University of Rhode Island Cooperative Extension's Watershed Watch Aquatic Plant Survey Manual

I. Introduction

Macrophytes: larger rooted aquatic plants.

Aquatic plants serve a critical role in lake and river ecosystems. *Macrophytes* provide food for waterfowl and wildlife, protect small fish and create spawning habitats, act as refuges for zooplankton, and oxygenate water. They reduce erosion by providing bottom stability and diminishing wave action. Macrophytes also play a crucial role in nutrient transport to and from sediments. They can be found throughout the *littoral zone*.

littoral zone: shallow areas where sufficient light reaches the lake bottom to promote photosynthesis in rooted plants.

While plants are important to the overall ecology of a waterbody, the proliferation of some species can be unhealthy. Of particular concern are the exotic, or non-native plants which can frequently crowd out native aquatic plants. They can become nuisances primarily because there are no natural controls to their growth. A lack of predators or pathogenic organisms allows exotics to out-compete native species for growing space, light, and nutrients. Shoreline and bottom disturbance can affect native plant communities, making it easier for exotic species to become established. Excess nutrients from runoff and other sources can also lead to overgrowth of both native and exotic species. Aquatic plants are referred to as "weeds" when they are a non-native species, or a native species growing in such abundance that the use and enjoyment of recreational waters is impaired.

Improved understanding of aquatic plants and the role they play in lake and river ecosytems is essential to the proper management of freshwater bodies. By mapping and monitoring aquatic plants, it can often be determined which areas may be sensitive to runoff and disturbance. It is important to watch for problems in plant communities (such as the introduction of exotics and the loss of plant diversity) that may be warning signals for the entire lake ecosystem. It is equally useful, and quite rewarding, to observe improvements (such as re-establishment of native species or an increase in species diversity) that may result from lake and watershed management activities.

In order to determine if, or when, to manage plants, knowledge of their abundance and distribution is necessary. While an extensive plant survey may be necessary in some cases, often a semi-quantitative assessment can provide a great deal of

information. Trained volunteers can map the general distribution of aquatic plant beds, determine the relative abundance of various plants in specific beds, identify common plant species, and also collect difficult to identify species for professional identification.

The following protocol has largely been adapted from the EPA *Volunteer Lake Monitoring: A Methods Manual,* the *New York Citizens Statewide Lake Assessment Program Sampling Protocol,* and the Wisconsin Department of Natural Resources *Aquatic Plant Monitoring Procedures Self-Help Lake Volunteer Training Manual* for the University of Rhode Island's Watershed Watch (WW) program. The protocol was designed to obtain baseline data on aquatic plant distribution and to assess whether surveyed lakes are affected by non-native species such as Eurasian watermilfoil. It is easily adaptable to rivers by addressing them as river segments, and performing the survey one segment at a time.

II. Recognizing plant form

A. Four major aquatic plant forms

Aquatic plants can basically be divided into groups based on their *life-forms*. Height, branching pattern and leaf shape all contribute to form. The form that a plant has affects how it functions, and where it may grow in a lake. Various plant forms impact recreational and wildlife usage differently.

life-form: the physical structure or growth habit of a plant

B. Submergents

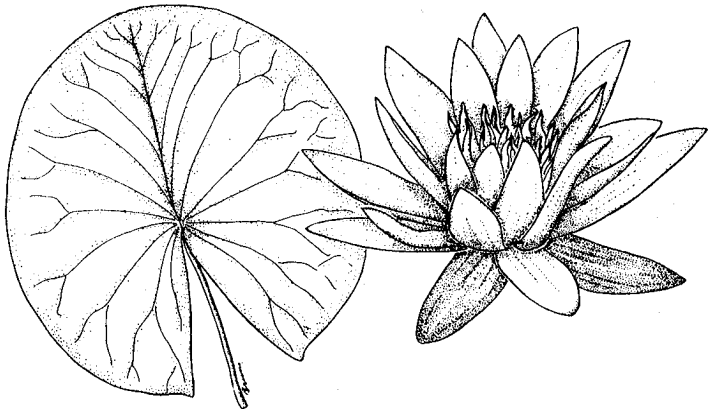
The life-form "submergent" refers to plants that grow entirely beneath the water surface. Some species in this group may have flowers that extent above the water. Most submergents are rooted to the bottom. Common submergent species in Rhode Island include *Cabomba caroliniana* (fanwort), *Ceratophyllum demursum* (coontail) or *Utricularia radiata* (bladderwort).

