United States
Environmental Protection
Agency

Chesapeake Bay
Program
Annapolis MD 21403

Research and Development

EPA-600/S3-83-047 Sept. 1983

EPA

Project Summary

Biology of Submerged Aquatic Macrophyte Communities in the Lower Chesapeake Bay (Volume III)

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As a part of the Functional Ecology Program on Chesapeake Bay submerged aquatic vegetation (SAV), this study investigated infaunal and epifaunal trophic dynamics. The work was conducted in conjunction with other major aspects of the program (see Volumes I, II, and IV) and represents the culmination of four years of intensive field and laboratory investigations.

The main study area established for investigating the functional ecology of resident consumers in the lower Chesapeake Bay was a large grass bed located at Vaucluse Shores on the bayside of Virginia's eastern shore. Vaucluse Shores was chosen as the study site because: 1) the site had been previously studied and background information was available; 2) the bed is well established and historically stable; 3) the area is relatively remote and unperturbed; 4) the bed contained the two dominant lower Bay macrophyte species, *Zostera marina* and *Ruppia maritima;* and 5) the bed was large enough to simultaneously accommodate varied studies and sampling regimes. This bed was intensively mapped in 1978 and 1979, and permanent transects were established for sampling reference points.

This Project Summary was developed by EPA's Chesapeake Bay Program, Annapolis, MD, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

One of the most notable features about habitats with SAV is the characteristically high density of the associated fauna. Included are epibiota and infauna which are represented by a diverse and complex assemblage of micro- and macroalgae, protozoans, hydrozoans, anthozoans, turbellarians, gastropods, isopods, amphipods, polychaetes, oligochaetes, bivalves, decapods, and barnacles. Many of these groups exhibit distinct seasonal pulses of abundance depending on their individual spawning periods. The epibiotic community within grass beds is quite distinct from the communities in adjacent unvegetated areas. Due to the lack of a suitable substrate, there is usually very little epifauna in bare sand or mud areas. Epibiota primarily use the blades as a substratum for attachment (i.e., barnacles, algae, hydroids, etc.) or, in the case of microherbivores grazing on the microalgae that colonize the blades, a feeding platform. Thus, grass beds provide substrates, protection, and food resources which allow for the maintenance of high densities, which in turn attract and trophically support numerous migratory utilizers of SAV habitats such as crabs, fishes, and waterfowl. These features are fundamental to the resource value of SAV beds on a world-wide basis.

Our initial effort in examining the functional ecology of resident consumers was to determine the structural aspects of the grass-bed community compared to unvegetated areas (Chapter 1). We subsequently conducted predator-exclusion ex-

periments to determine the role of predation in structuring the biotic community in grass beds (Chapter 2) and examined, in greater detail, predator-prey interactions in vegetated habitats (Chapter 3). Having established which species were numerically dominant, we calculated the secondary production of those species which were trophically or functionally important (Chapter 4). We then focused our attention on one dominant species, an herbivorous grazer, and examined its role in controlling epiphytic fouling on *Zostera marina* (Chapter 5). Because waterfowl have been the least studied trophic components of the grass-bed systems in the lower Bay, we determined the intensity of utilization by wintering waterfowl of the Vaucluse grass system (Chapter 6). We also measured the impact of feeding by one species (buffleheads) on the density of macroinvertebrate population densities. Finally, we tried to place into perspective major trophic links in the Vaucluse Shores grass bed by examining natural carbon isotope ratios (^{13}C to ^{12}C) in some of the dominant species (Chapter 7). Such an approach enabled us to determine the sources of primary production utilized by the resident consumers.

I. Structural Analysis of Benthic Communities Associated with Vegetated and Unvegetated Habitats

Procedure and Methodology

Three distinct habitats in the lower eastern Chesapeake Bay (Vaucluse Shores at the mouth of Hungars Creek) were compared based on a structural analysis of the associated fauna. These habitats included a grass bed (*Zostera marina* and *Ruppia maritima*), large sand patches within the grass bed, and an offshore sand-bar system. Within the vegetated habitat, comparisons were made of the fauna associated with pure stands of *Z. marina*, pure stands of *R. maritima*, and mixed stands of both species.

