Great Lake Environmental Indicators (GLEI)
Standard Operating Procedures:
Fish and Invertebrate Community Sampling

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Site Selection Process: Map Based Selection Criteria

1. 20 clusters will be defined for each geomorphic unit, and segments will be randomized within each cluster.

2. Segments will evaluated in the order in which they appear on the spreadsheet and chosen to maximize coverage of the stressor gradients and overlap among subprojects.

3. Unit definition:

A) Embayment: opening must be narrower than the distance from mouth to shoreline; area > 1 km^2. Embayments cannot contain > 1 embedded embayment meeting the above criterion. Dominant hydrologic processes represent a continuum of lake to riverine influences, depending on the size of the opening to the lake and the number and size of rivers entering the embayment. Minimum size = 1 km^2; Maximum unit = 20 km^2

Note[1]: Estuaries are embayments fed by large rivers. Large estuaries (e.g., St. Louis River) usually contain smaller embayments and therefore are excluded from our sampling domain. We will sample bays fed by tributary streams when: 1) the stream mouth is not a dominant habitat zone (mouth and delta are < 10% of unit), 2) the bay is large enough that transects can be placed more than 500m from the mouth of the stream.

Note [2]: Embayments frequently contain fringing wetland vegetation. We will classify a unit as an embayment when the fringing vegetation comprises less than 50% of the unit.

Note [3]: Drowned river mouth systems frequently terminate in a large lake which has an inlet into one of the Great Lakes. These large lakes resemble bays in many ways, except their hydrology is regulated largely by riverine and watershed processes, and stressors are largely derived from upstream sources.

B) High energy shoreline - open shoreline; may be contained within a large embayment (e.g., Green Bay), but emergent vegetation must not be more than 10% of the unit (and therefore is not considered a dominant shoreline zone). Minimum size = 2 km of shoreline; Maximum size of unit = 10 km of shoreline x 2 km into lake. Segments that are smaller than 2 km can be considered if adjacent segments belong to the same cluster.

[Note[1]: High energy shoreline can be formed by the presence of rip rap, dykes, and other shoreline hardening.

Note [2]: High energy shoreline can be contained within a large embayment (e.g., Green Bay).

Note[3]: High energy shoreline can be shorter than 2 km in situations where all the high energy shoreline in the area is divided into small segments, and adjacent segments fall into the same cluster. See notes under transect placement for

details.]

C) Protected Wetland: wetland that lies behind a land barrier; “isolated from most direct hydrologic processes generated by the lake” (Keough et al. 1999); small tributaries may feed into this unit type; small outlets (less than 5-10 m in width) may be present and may connect the unit to the lake. Sediments are mainly organic, overlying sand or sandy gravel. Minimum size = 4 ha; maximum = 200 ha (including emergent & wet meadow zones)

D) Coastal Marsh: Directly connect to the lake; substrates variable depending on the depth and exposure; may or may not have offshore islands or reefs. Minimum size = 4 ha; maximum = 200 ha (including emergent & wet meadow zones)

E) River-influenced wetlands: Directly connect to both the lake and the watershed; sediments are variable, but probably intermediate between coastal marsh and protected wetlands with respect to depth of organic deposits. Many river-influenced wetlands contain semi-protected or protected wetlands within their floodplain. Minimum size = 4 ha; maximum = 200 ha (including emergent & wet meadow zones)

4. Information to be noted while performing assessments:
   a) Access to a boat ramp (~5 mi, (8 km) or less)
   b) Ownership (i.e., Indian reservation, other restrictive holdings as noted on topo maps such as wildlife preserves, etc...)
   c) Selection by Bird/amphibian subproject; Selection by Contaminants Subproject; selection by EPA wetland group or other GLEI subprojects.
   d) situated within a QuickBird image zone
   e) Size of unit
   f) Overlap with other projects, e.g, NSF Biocomplexity

SITE SELECTION AND SAMPLING LOCATION DELINEATION:

1. UNIT SIZE:

A. High energy units will have shorelines a maximum of 10 km and a minimum of 2 km long (minimum size of unit = 2 km x 2 km from shore), and located within 8 km of a boat access point. [Note: In areas where all high energy shoreline is in short segments, the selected segment may be shorter than 2 km long.] The maximum distance from shore for sampling in high energy units is at the 10-m contour or 2 km offshore, whichever is closer to shore. Similarly, we will sample at the nearer of the 5-m contour or 1 km from shore, whichever is closer to shore. The maximum area to be circumscribed by sampling in a high energy zone is 10 km x 2 km (20 km^2 or 2000 ha).

High energy units longer than 10 km will be subsampled as follows: 1) If there are multiple access points (e.g., boat ramps) in the segment, choose the boat ramp that lies closest to the center of the segment; 2) measure the segment length on each side of the boat ramp that falls within the segment; 3) choose the longer of the two segment lengths; 4) select a shoreline length that encompasses 10 km of shoreline on that side of the ramp. If the length of that shoreline is less than 10 km, include whatever distance is needed on the opposite shoreline to the boat ramp to achieve 10 km.

Sampling areas for high energy units shorter than 2 km will be selected using the following criteria: Sampling areas should be at least 250 m from the boat launch and any 2^{nd} order or greater streams; sampling areas should be a minimum of 500 m and up to 2 km in length, if possible, and may cross segment shed boundaries as long as the shoreline remains high energy and meets the above criteria; if possible locate one sampling area on either side of the stream defining the segment shed.

B. Embayment: Defined geometrically by having an enclosed area of shoreline whose bay length is greater than the width of the opening to the Lake. Minimum water area is 1 km^2. Our sampling domain will not include embayments larger than 20 km^2 (2000 ha). Bays will be treated as unique sampling units, even when they cover more than one shoreline segment. Large embayments can contain high energy shoreline units and coastal wetland units, provided they meet the criteria defined above.

