Padilla Bay
National Estuarine Research Reserve

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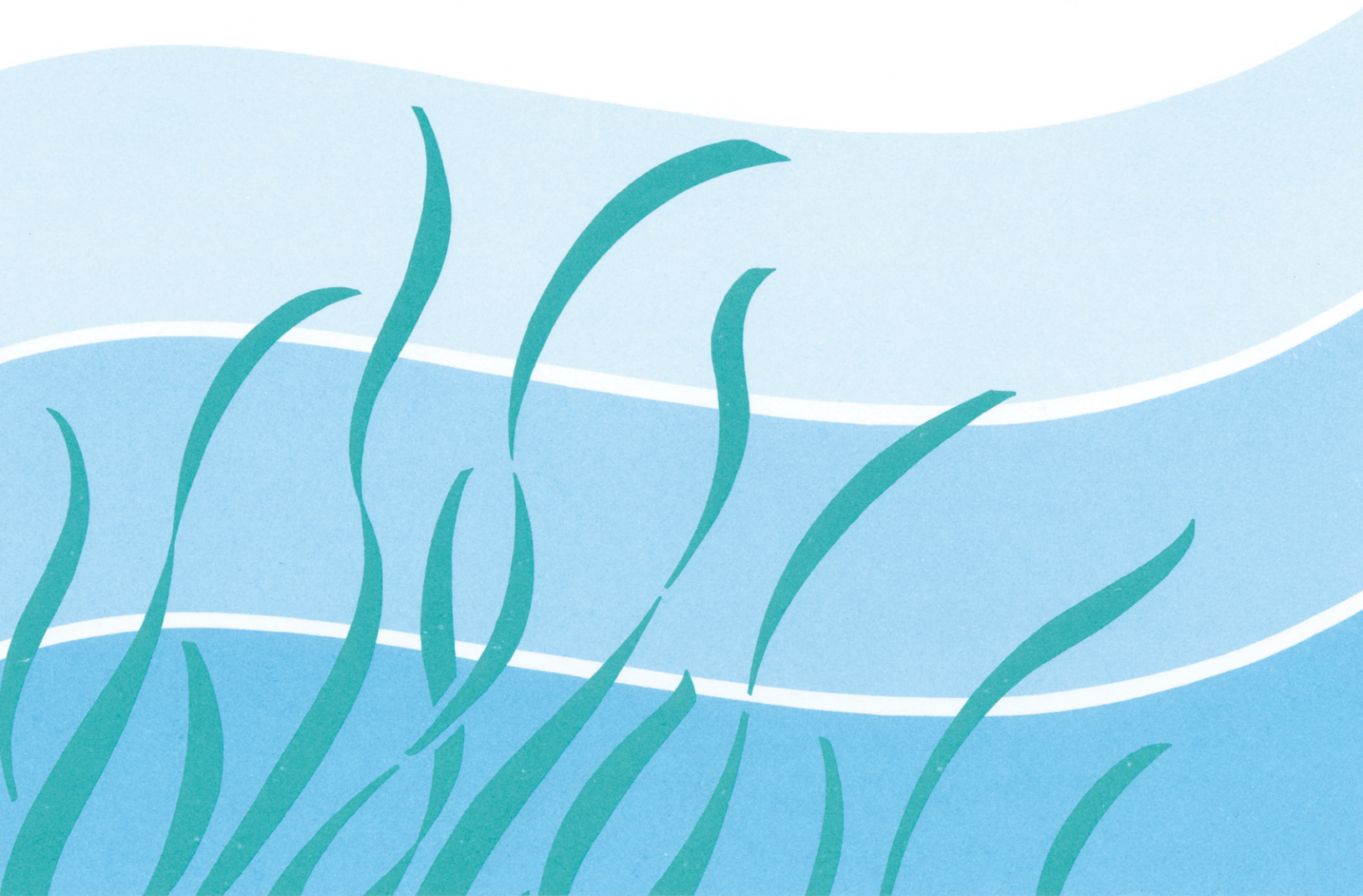
A BASELINE STUDY OF THE DISTRIBUTION OF *SPARTINA ALTERNIFLORA* IN PADILLA BAY

