump. The measurement is recorded on the data sheet as a negative (-) number. This is the condition across much of the beach.
    b. ***When the seaward profile rod is higher than the landward profile rod (upward slope of the beach)***
    Standing behind the landward profile rod, the beach profiler lowers their eye level until the top of the landward profile rod is level with the horizon. The imaginary line made by aligning the horizon with the top of the landward pole will intersect the seaward profile rod. The corresponding value read off the seaward rod is the

relative difference in elevation between the profile rods (and hence the beach) for that jump. The measurement is recorded on the data sheet as a positive (+) number. This typically occurs on the upper beach before reaching the berm, at a bar migrating across the lower beach, or when an artificial berm is present.

c. ***When the seaward profile rod and landward profile rod are level (no change in the slope of the beach)***

   If the top of both profile rods and the horizon are aligned and form a plane, the beach is level and there is no elevation change occurring. In this case, the recorded data point for the jump is "0" (no sign).

Note: It is crucial that all data is recorded with the correct sign.

Figure 2-14: The first measurement or "jump" of a profile, where the landward rod begins at the station marker. Both rods are perpendicular to the sand surface and the rope in between is pulled taut. In this case, the slope of the beach is downward, and therefore the elevation measurement will be negative.

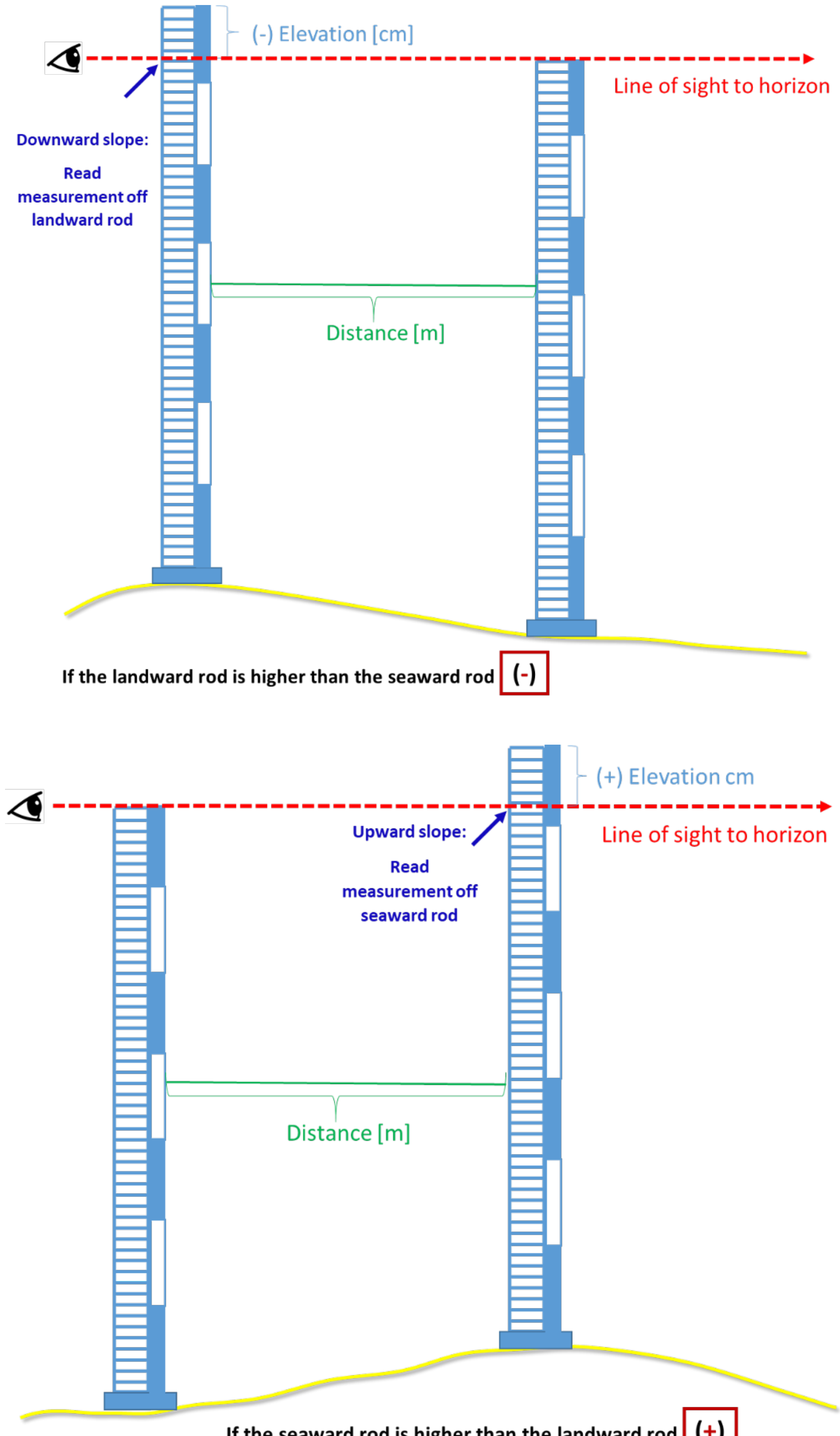


Figure 2-15: Graphic depiction of negative (top; downward slope) versus positive (bottom; upward slope) measurements. The profiler holding the landward rod (left-hand side) records the measurement.

3. **Continue to the next "jump."** To continue with the profile measurements, the landward rod should be moved to occupy the same "footprint" as the seaward rod (**Figure 2-16)**. Once the landward rod is ready to be placed in its new position (so this "footprint" is not lost), the seaward rod can then be moved again towards the ocean, aligned on the transect, and the rope pulled taut before being placed down on the sand. The volunteers should walk next to the profile line rather than on top of it. The next elevation measurement can then be taken.
4. **Collect subsequent "jumps" to complete the profile.** Relative elevation change is measured at each "jump" along the transect until the water line is reached. The final measurement should be taken as close to the water line as possible (the longer the profile the better). The "End Time" should be filled out on the data sheet.
5. **Record observations along the beach.** A "notes" column should be provided on the data sheet for recording observations at a specific jump or of the overall beach (e.g., sediment type such as gravel or sand, unusual features such as bulldozer tracks or human-made berms, evidence of recent storm activity such as seaweed and exposed pebbles, or estimated thickness of snow or ice that cannot be removed). It is also helpful to note basic features such as "berm," "wrack line," etc. (see **Appendix 2** for definitions of terms provided with the data sheet).

Figure 2-16: Continuing to another "jump." The landward profiler places their profiling rod in the same footprint as the seaward rod before the seaward profiler continues down the beach to align the profile rod for the next "jump" along the transect.

Suggestions for Unexpected Beach Conditions

1. **Questionable weather.** If the weather looks questionable and there is concern the horizon will not be clearly visible, beach webcams are a good resource to check before leaving for the field (particularly for volunteers who travel longer distances). These types of webcams are now very common in coastal areas for recreational purposes and can be found by searching the internet for beach webcams with a general location.
2. **False horizon.** Some weather conditions may produce what is known as a "false horizon," such as when low clouds, a layer of fog, or sea mist are present (**Figure 2-17**). It is crucial that a clear horizon is viewable or significant errors will occur in measuring relative changes in beach profile elevations. If the horizon is questionable, the profile should not be run.
3. **Snow on the beach.** If snow is present, it must be removed so that the profiling rods can reach the sand surface for the most accurate measurements (**Figure 2-18**). If this is not possible, the rods can remain on top of the snow/ice, but the thickness must be estimated at each jump and noted on the data sheet.
4. **Need for shorter or longer jumps.** In some cases, unexpected and disruptive features or morphology may make it difficult to complete a full jump (e.g., steep mound of sand or gravel against seawall that is less than a full jump's length, large hole on the beach, or a human-made berm). If these situations occur, a more accurate measure of elevation change can be obtained by shortening the horizontal distance between the profile rods and making smaller jumps. A tape measure can be used to determine the length of the altered jump (**Figure 2-19)**. Conversely, longer jumps can be made if a spare profile rod is available or if the profile rod set is separated. The new distance between the profile rods must be carefully recorded on the data sheet.
5. **Deep pools of water along profile.** Data must be collected continuously across the beach regardless of any ponded water above the low tide line. If the beach elevation profile cannot be completed with continuous jumps, it must be stopped. If a beach has ponded water behind ridges or other locations, be certain to always have boots available.

Figure 2-17: Example of an unclear or false horizon. Although the weather is favorable, the horizon is fuzzy due to sea mist or fog, and makes for questionable profiling conditions.

Figure 2-18: Snow was removed in order for the profile rods to reach the sand surface.

Figure 2-19: An example of how to measure a short jump. A measuring tape is used here to measure the distance between the profile rods.

Photographing the Beach

High quality photographs taken at specific and consistent locations on the beach during field work provide critical information for interpreting profile data and for QA/QC purposes. Photographs of the condition of the beach, the distance from the station marker to the beach surface, any unusual features, any human-made changes to the beach, and the clarity of the horizon are very helpful for understanding profile features and identifying problems that require further inquiry. The NH VBPMP maintains a photographic time-series for each profile station. Guidelines and photograph locations used by the NH VBPMP are listed below and shown in **Figure 2-20**. Additional information on photographing is available in **Appendix 6.**

Suggested Locations to Photograph

1. Photograph the measurement of the distance between the station marker and the beach surface (**see Figure 2-12)**.
2. Photograph the beach from the station marker, looking parallel along the seawall or dunes in both directions (up and down the beach), as well as looking seaward along the profile transect (90^{o}).
3. Photograph the beach from ~10 to ~50 m away from the station marker along the seawall or dune-beach boundary at a location where the profile transect is visible (rather than directly on the profile line). Photographs should be taken of the landward boundary, and at 45° and 90° angles across and down the beach (to capture the length of the transect).
4. Photograph the beach along the transect in all four directions roughly 1/4, 1/2, and 3/4 (close to water line) of the distance from the station marker to the low tide line. At each of these sites, photograph the beach landward, seaward, up, and down the beach. These locations should be as consistent as possible during each profiling period to facilitate month-to-month comparisons or a time series.
5. Photograph all interesting features or observations during that profiling period.

Advice for Good Photographs

1. Photographs should be taken in *landscape* orientation whenever possible to acquire the widest coverage of the beach. An exception is the photograph taken of measuring the distance between the station marker and beach with the profile rod, which is better shown in portrait mode due to the vertical profile rod.
2. Photographs should include more of the beach than the sky in the frame (e.g., 2/3 beach and 1/3 sky).
3. The camera should always be held level when taking photographs. This makes it possible to distinguish slopes (rather than a photograph angled in the same direction as the slope of the beach) and improves the aesthetic value of the photograph. When facing the horizon or landward boundary, that surface should be level in the photograph.

4. If using a smartphone, enabling the internal camera gridlines can assist in aligning the photograph to be 2/3 beach and 1/3 sky, and to ensure the photograph is level. To set up gridlines on your phone, go to Settings, tap Camera, and then enable the Grid option.

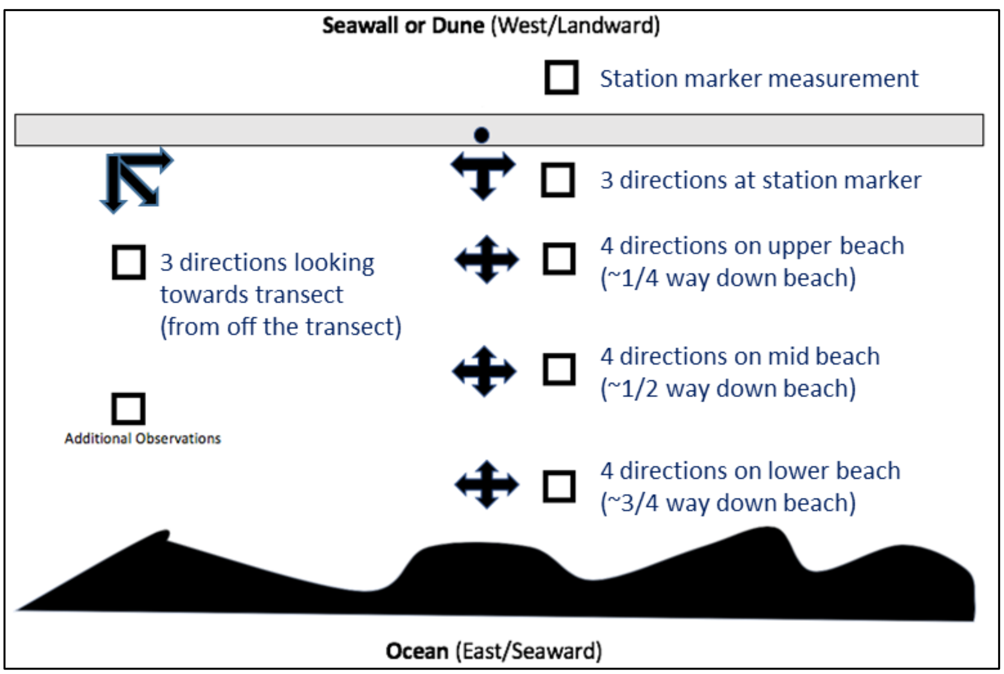


Figure 2-20: Example of approximate photograph locations. The top figure shows a satellite image of the beach at station Hampton Beach HB04, with camera icons depicting suggested photograph locations and blue triangles representing the two dune marker stakes. A diagram of the general photograph locations and directions suggested for the volunteers of the NH VBPMP is shown in the bottom figure.

Data Uploading by Volunteers

The NH VBPMP uses Google Drive for the volunteers to upload field data and photographs. Google Drive is easily accessed, free, and user-friendly. Data folders and digital data sheets are set up by the project team for the volunteers to update after each profiling period. The process used by the NH VBPMP is listed below.

1. **Field data sheet.** A scan or photograph of the field data sheet must be uploaded to safeguard against losing any data and for verifying the digital uploads.
2. **Digital data sheet.** A digital "Beach Profile Data Sheet" is provided for the volunteers to fill out. All information from the field data sheet should be transferred to the online data sheet, including notes and observations.
3. **Field photographs.** All photographs should be uploaded to the online platform for QA/QC and to act as an archive of beach conditions over time. It is helpful if the photographs are annotated as well.

Chapter 3: Data Processing

The field data, notes and photographs uploaded to Google Drive by volunteers are downloaded by project analysts. Subsequently, the beach profile elevation data and photographs are subjected to a rigorous quality assessment. Any questions or uncertainties are dealt with before processing. Once any issues or discrepancies in the data have been eliminated, the beach elevation profiles are referenced to elevation datums, processed for beach profile plotting, and calculations are performed for beach sediment volume and mean profile elevation (**Figure 3-1**). After the data has been verified and processed, it is uploaded to Microsoft SharePoint, the online document management and storage system for the University of New Hampshire, for long-term storage or archiving.

