Invertebrates Associated with Communities of Aquatic Macrophytes: Native Polycultures and Milfoil Monocultures

Preliminary Report

by

David L. Smith
Sallie P. Sheldon
Charles W. Boylen

Report #88-11

Invertebrates Associated with Communities of Aquatic Macrophytes: Native Polycultures and Milfoil Monocultures

Preliminary Report

by

David L. Smith
Sallie P. Sheldon
Charles W. Boylen

Rensselaer Fresh Water Institute
Rensselaer Polytechnic Institute
Troy, New York 12180-3590

Fresh Water Report #88-11

Charles W. Boylen, Director

December 16, 1988

Introduction

Aquatic macrophytes add structure to an otherwise relatively uniform expanse of water providing microhabitats and refugia for invertebrates and fish. Feeding activity by invertebrates on these macrophytes and the epiphytic (attached) algae and bacteria that colonize the macrophyte surfaces not only increase the rate of nutrient and carbon cycling but serve as an important link in the aquatic food web.

Contrary to previous thinking, herbivores have been shown to have a significant impact on the growth of freshwater macrophytes. Important macroinvertebrate herbivores include crayfish (Lodge and Lorman 1987), beetles (Wallace and O'Hop 1985), lepidopteran larvae (Fiance and Moeller 1978), and snails (Lodge 1985, Sheldon 1987). In turn, these macroinvertebrates are fed upon by many species of fish. Thus the nature of the macrophytes and their associated invertebrate communities are important components of lake ecosystems.

With the introduction of Eurasian Watermilfoil (*Myriophyllum spicatum*) to Lake George and its subsequent dominance over the native macrophyte species, some localized plant communities have changed from a complex polyculture of many plant species to a virtual monoculture of Eurasian Watermilfoil. These changes most likely alter not only the type and number of potential habitats for epiphytes, bacteria and macroinvertebrates, but may influence the fish community as well (Cyr and Downing 1988, French 1988).

To date there has been little documentation of the impact of changes in aquatic plant structure on the invertebrates associated with the plants. The data generated by this project will allow a direct comparison of invertebrate populations between two different plant communities at one site as well as detecting year to year variability in the invertebrate community. Given the importance of the invertebrate community both in serving as a link in the food web and in affecting macrophytes, it is important to determine which species are present, their abundance and their response to community type.

As part of a project begun in the summer of 1988 we proposed to do two sets of studies, the first to determine density and diversity of plant and macroinvertebrate species in the native polycultures and milfoil monocultures of Lake George, and the second to investigate the presence, distribution and density of an aquatic lepidopteran herbivore, *Acentropus niveus*. Painter and McCabe (1987) have recently reported that *A. niveus* may have led to the decline of Eurasian Watermilfoil in several Canadian lakes. The presence of this invertebrate in Lake George would offer the potential for biological control of Eurasian Watermilfoil, and to determine if it would be effective, its distribution, abundance, and feeding habits, as well as its effect on other plants and invertebrates must be known.

Methods

The macrophyte community in Sunset Bay, Huletts Landing, NY (see Figure 1) was examined during the summers of 1987 and 1988. Eight other locations on the lake, East Brook LGV, West Brook LGV, Shepards Park, Congers Point, Huddle Bay, Shadoe Bay, Northwest Bay and Mossy Point (Figure 1) were surveyed for the presence of the aquatic lepidopteran, *A. niveus*. These sites are characterized as having at least 50% of the substrate covered by Eurasian Watermilfoil (RFWI *et al.* 1988).

The 1987 preliminary samples in Sunset Bay were taken weekly from 6/1 - 8/31 and biweekly 5/1 - 6/1 and 9/1 - 11/15, resulting in 126 samples. During the summer of 1988, samples were taken weekly, 5/19 - 6/29, and then biweekly until 11/14 (110 samples).

The Sunset Bay sampling area was divided into three sections, the milfoil bed and two native polycultures on either side of the bed (Figure 2). For the 1988 samples the area was re-sectioned into the milfoil bed, one native polyculture in the north and a mixed milfoil-native polyculture on the south (Figure 2).

