

National Park Service
Inventory and Monitoring Division



Survey Timing and GPS Mission Planning—Version 1.0

Bracewell, J. 2017. Survey timing and GPS mission planning—Version 1.0. Gulf Coast Network Standard Operating Procedure NPS/GULN/SOP—SHR03. Gulf Coast Network, Lafayette, Louisiana.

This standard operating procedure (SOP) details the process for selecting the temporal window for conducting the survey. A standardized GPS survey window allows for comparability of the seasonal data set by collecting similarly-derived shorelines each year.

Revision Log

[illegible]

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Creating the Survey Window

Over the course of a year, a sandy beach goes through a landward and seaward oscillation as the land/water surface contact (the shoreline) varies in position based on wave energy, sediment supply, and water level. These seasonal oscillations result in a narrowing and broadening of the beach. A key objective of the long-term shoreline monitoring is to consistently capture a season-based conditional state, so that this oscillating effect is minimized. As the GULN shoreline monitoring effort seeks to avoid tropical storm impacted shorelines and nesting shorebirds and to maintain seasonal concurrence with other GULN monitoring efforts, April and May are highlighted as the best sampling months.

Applying the Neap Tide Variable

The GULN parks have diurnal tides; there is one high tide and one low tide each day. Each month there are two periods when the difference between high and low tide (the tidal range) is at a maximum, **SPRING TIDE**, and when it is at a minimum, **NEAP TIDE** (Figure 1).

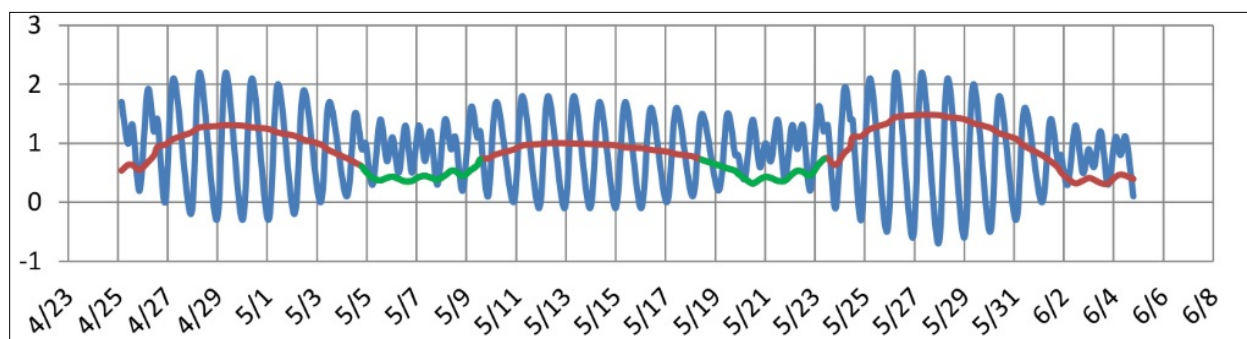


Figure 1. Predicted diurnal tide levels (in feet) during the May sampling window at Bob Hall Pier, Port Aransas, PAIS (NOAA 2017a). There is generally one high and one low tide each day. The spring tides peak at the end of April, mid-May, and late May. The neap tide periods are centered around 7 May and 21 May. These days, and the days immediately before and after, have minimal tidal variation and are ideal for sampling.

There are periods of mixed tides when there is not a clean neap/spring signal. Times of elevated water levels relative to spring tide have the potential to have wave-generated run-up (swash) overtop the berm crest and spill onto the berm surface. Times of reduced tidal range, such as neap tide, minimize the water level variations within the monthly tidal cycle and therefore minimize variations in the shoreline position. Therefore, the neap high-tide swash line provides an optimal reference line because it will form on the beach face and will represent similar shoreline positions (Figure 2).

