CHAPTER 9. AQUATIC PLANT SAMPLING

Goals of a standardized plant sampling regime:

1. Be efficient, taking a day or less to complete.
2. Be repeatable.
3. Be unbiased, sampling all aquatic habitats and species present.
4. Obtain data that are quantifiable, and allow statistical comparisons.
5. Be flexible, allowing the surveyor to do both a cursory and a more comprehensive sample based on objectives, e.g. produce a plant distribution map, find frequency of occurrence and track changes over time, give surveyor a way to track changes in density.
6. Positive ID of aquatic plant samples.
7. Incorporate data into a web-based database.

INTRODUCTION

Vegetation is an important facet of lake ecology. Invertebrates use aquatic plants, young of the year (YOY) fish escape predation in both submersed and emergent vegetation, and fish feed on organisms associated with vegetation. Birds, amphibians, and terrestrial animals also associate with aquatic plants for food and cover. Despite the obvious benefits of aquatic vegetation, too much can be a detriment. Both the eutrophic conditions of many of Iowa's lakes and increasing numbers of post-renovation lakes with clear water can lead to algal blooms impairing water quality as well as nuisance growths of vascular plants inhibiting recreational use (Henderson 1996), and causing slow growth and an imbalance in sportfish populations (Mitzner 1978; Colle and Shireman 1980; Valley et al. 2004).

For these reasons control of nuisance plant growths has been a primary concern of lake managers. Both herbicides and grass carp (*Ctenopharygodon idella*) have been used to control aquatic plants, though results short of vegetation eradication (a common result of grass carp stocking) have not been well documented.

Iowa does not have a standard method for surveying aquatic plants, making documentation difficult. Unbiased results can be documented and managers will be better equipped to make sound management decisions by developing a standard method of vegetation sampling.

Several methods are available to survey aquatic plants and the variety of sampling regimes continues to grow with further advances in technology. Geographical Information Systems (GIS) and Global Positioning Systems (GPS) have been beneficial in mapping aquatic vegetation coverage. Hydroacoustics, point-intercept and transect surveys are being used to assess biovolume, biomass, presence/absence data, and frequency of occurrence. Each method is designed to analyze different aspects of a plant community and careful consideration needs to be addressed when deciding on a method to use.

Hydroacoustic equipment is used to assess plant abundance in lakes and in recent years, with the introduction of GPS, hydroacoustics has become more useful and reliable. Bathymetric and biovolume maps of aquatic vegetation can be constructed from one survey.
Additional surveys must be conducted if species richness and emergent vegetation maps are objectives of the sampling methodology. Sounding equipment and software used to analyze the data is expensive and technical training is required to operate the equipment and software package.

Point-intercept sampling is most suited for whole lake or large plot assessments (Madsen 1999). Stratified random point sampling is the most common method of point intercept sampling used to assess aquatic vegetation in lakes and is used by the Long Term Resouce Monitoring,LTRM, on the Upper Mississippi River,UMR, (Yin, et. al. 2000). Points are set up on a grid at predetermined distances and are given GPS coordinates. Each point is then located on the lake using a GPS unit and sampled from a boat. One drawback is that, especially on long, narrow lakes, areas close to shore may not be well represented in the survey therefore biasing your data. Bruce (2006) compared the stratified random point intercept method to a modification of transect sampling and found fewer species in the point intercept survey. Additional species found with the modified transect were characteristic of near shore aquatic habitats.

Transects are a versatile aquatic plant sampling method and can be modified to fit the objectives of the study (Titus 1993). Generally, snorkeling or diving is employed to observe and enumerate plant species that intersect a line or are contained along a line within a predetermined width in water greater than 3 feet (Madsen 1999). Madsen and Bloomfield (1993) found the transect method strong in indicating species composition of a community and charting the distribution of species. Transects can also be useful in charting the effect of management practices on species diversity in small plots.

JUSTIFICATION

With the above goals in mind, we have elected to use a transect method as a first approach to sample aquatic vegetation in Iowa lakes.