C. Wetland units must be a minimum of 4 ha of open water + emergent vegetation. Units larger than 200 ha should be subsampled. To subsample, a random point will be selected along the shoreline of the wetland within 10 km of an access point. A 200 ha area enclosing that point will be selected, the shape of which will be determined by the type and shape of the wetland. If this polygon does not include sufficient aquatic habitat to permit 6 transects [e.g., at least 3 km of shoreline length], a second point will be selected. These points will be determined prior to field sampling.

2. Transect Placement

Prior to arriving in the field, check aerial photos. Note dominant shoreline habitat zones (a shoreline zone is created by the combination of shoreline type or structure and the upland landuse adjacent to (behind) the shoreline. Combinations of shoreline types and landuse types create different shoreline habitat zones). Generally the three most dominant shoreline zones will be sampled. Determine approximate location of transects from air photos. Where possible transects will intersect those of the vegetation group at the wettest end. The following rules should be applied to the positioning of transects:

A) For all unit types:

- Since segments are defined by rivers of 2nd order or greater, all segments will contain a river. Transects should be at least 500 m (1/2 km) from the mouth of a river (except for riverine wetlands) or from a boat ramp. An exception will be made when for segments that contain a high density of 2nd order or larger streams (e.g., Lake Erie, Lake Ontario). In these situations, transects may be located up to 250 m from the river mouth.
- A minimum distance of 100 m (high energy and embayments) or 50 m (wetlands) must be maintained between adjacent transects.
- A minimum of 2 transects is sampled for each unit.
- Three dominant shoreline zones will be sampled. Each zone must represent at least 10% of the shoreline length of the unit to be considered "dominant". The configuration of shoreline zones will determine the placement of transects. If a shoreline zone is represented only once within the unit, divide the segment into two halves and place a transect in the center of each half. If the shoreline zone is repeated within the unit, single transects should be located at the center of each shoreline zone.
- Sample points on different transects should not be located within 50 m of one another. In the event that this distance cannot be achieved, the sample will be collected, but the data sheets for both samples should be marked as follows. "**SAMPLE LOCATED WITHIN X m OF SAMPLE NUMBER X ON TRANSECT X**."

B) High Energy Shoreline: If the shoreline unit extends 10 km or more, we will allocate 6 transects to even a homogeneous shoreline unit (one with no differences in shoreline zones). If the reach (defined by geomorphology) is smaller than 10km long and homogeneous, we reduce the number of transects proportionally. e.g., if the unit is 5 km, we employ 3 transects - 1 transect for every 1.6 km of shoreline - but we always sample a minimum of two transects per site.

Transect Number:

1) unit 10 km; 6 transects even with a homogeneous shoreline;
2) 1 transect for every 1.6 km of shoreline;
3) minimum of 2 transects per unit.

Sample locations on transects will be distributed as follows:

1) shallow emergent zone: 0.25 - 0.5 m
2) emergent/submergent zone 0.5 - 1 m
3) 5 m contour or deepest point possible within 1 km of shore.
4) 10 m contour or deepest point possible within 2 km of shore.

C) Embayments: Rivers are commonly found entering embayments. Transects within embayments should be at least 1/2 km from the mouth of a river, and the opening of the bay. A minimum distance of 100 m should be maintained between adjacent transects.

In the event that the unit contains only one shoreline zone, transects will be allocated as follows:

1) > 1000 ha = 6 transects
2) 1000 - 100 ha = 4 transects;
3) <100 ha with homogeneous shoreline units and homogeneous aquatic habitat = 2 transects.

Sample locations on transects will be distributed as follows:

1) shallow emergent zone: 0.25 - 0.5 m
2) emergent/submergent zone 0.5 - 1 m
3) 5 m or deepest point possible within 1 km of shore.
4) 10 m or deepest point possible within 2 km of shore.

In an enclosed basin, the deepest samples on different transects may begin to converge upon one another. Sample points on different transects should not be closer than 50 m of one another. In the event that this distance cannot be achieved, the sample will be collected, but the data sheets for both samples should be marked as follows. "SAMPLE LOCATED WITHIN X m OF SAMPLE NUMBER X ON TRANSECT X."

D) Riverine Wetlands: Transects run from shore to deeper water, perpendicular to the shoreline rather than parallel to the watercourse. A minimum distance of 50 m should be maintained between adjacent transects. Samples should not extend into the river thalweg, but rather, should be restricted to the depositional areas adjacent to the river channel. Two areas within riverine wetlands will be sampled: 1) off-channel areas that maintain an active connection to the river channel (i.e., not totally enclosed) and 2) depositional areas of the river channel that support wetland vegetation. Unvegetated river mouths and shorelines are outside the sampling domain of the unit.

Sampling areas will reflect most of the criteria used by the REMAP group. "Areas will be geographically centered in the wetland so that it would neither be too far upstream and therefore be considered tributary water or out of the influence of the lake seiche action, nor would it be too close (or adjacent) to coastal great lake waters unless this is the only place where there is open water." The GLEI group has decided that samples should generally be confined to areas within 2 km of the lake.

In the event that the unit contains only one shoreline zone, transects will be allocated as follows:

1) > 100 ha = 6 transects;
2) 100-50 ha = 4 transects;
3) <50 ha with homogeneous shoreline units & homogeneous aquatic habitat = 2 transects

Sample locations on transects will be distributed as follows:
1) shallow emergent zone: 0.25 - 0.5 m
2) emergent/submergent zone 0.5 - 1 m
3) deepest point possible, but not including thalweg of river channel.

D) Coastal Wetlands: Rivers are commonly found entering coastal wetlands. Transects within coastal wetlands should be at least 1/2 km from the mouth of a river. A minimum distance of 50 m should be maintained between adjacent transects (100 m is preferable).

In the event that the unit contains only one shoreline zone, transects will be allocated as follows:
1) > 100 ha = 6 transects;
2) 100-50 ha = 4 transects;
3) <50 ha with homogeneous shoreline units & homogeneous aquatic habitat = 2 transects

Sample locations on transects will be distributed as follows:
1) shallow emergent zone: 0.25 - 0.5 m
2) emergent/submergent zone 0.5 - 1 m
3) deepest points possible but not farther than about 500 m offshore of the deepest visible vegetation (this sample should still be reasonably close to the wetland, not way out in the lake).

