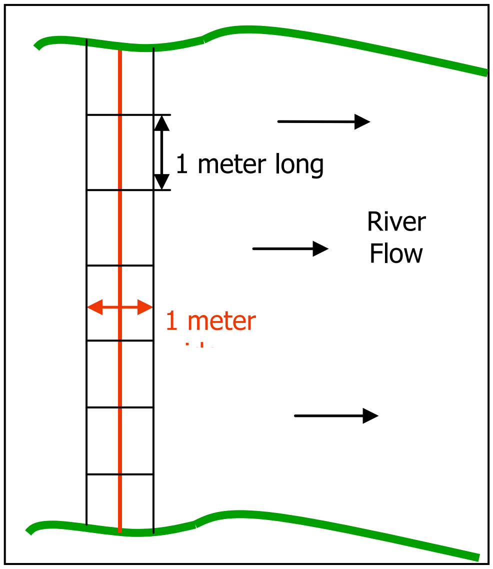
Assessment of Transect Survey Methodology for Sampling Aquatic Macrophytes in Flowing Water



Establishing transects through deep areas with GPS

Project Initiated by: Friends of the St. Croix Headwaters, the Wisconsin Department of Natural Resources, and the National Park Service

Following a transect in strong current on the upper Namekagon River

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Summer 2010 and 2011

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION:

Exotic plant species are a growing problem in Wisconsin's aquatic ecosystems. This has led to an explosion in research in the state's lakes and prompted the development of a standardized methodology to ensure that all plant sampling in lakes will be conducted in the same manner; thus allowing data to be compared across time and space. However, no standard methodology has been established for plants in streams and rivers. Because of this, we modified the methods first outlined by Anderson and Olson (2008) to quantify plants regardless of the size and width of a flowing water body. These methods have NOT been statistically evaluated so data should be used with caution. At the very least, these data provide a distribution of plants within the waterbody as well as give a general idea of how common they were at a given site. Using this methodology, we surveyed Ox Creek, Mud Creek, the Lower Eau Claire River, the Totogatic River, the Namekagon River, and the St. Croix River from the Gordon Dam to the St. Croix Falls Dam in Douglas, Washburn, Burnett, and Polk Counties, WI in August 2010 and August 2011. The primary goals of the project were to establish baseline data on native plant distribution, identify exotic species along/in the river, and test the functionality of this survey methodology in the field.

PLANT SURVEY METHODS:

Using ArcMap 9.3.1, we generated survey location points at 1km increments by following the centerline of the WDNR's 24K HydroArc shapefile either moving upstream from the confluence with the St. Croix River or downstream from a dam or bridge where we started our survey. Study sites were navigated to using canoes provided by the Friends of the St. Croix Headwaters or boat. All transect points were located using a Garmin 76CSX, and, during the survey, we created additional waypoints to mark both ends of the transect for future reference. All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006), and a voucher was pressed and mounted on high grade paper to be sent to the state herbarium in Stevens Point for identification confirmation.

At each study site, regardless of the width of the river, we surveyed 50 quadrats (quads). This was accomplished by stretching a tape measure bank to bank thus forming a diagonal transect and allowing us to keep a constant level of effort at each site regardless of the river width (Figure 1). Following the establishment of the transect, we proceeded to sample from the east/south bank at 1m intervals. If the width of the river was >50m, we stretched the tape to 100m and surveyed every other meter and so forth. Within each quad, we recorded all macrophytes species seen within .5 meters of the tape. All species present were assigned a value of 1-3 based on abundance where 1 = species growing in <1/3 of the sample quad, 2 = >1/3rd but <2/3rds and 3 = >2/3rds. A rake was also used to sample the bottom at each site to ensure we didn't under survey small/fine leaved species. We also used the rake to establish a total density of plants at each quad (Figure 2). In the center of each quad, we also noted the depth and dominant substrate type (sand, rock or muck). Any additional species seen outside the quadrs, but within the transect area, were recorded as visuals. We also noted any previously undetected species between survey points and recorded incidental habitat notes.