Six samples were taken in Sunset Bay on each of the 1987 sampling dates, three of which were randomly located in the milfoil bed and three randomly located in the native polycfuture (with at least one sample in each native area). Because the north and south native areas were no longer similar in 1988, two samples were randomly taken in the milfoil bed, three samples randomly located in the native polyculture and two samples taken in the mixed milfoil-native area. Samples were taken with a sampler that was lowered through the water column, enclosing approximately 0.4 m^2 of the substrate, the macrophytes and their associated macroinvertebrates. The plants were cut at the sediment level, a sieve placed under the the sampler, and the plants and invertebrates brought to the surface where they were preserved for later identification.

The nine locations listed above were sampled for the presence of *A. niveus* and at all sites, five non-random samples were taken in July 1988 (three in the milfoil bed and two in the native polyculture surrounding the milfoil). These samples were taken using the sampler described above and were also preserved for later sorting and identification. Additionally, plants were collected by hand, kept alive in aquaria and checked periodically for larvae. Night samples, taken by dragging nets across the waters surface, were done in July and August 1988 to check for emerging adults.

All preserved samples were sorted by hand to separate the macroinvertebrates from the plant material. The plant material was then sorted by species and dried at 21° C for 72 hrs to determine sample biomass. Reference specimens of the invertebrates have been preserved and confirmation of our preliminary identification of *A. niveus* has been requested from experts at Cornell University and the United States National Museum (Washington, D.C.).

The various project phases, their current status and their actual or anticipated scheduling are shown in Table 1.

Results

Selected samples (one set /month) from the preliminary study in 1987 have been analyzed at this point in time. Sixteen orders and at least 27 families of invertebrates have been found (Table 2). Generally there were more invertebrates in the native samples than in the milfoil samples, although by the end of the sampling season the numbers were similar (Figure 3). Invertebrate diversity (H), which expresses the number of organisms in a species relative to the number of species present, was generally higher in the native plant areas although once again there was little difference between the two areas in November 1987 (Figure 4).

The mean weight of plant samples in the native areas remained fairly constant over time, however there is a trend of increasing sample weight observed in the milfoil samples, which peaks in the October samples (Figure 5) and is generally indicative of seasonal biomass changes. The plants found in the Sunset Bay community are listed in Table 3.

As a result of field sampling during July 1988 the aquatic moth, *A. niveus*, has been located in nine sites within Lake George. Individuals have been found at three locales in the northern basin (Mossy Point, Gull Bay and Sunset Bay) and at Northwest Bay, Shadoe Bay, Huddle Bay, Conger's Point, East Brook (LGV) and West Brook (LGV) in the southern basin (Figure 1). Both the larval form (caterpillar) and pupae of *A. niveus* have been found on a variety of native aquatic macrophytes as well as Eurasian Watermilfoil. Although not all of the samples taken for the *A. niveus* survey have been sorted completely, as many as 8 larvae have been found in one sample from the East Brook (LGV) bed.

Discussion

At this point in the processing of the samples it is not yet possible to determine if there are differences between invertebrate communities asociated with different bed types. Some differences can be seen but it is not clear whether they are real or merely artifacts of the sampling or sample processing (not all of the samples have been analyzed). As more of the data becomes available, the significance of the observed differences can be tested.

With the single exception of Shepards Park, *A. niveus* has been found in all surveyed locations, and in one coincidental finding (Gull Bay). The preliminary data suggest that larval densities may be as high as 20 larvae/m^2 in some of these areas sampled. It is difficult to compare these data to other published reports on *A. niveus* as their abundances have been haphazardly defined for the most part. Buckingham *et al.* (1981) reported "almost all watermilfoil plants had one or more larval cases of *A. niveus* attached". Batra (1977) reported finding 1 - 3 larvae per plant in approximately half of the plants that she collected. Painter and McCabe (1987) observed as many as 6 larvae and 17 larval shelters per 10 apical tips of milfoil. If these numbers are corrected using milfoil densities observed in Lake George (Madsen and Boylen 1988), larval densities of approximately 135 larvae/m^2 (Painter and McCabe 1987), 225 larvae/m^2 (Buckingham *et al.* 1981) and 240 larvae/m^2 (Batra 1977) could be expected. However these numbers seem excessive and therefore may only be useful as an indication of an upper density limit for *A. niveus*.