Jim Wiggins and Elizabeth Binney

1987



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A Baseline Study of the Distribution of *Spartina alterniflora* in Padilla Bay

Sponsored by the Padilla Bay National Estuarine Research Reserve

Jim Wiggins and Elizabeth Binney

11 June 1987

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INTRODUCTION

Spartina alternifora is the most widespread of the North American tidal marsh plants. The species forms dense, monospecific stands and dominates the intertidal zone along the Atlantic Coast from southern Canada to northern Florida and along the Gulf of Mexico from Florida to southern Texas. (Smart M.R. 1982). S. alterniflora grows in the lower salt marshes along the edges of tidal creeks, being inundated twice daily. It is an important contributor to the deposition of sediment and it introduces organic matter to the detrital system. Marine invertebrates utilize the detritus which in turn are fed upon by a variety of avain species (Versage 1987).

S. alterniflora was first introduced into Washington State in approximately 1910 at Willapa Bay presumably with an oyster culture (Garrett 1981). This species is also found on the southern end of Padilla Bay where it was introduced between 1941 and 1945 onto Dike Island by the Dike Island Gun Club to assist in the stabilization of the beach (Garrett 1981). Two hybrids of S. alterniflora (S. anglica and S. townsendii) are found in the Puget Sound region occupying areas in Port Susan Bay and in the Dosewalips delta. S. alterniflora is also found at Thorndyke Bay, Gibson Spit, and Kala Point. It was introduced in these locations to enhance duck habitat and in some areas as cow fodder (Frenkel and Kunze, 1984; Garrett, 1981).

It is the concerns of the Washington State Department of Game and the Department of Natural Resources that this species

is infringing upon the natural habitats of several avian species of birds which utilize these mud flats. There is also the possibility that S. alterniflora may invade mudflats which contain Zostera spp. (eelgrass) in the lower elevations and native flora at higher elevations. (i.e. Salicornia virginica, Triglochin maritimum and Distichlis spicata).

The Padilla Bay National Estuarine Research Reserve, located in northwestern Washington State near the town of Bay View in the Puget trough is one of 17 National Estuarine Research Reserves in the federal system. These reserves are designed to preserve a series of biologically and geologically unique estuaries for the purpose of research and education. Padilla Bay encompasses over 11,500 acres, with more than 10,300 acres of subtidal and intertidal mud flats. As part of the historic Skagit River delta, diked farmlands and wooded uplands border the 16 miles of surrounding shoreline. Present fresh water inflow is via several major agricultural drainage sloughs which follow old river channels through fields and across the tide flats. The predominant community in Padilla Bay is the sea grass meadow, made up of Zostera spp. This is one of the largest eelgrass expanses in the Pacific Northwest and the most important biological resource protected by the sanctuary (approximately 7,500 acres) (Webber 1987).

Salinity is relatively high and constant throughout the year (25-29 ppt), and fairly homogenous due to tidal mixing of the water with each tidal cycle. A channel network extends through the tidal flats at a considerable depth below surface grade (4 to 8 feet), with major courses retaining water during the lowest

tides. Tide flat sediments range from silts and clays to fine sands. The majority of the sediments were deposited by the Skagit River directly into the bay in the post-glaciation period prior to diking efforts in the late 1890's. Deposits of coarse sand are remnants of "sand islands" created by historic maintenance dredging of the Swinomish Channel in the southern portion of the reserve (Webber 1987).

Padilla Bay, because of its abundant food resource and relatively undisturbed condition, is a highly important estuarine habitat for waterfowl along the Pacific Coast. Some 80,000 diving and dabbling ducks are found in Padilla Bay and the vacinity, feeding on fish, shellfish, and tideland vegetation. Other sea birds, including loons, grebes, and gulls, are also common in the winter. Over 241 species of birds using the estuarine habitat and adjacent uplands have been identified in the Padilla Bay region. Most use the estuary seasonally, either during spring and fall migrations or during the nonreproductive winter period (Webber 1987).

Padilla Bay is of particular importance to the black brant (Branta nigricans) population of the Pacific Coast Flyway. Spring migration counts of nearly 50,000 brant have been recorded at Padilla Bay. The intertidal eelgrass meadows are the main feeding attraction for this species and play an important role in migratory movements. A wintering population of some 8,000 brant is currently found in Padilla Bay, a reduction from historic numbers that once approached 30,000 birds (Webber 1987).

