

Rapid Macrophyte Habitat Assessment Methodology



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Cover Photograph: Wisconsin DNR scientist implementing the rapid macrophyte assessment methodology. Photo by Alison Mikulyuk, Wisconsin DNR.

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Summary of Assessment Method

This method was created to provide a tool for rapidly assessing macrophyte biotic condition on lakes. It is intended to be used comparatively, and may not provide information suitable for lake management planning or monitoring. Implementation is intended to be quick (1-3 hours per lake) and requires relatively little taxonomic knowledge. The assessment includes information on the depth, density, richness, and growth form of aquatic plants; it measures the maximum depth of plant colonization as well as the presence of invasive species. Macrophyte data are recorded at individual sample points stratified by lake depth and lying along transects perpendicular from shore. The method uses a double-sided rake to sample macrophytes.

Macrophyte Habitat Transect Placement

Each lake should be sampled using a minimum of 10 transects. Randomly assign the first transect location, and evenly distribute the remaining nine transects along the shoreline. Additional transects can be sampled for larger lakes, but no fewer than 10 should be sampled. Place transects perpendicular to the shoreline, ending halfway across the lake (midpoint between starting point and point on directly opposite shore). Each transect's start and ending point can be situated *a priori* using geographic information system (GIS) technology. This will increase the accuracy of the transect spacing and the transect trajectory from shore, but is not necessary to implement the method.

Stopping a Transect

Each transect should be sampled with a minimum of six points, but the distribution of the points along the line will vary depending on the bathymetry of the lake basin. Points are laid along the transects and stratified by depth. We discuss sample point placement below ("Point Placement along the Transect," page 5), but first let us concentrate on transect length. Due to varying lake morphometry, it sometimes will make sense to stop sampling before the transect ends at the halfway point. For example, on deep lakes, it is not necessary to sample beyond the littoral zone where no plants are growing. Conversely, on large, shallow lakes, it is impractical to sample to the midpoint of the lake, even if it is entirely littoral. If any of the identified stop criteria (see pages 4-5) is met during sampling, you have reached the end of the transect (although not necessarily the last rake tow). Points are stratified by depth and placed along the length of the transect starting at shore and continuing lakeward until one of the identified stop criteria (pages 4-5) apply.

STOP CRITERIA

A. Transect reaches halfway to the opposite shore (Figure 1).

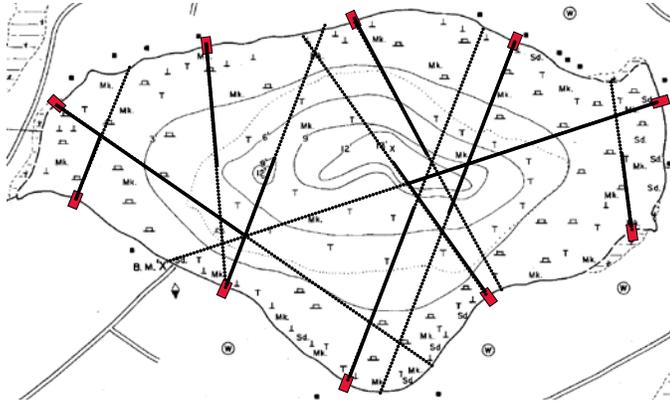


Figure 1. Transect placement (dotted lines) and sampled portions of those transects (solid lines). On a lake less than 7m deep that is likely 100% littoral, transects are typically sampled to the halfway point.

B. Littoral-profundal transition occurs, putting you beyond the maximum depth of macrophyte colonization (as indicated by two consecutive rake samples having no plants present; Figures 2-3).