E) Protected Wetlands: Small tributary streams are commonly found entering protected wetlands. Sample points should be placed to avoid the direct influence of these tributaries (sampling locations should be 250 to 500 m from the stream mouth, if possible). A minimum distance of 50 m should be maintained between adjacent transects (100 m apart is preferable).

In the event that the unit contains only one shoreline zone, transects will be allocated as follows:
1) > 100 ha = 6 transects;
2) 100-50 ha = 4 transects;
3) <50 ha with homogeneous shoreline units & homogeneous aquatic habitat = 2 transects

Sample locations on transects will be distributed as follows:
1) shallow emergent zone: 0.25 - 0.5 m
2) emergent/submergent zone 0.5 - 1 m
3) deepest point possible

3. Fyke Net Placement

SEE THE FISH SOP DOCUMENT.

4. Benthos Sample Locations

The number and placement of sample locations along a transect is sample unit dependant (see above Transect Placement A-E). Sample locations will be evaluated for vegetative cover, sediment, water chemistry, and macroinvertebrates. Points along a transect are allocated based on depth, but vegetative cover and habitat may influence placement. For example, if the 0.25 - 0.5 m and the 0.5 - 1.0 m contours contain a succession of vegetative cover (e.g., from emergent to submergent) the sample points should be placed in an area containing a vegetative break or an edge.

These observations are made at each point (0.25 - 0.5 m, 0.5 - 1.0 m, and deepest point) on each transect in each unit type:

A. Water quality parameters are measured with meters (see Data Sheet Instructions)

B. Sediment parameters are collected with probes and the sediment is described (see Data Sheet Instructions)

C. Sediment is collected for particle size analysis and contaminant evaluation

1. Fish/Invert Subproject takes ponar samples at each depth point (emergent, submergent, etc) on each transect.
2. Similar depths across transects are composited, with the goal of collecting at least **2 L** of sediment, total, for each depth composite.
3. From each composite, fill a 1 gallon heavy duty ziplock bag at least half-full.
4. Double bag sample, label with segment number, date, and depth to label, and store in cold and dark.
5. Contaminant Subproject personnel will retrieve samples from NRRI and take to EPA-MED for toxicity screening.
6. For the 20 contaminants sites: A subsample of about 100 mL wet sediment is placed in each of 2 clean Qorpak jars and shipped to UMN-TC by EPA-MED.

D. Invertebrates are sampled:

a) Emergent zone samples include 2 benthic cores and 2 D-net sweeps.

- Core samples are taken in duplicate with a 7.62 cm (dia.) x 50 cm polyethylene tube. The core is designed to sample sediment and detrital surfaces of open shorelines and within emergent aquatic vegetation. The core device is forced into the bottom substrate and then retracted after making a seal on the upper end of the cylinder (eg., using your hand or stopper). A 10 cm line marks either end of the core. An extruder is forced into the bottom end of the core until the desired sediment layer remains (only 10 cm). Samples are washed through a 250µm wash net, preserved, and labeled (see CODE SHEET).

- Rock scrubs replace cores when substrate conditions do not allow coring. Rock scrubs are collected by removing enough rocks to equal the ponar surface area (approximately 0.023 m^2). Rocks selected should be counted, two circumference measurements recorded (2 axes), and placed in a wash basin. Water is added and particles are thoroughly scrubbed. Contents of the wash basin are poured through a wash net (250 µm) and the remainder preserved (see below) and labeled (see CODE SHEET).

- D-framed nets (500 µm) are used to sweep aquatic vegetation, large substrates, and to jab into debris piles or vegetative mats. A pulsating action on substrate surfaces is recommended to dislodge macroinvertebrates and to avoid excessive amounts of detritus and substrate particles. Continuous forward movement is also required. D-nets sampling is timed (30 sec.) and an estimated distance covered during sampling is recorded. See Sweep Protocol below for more details. D-net samples are taken in duplicate, preserved separately (see below), and labeled as per the labeling protocol (see CODE SHEET).

b) Submergent zone samples include 2 d-nets and 2 cores or 2 petite-ponars.

- D-net and core procedures are identical to Emergent Zone effort.
- A petite-ponar dredge (0.023 m^2) is used in locations that cannot be sampled effectively with the sediment corer. The ponar device is gently placed on the surface, activated, retrieved, and placed in a wash basin. The contents are not saved when samples are returned with no sediment, or substantial amounts of water, flowing from the device. If grabs do not return "good" samples, 5 or 6 attempts are made before moving to an alternate point. Estimate percent fullness of the ponar.

c) Open water, 5 and 10 m sample locations include 2 ponar samples as described above.

E. Sample Processing

All invertebrate samples are hand washed through 250 µm mesh netting and preserved in Kahle's preservative (D-nets are outfitted with 500 µm mesh but the small 250 µm nets are used to transfer contents from the basin to the sample jar). All samples are spiked with enough preservative to cover all contents. Use additional jars if sample completely fills the original sample container. Remember to label multiple-jar samples appropriately (i.e. ponar 1 of X). After the samples are spiked the jars should be adequately rotated to mix the preservative and the sample contents. Samples are labeled on the inside and outside of each container. See Benthic Sample Processing SOP for details (NRRI/TR-99/37).

