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Project Summary

Submerged Aquatic Vegetation: Distribution and Abundance in the Lower Chesapeake Bay and the Interactive Effects of Light, Epiphytes, and Grazers

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Submerged aquatic vegetation (SAV), a major ecological resource, has undergone a major decline in Chesapeake Bay during the past decade. Aerial photographs of Lower Chesapeake Bay taken in 1980 and 1981 were compared with 1978 aerial photographs of the same Bay area. The photographs showed that SAV had declined in every area of the lower Bay except the lower western shore. A literature review of the relationship between epiphytic fouling by macroalgae and periphyton and the grazers that feed on these epiphytes indicates that grazing plays a major role in preventing over-growth of epiphytes.

Nutrient enrichment can stimulate the excessive growth of epiphytes, resulting in death of the plants. The salinity tolerances of one major grazer, the snail *Bittium varium,* were studied to determine whether rapid fresh-water influx (such as occurred during Tropical Storm Agnes) would prove fatal to the snail. Larvae subjected to a rapid salinity drop (from 22.3 to 11.1 ppt) did not survive; however, adult snails were less sensitive. Studies of plant vigor, under three shading conditions, in the presence and absence of *Bittium varium,* indicated that within each shading condition plant vigor was enhanced by the presence of the snail. The decreased salinities that occurred with Tropical Storm Agnes were probably a factor in decreasing populations of *Bittium varium.* In turn, the loss of the snail may permit over-growth of epiphytes resulting from nutrient enrichment and thus contribute to the decline of SAV in the lower Chesapeake Bay.

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

Since 1978, submerged aquatic vegetation (SAV) has been the subject of an intensive research program funded by the U.S. Environmental Protection Agency's Chesapeake Bay Program (EPA/CBP). SAV was deemed to be a high priority area of research in this program because of its high primary productivity, and because of its important multiple roles in the Chesapeake Bay ecosystem -- a food source for waterfowl, a habitat and nursery area for many species of commercially important fish and invertebrates, a shoreline erosion control mechanism, and a nutrient buffer. Most importantly, research was focused on SAV because of the dramatic, Bay-wide decline of these species in the late 1960's and 1970's. The initial emphasis of this study was an investigation of the changes in SAV distribution and abundance between 1978 and 1981.

Numerous aspects of the functional ecology of these complex systems are still poorly understood. One such area involves the relationship between epiphytic fouling by both macroalgae and periphyton (community of diatoms, microfauna, and particulate material) adhering to seagrass blades and the grazing organisms which rely on these epiphytes as important food sources. This relationship is the subject of a literature review contained in this report.

The eelgrass *(Zostera marina L.)* epifaunal community in Chesapeake Bay is a diverse assemblage of species from numerous taxonomic groups. One numerically dominant herbivorous gastropod, *Bittium varium* Pfeiffer (Cerithiidae), is investigated in the present study. *B. varium* may be an important consumer. Its grazing action may have important implications for the distribution of eelgrass, especially for those plants living in habitats where light levels reaching the plant surface may be only marginally adequate for photosynthetic maintenance.

The productivity of both macro- and micro-epiphytes of seagrasses is enhanced by nutrient enrichment, and the resulting epiphytic proliferation can be a factor in the demise of seagrass beds. Grazers of periphyton can substantially reduce the biomass of micro-epiphytes, thereby possibly mediating the effects of nutrient enrichment on periphyton proliferation. In the absence of grazers, periphyton may have the potential to rapidly overgrow and shade the host plant, thus reducing photosynthetic activity.

In Chesapeake Bay, *Bittium varium* has been shown to significantly reduce the biomass of periphyton associated with *Z. marina* under laboratory conditions. The presence of periphyton grazers can indirectly affect the vigor of the host plant by preventing periphyton proliferation to potentially harmful levels. The final objective of this project was to examine how the growth of *Zostera marina* was affected by the presence or absence of *Bittium varium* in laboratory experiments.

Procedure/Methodology

From aerial photographs taken in 1980 and 1981, beds of submerged aquatic vegetation in the lower Chesapeake Bay were mapped onto U.S. topographic quadrangles (1:24,000 scale). To insure maximum delineation of the SAV beds and to obtain comparable data, the 1980-1981 aerial photography was conducted using similar techniques and film and under the same constraints observed in the acquisition of the 1978 photographs of the same Bay area. Only those topographic quadrangles in the polyhaline and mesohaline areas of the lower Bay were monitored in 1980 and 1981, resulting in the mapping of 27 quadrangles. These maps were compared with those obtained in the in the 1978 survey.

Field-collected specimens of *Bittium varium* were used in laboratory studies of its salinity tolerances. Tolerances of laboratory-reared larvae were also investigated. Effects of rapid salinity reduction for short periods and gradual salinity reduction on adult and larval survival and activity were tested.