Random Transect Survey

Setting Up Transects

1. Total number of transects are determined by the total surface acres of the lake (Quist et al. 2007). Transect starting locations will be randomly selected around the perimeter of the lake using ArcView (Figure 2).
    a. <100 acres = 13 transects
    b. 100 - 250 acres = 19 transects
    c. 250 - 500 acres = 25 transects
    d. 500 – 1,000 acres = 29 transects
    e. 1,000 acres = 49 transects

2. Transect starting locations will be marked with UTM coordinates using the NAD83 map datum.
    a. Map datum options can be found in the setup screen of your GPS unit.

Site Selection and Location

1. Vegetation transects
    a. Randomly select points at full pool height around edge of lake using GIS software.
    b. Transects run perpendicular to the shore into the lake at each point.

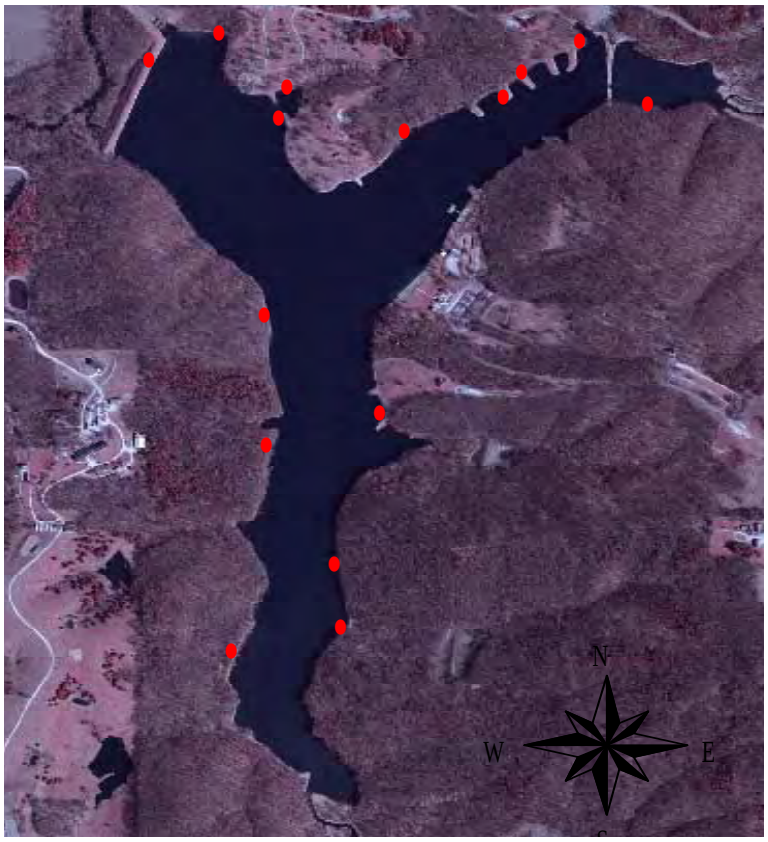


Figure 2. Lake showing randomly chosen vegetation transect locations.

Survey Procedures

1. **Timing:** surveys will be conducted from May 1st through September 30th. All samples should be taken on a single day or on consecutive days if more time is needed. Most plant species obtain maximum biomass and maturity in July and August, therefore these are the most favorable times to sample.

    a. When surveying specifically for curly-leaf pondweed (*Potamogeton crispus*) timing will typically be in May compared to early August with other species based on its life cycle (Borman et al. 1999). Curly-leaf is also known to change growing patterns from one system to another (Madsen, 2005). Though uncharacteristic, curly-leaf plants have been found sprouting in July with 81˚F water temperatures (L. Bruce, pers. comm)

2. **Water level** must be taken before each survey is started (i.e. how far above or below the outlet structure is the water level).

    a. The location used to calculate lake level should be a permanent fixture on the lake and be marked with UTM coordinates for future survey use. Outlet or other permanent structures are preferred over docks, stakes, or trees.

3. **Transects** will be sampled perpendicular from the shoreline outward at 2' contour depth increments to a minimum of 8' of water, i.e. a minimum of five samples will be collected at each transect . Each transect will always start at the water's edge and continue outward perpendicular to shore. Transects are complete when two consecutive samples taken in water are void of vegetation and water depths have been sampled out to at

least 8’ depth, or water depth starts to decrease instead of increase i.e. you start to go up the other shoreline or an island.

