TIER II AQUATIC VEGETATION SURVEY PROTOCOL

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1.0 Monitoring Strategy for Aquatic Vegetation

The following protocol is currently being used by the IDNR Division of Fish and Wildlife to provide a quantitative sampling mechanism for aquatic plant surveying. Pearson (2004) provides additional details regarding the protocol and an example of its use to quantify the occurrence, distribution, and abundance of aquatic plants in 21 northern Indiana lakes. Plant sampling protocols used by the IDNR serve the following objectives:

1. To document the distribution and abundance of submersed and floating-leaved aquatic vegetation within selected areas and at a lake-wide scale;
2. To compare present distribution and abundance with past distribution and abundance within select areas and at a lake-wide scale.

Aquatic vegetation is monitored in an assortment of lakes and streams across the state as part of a variety of projects. The following procedure is applicable for State-sponsored surveys, integrated fisheries management, pre-treatment and post-treatment herbicide application, and possibly for volunteer monitoring. All of the data collected through the use of this protocol is recorded on standardized data sheets (Appendix A). For State-funded surveys, data sheets must be submitted with the final aquatic vegetation management plan/update to the Department of Natural Resources Division of Fish & Wildlife, LARE Office.

1.1 Habitat Stratification

The waterbodies to be surveyed are divided into strata and subjected to discrete sampling efforts to increase efficiency, effectiveness, and knowledge of habitat influence on plant communities. Each stratum represents a major aquatic geomorphic feature in the State of Indiana (Table 1). A few other strata are not sampled. For example, the main navigation channel on the Ohio River is not sampled because aquatic vegetation is unlikely to grow in this area due to the prevailing depth and flow conditions. In addition, the aquatic areas near dams and spillways may not be sampled because of safety considerations. Refer to Table 1 when categorizing the sampled stratum.

Table 1. Aquatic Area Strata and Codes

Stratum Description	Stratum Code
Inland Lake	IL
Inland Reservoir	IR
Lake Michigan	LM
First Order Stream	FOS
Second Order Stream	SOS
Third Order Stream	TOS
Fourth Order Stream	FROS
Fifth Order Stream	FHOS
Other*	OTR

* When “Other” is selected, describe the habitat type in the comments section of the data sheet.

1.2 Littoral Zone Definition

The littoral zone in lakes is defined as the portion extending from the shoreline to the greatest depth occupied by aquatic plants. Where insufficient information is known about plant growth in a particular water body, the maximum depth of the littoral zone may be estimated based on the trophic status of the lakes as compiled by the Indiana Department of Environmental Management using the Indiana Trophic State Index (Table 2).

In some cases, the actual distribution of plants will not conform to the prediction made by the ITSI. For this reason, 10 extra sampling points are always taken below the lowest contour at evenly distributed points around the lake bed to determine if plants are growing deeper than anticipated. These results guide the placement of future sampling points and are not included in the current year calculations. In subsequent years, distribution of points throughout the littoral zone may be adjusted for actual conditions at that water body. If sampling is being conducted for a state-sponsored project, any adjustment to distribution of points must be confirmed with the agency project manager. Sampling depths for selected lakes, as determined either by actual plant distribution or estimated based on trophic state, are provided in Appendix D.

Table 2. Maximum depth of plant sampling as determined by trophic state.

Trophic State	Maximum Depth of Sampling (ft)
Hypereutrophic	10
Eutrophic	15
Mesotrophic	20
Oligotrophic	25

1.3 Sampling Point Selection

After determining the maximum depth of the littoral zone (see Section 1.2), sampling should be conducted using a stratified random methodology. Sampling points should be apportioned based on the depth classes listed in Table 3. This will ensure that the sampling points are well distributed throughout the littoral zone of the lake. It may be useful to predetermine on a bathymetric map the general locations of the number of points listed in Table 3 so that they are evenly distributed throughout each of the depth contours.

If a current GPS-oriented bathymetric map is available for the lake, a point-intercept method may be used to evenly distribute points across the littoral zone using a grid pattern. Grid size is adjusted to produce the required number of points, based on lake size and any other factors specified in the project scope.

To facilitate fieldwork, points may be programmed into a GPS unit. During the sampling process, these predetermined locations can be adjusted to account for field conditions.

1.4 Sampling Efforts and Schedule

Sampling is conducted twice during the growing season, in order to describe phenological changes (plant community differences that track seasonal climatic differences). For state-sponsored projects, the first (or spring) sampling is typically conducted between May 15 and June 15, and the second (or summer) sampling occurs between July 15 and August 31.

Sampling times may be altered, depending on the purpose of the study. For example, if time and resources only allow one sampling event per year and the purpose is to examine peak diversity, sampling would be done between July 15 and August 31. Sampling for early-season invasive plants, such as curly-leaf pondweed, may be conducted earlier in the spring.

Calendar date alone may be insufficient to determine appropriate sampling windows for any particular year due to annual variation in seasonal conditions. Water temperature may also be used to determine when the spring sampling occurs. If surface water temperature is >18°C (65°F) on May 15, then sampling can begin. However, if water temperature is <18°C (65°F) on May 15, then it is monitored and sampling delayed until temperatures reach the 18°C threshold. If water temperatures remain low two weeks later (May 29), sampling can be initiated regardless of water temperature in order to complete spring sampling within the sampling window (before June 15).

1.5 Equipment and Definitions

A sampling rake (Figure 1) is used for collecting vegetation samples. The sampling rake is essentially a double-headed garden rake attached to a rope (Deppe and Lathrop 1992). It has a 36 cm (13.5 inch) wide head, has 14 teeth 5-cm long (2.25 inch) on each side spaced 1.9 cm (0.75 inch) apart, and is made by welding two square-headed garden rakes together. The rake head is marked into five parts corresponding to 20% increments spaced evenly along the tine length. The rake head is attached to a rope that is scaled at one foot increments (clearly visible marks every five feet) so that it can be used to measure water depth.