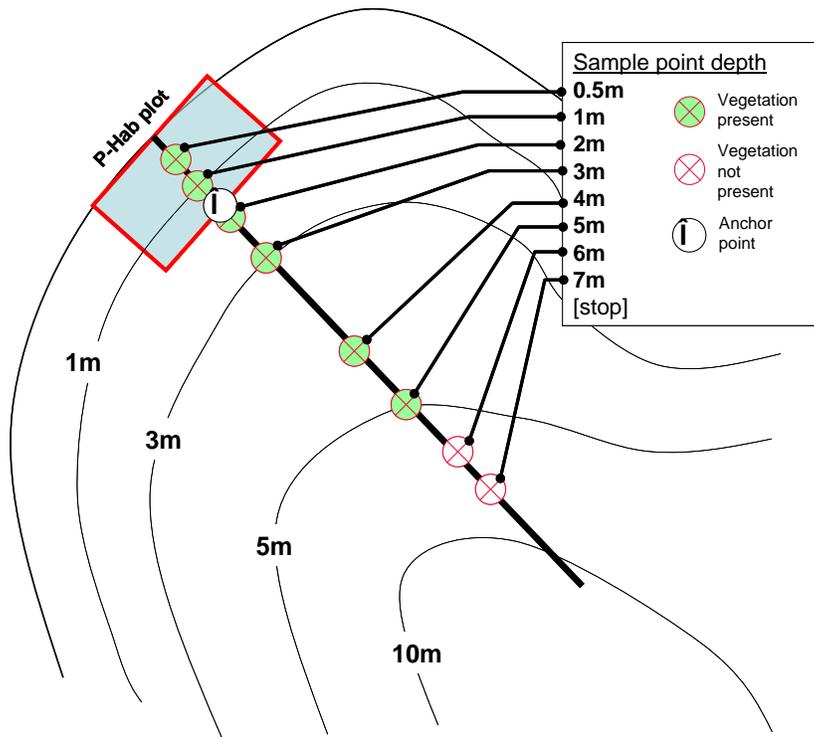


Figure 2. Sample point placement in a deep lake. Occurrence of two sample points without plants suggests the littoral-profundal transition, in which case the transect is ended in 7m of water, after the 8th point is sampled.

Criteria continue on next page.

STOP CRITERIA, *Continued*

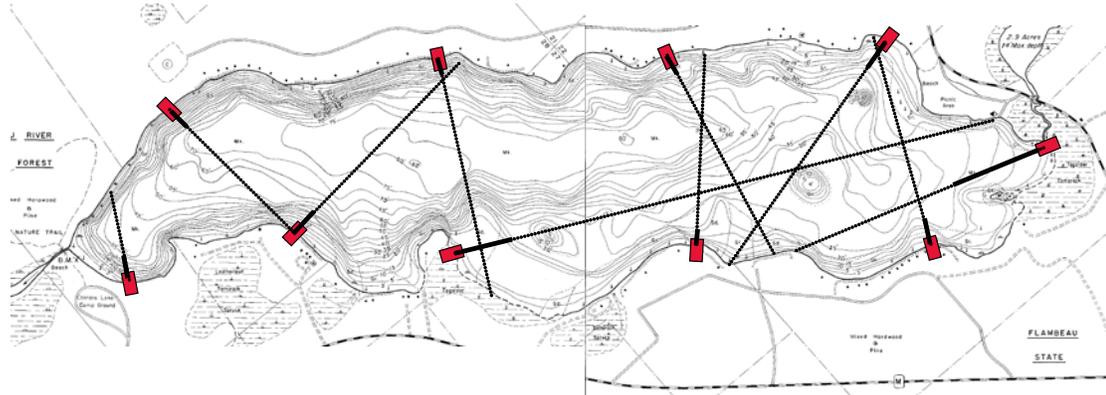


Figure 3. Transect placement (dotted lines) and sampled portions of those transects (solid lines). On a lake with steep sides that is over 7m deep, transects will not be sampled all the way out to the halfway point.

- C. Nine minutes have passed at slow-no-wake speed with no additional points sampled.
- In large, shallow systems, depth may not increase to allow for the placement of additional depth-stratified points, but traveling all the way out to the halfway point may be cost-prohibitive.
 - Nine minutes traveling at slow-no-wake speed (~3-4 mph) is approximately 1000 m. This defines a maximum transect length as determined by travel time.