Stations along the transect at each contour will be collected at the beginning of each contour, i.e. if you are sampling the 2’ contour the sample will be collected as soon as the water depth reaches 2’ not somewhere between the 2’ and 4’ contour. Depth will be determined using the sample rake and not sonar equipment.

Vegetation is only sampled out to 16’ of water and recorded as both rake and individual species density. After the 16’ contour has been sampled one additional rake grab will be collected at the 18’ contour and vegetation will be recorded as present or absent.

Example: Lost Lake is 6’ low and the protocol is to sample every 2’ of contour change. The first sample is located at the waters edge. Rake grabs at contour depths 2’, 4’, and 6’ did not have vegetation but you still continue sampling on the contours until you reach 8’ of water.

4. **Floating hoop/quadrate:** is only used to sample emergent and floating leafed vegetation. If only submersed vegetation is present the double sided rake will be the only sampling equipment used for that specific sample point. Always sample emergent and floating leafed species with the hoop before pulling a rake sample.

Sampling a transect for emergent and floating leafed species.

1. A 1-m (3.3-ft) diameter hoop/quadrate will be used to sample emergent and floating leafed vegetation (Figure 3). The hoop will be placed over the same area the rake sample will be collected. If emergent and/or floating leafed vegetation is found on the 1st sample point the edge of the hoop will be placed where the water meets the shoreline so the entire area of the hoop is in the water. Emergent and floating leafed species should be evaluated before submersed species are sampled.

Figure 3. Floating hoop used to sample emergent and floating vascular plants.

2. After the hoop is placed on the water, percent coverage of all emergent and/or floating leafed plants is recorded together. Plants must be on the surface or breaking the surface to be considered for the plant coverage rating. When floating in a mat, filamentous algae will be included in floating plant density as ALGAE.

3. Wind-rowed submersed vegetation, and submersed vegetation without floating leaves will not be included in the emergent/floating leafed coverage.

4. Each sample will then be visually separated by individual species and recorded as a percent of the total plant material seen inside the quadrate. Each plant species has a four to six letter code (Appendix 2) for recording on datasheets. The percentages should add up to 100 for each station on the transect.

Sampling on a transect for submersed species

1. Samples of submersed plant species will be collected using a double sided rake (Figure 4). Two garden rakes measuring 14" wide and having 14, 2-inch long teeth, are welded together and attached to an extendable pole (Yin et al. 2000). If emergent or floating leafed plants have been sampled first, the rake should be placed in the same location as the floating hoop. Depth should be read on the pole. Substrate composition should be noted and recorded at this time.

2. To sample submersed species, the rake will be dropped to the bottom and twisted 180 degrees. If the rake has more than a strand or two of vegetation or is muddy, before estimating rake density or pulling the rake into the boat, pull the rake horizontally (swish) through vegetation-free water to rinse and compact vegetation on the rake head (Yin et al. 2000). If there are long strands of vegetation trailing the rake during this maneuver, catch them with the leading tines of the rake while underwater, and then pull the rake into the boat.

Figure 4. Twenty-foot long, two-headed rake used for submersed vegetation sampling.

3. After the rake has been pulled out of the water plant material still hanging off the rake head (i.e. not on the rake pole) can be added to the tines. Plant strands hanging off the rake pole should be ignored. In some instances where plant strands are added to the rake tines gentle compaction of the plants on the tines may be warranted (Figure 5).