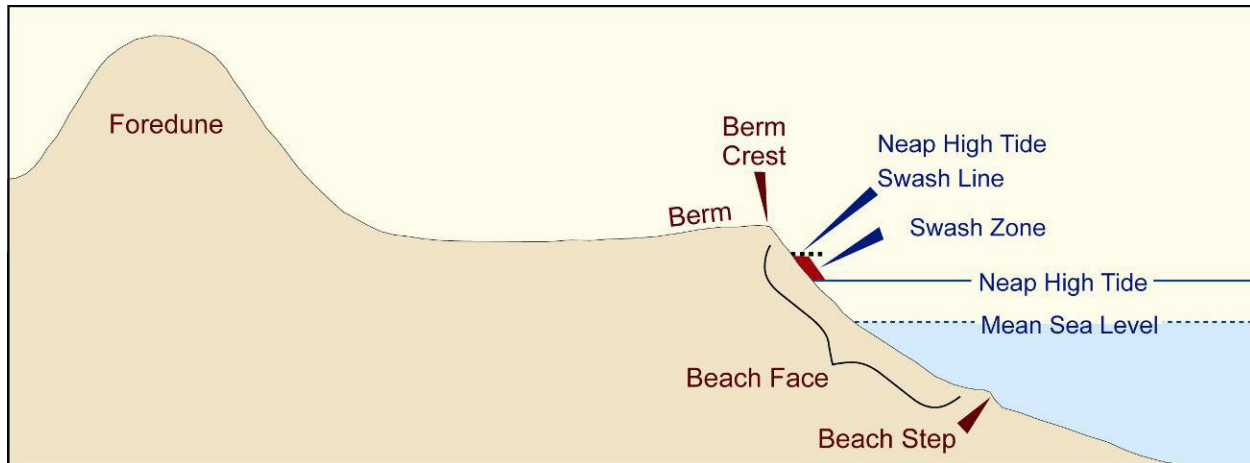


Figure 2. Conceptual dune-beach profile showing the juxtaposition of water level, topographic features, and the identification of the neap high-tide swash line. Figure and caption from Psuty et al. (2010).

Consequently, the optimum opportunity for shoreline collection within a one-month survey window is any day within three or four days of a neap tide when the tide level is minimum. Running the survey during the minimum tide levels will guarantee that the swash line location between surveys is consistent.

To determine the predicted tides for the survey window:

1. Go to the predicted tide calculations available at the following NOAA website:
https://tidesandcurrents.noaa.gov/tide_predictions.html (NOAA 2017a)
2. Select the station according to its Station ID (Table 1):

Table 1. Park station IDs and gauge locations for predicted tides.

Park	Station ID	Gauge Location
PAIS	8775870	Bob Hall Pier, Corpus Christi, Texas
GUIS, MS	8742221	Horn Island, Mississippi
GUIS, FL	8729887	Fort McRee Breakwater, Florida

3. Select Current Sampling year in the “Begin Date” dialog.
4. Go to “Published Tide Tables Formats” and select “Annual TXT” (Figure 3)

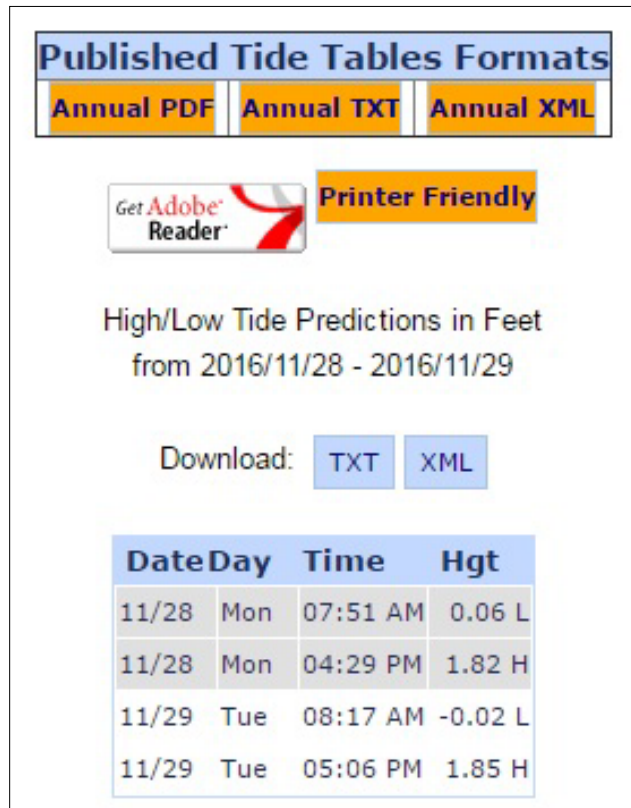


Figure 3. Screenshot of tide tables on the NOAA website.

Within each of the month-long survey windows designated for the spring surveys, there will be many available survey days around the dates of neap tide water levels. The selected survey day should be the earliest convenient day in the window to allow for rescheduling if necessary. If it isn't possible to conduct the survey in the prescribed sampling month, the survey should take place on the next available neap tide.