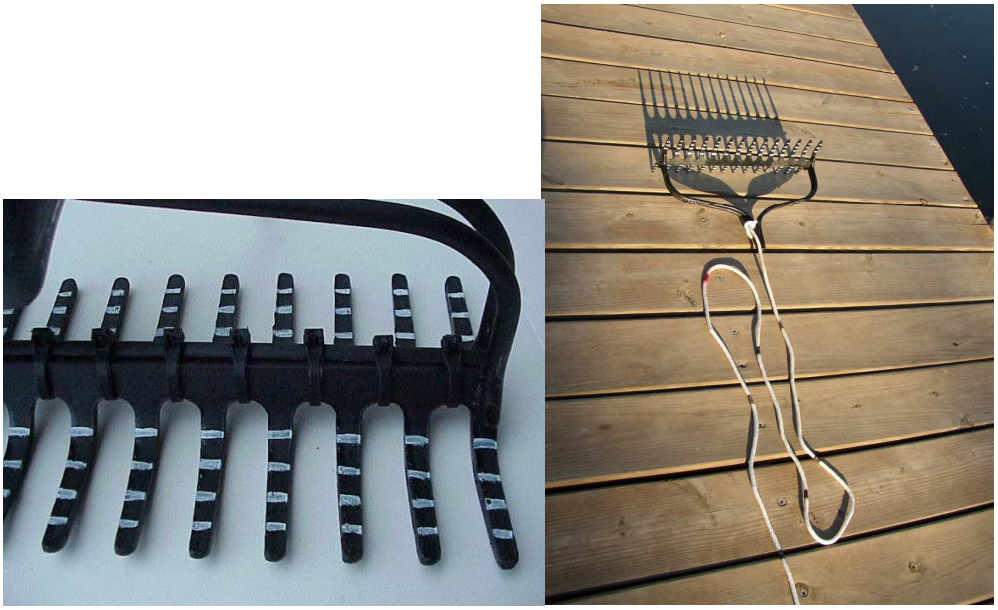

Figure 1: Double-headed rake for aquatic vegetation sampling

Most of the sampling is conducted by boat. The sampling procedures are designed in reference to a typical 16-ft boat, which is approximately 5 m long and 2 m wide.

Throughout the procedure manual, aquatic vegetation or aquatic species refer to the following plant types: submersed (S), rooted floating-leaved (F), non-rooted floating-leaved (N), and emergent (E). The non-rooted floating-leaved category is composed of *Lemnaceae* and *Azolla* sp. Filamentous algae (ALGA) are treated as if they were a single taxon and noted separately.

Table 3. Sample size requirements as determined by lake size and trophic state, apportioned by depth class.

		Hypereutrophic		Eutrophic			Mesotrophic				Oligotrophic				
Lake Acres	**Total # of Points**	**0-5 foot contour**	**5-10 foot contour**	**0-5 foot contour**	**5-10 foot contour**	**10-15 foot contour**	**0-5 foot contour**	**5-10 foot contour**	**10-15 foot contour**	**15-20 foot contour**	**0-5 foot contour**	**5-10 foot contour**	**10-15 foot contour**	**15-20 foot contour**	**20-25 foot contour**
<10	20	10	10	10	7	3	10	5	3	2	10	4	3	2	1
10-49	30	20	10	10	10	10	10	10	7	3	10	10	5	3	2
50-99	40	30	10	17	13	10	10	10	10	10	10	10	10	7	3
100-199	50	40	10	23	17	10	14	14	12	10	10	10	10	10	10
200-299	60	50	10	30	20	10	18	16	16	10	14	12	12	12	10
300-399	70	60	10	37	23	10	22	20	18	10	17	15	14	14	10
400-499	80	70	10	43	27	10	25	23	22	10	19	18	17	16	10
500-799	90	80	10	50	30	10	29	27	24	10	22	21	19	18	10
>=800	100	90	10	57	33	10	33	31	26	10	25	23	22	20	10

2.0 Sampling

A cover sheet is completed for each waterbody (Appendix A). If an erroneous entry is made, mark a line through the field, fields, or entire record, whichever is appropriate, and record initials next to the deletion. To change a field value, line out the incorrect data, enter the corrected value next to it, and initial the correction. All data fields on the data sheets are explained in detail in Appendix B.

Begin the sampling effort by recording general waterbody information on the waterbody cover sheet. Some fields (such as **Total # of Species**) will remain blank until the all points have been sampled. The sampling operation is composed of multiple steps, beginning with recording **Site information**.

Step 1. Determine sampling times, according to program or research needs (refer to Section 1.4). Record at least one Secchi disk transparency reading offshore. The protocol for accurately measuring **water transparency** is as follows:

A. Anchor the boat to prevent drifting. Be careful not to disturb the sediments on the bottom when anchoring since this could cloud the water and interfere with the Secchi disk reading, especially in shallow lakes.

B. Once you are at the deepest point of the lake, go to the shady side of the boat and if you are wearing sunglasses, remove them.

C. Lower the Secchi disk (8-inch diameter) straight down into the water until the disk just disappears from sight. Mark the rope at the water level with a clothespin.

D. Slowly raise the disk up until it reappears. Mark the rope at the water level with your fingers or with another clothespin.

E. To find the Secchi depth, grasp both clothespins in one hand and find the center of the loop of rope. Move one clothespin to that point and remove the other. This point is one-half the distance between the point of disappearance of the disk and the point where it re-appeared. Measure the distance from this point to the Secchi disk using a measuring tape.

F. Record the Secchi depth on your data sheet to the nearest tenth of a foot.

Step 2. Locate each random sampling point throughout the littoral zone, apportioned by depth contour. The littoral zone was previously identified by trophic status or actual plant growth records (see Section 1.2). The number of sample points for each depth contour is dependent on lake size and is given in Table 3.

Step 3. Stop the boat at each sampling point. Anchoring the boat is not necessary. Record or log as a waypoint the GPS coordinates of the point.

