Continuous Water Level Standard Operating Procedures

Suggested citation: US Geological Survey. 2012. Water level continuous standard operating procedures. Unpublished protocols. USGS, Western Ecological Research Center, San Francisco Bay Estuary Field Station, Vallejo, CA.

Purpose/Objective:
Water level loggers are used to measure water depth in a continuous monitoring mode, collecting data at user defined intervals and storing the data until it is downloaded in the field. These data can be used to describe local tidal prism, a key indicator of sea level rise and a primary driver of habitat type and distribution. Number and spatial distribution of loggers is dependent on restoration and monitoring objectives and site specific considerations.

Due to the different installation, download, and maintenance requirements of various water level logger brands, we present here general guidelines and tips that should apply to all loggers.

Water Level Logger Types:
Loggers use pressure transducers to measure water depth. Data is affected by atmospheric pressure. Two primary types of loggers have been designed to account for this:

1. Vented cable corrects for atmospheric pressure automatically (Telog, YSI)
2. No cable, additional barometric sensor required for conversions (Solinst, HOBO)

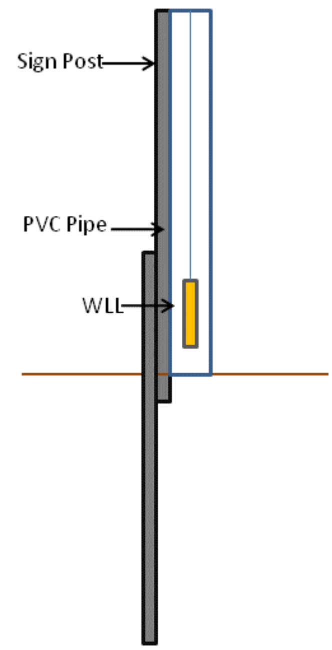

Figure 1. Diagram of water level logger (WLL) installation setup.

Field Methods: *Level logger Installation*
Methods for level logger deployment will vary by site. Considerations include:

1. sampling intent
    a. full tidal range – logger should be placed in deepest part of tidal channel to capture both highest and lowest tides.
    b. marsh inundation time – logger can be installed on marsh plain to record times and depths when marsh plain is inundated.
2. logger location (e.g. river, tidal channel, or marsh plain)
3. method of access (e.g. boat on high tide vs. foot on low tide)
4. substrate type – soft substrates may require additional reinforcements to keep logger in place
5. potential threats to instrument (e.g. logs, *Ulva sp.*, boats)

For most purposes, installation includes driving a length of fence post into the ground to which the logger is attached, either directly to the post or in a protected PVC pipe. It is critical that the logger be returned to the same location within the water column after each download so that water depth data can be converted to a tidal datum. Otherwise, the elevation of the logger must be surveyed during every download.

Field Methods: *Surveying Logger*
The elevation of the logger in the field should be measured using surveying equipment or a Real Time Kinematic Global Positioning System (RTK GPS) so that water depth data can be converted from relative depth to elevation or tidal datum to allow for comparison amongst sites and to predicted tides.

Continuous Water Level Standard Operating Procedures

Field Methods: *Programming Logger*

Before deploying a level logger for the first time, the logger settings must be set by directly connecting the logger to a computer. Use instructions provided by instrument's user manual.

Sampling frequency typically can be changed and may range from every 6 minutes to every hour. When determining your sampling frequencies consider the following:

- alignment with other data (e.g. NOAA (6 min or 1 hr))
- resolution needed for inundation models
- download frequency (more data points = more downloading)

Field Methods: *Download & Maintenance*

Download frequency will depend on logger data storage capacity and sampling frequency. When out in the field, check logger for the following:

- corrosion (may need to replace; zinc washers may eliminate metal on metal corrosion)
- biofouling, clean if needed (nylons and/or copper mesh or tape around sensor may help)
- battery life
- data; does it make sense? (recommend bringing back up logger with you in case you need to swap out a broken logger)

Field Methods: *Calibration (optional)*

If your logger also measures water quality parameters (e.g. conductivity, DO, etc.), adjust your download schedule to recommended calibration frequency.