F. Habitat Evaluation: Fill out the habitat evaluation for each transect point (see Data Sheet Instructions)

SWEEP NET SAMPLING PROTOCOL

The goal of sweep samples is to collect the epifauna - organisms that live upon the substrate or in/among macrophytic vegetation or attached to/beneath stones. Core and ponar samples will collect the infauna. We use sweeps especially to try and sample the large, rarer, often strong-swimming benthic organisms that may not turn up in cores or ponar grabs. These may include

-large hemipterans (water scorpions, water striders, giant waterbugs, etc.).
-diving beetles and whirligigs
-dragonfly and damselfly larvae
-megalopterans
-mayflies
-cased caddisflies
-crayfish and freshwater shrimps
-unionid clams

Sweep samples are collected in the 'emergent' (0-50 cm) and submergent (50-100 cm) zones. Each sweep sample represents a composite of collections from the various microhabitat types that can be located within 20-30 m of the core sample location. Sweep samples should be taken on foot, if possible. However, soft substrates or deep water may necessitate sweeps being collected from the side of a boat.

Each distinctive microhabitat type should be sampled for a total of 30 s.

When sweeping along the bottom, the dip net should be brushed along the substrate with the lower lip just touching or slightly beneath the sediment surface to dislodge epibenthic animals but minimize the amount of sediment scooped into the net. Sweeps have to be rapid enough to prevent strong-swimming benthos (corixids, beetles) from escaping. Fine sediments in the net can be reduced by raising and lowering the net in the water (keeping the mouth above water) to flush out fines before emptying the net contents into a pan (see below).

When sweeping through submergent and emergent vegetation, the goal is to brush the stems and leaves to dislodge epiphytic organisms without collecting large masses of organic materials. Fine sediments in the net can be reduced by raising and lowering the net in the water (keeping the mouth above water) to flush out fines before emptying the net contents into a pan (see below).

Often, specimens will be seen but will evade capture within the 30-s time limit. These observations should be recorded on the field notes sheet.

Following sweeping and flushing, the net contents should be emptied into an enamelled pan containing 5-10 cm depth of water. Mats of vegetatatation and clums of sediment can be teased apart wth coarse forceps. If the water is very murky, the sample can be emptied back into the net and flushed again.

Note and record the presence of large, easily identifiable taxa on the zoobenthos data sheet.

Unionid mussels should be photographed (if possible) and released. Also record and release crayfish and freshwater shrimp if more than one or two are captured. Fishes should be identified, noted, and released.

Large leaves, stems and pieces of detritus should be gently rinsed to dislodge adhering animals and discarded.

Material remaining in the pan should be emptied into a sieve bucket or sieve bag and treated like a Ponar grab or core sample.

Sweeping techniques:

a. Forward shovel-sweep. The net is held in front of the body with the mouth facing away, while walking forwards, with the lower edge at or just beneath the substrate surface. Five to ten m should be covered over the 30-s sampling period. This is used on unvegetated or sparsely-vegetated substrates.

b. Arc-sweep. The net is held in front of the body and swept in an arc while gently probing the submergent or emergent vegetation strongly enough to dislodge benthos but not so strongly as to dislodge huge masses of vegetation. This may be interspersed with the forward shovel-sweep.

c. Backward/sideways kick-shuffle. This method is used for coarse (gravel, shingle, cobble, bedrock), hard substrates, where the substrate is difficult to turn over or penetrate with the bottom lip of the net itself. The net is held in front of the body (or to the side) with the mouth facing towards the individual. Travel backwards or sideways, scuffing the bottom and overturning rocks/cobbles with your feet to dislodge zoobenthos on the tops of and beneath the substrate. In the case of stony substrates of cobble size or larger, the top and bottom surfaces of large materials can be rubbed with a hand to dislodge sessile organisms or those hiding in crevices on the substrate surface.

The list below summarizes various habitats and the recommended sweep style, length and duration.

a. Hard Substrates:

I) bedrock,boulder, coarse cobble: Use a travelling backward or sideways shuffle to dislodge as much attached material as possible (2-3 m in 15 s). Turn over and rub selected substrates at or into the mouth o the sweep net. Complement with a rapid forward, shovel-sweep.

ii) shingle/gravel/sand: Use a rapid, forward, shovel-sweep if possible. Supplement with a backward shuffle if necessary.

b. Vegetated: emergent, floating, and submergent microhabitats: use shovel-sweeps and arc-sweeps, whichever method is most suited to covering the area effectively without

catching too much vegetation. Be sure to sample some of water surface film when in emergent vegetation zones.

c. Soft, unvegetated: sand, mud, silt, clay microhabitats: Use a forward shuffle-sweep, taking care to minimize amounts of sediment caught in the net.

Field Data Sheet Instructions

The following instructions should be used as a reference, in conjunction with the sample data sheets and Code Sheet, when recording data on the Site Reconnaissance, Vegetation Survey, Benthos transect, and Fish Data Sheets. Note about recording the date: please spell out the month, then provide date and year (e.g., July 8, 03).

I. Data Sheet 1, Side 1: Site Reconnaissance (from aerial photos, verified on site):

Aerial photos and/or digital ortho photo quads (DOQ's) will be available for most sites before sampling. One of the goals of site reconnaissance will be to verify that no major physical changes have occurred since the photo was taken. Any notes accompanying the photos should be recorded in field notebooks, and if possible should be recorded directly on the photo, using the white margins of the page for notes.

A.

1. Project (circle GLEI or Reference Area) and provide site information from maps. This includes the Segment # or Reference Code, Unit Type (Rw, He, Pw, etc.), locale #, and the site name.

2. Indicate GPS unit number used and provide waypoint number at an easily identifiable location.

B. Each sampling unit is to be classed into zones consisting of a unique combination of a shoreline structure and an adjacent landcover (e.g. Sand beach + upland forest = zone 1). A zone must cover at least 10% of sampling unit to be considered. No more than three zones are to be described for a given unit (unit = wetland, embayment, or high energy shoreline, **not** a segment).

1. Use the aerial photos to determine how the land is being used, unless it is obvious that land use has changed. Assign one shoreline structure and one adjacent landcover to each zone by marking the zone number next to the corresponding classification. A zone **can only contain one shoreline structure and one landcover**. If a given classification applies for more than one zone, separate the indicated zones with a comma.

2. Percent of (Sampling) Unit: For each zone, enter the percent of the unit's shoreline that is covered by this zone. The combined percentages of all zones do not necessarily need to sum to 100%, but they must not surpass it.