Padilla Bay is a spawning and nursery area for herring and other bait fish, and a nursery for many species of flatfish such as sole and starry flounder. The bay is important to all juvenile salmon species as a migration route, and is of particular importance to chinook salmon as a rearing area. The mud flats and eelgrass meadows also serve as a nursery area for the commercially important dungeness crab. The muddy sediments are habitat for hardshell and softshell clams, which are important for a local recreational fishery. A resident population of harbor seals enjoy several haul-out areas in the south central bay, and pupping activity draws large numbers each year to the safety of the channel cut tideflats (Webber 1987).

The quantitative distribution of S. alterniflora in Padilla Bay was unknown and the need existed for a comprehensive inventory of the locations and extent of coverage of this species. A determination of its potential spread and areas of availability are of importance. The ultimate goal of our preliminary study of S. alterniflora in Padilla Bay was to provide baseline data to monitor S. alterniflora. To achieve this goal we were concerned with the following:

1. Identifying salt marsh areas and map the S. alterniflora distribution in Padilla Bay.
2. Estimating the area dominated by S. alterniflora.
3. Verifying the S. alterniflora species present and provide taxonomic descriptions.
4. Designating permanent plots to monitor the invasion rate of S. alterniflora.
5. Running three transects along Dike Island.

6. Preparing a discussion of the results.

7. Making recommendations for future research.

METHODS

In order to locate all S. alterniflora stands we walked the shoreline of all known salt marsh areas. Much of Padilla Bay is surrounded by a dike eliminating most high elevation salt marshes, we therefore concentrated our efforts on Samish Island (1), Joe Leary slough (2), the Log Jam (3), and all of the southern end from the town of Bay View to the Swinomish Channel (4) (Fig. 1). During these walks we concentrated our efforts at the high tide line where the mud ends and the flora begins. Those plants predominately being Salicornia and Distichlis. We located seven major stands of S. alterniflora all south and east of Dike Island (Fig.2) and several small (1 m^2) clumps in Telegraph slough. At each of the seven stands we placed two, 1 meter, 2x2 inch cedar stakes into the ground at each end running along the shoreline. Each stake is marked with slashes designating its numbered location. At this time we ran a rope which was marked off in one meter intervals between the stakes. From there one person held a tape on this line while the other walked the perimeter of the S. alterniflora stands measuring the size.

Three transects were run on Dike Island which is comprised of nearly 50 % S. alterniflora (Fig. 3). One transect at each end and one in the middle of the island. Cover of the dominant species was measured twice at each meter along the transects with