Results and Conclusions

Generally, there was a trend toward a greater species diversity (Shannon-Weiver Index $\bar{h}$) and abundance of infaunal species and individuals in the vegetated habitats than in the two sand habitats. Many species which occurred as one of the top ten in each habitat persisted throughout the study (July 1978 to November 1979) and were characteristic of the habitat examined. Although infaunal abundances were concentrated at the sediment surface in all three habitats, the grass bed supported a larger number of individuals deeper in the sediments than did the other two habitats.

The epifaunal component of the vegetated habitat comprised a unique and diverse assemblage of species which was similar between each area investigated (i.e., *Zostera marina*, *Ruppia maritima*, and mixed stands). Few seasonal patterns in epifaunal abundance were evident in the data. Vegetated areas provided greater habitat heterogeneity and were therefore capable of supporting a greater overall diversity of species than nonvegetated habitats.

II. Predator-Exclusion Experiments in a Chesapeake Bay Grass Community

Procedure and Methodology

The effects of predators on the density of eelgrass epifauna and infauna, and sand infauna were studied using predator exclusion techniques. A large topless pen (20 m^2) and smaller cages (0.25 m^2) within the pen as well as outside the pen, were set up in a bare sand and an adjacent grass habitat to test the hypothesis that predation has a significant effect on the structure of associated faunal communities.

Results and Conclusions

The grass habitat consistently had more infaunal species per core than the sand habitat for all treatments. There were no distinct differences among the grass treatments for species infaunal numbers but in the sand species numbers were higher in pen and cage treatments compared to the control. Except for the sand cage treatments, there was no difference between the pen and cage treatments for number of species in both habitats.

Density of individuals in the grass habitat treatments was generally higher than the sand habitat treatments except for the June cage treatments. In the sand area, infaunal densities were always higher in the cage and pen treatments compared to the control. In the grass habitat, only the September cage and pen treatments were higher than the control.

Epifaunal densities in the grass habitat were generally higher in cage and pen treatments than the control. Species responses to these treatments were variable and controlled by the abundance of grass in the treatment.

The results of this work support recent evidence for the importance of predation for the structuring of benthic communities both in vegetated and non-vegetated habitats.

III. Predator-Prey Interactions in a *Zostera marina* (Eelgrass) Ecosystem in the Lower Chesapeake Bay, Virginia

Procedure and Methodology

Experiments were conducted with artificial seagrass in small wading pools to assess the ability of prey to survive predation at different densities of grass.

Results and Conclusions

Experiments using *Mulinia lateralis*, a bivalve, as prey, and adult *Callinectes sapidus*, a crab, as predator, showed that almost no *M. lateralis* survived at three different densities of grass. Experiments with juvenile *C. sapidus* as prey and adult *C. sapidus* as predator showed greatest survival at highest densities of grass. The behavior of the juvenile crabs in relation to their predators was different in the presence of the grass than in its absence. It was believed that the survival of a particular prey species in a vegetated habitat will depend upon the life style and life cycle of both prey and predator and the density and morphology of the vegetation.

IV. Secondary Production of Some Dominant Macroinvertebrate Species Inhabiting a Bed of Submerged Vegetation in the Lower Chesapeake Bay

Procedure and Methodology

Secondary production of dominant macroinvertebrate species at the Vaucluse Shores SAV bed was examined from monthly samples taken in the *Zostera-Ruppia* area. Length-weight as well as ash-free, dry weight calculations were made on all individuals. Production for each species was determined using the size-frequency method and instantaneous-growth method.

Results and Conclusions

The production of the top nine trophically important species to the higher level consumers at the Vaucluse Shores grass bed was 40.7 $g \cdot m^{-2} \cdot yr^{-1}$. This is a higher productivity than reported for most community production studies. If this rate of production is projected over the entire 140-hectare grass bed, a total of 53 metric tons of dry tissue was produced and potentially available for consumption by other trophic levels. This also represents 6×10^{10} individuals that are born, grow, and die in a year. The average standing stock over the year was 4.6 metric tons.

The isopod *E. attenuata* accounted for 43 percent of the total production for the nine species. The next two high ranking producers were *C. sapidus* and *G. mucronatus*, which, when combined with *E. attenuata*, accounted for 84.8 percent of biomass produced by the nine species. Turnover ratios were highest for *G. mucronatus* (24.5) and lowest for the snail *B. varium* (3.2).

V. Preliminary Studies of Grazing by *Bittium varium* on Eelgrass Periphyton

Procedure and Methodology

The grazing activities of *Bittium varium* Pfeiffer on periphyton colonizing live eelgrass (*Zostera marina* L.) and artificial eelgrass (polypropylene ribbon) were investigated. Quantitative measurements of grazing impact on artificial substrates were determined by periphyton pigment extraction and dry weight differences between grazed and ungrazed blades.