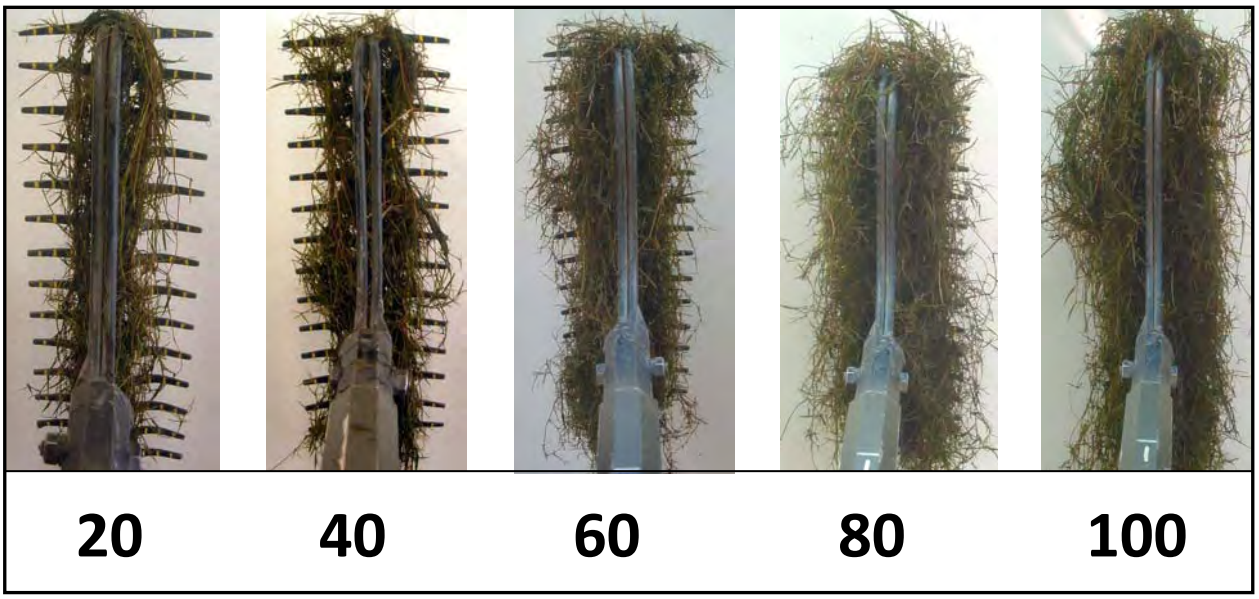
Figure 5. Lightly compact vegetation on the rake after plant strands have been added to the rake head.

4. Density of the entire rake sample will be estimated as a percentage (Table 1). These estimates should be based on an average of the entire rake, i.e. if one side of the rake has 20 percent coverage and the other side has 40 percent coverage the rake density estimate entered on the data sheet would be 30 percent.

5. The entire rake sample will then be taken off the rake head and separated by individual species. This can be done either with visual observation, or by physically going through the sample. We recommend the former until each sampler's ability becomes more proficient. Proficiency will develop with more experience. Abundance of each species is then recorded as a percent of the whole sample. (Again, do not include plants that are on the rake pole.) These individual species percentages should add to 100. Each plant species has a code for recording on datasheets. Filamentous algae will be included in submersed plant density as a single species – noted as ALGAE.

6. Data sheets are posted at: http://www.iowadnr.com/fish/programs/library.html

Table 1. Examples of plant rake densities.



Voucher Specimen Collection

1. As new species are encountered, they should be saved as a voucher specimen. Digital photos should be taken at the same time to include with the pressed plant. It is always recommended to press plants that have seeds or fruiting structures. Many times these are the only thing that will allow the plant to be keyed to species. Other structures to take and things to note when taking an unknown plant from the field for lab i.d. include: substrate type, water depth, plant height, root type, growth form and abundance. There is a note-taking sheet on the web (with the data sheet) for field use that will be helpful when taking samples for lab i.d. and voucher purposes.

2. Plants collected in the field should be stored in water until you identify and press them, coolers or zip-lock bags filled with water work well for storing plants in the field.

3. The Cold Springs office and the Decorah office will be available to help you with plant i.d. Send us your digital photos and we'll do what we can to identify to species.

4. Plant presses are designed to dry the plant as quickly as possible (Figure 6). To press a delicate, submersed or floating leafed plant, the specimen can be floated in a pan of water and a piece of newspaper slid underneath and carefully lifted out. Place this wet paper on top of other newspapers to dry excess moisture without desiccating the plant. Flowers or fruiting structures should be clearly visible, move leaves and stems if necessary. Label specimen with date sampled, lake, and species (if known).

5. Especially with emergent species, pull, clean and press a portion of the plant's roots. Stems can be cut or folded, and plant height noted in the field notes. Always press the seed head with the plant. Thick structures may need to be cut in half before pressing.

