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A Comparison of Two Rake Sampling Techniques for Sampling Aquatic Macrophytes

by Elisabeth R. Deppe
Richard C. Lathrop

Introduction

Techniques for aquatic macrophyte surveys differ greatly in accuracy, efficiency, repeatability, and degree of detail. Frequently used techniques include qualitative rake surveys and quantitative biomass studies, the latter using sonar or manual collection of plants from quadrats (e.g., 0.1 m^2). Choice of a particular survey technique depends on the goals and resources of the researcher. Rake surveys permit species identification, a distinction not possible with sonar. In addition, rake surveys allow larger areas to be sampled than with quadrat biomass techniques, which are more labor-intensive. These limited-area biomass studies often yield a rather incomplete picture of a macrophyte community.

During the summers of 1989-90, the macrophytes of Lake Mendota, a 3,985-ha eutrophic lake in south central Wisconsin, were surveyed to document species presence, relative density, and maximum rooting depth. Sampling was based on a standard-type rake survey technique that was modified at the beginning of the study. This modification (first used by Carl Molter, an aquatic plant specialist with the Wisconsin Department of Natural Resources) allowed a more quantitative assessment of the macrophyte community. To permit later comparisons, both techniques were used in both years.

Species found during the survey will be reported in Deppe and Lathrop (ms. in prep.). This Findings article compares results of the standard-type rake survey with the modified technique. It also describes this new technique in sufficient detail for other surveyors to replicate it.

Methods

Macrophytes were sampled by boat at stations located at 0.5-m depth intervals along 47 transects perpendicular to the lake shoreline. Both survey techniques used the same method of plant collection at each station. This involved throwing a weighted, double-headed garden rake off the front left, front right, rear left, and rear right of the boat. The rake, with a head width of 35 cm and 14 teeth, each 5 cm long, was thrown into the water and dragged about 2 m across the bottom by means of an attached line. After the rake was pulled off the bottom, it was flipped 180° to ensure that plants snagged on the teeth would remain on the rake.

The survey techniques differed in their methods of plant recording (Table 1). The standard technique—referred to as the rake frequency (RF) technique—involved an assessment of species presence or absence on each rake cast. After all 4 casts were made, each species was assigned an overall density rating from 0-5. This rating was based on the number of rake casts in which the species appeared for each sampling station (Jessen and Lound 1962). For example, a species found on one of the 4 rake casts would receive a rating of 1, a rating of 2 if found on 2 casts, and so on. If a species appeared very dense (i.e., rake teeth were full) on all 4 throws, it would receive a rating of 5.

Table 1. Methods of recording macrophyte density according to 2 rating techniques.

Density Rating	Rating Criteria: Rake Frequency* (Presence of a Species on Rake Head)	Rake Coverage** (% of Rake Head Covered by a Species)
5	Present in all 4 rake casts (rake teeth full all casts)	81–100
4	Present in all 4 rake casts (rake teeth less than full)	61–80
3	Present in 3 rake casts	41–60
2	Present in 2 rake casts	21–40
1	Present in 1 rake cast	1–20
0	Present in 0 rake casts	0

*After Jessen and Lound (1962).
**After C. Molter.

The modified technique—referred to as the rake coverage (RC) technique—involved a more quantitative assessment of actual plant density. For each rake cast, each species present was assigned a density rating from 0-5. This rating was based on the extent of coverage of the upper rake head. For example, a species covering about 1-20% of the upper rake head would receive a rating of 1, a rating of 2 if covering about 21-40%, and so on. Determination of percent coverage involved judgment of the surveyor as to the number of rake teeth and area of teeth covered by each species (Fig. 1). Separation of the plants to assess individual species coverage was sometimes necessary, particularly when plants were entwined with each other or filamentous algae. Ratings from the 4 rake casts at each station were averaged to compute an overall density rating for each species found at the station.

