Aquatic Macrophyte Coverage Procedures For Lake Assessments

(Adapted from MA DEP, WI DNR and NALMS protocols by B.F. Lathrop, PA DEP, 12/2008)

Assessing and Monitoring Aquatic Plants

Introduction

Aquatic plant (macrophyte) mapping is commonly used to aid in lake assessments, recognizing the fact that plants have an important role in a lake ecosystem. Aquatic plants provide nesting areas and building materials as well as food, for fish, amphibians, reptiles, and birds. Aquatic plant beds are important fish spawning and nursery areas, and provide cover for many species. Microorganisms living on the plant material form a food base for macroinvertebrates, which in turn support other lake-dwelling species through a diverse food web. Emergent vegetation provides shoreline habitat and cover for reptiles, amphibians, birds, and small mammals. Lack of vegetation reduces available habitat, causing a decrease in biodiversity and overall biomass of the lake ecosystem. Paucity in PA lake vegetation is a natural condition of young reservoirs, especially those with steep shorelines, but also can indicate aggressive weed management by lake owners.

Aquatic macrophytes can be used to assess the recreational use of a waterbody. A dense population of aquatic plants can inhibit swimming, fishing, boating, water skiing, and aesthetic appeal. Judicious plant management can protect the waterbody's recreational use while retaining the beneficial aquatic life habitats. However, aquatic plant management can be an on-going balancing act, unique to each lake.

Assessment of the aquatic plant biomass or coverage in a lake can also be helpful in interpreting lake Trophic State Indices (TSIs). When macrophytes are very abundant, they can serve as a phosphorus sink, utilizing much of the available phosphorus, and can also stabilize and trap sediments alongshore, contributing to clearer lake water. To help determine if the presence or paucity of aquatic macrophytes influences a lake system, it is advisable to quantify the non-algal plant coverage.

Monitoring

The following procedure has been used in Pennsylvania to determine macrophyte coverage for the assessment of lakes. The density, diversity, and growth patterns of aquatic plants are unique to each lake. Details concerning sample site locations and other sampling aspects should be worked out on a lake-specific basis. Surveys should be conducted during the macrophyte's main growth period of July and August. As an exception, if you are trying to obtain information on *Potomogeton crispis* (a non-native, invasive aquatic plant), the survey should be completed in May, because by July, this species will be senescing. At a minimum, record the location of significant plant beds, their bed boundaries, and the general types of aquatic plants in each bed. The plant species can be identified using appropriate keys and/or by collecting representative specimens for expert verification.

Below are general procedures for mapping the distribution of aquatic plants, collecting plant species, and determining the relative density of plant beds at select sites.

Equipment:

Anchor
Depth finder, leadline, calibrated oars or line
Rangefinder
GPS
Secchi disk
Weighted rake (Weed Weasel® or 2 garden rakes with handles cut in half & then bolted together) with about 25-30ft of throwing line
Plastic bags for specimens
Clipboard, pencils, permanent marker
Map/outline of lake w/ sampling sites marked
Data sheets for recording
View scope

Mapping:

1. Slowly move the boat along the lake's shoreline extending out to a 12-15 foot depth. Observe areas of the lake where aquatic vegetation is present BELOW, NEAR or AT the SURFACE. Using a clean copy of the lake map, sketch the extent of the vegetation beds. Every so often, or at any notable demarcations, take a GPS reading and record on the map. For significant plant beds, circumvent the plant patch, recording multiple GPS readings. Note whether the plants are **submerged** (below the surface), **floating** at the surface, or **emergent** (projecting above the surface, mainly at the shorelines).

2. Use a scale on the map or a range-finder to estimate the length & width of significant plant beds or record GPS points at the beds furthest extent and edges.