C. Morphometry:

1. Shape: Deviation from circle (only for unit types embayment, protected wetland, river-influenced wetland), scaled from 0-5. Circle the best description.

2. Braiding Index. For riverine wetlands only. Circle the best description.

3. Hydrologic Connection to Lake: For wetlands only. Circle the best description.

4. Relative elevation of lake to wetland: For wetlands only. Circle the best description.

5. Sketch the unit, label shoreline zones, transects, location of disturbances, surrounding land use, and roads. Label North. Much or all of this sketching can often be done on the map or aerial photo; if that has been done, there is no need to sketch the unit here.

D. Water Level: field observation - circle all that apply.

E. Habitat Structure

1. Habitat Types: field observation - circle all types that are present.

2. Vegetation Patch Structure: choose only one

F. Disturbance

1. Disturbance Within Unit: Circle all that apply. Indicate Small, Medium, or Large for marinas and count the number of docks.

2. Shoreline Modification: Describe anthropogenic alterations to the shoreline that weren't covered above.

3. Recreational Activities: Circle all that apply and rank each as Low, Medium, or High.

4. Pollution: Circle all that apply and rank each as Low, Medium, or High.

5. Other disturbance: Note any other disturbances not already mentioned.

II. Data Sheet 1, Side 2: Field Check List

This sheet is intended to prompt thorough completion of all tasks at each site. Read and initial each box to verify that all data fields are filled in or have documented reasons if they are not filled in. This sheet is also to be used as a way of indicating to the next crew if certain items need particular attention.

III. Data Sheet 2, Side 1 and 2 – **Vegetation Survey: Random Point** (One sheet will include 6 random points, with total number of sheets dependent on the number of random points visited).

Points are distributed in a random pattern throughout the unit prior to arrival and uploaded into the GPS. Generally, 24 random habitat points will be sampled in each unit. Less than 24 points will be sampled under the following conditions: a) high energy units: a minimum of 5 points per linear km of shoreline will be sampled, up to a maximum of 24 points; b) embayments: a minimum of 12 points will be sampled in bays that are 1-5 km^2; larger bays will receive the full complement (24) of points; c) wetlands: a minimum of 12 random points will be sampled in units ranging in size from 5-50 ha; wetlands larger than 50 ha will receive the full complement of points.

In the event that 12 points do not fall in the aquatic habitat, an effort will be made to sample as closely as possible to existing random points. Do not spend excessive time attempting to reach grid points that are inaccessible. If a point cannot be reached by boat due to an obstruction or water depth use the following rules: a) if the grid point is relatively close to a transect sampling point, note this on the data sheet; b) If the grid point is not in the vicinity of transect locations, choose an alternate point from the grid; c) If alternate points are inaccessible, create a grid based on the outermost (deepest) random points and sample at these locations. Create the grid by drawing straight lines from shallow to deeper water along either an E-W or N-S direction through the outer most random points. Next, determine the number of random points that are needed, divide by the number of gridlines, and evenly space random points along each gridline so that the points are a minimum of 50 m apart and a maximum distance that keeps the farthest points at about 1 km from shore. Be sure to draw the gridlines on the map, document your work, and take

GPS readings at each random point. Explain other reasons for not sampling points using standard codes (see Code Sheet).

A. Project (circle GLEI or Reference Area). Provide today's date (month DD,YY) and relevant site information from map.

B. Habitat Types and Diversity (based on vegetation located within a 5 m radius from point)

1. Random point number - provided from map
2. GPS#: Record new point number from GPS unit.
3. Vegetation Type:
    a) Emergent zone:
        1. Estimate width (meters) of emergent vegetation zone in this area of the wetland (if you are in emergent vegetation). This will likely lie outside the 5 m radius circle.
        2. List the first and second most abundant taxa under Dom1 and Dom2, respectively, within a 5 m radius of the boat.
        3. Estimate the density (see Code Sheet) and % cover of the emergent vegetation within the 5 m radius.
    b) Submergent: If present, list the two most abundant taxa of submergent vegetation within the 5 m radius. Estimate the density (see Code Sheet) and % cover of the submergent vegetation within the 5 m radius.
    c) Floating: If present, list the two most abundant taxa of floating vegetation within the 5 m radius. Estimate the density (see Code Sheet) and % cover of the floating vegetation within the 5 m radius.
    d) Open Water: Estimate the % cover of unvegetated area within the 5 m radius.
4. Density and Percent Cover: Density should be given to each classification according to the codes on Code Sheet. Percent cover should always total 100% for a given 5 m radius area (thus, open water counts toward the percent cover total).
5. Aquatic Habitats (within 5 m): Refer here to codes and circle all that apply.
6. Shoreline Habitats (within 10 m radius): Refer here to codes and circle all that apply.
7. Growth Forms Present: Refer here to codes and circle all that apply.
8. Other macrophytes not listed above: Enter taxa here that are present but were not listed as dominant or subdominant above.

C. Water Quality Characteristics:

1. Depth is recorded using the depth finder on boat (m).
2. Secchi depth (meters; 2 times): Valid only when the line is vertical and the secchi disc is not resting on the bottom. If disc is still visible and on bottom, then enter "**bottom**" on data sheet.
3. Turbidity Tube (m): Turbidity tube measurements should be taken at all points ≤ 1m,

when secchi depth is < 2m, or when unable to get a valid secchi depth reading. If tube is full and disc is still visible, then enter "**too clear**" on data sheet.

4. Depth of unconsolidated sediments: Determined using ponar, walking around, or with pole/stick. Circle nearest estimate and note whether or not the Ponar was used to estimate this depth.
5. Ponar:
   - Was one used to estimate the depth of unconsolidated sediment?
   - Did this sample contain macrophytes?
6. Sediment: If present, refer to code sheet to classify texture, color, and odor. Circle **n/a** if no sediment could be obtained for these characteristics.