The limited collections from 1988 do not lend themselves to any interpretations as to the generation times of *A. niveus*. Buckingham *et al.* (1981) suggest that generation time may vary from one per year in the field to as many as three per year under laboratory conditions. Buckingham *et al.* (1981) further suggest that the long development times and staggered emergences of adult *A. niveus* may allow only a few adults to be present at any one given time. When combined with the fact that adults appear to live only about 24 hours (Batra 1977) it is not surprising that the night samples taken in July and August 1988 were not especially productive.

The analysis of the remaining samples already collected combined with the sampling that will be done in the summer 1989 (see Table 1) will provide perhaps the first real field density estimates for *A. niveus* in the United States as well as a data base which will allow suggestions as to the efficacy of *A. niveus* as a biological control for Eurasian Watermilfoil in Lake George.

Research Recomendations

Although the data are only partially analyzed from this project, there are at least two areas which present themselves as logical next steps. First, the feeding habits of *A. niveus* need to be examined. The literature on *A. niveus* shows a variety of feeding studies that were attempted but none of them really provide sufficient data upon which to draw conclusions. The Sunset Bay data suggest that a number of invertebrates which may act as herbivores are inhabiting the milfoil beds and their feeding habits need to be thoroughly investigated. Secondly, it would seem prudent to begin an examination of the fish communities which utilize the native plant beds and the milfoil areas to see if there are differences. Whether this study took the form of a survey over several areas or an intense examination of one area, such as Sunset Bay, the information gained would be important to understanding the impact of Eurasian Watermilfoil on Lake George fisheries.

Acknowledgements

We thank the assistance of J.H. Witting, L. J. Taggett, S. F. Smith and most especially Rachel Simpson, whose unfailing presence made it possible for much of this work to be concluded. The Rensselear Freshwater Institute gratefully acknowledges the support of Warren County and the Warren County Lake George Affairs Committee.

References

Batra, S. W. T. 1977. Bionomics of the aquatic moth, *Acentropus niveus*, a potential biological control agent for Eurasian watermilfoil and Hydrilla. J. N. Y. Entomol. Soc. 85:143-152.

Buckingham, G. R. and B. M. Ross. 1981. Notes on the biology and host specificity of *Acentria nivea* (=*Acentropus niveus*). J. Aquat. Plant Manage. 19:32-36.

Cyr, H. and J. A. Downing. 1988. Empirical relationships of phyto-macrofaunal abundance to plant biomass and macrophyte bed characteristics. Can. J. Fish. Aquat. Sci. 45:976-984

Fiance, S. B. and R. E. Moeller. 1978. Immature stages and ecological observations of *Eoparagyractis plevie.* J. Lepidopt. Soc. 31:81-88.

French, J. R. P. 1988. Effect of submersed aquatic macrophytes on resource partitioning in yearly rock bass (*Ambloplites rupestris*) and pumpkinseeds (*Lepomis gibbosus*) in Lake St. Clair. J. Great Lakes Res. 14:291-300.

Lodge, D. M. 1985. Macrophyte-gastropod associations: observations and experiments on macrophyte choice by gastropods. Freshw. Biol. 15:695-708.

Lodge, D. M. and J. G. Lorman. 1987 Reductions in submersed macrophyte biomass and species richness by crayfish *Orconectes rusticus.* Can J. Fish. Aquat. Sci. 44:591-597.

Madsen, J. D. and C. W. Boylen. 1988. The physiological ecology of Eurasian Watermilfoil (*Myriophyllum spicatum*) and a native macrophyte (*Potamogeton praelongus*): Depth distribution of biomass and photosynthesis. Rensselaer Fresh Water Institute Report 88-5, Troy, New York.

Painter, D. S. and J. K. McCabe. 1988. Investigation into the disappearance of Eurasian Watermilfoil from the Kawartha Lakes. J. Aquat. Plant Manage. 26:3-12.