3. For significant plant beds, estimate and record on the map the aerial coverage of the plants as:

Sparse	=	0 to 25 % cover
Moderate	=	>25 to 50 % cover
Dense	=	>50 to 75 % cover
Very dense	=	>75 to 100 % cover

Cover is determined by first visually projecting all of the vegetation in the water column, onto the lake surface. Then approximate the percentage of surface area the vegetation would cover. The following markings can be used to denote areas of different coverage on your map (Figure1):

Sparse areas ----------no markings
Moderate areas ----------stippling (:::::)
Dense areas ----------hatched lines (//////)
Very dense areas ----------cross-hatched lines (XXX)

If enough GPS coordinates are recorded, the macrophyte coverage can later be visually displayed in a GIS platform, as a plant patch polygon. This polygon can then be used to create electronic and printable maps.

4. Record Secchi depths in approximately each quarter of the lake.

Keep in mind that mid-lake areas may have plants on the bottom, if the depth is around 15 feet. Use a view scope (if feasible, based on water clarity) or the rake often to determine plant presence. Maximum light attenuation in PA lakes is about 12 to 15ft, or about 2 times the Secchi depth, therefore, depths over 15 feet usually do not need to be sampled, unless the lake is unusually clear.

When using the rake, plant density can be estimated based on the macrophyte abundance on the rake head. For each cast, estimate the rake "fullness" by categorizing the plant coverage on the rake head. "Sparse" would correspond to a few plants captured on the head of the rake. "Moderate" would be a fairly full rake, with plants between every tine, but rake tines still visible. "Dense" indicates a full rake of plants, with no rake tines visible. "Very dense" would correspond to a rake overflowing with plants, almost too heavy to pull in. Plants in this category are likely visible as a dense mat in or on the water.

The rake method has shown to compare favorably to more intense surveys such as collections by divers or Ponar (Deppe and Lathrop, 1992; Kenow, et al 2007; Rodusky et al 2005).

Equipment Care:
Be cognizant of transporting plant fragments to other lakes! The following steps should be completed at the end of each sampling day. Wash the inside and outside of your boat, the motor, oars, any equipment used during the survey, and the entire trailer. The recommended procedure is to use a high pressure spray (like those at a car wash), without soap and preferably hot water over cold. EPA recommends washing equipment in a 2% Clorox solution. If possible, allow the boat/trailer to dry out completely before launching in another lake. Complete procedures for washing equipment are located at EPA's National Lake Survey website http://www.epa.gov/owow/lakes/lakessurvey in the *Final Survey of the Nation's Lakes Field Operations Manual, 2007* and also at PA Fish and Boat Commission's website, http://www.fish.state.pa.us/cleanyourgear.htm.

Extended Information

The following procedure is used to record the "types" or species of plants that occur most commonly within the lake (*frequency of occurrence*). This is a more in-depth procedure, and the use of a larger scale map and knowledge of aquatic plant taxonomy is recommended.

Prior to starting your survey, mark a series of planned observation points on your lake map. Use a minimum of 20 sites per lake, up to 200 acres; add ten sites for every 100

additional acres. Place the stations at uniform intervals across the map; be sure to include areas with shallow and deep plant beds. At each site, record on a datasheet the GPS reading and tally the number of plant species, using tick marks (Figure2). Frequency of occurrence for each plant type (species) can be calculated as a percentage of the total number of sites observed. Moderately enriched and eutrophic lakes will have a fairly good species list, with not many species dominating (<30%). An imbalanced population will have fewer species that occur more frequently.

It may be useful to record the specific location of each plant species. Mark the species (or plant type) on a copy of the lake map. You may want to create a code, for each species or type, making it easier to fit on the map. The same codes should be maintained in the future to avoid confusion.

Voucher specimens:
Collect representative specimens of each plant type, at every lake. Place specimens in a labeled (lake/date), sealable plastic bag. On shore or in the Lab the next day, press specimens in a plant press between labeled newspapers, using blotter papers and cardboard spacers to help the drying process. After the specimens are dry and flat (a week or more depending on ambient humidity), store in a safe dry place until the end of the sampling season. Morris Arboretum has agreed to verify the identification of aquatic macrophyte specimens and will include them in their PA plant inventory. Coordinate with Barbara Lathrop, DEP Central Office at 717-772-5651, to submit your specimens to Morris Arboretum. Your plant maps and species lists should be filed with the other data collected at the lake.

