CHAPTER I

Introduction

Underwater grasses, or submerged aquatic vegetation (SAV), represent a conspicuous and important component of shallow estuarine and coastal environments worldwide, because SAV species are keystone species in these ecosystems. Their many roles include providing habitat for juvenile and adult fish and shellfish and protecting them from predators; providing food for waterfowl, fish and mammals; absorbing wave energy and nutrients and producing oxygen; improving water clarity and settling out sediment suspended in the water; and stabilizing bottom sediments. The rich estuarine habitats created by SAV support growth of diverse populations of living estuarine and marine resources.

Health and survival of these plant communities in Chesapeake Bay and other coastal waters depend on maintaining environmental conditions that effectively define the suitable habitat for SAV growth. SAV establishment and continued growth depends principally on light availability but also on several other factors, including the availability of propagules; suitable water quality, salinity, temperature, water depth and tidal range; suitable sediment quality, wave action and current velocity; and low enough levels of physical disturbance and toxic substances.

Suitable SAV habitats were characterized previously for Chesapeake Bay and its tidal tributaries by relating observations of SAV presence or absence to measurements of five water quality variables (Batiuk *et al.* 1992, Dennison *et al.* 1993). This comparative technique was used to define critical levels for dissolved inorganic nitrogen and phosphorus, water column light attenuation coefficient, chlorophyll *a* and total suspended solids. Growing season median values of these water quality parameters were compared at sites classified according to the degree of SAV growth nearby. Habitat requirements for each parameter were chosen that were near the highest (worst) median values found at sites that had SAV growth in each of four salinity regimes. Where growing season median water quality values were lower (better) than these medians, the habitat requirements were met and SAV growth should be possible (although SAV could still be absent from a site with good water quality due to lack of propagules, high wave energy or other causes).

While these five water quality variables relate to many aspects of SAV physiology, their influence on the plant's light climate appears to be of primary importance in determining whether SAV can grow at a site. Attainment of these SAV habitat requirements was used to predict SAV presence or absence at specific sites in Chesapeake Bay and its tidal tributaries (Batiuk *et al.* 1992, Dennison *et al.* 1993) . These predictions were accurate in a majority of cases but several problems remained, especially that of deciding how many of the four or five requirements had to be met to permit SAV growth; how to account for the primacy of the light requirements; and how to explain why some areas had SAV but consistently failed many of the SAV habitat requirements.

In the 10 years since work was first initiated on the first SAV technical synthesis, there have been renewed investments in more focused research, expanded monitoring and ecosystem modeling, prompted, in part, by gaps in understanding that were brought to light after synthesizing the vast quantities of information available through the late 1980s. Prompted by the accumulation of these new data and by insights and advances in ecosystem processes modeling, and driven by management needs for the next generation of habitat requirements, a team of scientists and managers assembled to produce this second technical synthesis.

TECHNICAL SYNTHESIS OBJECTIVES, CONTENT AND STRUCTURE

Synthesis Objectives

The *SAV Technical Synthesis II* has seven major objectives:

1. to establish scientifically defensible minimum light requirements for Chesapeake Bay SAV species;

2. to develop a set of models for determining light availability through the water column and at the leaf surface under a variety of water quality conditions and at varying restoration depths;

3. to provide the management and scientific communities with a set of diagnostic tools necessary to better interpret not only the relative degree of achievement of the light requirements, but also to understand the relative contributions of different water quality parameters to overall light attenuation;

4. to recognize and quantify the many other physical, geochemical and chemical habitat requirements, pointing out the need for further research where the data necessary to develop specific requirements are lacking;

5. to document refinements to the Chesapeake Bay Program's tiered distribution restoration goals and targets;

6. to provide an in-depth assessment of the applicability of midchannel monitoring data for evaluating the water quality in adjacent shallow-water habitats; and

7. to produce a concise list of research needs required to improve our ability to define a holistic picture of habitat quality suitability for SAV.

Synthesis Content and Structure

Interactions among SAV, water quality and physical habitat, which are quantified in the rest of the technical synthesis, are laid out within their respective contexts (Chapter II). Water column-based light requirements for SAV survival and growth are determined through an extensive review of the literature and an evaluation of experimental results from research and monitoring conducted in Chesapeake Bay (Chapter III). The scientific basis for developing diagnostic tools for defining water quality necessary to meet water-column conditions supporting restoration and protection of SAV are documented. This is followed by an illustration of the management applications of the diagnostic tools (Chapter IV). A model is described for calculating light at the leaf surface of plants at given restoration depths under specific water quality conditions (Chapter V). Physical, geological and chemical factors affecting the suitability of a site for SAV survival and growth are discussed with specific quantitative requirements established where supported by scientific data (Chapter VI). Two types of SAV light requirements are defined, along with explanations of how to test their attainment (using two new percent-light parameters calculated from water quality data) and how to account for tidal range. The relationships are tested among the percent-light parameters, SAV area and the average depth at which SAV is growing in Chesapeake Bay (Chapter VII). Refinements to and expansions of the original tiered restoration goals and targets are then documented (Chapter VIII). An expanded, in-depth analysis of midchannel and nearshore water quality measurements is laid out, along with recommendations for site-specific application of midchannel data in characterizing nearshore habitats (Chapter IX). Drawn from the preceding chapters, the technical synthesis concludes with a detailed list of follow-up monitoring and research needed to provide the basis for further quantification of a more expanded set of SAV habitat requirements (Chapter X). The appendices include copies of more extensive tables and methodological documentation referred to within the technical synthesis.