Rensselaer Fresh Water Institute, New York State Department of Environmental Conservation and Adirondack Park Agency. 1988. The Lake George Aquatic Plant Survey Interim Report. New York State Department of Environmental Conservation, Albany, New York. March 1988.

Sheldon, S. P. 1987. The effects of herbivorous snails on submerged macrophyte communities in Minnesota lakes. Ecology. 68:1920-1931.

Wallace, J. B. and J. O'Hop. 1985. Life on a fast pad: waterlily leaf beetle impact on waterlilies. Ecology. 66:1543-1544.

Table 1. Timeline for 1988 - 1989 project phases.

	1988						1989								
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	
	FSA													FSA	
	FSM ----	----	----	----	FSM										
	P ----	----	----	----	----	----	----	----	----	----	----	----	----	---- P	
	N	N											N	N	
						Report									Report

FSA = field sampling *A. niveus* (1988 - 100% complete)
FSM = field sampling in Sunset Bay (100% complete)
P = processing of samples, identification of invertebrates (50% complete)
N = night sample for adult *A. niveus* (1988 - 100% complete)
Report = preliminary report in December 1988
final report in August 1989

Table 2. Invertebrates found in 1987 Sunset Bay samples. Phyla and orders are listed followed by their common names. The family names are given in parentheses. Classification based on Barnes (1987).

- Cnidaria
  - Hydroida - Hydra
- Platyhelminthes
  - Tricladida - Planaria
- Annelida
  - Tubificida - Tubifex
  - Rhynchobdellida - Leeches
- Mollusca
  - Basommatophora - Snails (Planorbidae, Physidae, Lymnacidae, Ancylidae)
  - Unionida - Freshwater clams (Sphaeriidae)
- Arthropoda
  - Acariformes - Freshwater mites
  - Amphipoda - Amiphipods or scuds (Taltridae, Gammaridae)
  - Isopoda - Freshwater sow bugs (Asellidae)
  - Cladocera - Daphnia (Daphnidae)
  - Cyclopida - Rotifers (Cyclopidae)
  - Ephemeroptera - Mayflies (Baetidae, Caenidae)
  - Odonata - Damselfies and dragonflies (Calopterygidae, Agrionidae, Libellulidae)
  - Coleoptera- Beetles (Gyrinidae, Halipidae)
  - Trichoptera - Caddisflies (Hydroptilidae, Phryganeidae, Polycentropidae, Limnephilidae)
  - Diptera - Flies (Chironomidae)

Table 3. Plant species collected from the milfoil and native plant beds in Sunset Bay , May - November 1987. Classification scheme taken from Ogden et al. (1976) and Prescott (1969).

Chlorophyta
- *Chara* sp.
- *Nitella* spp.

Bryophyta
- *Fontinalis* sp.

Spermatophyta
- *Bidens beckii*
- *Certatophyllum demersum*
- *Elodea canadensis*
- *Heteranthera dubia*
- *Isoetes* sp.
- *Myriophyllum spicatum*
- *Najas flexilis*
- *Potamogeton* *amplifolius*
  - *gramineus*
  - *gemmiparous*
  - *perfoliatus*
  - *praelongus*
  - *pusillus*
  - *richardsonii*
  - *robbinsii*
  - *zosteriformis*
- *Utricularia resupinata*
- *Vallisneria americana*