Cerotophyllum demursum

C. Floating-leaved

Plants that are rooted to the bottom with leaves that float on the water surface, are of the "floating-leaved" life-form. Species in this group generally have flowers that are above water. *Nymphaea ordorata* (white water lily), *Potamogeton epihydrus* (ribbonleaf pondweed) and *Brassenia schreberi* (water-shield) are floating-leaved species common in Rhode Island.

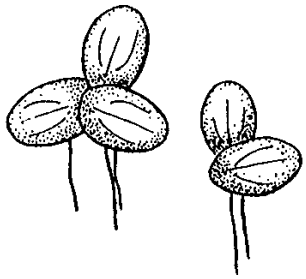
Nymphaea ordorata



D. Free Floating

The "floating" life-form refers to plants that are not rooted to the bottom, that float freely on the surface. Plants in this group are generally very small. Species in the Genus *Lemna* (duckweed) may be found in Rhode Island.

Lemna minor



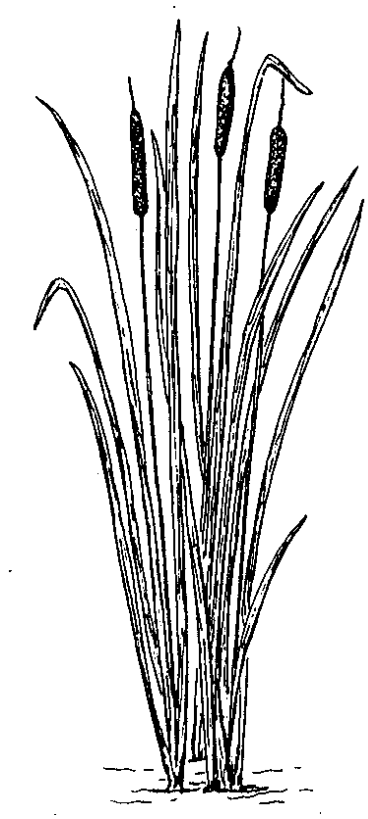
Not to scale

E. Emergents

herbaceous: plants with a fleshy rather than woody stem

The life-form "emergent" refers to rooted *herbaceous* or semiwoody plants that have the majority of their vegetative parts above the surface of the water. Emergent plants may be found in areas where the water is several feet deep, up to where the lakeshore is only sporadically flooded or moist. Emergents take a variety of sub-forms. *Juncus militaris* (bayonet rush), *Lythrum salicaria (*purple loosestrife), and *Typha latifolia* (broad-leaf cattail) are examples of common Rhode Island emergent species.

Typha latifolia



III. Survey schedule

surface: includes both free-floating and floating-leaved plants

While macrophyte communities in New England experience significant seasonal fluctuations, there is little variation on a daily basis. Therefore, an aquatic plant survey may be completed over a period of up to two weeks if necessary. Emergent and *surface* plant beds may be surveyed at any time of the day, provided there is adequate light. Submergent plant beds should be surveyed during the period when light penetration is greatest, between 10 AM and 2 PM, the same as for Secchi depth determination.

Aquatic plant surveying and mapping are best completed during mid-July when nearly all of southern New England's macrophyte species are in full growth. This is also the period when many species are in bloom, which makes it easier to correctly identify species which may otherwise appear similar.