Once any of the stop criteria is met, take a rake tow, and then count the points sampled on that transect. If six points have been sampled, the transect is done. **If the minimum six points have not been sampled, turn 180 degrees and distribute the remaining points evenly while heading along the transect back to shore (see Figure 4).**

Point Placement along the Transect

Place a minimum of six points per transect stratified by water depth, with the first point at 0.5m depth ($\pm 0.2m$), the second at 1m depth ($\pm 0.2m$), then every meter thereafter. Sample at least six points per transect, regardless of lake morphometry or clarity. Use a depth finder to determine point placement. Place points within 0.2m of the target depth.

- Place the first point on the transect in 0.5m ($\pm 0.2m$) water depth as close to shore as possible.
- Moving lakeward, sample the second point on the transect when depth increases to 1m ($\pm 0.2m$) water depth.
- Sample the third point on the transect in 2m ($\pm 0.2m$) of water.

- D. Sample the fourth point on the transect in 3m ($\pm 0.2\text{m}$) of water. Continue taking points at each 1-m increase of water depth until one of the stop criteria applies.
- Take a rake tow at that location (the midpoint of the transect or when you have traveled with no depth increase for nine minutes). If you have not sampled six points, turn around 180 degrees and face back toward shore.
 - If you do not find plants and you are beyond the maximum depth of macrophyte colonization: Return to the greatest depth that you have observed plants on that lake (visually or at any other transect).
 - Sample points along the transect toward shore, aiming for an even spatial distribution until you reach the minimum total of six points in that transect (Figure 4).