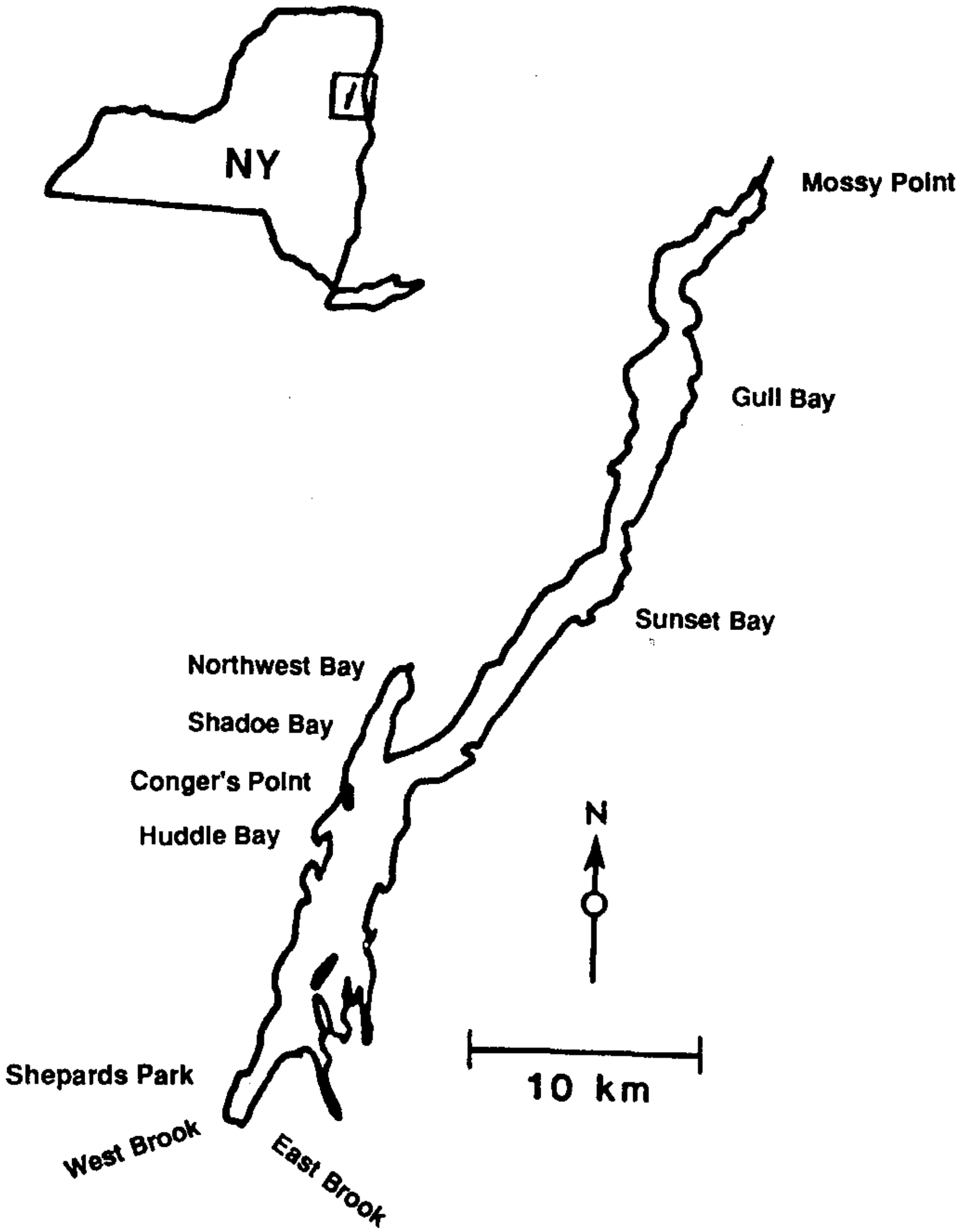

Figure 1. Map of Lake George, its location in NY and the sampling sites used in this study.