IV. Choosing survey locations

A. Preliminary aquatic plant bed assessment

Ideally, survey locations should be selected at sufficient intervals to construct a map of plant coverage throughout the littoral zone. However, time constraints may prevent volunteers from performing such an in-depth survey. In order to ensure that the species distribution of a lake's major aquatic plant beds are mapped, a preliminary assessment should be performed. In this assessment, the volunteer paddles or cruises around the perimeter of the lake marking the location of emergent, submergent, floating-leaved and free-floating plant beds on a map of the lake. Note the depth at which emergent plants give way to submergents completely. Step by step instructions for completing a preliminary assessment are in section VI.

bathymetric depth contour lines

If available, a *bathymetric* map should be used. *Fisheries Investigation and Management in Rhode Island Lakes and Ponds*, published by the Rhode Island Department of Environmental Management (Guthrie and Stolgitis, 1990), has bathymetric maps for 101 Rhode Island ponds. Lake maps copied from United States Geological Survey topographic maps are also very useful as they may have landmarks already noted, and are readily available. Finally, lake maps can also be copied from road maps.

Use a lake map which is large enough to draw in the plant beds. Remember to include some indication of map scale. The scale printed an original map may not apply an enlarged copy. In such a case, you should write in the approximate distance between two known points as a reference. For example, if you have enlarged a section of a road map, try to keep some perimeter roads on your copy. You can then write in that it is "1 mile from the Maple St. to Brown St.", drawing in the 1 mile line. This becomes a reference for determining approximate distances and areas (Figure 1).

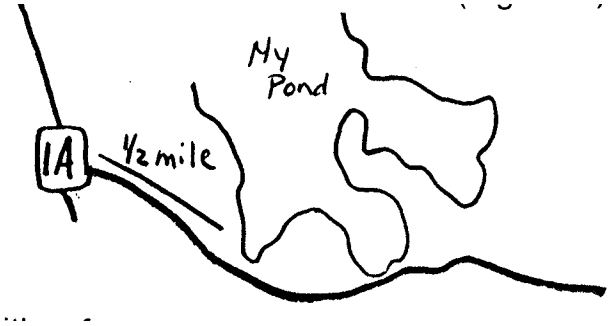


Figure 1. Map with reference marks

B. What is a survey location?

transect: a line between 2 points sampled at regular intervals

A survey location consists of a *transect* perpendicular to the shoreline, with three sampling sites per transect. The deepest of these sites is at a depth equal to the maximum Secchi depth of the current monitoring season. This approximates the maximum depth of the littoral zone. The remaining sites along the transect should be spaced equidistant from the deep site to the shore. This means that if your first site is approximately 90 feet from the shoreline, your second site would be 60 feet from shore, and your third, 30 feet from shore.

C. Survey location selection

The aquatic plant bed map serves as the basis for the volunteer to determine the specific survey locations. Depending on lake or river features and the time that the volunteer has available, four to six survey locations should be identified (additional sites are optional). At least one survey location should be situated in each of the major plant beds identified on the preliminary assessment map.

If it is not possible to survey each of the major plant beds, the areas in which sediment and nutrients are concentrated, such as an outlet or inlet, boat launch sites, marinas, and other shallow areas should be mapped. Areas which are also of specific interest to the volunteer, such as an association beach, a favorite fishing cove, or bed of atypical plants, should also be included.

D. Collecting optional survey location information

While it is not necessary, photographing the area between each survey location and the shore can be very useful. This provides a visual record of the emergent plant communities that can be compared with photographs taken in the future. By recording the survey location information on the back of the photograph, and cross referencing it with the survey information sheet, it becomes even more valuable.

Conducting a shoreline survey of the natural and manmade features of the lake or river shore can provide some insight into the distribution of aquatic plants. Information regarding how to conduct a shoreline survey may be obtained through WW.