Step 4. Drop a double-sided weighted rake attached to a rope pre-measured in one-foot intervals (highly visible marks every five feet) off the bow of the boat straight down to the lakebed. Record water depth under “Depth” on the datasheet.

Step 5. After water depth is measured, reverse the boat at minimum operating speed for a distance of ten feet of additional rope length held firmly at the bow of the boat. Then drag the survey rake to the boat with moderate force with the outboard motor still in reverse. The boat is typically backed in the opposite direction as it had approached the point or the boat may be backed with the wind direction.

Step 6. Score the abundance of the individual plant species at each point throughout the littoral zone. Separate the various plant species and place on the rake for an abundance score of 1, 3, or 5 (Table 4). Small tubs are convenient for separating each species prior to scoring their abundance. When re-

piling various plant species back on the rake, spread them evenly on one side of the rake across the complete row of tines. Do not overly pack the plants on the rake. When a species is on the borderline between abundance ratings, round to the middle rating. For example, if a species fills the rake right to the first mark, score it as a "3" rather than a "1", so that a score of "1"represents only those instances in which the species is less than 20% abundant. Likewise, if a species fills the rake right to the tip of the rake teeth, score it as a "3" rather than a "5", so that a score of "5" represents only those instances in which the species is over 100% abundant. Record the abundance score for each species on the datasheet under the appropriate acronym heading. Use a single row on the datasheet to record each point.

For those points where a species is observed but not picked up on the rake, record the species code and use a "9" in the space for that point to denote the presence of that species. Note the presence of filamentous algae or emergent species on the rake using a "9". (Note that a number outside the 0 to 5 rating range is used to denote presence rather than a letter in order to facilitate electronic computation.)

Table 4. Vegetation Abundance Ratings[a]

Rake teeth filled (%)	Abundance rating
100+	5
20-100	3
1-19	1
No plants retrieved	0

[a]Ratings are modified from Deppe and Lathrop (1992).

Step 7. When field identification of a plant is uncertain, or a species is suspected not to be in the state herbarium at Purdue University North Central or another official location, representative specimens of each species should be collected and submitted as voucher specimens. For those species for which the genus and/or species are unknown, a species code should be assigned following the instructions in Section 2.2. The abundance score is recorded on the datasheet under the appropriate acronym heading. Record the voucher number ("V1", "V2", etc) and corresponding species code in the "Comments" section on the datasheet. See Section 2.2 for complete instructions on assigning species codes for unknown species and collecting voucher specimens.

Step 8. Record any other species observed in the lake while traveling between points by listing the species code at the bottom of the datasheet. Use of the rake may facilitate generating a complete species list for the lake, especially where no other extensive sampling protocol is used, such as a Tier I survey.

Step 9. Upon completion of all sample points, record any remaining waterbody summary data (such as **Total # of Species**) on the waterbody cover sheet and attach all datasheets to this cover sheet.

2.1 Unusual Situations

No aquatic vegetation:

If a sample point has no aquatic vegetation, regardless of the reasons, put "0" in the "Notes" column of the datasheet.

Dead or dying plant material:

Include any dead or dying plant material that is intact and identifiable, but discard material that has decayed to the point that identification is not possible. If previous herbicide treatment is known or

suspected to be the cause of decaying plants, note this in the "Comments" field and report any possible illicit use of herbicides to the DNR Fisheries Section.

Filamentous algae only:

If only filamentous algae is collected at a point, enter a species code of ALGA, record a "9" in the rake score box, and record the estimated percent bottom coverage (from 1 to 100%) in the "Notes" column.

Inaccessible points:

If a site cannot be accessed, put "NOSMPL" in the Species Code box. Record the UTM coordinates of the boat stop location **and the reason for not sampling** in the "Comments" field. It may be necessary to add additional points so that the required number of sample points is reached.

Unable to rake:

If physical conditions such as depth, wind, obstructions or current velocity preclude raking the bottom for aquatic vegetation, the point should be treated the same as an *Inaccessible point* described above. However, the same physical conditions often preclude the existence of aquatic vegetation. The investigators are encouraged to make a careful assessment of the probability of aquatic vegetation growth under the conditions. If vegetation is not observed or its presence is determined to be highly unlikely, the point should be treated the same as *No aquatic vegetation* described above. Record the reason for not raking and explain any classification of "no vegetation" in the "Comments" field.

Threatened and endangered or suspected new exotic species:

Threatened or endangered species (T&E) or suspected new exotic species should be vouchered, recorded on the data sheet, noted on the reconnaissance map, and described on the Indiana Special Plant Survey Form (included in Appendix A). Records on T&E species should be sent to the IDNR Division of Nature Preserves. **Suspected new exotic species must be reported immediately to the Aquatic Invasive Species Coordinator, IDNR Division of Fish & Wildlife. Where possible, use rake tosses to determine whether this represents an isolated plant or if multiple individuals of the species are present. Using a GPS unit, record the location of the collected species and the approximate extent of the species' distribution.**

2.2 Taxonomy, Species Codes, and Voucher Specimens

Plants should be identified to the species level, or lowest taxonomic level possible, using the following taxonomic keys or similar references: Fassett (1957), Voss (1972, 1985), and Gleason and Cronquist (1991). A list of the aquatic species found in Indiana is included in Appendix C. Species codes not available in Appendix C are determined by using the first three letters of the genus name followed by the first three letters of the species name. Note: For those genera that represent nearly indistinguishable species, it is sufficient to simply identify plants to the genus level. These taxa are listed in Appendix C by the genus name followed by "sp." (eg. *Chara* sp., *Riccia* sp., *Nitella* sp.).

If the genus of a plant is known and species unknown, make up a new code with the first three letters of the genus name followed by "001" for the first unknown species in the genus. Any subsequent and different unknown species in the same genus should be labeled "002" and so on (for example, "POT001" for *Potamogeton* sp.). If the genus is unknown, make a unique code (e.g., "UNKN01", "UNKN02", etc.) for each unknown taxon. Upon positive identification, uncertain and unknown species codes will be confirmed or replaced with new codes.

