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Rapid Qualitative Method for Estimating the Biomass of Submersed Macrophytes in Large Water Bodies[1]

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INTRODUCTION

A major problem facing investigators who survey submersed macrophytes in large (greater than 500 km²; 4) water bodies is the large expenditure of time and money required to obtain measurements of macrophyte biomass by traditional sampling methods (1, 2, 3, 6, 8). As a result, quantitative information about macrophyte biomass may be obtained from only a few representative areas rather than from the entire waterbody, and some surveys of submersed macrophytes in large waters consist of species lists and subjective descriptions of macrophyte abundance (5, 7, 10). The grapnel is recommended for surveying the taxonomic composition of submersed macrophytes in many habitat types (9, 12), but has produced estimates of macrophyte biomass (e.g., sparse, medium, and dense) that are not comparable between studies (5, 10) because they were not expressed in a standard unit of measure. Information about submersed macrophyte biomass obtained with a grapnel would be comparable between studies, if macrophyte biomass were expressed in terms of grams of dry weight of macrophytes per square meter of lake bottom (11, 13). In this note we present a preliminary but promising method in which the grapnel is used to rapidly estimate the biomass of all submersed macrophyte taxa combined in these terms in large waters, where detailed, quantitative surveys cannot economically be done by other means. Although we present only the procedure to determine the biomass of all taxa combined in grapnel samples, the method could also be used to determine biomass of individual macrophyte taxa, if their percent composition in the grapnel sample were determined at each survey station.

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METHODS

Submersed macrophytes, primarily wild celery (*Vallisneria americana* Michx.), muskgrass (Characeae), redhead grass (*Potamogeton richardsonii* [Benn.] Rydb.), Eurasian watermilfoil (*Myriophyllum spicatum* L.) and waterweed (*Elodea canadensis* Michx.), were sampled with a grapnel and a Ponar grab at seven stations (Great Lakes Fishery Laboratory unpublished data) in the St. Clair-Detroit River system from 13 June to 29 November 1978. Stations were selected to represent the range of macrophyte biomass present in this system. The grapnel was lined with 1-cm square mesh screen to increase its effectiveness in collecting vegetation. Vegetation collected from six 10-m drags of the grapnel along the bottom at each station was combined to provide a sample of submersed macrophyte biomass at each station (Great Lakes Fishery Laboratory unpublished data). The biomass of the sample collected with the grapnel was visually estimated to be "low," "medium," or "high" and then discarded. The Ponar grab we used (bottom coverage 484 cm², modified by adding notches 10 mm wide by 20 mm high on both jaws) was similar to the macrophyte sampler used by Dromgoole and Brown (3). Vegetation collected with 15 Ponar grabs was used to determine the mean gravimetric biomass of submersed macrophytes at each station. Macrophytes were removed from the Ponar following methods of Dromgoole and Brown (3), washed over a 3-mm sieve, and refrigerated for up to 3 days before being dried at 105°C until they passed through a 1-mm sieve to remove debris. The weight of sieved macrophytes was determined after they were dried for 24 h at 105°C and expressed as grams dry weight per square meter of lake bottom.

RESULTS

A positive increasing relation was found between low, medium, and high grapnel biomass values and corresponding mean Ponar biomass values (Figure 1). The range of Ponar biomass values for each grapnel biomass value was 15 to 135 g/m² for low, 38 to 287 g/m² for medium, and 103 to 427 g/m² for high. Mean Ponar biomass values ($\bar{x} \pm$ SE; coefficient of variation) that corresponded to grapnel biomass values of low (54 ± 9.2 g/m²; 66%) and high (190 ± 19.5 g/m²; 41%) were significantly different (ANOVA, P less than 0.05).

DISCUSSION

The agreement between grapnel and Ponar biomass values of submersed macrophytes suggests that the grapnel can be used to obtain qualitative estimates of gravimetric biomass, after the relationship of grapnel to gravimetric biomass is determined.