V. Filling out the "Aquatic Plant Survey Form"

A. Location information

Fill out an *Aquatic Plant Survey Form* for each survey location. An example is shown in Figure 2. Each form must be properly identified with the volunteers' names, the name of the waterbody being surveyed, and the date of the survey. Try to find two landmarks with which to align your transect, noting the landmarks on the survey form. When possible, these landmarks should be "permanent" features such as identifiable boulders, bridges or buildings, rather than trees or shrubs which may easily be removed or destroyed. This information should be detailed enough to allow that site to be re-assessed in the future. The landmarks should also be recorded on a lake map (Figure 3). For each survey site along the transect, the following conditions must be assessed.

WW Aquatic Plant Survey Form

Volunteer Name(s) S. Smith; J. Gordon Date 8/16/94

Lake Name Blue Pond Survey Location Letter A

Landmarks Gray house (cape) — large boulder next to stream
A frame house — Jones dock

Present lake level as compared to previous years at this time of the year (Circle one):

LOW (AVERAGE) HIGH DO NOT KNOW

Site 1

Depth of sampling site (meters) 4.3 Distance from shore 75 feet

Percent coverage of the bed (Circle one):

0% 25% (50%) 75% 100%

Dominant Bottom type (Circle one)

(MUD), SAND, ROCK, GRAVEL, MUCK, DEBRIS, UNKNOWN, OTHER

SUBMERGENT PLANTS			EMERGENT and/or FLOATING PLANTS		
Plant #	Species	% abundance	Plant #	Species	% abundance
1	Cabomba C.	35%	1	Nymphaea O.	40 %
2	Ceratophyllum d.	25%	2		
3			3		
4			4		
5			5		

(Additional space on reverse side if necessary)

Site 2

Depth of sampling site (meters) 2.25 Distance from shore 40

Percent coverage of the bed (Circle one):

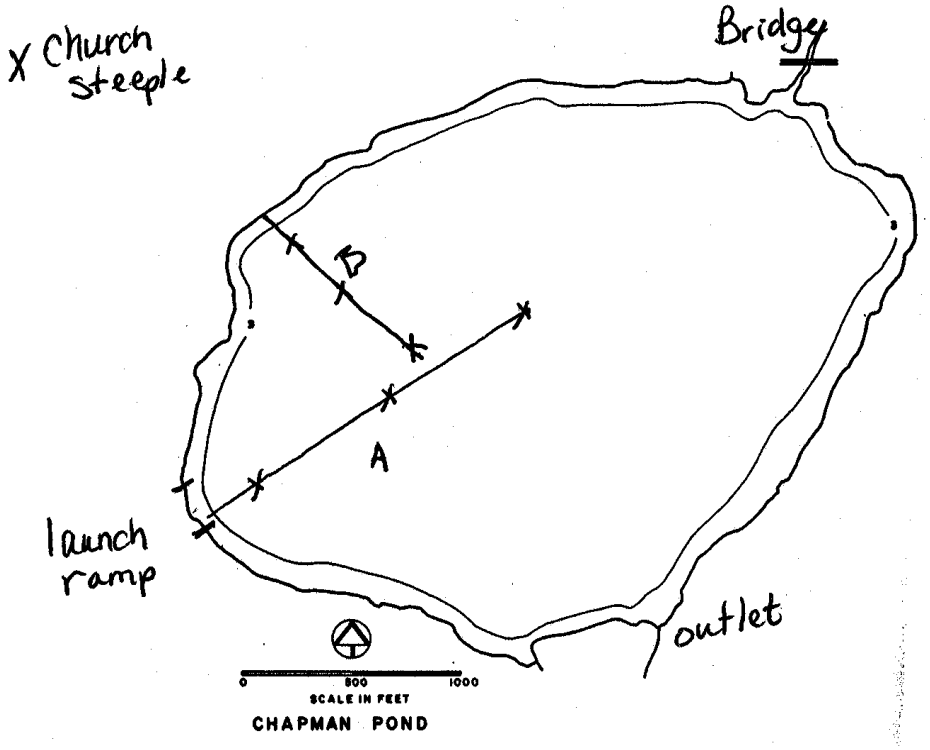
0% 25% 50% 75% 100%

Dominant Bottom type (Circle one)