Collect voucher specimens for each individual taxon whose identity is in doubt for follow-up verification by external taxonomists, or if a taxon is suspected not to be in the state herbarium at Purdue University-North

Central or another official location. Vouchers should include multiple specimens (3 to 5) of the plant, including all available morphological characteristics (leaves, flowers, fruit, roots, tubers, etc.). Specimens should be sealed in an individual ziplock bag and immediately placed on ice in a cooler with a label placed inside the bag that lists the following information: waterbody name, county, date, name of collector, voucher number (eg. V1, V2, and so on) and taxonomic name, if known. Two or more voucher specimens for each unknown taxon should be collected from different points within the lake, if possible. Voucher specimens are directed to the attention of Dr. Robin Scribailo at Purdue University-North Central or other official state herbarium.

2.3 Data & Equipment Management

All data sheets are identified with the sampling organization's name and waterbody name. Copies of all data sheets must be available upon request of the LARE program office **within two weeks of completing the survey**. All originals are retained by the sampling organization.

To avoid the spread of Aquatic Invasive Species (AIS), survey crews should insure that all traces of aquatic vegetation are removed from boats, motors, and sampling gear before surveying other waterbodies. Even if an exotic species such as Eurasian watermilfoil is known to occur in two bodies of water, care should still be taken not to transfer plant fragments between these waterbodies since herbicide resistant genotypes may be spread to lakes where they did not previously occur. For waterbodies where other aquatic invasive species (e.g., zebra mussels) are known to occur, specific steps should be taken to eliminate the hazard prior to going to another body of water. For zebra mussels, this includes one of the following measures: drying equipment for five days, pressure washing with 104°F water, or chemical disinfection. A list of zebra mussel positive waterbodies can be found at www.invasivespecies.in.gov. For additional information on reducing the spread of AIS contact the DNR AIS Coordinator at (317)234-3883.

3.0 Plant Community Analysis

This section outlines the quantitative and analytical procedures that should be used to describe the plant communities sampled using the Tier II survey for Aquatic Vegetation Management Plans (AVMP) and plan updates. The Aquatic Vegetation Calculator (AquaVeC) Version 2.1, or the most recent data entry and calculation guidelines, should be used to ensure accurate, consistent calculations of the metrics described below. An example table for presenting the results of data analysis is included in Appendix A. This output format is required for most state-funded projects. Additional information on analytical procedures may be found in Pearson (2004).

3.1 Survey and Lake Characteristics

Littoral depth: Maximum depth that should be surveyed for submersed aquatic plants as specified above in Section 1.2.

Total points (N): Total number of points as specified above in Section 1.3. This is the number of points that will be used as the denominator in the plant metrics described below. **Note: This may differ from the method used in older LARE AVMPs and in Pearson (2004) to calculate these values.**

Secchi depth: A measure of the transparency of the water, measured to the nearest one-tenth foot. This parameter must be included in a table summarizing the plant sampling results.

3.2 Community Metrics

Species richness: A count of *all* submersed plant species collected during the survey.

Native species richness: A count of submersed *native* plant species collected during the survey.

Maximum number of species per point: The highest number of species collected at any point.

Mean number of species per point: The average number of all species collected per sampling point. This is calculated as the number of all species collected at each point summed for all points and divided by the total number of points (i.e., $((\sum s_{i..j})/N)$, where s is the total number of species at each point, summed from points numbered i to j, and N is the total number of points surveyed).

Mean number of native species per point: The average number of native species collected per point. This is calculated as the number of native species collected at each point summed for all points and divided by the total number of points (i.e., $((\sum s_{i..j})/N)$, where s is the number of native species at each point, summed from points numbered i to j, and N is the total number of points).

Species diversity index (SDI): This is a modified Simpson's diversity index, which is a measure that provides a means of comparing plant community structure and stability over time. The $SDI = 1 - (\sum((n_{i..j})/\sum n_{i..j})^2)$, where n is the number of points where each species occurred, summed for the species numbered from i to j.

Native species diversity index (NDI): This is a modified Simpson's diversity index to measure the diversity of native species. The $NDI = 1 - (\sum((n_{i..j})/\sum n_{i..j})^2)$, where $n_{i..j}$ is the number of points where each **native** species occurred, summed for the species numbered from i to j.

3.3 Species Metrics

Frequency of occurrence: This parameter measures the proportion of points where each species is present and is calculated as $(s/N)*100$, where s is the number of points where the species is present and N is the total number of points surveyed.

Dominance index: This measure combines frequency of occurrence and relative density into a dominance value that characterizes how dominant a species is within the macrophyte community. This is calculated as $((\sum r_{i..j})/(N*r_{max}))*100$, where r is the rake score for a species at each point, summed from points numbered from i to j, r_{max} is the theoretical maximum rake score at each point, and N is the total number of points surveyed.

4.0 References Cited

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Gleason, H.A., and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Canada. Hafner Press, New York.

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IDNR. 2004. Procedure manual for aquatic vegetation reconnaissance surveying. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana. 7p.