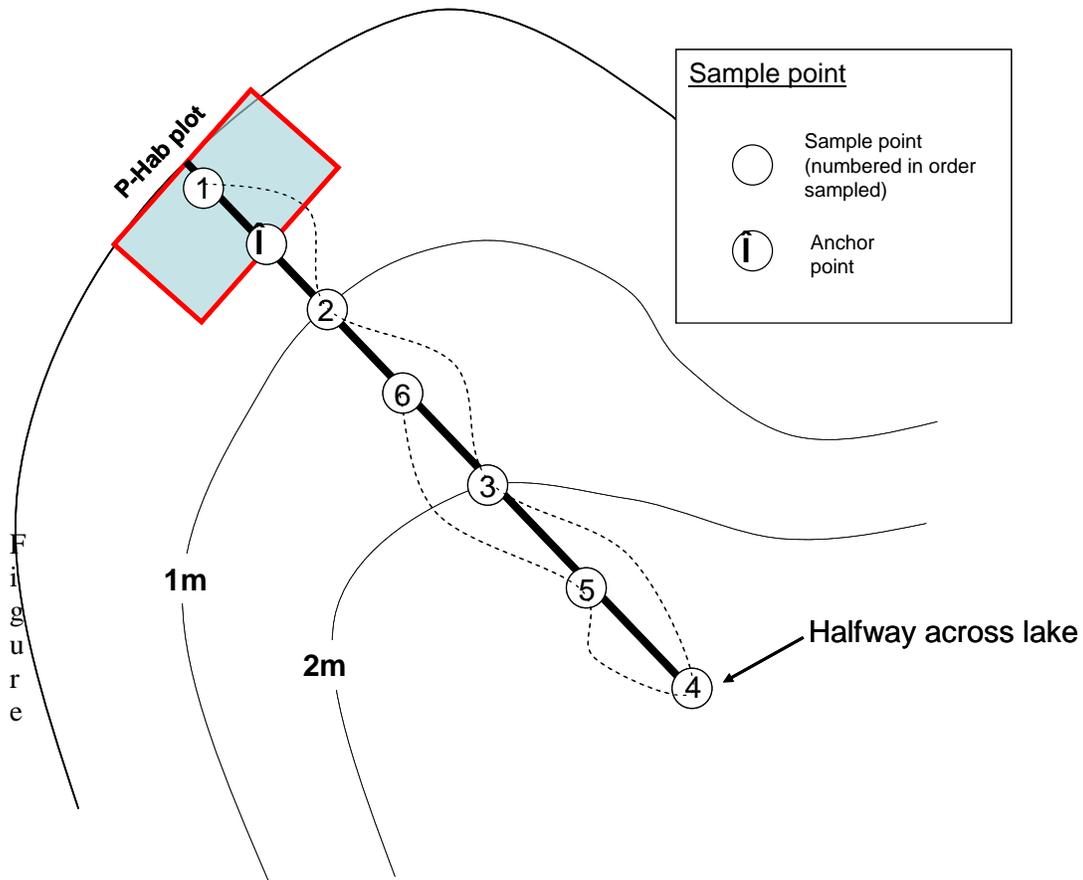


Figure 4. Point placement on a transect that ends before 6 points are sampled. After reaching halfway to the opposite shore, the fourth sample point is taken in 3m of water. Since the minimum 6 points per transect has not been satisfied, the field worker turns around and travels back to shore along the transect. Two additional points evenly distributed along the transect are sampled on the return trip.

Data Collection

At each point, record depth, density of plants on the rake, density of filamentous algae on the rake, plant growth forms present, number of morphologically distinct species and presence of invasive species. At the end of the survey, record the number of morphologically distinct species encountered lakewide.

A. Navigate to the first transect sample point.

- a. Extend the rake vertically through the water column to *gently* rest on the sediment surface. See Hauxwell *et al.* 2010 for instructions on constructing a rake sampler.
- b. Record the actual depth to the nearest 0.1m.
- c. Twist the rake 360° and pull vertically up and into the boat.
- d. Record plant rake density (include Charophytes) (0-3)

0 No plants present

1 Less than 25% of the rake is full



2 25% to 100% of the rake is full



3 Greater than 100% of the rake is full (no tines visible)



- e. Record filamentous algae rake density on the same scale (0-3) if the filamentous algae presence is obvious. Very small amounts of filamentous algae may be present in nearly all rake tows, so only record filamentous algae as present if there would be enough to roll into an approximately nickel-sized ball.

- f. If vegetation is present:
 - i. Use the “Key to Plant Growth Forms” and “Illustrated Guide to Plant Growth Forms” (Pages 10-11) to determine the growth form of all plants sampled with the rake or detached from the bottom by the rake and floating. Include plants touched by the rake even if they do not detach or if they fall off the rake head. This is particularly relevant when sampling emergent or free-floating plants.
 - ii. Do not count filamentous algae as a species in the plant density rating or when determining maximum depth of plant colonization.
- g. Record the number of morphologically distinct species for that point.
 - i. Count easily lumped species such as thin-leaved pondweeds or floating duckweeds only once.
 - ii. If no plants are present, record 0 for number of species
 - iii. Put one example of each newly-encountered species into a cooler or large ziplock bag to allow a count of species richness for the lake once all transects have been sampled.
- h. Invasive species – Note the presence of:
 - i. Eurasian watermilfoil (*Myriophyllum spicatum*)
 - ii. Curly-leaf pondweed (*Potamogeton crispus*)
 - iii. Purple loosestrife (*Lythrum salicaria*)
 - iv. Reed canary grass (*Phalaris arundinacea*)
 - v. Brittle waterlily (*Najas minor*)
 - vi. Yellow floating-heart (*Nymphoides peltata*)
 - vii. Hydrilla (*Hydrilla verticillata*)
 - viii. Brazilian waterweed (*Egeria densa*)