To study the effects of grazing on eelgrass vigor, plants of *Zostera marina* were grown in large tanks filled with continuously-pumped York River water. Three degrees of shading, in the presence or absence of of *Bittium varium,* were applied and the resultant plant growth determined. Plant growth was ascertained through leaf area measurements and dry weight determinations. Growth of epibiota was also assessed by determination of dry weight and ash-free dry weight.

Results/Conclusions

From 1978 to 1980, reductions of SAV occurred in all sections of the lower Bay except the lower western shoreline. Almost no vegetation was found in the Rappahannock River section in 1980, and only a slight increase occurred in 1981. SAV in the James River in 1978, which existed in a narrow band between Ft. Eustis and Newport News Point, was completely absent by 1980.

The predominant SAV beds in 1980 and 1981 were still found in those major areas identified in 1978: (1) along the western shore of the lower Bay between Back River and York River; (2) along the shoreline of the Mobjack Bay and immediately adjacent to the Guinea Marshes at the mouth of the York River; (3) the shoal area between Tangier and Smith Island (this represented the largest and most extensive SAV bed in the entire Bay); and (4) behind large protective sandbars near Hungar's Creek and Cherrystone Creek along the Bay's eastern shoreline.

Comparison of the 1980 and 1981 data at the six historical SAV sites mapped in 1978 showed no recovery of any SAV at the Parrott Island (Rappahannock River) and Mumfort Island (York River) site. These two sites remained devoid of any SAV. SAV at the Fleets Bay (lower western Chesapeake Bay) site continued to decline from 1978 to 1980 but showed a slight rebound in 1981. At Vaucluse Shores, as well as in the the rest of the eastern shore, SAV beds remained relatively stable during this time period. SAV at the East River (Mobjack Bay) site declined both in 1980 and 1981. Four complete surveys showed the decline of SAV to have occurred primarily in the deeper, offshore areas rather than the inshore, shallower locations. This pattern was repeated in many other locations in the lower Bay region. Although total SAV area showed a slight decline in 1980 and 1981 at the Jenkins Neck (York River) site, recruitment by eelgrass seedlings was observed in the vicinity of Allens Island in both years, primarily in the more inshore, shallower areas. These seedlings grew vigorously and resulted in numerous patches measuring up to one m^2. This pattern was also observed along the York River shoreline from Allens Island to Sarah's Creek.

In tests of *Bittium varium* salinity tolerance, nearly 100 percent of adult snails, subjected to a rapid drop from 22.4 ppt to 10.8 ppt for 72 hours survived, while less than one percent survived when subjected to a drop from 22.4 ppt to 6.7 ppt for 72 hours. Greatest mortality (97.6 percent) at the lower salinity was seen within 24 hours. Snails subjected to a gradual drop in salinity (from 21.9 ppt to 3.4 ppt over 456 hours) did not exhibit significant mortality or change in activity. Activity did decrease after the first 25 hours spent at 3.4 ppt.

No larvae subjected to rapid salinity decrease from 22.3 to 11.1 metamorphased. However, larvae subjected to a drop in salinity from 22.3 ppt to 16.3 ppt after 24 hours, metamorphased, as did larvae kept at 22.3 ppt. No larvae subjected to a drop from 16.3 ppt to 11.1 ppt after 24 hours metamorphased. Larvae kept at 16.3 ppt and 22.3 ppt survived for about eighteen days.

In the study of effects of interacting factors on plant vigor, the three shading conditions used represented a 43, 58, 69 percent decrease in available light. There were no significant differences in numbers of shoots, leaf weight, or leaf area index among the three shading conditions. However, within a shading level, treatments with *Bittium varium* showed significantly higher values for each variable than did tanks containing no snails.

With respect to periphyton and periphyton ash-free dry weights, treatments lacking *Bittium varium* resulted in significantly higher weight than treatments in the presence of the snail.

In the presence of high shade with *Bittium varium*, chlorophyll *a* levels were significantly lower than with other treatments, all of which were statistically similar. Phaeophytin *a* level increases with increased shading; the presence of *Bittium varium* results in lower phaeophytin *a* concentrations at each shading level.

Recommendations

Since 1978, there have been some overall decreases in the area vegetated with SAV in the lower section of the Bay; this may be simply a function of year-to-year variations and does not mark a significant continued decline of the resource. Continued annual mapping will permit better definition of this variation. An annual monitoring program for SAV using aerial photography is strongly recommended.

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The complete report, entitled "Submerged Aquatic Vegetation: Distribution and Abundance in the Lower Chesapeake Bay and the Interactive Effects of Light, Epiphytes and Grazers," (Order No. PB 83-189 365; Cost: $14.50, subject to change) will be available only from:
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