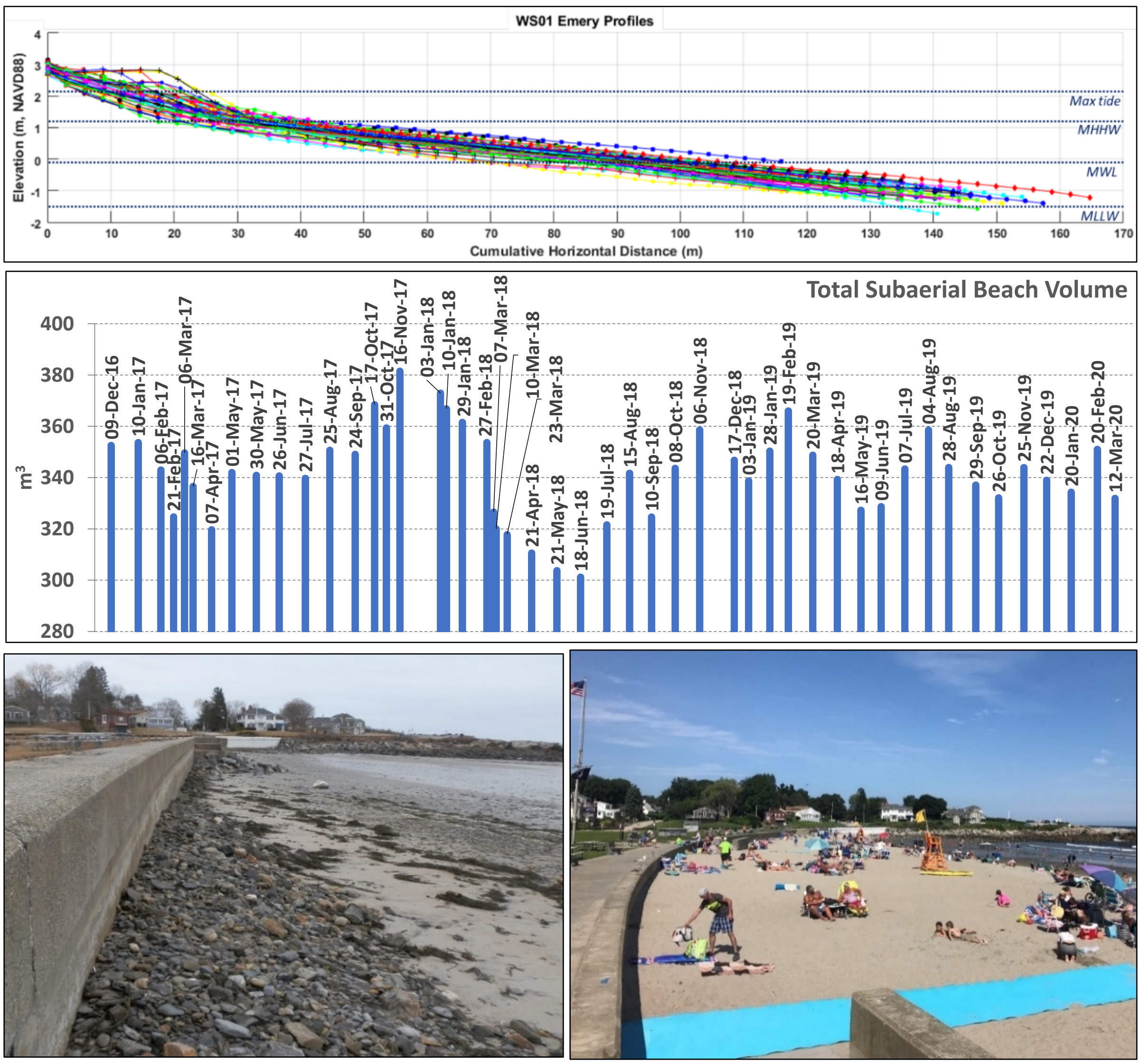


Figure 3-1: Examples of plotted beach profiles, sediment volume calculations, and field photographs from Wallis Sands, NH.

Tracking Data Collection and Processing

Due to the large volume of data generated by monthly profiling at fourteen profile sites for multiple years, it is important to track the collection and processing of the database. The NH VBPMP maintains a careful record of fieldwork performed and data uploads, processing, and archiving in an Excel spreadsheet, which is updated frequently by project analysts in a UNH SharePoint folder. An example of the tracking spreadsheet is presented in **Figure 3-2.**

Beach	Station	Profiling Date	Scan of Datasheet in Box (UNH)	Scan of Datasheet in CCOM Archive	Photos of Profiling in Google Drive	Photos of Profiling in CCOM Archive	Original Excel Sheet on Google Drive	Original Excel Sheet in CCOM Archive	Does Scan Match Excel Datasheet?	Reformatted Excel Sheet in CCOM Archive	Profile-Georef erenced (.csv)	Archived in (.mat)	Plotted in (.fig)	Volume Calcualtions for the Profile	NHGS Profile and Volume Sheets Updated	Status Comments
Wallis Sands	WS01	20210110	y	y	y	y	y	y	y	y	y	y	y	y	y	All Set
Wallis Sands	WS01	20210206	y	y	y	y	y	y	y	y	y	y	y	y	y	All Set
Wallis Sands	WS01	20210305	y	y	y	y	y	y	y	y	y	y	y	y	y	All Set
Wallis Sands	WS01	20210329	y	y	y	y	y	y	y	y	y	y	y	y	y	All Set
Wallis Sands	WS01	20210428	y	y	y	y	y	y	y	y	y	y	y	y	y	All Set
Wallis Sands	WS01	20210527	y	y	y	y	y	y	y	y	y	y	y	y	y	All Set

...continued from above

Figure 3-2: Record maintained by the NH VBPMP to track the processing status of profile data.

Quality Assurance/Quality Control (QA/QC) Procedures

All downloaded data are reviewed for discrepancies or errors between the field data scans or photographs uploaded by the volunteers and the values entered into the online (Google Drive) spreadsheet. The data is also reviewed for anomalies in measurements or beach conditions. The VBPMP uses the following checklist for QA/QC:

1. All photographs are examined to ensure the horizon was clear during profiling. The volunteers are asked to record weather conditions during profiling (cloudy, foggy, rain).

   If the horizon is not clearly visible, the relative elevation changes recorded by the volunteers may not be accurate (artificially too high or too low), and the profile data may need to be discarded. In these cases, the data are flagged and a determination made on the acceptability of the data based on further review of photographs, comparisons to other photographs collected on the same day at other stations, volunteer notes, or anomalous trends. Volunteers may be contacted for specific questions.

   Note: If photographs are provided in HEIC format (common image format from iPhones), it is helpful to convert them to a standard image format. At present, the VBPMP is using iMazing HEIC Converter to convert photographs taken in HEIC format to a JPEG or PNG.

2. The distance from the station marker to the beach surface measurement, which is critical for the profile, is verified from the field photographs and data sheet. In addition, month-to-month trends are reviewed.

   If there are large changes in the distance between the beach and station marker between profiling dates, the field photographs are reviewed and general conditions of the beach assessed. Very different values usually indicate accretion or erosion of sand at the seawall or dunes. The data entered by the volunteers in the online Google Drive spreadsheets are verified against the field sheet scans to ensure all data was entered correctly, including positive and negative value signs.

   Any errors found are corrected on the downloaded copy of the spreadsheet. If one horizontal "jump" (indicating the movement of the profile rods across the beach) is incorrectly entered, all subsequent values will be affected, so it is important to check every value. It is good practice to also make note of any corrections made.

3. All numeric unit values are verified.

   Prior to processing data, it is important to verify that all data recorded used the correct units (rope length, horizontal distances, station marker height, etc.).

4. Verify all "jump" distances were entered correctly.

   Although it is unusual, the distance of a "jump" or forward movement of the profile rods while running a beach profile may vary from the set distance (~3 m). This may occur if the profilers found that a shorter or longer jump was necessary at some point along the profile.

Processing Elevation Data, Datum Adjustments, and Volume and Elevation Calculations

Processing the profile elevation data involves several steps. First, the cumulative distance and elevation along the profile transect (relative to the station marker) is calculated by summing the horizontal distance and relative elevation changes for each "jump" or movement of the profile rods. The second step is converting the relative elevation values to standard elevation datums (e.g., NAVD88, IGS08, and MLLW). Next, the total beach sediment volume above approximately MLLW is calculated along a standard length of the profile. Finally, the mean elevation of the profile is computed. These analyses allow for month-to-month and station-to-station comparisons, and insight into impacts of storms, recovery, or beach manipulation (e.g., nourishment).

Converting Field Data Values to Cumulative Distance and Elevation

Once downloaded from Google Drive by a data analyst and subjected to internal QA/QC review, field data values are converted to cumulative distance and relative elevation referenced to the station marker. This facilitates the plotting of elevation profiles, elevation datum adjustments, and computing volume and mean elevation. The NH VBPMP uses a Microsoft Excel spreadsheet for performing calculations on profile data (**Figure 3-3**); however, any standard spreadsheet will work.

The field data for a beach elevation profile is copied into a new spreadsheet on a local computer where the calculations are performed (**Figure 3-3**; dark blue outlined area). The cumulative distance and relative elevations for the beach profile are calculated by simply summing each "jump" or movement (~3 m increments down the beach) from the landward boundary to the water line (outlined in yellow in **Figure 3-3**; enlargements of area and calculation shown in **Figures 3-4 and 3-5**). The first jump starts at the base of the station marker (post or seawall) which marks the "0" meter "Cumulative Profile Distance". The relative elevation at this location is the distance from the station marker to "0". Subsequently, the length of each jump and relative elevation is added until the seaward limit of the profile is reached.

__Note:__ The NH VBPMP uses a fixed distance (~3 m) for each "jump" or distance between measurements. However, periodically a jump distance varies. It is important that the correct jump distance is entered into the spreadsheet.

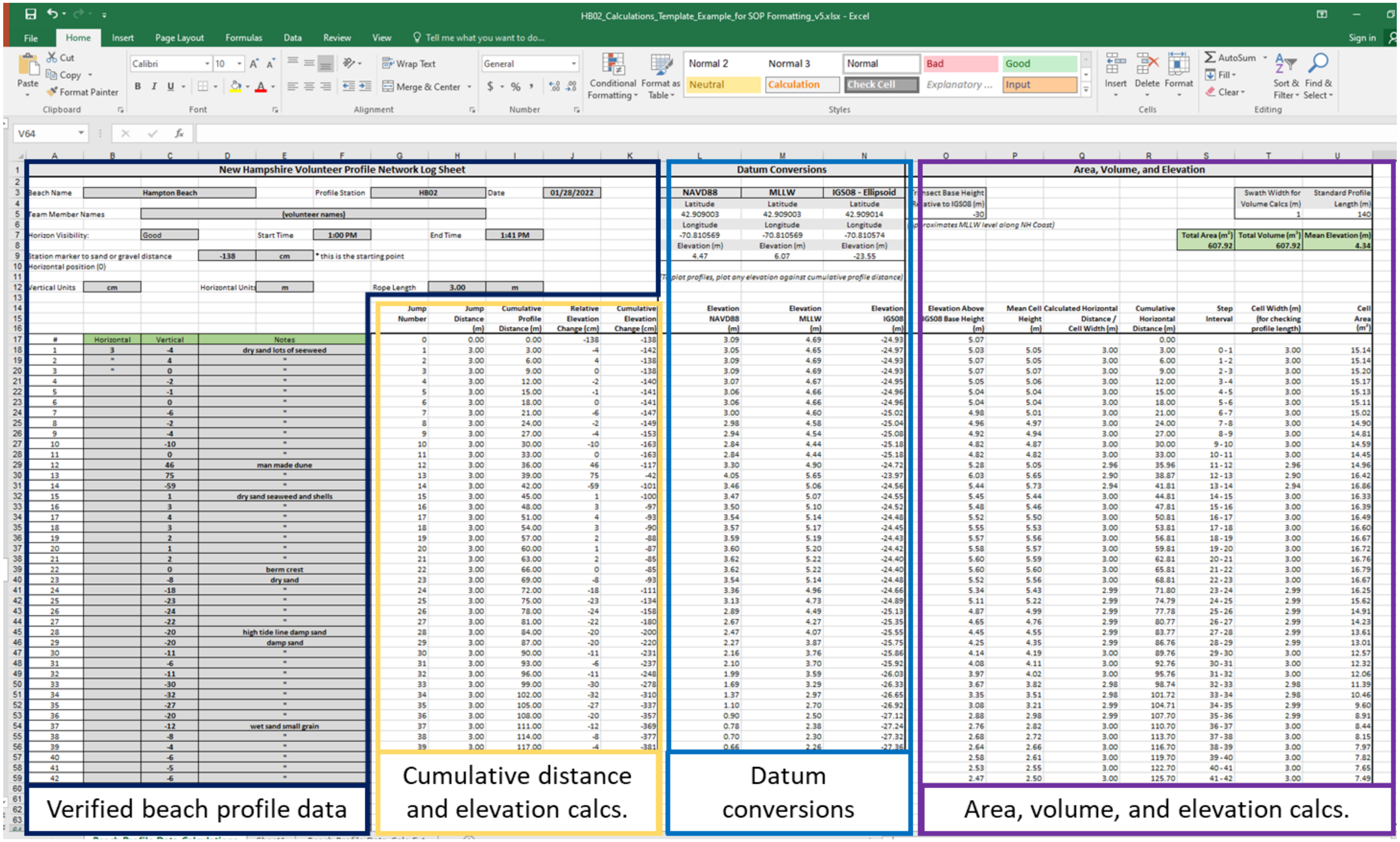
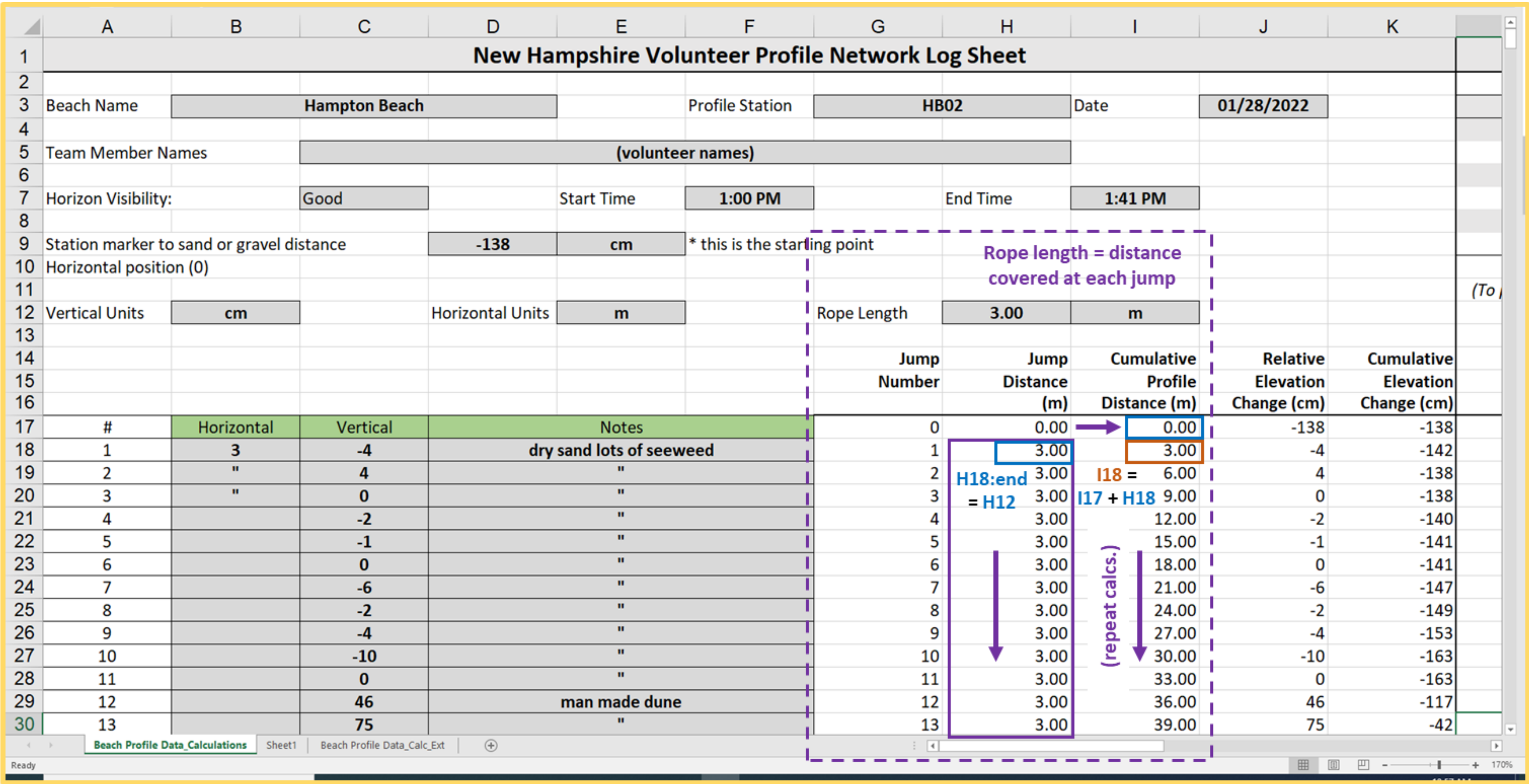


Figure 3-3: Overview of the spreadsheet used by the NH VBPMP. The verified field data is entered in the section outlined in dark blue. The cumulative distance, relative elevation, and cumulative elevation changes are calculated in the section outlined in yellow. The relative elevations are adjusted to standard elevation datums (NAVD88, MLLW, and IGS08) in the section outlined in light blue. Total area, total volume, and mean elevation are calculated in the section outlined in purple.