MUD, SAND, ROCK, GRAVEL, MUCK, DEBRIS, UNKNOWN, OTHER

Figure 2. Sample Aquatic Plant Survey Form

Figure 3. Sample map with landmarks and transect noted



B. Survey site depth

The present lake level, as compared with previous years during the same period should be assessed. Circle the most appropriate choice (low, average, high, do not know). Transects should start at a depth equal to the maximum Secchi depth of that season, or 3 meters (~10 feet). Determine the depth at which the samples are taken with a Secchi disk or a weighted measuring tape. Record that information for each site on the transect in the appropriate spaces.

C. Recording plant density

Visually assess the relative density of the aquatic plant bed and record as percent coverage of the bed (0%, 25%, 50%, 75% or 100%). Observing the bed through the view scope or goggles gives a sense of how densely vegetated the bed is. If the bottom is not visible at all, the percent coverage is 100%. If vegetation is sparse, and the bottom is apparent throughout most of the bed, it is recorded as a percent coverage of 25%. The volunteer will quickly develop a sense of how densely the plants are growing, and how much of the bottom they are covering.

D. Recording bottom type

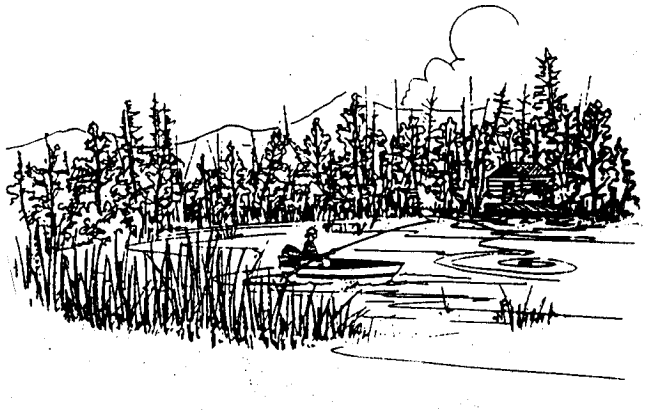
Record the dominant bottom type by circling the most appropriate choice. Typical bottom compositions are: mud, sand, rock, gravel, and muck.

- Mud is a mixture of organic material and sand
- Rock is exposed bedrock, more or less solid
- Gravel includes smaller rock forms from pebbles to cobbles.
- Muck is very high in organic material, of a loose consistency, or "oozy".

The bottom sediments may not be visible due to leaves or other debris. In that case, record that debris was present. If possible, use a rake to remove some of the debris to identify the bottom condition.

E. Recording plant abundance

The percent abundance of individual species is determined quantitatively by collecting four sets of plant samples from each of the sites on the survey transect. The plants from each site are separated into piles based on species. The percentage of each plant species found at that site is estimated, and recorded along with the species name (or label if you are unable to identify it). Step by step instructions for collecting plant samples and assessing abundance are in section VII.



VI. Making a preliminary aquatic plant bed assessment

Equipment checklist

In addition to the required safety equipment, the following items should be brought on the boat when conducting a preliminary assessment of aquatic plants

_____ clip board and pencil
_____ clean map of the lake (bathymetric if possible)
_____ Secchi disk or weighted measuring tape
_____ view scope or goggles
_____ anchor

