Chapter 1

Program Overview and Contents

# FUNCTIONAL ECOLOGY OF SUBMERGED AQUATIC VEGETATION IN THE LOWER CHESAPEAKE BAY

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Draft Final Report

to

Mr. William A. Cook, Project Officer
Chesapeake Bay Program
U.S. Environmental Protection Agency
2083 West Street
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# PROGRAM OVERVIEW

## FUNCTIONAL ECOLOGY OF SUBMERGED AQUATIC VEGETATION IN THE LOWER CHESAPEAKE BAY

In July 1978, an interdisciplinary research team began an integrated study of the ecology of submerged aquatic vegetation communities in the lower Chesapeake Bay. The overall goals of the program were twofold: 1. to describe, both qualitatively and quantitatively, the principal components of these communities and 2. to investigate what were a priori considered the major environmental and biological interactions governing community structure and production of both ecologically and economically important species populations. These data were then used to determine the structure of and input to a computer simulation model of energy flow and transformations within the seagrass ecosystem.

As of 1978, few data existed on lower Bay seagrass communities and consequently, much of the initial efforts were devoted to descriptive studies. Many of these studies were completed by mid-1979. The research has evolved over the course of the program toward more experimental approaches involving both field and laboratory investigations designed principally to elucidate cause-effect relationships. Many of these studies have been recently completed and several are continuing. The reports that follow present the results of all investigations completed to date (December, 1980).

At the initiation of the program, the research team adopted an approach of both routine sampling and intensive studies in a single, unperturbed seagrass community in the lower Bay. We decided that concentration of the research effort in a single system would facilitate both coordination of the program and perhaps more importantly, create as complementary and comparative a data set, in both time and space, as possible.

The efforts over the past 30 months can be broadly subdivided by discipline and overall encompass investigations of:

1. Productivity, Nutrient Cycling and Community Metabolism (Wetzel, Webb and Penhale),
2. Interactions Involving Resident Consumers (Boesch and Orth),
3. Studies of Higher Level Consumers (Merriner), and,
4. Ecosystem Modeling (Wetzel).

Studies within these areas included both field and laboratory programs. Names in parantheses identify the responsible principal investigators.

The principal study site used during the research program is located at Vaucluse Shores in the lower Chesapeake Bay on the Eastern Shore of Virginia. The seagrass community in this area was chosen, because: 1. historically, the grass bed has been persistent and stable over many years, 2. the area is generally unperturbed by man-related activities, 3. the bed is large enough to simultaneously accomodate our various studies, and 4. the locale is remote, allowing long term studies to be planned and carried out. The only outside influences to the area are recreational fishing and commercial crabbing.

The seagrass bed at Vaucluse is roughly triangular in shape, covering a bottom area of approximately 140 hectares and is north-south oriented. Water depths in the vegetated zones range from mean low water (MLW) to greater than a meter deep adjacent to the western, sandbar boundary. Salinity is nominally 18-20 o/oo and temperatures range from near 0°C in late January-early February to 31+°C in July-August. The area shoals from south to north and some evidence suggests the shoal sandbar is slowly migrating south.

Vegetationally, the grass bed is co-dominated by Ruppia maritima L. (Widgeon grass) and Zostera marina L. (Eelgrass). Areal coverage is approximately divided equally between the two species. The transects illustrated in Fig. 1 (See Chapter 1; Section 1).

were established in July 1978 for mapping plant distribution and relative abundance and have been used throughout the program as sampling site references for the various studies (e.g. Orth et al., 1979). The distribution of the seagrasses at Vaucluse is typical of lower Bay seagrass communiites with Ruppia dominating the shallow, inshore regions and Zostera dominating the deeper, offshore areas. Five habitats were chosen for comparative studies; these include Ruppia, mixed Ruppia-Zostera vegetation, Zostera, bare substrate within the bed, and sand bar areas. The majority of studies within the program have been field-oriented and directed toward interhabitat comparisons.