Assessment

Once the survey is complete and the sketched map of the lake's macrophyte coverage is finished, lay a see-through grid pattern (approximately ¼" squares) over the entire map. Count plant-covered squares vs. open lake squares to estimate percent coverage. Count partial squares until they equal one square. For example, two half-covered squares equals one, and three 1/3rd covered squares equals one. Apply this percentage to the known acreage of the lake to determine the acres of macrophytes.

Once the plant coverage is known, use Best Professional Judgment and the extent of coverage to assess recreational impairment. Generally, a *surface* coverage of 40% or greater will impair the recreational use. For example, if you have a 100 acre lake, and more than 40 acres of the lake OR shoreline is covered with aquatic macrophytes, you have an indication of impairment. For larger lakes, assess only the percent surface coverage of the *shoreline area*, because it is unlikely that a large lake will have any coverage offshore. There are a few exceptions, as Pennsylvania does have some large shallow lakes. In these cases, how the lake is managed will be a factor in the amount of plant coverage and in the assessment of recreational impairment. Macrophyte coverage can also be used to assess for Aquatic Life Use. In this case, a 40% and greater *underwater* coverage indicates good habitat conditions and reason not to impair the Use. An underwater coverage of 10% or less indicates habitat impairment. Macrophyte

coverage between 10% and 40% requires the reviewing biologist to consider other factors and assessed data, and could be used to support an impairment decision.

When using macrophyte coverage to assess lakes, consider the following factors. Take note of the presence and extent of invasive non-native species, and the degree of weed management measures used by lake stakeholders (e.g. harvesting, application of herbicides or aqua-shades, drawdowns, etc.). Non-native species can degrade habitat and limit native aquatic plants. Over-management of weeds reduces fish habitat and nursery areas, and encourages algal blooms and algal or sediment turbidity. However, judicious management can improve boating and swimming areas, while retaining fish habitat.

Trophic State Indices (TSIs) are sensitive to algal biomass, and therefore may underestimate the TSI of a macrophyte-dominated lake. When TSI parameters on a lake do not agree, often non-algal turbidity or extensive weed growth is the reason. Use the knowledge of a macrophyte-dominated lake to evaluate TSI differences to rate the lake's overall trophic status.

References and Literature Cited:

Table 5-1. Recommended Water Quality Indicators for General Designated Use Categories. p 52 in "Guidance for 2006 Assessment, Listing and reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, a Memorandum to States dated July 29, 2005. (Source – *Elements of a State Water Monitoring and Assessment Program*, Office of Water, US EPA; EPA 841-B-03-003, March 2003).

Canfield, D.E. Jr., K.A. Langeland, M.J. Maceina, W.T. Haller, J.V. Shireman, and J.R.Jones. 1983. Trophic state classification of lakes with aquatic macrophytes. Can. J. Fish. Aquat. Sci. 40: 1713-1718.

Deppe, E.R. and R.C. Lathrop. 1992. A Comparison of Two Rake Sampling Techniques for Sampling Aquatic Macrophytes. In Research Management Findings, Bureau of Research – Wisconsin Dep. Natural Resources, Number 32, March 1992

Environmental Protection Agency. 2007. FINAL Survey of the Nation's Lakes Field Operations Manual. Doc. EPA 841-B-07-004. Office of Water, Washington, D.C. 104 pp.

Pennsylvania Fish and Boat Commission. 2009. Clean Your Gear – Help Reduce the Spread of Aquatic Invasive Species. Website http://www.fish.state.pa.us/cleanyourgear.htm

Kenow, K.P, J.E. Lyon, R.K. Hines, and A. Elfessi. 2007. Estimating Biomass of Sumberges Vegetation Using a Simple Rake Sampling Technique. Pp 447-454 in: Hydrobiologia. Vol. 575, No. 1, Jan. 2007.