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APPENDIX A

Aquatic Vegetation Random Sampling (Tier 2)

Waterbody Cover Sheet

Surveying Organization:

Contact Information:

Waterbody Name:

Lake ID:

County(s):

Date:

Habitat Stratum:

Avg. Lake Depth (ft):

Lake Level:

GPS Metadata

Crew Leader:

Datum:

Zone:

Accuracy:

Recorder:

Method:

Secchi Depth (ft):

Total # of Points Surveyed:

Total # of Species:

Littoral Zone Size (acres):

- ❑ Measured
- ❑ Estimated

Littoral Zone Max. Depth (ft):

- ❑ Measured
- ❑ Estimate (historical Secchi)
- ❑ Estimated (current Secchi)

Notable Conditions:

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

Page ____ of _____

WATERBODY NAME:	**DATE:**
COUNTY:	**SECCHI DEPTH (FT):**
SITE ID:	**MAX PLANT DEPTH (FT):**
SURVEYING ORGANIZATION:	**WEATHER:**
CREW LEADER:	**COMMENTS (Include voucher codes - V1, V2...):**
RECORDER:	
CONTACT INFO:	***Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.***

Point #	R/T	Latitude	Longitude	Depth	Species Codes:								Notes

Other plant species observed at lake:

Example Table of Data Analysis Results

Occurrence and abundance of submersed aquatic plants in Lake _____.						
County:		Sites with plants:			Mean species/site:	
Date:		Sites with native plants:			Standard error (ms/s):	
Secchi (ft):		Number of species:			Mean native species/site:	
Maximum plant depth (ft):		Number of native species:			Standard error (mns/s):	
Trophic status:		Maximum species/site:			Species diversity:	
Total sites:					Native species diversity:	

All depths (0 to 20 ft)	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	

Depth: 0 to 5 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	

Depth: 5 to 10 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	

Depth: 10 to 15 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	

Depth: 15 to 20 ft	Frequency of	Rake score frequency per species				Plant Dominance
Species	Occurrence	0	1	3	5	

Quad Code:_____

Indiana Special Plant Survey Form

Element Name: _____

Surveyor (s): _____Date: _____ Time: ____ to _____

Contact information (telephone or email): _____

Location: ____ ¼ ____ ¼ ____ ¼ ____ Sec. ____T ____R ____ Quad name: _____

Repeat visit: Yes No Repeat visit needed: Yes No When: _____

EO boundaries mapped: Yes No County: _____

Area name (if applicable): _____

Biology

Phenology	Approx # Indiv	Population Area	Age Class
__In leaf	__ 1-10	__ 1 yd^2	__ % Seedlings
__In bud	__ 11-50	__1-5 yd^2	__% Immature
__In flower	__ 51-100	__5-10 yd^2	__% 1st year
__In fruit	__101-1000	__10-100 yd^2	__% Mature
__Seed Dispersing	__ 1001-10,000	__100 yd^2-2 ac	__%Senescent
__Dormant	__10,001+	__2 ac +	

Comments on above: _____

Compared to your last visit to this site:	Approx # Indiv	Population Area	Age Class
	__more	__more	__same
	__same	__same	__diff
	__less	__less	

Reproduction Is reproduction occurring?__ Type: __sexual, __asexual, __both

Show exact location and boundaries of taxon on map. (attach)

Population Distribution __ solitary, __clumps or dense groups, __small patches or cushions

__small colonies or large carpets, __large, almost pure population stands.

Vigor: 1) very feeble, 2) feeble, 3) normal, 4) exceptionally vigorous

Evidence of symbiotic or parasitic relationships: _____

Habitat

Aspect	Slope	Light	Topographic Position	Moisture
__N	__Flat	__Open	__Crest	__Inundated (Hydric)
__E	__0-10’	__Filtered	__Upper slope	__Saturated (Wet-mesic)
__S	__10-35’	__Shade	__Mid-Slope	__Moist (Mesic)
__W	__35’ +		__Lower slope	__Dry (Xeric)
	__Vertical		__Bottom	

Elevation: _____ft to _____ft. Surface Relief: ___/: ___∪:___∩:___—:___~~

Substrate/Soils: _____

Associated Natural Community/Plant Community: _____

List other members of this genus co-occurring at this site: _____

Characteristic associated species: _____

_____

Estimated size of potential Habitat: (as in population area) Boundaries mapped: yes no

---

Ownership info: (if known) _____

NOTE: Collect specimen if a healthy, viable population exists. Collection # _____

APPENDIX B

Explanation of Fields on the Aquatic Vegetation Waterbody Cover Sheet

Surveying Organization: Name of agency, corporation, group, individual, etc. that is collecting the data.

Contact Information: Means of reaching the surveyor (telephone or email address).

Waterbody name: Common name of the lake or stream. Name should be consistent with the name found on the USGS Topographic Map (e.g. Lake Lemon, not Lemon Lake). If not identified by USGS, list all commonly used local names for the waterbody (e.g., Little Maxinkuckee, Lost Lake and Hawk's Lake). See Appendix D for names of selected lakes.

Lake ID: Unique State-assigned alphanumeric code for the specific waterbody. Available through IDNR Division of Fish & Wildlife.

County(s): Name of the county(s) where sampling was conducted. When the waterbody or stream section traverses more than one county, list the primary county (county with the greatest acreage of water) first.

Date: The month (MM), day (DD), and year (YYYY) on which a site was sampled. Zeros (0) must be written in so that the date has eight digits (MMDDYYYY).

Habitat stratum: Each stratum code defines a unique, major aquatic geomorphic feature in the state of Indiana. The habitat stratum of the site according to the above protocol is an important ecological consideration and is valuable for the purposes of stratifying future sampling. The letter codes are listed in Table 1.

Average Lake Depth: Average depth of the lake. Reference bathymetric maps, state personnel, historic studies etc.

Lake Level: Actual lake level at the time of sampling as a measurement against a gauge at the dam or other known elevation, if available.

Crew leader: The full name to identify the individual responsible for certifying that the samples and the data on the data sheets were collected in compliance with current protocol and are, to the best of their knowledge, complete and free of errors. This identifying field is an important chain-of-custody procedure.

Recorder: Name to identify the individual recording the data on the data sheets.

Datum: A mathematical model describing the shape of the earth. **NAD 83** is the preferred datum.

Zone: The number that identifies the correct grid from which the coordinates were taken. All of the State of Indiana falls into Zone 16.