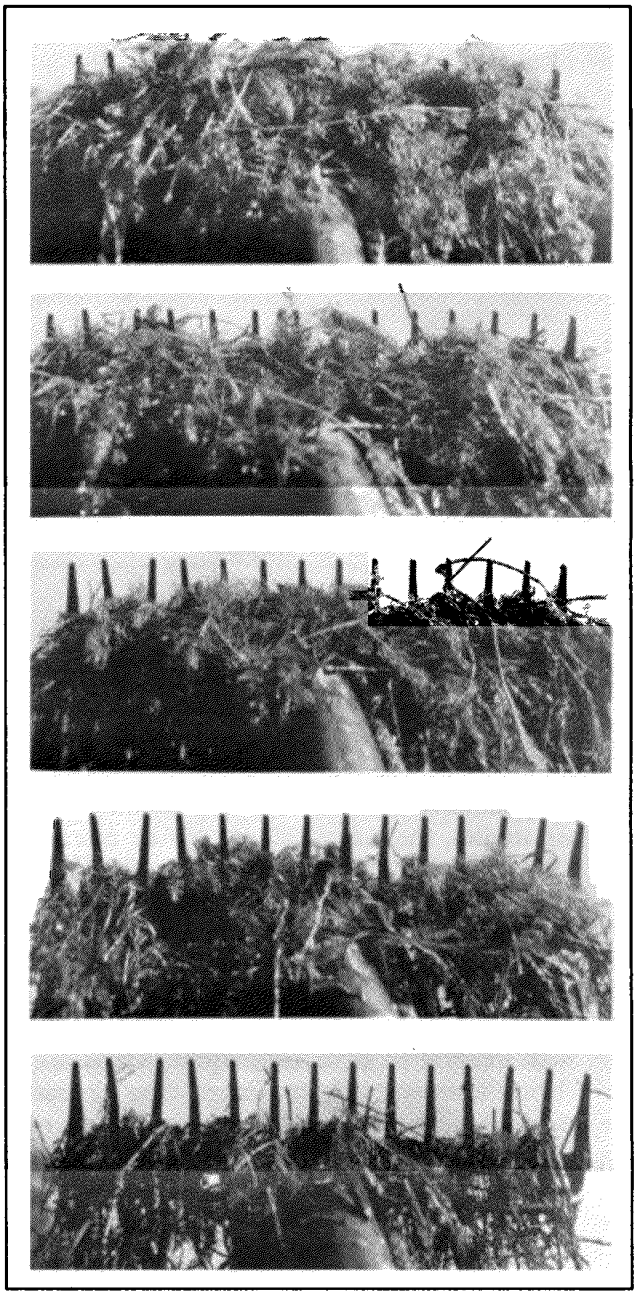

Figure 1. Examples of rake fullness, illustrating density ratings assigned by the RC technique for an individual species. Ratings, from top to bottom, are 5 to 1.

To compare data from the 2 survey techniques, we computed ratings for species at selected individual stations. We also used mean density ratings (MDRs), additive density ratings (ADRs), and the percent changes in these ratings from 1989-90. MDRs were calculated for each species by adding the density ratings at the same depth for all transects and computing a mean from this total. ADRs were computed for each species by adding the density ratings at all depths for each transect.

Results and Conclusion

The basic difference between the 2 survey techniques is that the RF technique does not accurately distinguish between different plant densities on the rake head, as does the RC technique. Four rakes very full of a given species would receive a 5 rating by either technique. Four sparsely covered rakes would be very differently rated: a 1 by the RC technique and a 4 by the RF technique.

This difference is illustrated by density data from individual sampling stations at 2 sites (Table 2). The RC technique revealed large differences in density of Eurasian water milfoil between the 2 depths surveyed at Site A and differences in density of 2 additional species at a single depth at Site B. By contrast, the RF technique evaluated all 3 species at all depths as having identical or very similar high densities.

Statistics from all transects also showed differences between the techniques. For plants found frequently but at low densities (sago pondweed, wild celery, water star grass, and elodea), MDRs computed from RF data were 49-76% higher than those from RC data. RC ratings were also higher for the abundant species (coontail and milfoil) which declined significantly between 1989 and 1990. Although both techniques documented this decline, it appeared much less dramatic according to the RF technique (Fig. 2).