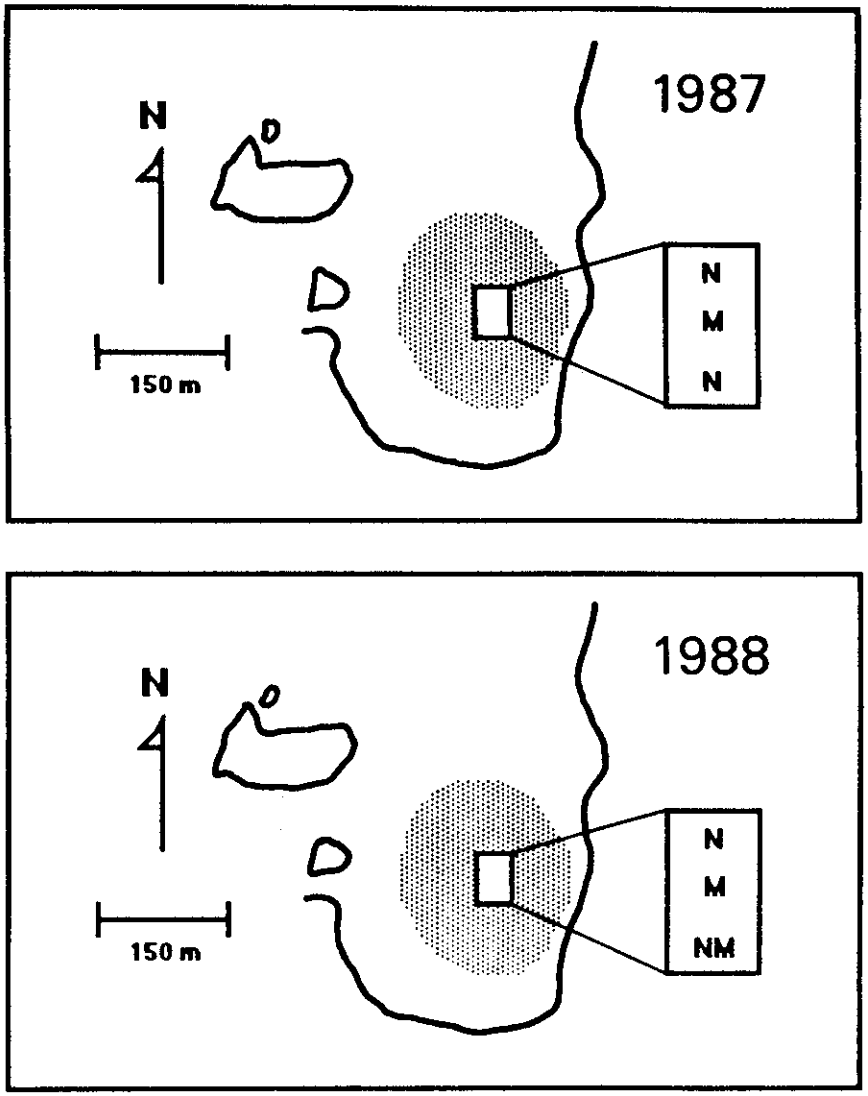

Figure 2. Map showing the location of macrophyte community in Sunset Bay, Lake George. Insets mark locations of native (N), milfoil (M) and mixed native-milfoil (NM) beds.

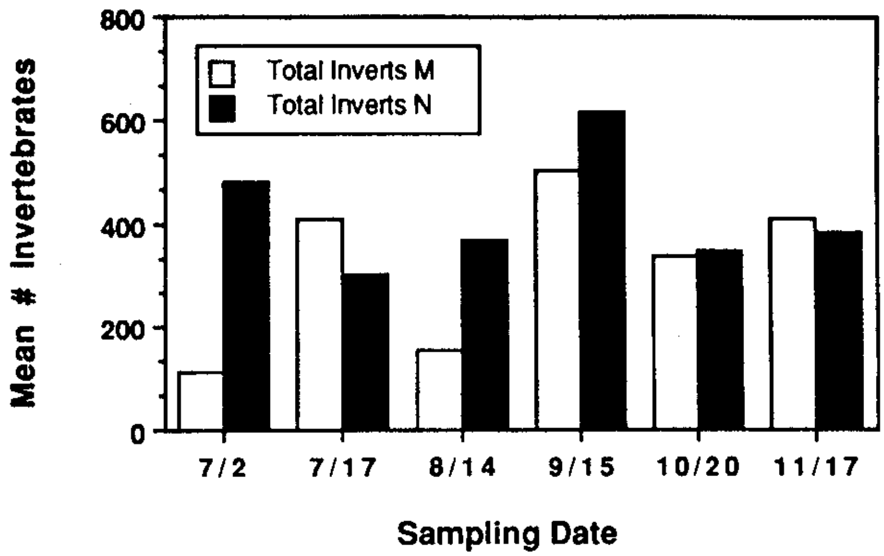

Figure 3. Comparison of the mean number of invertebrates collected from the native and milfoil macrophyte beds (Sunset Bay) in 1987.

