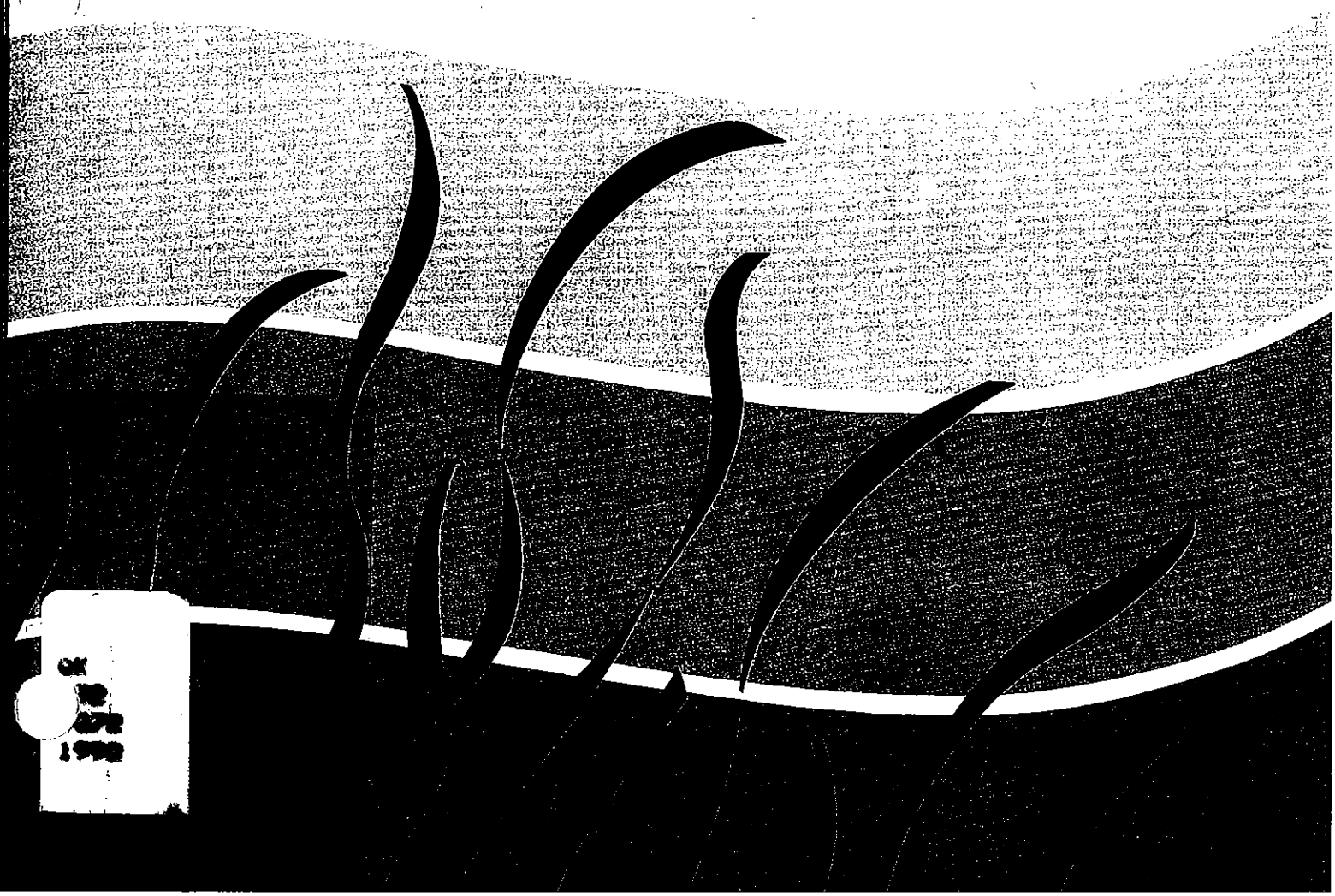
Padilla Bay
National Estuarine Research Reserve