Massachusetts Department of Conservation and Recreation Lakes and Ponds Program online materials adapted from: Simpson, J.T. 1991. Volunteer Lake Monitoring: A Methods Manual. EPA 440/4-91-002.

Rodusky, A.J., B. Sharfstein, T.L.East, and R. P. Maki. 2005. A Comparison of Three Methods to Collect Submerged Aquatic Vegetation in a Shallow Lake. Pp. 87-97 in: Environmental Monitoring and Assessment. Vol 110, Nos 1-3, Nov. 2005.

Aquatic Plant Identification Manuals:

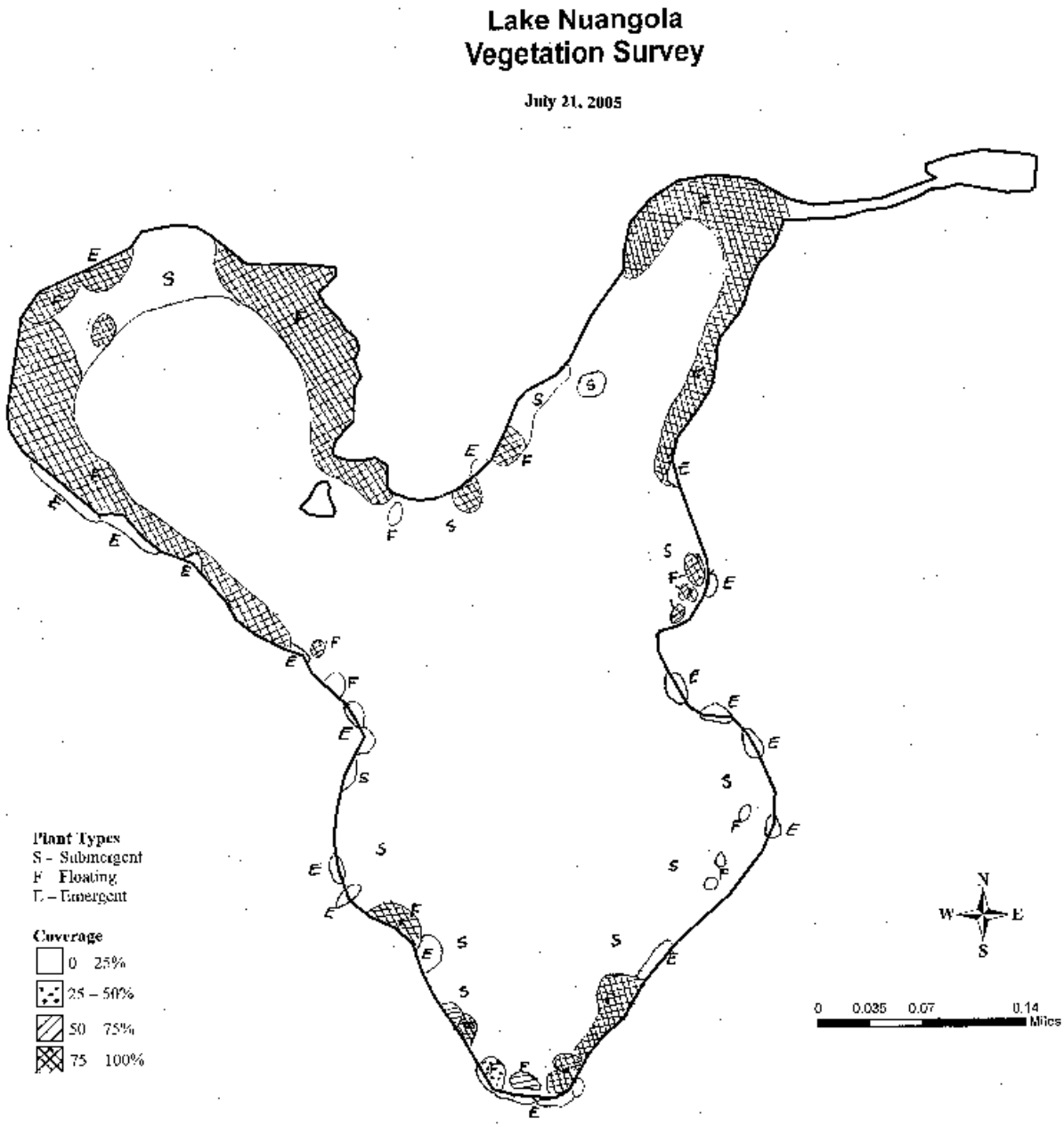
Block, T. A and A.F. Rhoads (in press). Plants of Pennsylvania's Lakes and Streams. Identification and Ecology. Morris Arboretum of the University of Pennsylvania. 186 pp.

