Nearshore Substrate Inventory (Loop 2 – along with CWH)

The nearshore substrate inventory (NSI) obtains data on littoral substrates potentially available for fish spawning. We recommend conducting the NSI during the coarse woody habitat (CWH; optimally during early spring or fall for best visibility) survey as part of "Loop 2" within the Lake Shoreland & Shallows Habitat Monitoring Field Protocol (LSSP). As in the LSSP, begin by measuring the water clarity via Secchi disk to the nearest 0.5'. If the observed Secchi depth is less than 2', do not perform the survey due to unreliability of visual observations. Record the present water level (PWL) by checking if the water level is below, at, or above the high water level (HWL, see LSSP pg. 7). If the present water level is low enough where accurately observing exposed lake bed substrates back to the high water level is not possible, do not perform the NSI survey.

The observation team should calibrate their eyes to the size gradients of the associated substrate classifications below (Table 1) using a tape measure and commonly recognized items (Figure 1) before beginning the survey and periodically recalibrating as needed. The "wood calibration stick" used for CWH assessment can also be used for substrate size classification determinations. The PVC portion of the calibration stick is 6" long with 4" diameter and is attached to a 5' long wooden pole. "Rubble" diameter measures approximately one length (+) of the PVC portion, whereas "Boulder" diameter measures two (+) lengths.

Take a GPS waypoint at the boat landing designating the starting point of the survey and corresponding to the first ID # on the data sheet (note: ensure all GPS waypoints correspond to their respective data sheet ID #s) and record the predominant substrate class observed. The driver should operate the boat slowly at the 2' depth contour as close to shore as possible. Wearing polarized sunglasses, the observer should continually scan the substrates present across the zone between the PWL and 2' depth, recording the predominant substrate class present following the substrate classifications in Table 1. If an approximate equal mix of two or more substrate classes are present within the PWL and 2' depth zone, the substrate class present at the PWL should be used to determine the predominant classification recorded. When the predominant substrate class changes (only in the PWL -2' depth zone), another GPS waypoint should be taken at the transitional point to identify the end of the preceding ID # and the beginning of the new/present ID # (i.e., end of one substrate class and start of another). Keep in mind that if CWH point data is also being collected concurrently, substrate classification ID #s will likely not be consecutive but perhaps separated by several ID #s representing CWH data. Collect subsequent GPS waypoints at each following transitional point where predominant substrate class changes and recorded as new data sheet ID #s (Figure 2, Appendix A).

There is no minimum shoreline distance required for designating a new substrate classification. However, if a classification change is questionable and moves only to a directly adjacent classification (e.g., Sand – Gravel), the observer should try to look ahead to determine if the suspected new classification persists or not. Teams should use their best professional judgement in these questionable cases as to whether a classification change is warranted, but in general, if the lineal distance of the new substrate class is ≥ 30 ' (approx. two boat lengths) then it should be documented. More apparent substrate classification changes (e.g., substrate size changes skipping an adjacent class; Sand – Cobble, skipping Gravel) should be recorded regardless of distance.

For assessing substrate around islands, use a unique data sheet for each island, identifying the respective island by name (if applicable) or some other informative characteristic(s) within the "portion of lake" field at the top of the data sheet. Island waypoint ID #s should continue in sequence as conducted within the entire survey. Record the direction of travel, and also note that when you complete a portion of a lake (whether a loop around the main shore or a loop around an island), you should not record an end waypoint unless there is a substrate transition at that location that needs to separate the end substrate zone from the first one. The first waypoint will always be used as the last waypoint for each respective "portion of lake" surveyed. See Appendix A.

When lake levels are low and expose at least 3 horizontal feet of lake bed between the PWL and the "bank toe" (see LSSP pg. 9), survey the substrate on the exposed lake bed. Record "Y" (yes) in the "Exposed Bed" data sheet column in the same row as the adjacent substrate class present in the 0-2' depth zone and record the predominant substrate class of the exposed lake bed (Figure 3).