New Hampshire Volunteer Profile Network Log Sheet

Beach Name: Hampton Beach | Profile Station: HB02 | Date: 01/28/2022

Team Member Names: (volunteer names)

Horizon Visibility: Good | Start Time: 1:00 PM | End Time: 1:41 PM

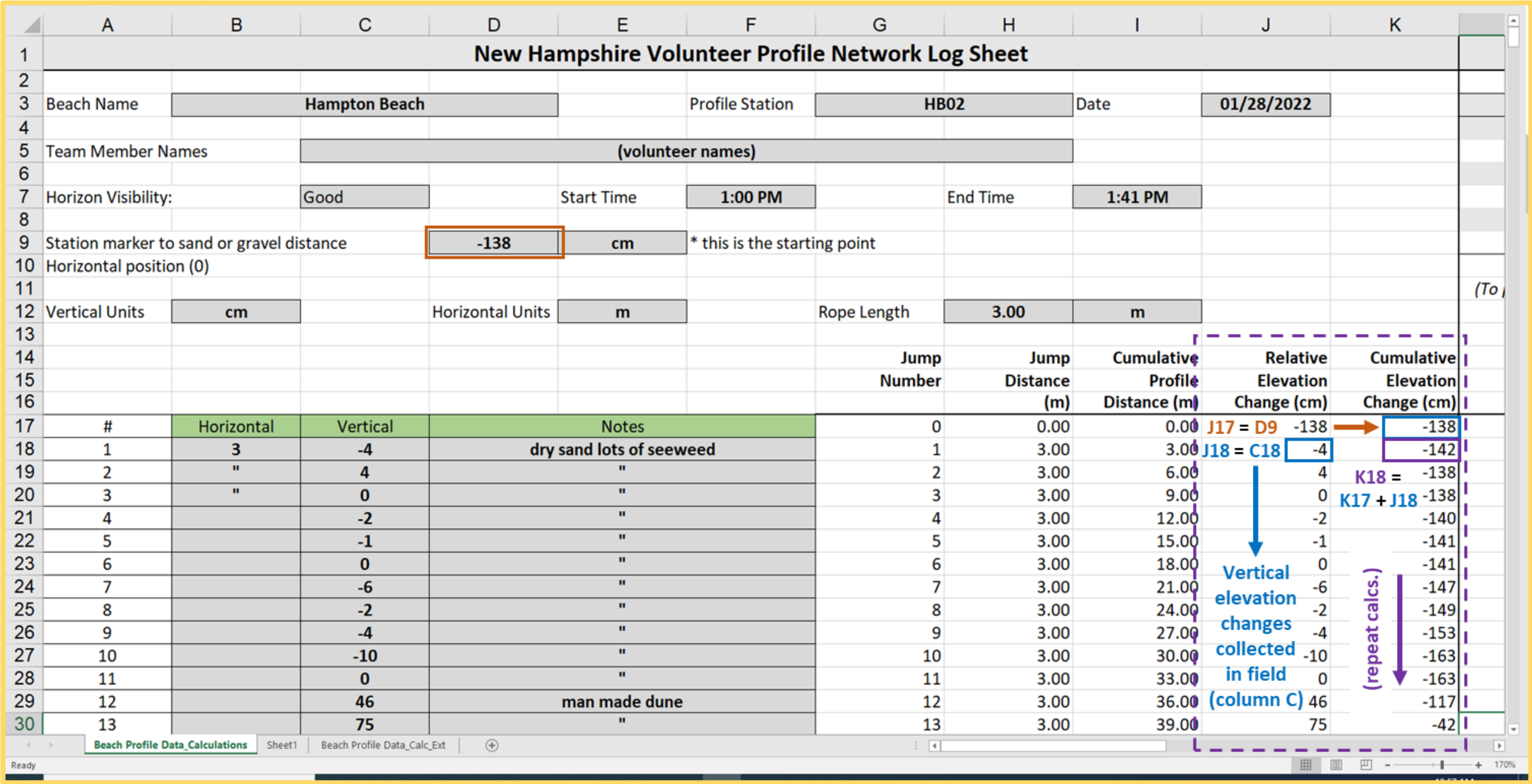
Station marker to sand or gravel distance: -138 cm * this is the starting point

Horizontal position (0)

Vertical Units: cm | Horizontal Units: m | Rope Length: 3.00 m

#	Horizontal	Vertical	Notes	Jump Number	Jump Distance (m)	Cumulative Profile Distance (m)	Relative Elevation Change (cm)	Cumulative Elevation Change (cm)
				0	0.00	0.00	-138	-138
1	3	-4	dry sand lots of seeweed	1	3.00	3.00	-4	-142
2	"	4	"	2	3.00	6.00	4	-138
3	"	0	"	3	3.00	9.00	0	-138
4		-2	"	4	3.00	12.00	-2	-140
5		-1	"	5	3.00	15.00	-1	-141
6		0	"	6	3.00	18.00	0	-141
7		-6	"	7	3.00	21.00	-6	-147
8		-2	"	8	3.00	24.00	-2	-149
9		-4	"	9	3.00	27.00	-4	-153
10		-10	"	10	3.00	30.00	-10	-163
11		0	"	11	3.00	33.00	0	-163
12		46	man made dune	12	3.00	36.00	46	-117
13		75	"	13	3.00	39.00	75	-42

*Figure 3-4: Calculating cumulative distance along the beach profile. The rope length (**Cell H12**) is representative of the "jump distance" and is used to calculate cumulative profile distance by adding each subsequent jump until the end of the profile is reached (**Column I**). Note that sometimes a jump distance may vary from the standard 3 meters; if this occurs, the jump interval must be adjusted manually.*



New Hampshire Volunteer Profile Network Log Sheet

Beach Name	Hampton Beach	Profile Station	HB02	Date	01/28/2022
Team Member Names	(volunteer names)				
Horizon Visibility:	Good	Start Time	1:00 PM	End Time	1:41 PM
Station marker to sand or gravel distance	-138	cm	* this is the starting point		
Horizontal position (0)					
Vertical Units	cm	Horizontal Units	m	Rope Length	3.00 m

#	Horizontal	Vertical	Notes	Jump Number	Jump Distance (m)	Cumulative Profile Distance (m)	Relative Elevation Change (cm)	Cumulative Elevation Change (cm)
				0	0.00	0.00	-138	-138
1	3	-4	dry sand lots of seeweed	1	3.00	3.00	-4	-142
2	"	4	"	2	3.00	6.00	4	-138
3	"	0	"	3	3.00	9.00	0	-138
4		-2	"	4	3.00	12.00	-2	-140
5		-1	"	5	3.00	15.00	-1	-141
6		0	"	6	3.00	18.00	0	-141
7		-6	"	7	3.00	21.00	-6	-147
8		-2	"	8	3.00	24.00	-2	-149
9		-4	"	9	3.00	27.00	-4	-153
10		-10	"	10	3.00	30.00	-10	-163
11		0	"	11	3.00	33.00	0	-163
12		46	man made dune	12	3.00	36.00	46	-117
13		75	"	13	3.00	39.00	75	-42

*Figure 3-5: Calculating cumulative elevation change along a beach profile. The station marker to sand distance (**Cell J17**) represents the non-datum adjusted starting point, followed by all measured vertical elevation change values collected along the profile. Cumulative elevation changes are calculated by adding each subsequent measured elevation value until the end of the profile is reached.*

Datum Adjustment of Elevation Profiles

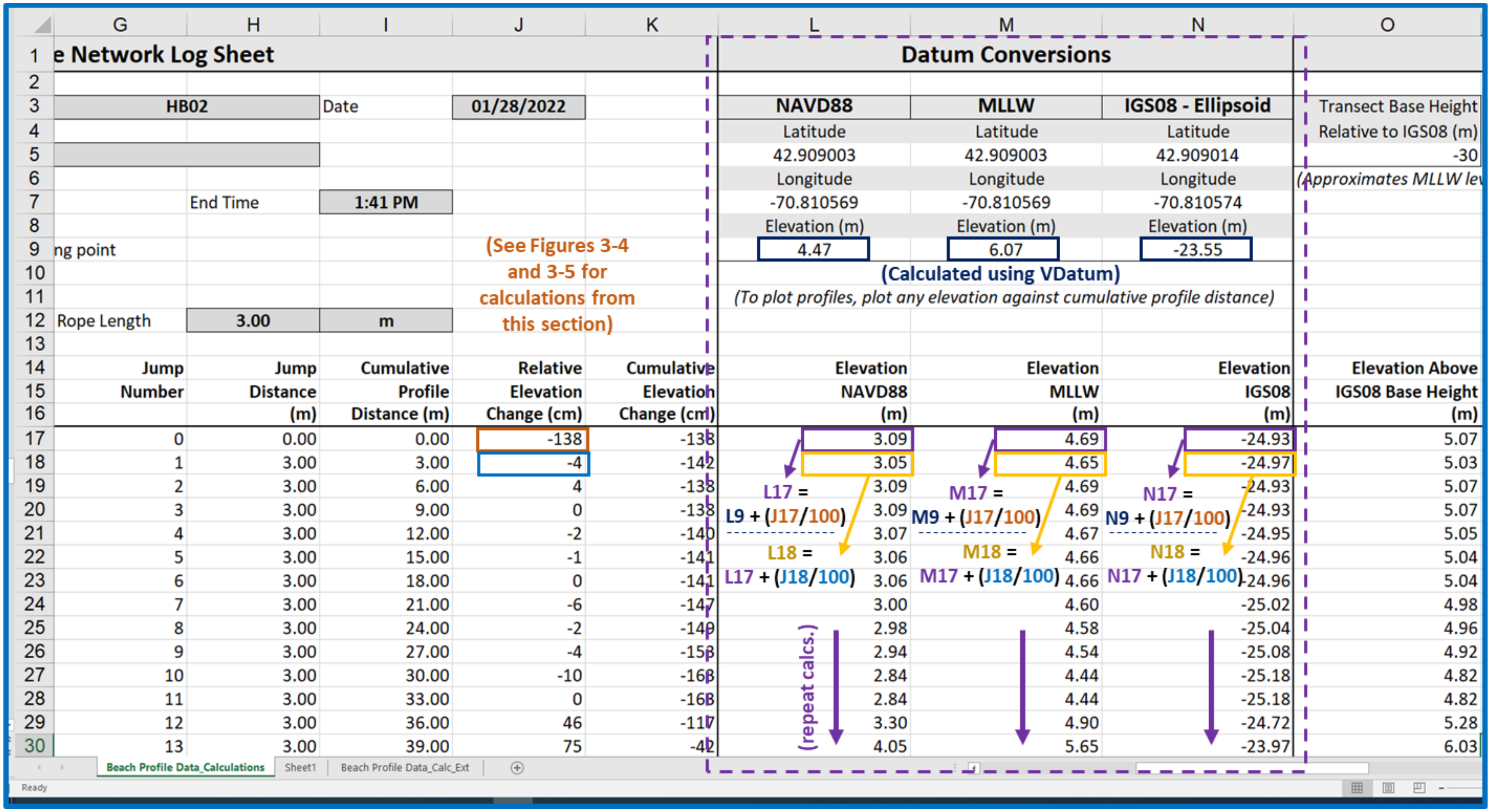
Each beach profile has an accurately positioned station marker with a known elevation, latitude, and longitude determined using GNSS referenced to the ellipsoid (WGS84). Subsequently, the station marker elevations are adjusted to NAVD88 and Mean Lower Low Water (MLLW) referenced to NAD83 (1986) using VDatum (NOAA NOS, accessed January 2023; http://vdatum.noaa.gov/). These elevations are used to convert the relative elevations of the beach profile to standard datums.

The conversion of the relative elevation profile to a known datum is accomplished by a two-step process.

1. The distance versus relative elevation of a beach profile, referenced only to the station marker (no assigned elevation datum), is computed as described above in ***Converting Field Data Values to Cumulative Distance and Elevation*** **(Figures 3-4 and 3-5)**.
2. The relative elevation profile is converted to standard elevation datums by adjusting the station marker elevation to the desired datum (e.g., MLLW, NAVD88, IGS08; **Figure 3-6**).

To adjust a relative elevation profile to a standard datum, the station marker, which is considered zero for calculating the relative elevation profile, is simply replaced by a common elevation datum (measured with GNSS). The distance from the station marker to the beach surface is then subtracted from the elevation of the station marker referenced to a datum at the first jump or “0” cumulative distance (**Figure 3-6**). All subsequent jumps are added to the previous elevation value to calculate cumulative elevation change across the entire beach. This process is done for each elevation datum desired. The NH VBPMP uses NAVD88, MLLW, and IGS08.

The datum-adjusted cumulative elevation changes can be exported along with the cumulative horizontal distance for plotting of the profile in any data processing software (e.g., Excel, MATLAB).



Row	Jump Number	Jump Distance (m)	Cumulative Profile Distance (m)	Relative Elevation Change (cm)	Cumulative Elevation Change (cm)	Elevation NAVD88 (m)	Elevation MLLW (m)	Elevation IGS08 (m)	Elevation Above IGS08 Base Height (m)
17	0	0.00	0.00	-138	-138	3.09	4.69	-24.93	5.07
18	1	3.00	3.00	-4	-142	3.05	4.65	-24.97	5.03
19	2	3.00	6.00	4	-138	3.09	4.69	-24.93	5.07
20	3	3.00	9.00	0	-138	3.09	4.69	-24.93	5.07
21	4	3.00	12.00	-2	-140	3.07	4.67	-24.95	5.05
22	5	3.00	15.00	-1	-141	3.06	4.66	-24.96	5.04
23	6	3.00	18.00	0	-141	3.06	4.66	-24.96	5.04
24	7	3.00	21.00	-6	-147	3.00	4.60	-25.02	4.98
25	8	3.00	24.00	-2	-149	2.98	4.58	-25.04	4.96
26	9	3.00	27.00	-4	-153	2.94	4.54	-25.08	4.92
27	10	3.00	30.00	-10	-163	2.84	4.44	-25.18	4.82
28	11	3.00	33.00	0	-163	2.84	4.44	-25.18	4.82
29	12	3.00	36.00	46	-117	3.30	4.90	-24.72	5.28
30	13	3.00	39.00	75	-42	4.05	5.65	-23.97	6.03

Figure 3-6: Datum conversions of a beach elevation profile. The relative elevation profile is adjusted to a common datum by replacing the station marker elevation, which is initially considered "0" with the actual elevation of the station marker relative to a common datum. Subsequently, the elevation profile is calculated. The distance from the station marker to the beach directly below the marker is subtracted from the datum and then each jump is added.

Calculation of Beach Sediment Volume and Mean Elevation

To facilitate comparisons between beach elevation profiles at a station over time, the NH VBPMP calculates the volume of sediment above approximately Mean Lower Low Water (MLLW) for each beach elevation profile collected. Differences in sediment volume show whether the beach accreted (positive increase in volume greater than uncertainty), eroded (decrease in volume greater than uncertainty), or remained unchanged (volume changes within limits of uncertainty). The mean elevation of each profile can also be calculated from the volume, which allows further comparisons between different profiling stations and between different beaches.

Determination of the volume of sediment under a beach elevation profile requires defining the landward, seaward, and lower extents for calculation, as well as the swath width. The swath width refers to the width of beach along the path of the profile that will be used for the volume calculations. The NH VBPMP uses the station marker as the landward boundary, a "standard profile length" for the seaward boundary, the -30 m elevation contour referenced to the IGS08 ellipsoid as the lower boundary, and 1 meter as the swath width.

The standard length of a beach elevation profile is the length that encompasses most profiles at a given station over time under varying conditions (e.g., erosional or depositional). The -30 m ellipsoid contour was chosen because it is relatively close to the Mean Lower Low Water level (MLLW) along the NH coast (-0.38 m MLLW at the southern extent and -0.63 m MLLW at the northern extent of the NH coast; **Ward et al., 2021**). Therefore, the calculations approximate the volume of sediment for a 1-meter-wide swath of the intertidal beach under an elevation profile from the landward boundary (seawall or foredune ridge) to approximately MLLW. The mean elevation of a profile is determined by dividing the total area under the elevation profile by the profile's standard length.

Determining a Standard Profile Length

The width of a beach from the landward boundary to the low water line varies over time, sometimes substantially, due to tidal conditions, storm impacts, or other factors. Therefore, beach elevation profiles vary in length even though the profiles are all typically run at similar low tide levels (usually spring tide). However, for consistent and comparable calculations at a given station, the same profile length must always be used to make volume calculations. Therefore, a "standard profile length" is determined for each profile to use for volumetric calculations.

The standard elevation profile length is determined by reviewing all available profiles from the station and determining a length that captures most profiles (**Figure 3-7**). This is determined visually by a trained analyst. Some profiles will be shorter than the standard length. In these cases, the profiles are lengthened to the standard length by assuming the profile continued seaward at a slightly lower grade (flatter) than the last few measurements, or that the profile flattens out. The lower beach naturally tends to have a very low gradient. Experience from the NH VBPMP has shown that this is a reasonable assumption. If profiles are longer than the standard length, they are truncated at the specified length. Experience has shown that truncating a profile has a limited impact on the volume calculation since the lower portion of the profile is already very close to MLLW.