Applying the Variable of Satellite Availability

The GPS data used to record shoreline positions are derived from the time signals sent from satellites. Each surveyed position requires simultaneous readings from a minimum of four satellites (Trimble, 2014). Five or more satellites will improve accuracy slightly. More important than the finite number of satellites is the combination of their number and their geometry, called PDOP (position dilution of precision). The PDOP is a unitless value that describes the accuracy of the derived position based on satellite count and geometry. This numerical value may vary during the course of a survey and thus it needs to be considered in the date and time selection. A PDOP between zero and six is necessary to collect accurate and precise shoreline positions.

The PDOP is a predictable value that can be plotted for the planned survey day. Various planning tools, including Trimble Planning, will plot future PDOP values and allow the surveyor to plan for

predicted PDOP spikes (Figure 4). The plot represents the potential PDOP; this number will be increased (worsened) if the GPS/GNSS antenna has an obstructed view of the sky, or if satellites become unavailable. The PDOP value fluctuates throughout the day as the satellites move in their orbits and change their relative geometry. Predictions of PDOP value are valid for a maximum of 30 days in advance.

By late 2011, the Russian Global Satellite System (GLONASS) had reached global coverage providing access to a much larger constellation of satellites. A GPS receiver provides access to United States Global Positioning System, whereas Global Navigation Satellite Systems, or GNSS, provide access to GPS, GLONASS and other satellite systems. With the use of a GNSS receiver, it is unlikely that the PDOP will exceed 6.0. Although GPS receivers are capable of recording positional data adequate for this monitoring effort, because of their increased accuracy and reliability, GNSS receivers are recommended for shoreline surveys. Regardless of the receiver, it is advisable to check the PDOP plan to identify windows of poor satellite geometry, hence degraded positional accuracy.

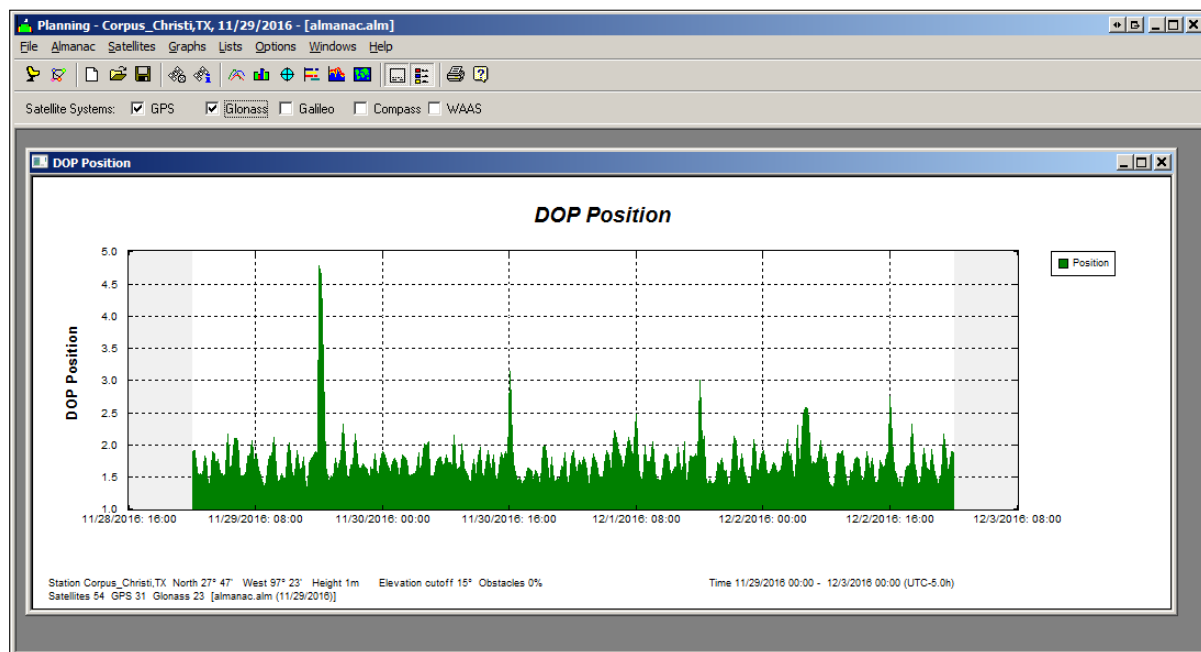


Figure 4. An example of the distribution of PDOP values using the Trimble Planning software. PDOP values between 0 and 6.0 meet the survey criteria. In this example none of the planned survey days exceed the threshold.