Reprint Series No. 4
Reprinted October 1990

PLANT COMMUNITIES OF A SALT MARSH IN PADILLA BAY, WASHINGTON

Teri Granger and Mary Burg

1986



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Padilla Bay National Estuarine Research Reserve is managed by the Shorelands and Coastal Zone Management Program, Department of Ecology, State of Washington, in cooperation with the Marine and Estuarine Management Division, U.S. National Oceanic and Atmospheric Administration (NOAA). The preparation of this document was financially aided through a grant to the Washington State Department of Ecology with funds obtained from NOAA/Office of Ocean and Coastal Resource Management, and appropriated for Section 315 of the Coastal Zone Management Act of 1972, as amended.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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Bibliographic citation: Granger, Teri and Mary Burg. 1986. Plant communities of a salt marsh in Padilla Bay, Washington. Report to Washington Dept. Ecology, Padilla Bay National Estuarine Research Reserve by Washington Dept. Ecology, Shorelands & Coastal Zone Management Program, Wetlands Section. 14 pp. Olympia, Washington. Padilla Bay National Estuarine Research Reserve Reprint Series No. 4, 1990.

Wetlands Section
Shorelands and Coastal Zone Management Program

December 1986

INTRODUCTION

In 1980, ten thousand acres of Padilla Bay, located in northern Puget Sound, were designated as a National Estuarine Sanctuary and Research Reserve. One of 17 estuarine sanctuaries in the United States, it is unique due to its climate, diverse flora and fauna, and especially its extensive eelgrass beds which are some of the largest on the Pacific Coast. With the formation of the sanctuary, managed by the Washington State Department of Ecology, four primary objectives were identified:

- to gain a thorough understanding of ecological relationships within the estuarine environment;
- to collect baseline ecological measurements;
- to serve as a natural control for monitoring changes and assessing the impacts of human stresses on the estuarine ecosytem of Puget Sound;
- to provide a vehicle for increasing public knowledge and awareness of the complex nature of estuarine systems, their values and benefits to humans and nature, and the problems that confront them.

Various research projects are being conducted to understand the ecological relationships and establish baseline ecological measurements. These include:

- food web linkages of epibenthic crustaceans (Wissmar, et al. 1986);
- Dungeness crab habitat (Armstrong, et al. 1986);
- water quality baseline data log (Cassidy 1986);

- production rates of two seagrass systems (Nakatani and Thom 1986).

The purpose of this research project was to identify, describe, and map the extent and location of the plant communites on the salt marshes of Padilla Bay. Previous research on Padilla Bay's salt marsh ecology includes a study of net annual primary productivity (Lynn and Burg, 1985).

STUDY AREA

Location. The Padilla Bay estuary lies 80 km north of Seattle and is due east of Anacortes in Skagit County, Washington. Padilla Bay is connected with Samish Bay to the north and, via Swinomish Channel, to Skagit Bay to the south.

Padilla Bay Estuarine Sanctuary is composed of a number of distinct habitat types: open marine waters, subtidal sand and mud, eelgrass beds, intertidal mudflats, salt marshes, beaches, rocky shorelines, dredge spoil sites, nonforested and forested uplands. The salt marshes, which prior to diking extended inland, have been reduced to narrow bands scattered along the bay's perimeter and up the margins of tidal sloughs.

Climate. Padilla Bay is influenced climatically by the waters of Puget Sound and the Rosario Strait, resulting in a mild, maritime climate. The winters are cool and wet, the summers warm and dry. The average temperature ranges from

6.9° C in January to 22.4° C in July. Mean annual precipitation is 25.7 in (U.S. Department of Commerce and Washington State Department of Ecology 1980) only 50 per cent of the state average (U.S. Department of Commerce and Washington State Department of Ecology 1984). Seventy per cent of this precipitation falls between the months of November and April. The lower than average precipitation at Padilla Bay is due in part to its location in the rain shadow of the Olympic Mountain Range lying to the southwest.

Geology. The Puget Trough is a topographic depression formed during the uplift of the Cascade and Coast Range Mountains. The Sound and its north-south aligned bays, including Padilla Bay, were carved out by the successive advances and retreats of the continental glaciers. These glaciations, the last of which was the Vashon Glacier 14,000 years ago, also deposited large amounts of glacial debris. The soils of the bay are a combination of clays, silts, and sands formed by the action of wave energy on these alluvial deposits (U.S. Department of Commerce and Washington State Department of Ecology 1980).