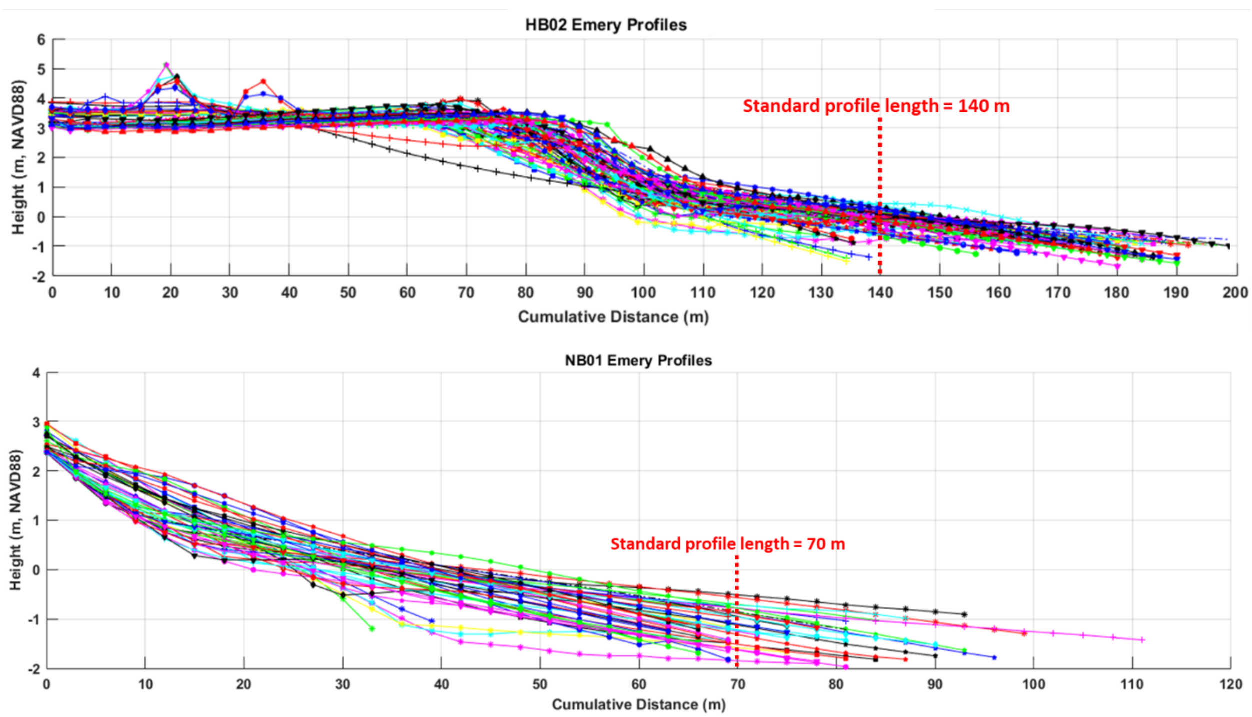


Figure 3-7: Three examples of determining the standard profile length representative of an individual station, based on examining all plotted profiles together. The total subaerial beach volume is calculated from the station marker to this chosen length.

Method for Computing Sediment Volume and Mean Elevation

The volume of sediment between a beach elevation profile and the -30 m (IGS08) ellipsoid contour is determined by first calculating area (m^2), whereby each "jump" underneath the profile (each ~3 m movement of the profile rods along the transect) is treated as an individual cell. The mean height and width of each cell is calculated to find the area of that cell, and then all cells are summed over the standard length of the profile to determine the total area. Then, the assumption is made that this area (m^2) is valid for a 1-meter-wide swath along the beach to determine volume (m^3). Mean elevation is simply the area under the elevation profile divided by the standard profile length.

The following steps and equations are used to perform the area-volume-elevation calculations. A graphical depiction of this process (showing a cross-section of a beach profile) is given in **Figures 3-8 to 3-11.** All equations and steps are shown in the spreadsheet developed by the NH VBPMP (**Figures 3-12 and 3-13; entire spreadsheet shown in Figure 3-3**).

<u>Note:</u> The beach elevation values have been set relative to the IGS08 ellipsoid for the method shown below (see **section *Datum Adjustment of Elevation Profiles***).

The average height (**H_A**), or distance of a cell above -30 m (IGS08), is determined by calculating the height of the landward (**H_L**) and seaward boundaries (**H_S**) of each cell and then averaging these values (**Figure 3-8**). The height of a cell boundary is the beach profile elevation (**BPE**) minus the -30 m elevation contour (**Y_1**), both referenced to the IGS08 ellipsoid.

Equation 1: $H_L = BPE_L - Y_1$ **<u>(and)</u>** $H_S = BPE_S - Y_1$

Equation 2: $H_A = (H_L + H_S)/2$

The horizontal width of the cell (rather than the distance between the profile rods, which is the "over land" distance) is calculated by use of the Pythagorean Theorem (**Figure 3-9**). The "over land" distance of the jump, or distance between the profile rods (**BPJ**), is the hypotenuse**.** The difference in elevation between the boundaries of the cell is one side of the right triangle (**H_L - H_S**)**.** The third side of the right triangle is the width of the cell (**C_W**). This increases the accuracy of the horizontal distance (or "width" of a single cell) by adjusting for changes in slope along a profile.

Equation 3: $C_W = \sqrt{(BPJ^2 - (H_L - H_S)^2)}$

The area of each cell (**C_A**) is calculated from the average height (**H_A**) and width of that cell (**C_W**) (**Figure 3-10**). Then, all cell areas are summed over the standard profile length to obtain the total area (**A_T**).

Equation 4: $C_A = H_A \times C_W$

Equation 5: $A_T = \Sigma C_A$

The total sediment volume (V_T) above -30 m IGS08 (approximately MLLW) is determined by the total area under the elevation profile multiplied by a given swath width of the beach (**S_W; 1 meter**) (**Figure 3-11**).

Equation 6: $V_T = A_T \times S_W$

The mean beach profile elevation (**BPE_M**) is calculated by dividing the total area of the beach profile (**A_T**) by the beach profile standard Length (**BP_{SL}**; **Figure 3-7**).

Equation 7: $BPE_M = A_T / BP_{SL}$

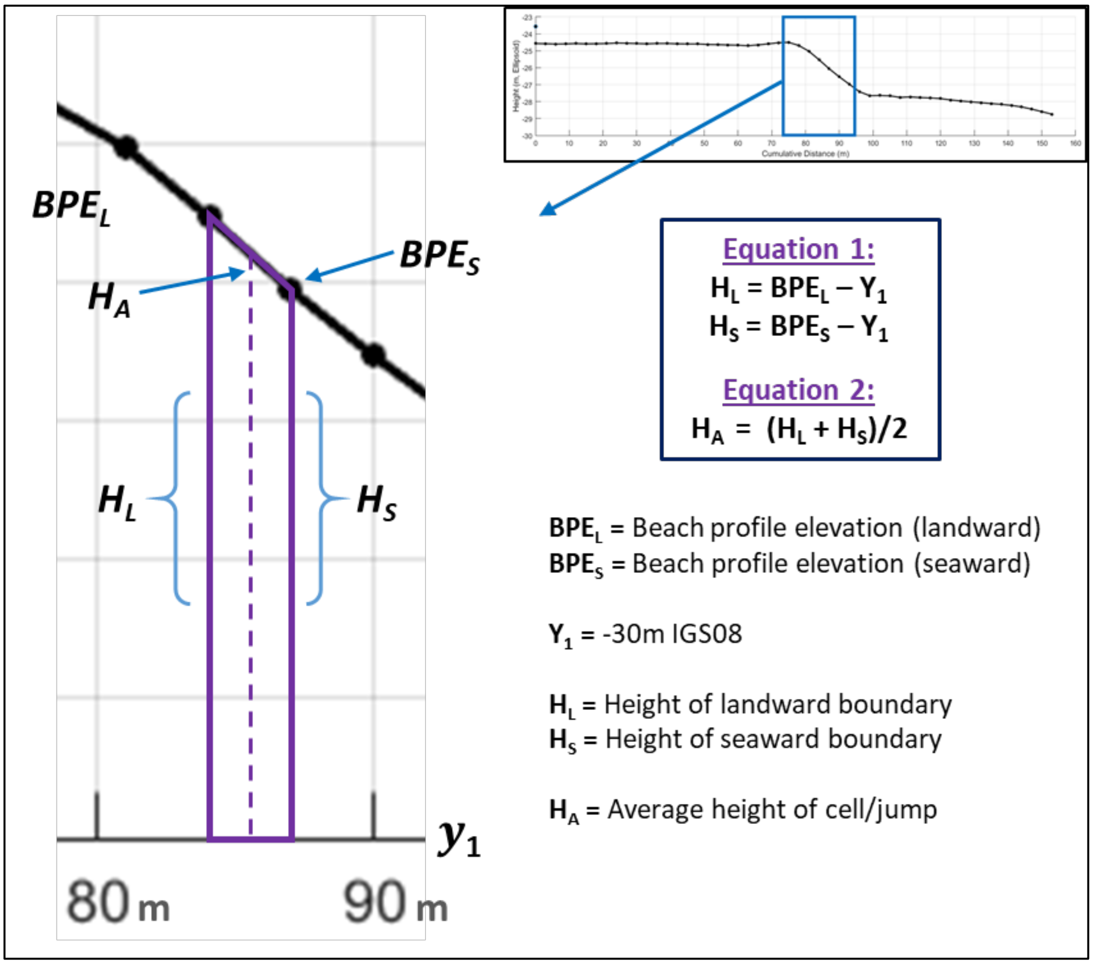


*Figure 3-8: Diagram illustrating the first step in the method for calculating sediment volume. The profile section chosen as an example is outlined in blue in the inset at top. The method and equations used to determine the average height (**H_A**) of an individual cell or jump above -30 m IGS08 are shown below. Explanations for equations can be found in the **section "Method for Computing Sediment Volume and Mean Elevation"**. Calculations are also shown in the spreadsheet in **Figure 3-12**.*

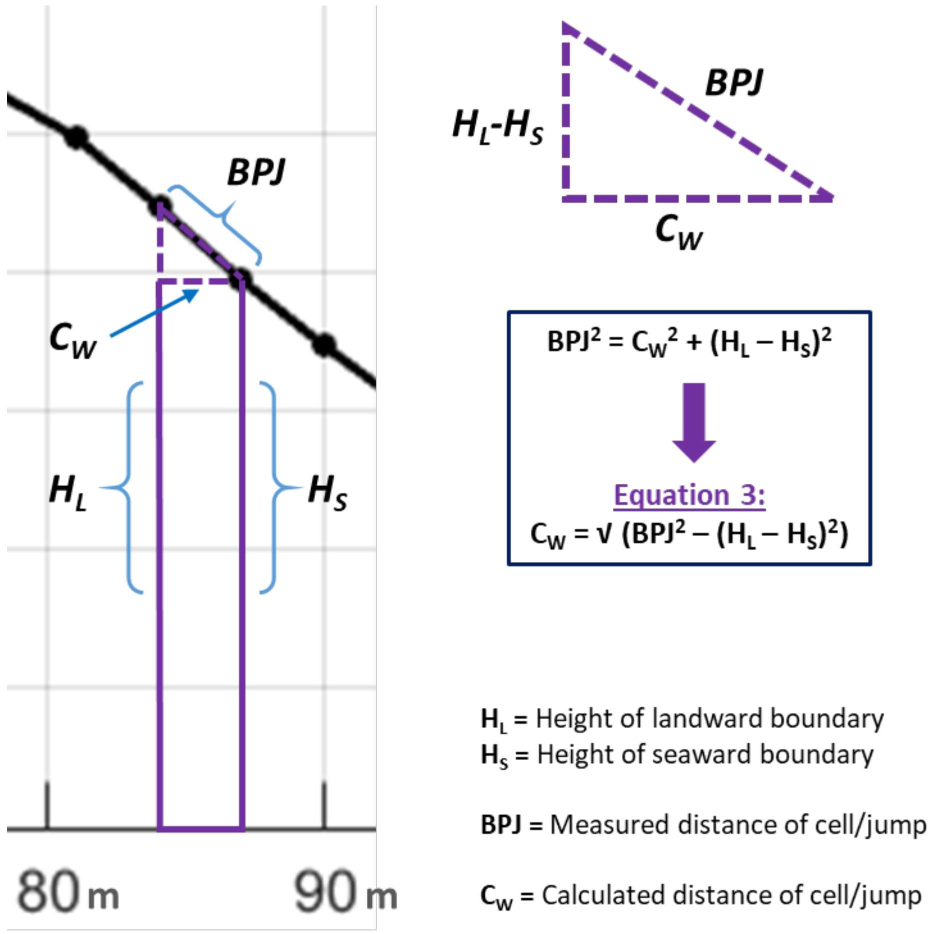
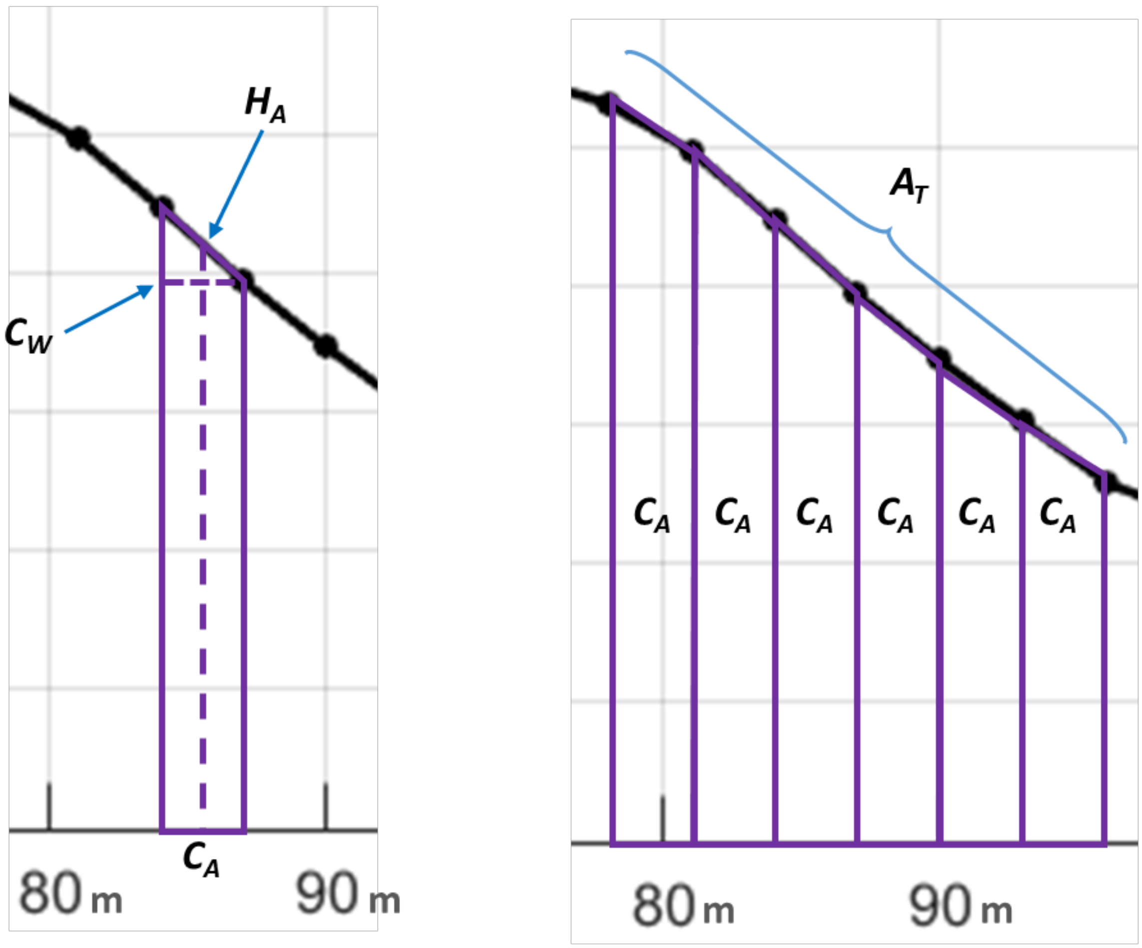