Accuracy: The GPS measure of possible error related to the geometry of satellites. This number value is recorded when the Lat/Long coordinates are recorded. The method field indicates whether the scale is PDOP (Percent Dilution of Precision)

	or FOM (Figure of Merit). For WAAS-enabled GPS receivers, indicate whether a differentially corrected signal was being received.
Method:	A code that identifies the method used to locate the point and the type of accuracy measurement used by the equipment. B = Base Map D = GPS with differential corrections and PDOP G = GPS without differential corrections and PDOP F = GPS with differential corrections and FOM X = GPS without differential corrections and FOM W = GPS with WAAS-enabled O = other (explain)
Secchi Depth:	A measure of water transparency. Secchi depth is measured to the nearest one-tenth foot over the deepest point in the lake.
Total # of Points:	Number of points surveyed on the particular waterbody as part of this sampling effort.
Total # of Species:	The total number of species observed at the particular waterbody. This number represents the species richness for the entire waterbody.
Littoral Zone Size:	The littoral zone in lakes is defined as the portion extending from the shoreline to the greatest depth occupied by aquatic plants. Size in acres of the entire littoral zone may be measured through a variety of mapping techniques or estimated by the surveyor. The method is then noted.
Littoral Zone Max. Depth:	Maximum littoral depth may be estimated through the use of current Secchi disk reading or by calculating an average of recent historical data for actual plant distribution (i.e., over the past five years). The extent of the photic zone can also be determined by multiplying the average or current Secchi depth by three (see IDNR 2004). The photic zone is the depth to which light dims to about 1% of surface light and may approximate the depth of light penetration that can support plant growth. The method is then noted.
Notable Conditions:	Comments that describe any unusual weather or water conditions that may interfere with accurate sampling such as rain, strong winds, algal blooms, equipment failure, etc.

Explanations of Fields on the Aquatic Vegetation Survey (Tier II) Datasheet

SITE INFORMATION

Waterbody name: Common name of the lake or stream. Name should be consistent with the name found on the USGS Topographic Map (e.g. Lake Lemon, not Lemon Lake). If not identified by USGS, list all commonly used local names for the waterbody (e.g., Little Maxinkuckee, Lost Lake and Hawk's Lake). See Appendix D for names of selected lakes.

County(s): Name of the county(s) where sampling was conducted. When the waterbody or stream section traverses more than one county, list the primary county (county with the greatest acreage of water) first.

Site ID: Two-digit number assigned to uniquely identify each site in the DNR database. Accuracy of the Site ID is critical because it links field data to be collected with data already available in the database. A zero must be written before the number so the ID # is a two-digit number starting with "01".

Surveying Organization: Name of agency, corporation, group, individual, etc. that is collecting the data.

Crew leader: The full name to identify the individual responsible for certifying that the samples and the data on the data sheets were collected in compliance with current protocol and are, to the best of their knowledge, complete and free of errors. This identifying field is an important chain-of-custody procedure.

Recorder: Name to uniquely identify the individual recording the data on the data sheets.

Contact Information: Means of reaching the surveyor (telephone or email address).

Date: The month (MM), day (DD), and year (YYYY) on which a site was sampled. Zeros (0) must be written in so that the date has eight digits (MMDDYYYY).

Secchi Depth: A measure of water transparency. Secchi depth is measured to the nearest one-tenth foot over the deepest point in the lake.

Max. Plant Depth: The maximum depth at which plants are found, measured in feet.

Weather: Record weather conditions that exist at the time of sampling.

Comments: A field for recording any additional observations. Voucher codes, with their corresponding species codes, should be recorded here.

SITE COORDINATES

Point #: Record the number of the point.

R/T: Record whether the sample point is a random point ("R"), or a targeted point ("T") selected in order to survey a particular area that was missed through the

random sampling (e.g., "extra" points below the prescribed deepest sampling point). Data collected at targeted points are not included in the analysis of plant community or species metrics.

Latitude: The latitude coordinate for the point recorded in decimal degrees (e.g., 40.12345). The coordinate is recorded from a GPS unit when first arriving at the point.

Longitude: The longitude coordinate for the point recorded in decimal degrees (e.g., 85.12345). The coordinate is recorded from a GPS unit when first arriving at the point.

Depth: The measured depth (in feet) to the lake bottom at the sampling point.

SPECIES INFORMATION

Species code: Record the alphanumeric six character code for each species collected on the rake. Many of the common species codes are listed in Appendix C. If the genus of a plant is known and species unknown, make up a new code with the first three letters of the genus name followed by "001" for the first unknown species in the genus, for example, "POT001" for *Potamogeton* sp. If the genus is unknown, use a unique code (e.g., "UNKN01") for each unknown taxon. Collect voucher specimens of unknown species following the protocol described above in section 2.2 and record the voucher code (V1, V2…) in the Comments section on the datasheet. Upon positive identification, uncertain and unknown species codes will be confirmed or replaced with new codes.

Rake score: Record under the species code a number (1, 3, or 5) for plant abundance rated according to Table 4 for each submersed species found in the rake sample of vegetation. A floating-leaved or emergent species receives a "9" regardless of its plant density as long as the species was collected in the rake sample of vegetation. Species observed at the sampling point but not sampled by the rake receive a "9". Record the presence of filamentous algae with a "9".

Notes: When there is no aquatic vegetation at a point, record a "0" in this column.

Other plant species observed at lake:
Additional species observed in the lake while traveling between sampling points are listed at the bottom of the datasheet, using species codes.