Results and Conclusions

Significant differences occurred in phaeophytin and dry weight calculations but chlorophyll *a* measurements were not significantly different. This suggests that senescent diatoms constituted the bulk of the periphyton weight and were selectively removed over more actively photosynthesizing diatoms.

An examination of scanning electron micrographs further elucidated the impact of grazing by *Bittium varium*. Some micrographs revealed that *B. varium* removed primarily the upper layer of the periphyton crust on both artificial substrates and living *Zostera marina*. The diatom *Cocconeis scutellum* Ehrenb. which attaches firmly to living *Z. marina* blades was less commonly removed than *Nitzschia* or *Amphora*. Through its grazing activities, *B. varium* may maintain community dominance by tightly adhering diatoms such as *C. scutellum*. Evidence of the complete removal of periphyton exposing the *Z. marina* epithelium was revealed in other micrographs.

The grazing activities of *Bittium varium*, a species which removes periphyton from seagrass blades, could have important implications for the distribution and abundance of *Zostera marina* in the Chesapeake Bay.

VI. Waterfowl Utilization of a Submerged Vegetation (*Zostera marina* and *Ruppia maritima*) Bed in the Lower Chesapeake Bay

Procedure and Methodology

A study of waterfowl use of a bed of SAV was conducted over two winters in the lower Chesapeake Bay (Virginia). Waterfowl abundances were estimated from census counts made during the winters of 1978 to 1979 and 1979 to 1980. Food habits of birds were examined using the stable carbon isotope methods. Waterfowl exclosure experiments were conducted to assess the effect of waterfowl feeding on the infauna and epifauna.

Results and Conclusions

In the winter season of 1978 to 1979, Canada geese (*Branta canadensis*) were the dominant waterfowl in the study area. Goose foraging activity was correlated with tide stage, and was greatest at low tide. Consumption by grazing waterfowl was calculated from bird densities, and was approximately 25 percent of the standing crop of vegetation in the shallow portion of the habitat.

From 1979 to 1980, diving ducks, primarily buffleheads (*Bucephala albeola*), were dominant. Abundance of waterfowl was influenced by wind parameters; but tide, temperature, and time of day had little or no influence on bird numbers. Within-habitat variation in abundance was examined, and highest densities were associated with the deeper *Zostera marina* zone.

Gizzard samples and $\delta\ ^{13}C$ analysis revealed that buffleheads fed primarily on small gastropods and nereid worms characteristic of the grass-bed epifauna. Consumption of important invertebrate prey items, calculated from exclosure experiments and waterfowl densities, amounted to nearly 50 percent of the fall standing crop of these species in *Zostera marina*.

VII. Trophic Relationships in a Submerged Macrophyte Bed Based on $\delta^{13}C$ Value

Procedure and Methodology

Trophic relationships in a lower eastern shore Chesapeake Bay (Vaucluse Shores at the mouth of Hungars Creek) seagrass bed were investigated by examining time integrated stable carbon isotope ratios ($^{13}C/^{12}C$) in primary producer and consumer populations.

Results and Conclusions

The periphyton grazing snail, *Bittium varium,* exhibited close ties to the microalgae found on *Zostera marina* leaves. Dominant isopods (*Erichsonella attenuata* and *Idotea baltica*) were more closely linked to the seagrasses themselves. In several other invertebrate and vertebrate species, trophic relationships were more obscure. These will be more closely examined in a forthcoming publication. Overall, carbon isotope analysis appears promising as a method for elucidating general trophic relationships in seagrass communities.

Recommendations

The trophic function of SAV communitie and the refuge that SAV provides appea to be the key to understanding the role thes habitats play in supporting living resource of direct importance to man. These two at tributes are so functionally interrelated tha although it may be necessary to separat the two for the purpose of modeling th system, they must be addressed with a uni fied research approach.

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***David Flemer** is the EPA Project Officer (see below).*
The complete report, entitled "Biology of Submerged Aquatic Macrophyte Communities in the Lower Chesapeake Bay: Volume III. Interactions of Resident Consumers in a Temperate Estuarine Seagrass Community: Vaucluse Shores, VA, USA," (Order No. PB 83-233 395; Cost: $20.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

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