D. Sample Site Context: Top section to be filled out for <u>all</u> wetlands, including riverine.

1. Flow regime: Choose only one.
2. Vegetation at closest shoreline: Choose only one.
3. Landuse at closest shoreline: write in appropriate land use.
4. Distance and direction to emergent zone and shore: Note distances in meters. If the opposite shore is > 500 m distant, write "**> 500 m**".
5. Bottom section is only applicable to riverine wetlands. Circle the appropriate amount of bank erosion, use the range finder to measure channel width in m, and quickly sketch a channel cross section.

IV. Data Sheet 3, Side 1 – Benthos Data Sheet

A. Transect Information*

1. Circle Project (GLEI or Ref.) and enter today's date (month DD, YY).
2. Enter Site Name, GLEI Seg. # or Ref Code, locale #, and Unit Type (i.e. Rw, He, Cw, etc.)
3. Local time at start and end of data and sample collection at given transect – recorded in 24 hour clock format.
4. Names of field collectors, brief description of current weather conditions, and current air temperature in ^{O}C.
5. Shoreline/Landcover zone # (taken from designation on Sheet 1, Side 1). [Note: It is very important that we are able to link each transect to a shoreline zone defined on the first (Recon) data sheet.]
6. Water's edge to emergent vegetation = distance from the emergent vegetation collection point to the edge of the water, if applicable (this will often be zero). Distance and direction to depth 0 = the distance and direction from point of collection to water's edge (again, this may be zero).
7. Assign a new GPS waypoint for each sampled zone in transect, and enter corresponding # in appropriate box.

8. Record water depth (in meters) at each core or ponar sample point along the transect.

B. Water Characteristics

1. Enter number of YSI meter, as well as date last calibration and name of calibrator.
2. Record from YSI meter the current temperature, conductance, DO%, DO (mg/L), pH, and ORP in designated units. This is to be done for **all** zones of transect, and at both surface and bottom of water column for every zone except emergent. Do not skip measurements just because the area appears homogenous.

C. Sediment Characteristics

1. Enter information on sediment Texture, Color, and Odor according to codes from Code Sheet.
2. When applicable, measure pH and ORP (mV) using hand held probes (**DO NOT use the YSI for this**).
3. Check the Sediment Composite box when sediment has been collected for each zone. Sediment from each transect is composited by zones (emergent, submergent, etc). So the sediment from the emergent zones on all transects is composited together and so forth. This check box is a reminder to collect enough sediment (at least 2 L) from each zone for particle size analysis and to share with the Contaminants subproject.
4. Circle the number of cores that were taken at this zone (leave blank if no cores were taken).
5. If it is necessary to do rock scrapes in lieu of cores, then try to find the least number of rocks that would fill the volume of the ponar. Measure circumference (cm) along both axes of individual scraped rocks and record these numbers with the corresponding rock number. From this data we should be able to tell how many rocks were scraped and calculate an approximate surface area of each rock. This is to be done for each rock scrape (1 and 2) at the emergent and submergent depths of the transect.
6. If sediment is collected using the ponar, estimate the approximate percent fullness of the ponar according to the percentages given and circle the closest figure.
7. Record number of samples collected with the D-net, along with the sweep distance (m), sweep time(s), and # of microhabitats included in each sweep sample.
8. Circle Y or N to indicate whether or not a macrophyte voucher was collected at this point.

D. Habitat assessment: Habitat Types and Diversity (within a 5 m radius of point)

1. GPS#: Record new point number from GPS unit.
2. Circle the habitat zone (emergent, submergent, etc.)
3. Vegetation Type:
    a) Emergent zone:
        1. Estimate width (meters) of emergent vegetation zone in this area of the wetland (if you are in emergent vegetation). This will likely lie outside

the 5 m radius circle.

2. List the first and second most abundant taxa under Dom1 and Dom2, respectively, within a 5 m radius of the boat.
3. Estimate the density (see Code Sheet) and % cover of the emergent vegetation within the 5 m radius.

b) Submergent: If present, list the two most abundant taxa of submergent vegetation within the 5 m radius. Estimate the density (see Code Sheet) and % cover of the submergent vegetation within the 5 m radius.

c) Floating: If present, list the two most abundant taxa of floating vegetation within the 5 m radius. Estimate the density (see Code Sheet) and % cover of the floating vegetation within the 5 m radius.

d) Open Water: Estimate the % cover of unvegetated area within the 5 m radius.

4. Density and Percent Cover: Density should be given to each classification according to the codes on Code Sheet. Percent cover includes open water area and should always total 100% for a given 5 m radius area.
5. Aquatic Habitats (within 5 m): Refer here to codes and circle all that apply.
6. Shoreline Habitats (within 10 m radius): Refer here to codes and circle all that apply.
7. Growth Forms Present: Refer here to codes and circle all that apply.
8. Other macrophytes not listed above: Enter taxa here that are present but were not listed as dominant or subdominant above.

E. Habitat Assessment: Water Quality Characteristics:

1. Secchi depth (meters; 2 times): Valid only when the line is vertical and the secchi disc is not resting on the bottom. If disc is still visible and on bottom, then enter "bottom" on data sheet.
2. Turbidity Tube (m): Turbidity tube measurements should be taken at all points ≤ 1m, when secchi depth is < 2m, or when unable to get a valid secchi depth reading. If tube is full and disc is still visible, then enter "**too clear**" on data sheet.
3. Depth of unconsolidated sediments: Determined using ponar, walking around, or with pole/stick. Circle nearest estimate and note whether or not the Ponar was used to estimate this depth.

4. Ponar:

- Was one used to estimate the depth of unconsolidated sediment?
- Did this sample contain macrophytes?

F. Sample Site Context: Top section to be filled out for <u>all</u> wetlands, including riverine.

1. Flow regime: Choose only one.
2. Bottom section is only applicable to riverine wetlands. Circle the appropriate amount of bank erosion, use the range finder to measure channel width in m, and quickly

sketch a channel cross section.