B. Sample remaining points (minimum of six per transect)

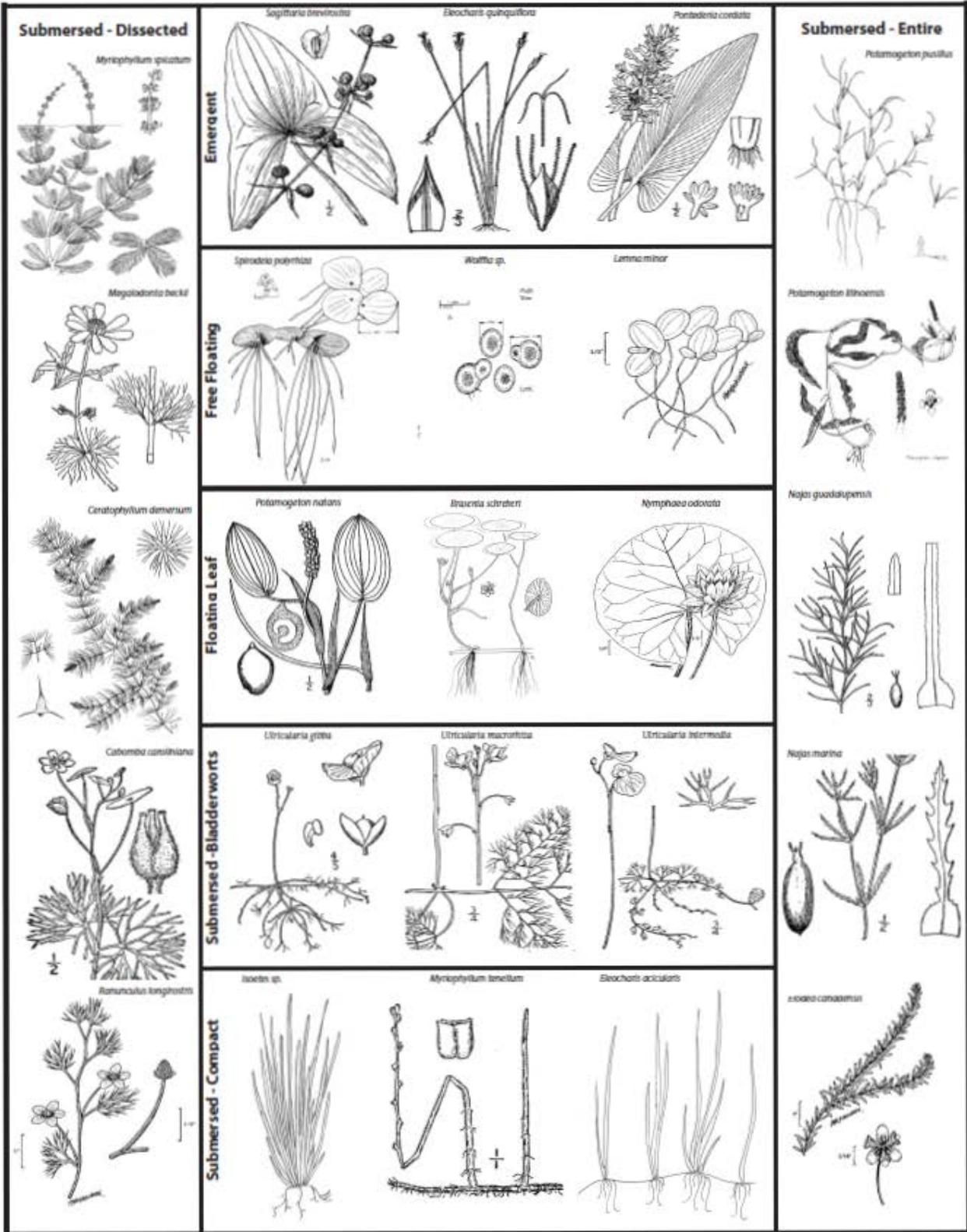
- a. Visually select a navigation point on the opposite shore in the direction of the transect and navigate slowly lakeward.
- b. Use a sonar unit to assess depth.
- c. Take rake samples stratified appropriately by depth (at 0.5 and 1m, thereafter every meter, ensure you are within ± 0.2 m of each depth target)
- d. Sample until one of the stop criteria (pages 4-5) applies