Table 2. *Comparison of actual densities assigned by the 2 different rating techniques.*

Site and Species	Depth (m)	Density Ratings for Individual Rake Throws: Rake Frequency 1	2	3	4	All	Rake Coverage 1	2	3	4	All
Site A											
Milfoil	0.5	P*	P	P	P	4	1	1	1	1	1.00
Milfoil	2.5	P	P	P	P	4	5	4	5	3	4.25
Site B											
Coontail	1.5	P	P	P	P	4	5	4	3	5	4.25
Water star grass	1.5	P	P	P	A	3	1	1	1	0	0.75

*P = presence; A = absence.

This difference in the degree of decline is also shown by comparison of ADRs computed from both techniques. In the 2 lake regions of greatest plant density, the estimated decline in coontail density was greater (51-60%) using the RC technique than that (25-33%) using the RF technique. The difference in ADRs for milfoil was similar.

Based on our observations of the macrophyte community in Lake Mendota and on the main difference in the 2 types of rake survey techniques, we feel the RC technique more accurately depicted actual plant densities. Had only the RF technique been used, it would have led to different interpretations about the macrophyte community and its changes.

Management Implications

The RF and RC techniques have their respective advantages and disadvantages. Plant recording can be done more quickly with the RF technique. Because it involves no subjective judgment of density, this type of plant survey would be easier for surveyors to use. However, because this technique is based only on plant presence and absence, it should not be used to determine density. Instead it allows only relative frequency or occurrence of plants to be assessed.

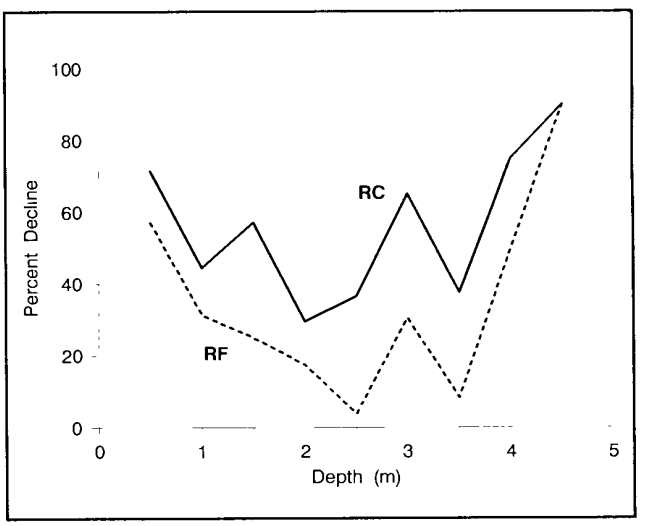

Figure 2. *Percent decline in coontail mean density ratings (MDRs) in Lake Mendota from 1989 to 1990 as documented by the RF and RC techniques.*

The RC technique is more accurate in assigning actual densities. However, data recording takes a little longer with this technique, and it can involve subjectivity, as the surveyor must assess rake fullness.

This subjectivity can be greatly reduced by marking off each rake tooth into 5 equal increments. Subjectivity can be further reduced if surveyors can follow good reference photos (such as shown in Fig. 1) or can be instructed by an experienced surveyor on the standard for density rating.

In summary, the RC technique would be most appropriate for an intensive survey attempting to gauge short-term changes in plant densities as well as relative frequencies of the species found. The RC technique may also provide useful long-term density information, particularly if problems of subjectivity are reduced and labor-intensive biomass techniques are not practical. On the other hand, the RF technique is suited primarily for periodic, discontinuous surveys attempting to assess relative plant frequencies and obtain less-detailed information about plant community structure.

References

Jessen, R. and R. Lound. 1962. An evaluation of a survey technique for submerged aquatic plants. Minn. Dep. Conserv. Game Invest. Rep. No. 6. 10 pp.

Elisabeth Deppe was a limited term biologist with the Bureau of Research, where she has conducted macrophyte surveys of the Yahara Lakes in 1989, 1990, and 1991. Richard Lathrop is a limnologist with the Bureau of Research. He supervised the macrophyte surveys as part of research on the Yahara Lakes that he has conducted since 1976. Address: 3911 Fish Hatchery Road, Fitchburg, WI 53711. Phone: (608) 275-3221.

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Edited by Susan Blair Nehls

Bureau of Research
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

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