Data Entry and Analysis:

Output from loggers is a series of water levels. Data should be:

1. Corrected for atmospheric pressure (if applicable)
2. Converted to elevation (e.g. NAVD88 or MHHW)

After corrections have been made, data can be used in multiple analyses. Examples include:

1. Hydrographs
    a. Analyzing change over time with restoration actions (e.g. increased tidal prism, range, etc.)
    b. Comparing restored to reference tidal channels

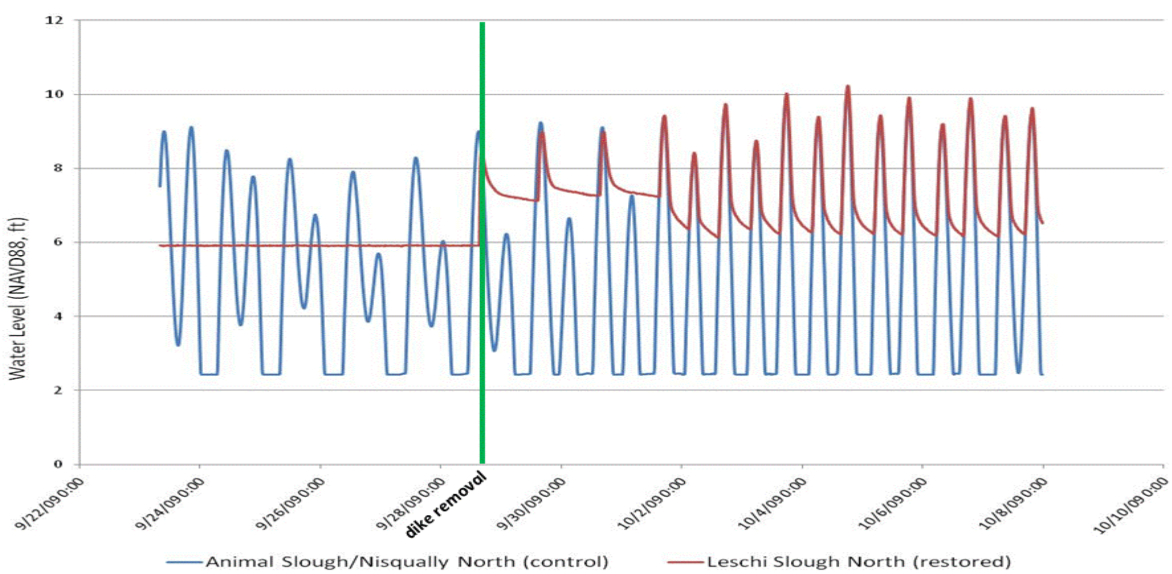

Figure 2. Hydrograph comparing restored (Leschi) and control (Animal) tidal sloughs pre- and post-dike removal, Nisqually Estuary, WA.

Continuous Water Level Standard Operating Procedures

2. Inundation Curves (in combination with tidal marsh elevation data)
    a. Calculate the amount of time areas of interest are accessible to fish, mammals or specific waterbird guilds
    b. Model changes in access in relation to sea level rise