*Figure 3-9: Diagram illustrating the method and equations for calculating the horizontal width (C_W) of an individual cell. The explanation for equation 3 can be found in the s**ection "Method for Computing Sediment Volume and Mean Elevation".** Calculations are also shown in the spreadsheet in **Figure 3-12**.*

Equation 4: $C_A = H_A \times C_W$

Equation 5: $A_T = \Sigma\, C_A$



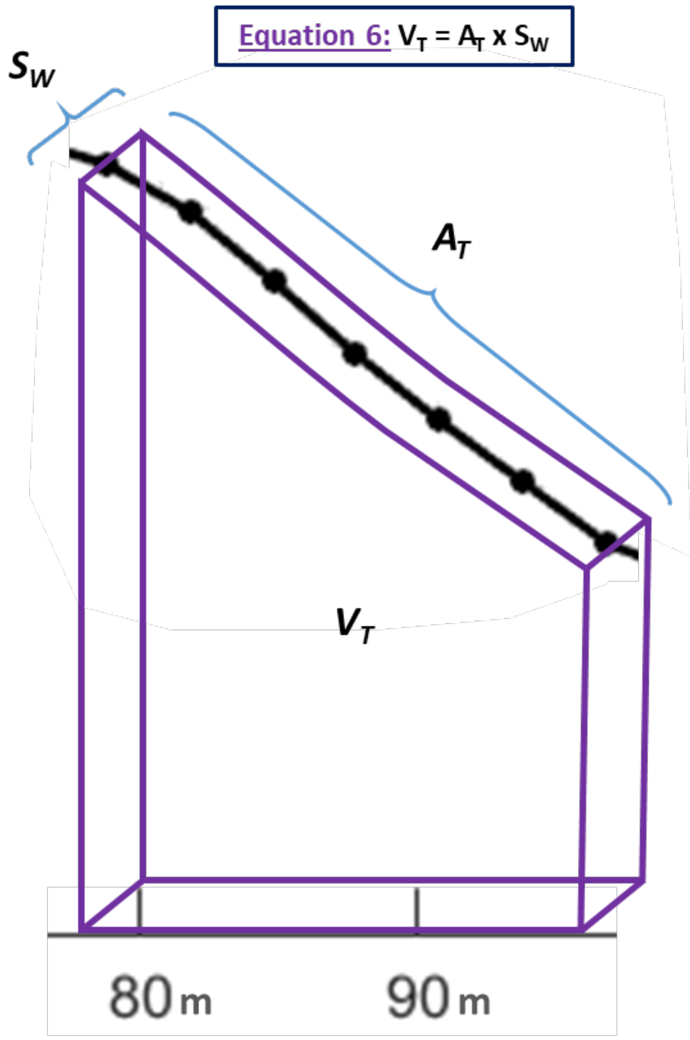
H_A = Average height of cell/jump

C_W = Calculated distance of cell/jump

C_A = Area of a single cell

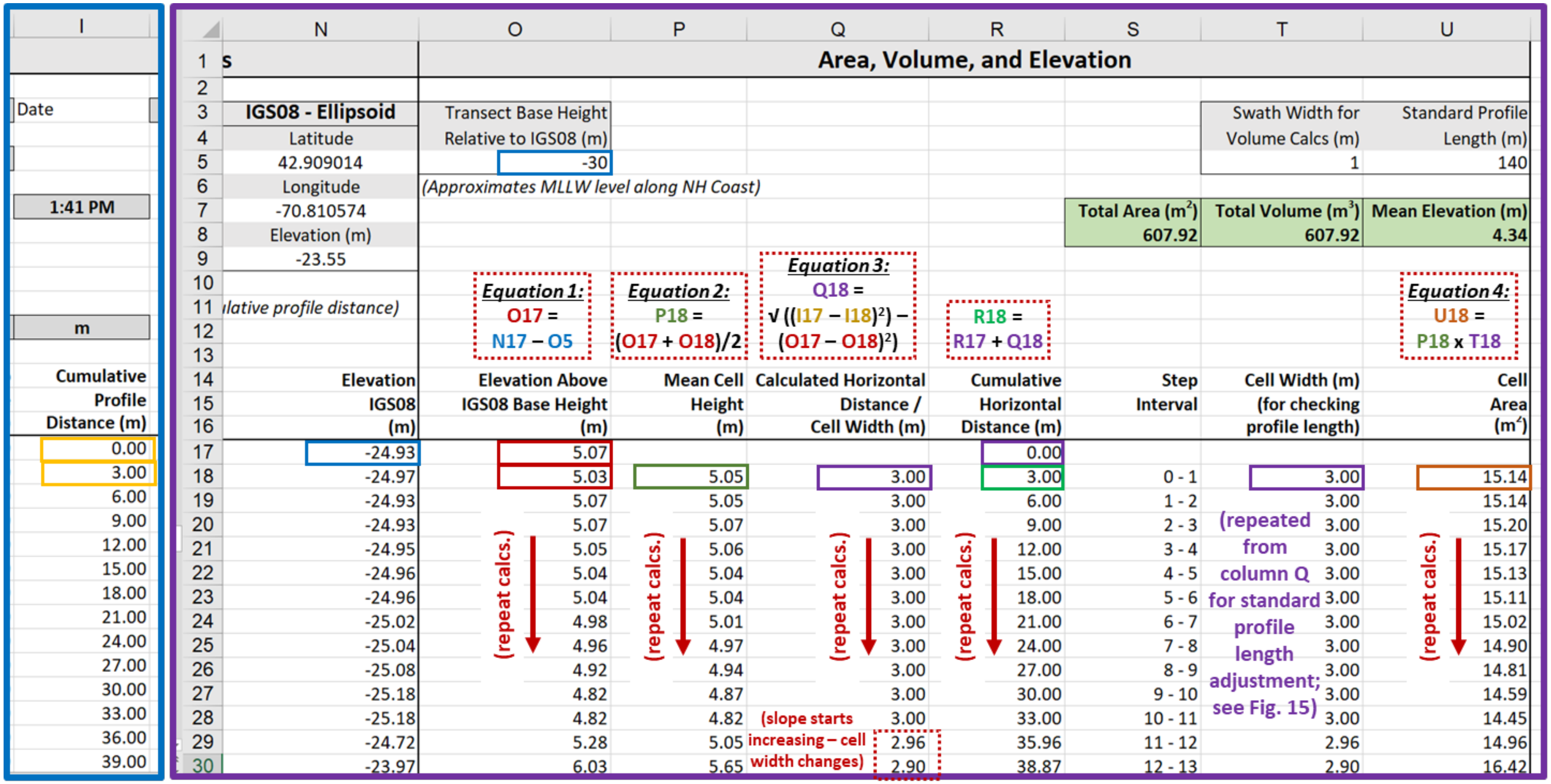
A_T = Total area of all cells (area of beach profile from landward boundary to chosen standard length, above -30m IGS08)

*Figure 3-10: Diagram illustrating the method and equation for calculating the area of an individual cell (left figure), and for determining the total area along an entire beach profile (right figure). Explanations for equations 4 and 5 can be found in the s**ection "Method for Computing Sediment Volume and Mean Elevation".** Calculations are also shown in the spreadsheet in **Figures 3-12 and 3-13**.*



V_T = Total sediment volume for a given swath width of beach (volume of, e.g. a 1-meter-wide beach profile, from landward boundary to chosen standard length, above -30m IGS08)

*Figure 3-11: Diagram illustrating how total volume is determined from total area for a given swath width of the beach. The mean beach profile elevation can subsequently be determined from the volume by dividing the total area of the beach profile by the beach profile standard length (see equation 7 in the s**ection "Method for Computing Sediment Volume and Mean Elevation"**). Calculations are also shown in the spreadsheet in **Figure 3-13**.*



Row	I: Cumulative Profile Distance (m)	N: Elevation IGS08 (m)	O: Elevation Above IGS08 Base Height (m)	P: Mean Cell Height (m)	Q: Calculated Horizontal Distance / Cell Width (m)	R: Cumulative Horizontal Distance (m)	S: Step Interval	T: Cell Width (m) (for checking profile length)	U: Cell Area (m^2)
17	0.00	-24.93	5.07			0.00			
18	3.00	-24.97	5.03	5.05	3.00	3.00	0 - 1	3.00	15.14
19	6.00	-24.93	5.07	5.05	3.00	6.00	1 - 2	3.00	15.14
20	9.00	-24.93	5.07	5.07	3.00	9.00	2 - 3	3.00	15.20
21	12.00	-24.95	5.05	5.06	3.00	12.00	3 - 4	3.00	15.17
22	15.00	-24.96	5.04	5.04	3.00	15.00	4 - 5	3.00	15.13
23	18.00	-24.96	5.04	5.04	3.00	18.00	5 - 6	3.00	15.11
24	21.00	-25.02	4.98	5.01	3.00	21.00	6 - 7	3.00	15.02
25	24.00	-25.04	4.96	4.97	3.00	24.00	7 - 8	3.00	14.90
26	27.00	-25.08	4.92	4.94	3.00	27.00	8 - 9	3.00	14.81
27	30.00	-25.18	4.82	4.87	3.00	30.00	9 - 10	3.00	14.59
28	33.00	-25.18	4.82	4.82	3.00	33.00	10 - 11	3.00	14.45
29	36.00	-24.72	5.28	5.05	2.96	35.96	11 - 12	2.96	14.96
30	39.00	-23.97	6.03	5.65	2.90	38.87	12 - 13	2.90	16.42

*Figure 3-12: Spreadsheet developed by the NH VBPMP to calculate area, volume, and elevation of a beach profile. Note: colors used in equations correspond to colors outlining cells. First, the difference between the IGS08-adjusted station marker elevation (**Column N**) and -30 m referenced to IGS08 is determined. This height difference is calculated for each subsequent jump (**Column O; Equation 1**). The difference between the landward and seaward heights of each jump are averaged to find the mean "height" of a cell (**Column P; Equation 2**). The width of each cell is calculated using the Pythagorean Theorem based on the measured "jump" length and the difference between the landward and seaward heights (**Column Q; Equation 3**). The area of each cell was calculated by multiplying the mean width by the mean height of the cell (**Column U; Equation 4**). Equation numbers correspond to those presented in the text above.*

	N	O	P	Q	R	S	T	U
1	s	**Area, Volume, and Elevation**						
2								
3	**IGS08 - Ellipsoid**	Transect Base Height					Swath Width for	Standard Profile
4	Latitude	Relative to IGS08 (m)					Volume Calcs (m)	Length (m)
5	42.909014	-30					1	140
6	Longitude	*(Approximates MLLW level along NH Coast)*						
7	-70.810574					Total Area (m^2)	Total Volume (m^3)	Mean Elevation (m)
8	Elevation (m)					607.92	607.92	4.34
9	-23.55					***Equation 5:***	***Equation 6:***	***Equation 7:***
10						S8 = Σ(column U)	T8 = S8 x T5	U8 = S8 / U5
11	*lative profile distance)*							
12								
13								
14–16	**Elevation IGS08 (m)**	**Elevation Above IGS08 Base Height (m)**	**Mean Cell Height (m)**	**Calculated Horizontal Distance / Cell Width (m)**	**Cumulative Horizontal Distance (m)**	**Step Interval**	**Cell Width (m) (for checking profile length)**	**Cell Area (m^2)**
17	-24.93	5.07			0.00			
18	-24.97	5.03	5.05	3.00	3.00	0 - 1	3.00	15.14
19	-24.93	5.07	5.05	3.00	6.00	1 - 2	3.00	15.14
20	-24.93	5.07	5.07	3.00	9.00	2 - 3	3.00	15.20
21	-24.95	5.05	5.06	3.00	12.00	3 - 4	3.00	15.17
22	-24.96	5.04	5.04	3.00	15.00	4 - 5	3.00	15.13
23	-24.96	5.04	5.04	3.00	18.00	5 - 6	3.00	15.11
24	-25.02	4.98	5.01	3.00	21.00	6 - 7	3.00	15.02
25	-25.04	4.96	4.97	3.00	24.00	7 - 8	3.00	14.90
26	-25.08	4.92	4.94	3.00	27.00	8 - 9	3.00	14.81
27	-25.18	4.82	4.87	3.00	30.00	9 - 10	3.00	14.59
28	-25.18	4.82	4.82	3.00	33.00	10 - 11	3.00	14.45

*Figure 3-13: Spreadsheet developed by the NH VBPMP, showing the final calculations for total area, total volume, and mean elevation. Note: colors used in equations correspond to colors outlining cells. The total area (**Cell S8; Equation 5**) is calculated by summing all individual cell areas (**Column U**). The total subaerial beach volume (**Cell T8; Equation 6**) is calculated by multiplying the total area (**Cell S8**) by the chosen swath width of 1 meter (**Cell T5**). The mean elevation of the profile (**Cell U8; Equation 7**) is determined by dividing the total area (**Cell S8**) by the standard profile length for that station (**Cell U5**). Equation numbers correspond to equation numbers presented in the text above.*

Adjusting for changes in profile length

As described in the s**ection** ***Determining a Standard Profile Length***, volume calculations should be calculated from the landward station marker (0 meters cumulative horizontal distance) to the seaward boundary, as determined by the standard profile length (e.g., 140 meters). The spreadsheet developed by the NH VBPMP has been formatted to carry these volume calculations through the standard length specified for each profile station.

If a profile is longer than the standard length, the profile will be truncated by adjusting (shortening) the last jump needed to reach the specified length (**Figure 3-14**). The NH VBPMP refers to this last cell as the “partial jump” since it will be smaller than a full jump. If the profile is shorter than the standard length, the number of jumps in the profile must be artificially extended to reach the necessary length. To extend a profile to the standard length, the NH VBPMP estimates the relative elevation change of each extended jump by assessing previous, longer profiles at that station and assuming the profile continued at a slightly flatter elevation than preceding jumps (**Figure 3-15**).

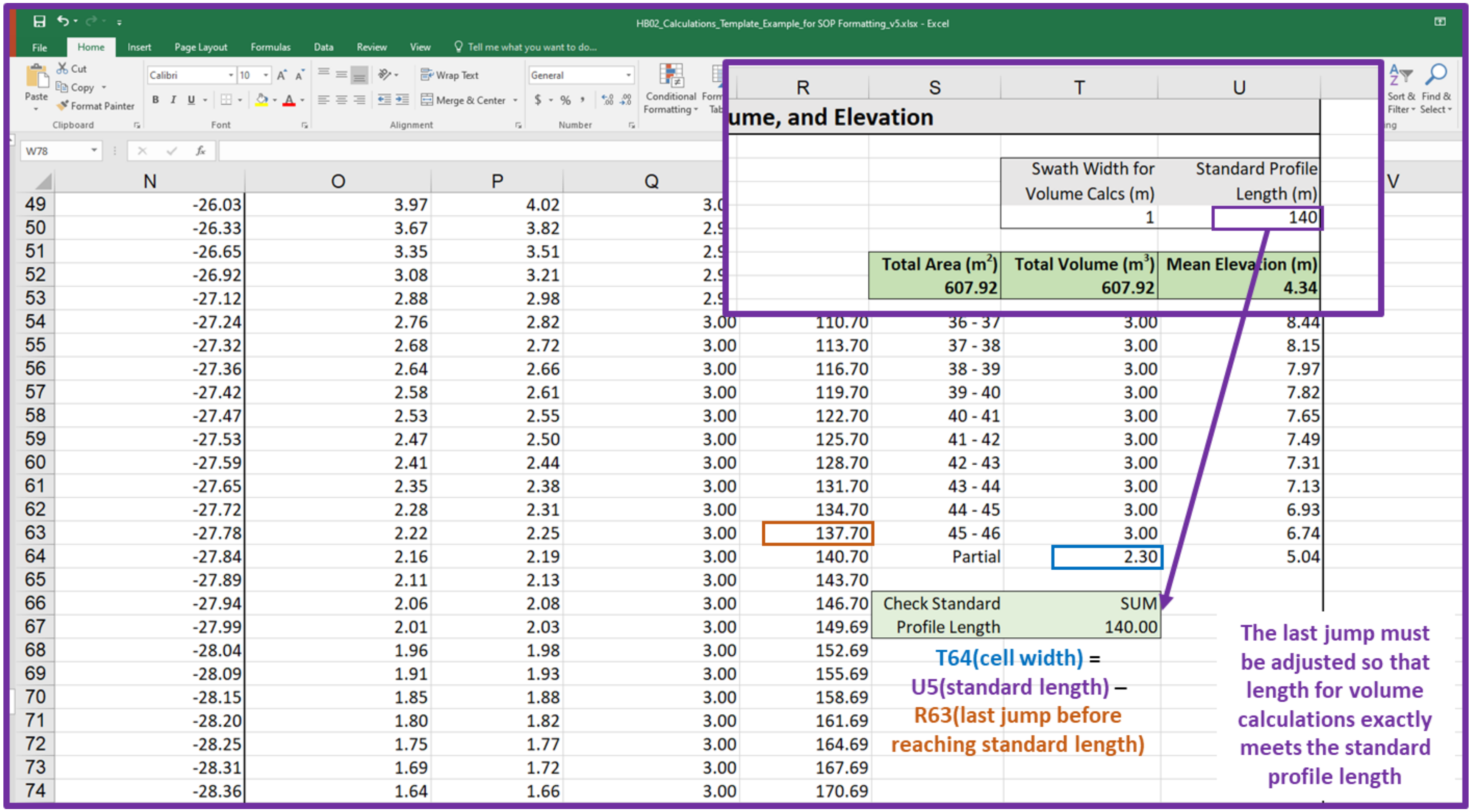


Figure 3-14: Truncating the profile at the pre-determined "standard profile length" (see ***Figure 3-7****) for subsequent volume calculations. The last cell width (****Column T****) required to reach the standard profile length will usually be a "partial jump" since the adjusted cell widths generally do not add up to exactly the standard profile length (e.g., 140 meters, and shown in* ***Cell U5****). The spreadsheet developed by the NH VBPMP has been formatted to adjust for this automatically, as well as to sum the values in* ***Column T*** *for an additional length check.*