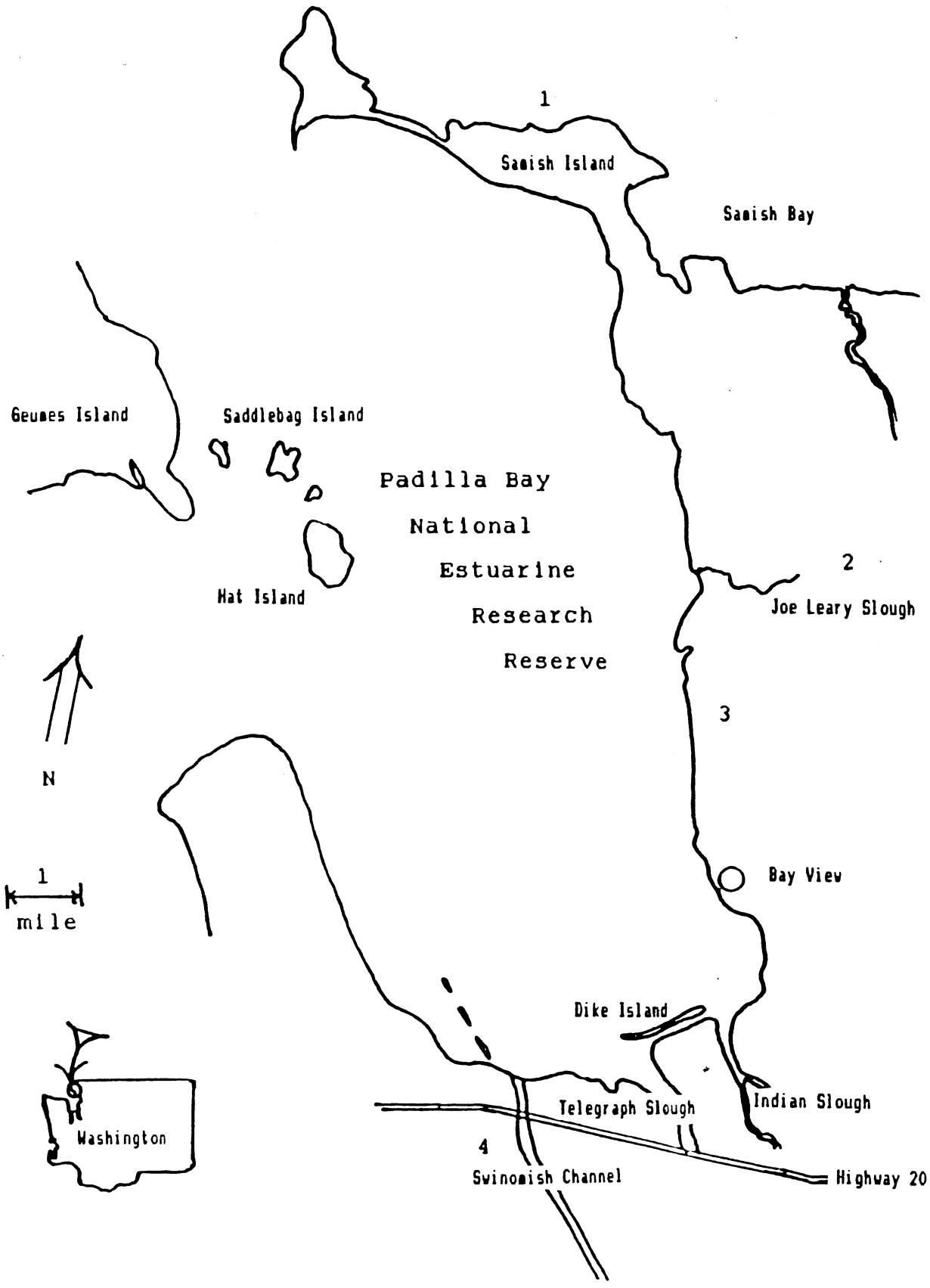

Figure 1. Map of Padilla Bay, Washington.