To obtain a prediction of PDOP prior to the survey:

1. On the Trimble website <http://www.trimble.com/gpsdataresources.shtml> (Trimble 2017), click “GPS almanac in SSF file format.”
2. When prompted, Save the File to Disk in the folder C:\Program Files (x86)\Common Files\Trimble\Planning.
3. Open Trimble Planning Software (TPS).

4. Select 'File,' 'Station' to open the Station Editor.
5. Select 'City,' Select location of the city nearest the survey site, or enter coordinates within the park.
 - a. PAIS – Corpus Christi, TX
 - b. GUIS, MS – Biloxi, MS
 - c. GUIS, FL – Pensacola, FL
6. 'Elevation Cutoff' is 15° and 'Height' is 1 meter (3.2 feet [ft]).
7. Select the date and time corresponding with the first day in the survey window.
8. Choose 'Time Zone' and select (UTC-6:00) Central Time (US and Canada). Check or uncheck Daylight Saving Time according to local time of survey, Click 'OK.'
9. Choose 'Almanac,' 'Load,' select the SSF file type, and browse to the almanac file downloaded in step 1. Click 'OK.'
10. Choose 'Graphs,' 'DOP – Position.'
11. Verify that PDOP is between zero and six for at least the majority of the survey day. If the PDOP frequently exceeds six, reschedule the survey to the next day in the survey window, and repeat the above steps.

Evaluation of Weather and Tide

In the Gulf Coast, the weather related tidal signal can be greater than the astronomical signal. Comparing the actual vs. predicted tides within the days leading up to a survey event can be helpful in identifying weather related tide events. A large difference between the astronomically predicted tide and the actual observed tide is usually representative of wind events that push the water level higher or lower than the predicted height creating a tidal surge. Planning a survey should involve an assessment of tidal surge the week prior to a survey event as well as accounting for predicted weather for the survey days. The project lead should start monitoring tidal surge six days prior to the planned survey day. Follow these steps to assess tidal surge:

1. Access the NOAA tide gauges through the CO-OPS website at <https://tidesandcurrents.noaa.gov/stations.html?type=Water+Levels> (NOAA 2017b).
2. Select 'Products,' then 'Water Levels.'
3. Select the appropriate station by station ID (Table 2).

Table 2. Park station IDs and gauge locations for assessing tidal surge.

Park	Station ID	Gauge Location
PAIS	8775870	Bob Hall Pier, Corpus Christi, Texas
GUIS, MS	8741041	Dock E, Port of Pascagoula, Mississippi
GUIS, FL	8729840	Pensacola, Florida

4. View the plot of water levels. The data may also be viewed in tabular form by clicking the **Data Listing** link. The difference between the **Prediction** and **Preliminary Observation** is the **Residual**, or surge (Figure 5). If the residual value exceeds one foot (0.3 meters [m]) at high tide in the week prior to the chosen survey day, the park contact should be consulted to see if unusually high tide events have occurred. If the presence of a storm surge prevents the shoreline survey from occurring during the allotted timeframe, reschedule the survey to the next convenient day in the survey window.