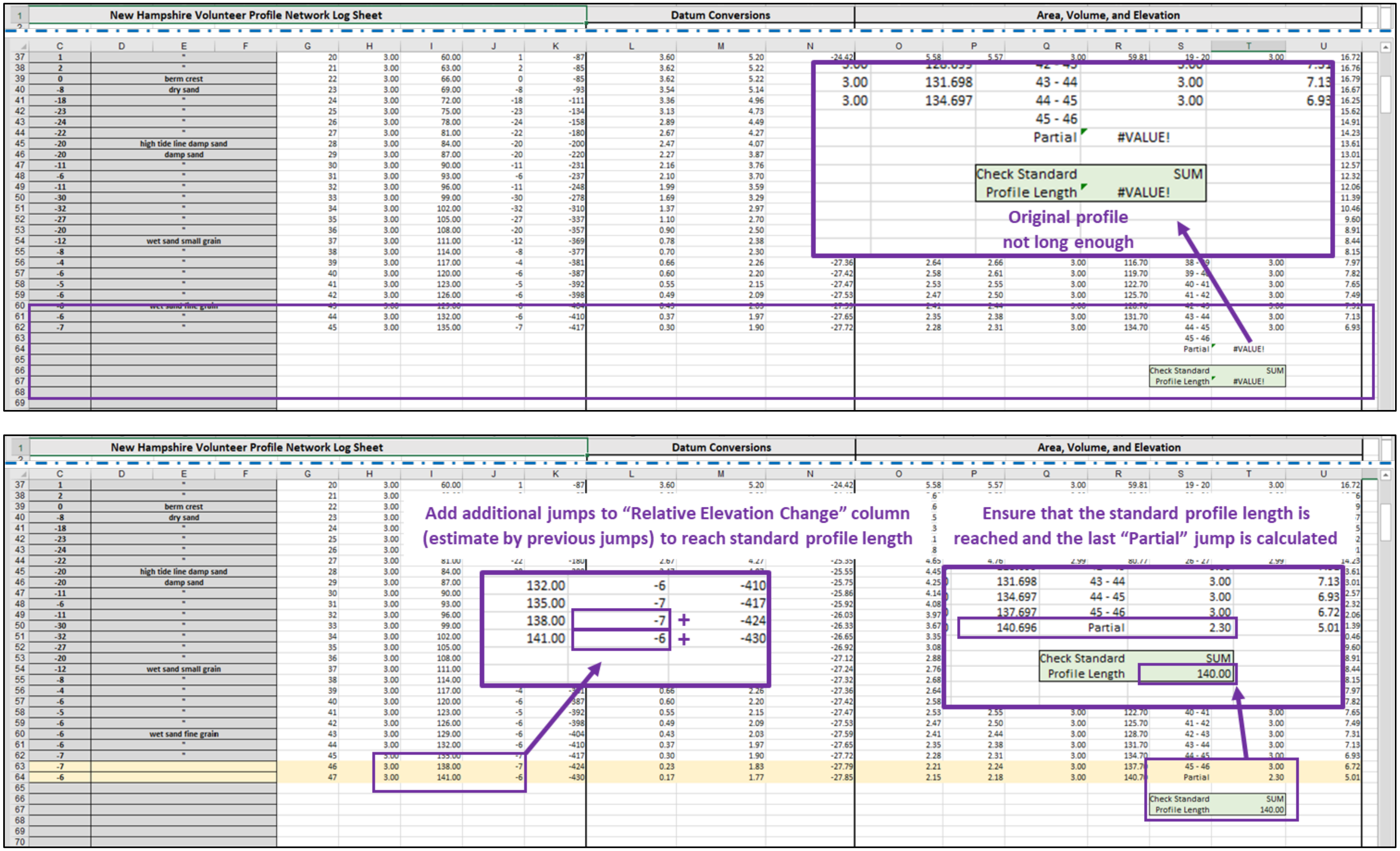


Figure 3-15: Process for extending a profile that is shorter than the standard profile length. The top figure shows a profile that is two jumps short of reaching the standard length (e.g., 140 meters). The bottom figure shows how two additional jumps were estimated and added to the profile, so that volume calculations could be completed.

Uncertainty Estimation

No extensive uncertainty analysis of elevation and sediment volume calculations using the Emery method has been conducted for the NH VBPMP to date. However, **Ward et al. (2021**) performed a preliminary uncertainty analysis by comparing elevation profiles run by the VBPMP using the Emery method to GNSS elevation profiles run by **McPherran (2017)** on NH beaches in 2017. Several profile stations common to both studies (WS01, JB02, and HB02) were coincidentally run in 2017 within several days of each other. Importantly, **McPherran (2017**) conducted an extensive uncertainty analysis of beach elevation profile and sediment volume changes on the NH coast from 2016 to 2017 using a GNSS rover. **McPherran (2017**) indicated the uncertainty of the GNNS rover system for profiling was on the order of ±0.15 m for elevation and ±0.20 m for horizontal position when strong satellite signals were received. The profiles run by the VBPMP using the Emery method compared very well with those run with the GNSS rover and were within 0.15 to 0.20 m vertically. Although the profiles were not run at the same time (within several days), similar results were obtained between the methods.

Although it is not possible to assign error estimates for this study, it is useful to recognize the comparisons discussed above. Based on this reasoning and to be conservative, the changes or differences in the elevations of profiles from the same station must be greater than 0.20 m to be considered different. The same estimate is used to compare mean elevations for individual profiles run at the same station. Finally, comparisons of mean profiles between different stations must take into consideration the error in leveling the station marker, as well as errors in measuring profiles using the Emery method. Here, 0.20 m is again used for the uncertainty estimate. A final consideration is the uncertainty of the volume calculations. Assuming a 0.20 m vertical error and no horizontal positioning error, then the error in volume estimation for a one-meter-wide transect 100 m in length would be 20 m^3 and the error for a transect 150 m in length would be 25 m^3. Since all "standard length" transects are within this range, the uncertainty for volume is likely ≤25 m^3. Although these values cannot be quantified, it is useful to keep them in mind when comparing profiles and stations. It is recommended that **McPherran (2017)** and **Ward et al. (2021)** be reviewed and the uncertainty of both beach elevation measurements and sediment volume calculations be considered.

Based on this discussion, it also follows that gains or losses of sediment between consecutive profiles only reveal change if the uncertainty is exceeded. However, experience with the VBPMP has shown it is typically more useful to consider changes over several months to define change.

Chapter 4: Data Products and Summary

The procedures used by the NH VBPMP for the establishment of the profile network, collection of field data, quality assessment and quality control, and processing of the beach profile data has proven to be effective, allowing the maximum benefit to be derived from the large and growing beach elevation database. This includes the production of timely reports and data delivery, as well as a positive experience for the community volunteers (described in **Eberhardt et al., 2022**).

Examples of products from the NH VBPMP include:

- A comprehensive report describing the study area, methods, uncertainty analysis, and a synthesis of the results of the profiling program from late 2016 through March 2020 (**Ward et al., 2021**)
- An assessment of the volunteers' experience of the program and implications of the study published in a scientific journal (**Eberhardt et al., 2022**)
- An interactive web page maintained by the NH Geological Survey (**New Hampshire Beach Profiling Project: A Collaborative Project**; URL given below)
- Short "Beach Profile Reports" summarizing each NH beach monitored (see **NH Sea Grant, Coastal Resilience: Beach Resilience Data**; URL given below)

  Note: the comprehensive report, the NHGS data portal, and the "Beach Profile Reports" can all be accessed through the NH Sea Grant website. Information about volunteering can also be found here.
  https://seagrant.unh.edu/our-work/coastal-resilience/beach-resilience-data

Report and Publication

"Connecting science and community: Volunteer beach profiling to increase coastal resilience" was published in the journal Continental Shelf Research (**Eberhardt et al., 2022**). The development of and methodology behind the NH VBPMP is described, and results from several profiling locations are compared. This paper emphasizes how positive collaborations between community volunteers, local decision makers, and scientists can benefit awareness of coastal conditions and therefore increase coastal resiliency.
https://www.sciencedirect.com/science/article/pii/S0278434322000875

An extensive data report "Erosion and Accretion Trends of New Hampshire Beaches from December 2016 to March 2020: Results of the Volunteer Beach Profile Monitoring Program" is available through the UNH Scholars Repository and NH Sea Grant (**Ward et al., 2021;** https://scholars.unh.edu/ccom/1412/). Description of station locations as well as results of beach profile, volume, and elevation data is described in detail. Examples of beach profile sequences and volume calculation histograms are given in **Figures 4-1 and 4-2**, as well as a summary of mean beach elevation by profile location (**Figure 4-3**).

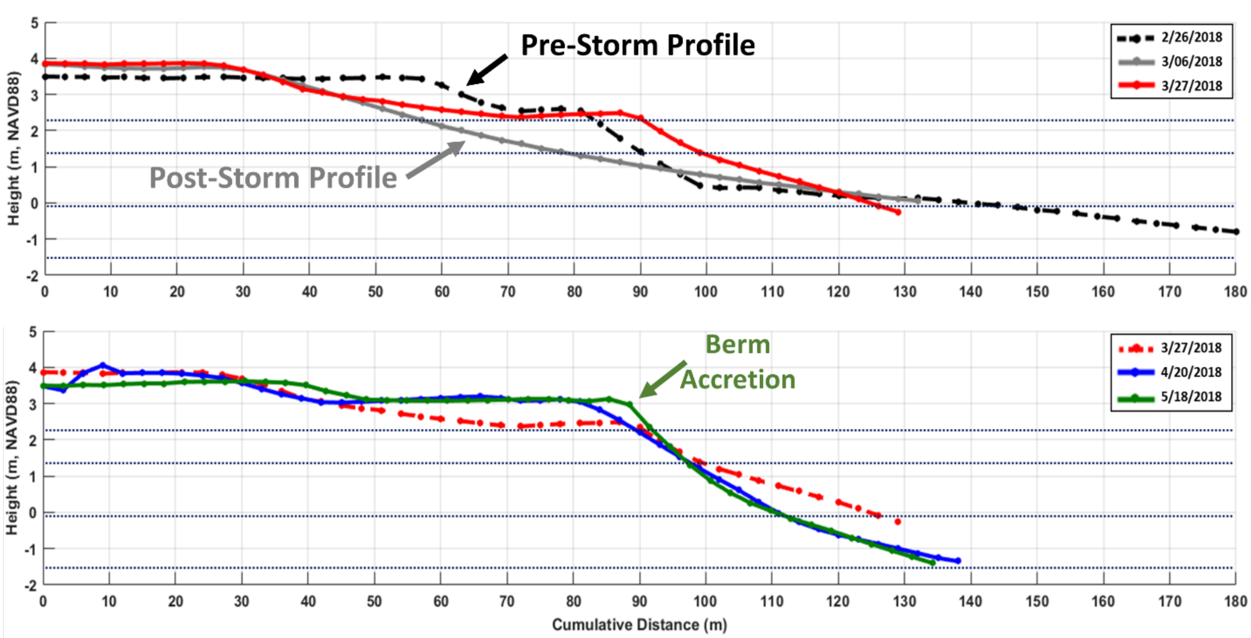


*Figure 4-1: Examples of beach profiles showing storm impacts (erosion) and recovery (accretion) at profile station Hampton Beach HB02 between February and May 2018 (from **Ward et al., 2021**). Note how the beach and berm were eroded following a series of three nor'easters in March 2018, and how the beach slowly rebuilt and recovered in the subsequent months. See **Figure 4-2** below for corresponding volume measurements.*

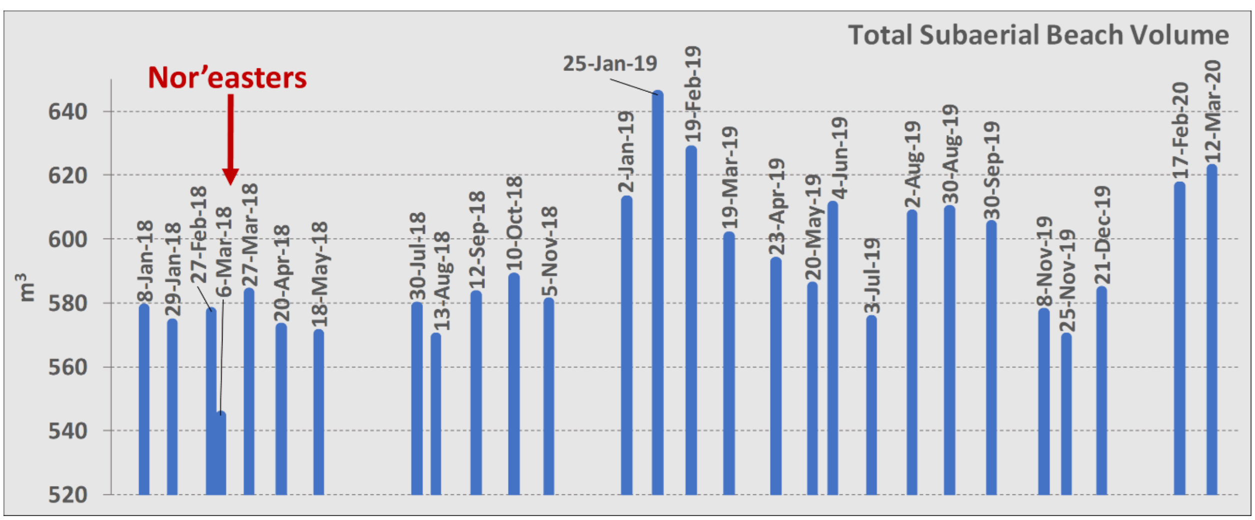


Figure 4-2: *Example of calculated subaerial beach volumes at profile station Hampton Beach HB02 between January 2018 and March 2020 (from **Ward et al., 2021**). The lowest volumes in March 2018 were due to a series of three nor'easters, which caused notable erosion (see **Figure 4-1** above for profiles showing morphology during and following these events).*

Beach	Station	Mean Elevation MLLW (m)	Mean Elevation NAVD88 (m)	Mean Profile Length (m)
North Beach	NB01	1.6	0.0	73.1
North Beach	NB02	1.5	0.0	74.8
Jenness Beach	JB01	2.1	0.6	148.5
Jenness Beach	JB02	2.4	0.8	169.0
Wallis Sands Beach	WS01	2.2	0.7	135.5
Wallis Sands Beach	WS02.5	2.2	0.7	120.4
North Hampton Beach	NHB01	2.4	0.9	70.7
North Hampton Beach	NHB02	3.0	1.5	106.6
Seabrook Beach	SB02	3.4	1.8	103.2
Seabrook Beach	SB04	3.4	1.8	87.1
Seabrook Beach	SB05	3.4	1.8	88.4
Hampton Beach	HB02	3.8	2.2	164.4
Hampton Beach	HB04	2.5	0.9	151.6

Figure 4-3: Mean beach elevation provided relative to MLLW and NAVD88, as well as mean profile length, for each profiling station between January 2018 and March 2020 (from ***Ward et al., 2021****).*

