Global Change and Submerged Aquatic Vegetation Research

Communities of submerged aquatic vegetation (SAV) are important components of many freshwater, brackish, and marine aquatic ecosystems. They prevent erosion by baffling the impacts of waves, especially from storms. These aquatic plant communities remove nutrients and other pollutants from river and runoff inputs to coastal areas, preventing their entry into surrounding waters. They provide nursery habitat for fish, shrimp, and other species, as well as forage for wintering waterfowl and endangered species such as sea turtles and manatees. Unfortunately, not only have the distribution and abundance of seagrasses in the northern Gulf of Mexico declined precipitously during the past 50 years, most notably from widespread deterioration of water quality, but submerged aquatic plant communities are also susceptible to long-term environmental changes that are predicted to accompany global climate change.

The direct effect of temperature on plant physiology may ultimately influence community composition and latitudinal species occurrence. Increases in the concentration of dissolved inorganic carbon, including both carbon dioxide and bicarbonate, may affect submerged plants directly and may have indirect effects by increasing the growth of attached and suspended algae.

Global sea level has risen between 10 and 25 cm over the past 100 years. The Intergovernmental Panel on Climate Change (IPCC, 1995) expects that average sea level will continued to increase as a result of thermal expansion and melting of glaciers and ice sheets. Models using the IPCC's "best estimate" values of climate sensitivity and ice melt suggest an increase in sea level of about 50 cm from the present to 2100. Continued rise in sea level will increase the depth of coastal waters and will cause inland and upstream salinity intrusion, both of which will affect submerged vegetation. While there is uncertainty regarding the influence of global warming on the frequency and intensity of storm events, sea-level rise alone has the potential for increasing the severity of storm surge, particularly in areas where coastal habitats and barrier shorelines are rapidly deteriorating.

Research has begun to yield information on the responses of submerged aquatic vegetation communities to some of the environmental consequences expected to accompany global change.

Seagrass Disturbance

Overwashes from storms frequently deposit sandy sediments in seagrass beds growing leeward or behind protective barrier islands, such as the Chandeleur Islands of Louisiana (Fig. 1). In Chandeleur Sound, turtlegrass (*Thalassia testudinum*) inhabits nutrient-rich protected areas, while manatee grass (*Syringodium filiforme*) dominates sandy areas subject to frequent overwash. Increased storm disturbances and overwash will alter the community composition of gulf seagrass beds by promoting increases in the abundance of manatee grass. Since different species of seagrass support different food webs, changes in the community composition of seagrasses will be propagated into changes at higher levels in the food chain.

Frequent severe overwash and barrier island erosion may even lead to total loss of all seagrasses from an area.

Fig. 1. Storm overwash fan deposited on a seagrass bed in the Chandeleur Islands, Louisiana.

Effects on Plant Photosynthesis

As atmospheric carbon dioxide increases with global change, concentrations of dissolved carbon dioxide and bicarbonate are expected to increase in aquatic ecosystems. The photosynthetic responses of some submerged aquatic vegetation species to additions of carbon dioxide were measured in the laboratory.

Photosynthetic capacity increased by as much as two to eight times ambient levels during certain times of the year in three freshwater species—wild-celery (*Vallisneria americana*), coontail (*Ceratophyllum demersum*), and hydrilla (*Hydrilla verticillata*)—and in a seagrass species, shoalgrass (*Halodule wrightii*). Only widgeon grass (*Ruppia maritima*) from an area rich in dissolved carbon did not respond to additions of carbon dioxide. Alteration of photosynthesis can lead to changes in plant growth, which may disrupt species dependent on these aquatic plants by altering plant biomass and seasonal timing of biomass availability.

Elevated Carbon Dioxide and Growth of Submerged Vegetation

Freshwater wild-celery and shoalgrass were grown for 6 weeks in mesocosms (Fig. 2) receiving four times the atmospheric concentration of carbon dioxide. While biomass did not increase in either species, other effects were found. Biomass of epiphytes (plants depending on another plant for mechanical support) on shoalgrass increased significantly. Excess epiphytic growth has been shown to reduce light to plants so much that the host plant cannot survive. Both species produced more root and rhizome biomass relative to leaf biomass. This change in biomass production suggests that climate change would favor grazing organisms that preferentially consume below-ground tissue. Leaf tissues of wild-celery had higher ratios of carbon to nitrogen than plants grown under normal carbon dioxide concentrations. High carbon-to-nitrogen ratios tend to provide poorer quality forage for consumer organisms such as wintering waterfowl.

Fig. 2. Wild-celery and shoalgrass mesocosms receiving enhanced atmospheric concentrations of carbon dioxide.

Table. Potential changes in community composition of various species of submerged aquatic vegetation as a result of increased salinity. Given this assemblage of species, those species marked with an asterisk are expected to dominate the community.

A. Potential community composition determined from maximum salinity tolerances of individual species. An X indicates species presence at the given salinity.

	Salinity ‰			
	0	4	8	16
Hydrilla	X	X		
Grassleaf mud-plantain	X	X	X	
Milfoil	X	X	X	X
Wild-celery	X	X	X	X
Sago pondweed	X	X	X	X
Widgeon grass	X	X	X	X

B. Predicted community structure based on salinity tolerance and competitive performance.

	Salinity ‰			
	0	4	8	16
Hydrilla	*	X		
Grassleaf mud-plantain	*	*	X	
Milfoil	*	*	X	X
Wild-celery	X	*	X	X
Sago pondweed	X	X	*	*
Widgeon grass	X	X	*	*

Effects of Increased Salinity

As sea level rises, many communities of fresh and brackish submerged aquatic vegetation will experience salinity increases. In some cases, an inland migration of communities might be possible, but in other cases salinity stress will change the community composition. Where salinities increase from freshwater to oligohaline (0.5-5.0 parts per thousand), community composition will be dominated by species which are strong competitors for light, nutrients, and other factors. Two nuisance exotic species, milfoil (*Myriophyllum spicatum*) and hydrilla, often outcompete other species at low salinities (Table). Increased hydrilla can lower water quality and oxygen concentrations, possibly causing fish kills. Under mesohaline (5-18 parts per thousand salinity) conditions, community structure will be strongly governed by the salinity tolerances of the species. Salt-tolerant species such as wild-celery, widgeon grass, and sago pondweed (*Potamogeton pectinatus*) are predicted to dominate submerged aquatic vegetation communities at higher salinities. Salinity-induced changes in community composition will induce changes in animal communities adapted to specific plant associations.

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