6. Plant presses are arranged for plant pressing in the following sequence of steps:

    a. Bottom of plant press
    b. Cardboard
    c. Blotter paper(thick paper towel)
    d. Newspaper
    e. Plant
    f. Newspaper

g. Blotter paper(thick paper towel)
h. Cardboard
i. Top of plant press
j. Wrap straps around frame and tighten.

7. The press should be put in a warm place to speed the drying process (e.g. inside a vehicle on a warm day).

8. Multiple plants can be preserved in one plant press at the same time as long as there is only one plant between each layer of newspaper, blotter paper, and cardboard.

Figure 6. Plant press showing layers of material in sequence for one specimen.

9. Once pressed and dried, specimens on the newspaper can be saved in a clear plastic sheet protector with field and i.d. notes. Sheets can be stored in a large envelope. Cold Springs staff will mount your plants onto herbarium sheets. This will insure that the plants don't deteriorate, and provide a long-term record.

Equipment

1. Aquatic Plant Identification Book
2. List of species present if available
3. Zip-Lock bags for voucher specimen collection
4. Cooler with ice for bagged plants
5. Double sided rake
6. Floating quadrate
7. GPS Unit (preferably a Garmin model Map 76 or Map 76S)
8. Digital camera
9. Tub for sorting plants after each sample (boat washout deck works great)
10. Data sheets (waterproof paper)
11. Two anchors
12. Depth rod sectioned into 6" increments
13. Sonar
14. Secchi disk
15. Permanent marker
16. Laminated species list/code
17. Extra push pole other than the sampling rake

18. Extra batteries for GPS and digital camera

Sampling Definitions

- Transect – Line extending perpendicular from shore out to the edge of vegetation.
- Stations – Plant sampling points at fixed depth contours along each transect.
- UTM- Universal Transverse Mercator is a grid of coordinates used to designate transects and other georeferenced locations, i.e., water sample locations, fish sampling stations, etc.
- GPS- Hand held Global Positioning System used to mark starting locations for each transect.
- ArcView- Geographical Information System used to download coordinates from handheld GPS unit and to randomly select transects.
- Full pool- Level at which water begins to flow out of the lake.

Plant Identification Links

- www.plants.usda.gov
    - Contains plant codes used on data sheets
    - Keys to identify aquatic plants
- http://aquaplant.tamu.edu/database/index.htm
    - Texas A&M Plant Identification
    - Contains several color photographs
- http://www.ecy.wa.gov/programs/wq/plants/plantid2/categories.html
    - Washington State Plant Identification
- http://sdafs.org/reservoir/
    - Southern Division AFS Reservoir Committee
    - Contains information about site selection for aquatic plant establishment
- http://www.npwrc.usgs.gov/resource/type_i.htm
    - Northern Prairie Wildlife Research Center Plant Identifcation
    - Useful keys for identifying aquatic plants

HACCP Approach

Refer to HACCP found in the procedures manual.

References

Borman, S., Korth, R., and Temte, J. 1999. Through the looking glass. ISBN: 0-932310-32-X. Merrill, WI pp.162

Bruce, L. J. 2006. Personel Communication. Unpublished data. Iowa Department of Natural Resources

Hill, K.R. 2004. Evaluation of limited aquatic vegetation restoration in two small Iowa lakes. Iowa Department of Natural Resources. Federal Aid Fish Restoration Annual Report F-160-R. Study 7023

Madsen, J. D. 1999. Point intercept and line intercept methods for aquatic plant management. Aquatic plant control technical note MI-02. Army Engineer Waterways Experiment Station, Vicksburg, MS. 16 pp.

Madsen, J. D., and J. A. Bloomfield. 1993. Aquatic vegetation quantification symposium:an overview. Lake and Reservoir Management. 7(2): 137-140

Madsen, J. D. 1999. Point Intercept and Line Intercept Methods for Aquatic Plant Management. APCRP Technical Notes Collection (TN APCRP-M1-02). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Madsen, J. D. 2005. Personal communication. GeoResources Institute. Mississippi State University

Quist, M, C., L. J. Bruce, K. Bogenshutz, and J. E. Morris. 2007. Sample Size Requirements for Estimating Species Richness of Aquatic Vegetation in Iowa Lakes. Journal of Freshwater Ecology 22: 477-491.