Studies completed on the submerged aquatic plant communities have included;

1. Routine studies of plant distribution, relative abundance, biomass, CHN ratios, rooting-depth, canopy structure (leaf area index) analyses and substrate chemical properties.
2. Laboratory studies of $^{14}C$-photosynthesis in relation to light and temperature.
3. Dome enclosure studies of community metabolism, nutrient exchange, and community response to light reduction.

These studies were scheduled and carried out to include seasonal effects.

The results of these efforts have provided extensive data sets for correlative analyses of environmental parameters with plant growth, species distribution and metabolic activity. These data also allow for analysis of natural variability, and evaluation of plant community response to low-level, short term nutrient (primary nitrogen species) enrichment and the effects of in situ light reduction. Based on analyses of these data and the results of more recent experiments, lower Bay seagrasses appear highly poised by the environmental conditions of light and nutrient regimes. We have recently begun more detailed studies of light-plant community response and environmental

parameters governing the light-energy field in submerged aquatic communities. These data together with new studies on the analysis of long term (4 or more years) data sets should provide information which should allow us to separate long term trends in environmental conditions from natural variability.

Studies of the macroinvertebrate populations inhabiting various areas of the seagrass community and utilization of the area by waterfowl have included a variety of activities:

1. Studies of resident, benthic macroinvertebrates have involved routine sampling in the various habitats to describe community structure, seasonal behavior, and to identify principal components in terms of secondary production and trophic importance.
2. Secondary production estimates were derived for key components through intensive sampling in specific habitats to assess energy available to support production at higher levels.
3. Predator-prey interactions have been investigated in both laboratory and field enclosure studies to determine the role of the seagrasses as a refuge and the role of predation in structuring and potentially controlling infauna and epifauna in both bare substrate and vegetated areas.
4. Waterfowl studies were completed over two winter periods to determine waterfowl utilization of various areas within the grassbed.
5. Tissue samples of the major species have been analyzed for various chemical parameters including $^{13}C/^{12}C$ ratios to elucidate trophic relations and calorimetry and C:N ratios to provide specific conversion factors.

Structural and functional aspects of the ecology of the fish populations utilizing seagrasses have also been investigated by combined field sampling and laboratory studies and have generally followed the same design as that

in studies of the benthic macroinvertebrates. The overall goals have been to assess the importance of seagrasses to production and maintenance of both ecologically and economically important fish populations. Studies have been divided into three components of the populations: 1. fish eggs, larvae, postlarvae and juveniles, 2. resident fishes and 3. migratory predators. Initial efforts were also placed in gear comparison studies as adequate sampling methodologies in these shallow water areas for this highly motile group are extremely difficult.

Specific topics addressed in the studies of this component included;

1. Recruitment and emigration studies.
2. Trophic interactions and refuge value of seagrasses.
3. Secondary production by finfishes.
4. Bioenergetic studies.

The last topic addressed in our research program was the development of an ecosystem simulation model that would incorporate the principal biological components of the seagrass system and simulate energy flow based on trophic structure. Over the last 18 months the conceptual model has evolved through three versions. The effort in this area has primarily been devoted to establishing a realistic structure for simulation, formulation and evaluation of mathematical interaction equation, establishing remote hardware and software, and, establishing input data bases. Considered in this report are the first simulation analyses with the current input data sets. These activities represent what we consider the first stage of development and model analysis. Continuing model studies will incorporate the results of ongoing studies, explicit representation in the model for the forcing functions of light and temperature, and information flows relative to nutrient conditions.

These various investigations in the research program are presented as a coherent effort that provides basic information relative to the functional

ecology seagrass systems in the lower Bay and makes available information relative to the development of both general and specific criteria for management of these important habitats. It is perhaps worth noting that we view the completion of the present program as a first step toward the eventual goals of management. The conclusions of the present studies as well as the data bases themselves will require study and review as new information is made available.

Richard L. Wetzel, Ph.D.
Program Manager

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