Classification	Description	Size Range
Man- made/Artificial	concrete, blacktop, artificial boat landing materials, etc.	NA
Inaccessible	too shallow (S), too densely vegetated (V), too much wood (W), artificial structure (A)	NA
Organic Matter	muck, silt, detritus (fine and coarse particulates)	NA
Sand	NA	0.2 – 6.3 mm (0.01-0.249 in.)
Gravel	NA	6.4 – 76.0 mm (0.25-2.99 in.)
Cobble	NA	76.1 – 149.9 mm (3.0-5.90 in.)
Rubble	NA	150.0 - 303.9 mm (5.91- 11.96 in.)
Boulder	NA	≥ 304 mm (≥ 11.97 in.)

Table 1. Substrate classifications used for the nearshore substrate inventory. Taken/modified from Richter et al. 2016 and Raabe and Bozek 2012; Specific to lake substrate classifications, not equivalent to wadable stream substrate classification measurements.

Clarification on Table 1 Substrate Classifications

The "Man-made/Artificial" substrate classification is only for unnatural materials such as concrete, blacktop or other synthetic materials. Artificially placed, natural substrates (e.g., sand blanket, gravel reef, rip rap) within the 0-2' depth zone should be recorded following the appropriate substrate classifications. Seawalls, rip rap, beaches, and other artificial shoreland modifications are identified within the bank zone assessment of the LSSP. For seawalls or

natural shoreline rock cliff scenarios where water depths directly underneath exceed 2', simply try to document the predominant substrate present.

The "Inaccessible" classification is for scenarios where substrates cannot be observed. If an area is "Inaccessible" identify the reasoning with one of the following tag acronyms on the datasheet: "-S" = too shallow, "-V" = too densely vegetated; "-W" = large amount of woody habitat; "-A" = artificial structure in way (e.g., boat house, pier complex).

NSI Step by Step Instructions

- 1. For maximum efficiency, conduct the NSI survey along with the CWH assessment during loop 2 of the LSSP. Record the woody habitat and substrate data concurrently using the "Wood_Substrate_Datasheet.pdf".
- 2. Before beginning the survey, measure the Secchi depth in deep water, and record whether the PWL is below, at, or above the HWL.
- 3. Calibrate eye to size measurements associated with substrate classifications (Table 1, Fig. 1).
- 4. Record a GPS waypoint at the survey starting point (typically the boat landing) that corresponds with the first data sheet ID # and record the predominant substrate class.
- 5. Traverse the entire lake shoreline at the nearest 2' depth contour to shore. Using polarized sunglasses observe substrates within the PWL 2' depth zone, recording each subsequent transitional point where the predominant substrate class changes. Each transitional point should correspond to a data sheet ID # (representing the beginning of a new substrate class and ending of the preceding substrate class/ID #).
- 6. For the zone in step 5, evaluate if an exposed lake bed exists (≥ 3 horizontal feet between PWL and bank toe). If so, indicate yes with a "Y" on the data sheet and record the predominant substrate class present. If not, indicate no with a "N" on the data sheet and leave the substrate exposed lake bed class blank. Substrate changes within the exposed lake bed should not be uniquely identified by a separate ID #.



Figure 1. Practical field examples of sand and rock substrate classification sizes with depictions of common items that align closely with the thresholds between size classifications.



Hypothetical Field Examples and Data Recording





Figure 3. Hypothetical coarse woody habitat and nearshore substrate scenario with an exposed lake bed present. The example data sheet shows how the woody habitat and substrate data recordings would differ with an exposed lake bed.

References:

- Hein CL et al. 2020. Lake shoreland & shallows habitat monitoring protocol. WI Dept of Nat Res. EGAD # 3400-2020-19.
- Raabe JK, Bozek MA. 2012. Quantity, structure, and habitat selection of natural spawning reefs by walleyes in a north temperate lake: a multiscale analysis. T Am Fish Soc. 141(4):1097–1108.
- Richter JT, Sloss BL, Isermann DA. 2016. Validation of a side-scan sonar method for quantifying walleye spawning habitat availability in the littoral zone of northern Wisconsin lakes. N Am J Fish Manage. 36(4):942–950.

Appendix A. Hypothetical lake habitats scenario depicting appropriate procedures and data collection following the Nearshore Substrate Inventory protocol.