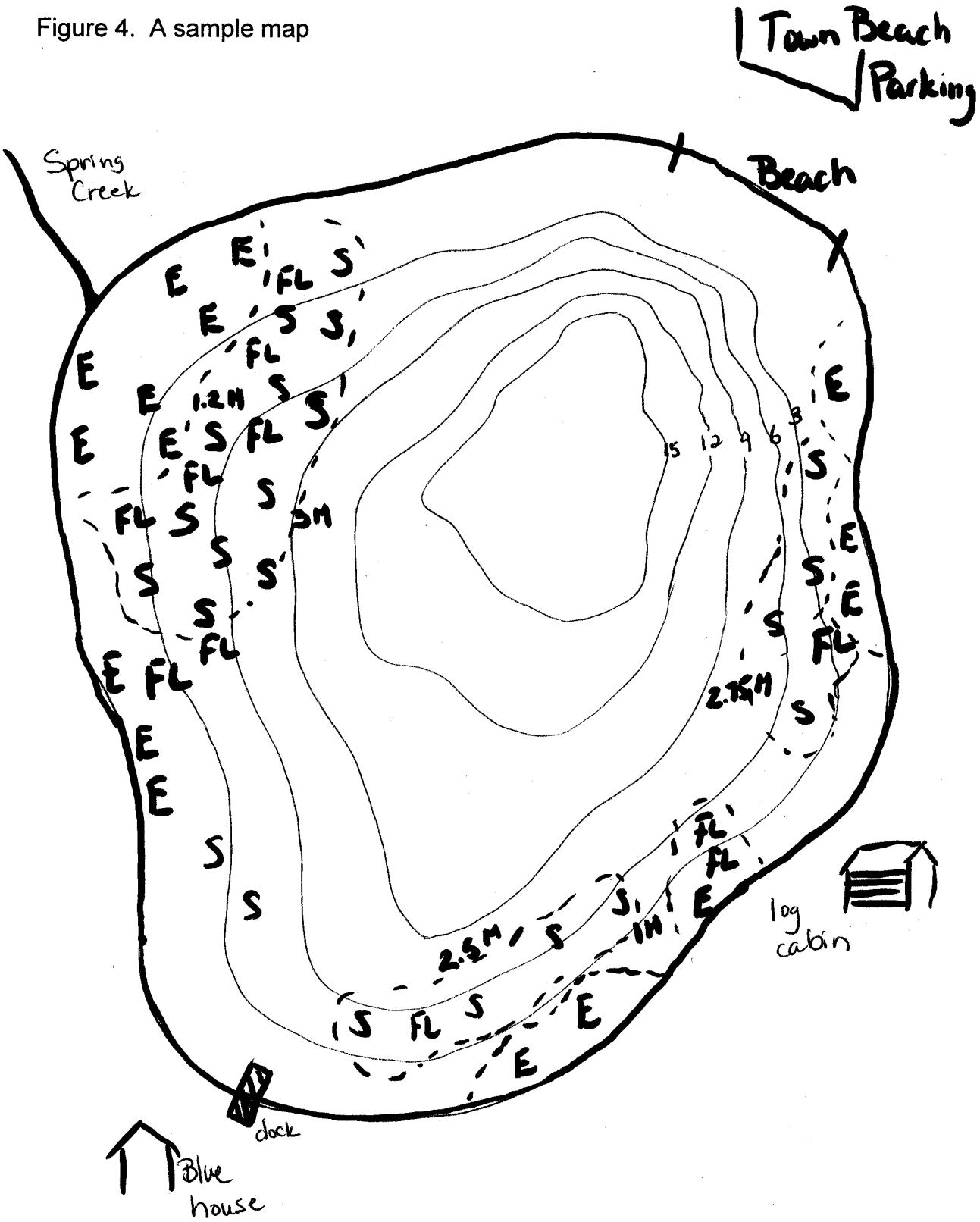
1. To permit a safe and successful assessment, try to conduct the preliminary aquatic pant bed mapping at a time when there is adequate light and little boating activity.
2. Mark the following information on your lake map: Lake, Date, Volunteer(s), and any additional observations.
3. Motor or paddle around your lakeshore once to get an idea of where plants are growing.
4. Stopping frequently for closer looks, circle the lakeshore again. Note the extent of plant beds and the form of plants growing there. Using the abbreviations listed below, mark this information on your lake map. Use a solid line to mark the approximate edge of each major plant bed.
5. Using a Secchi disk or weighted measuring tape, determine the lake depth where emergent plant beds end. Do the same for the submergent plant beds. Record this information on your map also. (An example map is provided in Figure 4.)