- e. Notes
- i. If a sample point is inaccessible due to an obstacle (e.g. swim area, dock, watercraft) move the point off the transect to the nearest possible accessible area in that depth range. Rake as close to the original point as possible (i.e. immediately adjacent to the swim area or under the edge of the dock) so that the impact of disturbance is captured. Resume sampling along the transect as soon as possible.
 - ii. If depth along the transect begins to decrease during sampling, continue until either greater depths are encountered or one of the stop criteria applies.
 - iii. Similarly, if an island intersects the transect, navigate around the island, then resume sampling on other side, travelling along the original transect line until depth increases enough to place the next sample point.
 - iv. If transects are placed in a channel, inlet or outlet, sample as usual by placing the transect perpendicular to shore extending out to the channel midpoint. Points may be very close together.
- f. Count the number of morphologically distinct species collected lake wide and record on the datasheet.

KEY TO PLANT GROWTH FORMS

- 1.a. Plant stems extending above or leaves visible on the surface of the water, submersed leaves absent 2.
- 1.b. Submersed leaves present, floating leaves present or absent 4.
 - 2.a. Floating leaves absent, leaves and/or stem extending above water EMERGENT
 - 2.b. Leaves floating on or just under the water's surface 3.
 - 3.a. Leaves free floating, neither rooted to bottom nor attached to tuber FREE FLOATING
 - 3.b. Plant rooted in sediment or attached to tuber FLOATING LEAF
- 4.a. Bladders on leaves or root-like branches SUBMERSED – BLADDERWORT
- 4.b. No bladders present 5.
 - 5.a. Plant small and free floating, stem not apparent (*Lemna trisulca*) FREE FLOATING
 - 5.b. Plant not as above 6.
 - 6.a. Submersed plants having short stature (<20cm) and compact growth form. Leaves basal (originating from a single point at the base of the plant) or plant consisting of short stalk with no apparent leaves SUBMERSED – COMPACT
 - 6.b. Plants with well-developed stems or leaves extending into the water column. Leaves basal, opposite, or whorled 7.
 - 7.a. Submersed leaves narrow and finely divided (branched) SUBMERSED – DISSECTED
 - 7.b. Submersed leaves not finely divided SUBMERSED – ENTIRE

ILLUSTRATED GUIDE TO PLANT GROWTH FORMS



Estimating Maximum Depth of Plant Colonization

In situ measurements of nutrient concentrations and water clarity tend to fluctuate over the course of a growing season. The use of single-event sampling data from a seasonally dynamic variable includes a significant risk of misrepresenting environmental conditions. Submersed aquatic plants reflect cumulative environmental conditions by integrating, for example, water clarity conditions over a long-term seasonal scale. Maximum depth of colonization is one metric we can use to capture integrated information about lake water clarity.

- A. Maximum depth of plant colonization is equal to the deepest depth at which plants are found
 - a) To ensure an accurate estimation, the littoral-profundal transition must be sampled at least five times during the survey.
- B. If the littoral-profundal transition was sampled fewer than five times, additional transects should be placed at the deep hole to better estimate this metric.
 - a) Navigate to deep hole
 - b) Check depth. If depth is over 12m, do not sample and skip to step d. If depth is less than 12m, take a rake sample.
 - c) If macrophytes occur, note this on the datasheet and do not continue. Maximum depth of plant colonization = maximum lake depth, and maximum depth of plant colonization does not reflect water clarity.
 - d) If macrophytes do not occur, face due north and pick a point on shore, navigate in a straight line toward it.
 - e) As depths approach 12m, take a rake sample, and then again with every meter in depth lost. Stop when plants are found, recording the depth to the nearest 0.1 meter.
 - f) Return to the deep hole and complete as many transects as necessary to estimate maximum depth of plant colonization, navigating away from the deep hole in several different directions
 - i. Complete as many transects as needed to estimate maximum depth of plant colonization on at least five transects (including the P-hab transects).
 - ii. The deepest depth encountered with plants growing during the entire survey is the lake's maximum depth of plant colonization.

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Notes

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