Following the retreat of the Vashon Glacier, the Skagit River deposited a vast plain and delta where it flowed into Padilla Bay.[1] Salt marshes developed along the Swinomish

[1]The present-day Skagit River empties into Skagit Bay.

Slough to the south and connected Samish with Padilla Bay. In the last 3,000-5,000 years, these features have been significantly altered by erosional forces and human impact.

Description. Padilla Bay is a shallow, nearly flat bay distinguished by its extensive mudflats and eelgrass beds. The topographic gradient of the bay is slight, with an elevation change of only 1 foot per mile (U.S. Department of Commerce and Washington State Department of Ecology 1980). Water depths reach an average of 5 to 6 ft, and 60 per cent of the bay is exposed at low tide (U.S. Department of Commerce and Washington State Department of Ecology 1984).

Unlike Skagit Bay, which is a river-mouth estuary, Padilla Bay now receives most of its fresh water indirectly. The two major contributors are the Fraser River in Canada and the Skagit River in the United States. Water flows between Skagit and Padilla Bays via the Swinomish Channel and via Rosario Strait by way of Deception Pass. Smaller amounts of of fresh water from upland drainage enter Padilla Bay through Indian, Telegraph, and Joe Leary sloughs.

Remnants of a cedar post seawall extend to the north and south of Joe Leary Slough on the eastern shore of the bay. The seawall is evidence of some of the human activities which have altered Padilla's shorelines. Extensive diking and draining of the salt marshes in the late 1800s, in the eastern and especially the southern

sections of the bay, converted marshes to agricultural farmland. Only 700 acres of salt marsh remain today. By 1890, most of the adjacent upland had been logged, encouraging further settlement of the area (U.S. Department of Commerce and Washington State Department of Ecology 1984). More recent development of Padilla Bay has included the construction of oil refineries at March Point on Padilla's western shore.

Study Site. The study site is a 3.4-ha strip of salt marsh referred to as the Sullivan-Minor property. It is located landward of the cedar post seawall south of Joe Leary Slough. Having been diked and drained in the late nineteenth and early twentieth centuries, it has reverted back to salt marsh following the failure of the seawall. The marsh's northern and southern boundaries are formed by two vegetated dikes. A drainage ditch marks the eastern boundary and its interface with the upland. A second drainage ditch runs along the southern dike.

The study site is bounded on the west by a gravel and sand berm which slopes gradually down to the mudflats. The 2-m high berm is interrupted by the outlets of three drainages located in the northern half of the marsh. The primary channels flow parallel to the shoreline and extend from the eastern drainage ditch to the waters of the bay. In the southeastern section of the marsh, three salt pans have developed. Eelgrass and algae mats are occasionally

found obscuring the vegetation throughout the marsh, interrupting the otherwise continuous cover of low-growing grasses and forbs.

Driftlogs have accumulated in the northeast and southeast corners of the salt marsh. The northeast log dump has an areal extent of .56 ha. The log and mud substrate is sparsely vegetated with pioneer species. The southeast log dump is .14 ha in size and is completely covered by herbaceous growth.

Elevation change in the marsh is gradual. From berm to upland, the marsh has a somewhat concave configuration. In a north-south direction, the topograpghy undulates slightly, the highest elevation occurring in the southern portion.

The distribution of plant species is dependent upon elevation, inundation, and related factors such as salinity and substrate. The berm and upland are characterized by species less tolerant of inundation and saline conditions. Species on the berm include A. millefolium, Ambrosia chamissonis var. bipinnatisecta, Composite sp., Lepidium sp., and Elymus mollis. The upland species include Spirea douglasii, Pseudotsuga menziesii, Alnus rubra, Salix sp., Acer macrophyllum and Holodiscus sp.. The southern section is dominated by grasses and forbs. Freshwater hydrophytic species are found in the southeast corner and along the eastern border. The remainder of the salt marsh is typified by low-growing, salt-tolerant species.

