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Importance of Eelgrass Beds in Puget Sound

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Seagrasses, grass-like flowering plants in marine environments (Fig. 1), inhabit intertidal and comparatively shallow subtidal regions of estuaries and the nearshore coastal zone, and support rather characteristic animal assemblages regardless of the particular geographic location or species composition. There are few parts of the world's coastal zone where one or more of the 48 species of seagrasses have not adapted. Seagrasses are one of the most common coastal ecosystem types, and generally are quite conspicuous for they tend to form extensive submerged meadows or beds on bottoms ranging from coarse sand to almost liquid mud.

Eelgrass, *Zostera marina,* which occurs extensively in Puget Sound, is a generally temperate (cool water) seagrass which has a very extensive geographic range. About 9 percent or over 125,000 acres of the bottom of Puget Sound is covered by eelgrass. On the Pacific coast this seagrass extends from Alaska to Mexico and on the Atlantic coast from Greenland to North Carolina. This grass also is present along the coasts of the British Isles, Europe, and Asia. The importance of eelgrass and seagrasses in general is not fully understood, and this knowledge is essential because their shallow water and intertidal existence often results in a conflict between their success and man's use of the coastal environment.

Figure 1.—Underwater photograph of an eelgrass meadow in Puget Sound. Photo by R. C. Phillips.

Documentation now exists which shows that seagrass meadows are not only important locally but also on a much larger scale. Phillips (1975) has summarized many of these findings. Examples include their use as nursery grounds for commercial shrimp in Florida; as a food source for migratory waterfowl, particularly the black brant, along the Pacific flyway, milkfish throughout the Indo-West Pacific, and green sea turtles in the Caribbean; as a habitat for the larval development and growth of commercial bay scallops along the Atlantic coast of the United States and fishes along all coasts where the grass is present; and as a buffer from hurricanes on the Florida coast.

In addition, Thayer et al. (1975) summarized examples of the impact of seagrass destruction on animals. For example, at Cape Ann, Mass., there was a severe decline in softshell and razor clams, lobsters, and mud crabs following the decline of eelgrass in the 1930's. However, declines in fisheries in the North Atlantic were not as drastic as had been predicted following the eelgrass catastrophy of the same period.

These observations and research efforts, primarily since the late 1960's, have shown that the importance of eelgrass systems does not necessarily lie in their direct food value to organisms but in their multifaceted functions. These functions are both obvious and subtle. Two of the obvious are that they provide a habitat for the growth of both

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commercial and noncommercial, but ecologically important, fish and invertebrates, and that because of their normally dense growth, seagrasses also provide small organisms a significant degree of protection from predators.

Less obvious but nevertheless equally significant are the facts that: 1) eelgrass leaves have a high rate of growth and although few organisms feed directly on the leaves, the major food chains are based on detritus (dead material) derived from the leaves; 2) detritus exported from these grass meadows may support food chains in adjacent waters; 3) the blades support many small epiphytic (biota growing on plants) organisms which are used as food sources by many invertebrates and fish; 4) the roots bind the sediments protecting the bottom from erosion, while the leaves slow currents and increase the rate of deposition of fine sediments and organic matter; and 5) the plant roots remove nutrients, e.g. nitrogen and phosphorus, from the substrate and transfer them to the leaves and then to the surrounding water, thus providing nutrients for other plants (McRoy and Barsdate, 1970; McRoy and Goering, 1974). Eelgrass also has been used as fodder, fuel, fertilizer, and insulation.

The animals inhabiting and using eelgrass beds in Puget Sound are not well documented, although some descriptions are available in Phillips (1972) and Kozloff (1973). There are, however, general relations existing between eelgrass meadows and their invertebrate and vertebrate fauna on the Pacific and Atlantic coasts of the United States and elsewhere that can be applied to the eelgrass communities of Puget Sound. In addition, invertebrate classes at Seattle Pacific University and the University of Washington and R. C. Phillips have made collections of organisms in Puget Sound eelgrass beds. The Washington State Department of Fisheries and the Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, Wash., also have information available on commercial and sport fishery organisms in Puget Sound. Where possible, we will use species from these collections and records (Tables 1 and 2) in describing the relationships existing between the plant and its fauna in Puget Sound.