Yin, Y., J.S. Winkelman, and H. A. Langrehr. 2000. Long Term Resource Monitoring Program procedures: Aquatic vegetation monitoring. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. April 2000. LTRMP 95-P002-7. 8 pp. + Appendixes A-C.

Appendix 1

Common Name	Scientific Name	Plant Code
Submersed		
Bladderwort	*Utricularia macrorhiza*	UTMA
Brittle Naiad	*Najas minor*	NAMI
Bushy Pondweed / Slender Naiad	*Najas flexilis*	NAFL
Canada Waterweed	*Elodea canadensis*	ELCA7
Southern Naiad	*Naja guadalupensis*	NAGU
Coontail	*Ceratophyllum demersum*	CEDE4
Pondweed	*Potamogeton sp.*	POTAM
Pondweed, Claspingleaf	*Potamogeton richardsonii*	PORI2
Pondweed, Curlyleaf	*Potamogeton crispus*	POCR3
Pondweed, Flatstem	*Potamogeton zosteriformis*	POZO
Pondweed, Floatingleaf	*Potamogeton natans*	PONA4
Pondweed, Fries	*Potamogeton friesii*	POFR3
Pondweed, Horned	*Zannichellia palustris*	ZAPA
Pondweed, Illinois	*Potamogeton illinoensis*	POIL
Pondweed, Largeleaf	*Potamogeton amplifolius*	POAM5
Pondweed, Leafy	*Potamogeton foliosus*	POFO3
Pondweed, Longleaf	*Potamogeton nodosus*	PONO2
Pondweed, Sago	*Stuckenia pectinatus*	STPE15
Pondweed, Small	*Potamogeton pusillus*	POPU7
Muskgrass	*Chara vulgaris*	CHVU
Watermilfoil, Eurasian	*Myriophyllum spicatum*	MYSP2
Watermilfoil, Northern	*Myriophyllum sibiricum*	MYSI
Water Stargrass	*Heteranthera dubia*	HEDU2
White Water Crowfoot	*Ranunculus aquatilis*	RAAQ
White Water Crowfoot II	*Ranunculus longirostris*	RALO2
Widgeon Grass	*Ruppia maritima*	RUMA5
Wild Celery	*Vallisneria americana*	VAAM3
Emergent		
Arrowhead	*Sagittaria sp.*	SAGIT
Arrowhead, Broadleaf	*Sagittaria latifolia*	SALA2
Arrowhead, Narrowleaf	*Sagittaria cuneata*	SACU
Blue Flag Iris	*Iris versicolor*	IRVE2
Bulrush	*Schoenoplectus sp.*	SCHOE
Bulrush, Hardstem	*Schoenoplectus acutus*	SCAC3
Bulrush, River	*Schoenoplectus fluviatilis*	SCFL11
Bulrush, Softstem	*Schoenoplectus tabernaemontani*	SCTA2
Burhead, Upright	*Echinodorus berteroi*	ECBE2
Burreed	*Sparganium sp.*	SPARG
Burreed, Floating	*Sparganium emersum*	SPEM2
Quillwort	*Isoetes sp.*	ISOET
Emergent (con't)		
Burreed, Giant	*Sparganium eurycarpum*	SPEU
Cattail	*Typha sp.*	TYPHA
Cattail, Common	*Typha latifolia*	TYLA
Cattail, Hybrid	*Typha × glauca*	TYGL
Cattail, Narrowleaf	*Typha angustifolia*	TYAN
Giant Reed	*Phragmites australis*	PHAU7
Marsh Milkweed	*Asclepias incarnata*	ASIN
Pickerelweed	*Pontederia cordata*	POCO14
Prairie Cordgrass	*Spartina pectinata*	SPPE
Purple Loosestrife	*Lythrum salicaria*	LYSA2
Reed Canarygrass	*Phalaris arundinacea*	PHAR3
Rice Cutgrass	Leersia oryzoides	LEOR
Sedge	*Carex sp.*	CAREX
Smartweed	*Polygonum sp.*	POLYG
Spikerush	*Eleocharis sp.*	ELEOC
Spikerush, Small's	*Eleocharis palustris*	ELPA3
Sweet Flag	*Acorus americanus*	ACAM
Water Horsetail	*Equisetum fluviatile*	EQFL
Water Plantain	*Alisma plantago-aquatica*	ALPL
Water Smartweed	*Polygonum amphibium*	POAM8
Water Willow	*Justicia americana*	JUAM
Floating leafed		
American Lotus	*Nelumbo lutea*	NELU
Duckweed, Big	*Spirodela polyrrhiza*	SPPO
Duckweed, Little	*Lemna minor*	LEMI3
Duckweed, Star	*Lemna trisulca*	LETR
Mexican Water-fern	*Azolla mexicana*	AZME
Pondweed, Floatingleaf	*Potamogeton natans*	PONA4
Pondweed, Illinois	*Potamogeton illinoensis*	POIL
Pondweed, Longleaf	*Potamogeton nodosus*	PONO2
Waterlily, Fragrant	*Nymphaea odorata odorata*	NYODO
Waterlily, White	*Nymphaea odorata tuberosa*	NYODT
Waterlily, Yellow	*Nuphar lutea variegata*	NULU
Watermeal	*Wolffia columbiana*	WOCO
Water Clover	*Marsilea spp.*	MARSI
Water Shield	*Brasenia schreberi*	BRSC
Other Codes		
Algae	*All species*	ALGAE
No Aquatic Vegetation		NOAQVEG
Unknown Species	*Unknown Species*	UNK