APPENDIX C

Aquatic Vegetation Species Codes

Species Code	Scientific Name	Common Name	Vegetation Type
ALGA	Any species of filamentous alga (incl. *Spyrogyra, Cladophora, Hydrodictyon*)	algae	N
AZO001	*Azolla* sp.	A mosquito fern species	N
AZOCAR	*Azolla caroliniana*	Carolina mosquito fern	N
AZOMEX	*Azolla mexicana*	Mexican mosquito fern	N
CERDEM	*Ceratophyllum demersum*	coontail	S
CHARA	*Chara* sp.	A chara species	S
EGEDEN	*EGERIA DENSA*	BRAZILIAN ELODEA	S
ELOCAN	*Elodea Canadensis*	Canada waterweed	S
ELONUT	*Elodea nuttallii*	western waterweed	S
HYIVER	*HYDRILLA VERTICILLATA*	HYDRILLA	S
LEM001	*Lemna* sp.	duckweeds (species within Lemnaceae)	N
LEMMIO	*Lemna minor*	small or common duckweed	N
LEMTRI	*Lemna trisulca*	star duckweed	N
LUDDEC	*Ludwigia decurrens*	primrose-willow	F
MYRSIB	*Myriophyllum sibiricum*	northern watermilfoil	S
MYRSPI	*MYRIOPHYLLUM SPICATUM*	EURASIAN WATERMILFOIL	S
MYR001	*Myriophyllum* sp.	a watermilfoil species	S
NAJFLE	*Najas flexilis*	slender naiad	S
NAJGRA	*Najas gracillima*	Northern naiad	S
NAJGUA	*Najas guadalupensis*	Southern naiad	S
NAJMIN	*NAJAS MINOR*	BRITTLE WATERNYMPH	S
NELLUT	*Nelumbo lutea*	American lotus	F
NITELL	*Nitella* sp.	a nitella species	S
NOAQVG		no aquatic vegetation at site	N
NUPADV	*Nuphar advena*	spatterdock	F
NUPVAR	*Nuphar variegata* (formerly *N. luteum*)	bullhead lily (yellow pond lily)	F
NYMODT	*Nymphaea oderata subsp. tuberosa*	white water lily (fragrant water lily)	F

POTCRI	*POTAMOGETON CRISPUS*	CURLY-LEAF PONDWEED	S
POTEPI	*Potamogeton epihydrus*	ribbon-leaf pondweed	S
POTFOF	*Potamogeton foliosus*	leafy pondweed	S
POTGRA	*Potamogeton gramineus*	variable pondweed	S
POTILL	*Potamogeton illinoensis*	Illinois pondweed	S
POTNLV	*Potamogeton foliosus*, *P. pusillus*, or other unidentified narrow-leaved pondweeds	narrow-leaved pondweeds	S
POTNOD	*Potamogeton nodosus* (formerly *P. americanus*)	American pondweed	S
POTPRA	*Potamogeton praelongus*	white-stemmed pondweed	S
POTPUP	*Potamogeton pusillus*	small pondweed	S
POTRIC	*Potamogeton richardsonii*	Richardson's pondweed	S
POTZOS	*Potamogeton zosteriformis*	flat-stemmed pondweed	S
RANFLA	*Ranunculus flabellaris*	yellow water crowfoot (yellow water buttercup)	S
RANLON	*Ranunculus longirostris* (incl. *R. trichophyllus*)	white water crowfoot (rigid white water crowfoot)	S
RICCIA	*Riccia* sp., *Ricciocarpus* sp.	A liverwort species	N
SPIPOL	*Spirodela polyrhiza*	greater duckweed	N
STUPEC	*Stuckenia pectinata*	sago pondweed	S
UNKN01		Unknown specimen No. 1	
UNKN02		Unknown specimen No. 2	
UTRMAC	*Utricularia macrorhiza* (also known as *U. vulgaris*)	common bladderwort	S
VALAME	*Vallisneria americana*	wild celery or eel grass	S
WOA001	*Wolffia* sp.	A watermeal species	N
WOACOL	*Wolffia columbiana*	watermeal	N
ZANPAL	*Zannichellia palustris*	horned pondweed	S
ZOSDUB	*Zosterella dubia* (also known as *Heteranthera dubia*)	water stargrass	S

Note: The scientific and common names of EXOTIC species are shown in ALL CAPITAL LETTERS.

Key to Vegetation Types:
F = floating-leaved, rooted vegetation
N = non-rooted floating vegetation
S = submersed vegetation

APPENDIX D

Surface Area, Trophic State, and Sampling Depth for Selected Lakes

Lake	Sponsor	County	Surface Area (acres)	Trophic Status	Tier II Max Sampling Depth (ft)[a]
Adams Lake	Adams Lake Conservation Club	Lagrange	308	M	15*
Atwood Lake	Atwood Lake Association	Lagrange	170	M	10*
Backwater Lake	Webster Lake Conservation Association	Kosciusko	140	M	20
Banning Lake	Barbee Lakes Association	Kosciusko	16	M	15*
Bass Lake	Bass Lake Conservancy District	Starke	1440	M	15*
Bear Lake	East Shore Property Owners Association	Noble	136	E	15
Beaver Dam Lake	Beaver Dam and Loon Lake Conservation Club, Inc.	Kosciusko	146	H	10
Big Barbee	Barbee Lakes Association	Kosciusko	304	E	20*
Big Chapman Lake	Chapman Lakes Foundation, Inc.	Kosciusko	512	O	25
Big Lake	Big Lake Association	Noble	228	E	15
Big Long	Big Long Lake Association	Lagrange	365	M	20
Big Turkey Lake	Big Turkey Lake Association	LaGrange	450	E	15
Brokesha Lake	Stone Lake Conservation Club	Lagrange	36	O	15*
Cedar Lake	Tri-lakes Property Owners Association	Whitley	99	E	25*
Center Lake	Center Lake Conservation Association, Inc.	Kosciusko	120	O	15*
Clear Lake	City of LaPorte	LaPorte	106	O	15*
Cook Lake	Four Lakes Lake Association	Marshall	93	M	15*
Crooked Lake	Crooked Lake Association	Steuben	828	M	20
Dallas Lake	Five Lakes Conservation Association, Inc.	LaGrange	283	M	25*
Dewart Lake	Dewart Lake Protective Association	Kosciusko	551	M	20
Diamond Lake	Diamond Lake Conservation Club	Kosciusko	92	E	15
Fish Lake	Michiana Fish Lake Association, Inc.	Lagrange Michigan	139	E	15
Fish Lake (Lower)	Fish Lake Conservancy District	LaPorte	134	O	20*
Fish Lake (Upper)	Fish Lake Conservancy District	LaPorte	139	O	20*
Flint Lake	Valparaiso Lakes Area Conservancy District	Porter	86	M	20
Griffy Lake	Bloomington Parks & Recreation	Monroe	130	M	20