PLANT FORM ABBREVIATIONS

Use the following letter to denote the form of plant growing at each location:

S = submerged - entire plant is growing under water (flowers may be above)
E = emergent - part of plant stem and leaves growing beneath the lake surface, part are growing above
FR = free-floating - entire plant is floating on surface (does not have stems)
FL = - floating leaves - stem underwater, and most/all leaves floating on surface

Figure 4. A sample map



VI. Making an Aquatic plant survey

Equipment checklist

A. For the boat

In addition to the required safety equipment, the following items should be brought on the boat when conducting a survey of aquatic plants

_____ WW Aquatic Plant Survey Forms
_____ clip board and pencil
_____ clean map of the lake (bathymetric if possible)
_____ pre-survey map of the lake with major beds noted
_____ Secchi disk or weighted measuring tape
_____ view scope or goggles
_____ weighted sampling rake with line attached to handle (can be an ordinary garden rake)
_____ plastic garbage bags, preferably white
_____ tape or labels for bags (especially if not using white bags)
_____ permanent ink pen ("Sharpie") for marking bags or labels
_____ buckets or coolers for storing bags of plants
_____ anchor

B. Shoreside

The following is needed on the shore when conducting an aquatic plant survey

_____ a large, flat area on which you can comfortably spread out plant specimens (picnic tables, grass, pick up truck tailgates, etc.)
_____ WW Aquatic Plant Survey Forms with survey location data
_____ clip board and pencil
_____ plastic garbage bags containing samples from each survey site
_____ aquatic plant identification key
_____ pictorial plant guide
_____ magnifying glass or hand lens
_____ sealable plastic bags for plant specimens
_____ tape or labels for larger plants
_____ permanent ink pen ("Sharpie") for marking bags and labels
_____ buckets or coolers for storing bags of plants

Step-by-step Survey Instructions

Step 1: Find the survey location

a. Using the preliminary plant bed assessment map, locate the first bed to be sampled. Move perpendicular to the shoreline out to a depth equal to the maximum Secchi depth of the current monitoring season (contact WW prior to the survey date if you do not know this).
b. Confirm the depth with the Secchi disk or weighted measuring tape.

Step 2: Record survey location information

a. Anchor the boat.
b. Give the survey location an identifying letter. Record it and a description of the landmarks being used set up your transect with on the survey form and lake map. (Figures 2 and 3).

Step 3 Begin transect site assessment

a. Determine and record the depth to the bottom at the survey site with a Secchi disk, or weighted measuring tape.
b. Record approximate distance from shore.

Step 4: Assess the percent coverage of the plant bed

a. Using the view scope or goggles, observe the bottom from all sides of the boat.
b. Determine how dense the plant coverage is in terms of the percent of the bottom that is covered, take emergent and floating leaved plants into consideration when assessing plant density.
c. Circle the most appropriate percent coverage on the survey form.

Step 5. Record bottom type

a. Using the view scope or goggles, observe the bottom from all sides of the boat.
b. If the bottom is not visible because of plants or debris, use your rake to try to clear the bottom.
c. Determine and record the bottom type (i.e. mud, gravel, etc.)

Step 6. Collect plant samples

a. Confirm that the line is securely attached to the rake.
b. Facing the shore, pitch the rake shoreward, about six feet from the boat.
c. Allow the rake to settle to the lake bottom. Then slowly pull the line so that the teeth of the rake drag along the floor of the lake.
d. Bring the rake back into the boat. Remove all of vegetation trapped on the rake teeth and put into a plastic garbage bag. If there are emergent or floating leaved plants in the bed you are sampling it may be necessary to pull them by hand in order to get them loose from the bottom.
e. Repeat the procedure three more times, pitching the rake away from the shore, and to the parallel to shore to the right and left. Put those plants into the same garbage bag that your put the first bunch.
f. Label the bag with the survey location letter, and the transect site number, i.e. A1 for the first site on the first location transect, A2 for the second site on that transect.
g. Store the bag out of sunlight if possible, in a bucket or cooler.