VBPMP Interactive Web Page

A web application was developed with the New Hampshire Geological Survey to provide beach profile data to the public and to act as an additional data archive. Individual profiling stations can be selected by the user, and all profiles and volume data for a station can be interactively plotted and figures exported (see **Figure 4-4** for a view of the website).

https://www4.des.state.nh.us/HydroServerMap/BeachProfiling/

Station Summary "Beach Profile Reports"

Summaries for each profiling station including beach conditions, erosion and accretion trends, and suggestions for the future are available through the NH Sea Grant website (Coastal Resilience: Beach Resilience Data). These profile reports are summarized from the results presented in **Ward et al. (2021)** and are an easily sharable product for the broader community (see **Figure 4-5** for an example of one of these summaries).

https://seagrant.unh.edu/our-work/coastal-resilience/beach-resilience-data

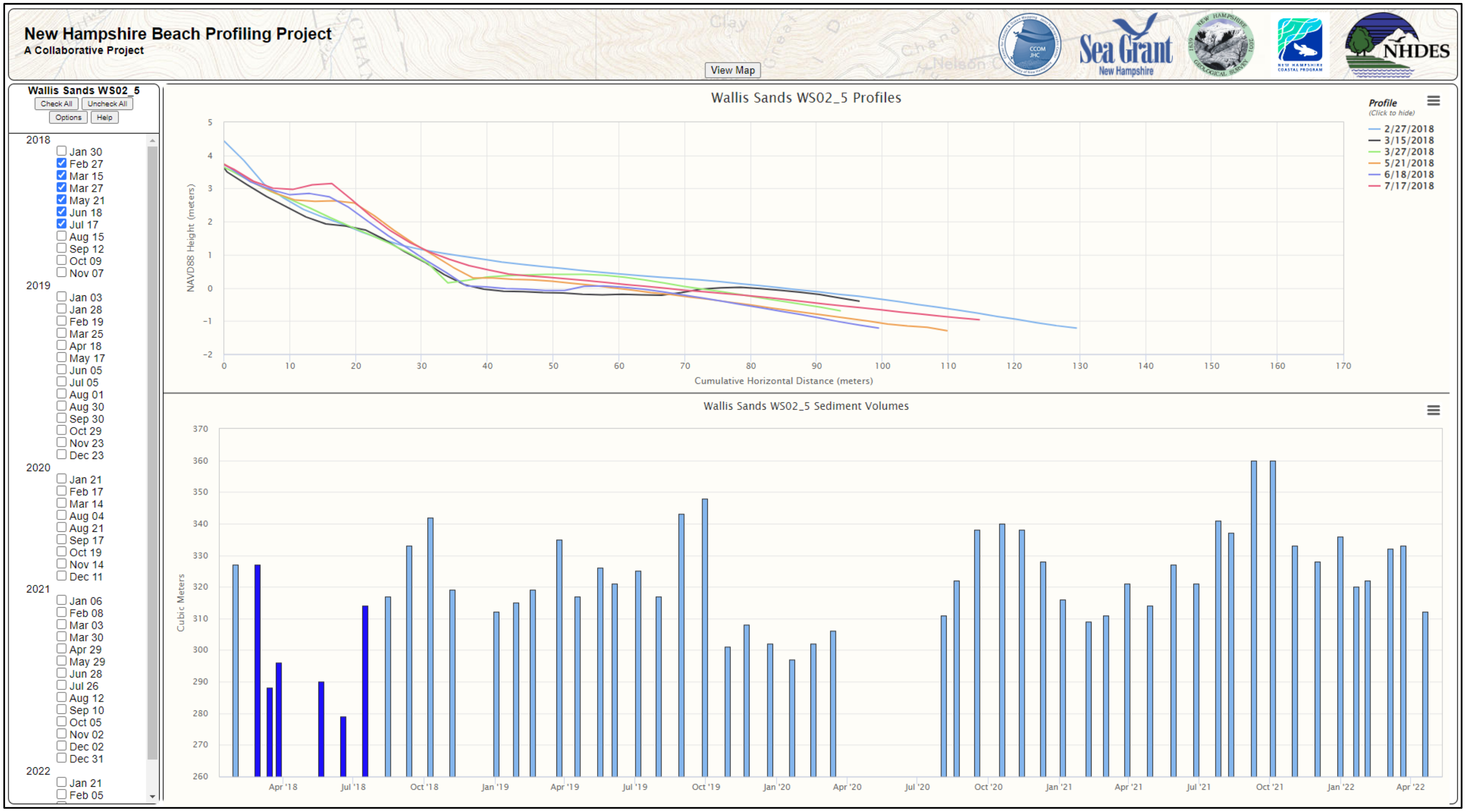


Figure 4-4: Example of plotting profiles and viewing the associated volume histogram on the collaborative website with the New Hampshire Geological Survey. Profile dates chosen to plot are simultaneously highlighted in the volume histogram below. Both of these figures can be exported. Available through: https://www4.des.state.nh.us/HydroServerMap/BeachProfiling/.

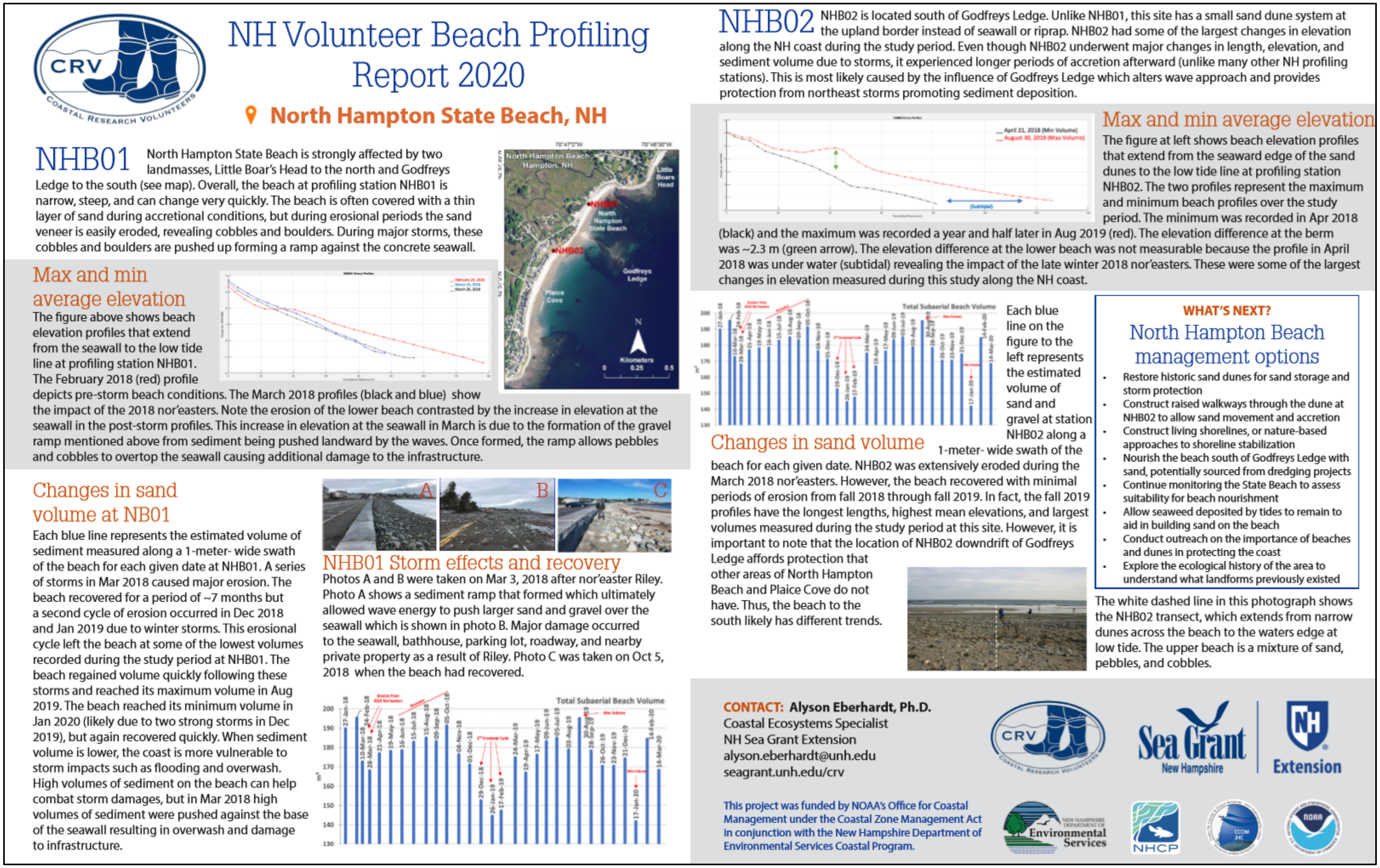


Figure 4-5: Example of a "Beach Profile Report" summary developed for sharing with the community, based on results from ***Ward et al. (2021)****. Available through:* [*https://seagrant.unh.edu/our-work/coastal-resilience/beach-resilience-data*](https://seagrant.unh.edu/our-work/coastal-resilience/beach-resilience-data).

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https://dx.doi.org/10.34051/p/2021.34

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Appendices

Appendix 1: Team Roles

VOLUNTEER MONTHLY MONITORING TEAM ROLES

Ideally, each team has three members to conduct beach profiling and obtain field photographs. A fourth member is useful to serve as a substitute but is not required. Each team member may perform the same role each field session, or roles can be switched so that all volunteers gain experience with all positions. Experience with the NH VBPMP shows most volunteers prefer to perform the same job consistently during field work.

Landward Profiler. The volunteer controlling the landward profile rod is responsible for measuring the relative elevation change for each "jump" during a profile and providing the value to the "data recorder" along with the proper sign (positive, negative, or zero).

Seaward Profiler. The volunteer controlling the seaward profile rod is responsible for aligning the profile rods on the profile transect and ensuring the rope between the profile rods is taut. Whenever the team is ready to move or "jump", the "seaward profiler" uses the station marker and back site to ensure the profile remains on the transect.

Data Recorder. The "data recorder" is responsible for recording the data, taking photographs, and making sure the profile rods are vertical when measurements are made, the rope between the profile rods is taut, and the profile is on the transect. The "data recorder" is essential to successfully running profiles and maintaining QA/QC.

Data Entry. One volunteer should be assigned to submit data and photographs after each profiling session. The only requirement is internet access. Experience from the NH VBPMP indicates the "data recorder" usually submits the data and photographs.

Equipment Storage. One of the volunteers should be responsible for storing the beach profiling binder and equipment, and for bringing it to each profiling session.

Team Leader. It may be helpful to assign a "team leader" who will take initiative to coordinate scheduling. This volunteer could start conversations about scheduling, make sure that any conflicts are noted early, and take the initiative to work with the staff volunteer coordinator to find substitute profilers if necessary.

Appendix 2: Beach Profile Data Sheet

New Hampshire Volunteer Profile Network Log Sheet

Beach Name ____________________ Profile Station___________________ Date ________________

Team Member Names ____

Horizon visibility: Good [ ] Poor [ ] Start Time____________ End Time___________

For seawall sites:
Station marker to sand or gravel distance ______________ * this is the starting point
Use a clipboard or profile rod as an aid to ensure a level reading if needed.

For dune sites:
Measure both wooden stakes. landward/west________ seaward/east________

Vertical Units ____________ Horizontal Units __________ Rope length ___________
(With cord taut, measure from front side to front side of each profiling rod)

* If the landward rod is higher than the seaward rod (-)
* If the landward rod is lower than the seaward rod (+)

#	Horizontal	Vertical	Notes
1			
2			
3			
4			
5			
6			
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10			
11			
12			
13			
14			
15			
16			
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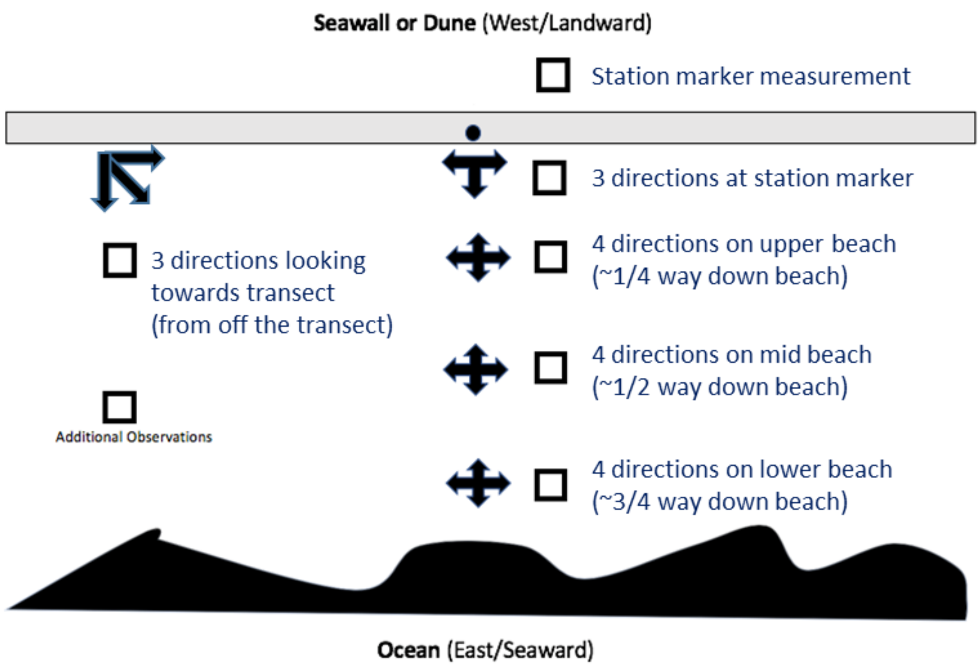
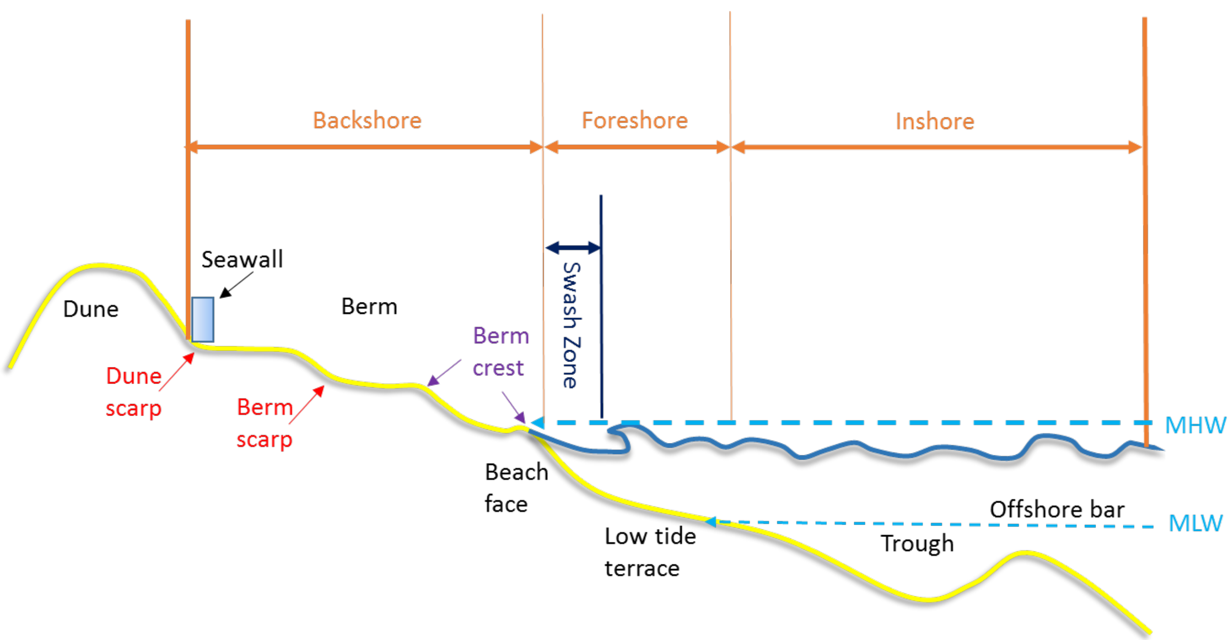
Photo Guide: Take photographs in ***landscape*** orientation whenever possible, except when photographing the station marker height. The most important photo is the station marker; include the sand/gravel surface if possible. Please check boxes when photos are taken.