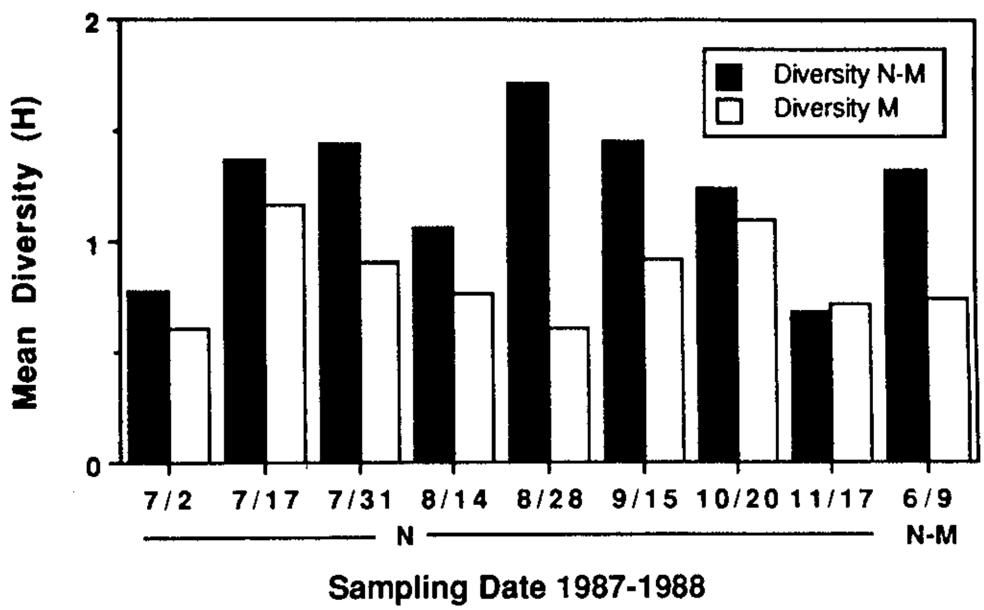

Figure 4. Comparison of mean invertebrate diversity (H) from the native and milfoil macrophyte beds in Sunset Bay (1987 and June 1988).

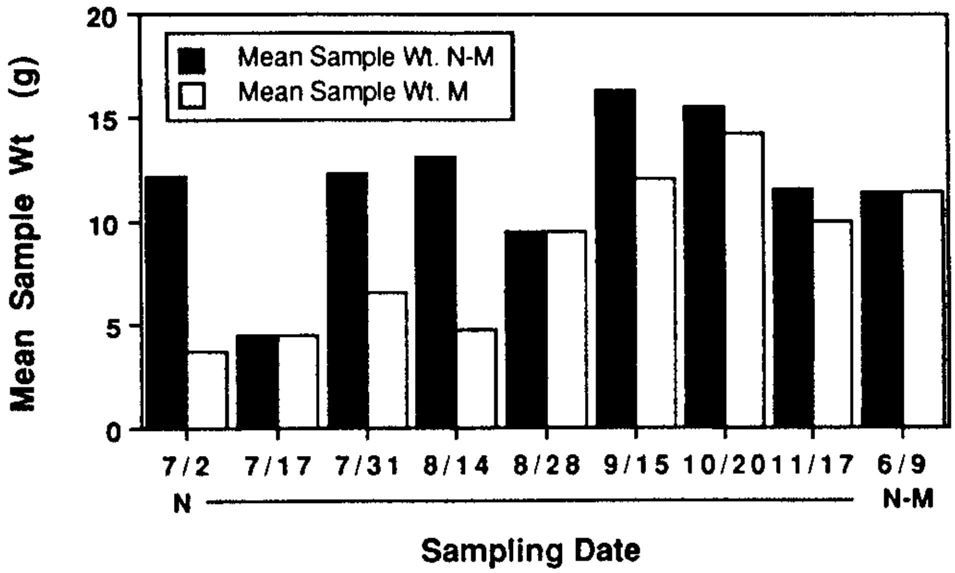

Figure 5. Comparison of mean sample weight (g) of plants from the native and milfoil macrophyte beds in Sunset Bay (1987 and June 1988).