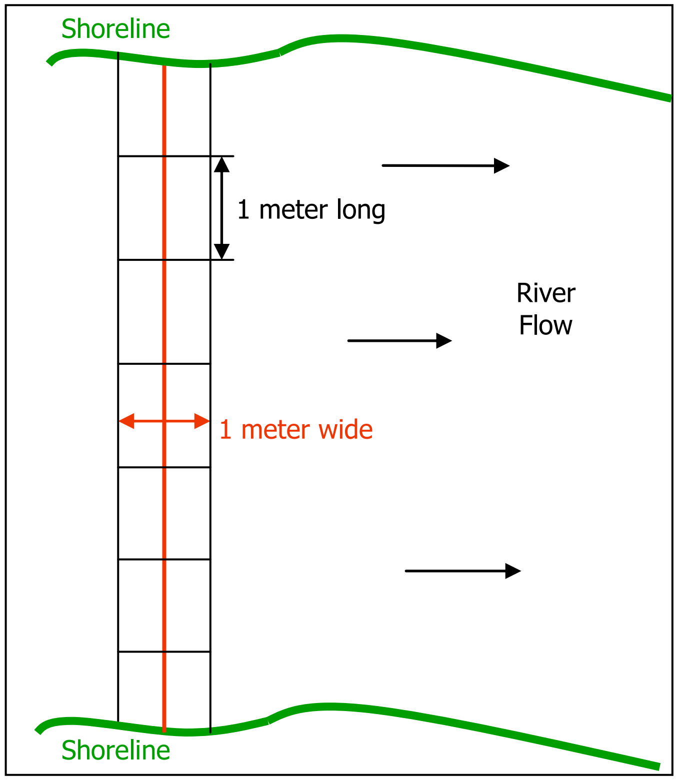

Figure 1: River Survey Transect

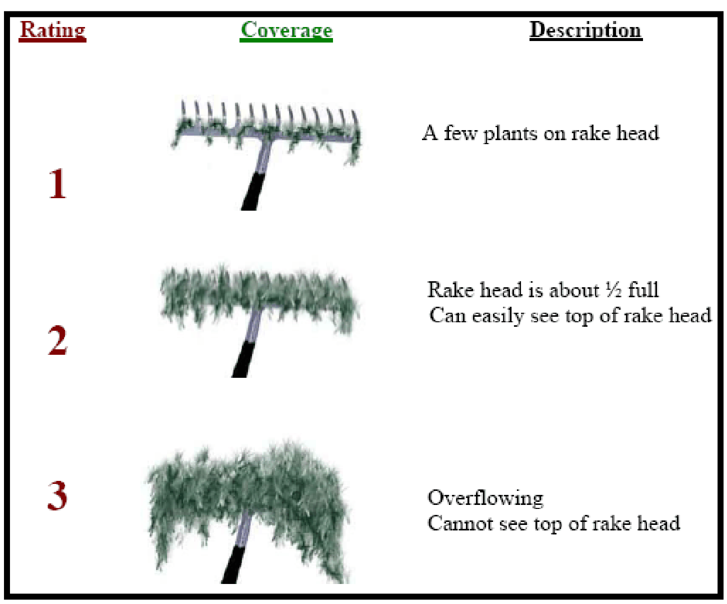

Figure 2: Rake Fullness Ratings (UWEX, 2010)

DATA ANALYSIS:

We entered all data collected at each of the 50 quadrats at a transect site into the standard APM spreadsheet (Appendix I) (UWEX, 2010). As the goal of the survey was to describe the plants in the whole river, we also entered all data from all transects into a combined spreadsheet. From this, we calculated the following for the entire system:

Total number of quads visited: This included the total number of quads sampled – in other words, 50 multiplied times the total number of transects surveyed.

Total number of sites with vegetation: These included all quads where vegetation was found. For example, if 20% of all quads have vegetation, it suggests that 20% of the river has plant coverage.

Frequency of occurrence: The frequency of all plants (or individual species) is generally reported as a percentage of occurrences at all sample quads. It can also be reported as a percentage of occurrences at sample quads with vegetation.

> Frequency of occurrence example:
>
> Plant A is sampled at 70 out of 700 total quads = 70/700 = .10 = 10%
> This means that Plant A's frequency of occurrence = 10% when considering the entire river sample.
>
> Plant A is sampled at 70 out of 350 total quads with vegetation = 70/350 = .20 = 20%
> This means that Plant A's frequency of occurrence = 20% when considering only those quads that had plants.
>
> From these frequencies, we can estimate how common each species was throughout the river.

Simpson's diversity index: A diversity index allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's diversity index, the index value represents the probability that two individuals (randomly selected) will be different species. The index values range from 0 -1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like waterbody size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse waterbody indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be **more resistant** to invasion by exotic species.

<u>Average number of species per quad:</u> This value is reported using two different considerations. 1) **vegetative sites only** indicate the average number of plants at all quads where plants were found. 2) **native species at vegetative quads only** excludes exotic species from consideration.

<u>Species richness:</u> This value indicates the number of different plant species found in and directly adjacent to (on the waterline) the waterbody. Species richness alone only counts those plants found in the rake survey. The other two values include those species seen adjacent to, but not in the transect and directly upstream/downstream from the transect. **Note: Per DNR protocol, filamentous algae, freshwater sponges, aquatic moss and the aquatic liverworts *Riccia fluitans* and *Ricciocarpus natans* are excluded from these totals.**

<u>Mean and median depth of plants:</u> The mean depth of plants indicates the average depth in the water column where plants were sampled. Because a few samples in deep water can skew this data, median depth is also calculated. This tells us that half of the plants sampled were in water shallower than this value, and half were in water deeper than this value.