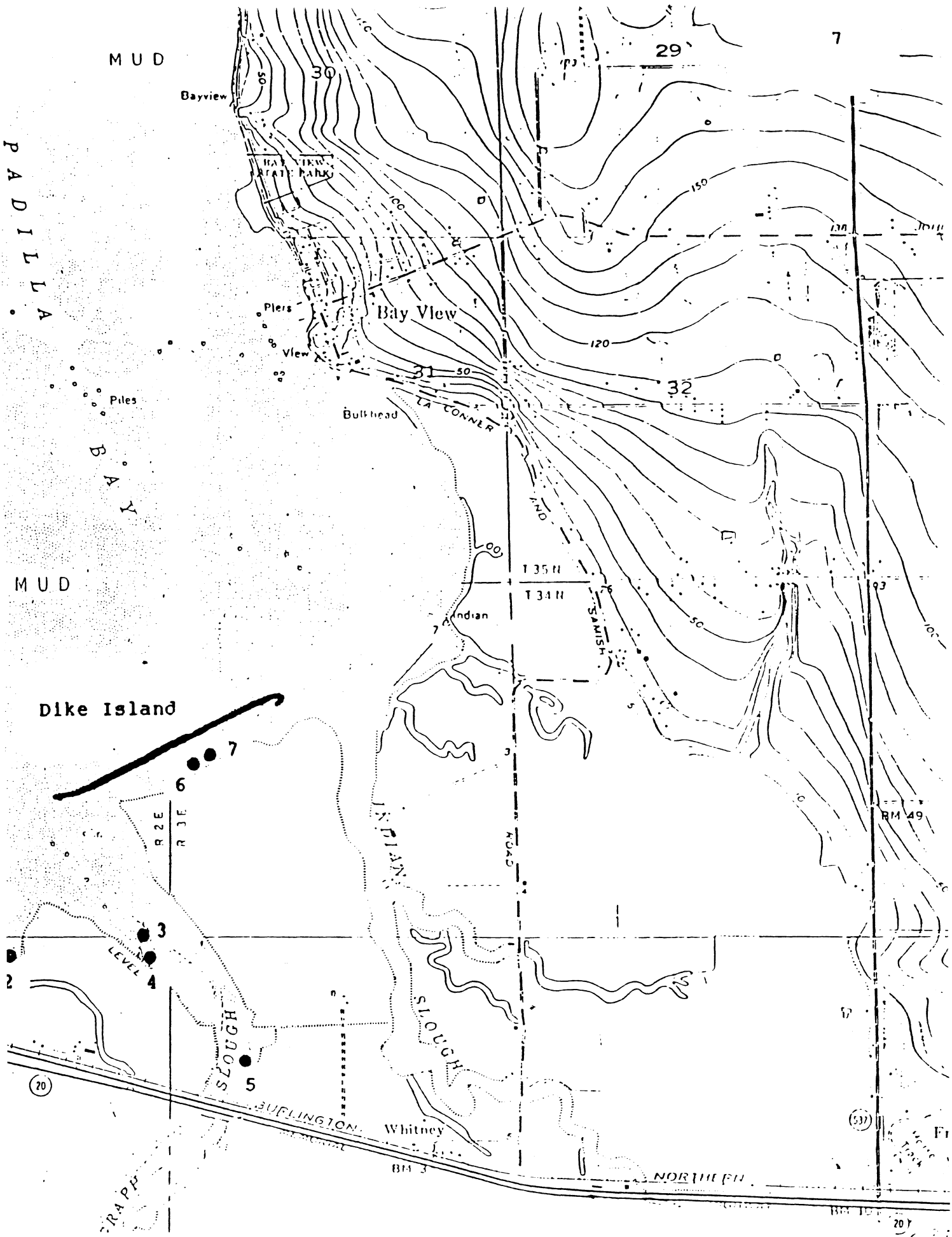

Figure 2. Location of Spartina alterniflora stands in Padilla Bay at Telegraph Slough and Dike Island (U.S.G.S.).