Table 1.—Partial list of invertebrates commonly collected in eelgrass beds in Puget Sound.

Taxonomic group	Representative genera	Common name	Comment on habitat
Porifera		Sponges	
	Haliclona		Both generally on substrate
	Lissondendoryx		
Coelenterata		Polyps	
	Epiactis	Anemone	On blades
	Haliclystus	Stalked jelly-fish	On blades
	Gonionemus	Jellyfish	On blades in deep water
Platyhelminthes		Flatworms	
	Freemania		On blades
Nemertea		Ribbon worms	
	Micrura		On blades and inside spathes
	Carinella		
Annelida		Segmented worms	
	Glycera	Beak thrower	Substrate
	Nereis	Nereid worm	Near base of blades and around roots
	Thelepus	Terebellid worm	Substrate
Arthropoda		Jointed animals	
	Ampelisca	Amphipod	On blades
	Amphithoe	Amphipod	On blades
	Idotea	Isopod	On blades
	Pandalus	Coon-stripe shrimp	On and around blades
	Crangon	Snapping shrimp	Around roots
	Pagettia	Spider crab	On substrate
	Cancer	Dungeness and red crabs	On substrate
	Pagurus	Hermit crab	On substrate
Pelecypoda		Bivalves	
	Pecten	Scallop	On and in substrate but small forms often on blades
	Clinocardium	Cockle	
	Macoma	White sand and bent nose *Macoma*	
	Panope	Geoduck	On and in substrate
	Mya	Soft-shell or steamer clam	
Gastropoda		Snails and slugs	
	Littorina	Periwinkle	All are found on blades as well as on and in the substrate
	Haminaea	Bubble shell	
	Lacuna	Variegated *Lacuna*	
	Hermissenda	Sea slug	
	Anisodoris	Sea slug	
	Acmaea	Limpet	On blades
Echinodermata		Sea stars, brittle stars, sea urchins, sea lilies, sea cucumbers	
	Leptoasterias	Starfish	All are found on the substrate but small forms often on blades
	Solaster	Sun star	
	Strongylocentrotus	Sea urchin	
	Dendraster	Sand dollar	
	Cucumaria	Sea cucumber	On substrate
Bryozoa		Moss animals	
	Membranipora		On blades

Table 2.—Organisms found in or utilizing eelgrass beds in Puget Sound which are of commercial or recreational importance.

Crustaceans	Fishes
Coon-stripe shrimp	Pacific herring
Broken-back shrimp	English sole
Dungeness crab	Striped seaperch
	Coho salmon (fingerlings)
Mollusks	
Geoduck clam	
Soft-shell steamer clam	Birds
Washington butter clam	Black brant