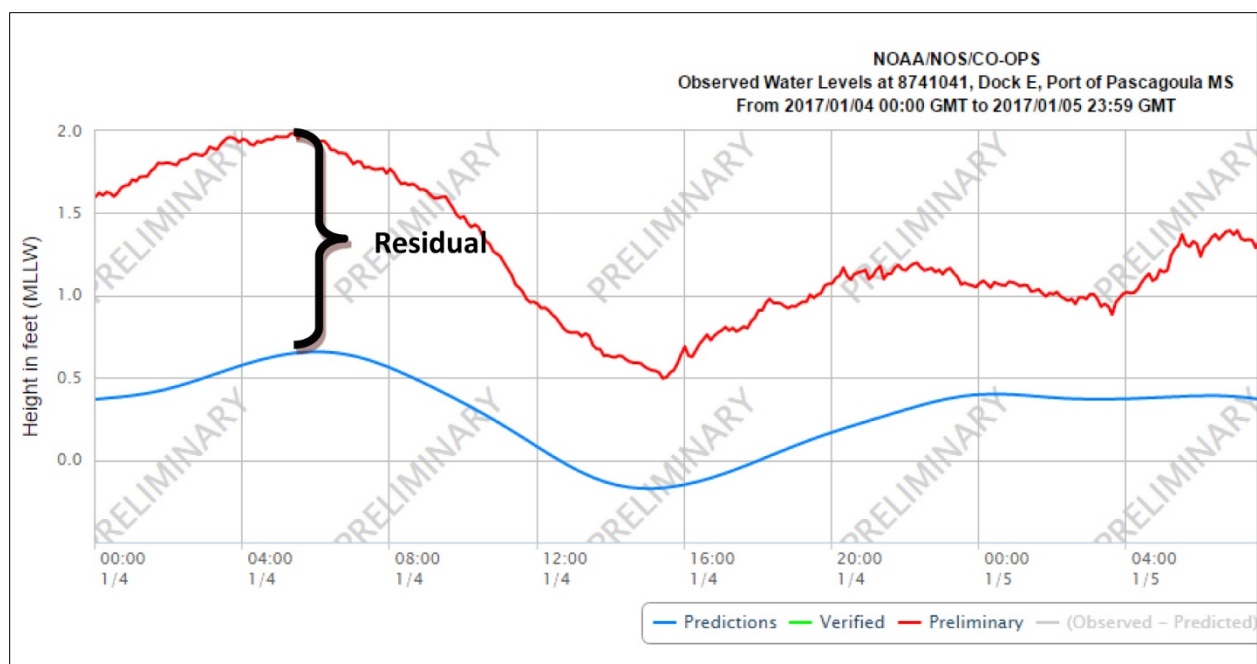


Figure 5. Residual of predicted vs. preliminary water level exceeding one foot may indicate a storm surge.

Likewise, if the weather predictions forecast high winds, a tidal surge is likely and the survey should be delayed until the next survey window. Although there isn't a hard and fast rule as to when the survey should be postponed because of weather, generally if the wind is forecast to exceed 20 knots (23 miles per hour [mph]), the survey should be postponed. Not only will these conditions create a likelihood of a surge exceeding 1 foot (0.3 meters [m]), but they will also create an unsafe work environment, especially where boat travel is required. Also, attention should be paid to active weather advisories such as 'Coastal Flooding.' Table 3 shows suggested stations and links for local weather forecasts.

Table 3. Local weather forecast stations.

Park	Forecast station website
PAIS	https://www.wunderground.com/us/tx/padre-island-natl-seashore (Weather Underground 2017a)
GUIS, MS	https://www.wunderground.com/us/ms/pascagoula (Weather Underground 2017b)
GUIS, FL	https://www.wunderground.com/us/fl/pensacola (Weather Underground 2017c)

Resource Related Issues

A complete shoreline position survey requires access to the beach face over the course of the survey. There may be time periods when access may be restricted to portions of the beach due to resource management issues that overlap with the survey window, such as periods of endangered species nesting, or park activities. Advanced planning is required to ensure complete spatial coverage.

Rare, Threatened, and Endangered Species

If the beaches are closed for resource related issues such as bird nesting, surveying the shoreline may require the assistance of park natural resource staff. The surveyor may require an escort through these areas, or the shoreline may need to be walked. If there are substantial areas that must be walked, allow extra time for the survey. If access to the shoreline will be completely restricted, plan the survey for an alternate day.

Other Constraints

There may be access restrictions or other activities that need to be addressed through park management. Scheduled events on the beach may restrict vehicular access to portions of the shoreline. If an event is planned on the survey day, allow extra time to walk the survey, or move the survey to another day in the survey window. If high beach visitation is expected during the survey dates, try to schedule the survey for a day when neap high tide falls outside of the peak visitation hours, such as early morning.

Storage of Planning Documents

Planning documents including tide predictions, weather forecast, PDOP plan, and correspondence related to resource-related restrictions should be exported to a .pdf format and organized in a folder named with the park name and date, and stored in the project directory at 'Z:\gis\guis\mon\geomorph\shoreline\trip_planning.'

Points of Contact

Shoreline surveys may overlap in time and space with other activities such as shore-bird or sea turtle surveys and might require cooperation and close communication between multiple agencies and divisions within the survey area. A contact list should be kept up-to-date and stored with the GPS/GNSS equipment. Contact should be made with any cooperating or neighboring agency, including management at state parks, county parks, other federal agencies, or other jurisdictional partners, in the weeks prior to the survey.

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