Source : http ://plants.nrcs.usda.gov/cgi_bin/topics.cgi?earl=dl_state.html

Appendix 2 (Cover Sheet)

Date _____ **Lake Code** _____ **Lake Level (in)** +_____-_____

Time _____ **Secchi Disk (in)**_____ **Algae Bloom?** Y / N_____

Wave Intensity (circle) Calm / Slight / Moderate / Severe / Extreme **Air Temp °F**

Wind Direction (circle) NW / N / NE / E / SE / S / SW **Conductivity (µmhos/cm)**_____

Comments _____

Survey Crew _____

Depth	°F	ppm O_2	Depth	°F	ppm O_2	Depth	°F	ppm O_2
1			16			32		
2			17			33		
3			18			34		
4			19			35		
5			20			36		
6			21			37		
7			22			38		
8			23			39		
1			24			40		
9			25			41		
10			26			42		
11			27			43		
12			28			44		
13			29			45		
14			30			46		
15			31			47		

Lowest DO Reading Limited by cable length? (circle) True / False
Was the DO meter standardized today? (circle) True / False

Rake % Density Examples[1]

Single Species Plant Abundance[2]
Individual species collected at each station of a transect will be broken down into 1% increments and recorded as a percent. These densities should add to 100%.

Appendix 2 (Data Sheet)

Date:	Lake Code:

EMERGENT AND FLOATING LEAF									
Transect:	Edge	2'	4'	6'	8'	10'	12'	14'	16'
Total % Cover									
Species Code	Single Species % Plant Abundance[2]								
SUBMERSED									
Rake Density[1]									
Species Code	Single Species % Plant Abundance[2]								
ADDITIONAL SPECIES""									
Substrate Type*									
getation Greater than 16' (circle) YES /	Additional Comments:								

EMERGENT AND FLOATING LEAF									
Transect:	Edge	2'	4'	6'	8'	10'	12'	14'	16'
Total % Cover									
Species Code	Single Species % Plant Abundance[2]								
SUBMERSED									
Rake Density[1]									
Species Code	Single Species % Plant Abundance[2]								
ADDITIONAL SPECIES""									
Substrate Type*									
getation Greater than 16' (circle) YES /	Additional Comments:								

* *Substrate codes* : **be**=bedrock; **bo**=boulder; **ri**=rip/rap; **co**=cobble; **gr**=gravel; **sa**=sand; **si**=silt; **cl**=clay; **mu**=muck; **de**=detritus

"" Additional species will *not* be given a percent cover or percent density. If location is between stations "T" for true will be recorded on both contours on the line for that additional species.