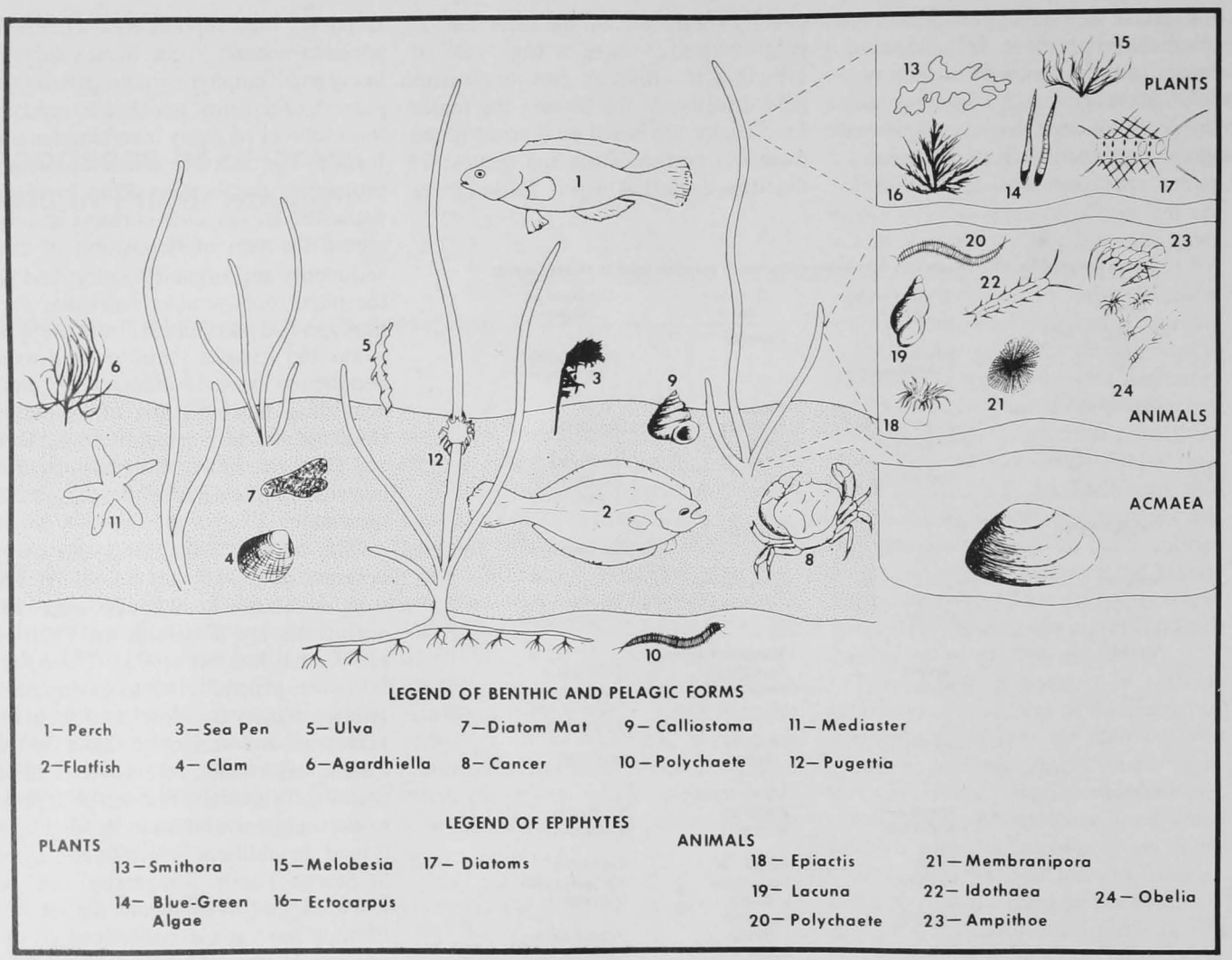

Figure 2.—Diagram of an eelgrass community showing some of the more conspicuous associated organisms in Puget Sound.

Although the specific organisms associated with eelgrass meadows vary from geographic area to geographic area and, indeed, even within a local seagrass system, the fundamental structure of animal communities of eelgrass beds is similar. There also is a striking similarity in the taxonomic structure of these communities. Characteristic organisms or types are found on the blades of the plants, around the bases of the plants, and around the roots (Fig. 2). In addition, numerous larger algae are found attached to the eelgrass blades and floating free within the beds. These algae increase the surface area and available hiding places so that more animals can be supported. In fact, the scientific literature indicates that the number of species and the abundance of organisms generally are greater than those of adjacent areas devoid of eelgrass.

The great variety of organisms and the richness of the animal populations in part are a response to the presence of a variety of habitats and food sources within the grass meadows. The animal associations of eelgrass beds in Puget Sound and throughout the world generally can be considered as having several major vertical layers or strata of organization: animals living on the blades and stems, those swimming among the plants, and those living on and in the bottom.

Those organisms living on the blades may have a close correlation with the bed and may not be found, or are found in significantly smaller numbers in regions devoid of the grass. Some of the animals living on or in the bottom, on the other hand, may be a part of the benthic community of adjacent bare substrates. Of the mobile, swimming organisms, some may be members of the grass bed, some are only seasonal migrants into the bed, and still others use the beds for food and protection, moving into the areas at high tide and at night. Representatives of these categories in Puget Sound are listed in Table 1.