METHODS

Vegetation analysis was conducted on August 13-15, 1986, at which time all species were flowering, with the exception of two grasses and Pacific silverweed (Potentilla pacifica). The study was confined to the salt marsh between the base of the berm and the upland. A quadrat sampling method was used consisting of 5 transects placed perpendicular to the maximum observable variation in vegetation and abiotic gradients. A total of 44 plots, 1 m^2 in size, were placed at 20-m intervals along the transects. Within the quadrats, species present and per cent areal cover were recorded. Each species was assigned to a cover class in one of the following ranges:

Class A	less than 1%	Class E	25% to 49%
B	1% to 4%	F	50% to 74%
C	5% to 9%	G	75% to 94%
D	10% to 24%	H	95% to 100%

Unequal-sized cover classes were used to avoid over-estimating extremes (Daubenmire 1968).

Raw data were analyzed by calculating frequencies and cover class mid-points (the species importance value) for each species in each quadrat. All quadrats were compared with one another and grouped, in an association table, according to their similarities. Groupings of similar quadrats represent distinct recognizable plant communities.

RESULTS AND DISCUSSION

Seven communities were identified in the study area. Six of these were identified using the data collected during vegetation sampling. An association table showing species, cover, and frequency is given in Table 1. The Carex lyngbei association was not sampled but was recognized in the field during reconnaissance and mapping.

The following is a brief description of the seven plant communities identified at the Padilla Bay study site.

1. The "Log Dump" community is located at the northern end of the marsh, at low elevation. This community is dominated by the presence of logs which have been transported by the tides and deposited in a stacked, tangled mass. Due to the logs' high cover value, causing extensive shading of the mud substrate and instability due to periodic shifting of logs, vegetative growth is restricted. Salicornia virginica, Cotula coronopifolia and Triglochin maritimum occur growing sparsely in the mud between logs. These three species are common in low salt marshes. Growing on the logs are various grasses such as Puccinellia lucida, Hordeum brachyantherum, and Hordeum jubatum. The logs near the upland serve as nurse logs for Pseudotsuga menziesei and Alnus rubra. Adjacent to the dike, accumulation of soil between the logs has increased the elevation and thereby decreased frequency of inundation. The species present are characteristic of higher elevation salt marshes. Typical salt marsh species such as Distichlis spicata, Atriplex

Table 1. Association table. Average c[illegible] (COV) and frequency (FRE) for each of the 18 species characterizing 6 plant communities on a Padilla Bay salt marsh.

DISP - Distichlis spicata, SAVI - Salicornia virginica, AGAL - Agrostis alba, ASTER - Aster sp., LOG - log dump, TYLA - Typha latifolia, PHAR - Phalaris arundinacea. + indicates less than one percent.

COMMUNITIES	DISP		SAVI		DISP-SAVI		AGAL-ASTER		LOG		TYLA-PHAR	
No. quadrats	5		15		16		4		3		1	
SPECIES	COV	FRE	COV	FRE	COV	FRE	COV	FRE	COV	FRE	COV	FRE
Distichlis spicata	95.4	100	7.4	80	60.4	100	21.8	25	20.6	33		
Salicornia virginica	8.8	100	90.6	100	60.4	93.7						
Atriplex patula	2.5	20	9.4	67	12.2	56			+	33		
Spergularia canadensis	+	40										
Cuscuta salina			+	13	+	6						
Lepidium sp.			+	6								
Agrostis alba							63.4	100	+	33		
Aster sp.							37.3	75	+	33		
Hordeum jubatum							+	25				
Composite sp.							+	25	+	33		
Achillea millefolium							+	25	+	33		
Grindelia integrifolia												
Puccinellia lucida												
Grass sp.												
Oenanthe sarmentosa											+	100
Phalaris arundinacea											97.5	100
Solanum dulcamara											7	100
Typha latifolia											17	100

patula, and Grindelia integrifolia occur with various grasses such as Agrostis alba, P. lucida, and one unidentified grass. Aster sp. and Achillea millefolium are also present.