Crow, G.E. and Hellquist, C.B. 2000. Aquatic and Wetland plants of Northeastern North America, Vol. 1 and 2. Unviversity of Wisconsin Press. Madison, WI.

Hotchkiss, N. 1972. Common Marsh, Underwater, and Floating-leaved Plants of the United States and Canada. Dover Publications, Inc. NY.

Nichols, S.A. 1999. Distribution and Habitat Descriptions of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey. Bull. 96. 266 pp.

FIGURE 1
Example Map



Common Name	Scientific Name
Smooth alder	Alnus serrulata
Black chokeberry	Aronia melanocarpa
Bur-marigold	Bidens cernua
Beggar-ticks	Bidens comosa
Small beggar-ticks	Bidens discoidea
Beggar-ticks	Bidens frondosa
False nettle	Boehmeria cylindrica
Watershield	Brasenia schreberi
Canada bluejoint	Calamagrostis canadensis var. canadensis
Wild calla	Calla palustris
Sedge	Carex canescens
Sedge	Carex echinata
Sedge	Carex lacustris
Water-hemlock	Cicuta bulbifera
Dodder	Cuscuta sp
Water-willow	Decodon verticillata
Long-stem waterwort	Elatine triandra
Needle spike-rush	Eleocharis acicularis
Capitate spike-rush	Eleocharis olivacea
Seven-angle pipewort	Eriocaulon aquaticum
Winterberry holly	Ilex verticillata
Jewelweed	Impatiens capensis
Spiny-spored quillwort	Isoetes echinospora
Water-willow	Justicia americana
Duckweed	Lemna minor
Marsh-purslane	Ludwigia palustris
Maleberry	Lyonia ligustrina
Swamp-candles	Lysimachia terrestris
Northern waternymph	Najas flexilis
Stoneworts	Nitella sp.
Spatterdock	Nuphar variegata
Fragrant water-lily	Nymphaea odorata
Sensitive fern	Onoclea sensibilis
Cinnamon fern	Osmunda cinnamomea
Royal fern	Osmunda regalis
Fowl bluegrass	Poa palustris
Halberd-leaf tearthumb	Polygonum arifolium
Pickerel-weed	Pontederia cordata
Bogleaf pondweed	Potamogeton amplifolius
Ribbonleaf pondweed	Potamogeton epihydrus
Snailseed pondweed	Potamogeton spirillus
Silky willow	Salix sericea
Pitcherplant	Sarracenia purpurea
Common skullcap	Scutellaria galericulata
Purple nightshade	Solanum dulcamara
Bur-reed	Sparganium eurycarpum
Meadowsweet	Spiraea alba
Skunk-cabbage	Symplocarpus foetidus
Marsh fern	Thelypteris palustris
Marsh St. John's-wort	Triadenum virginicum
Common cat-tail	Typha latifolia
Humped bladderwort	Utricularia gibba
Highbush blueberry	Vaccinium corymbosum
Cranberry	Vaccinium macrocarpon
Water-celery	Vallisneria americana
Northern arrow-wood	Viburnum recognitum
Yellow-eyed grass	Xyris sp.

FIGURE 2
Observation Tally Sheet

LAKE/POND: **Date:**

Collectors:

Total Observations (sites)

Species Name	Observation Tallys	Total