Step-by-step Survey Instructions

Step-by-step Survey Instructions (continued)

Step 7. Complete the survey transect

a. Move toward shore in a straight line perpendicular to the shoreline, repeat Steps 3 through Step 6 two more times (Sites #2 and #3), first anchoring the boat. Space these survey sites an equal distance apart. For example, if the first survey site was about 60 feet from the shoreline, the remaining two survey sites should be approximately 40 feet and 20 feet, respectively, from the shoreline.
b. You may either now return to shore to assess abundance and types of plants (Step 8), or complete the aquatic plant survey (Step 9)

Step 8. Assessing abundance and types of plants

This step can most easily be done on shore where there is room to spread out samples. However, if you have a suitable boat (such as a pontoon boat), you can do this while out on the water. If you decide to assess plant abundance on the boat instead of shore, make sure that you bring the equipment listed for **Shoreside**. In order to avoid mixing up samples, you assess samples from one transect site at a time. Try to complete the entire survey sheet for a location before spreading out the samples from another location. If you are unable to complete Step 8 immediately after returning to shore, add some water to the bags to keep the plant moist, and store the bags in the refrigerator.

a. Sort the different plant types into separate piles.
b. Using the plant identification key, determine the identification of each of the plant types, and record on the survey form.
c. Examine the piles to estimate the percentage of each species found, and record in the appropriate space on the survey form. The total should add up to 100 percent.
d. Species which can not be identified, should be labeled and stored in sealable baggies with a little water in a refrigerator for later identification by URI personnel. Contact WW as soon as possible to make arrangements. Plants may be stored for up to 2 weeks, with the water being changed as necessary

Step 9. Completing the aquatic plant survey

Complete Step 1 through Step 8 three to five more times, for a minimum of four to six survey location transects throughout the lake, filling out separate survey forms for each survey location, giving each location an individual location letter. You may survey additional locations if you have the time, and feel that it will provide useful information.

The survey need not be completed on a single day. Remember, please dispose of all plant material in the trash or composted, do not return it to the lake.

VII. What to do with the completed survey

When you have finished your survey, you may wish to re-draw your maps or copy the information onto fresh survey forms, especially if they got wet. Please make at least one copy of the *final* maps and survey forms, and return it to the WW office. Pre-stamped and addressed manila have been included in your protocol packet. Your local lake association or conservation commission may also be interested in receiving copies. You should keep a copy for yourself so that you can watch your lake for changes that could indicate problems, or just keep track of it as it slowly, and naturally ages.

References:

Golet, Francis, C. and Joseph S. Larson. 1974. *Classifications of Freshwater Wetlands in the Glaciated Northeast.* U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. Washington, D.C.

Lamb, Bonnie, Arthur J. Gold, Calvin P. Poon, and Christopher Deacutis. 1991. *Southern Rhode Island Water Quality Assessment Program: Final Report*. University of Rhode Island, Natural Resource Sciences Department.

McComas, Steve. 1994. *Lakes Smarts: The First Lake Maintenance Handbook-A Do-It-Yourself Guide to Solving Lake Problems*. Terrene Institute. Washington, D.C.

New York Department of Environmental Conservation, Division of Water, Lake Services Section and New York Federation of Lake Associations. 1994. *New York Citizens Statewide Lake Assessment Program: Sampling Protocol*.

Prescott, G.W. 1980. How to Know the Aquatic Plants. Wm. C. Brown Company Publishers. Doubuque, Iowa.

Simpson, J.T. 1991. *Volunteer Lake Monitoring: A Methods Manual*. EPA 440/4-91-002.

Tempte, Jo. 1994. *Aquatic Plant Monitoring Procedures: A Self-Help Lake Volunteer Training Manual*. Wisconsin Department of Natural Resources.