2. The Carex lyngbyei community occurs along the eastern border in the northern third of the salt marsh. It consists of a pure stand of Lyngby's sedge. The major factor influencing the distribution of C. lyngbyei appears to be fresh water from upland runoff. This species also occurs sparsely in the northeast area of the log dump, near a culvert draining fresh water into the marsh.

3. The Typha latifolia - Phalaris arundinacea community is found in the southeast corner of the salt marsh. It is also located in an area influenced by fresh water from upland drainage. The association is co-dominated by T. latifolia and P. arundinacea growing between driftwood logs. At a distance, the tall growing T. latifolia appears to dominate. However the lower-growing P. arundinacea is able to compete successfully. Occurring beneath the P. arundinacea are unidentified low-growing grasses, Oenanthe sarmentosa, Galium sp., and Heracleum lanatum. Solanum dulcamara is found climbing on the P. arundinacea.

4. The Distichlis spicata community occurs in the transitional areas between the low and high marsh. It is

characterized by dense growth in almost pure stands. S. virginica appears as individual plants scattered throughout the D. spicata association. A. patula and Spergularia canadensis occur infrequently. D. spicata occurs in all associations in the marsh except in the C. lyngbyei and T. latifolia associations.

5. The Salicornia virginica community is found at low elevations and around salt pans. In this association, S. virginica grows as a thick, low-growing carpet of vegetation, except near salt pans where a thin cover is characteristic. A. patula and Distichlis spicata occur growing sparsely in the S. virginica meadows. The parasitic Cuscuta salina is occasionally found entwined around S. virginica and, less often, A. patula.

6. The Distichlis spicata - S. virginica community is found in the low to intermediate elevations on the marsh. D. spicata and S. virginica are co-dominant and evenly intermixed. A. patula, typically low-growing over most of the marsh and in this association as well, is tall and robust when it occurs adjacent to sloughs. This growth form was noted extending in bands 1 to 2 m from the banks of the sloughs. The taller growth form also occurs in areas where hummocks of stranded eelgrass have formed. Though initial reconnaissance suggested that A. patula would constitute a separate association, its distinctive visual appearance reflects a change in growth form within the community rather

than a change in community. T. maritimum and G. integrifolia are confined to scattered clumps adjacent to the sloughs and the east ditch. (G. integrifolia also occurs along the beach berm.) Cuscuta salina again was found parasitizing S. virginica and A. patula.

7. The Agrostis alba - Aster sp. community characterizes the high elevation, southern portion of the marsh. A. alba is the dominant. The Aster sp. appears to be invading a pure stand of A. alba from the south dike, obscuring the drift logs, and from the berm on the west. Hordeum jubatum and Rumex sp. are scattered sparsely throughout the A. alba meadow, the H. jubatum becoming more prominent near the ditch. Numerous clumps of a tall, unidentified grass also grow in the meadow. A high concentration of D. spicata occurs in the northern portion of the A. alba - Aster community. In proximity to the berm, upland species such as A. millefolium and a large yellow composite appear.

The plant communities identified at the study site appear to be distributed along abiotic gradients such as salinity and elevation-inundation. The lowest elevations are located mid-marsh, between berm and upland and where sloughs empty into the bay. Zonation of vegetation, including the D. spicata, S. virginica, and D. spicata - S. virginica associations, extends out from these sloughs and low spots. The ecotones between these associations are generally subtle.

The D. spicata-S. virginica community occupies the areas adjacent to the sloughs and is distinguished by the robust A. patula growth form. Deposition of eelgrass forming broad mats covers vegetation in these areas, inhibiting the growth of all species except A. patula.

The lowest elevations and salt pans distant from the sloughs are occupied by the S. virginica association. These areas probably have higher salinities due to a combination of prolonged inundation, distance from freshwater drainages, and, in the case of salt pans, evaporation. C. lyngbyei and T. latifolia occur in areas that are low in elevation and low in salinity due to freshwater dilution.

An amendment to this report will include a vegetation map showing the extent and location of the plant communities at the study site. Vegetation analysis of the remaining salt marshes of Padilla Bay and its sloughs would be an important addition to an understanding of the vegetation and habitats of the bay.

ACKNOWLEDGEMENTS

We wish to thank Brian Lynn for invaluable assistance in the field.

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