*Recommended beach feature to record

Feature	Description
Seawall	Concrete or wooden shoreline structure.
Dune	Large accumulation of sand usually vegetated with grass located landward of the intertidal beach, formed by aeolian processes and storm surges.
Vegetation line	Edge of dune grass.
Berm	Dry upper flat portion of the beach generally located above MHW.
Berm crest	Formed along the upper limit of the wave swash, the linear break in slope near the maximum extent of the swash and forming the boundary between the backshore and lower beach.
Wrack	Accumulation of seaweed at top of swash zone.
Beach Face	The sloping portion of the beach dominated by wave swash.
Runnel	Part of a "ridge and runnel" system. A trough formed landward of a migrating sand bar or ridge on the low tide terrace.
Ridge	Part of a "ridge and runnel" system. A sand bar or ridge on the low tide terrace formed by sand migrating landward.
Runnel outlet	A breach in the ridge formed by water rushing seaward from a runnel.
Low Tide Terrace	The lower portion of the beach seaward of the berm. It is usually very flat and often wet.
Swash Zone	The area of wave swash (uprush) and backwash (back rush).
Cusps	A series of highs (horns) and lows (embayments) usually on the berm formed by swash processes. Spacing between horns can vary from less than one meter to 50-100 meters.
Water Line	Boundary between the beach and the ocean.



Appendix 3: Construction of Profile Rods

Precisely measured and labeled profiling rods are critical for collecting accurate data in the field and plotting the profiles. To our knowledge, no pre-made beach profiling rods exist for purchase. The following procedure was used to construct profiling rods for the NH VBPMP (see **Figures A-1 and A-2** for photographs of the equipment used and the final product).

1. Hardwood boards (1"x 4") were cut in half to create two 1"x 2" pieces (any 1"x 2" hardwood will work but are often difficult to find).
2. The 1"x 2" boards were cut to 150 cm lengths and lightly sanded to remove roughness. Both sides were painted white with semi-gloss paint.
3. One side of each profile rod was divided into 2 cm increments with a pencil or permanent marker. Subsequently, alternating 2 cm divisions were painted red. The whole rod was coated in a protective coating of polyurethane.
4. Feet for the rods were constructed from 1/4" Lexan cut into 3" x 2" pieces. Two holes were drilled through each footing and screwed onto the bottom of each rod with decking screws.
5. A stainless steel eye screw was attached to the all-white back of one rod and another eye screw attached to the red-and-white striped front of the other rod. Non-stretch cord was looped around each eye screw on each rod and fastened with cable clamps. The distance between the two profile rods was adjusted to be as close to 3 meters as possible before the cable clamps were tightened.
6. To assist in keeping the profile rods straight when profiling, bubble levels were also added onto each rod. Experience over time has shown that some of the volunteers benefited from use of the bubble levels, while others felt they were a distraction. The NH VBPMP advised its volunteers to use the bubble gages if helpful, but rely on their own visual expertise if preferable. It is important the bubble gages are checked periodically for alignment.

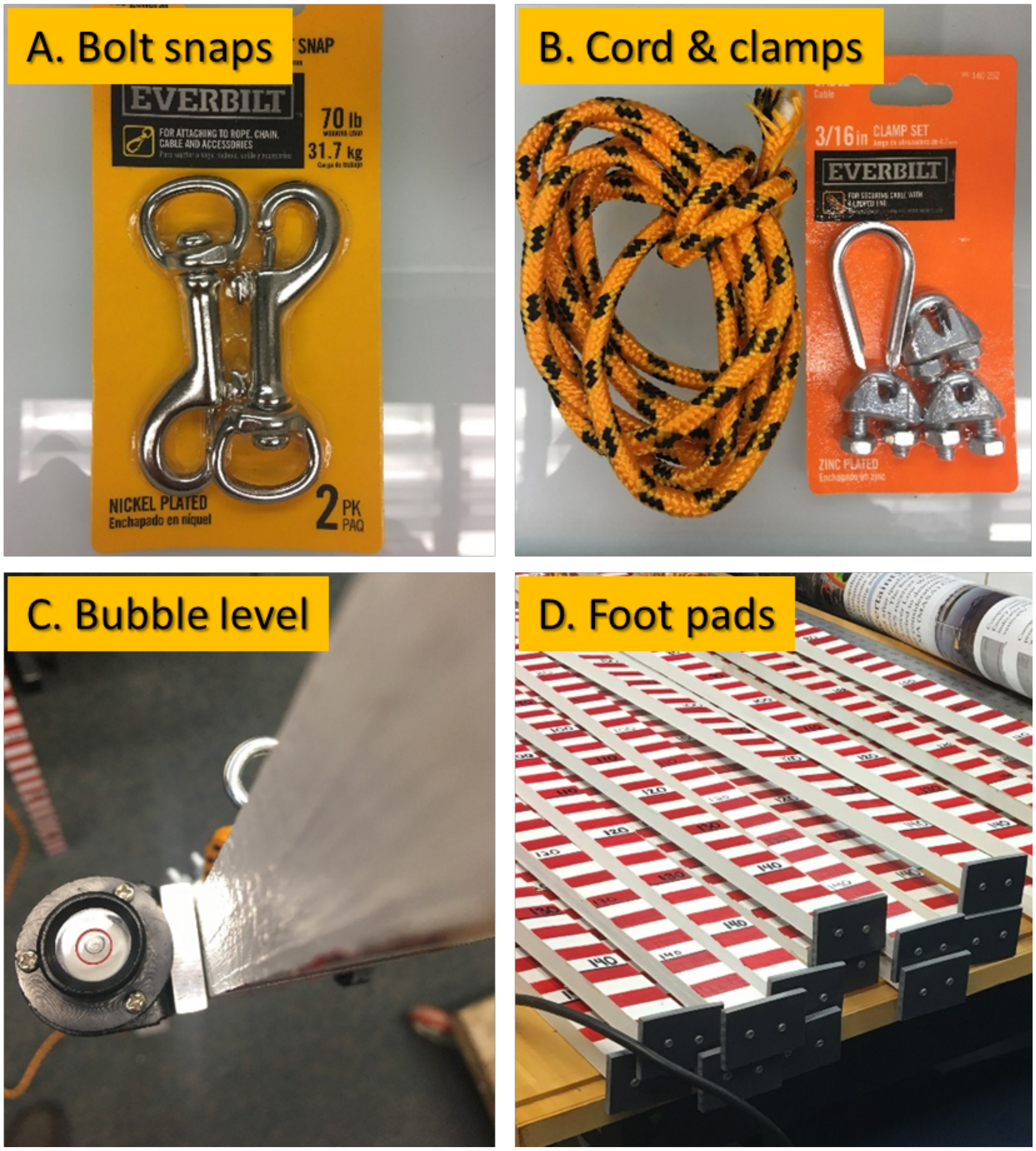


Figure A-1: Photographs showing the construction of the profiling rods and equipment used.

Figure A-2: Volunteers profiling with a completed profile rod set. The front side of each rod is painted with 2-centimeter increments and is connected by an approximately three-meter-long cord. Both rods have bubble levels. The cord is screwed onto the back of the landward rod (lower left-hand inset figure) and the front of the seaward rod (upper right-hand inset figure).

Appendix 4: Quick Beach Profiling Checklist

QUICK BEACH PROFILING CHECKLIST

Essential Supplies

- ☐ Profiling rods
- ☐ Reflectors
- ☐ Binder
- ☐ Data sheet, clipboard, and pencil
- ☐ Appropriate clothing (gloves, hat, boots, sunscreen, etc.)

Weather and Safety

- ☐ Are the conditions safe for profiling? Avoid excessive wind chills, icy conditions, or other dangerous conditions. *Profiling dates can be flexible if conditions do not allow safe, accurate profiling.*
- ☐ Is the horizon visible?

Quick Tips and Reminders

- ☐ Fill out all the information on your data sheet
- ☐ Remember that downhill measurements are recorded as negative numbers, uphill as positive
- ☐ Take notes and take photos to document anything unusual you notice on the beach
- ☐ Always walk next to the profile line, not on top of it
- ☐ Don't forget to take your photos
- ☐ Don't forget to submit your data

Appendix 5: Position Descriptions

BEACH PROFILING VOLUNTEER AND STAFF POSITION DESCRIPTIONS

Volunteer: Monthly Monitors

Purpose: To collect beach profile data approximately every four weeks.

General responsibilities:

- Work in a small team to collect beach profile data approximately monthly
- Collect occasional extra profiles as available (~ 3-4 times/year)
- Attend occasional profiling meetings and professional development if possible (~ 2 times/year)
- Stay in contact with beach profiling volunteer team and staff

Volunteer: Substitute Monitors

Purpose: To assist with data collection when a regular profiler must miss a planned session, or when we need extra help to collect data on relatively short notice to capture storm impacts.

General responsibilities:

- Receive training in beach profiling methods
- Serve on an email list and agree to be notified when the NH VBPMP is seeking extra volunteers
- Help out with profiling as needed and as schedule allows

Staff: Program Coordinators

Purpose: To oversee the operation of volunteer beach profiling, including training, recruiting, and assisting volunteers, and sharing data and results with volunteers as it becomes available.

General responsibilities:

- Training all volunteer teams and providing follow-up support
- Maintaining regular email communication with volunteer teams
- Providing supplies, parking reimbursement as needed, etc.

Staff: Data Processing Team

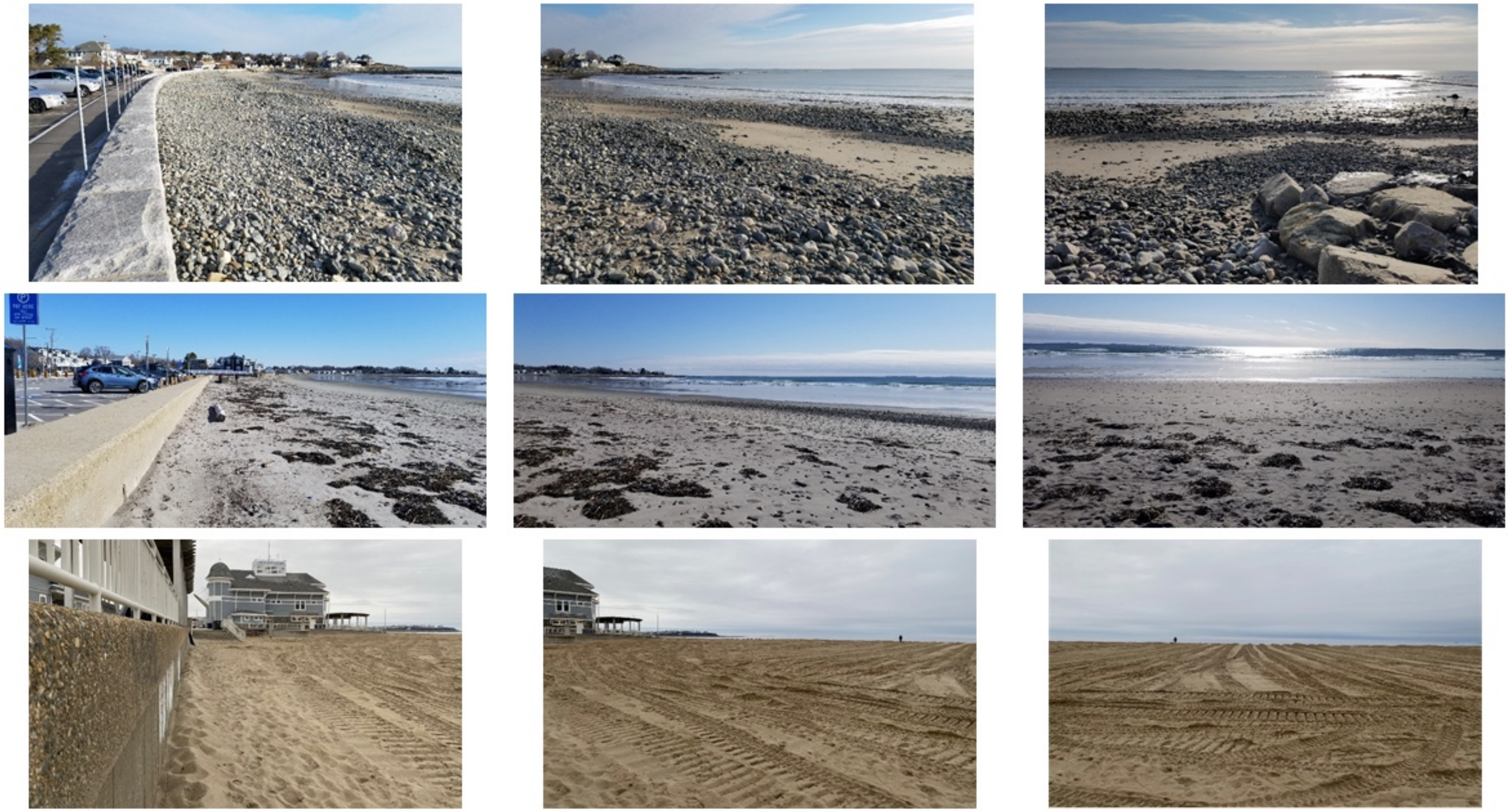
Purpose: To download, QA/QC profile data and photographs collected by volunteers, calculate volume and elevation data, plot beach profiles, and help visualize data through a number of data products (figures, tables, photograph time-series).

Appendix 6: Guidebook for Beach Profiling Photographs

1. Use landscape view, rather than portrait, whenever possible. More of the beach can be seen in landscape view. Photos of the station marker height are okay to take in portrait view.
2. Always keep the camera level when taking photographs. When facing the horizon or the water line, this will ensure the horizon or landward boundary (e.g., seawall) is level in the photograph. When facing up and down the beach, keeping the camera level will ensure that the slope of the beach is visible in the photographs.
3. Fill up make most of the image with the beach or land rather than the sky.
4. When taking photographs up and down the beach, make sure they are perpendicular to the transect.
5. When possible, take some photos that have permanent objects in part of the view. For example, include objects like seawalls, buildings, or other structures. Including features allows the level of the sand or gravel on the beach to be compared between photographs.
6. Once the preferred image perspectives (scenes) for each station are established, replicate the photographs every time the station is profiled. Taking photos with the same perspective each time makes comparing photographs and identifying changes easier and allows time-series sequences of the beach to be developed.
7. Take extra photographs of any interesting beach features, objects near the station, or human activities that may impact the profile measurements. For example, snow or seaweed on the profile line, bulldozers pushing sand around, vehicle tracks, or sandcastles or moats near the line.
8. It is okay to have people in some of the photographs. Although the beach is the focus, people often make the images more interesting.
9. Photographs are free – take a lot of them.

Examples of great photographs of measuring station marker to beach surface distance

The seawall station marker locations (left and middle) or dune stakes (right), as well as the beach surface, are visible in the zoomed-out photographs. The zoomed-in photographs clearly show the measurements (these are okay to take in portrait mode).



Examples of great photographic sequences of the beach looking at the profile transect (taken from off the transect)
Each beach is photographed from the seawall or dunes (slightly away from the transect) parallel to the beach, at a 45° angle to the beach, and perpendicular to the beach so that the entire profile transect is visible.

Examples of great photographic sequences of the beach taken from the station marker looking up and down the beach (parallel to the landward boundary)

Each beach is photographed from the seawall or dunes parallel to the beach, looking both up and down the beach. Note that the camera is level so that the slope of the beach is visible, the beach surface height relative to the permanent objects (seawall) is clear, and the beach is more prominent in the photograph than the sky.

Examples of great photographs taken from the station marker looking seaward along the profile transect (perpendicular to the landward boundary)

The view of the beach is clear, the horizon is level, and the beach is more prominent in the photograph than the sky.

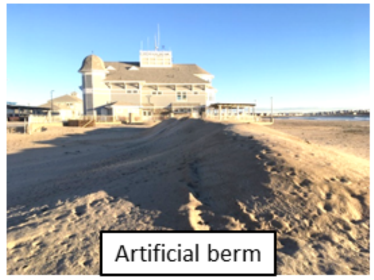
Examples of great photographs taken from mid-beach on the profile transect facing up and down the beach (parallel to the landward boundary)

The view of the beach is clear, the photographs are facing perpendicular to the profile transect (not angled), the camera is level so the slope of the beach is visible, and the beach is more prominent in the photograph than the sky.

Examples of great photographs taken from the lower beach on the profile transect facing landward and seaward
Clear view of the beach, the horizon or landward boundary is level, and the beach stands out more than the sky.

Photographs of interesting features and storm impacts


Exposed peat


Artificial berm


Beach nourishment


Bulldozer


Gravel ramp


Exposed pebbles


Post-storm seaweed


Sand ramp


Storm damage


Storm damage


Lobster traps post-storm


Berm erosion