Hackenberg	Five Lakes Conservation Association, Inc.	LaGrange	42	E	25*
Hamilton Lake	Hamilton Lake Association	Steuben	802	E	15
Harris Lake	City of LaPorte	LaPorte	35	N/A	15*
Heaton Lake	Heaton Lake Conservation Club	Elkhart	87	M	20
Holem Lake	Four Lakes Lake Association	Marshall	40	M	20
Hudson	Hudson Lake Conservation Association	LaPorte	432	O	25
Irish Lake	Barbee Lakes Association	Kosciusko	182	H	10
Jimmerson Lake	Jimmerson Lake Association	Steuben	434	O	25
Kreighbaum Lake	Four Lakes Lake Association	Marshall	20	M	20
Kuhn Lake	Barbee Lakes Association	Kosciusko	137	M	15*
Lake Bruce	Lake Bruce Conservancy District	Fulton and Pulaski	245	H	10
Lake George	Lake George Cottager's Association	Steuben	488	O	20*
Lake James	Lake Tippecanoe P.O.A.	Kosciusko	282	M	20
Lake Lemon	Lake Lemon Conservancy District	Monroe/ Brown	1650	E	15*
Lake Manitou	Lake Manitou Association	Fulton/ Miami	809	M	20
Lake Maxinkuckee	Lake Maxinkuckee Environmental Council	Marshall	1854	M	25*
Lake of the Woods	Lake of the Woods P.O.A	Marshall	416	E	15
Lake Pleasant	Lake Pleasant Cottage Owner's Association	Steuben	424	M	25*
Lake Tippecanoe	Lake Tippecanoe P.O.A.	Kosciusko	768	M	20
Lake Wawasee	Wawasee Area Conservancy Association	Kosciusko	3410	M	25*
Lake Winona	Winona Lake Preservation Association	Kosciusko	562	E	20*
Lily Lake	City of LaPorte	LaPorte	16	O	20*
Little Barbee	Barbee Lakes Association	Kosciusko	74	E	15
Little Cedar Lake	Tri-lakes Property Owners Association	Whitley	45	E	25*
Little Chapman Lake	Chapman Lakes Foundation, Inc.	Kosciusko	177	E	15
Little Turkey	Little Turkey Lake Association	LaGrange	135	E	15
Long Lake	Valparaiso Lakes Area Conservancy District	Porter	65	O	25
Loon Lake	Beaver Dam and Loon Lake Conservation Club, Inc.	Kosciusko	40	E	15
Messick	Five Lakes Conservation Association, Inc.	LaGrange	68	E	25*

Millpond Lake	Four Lakes Lake Association	Marshall	136	M	20
Oswego Lake	Lake Tippecanoe P.O.A.	Kosciusko	83	M	25*
Palestine Lake	Palestine Lake Association	Kosciusko	290	E	20*
Pine Lake	LaPorte Area Lake Association / City of LaPorte	LaPorte	564	O	25
Pleasant Lake	Lakeville Business Owner's Association	St. Joseph	29	M	10*
Pretty Lake	Pretty Lake Conservation Club, Inc.	LaGrange	184	M	20
Pretty Lake	Pretty Lake P.O.A.	Marshall	97	O	25
Riddles Lake	Lakeville Business Owner's Association	St. Joseph	77	M	10*
Ridinger Lake	Tippecanoe Environmental Lake & Watershed Foundation/ Ridinger Lake Association	Kosciusko	136	H	10
Rock Lake	Rock Lake Conservation & Improvement Club	Fulton	56	E	10*
Round Lake	Tri-lakes Property Owners Association	Whitley	131	E	25*
Sawmill Lake	Barbee Lakes Association	Kosciusko	74	M	15*
Sechrist Lake	Barbee Lakes Association	Kosciusko	105	M	15*
Shipshewana Lake	Shipshewana Community Lake Improvement Association	Lagrange	202	H	10
Shriner Lake	Tri-lakes Property Owners Association	Whitley	93	M	15*
Silver Lake	Silver Lake Association	Kosciusko	102	E	15
Skinner Lake	Skinner Lake Association	Kosciusko	125	E	15
Stone Lake	LaPorte Area Lake Association / City of LaPorte	LaPorte	125	M	20
Stone Lake	Stone Lake Conservation Club	Lagrange	116	M	15*
Sylvan Lake	Sylvan Lake Improvement Association, Inc.	Noble	630	M	20
Syracuse Lake	Syracuse Lake Association	Kosciusko	414	M	20
Wall Lake	Wall Lake Fisherman's Association	Lagrange	141	M	20
Waubee Lake	Waubee Lake Association	Kosciusko	127	M	25*
Waveland Lake	Waveland Park Board	Montgomery/ Parke	358	M	15*
Webster Lake	Webster Lake Conservation Association	Kosciusko	774	M	20

West Otter Lake	West Otter Lake Property Owners Association	Steuben	118	M	20
Westler	Five Lakes Conservation Association, Inc.	LaGrange	88	E	25*
Winona	Winona Lake Preservation Association	Kosciusko	562	E	20*
Witmer Lake	Five Lakes Conservation Association, Inc.	LaGrange	204	H	25*

Key to Trophic Status Codes (from IDEM 305b list):
H = Hypereutrophic
E = Eutrophic
M = Mesotrophic
O = Oligotrophic

[a] Unless otherwise noted, sampling depths are estimated based on trophic state.
* Sampling depth adjusted for actual plant distribution based on past survey data.
N/A = trophic state not available