V. Sheet 3, Side 2

These habitat type and diversity sections are to be filled in with information from corresponding habitat zones (emergent, submergent, open water, 5m, 10m) for the benthos transect.

VI. Sheet 4, Side 1 Use a separate sheet for each catch from each net. Combining nets or catches on a sheet can lead to confusion and error during data entry.

A. Fyke net set and location information*

1. Circle the project (GLEI or Reference)
2. Enter the GLEI Segment # or Ref Code, Segment Name, and Locale # (from map).
3. Circle the gear type and size and record the set or trawl number for each effort (eg., 2 LG and 2 SM fyke sets include arrays numbering 1 through 4. Perpendicular sets on shorelines will include nets 1 through 8. Use unique numbers for each net; there should not be a net 1 large and a net 1 small at the same site. Trawls will include passes 1 through 3). If the net set is mixed (some in parallel sets and some perpendicular), note this at the bottom of the sheet.
4. Circle day 1 or 2 (catch day: the day the net is first pulled is day 1, the day the net is first set is day 0).
5. Date (month DD, YY) and time (local, 24 hr) of net set (Day 0) or reset (Day 1, if the net is reset for a second day).
6. Date (month DD, YY) and time (local, 24 hr) of net check (Day 1 or Day 2).
7. Record the number of unknown or voucher species collected at this site and the jar number if there are multiple jars per net. Be sure to label jars properly (see Code Sheet).
8. List the field collectors.

B. Fish Taxa (**see Fish SOP for complete details**)

1. Enter fish's complete common name or genus and species in column on left (entering only Sunfish, Bullhead, etc, is not acceptable unless all these fish are also saved as unknowns for later ID, in which case they should not be listed among the taxa). When definite size groups are present for a given taxa, separate individuals into up to three sizes, measure up to 25 of each and note if Young of the Year (YOY).
2. Measure each fish in millimeters and enter up to 25 individual measurements for each species or size/age category for that species under TL (Total Length). Record number of individuals over the 25 measured in the # row. The total count (measured plus unmeasured) should then be entered in the 'Total' box to the right.
3. Comments regarding fish or other organisms caught may be entered under Comments at right.
4. Anomalies on fish should be noted next to individual species, using codes at the bottom of page.

5. Fish Taxa continues to Side 2, if additional space is needed. Please do not use Side 2 to list another net or another day's catch. This is VERY confusing for data entry and can lead to errors.

C. Notes and Complications:

1. Note any complications with net.
2. Note water level change at the nets from one day to the next (this may be measured by placing a secured pole in the water, with a marker at current water level – any change will be able to be measured from this mark. This pole must be separate from poles used to attach the nets if the set will be more than 1 day).
3. Briefly note the wind and weather conditions.

VII. Sheet 4, Side 2: Conditions at Location of Fyke Net Set

A. Habitat Types and Diversity

1. $Depth^1$ = Water depth at beginning of fyke net lead (this may be 0 if lead reaches dry land). Measured in meters.
2. $Depth^2$ = Depth at entrance to fyke net box. Measured in meters.
3. Distance = Distance in meters from $depth^1$ to $depth^2$.
4. GPS #: Waypoint number marked at the location of this fyke net.
5. Vegetation type at location of fyke net set (within 5m radius):

a) Emergent zone:

i. Estimate width (meters) of emergent vegetation zone in this area of the wetland (if you are in emergent vegetation). This will likely lie outside the 5 m radius circle.

ii. List the first and second most abundant taxa under Dom1 and Dom2, respectively, within a 5 m radius of the boat.

iii. Estimate the density (see Code Sheet) and % cover of the emergent vegetation within the 5 m radius.

b) Submergent: If present, list the two most abundant taxa of submergent vegetation within the 5 m radius. Estimate the density (see Code Sheet) and % cover of the submergent vegetation within the 5 m radius.

c) Floating: If present, list the two most abundant taxa of floating vegetation within the 5 m radius. Estimate the density (see Code Sheet) and % cover of the floating vegetation within the 5 m radius.

d) Open Water: Estimate the % cover of unvegetated area within the 5 m radius.

e) Density and Percent Cover: Density should be given to each classification according to the codes on Code Sheet. Percent cover includes open water area and should always total 100% for a given 5 m radius area.

f) Aquatic Habitats (within 5 m): Refer here to codes and circle all that apply.

g) Shoreline Habitats (within 10 m radius): Refer here to codes and circle all that apply.

h) Growth Forms Present: Refer here to codes and circle all that apply.

i) Other macrophytes not listed above: Enter taxa here that are present but were not listed as dominant or subdominant above.

B. Water Column:

1. Secchi depth (meters; 2 times): Valid only when the line is vertical and the secchi disc is not resting on the bottom. If disc is still visible and on bottom, then enter "**bottom**" on data sheet.
2. Turbidity Tube (m): Turbidity tube measurements should be taken at all points ≤ 1m, when secchi depth is < 2m, or when unable to get a valid secchi depth reading. If tube is full and disc is still visible, then enter "**too clear**" on data sheet.
3. Depth of unconsolidated sediments: Determined walking around or with pole/stick. Circle nearest estimate.
4. Sediment: Classify according to codes on Code Sheet.

C. Sample Site Context

1. Water Quality
   a. Water temperature, DO%, DO (mg/L), pH, Conductivity, and ORP are to be taken in the water column at the entrance to the fyke net box using the YSI meter. These numbers are to be recorded in the units requested.
   b. Record unit number of YSI meter and list date of last calibration and name of calibrator.
   c. Water quality characteristics must be recorded at all nets.
2. Sample Site Context: Top section to be filled out for <u>all</u> wetlands, including riverine.
   a. Flow regime: Choose only one.
   b. Vegetation at closest shoreline: Choose only one.
   c. Landuse at closest shoreline: write in appropriate land use.
   d. Distance and direction to emergent zone and shore: Note distances in meters. If the opposite shore is > 500 m distant, write "> 500 m".
   e. Bottom section is only applicable to riverine wetlands. Circle the appropriate amount of bank erosion, use the range finder to measure channel width in m, and quickly sketch a channel cross section.