The first category, the fauna living

on the leaves and on and within the coating of diatoms, encrusting algae, and bacteria on the leaves, is very diverse. As a group, these animals derive their nutrition from microalgae, detritus (dead matter), and small animals. They in turn are fed upon by larger animals. This category, for ease of presentation, can be further subdivided into five groups.

1) Small organisms living in and on the epiphytic coating. This group is probably the most diverse and least known or understood component of seagrass beds. It is made up of herbivores (animals feeding on living plants), detritivores (animals feeding on detritus plus the microbes growing on the detritus), and carnivore members of the protozoans (ciliates, flagellates, and foraminiferans), free living nematodes (unsegmented worms), small polychaetes such as *Nereis,* and small crustaceans.

2) Sessile or attached fauna. In Puget Sound there are encrusting bryozoans such as *Membranipora* and attached bryozoans (Fig. 2), anemones (*Epiactis*), and attached jellyfish (*Haliclystus* and *Gonionemus*). These organisms generally feed on small crustaceans, larval fish, and detritus. Barnacles and different life history stages of larger animals often are found attached to the plant leaves. For example, the Pacific herring lays eggs on eelgrass leaves and young scallops, and other bivalves also are often attached to the leaves.

3) Organisms which move over the blades. The most noticeable members of this group in Puget Sound are listed in Table 1, and are represented by snails, polychaetes, ribbon worms, amphipods, isopods, and some echinoderms (starfish and urchins primarily).

4) Swimming animals able to rest on the leaves. Some species of shrimps, small crabs, and certain fish are common members of this group.

5) Animals attached to stems and roots. This subcategory is represented by tube-building polychaetes and amphipods.

The second major category, the mobile animals swimming among and under the leaves, is more easily recognizable because of their larger size. As mentioned earlier, these organisms may be permanent, seasonal, or only occasional residents of eelgrass beds. For the most part, the members of this category are carnivores, feeding on detritivores; they also may feed on detritus. Because they are carnivores, their seasonal and daily movements into and out of eelgrass beds may significantly influence the trophic (nutritional) structure of the beds. Representatives of this category in Puget Sound are the decapod crustaceans (shrimps and crabs) belonging to the genera *Pandalus, Pagettia, Cancer,* and *Pagurus* (Table 1), and numerous species of fish. For the fish, the eelgrass beds form significant nursery grounds and common forms generally are larval and juvenile stages although adults of some species are quite common.

Several of the commercially important fish harvested in Puget Sound (Table 2) are members of this category, and are found in, and are partially dependent upon, eelgrass during part of their life history development. The broken-back shrimp, *Heptacarpus,* and the coon-stripe shrimp, *Pandalus,* although found elsewhere within the Sound, are collected in significant numbers in the grass beds. The Dungeness crab, *Cancer magister,* generally taken by traps on sandy bottoms in relatively deep water, also can be found at low tide in sandy and muddy regions of the Sound where there is a good growth of eelgrass.

The most common commercial species dependent on the Sound's eelgrass beds are the Pacific herring, English sole, striped seaperch, and the silver salmon. These fishes not only feed in the grass meadows on epifauna and crustaceans, but also use the beds as nursery areas. The Pacific herring enters the eelgrass areas in winter and spring to spawn and its eggs become attached to the grass blades. It is a prime baitfish for salmon, and its roe is sold on the open markets. The English sole, the most important demersal fish in Puget Sound, and the striped seaperch are collected by commercial trawlers and by sport fishermen using spears and hook and line in or near grass beds. The fingerling stage of the silver salmon, an important commercial species in Puget Sound, feeds on the animals living on eelgrass blades.

The third category, those organisms living in and on the bottom, contains members of the sponges, polychaetes, crustaceans, mollusks, and echinoderms (Table 1). The majority of these organisms appear dependent on eelgrass detritus as a major food source although microalgae and small crustaceans may also be consumed. Members of this category are not necessarily endemic to eelgrass beds but usually are an extension of the benthic community of adjacent bare substrates. Commercially important organisms belonging to this category are the large geoduck clam, *Panope,* the steamer or soft-shell clam, *Mya,* and the Washington butter clam, *Saxidomus.*

Animals may overlap between these three major organizational categories, especially at different stages of their life cycles.