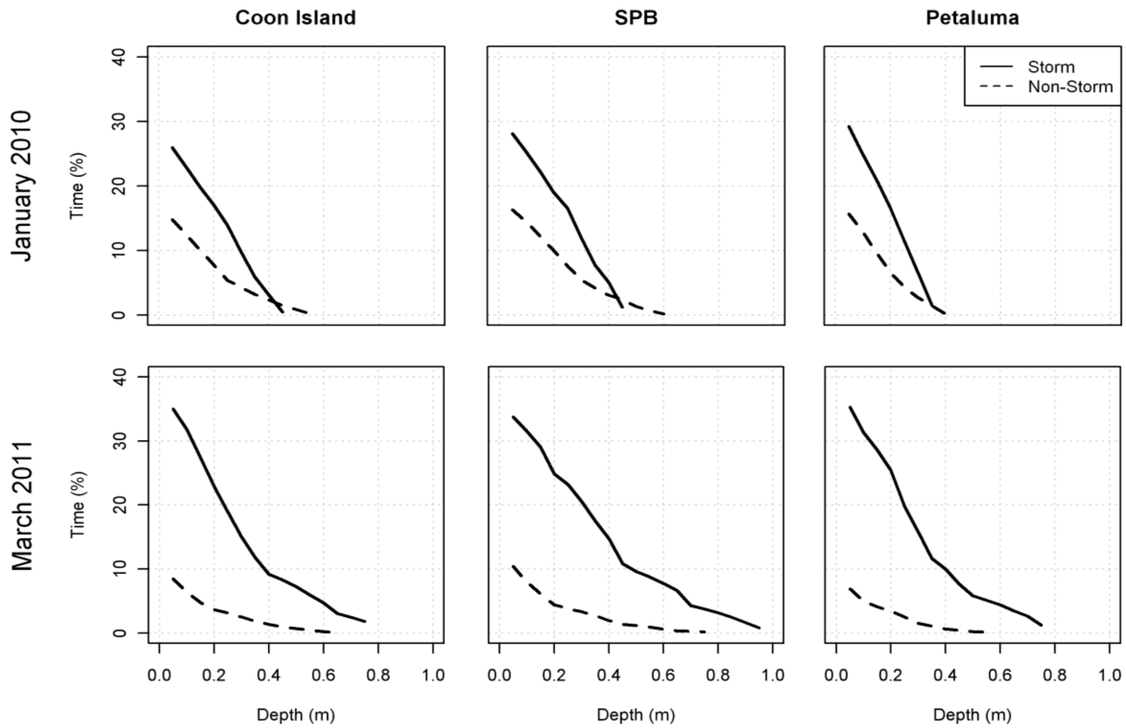

Figure 3. Comparison of inundation at three tidal marshes in San Francisco Bay, CA during storm and non-storm periods (Thorne et al. In review).

3. Percent Inundation 3D maps (in combination with tidal marsh digital elevation model)

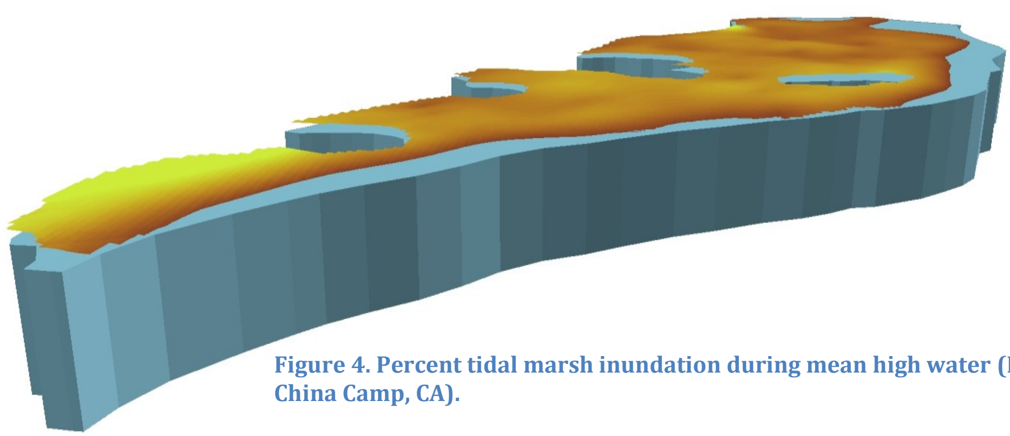

Figure 4. Percent tidal marsh inundation during mean high water (MHW; China Camp, CA).

References:

Thorne K. M., K. J. Buffington, K.M. Swanson and J.Y. Takekawa. *In review*. Frequency of storm events and climate change implications for salt marshes in San Francisco Bay, California. Quaternary International.