***If you are not able to fulfill one or all of these operations, refer to the Code Sheet to indicate the reason.**

APPENDIX 1. PROBLEM CODES FOR USE ON DATA SHEETS

Fyke net problem codes:

A: Depth: A1 too deep; A2 too shallow	R: Rough surf
B: Sediment: B1 unconsolidated; B2 rocky; B3 bedrock	S: Size of site too small
D: Nets damaged or missing	W: Weather not permitting
H: No habitat available	O: Other, please specify
M: Mechanical problems: M1 vehicle; M2 boat	P: Permission lacking

Random point problem codes:

L: Water level change, points on dry land or too shallow	R: Rough surf
N: Not done; explain on data sheet	W: Weather not permitting

Water quality problem codes:

A: Depth: A2 too shallow	O: Other; please specify
B: Sediment: B2 rocky; B3 bedrock	R: Rough surf
H: Homogenous area, WQ taken less frequently	W: Weather not permitting
M: Mechanical problems: M2 boat; M3 meters	

Transect point problem codes:

N: Not done; explain on data sheet	W: Weather not permitting
R: Rough surf	

Calibration of the YSI 556

If problems are encountered refer to the instrument manual for more detailed instructions
Conductivity and Redox (ORP) only need to be calibrated once per trip (9 days)

1.) Press "**on**"
2.) **"escape"** to display main menu
3.) Toggle to highlight "**calibrate**" and press "**enter**"
4.) RINSE PROBE AND CALIBRATION CUP BEFORE EACH PARAMETER

CONDUCTIVITY

1.) Toggle to "**conductivity**" and press "**enter**"
2.) Toggle to "**specific conductance**" and press "**enter**"
3.) Fill rinsed calibration cup with conductivity standard
4.) Key in the standard value (0.147 mS/cm typically) and press "**enter**"
5.) When the reading is stable (~1 min.) press "**enter**"
6.) Press "**enter**" and "**escape**"

DISSOLVED OXYGEN

1.) Rinse the probe and shake off
2.) Place 3mm (1/8") water in calibration cup and LOOSELY screw on
3.) Toggle to "**Dissolved Oxygen**", press "**enter**"
4.) Toggle to "**D.O. %**" and press "**enter**"
5.) Key in barometric pressure (see correction on back) and press "**enter**"
True BP = (corrected/radio BP)- [2.5 * (local altitude (ft)/100)]) *see back for additional help*
6.) Wait until stable for 30 seconds (up to 10 min.) and press "**enter**"
7.) Press "**enter**" and "**escape**" once

pH CALIBRATION

1.) Toggle to "**pH**" and press "**enter**"
2.) Toggle to "**2-point**" and press "**enter**"
3.) Add the first pH buffer to calibration cup and screw on sonde
4.) Enter the first pH value (temp. correct. table on back) and press "**enter**"
5.) When the reading is stable for 30 seconds (~1 min.) press "**enter**" twice
6.) Add second pH buffer to calibration cup and screw on sonde
7.) Enter the second pH value (*see temp. correction table on back*) and press "**enter**"
8.) When the reading is stable for 30 seconds (~1 min.) press "**enter**"
9.) Press "**enter**" yet again and "**escape**"

ORP CALIBRATION

1.) Toggle to "**ORP**" and press "**enter**"
2.) Fill rinsed calibration cup with ORP standard
3.) Enter the ORP value as E_H (mV) corrected for temp (*see table on back*) and press "**enter**"
4.) When the reading is stable for 30 seconds (~1 min.) press "**enter**"
5.) Press "**enter**" yet again and "**escape**"

IF PROBLEMS ARE ENCOUNTERED REFER TO THE INSTRUMENT MANUAL FOR MORE DETAILS

Barometric pressure (BP) is generally reported by the weather service news etc. as a "corrected" value and must be converted to a true BP (1 inch of mercury = 25.4 mm Hg).

True BP = corrected/radio BP (mm Hg) - [2.5 * (local altitude in ft/100)]

Altitude values:

Lake Ontario ≈ 246'/100 = 2.46 x 2.5 = **6**
Lake Erie ≈ 569'/100 = 5.69 x 2.5 = **14**
Lake Huron/Michigan ≈ 582'/100 = 5.82 x 2.5 = **15**
Lake Superior ≈ 600'/100 = 6.00 x 2.5 = **15**

Example:
True BP on L. Superior = BP on radio (30.11" Hg x 25.4 mm = 765 mmHg)
765 mm Hg – 15 = 750 (value to enter for calibration)

Effects of temperature on pH standards

[degrees Celsius; all pH values are in standard pH units]

Temp	**Buffer and nominal pH value**		
	4.00	**7.00**	**10.00**
0	4.00	7.14	10.30
5	4.00	7.10	10.23
10	4.00	7.07	10.17
15	4.00	7.04	10.11
20	4.00	7.02	10.05
25	4.00	7.00	10.00
30	4.01	6.99	9.96
35	4.02	6.98	9.92

Effect of Temperature on ORP standard

Degrees Celsius	E_H (mV)
0	+438
5	+435
10	+431
15	+428
20	+424
25	+420
30	+415
35	+411

Calibration solutions used:

pH = Tri-Chek chemvelope set, Fisher Catalog (2002-2003)#: 15-420-2W (pH 4, 7, and 10)

Conductivity = we make our own by dissolving 0.0746g anhydrous KCl in 1 liter of de-ionized water to yield a conductivity standard of 147µS/cm. Alternatively, conductivity calibration standards can be purchased from Fisher, cat.# 09-328-11 (EC25=1413 µS/cm) and diluted 1ml of standard plus 9ml de-ionized water to yield a 147 µS/cm standard.

ORP = ORP Standard, Fisher (online only) cat.# 13-641-210
Eh (mV) = +420 @ 25°C