An advantage of performing a survey of submersed macrophyte biomass in large waters with a grapnel rather than with a Ponar is the substantial saving of time that can be realized by using the grapnel. In the present study, about 2 minutes per station was required to make one 10-m drag with the grapnel, whereas about 20 minutes per station was required to collect one sample with a Ponar. In addition,

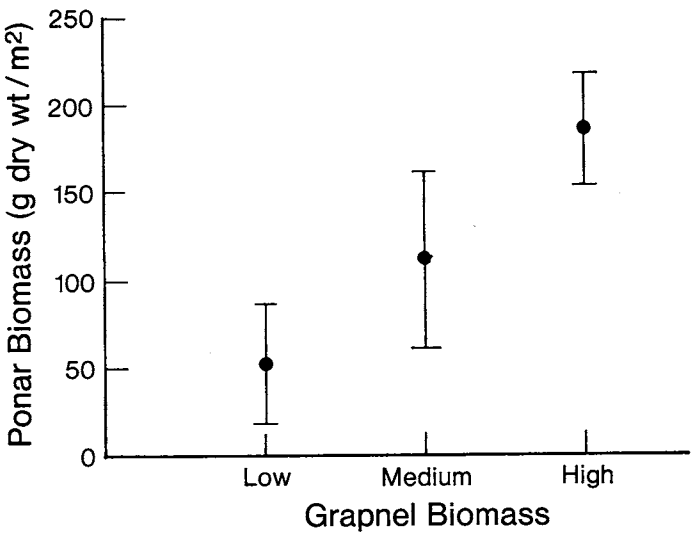

Figure 1. Submersed macrophyte biomass values showing the relationship between visually determined biomass values of low, medium, and high obtained with a grapnel and gravimetric mean dry weight biomass (vertical lines are 95% confidence limits) obtained with a Ponar grab.

no laboratory analysis of grapnel samples was needed, whereas laboratory analysis of each Ponar sample required about 5 hours. We recently used the method described here to survey the biomass of submersed macrophytes in the St. Clair-Detroit River system at 595 stations along 610 km of shoreline and 1100 km² of lake bottom (Great Lakes Fishery Laboratory unpublished data). Using the grapnel, we sampled about 25 stations per day over a 24-day period. A similar survey with a Ponar to obtain one sample per station would have required about 250 days of field work and about 3000 hours of laboratory analysis. In a large waterbody, such as the St. Clair-Detroit River system, the grapnel is the more practical method to survey submersed macrophytes because some loss of accuracy can be tolerated to describe large-scale changes in plant composition at reasonable expense.

A disadvantage of using the grapnel rather than the Ponar to determine macrophyte biomass is the lesser sensitivity of the grapnel. For example, in the present study the range of gravimetric biomass values corresponding to the "low" grapnel biomass value was great (15-135 g/m²). The inability to visually determine small differences in macrophyte biomass originates from subjective criteria applied by each investigator to assign grapnel biomass values, and probably limits the number of visually-determined grapnel biomass values to the categories of low, medium, and high. The grapnel-gravimetric biomass relation determined in the present study cannot be used as a general rule because it is based on subjective criteria that we adopted to visually determine the biomass of plants collected with the grapnel.

We recommend the method described here for use by other investigators to rapidly determine qualitative estimates of submersed macrophyte biomass in large waters. Additional verification is needed to establish the utility of this method. The procedure consists of the following steps: (1) sample throughout the study area with a grapnel to become familiar with the range of macrophyte biomass and

to locate several index stations where macrophyte biomass is judged to be low, medium, and high; (2) sample the index stations with a grapnel and Ponar to establish the relation between grapnel biomass values (low, medium, and high) and gravimetric biomass (grams dry weight per square meter) obtained with a Ponar; (3) use a grapnel to survey macrophyte biomass at a sampling intensity designed to meet survey objectives; and (4) calculate the biomass of macrophytes at survey stations by using the grapnel-gravimetric biomass relationship as determined at index stations. If the biomass of individual macrophyte taxa is desired, estimate by visual inspection or wet weight determinations the percent composition of each taxa in grapnel samples collected at each survey station in step 3 and apply the percentage factor to the biomass estimates calculated in step 4. We believe this procedure can be used by biologists to rapidly survey submersed macrophytes and develop qualitative estimates of their biomass in grams dry weight per square meter. In large scale surveys, this procedure should result in a 90% saving in time, compared with that expended if a grab-type sampler were used.

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