Although not normally considered members of the eelgrass community, several species of waterfowl feed extensively in the beds of Puget Sound. Most common are the black brant and scaup, both of which feed on the grass blades. It has been estimated that eelgrass constitutes about 80 percent of the winter food of the black brant. Cottam (1934), and McRoy (1966) calculated that black brant and Canada geese consume about 17 percent of the standing crop of eelgrass in Izembek Lagoon during summer and fall. When nearly all of the eelgrass disappeared along most of the U.S. coastline in the 1930's, the brant all but disappeared. Both the brant and the scaup are extensively hunted and thus, provide a significant source of revenue to the State of Washington.

The animal components of all of the strata are linked together by trophic (nutritional) relationships. These relationships plus the great variety of organisms and habitats within eelgrass beds result in a complex ecosystem which functions primarily through herbivore and detritivore food webs. The herbivore food chains generally are short, while the detrital chain normally

is long and complex. By far the predominant food pathways in these meadows are: eelgrass → detritus (plus attendant microbes) → detritivores, and eelgrass → detritus (plus attendant microbes) → detritivores → carnivores (e.g. some crabs, fish, birds, and man).

There are few organisms which feed directly on the living grass blades and, therefore, most of the plant materials produced within the bed falls to the substrate and is decomposed by bacteria. Most of the plant material is used by animals as partially decomposed matter, either suspended in the water or deposited in or on the bottom. Different stages of decomposition of the material may correspond to different detrital feeding organisms. For example, some urchins, crustaceans, and fish may feed on large plant pieces, while some mollusks and polychaetes may feed on fine plant detritus. In addition, detritus derived from the decomposition of eelgrass in Puget Sound is transported into the nongrassed areas of the Sound and into the coastal marine environment by waves and tides. Here it may form an important energy source for organisms inhabiting these areas.

Within the eelgrass meadow there are seasonal changes both in the grass itself and in the fauna associated with the system. Although eelgrass is a perennial plant, its abundance varies seasonally. In Puget Sound the density of eelgrass tends to increase in spring and summer and decrease in fall and winter. Data exist which indicate that as the grass increases in density during spring and summer, the blades of the plant become more highly colonized by microscopic plants and animals (Kozloff, 1973).

During this period there often is a conspicuous increase in animals which feed on the epiphytes or detritus on the grass blades. On the other hand, several studies indicate that detritivores and filter feeding animals tend to increase during the period of eelgrass decay. It also has been observed that minute flagellates often increase during the decay season, and that breeding season of several macroinvertebrate species coincides with this flagellate increase. The adults and their larvae feed on the flagellates and fine suspended matter.

Thus, the abundance and types of animals in seagrass meadows appear to be integrally linked with each other and with the abundance and stage of development or decay of the grass. The leaves support a myriad of organisms, many of which go unnoticed because they are (or nearly are) microscopic. These, in turn, support larger organisms of both ecological and commercial importance. The detritus produced within the meadows is transported to open waters of the Sound and nearshore coastal environment where it may provide an important energy source for open-water animals. Animals which feed in the beds and migrate elsewhere also link the beds to the open water environment for they excrete material which is used by microorganisms of these environments and they themselves may serve as food sources for larger animals inhabiting open waters.

Therefore, to fully appreciate the overall significance of eelgrass meadows in Puget Sound and elsewhere, the proportionate role that eelgrass plays in the energetic scheme of all estuarine and coastal productivity must be considered. The marine fishery and sport fishery organisms used by man ultimately depend on this productivity. Within the United States, the International Decade of Ocean Exploration of the National Science Foundation is funding a coordinated study of seagrass ecosystems. Both authors are members of this team, which has as one of its objectives the understanding of the role of seagrass ecosystems as natural resources of value to man, not just at the scientific level but also by individuals and organizations directly concerned with the management of our natural resources.

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