<u>Mean rake fullness:</u> This value indicates the mean rake density of all plant species for all quads in the river. Only quads that have vegetation are included in the statistic.

<u>Relative frequency:</u> This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequency will add up to 100%. Organizing species from highest to lowest relative frequency value gives us an idea of which species are most important within the macrophyte community.

Relative frequency example:

Suppose that we sample 100 quads and found 5 species of plants with the following results:

Plant A was located at 70 quads. Its frequency of occurrence is thus 70/100 = 70%
Plant B was located at 50 quads. Its frequency of occurrence is thus 50/100 = 50%
Plant C was located at 20 quads. Its frequency of occurrence is thus 20/100 = 20%
Plant D was located at 10 quads. Its frequency of occurrence is thus 10/100 = 10%

To calculate an individual species' relative frequency, we divide the number of quads a plant is sampled at by the total number of times all plants were sampled. In our example that would be 150 samples (70+50+20+10).

Plant A = 70/150 = .4667 or 46.67%
Plant B = 50/150 = .3333 or 33.33%
Plant C = 20/150 = .1333 or 13.33%
Plant D = 10/150 = .0667 or 6.67%

This value tells us that 46.67% of all plants sampled were Plant A.

Floristic Quality Index (FQI): This index measures the impact of human development on a lake's aquatic plants. Because it was developed for lakes, and because many species found in rivers are not included in the index, **the results should only be looked at as informative**. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point intercept survey, and multiplying it by the square root of the total number of plant species (N) in the lake ($FQI=(\Sigma(c1+c2+c3+\ldots cn)/N)*\sqrt{N}$). Statistically speaking, the higher the index value, the healthier the lake's macrophyte community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target's relative diversity and health.

**** Species that were only recorded as visuals or above/below transects, and species found in the quad that are not included in the index are excluded from FQI analysis.**

RESULTS AND DISCUSSION:

Plant Density and Distribution:

From a qualitative standpoint, we believe the survey was highly effective at locating species and providing presence/absence data. This was exemplified by the relatively few numbers of species that were only recorded "inter-transect" which told us that the transects weren't missing species that were present. Taking data at 1km intervals also minimized the chances of missing uncommon habitats that supported rarer species.

One of the criticisms of other river survey methodologies is the changing nature of rivers in regards to shifting channels and sediments. This would invariably lead to point location habitat changes and thus changes in plants over time making the survey nonreplicable. We believe this survey responds to this criticism because these habitat changes are largely longitudinal rather than lateral at any given site. By surveying across the entire river and normalizing the transect to 50 samples regardless of stream-width at each location, we feel this methodology works to eliminate this bias inherent in point intercept, longitudinal shoreline transect, or straight bank to bank transect methods.

Exotic Species:

Exotic species were found during each river survey. Fortunately, they tended to be much less invasive as the flowing waters and nutrient poor substrates that dominate rivers don't tend to be favored by species like Eurasian water milfoil (*Myriophyllum spicatum*) or Curly-leaf pondweed (*Potamogeton crispus*). Conducting the surveys in August seems to be the best time to look for exotics as Purple loosestrife (*Lythrum salicaria*) is in bloom, and other species have grown to maturity making them easier to identify.

Practicality of Survey Methods:

There is no question the survey methodology is labor intensive and logistically difficult. Surveying a river takes a minimum of four people and we found six is preferred. Also, entering and cross checking the sheer volume of data (330 survey points X 50 quads = 16,500 quads for the St. Croix River alone) was a herculean task. However, the results met the objectives stated in the proposal so, from an output standpoint, we consider the methods successful.

The surveys also succeeded in defining the limits of this methodology's effectiveness in real world conditions. Strong current, even in water <1m made it very difficult to survey, and areas that had any current with water over 2m deep were nearly unsurveyable. Fortunately, these conditions were quite rare. Also, in areas where the river width was >50m, it was essentially impossible to hold a tape up and out of the current. In these areas, we switched to a calibrated thin rope as it was stronger and easier to hold aloft. In areas >100m, even this was impossible so we relied on a laser range finder to establish and determine where we were along the transect. The upshot is, from both safety and functionality standpoints, these methods are most appropriate for wadable streams and rivers.

The next step in refining the protocol would be to have a statistician analyze the data set. We feel it is likely that surveying at 1km intervals may actually be over-surveying – at least on rivers longer than 25km. Analysis of the data could find the point of "diminishing returns" as far as species detection. This could lower the cost and effort needed to complete similar surveys in the future.

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Appendix I: Vegetative Survey Data Sheet

Observers for this lake: names and hours worked by each:																									
Waterbody:									WBIC									County						Date:	
Quad #	Depth (ft)	Muck (M), Sand (S), Rock (R)	Rake pole (P) or rake rope (R)	Total Rake Fullness	EWM	CLP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																									
2																									
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