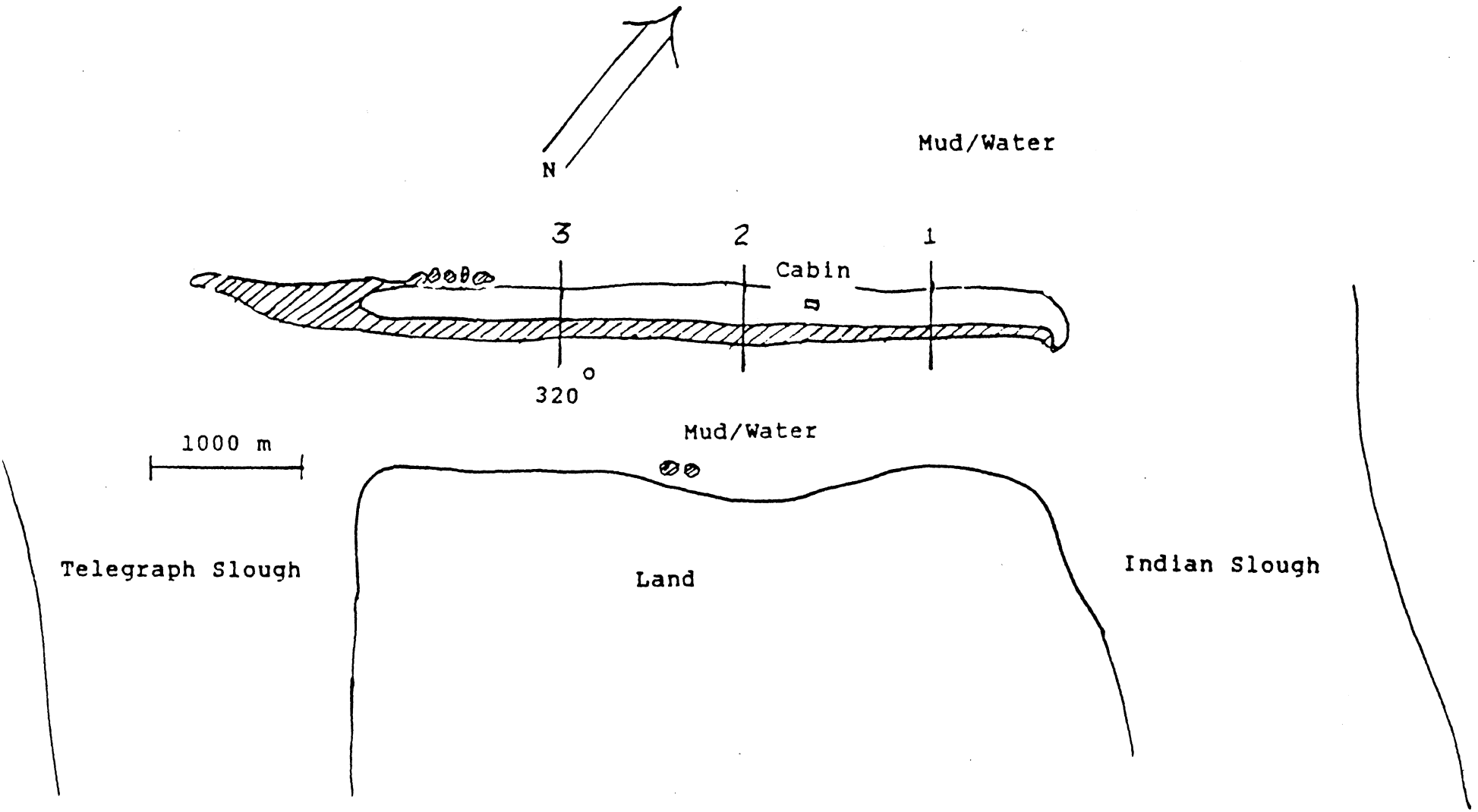

Figure 3. Map of Dike Island showing the three transects and the distribution of Spartina alterniflora.

a 20 x 50 cm frame. Percent cover was determined at transects 1, 2 and 3. Soil moisture, soil description and elevation was also measured along transect 3 at 2 m intervals.

Cover of dominant species was divided into a percentage of the following cover classes:

cover class	percent cover	midrange
1	< 1	1
2	1 - 5	3
3	5 - 25	15
4	25 - 50	38
5	50 - 75	63
6	75 - 99	87
7	100	100

Soil moisture samples were taken with a 2 cm diameter auger between 10 to 20 cm deep. Soil samples were weighed, dried at 105 C for 48 hours, then reweighed. Soil moisture was determined by the following formula:

$$\% \text{ moisture} = \frac{\text{Wet weight - dried weight}}{\text{dried weight}} * 100$$

Elevations were taken by setting an original hub at the high water mark on 25 May 1987 at 6:04 p.m. Upon viewing the meter station beneath the Swinomish Channel bridge at 5:30 p.m. it read a height of 259 cm above mean lower low water of 0 cm. We estimated that the tide ebbed another 15 cm therefore the hub set was at 274 cm above mllw. Elevations were shot using a Berger scope carpenters level. Elevations were measured every 2m along transect #3 and were taken at bare ground level.

RESULTS

All of the S. alterniflora we located was found either on Dike Island or on the mainland directly south or southeast of Dike Island. All of these stands were located in Telegraph slough or across the narrow channel from Dike Island (Fig.2). Figures 4 through 10 show the sites, their general shapes and compass directions of the stands. A rough estimate of the size of each stand of S. alterniflora are as follows:

Stand	area(m2)
1	60
2	250
3	390
4	1352
5	65
6	50
7	95
Total	2,262
Dike Island	22,000
Total	24,262

S. alterniflora occured in pure stands. No other vegetation was observed to the seaward side of S. alterniflora; only mud was observed. At the higher elevations Salicornia and Distichlis were the only plant species bordering S. alterniflora (Tables 1,2,3). S. alterniflora which is inundated twice daily occurs from a lower elevation of 252 centimeters above mean lower low water to 325 centimeters above mean lower low water (Fig. 11).

Along transect #3 soil moisture which was relative to dry weight of the soil ranged from 177.0% at the lower elevation to 1.6% at the higher elevation. The relative consistancy of the

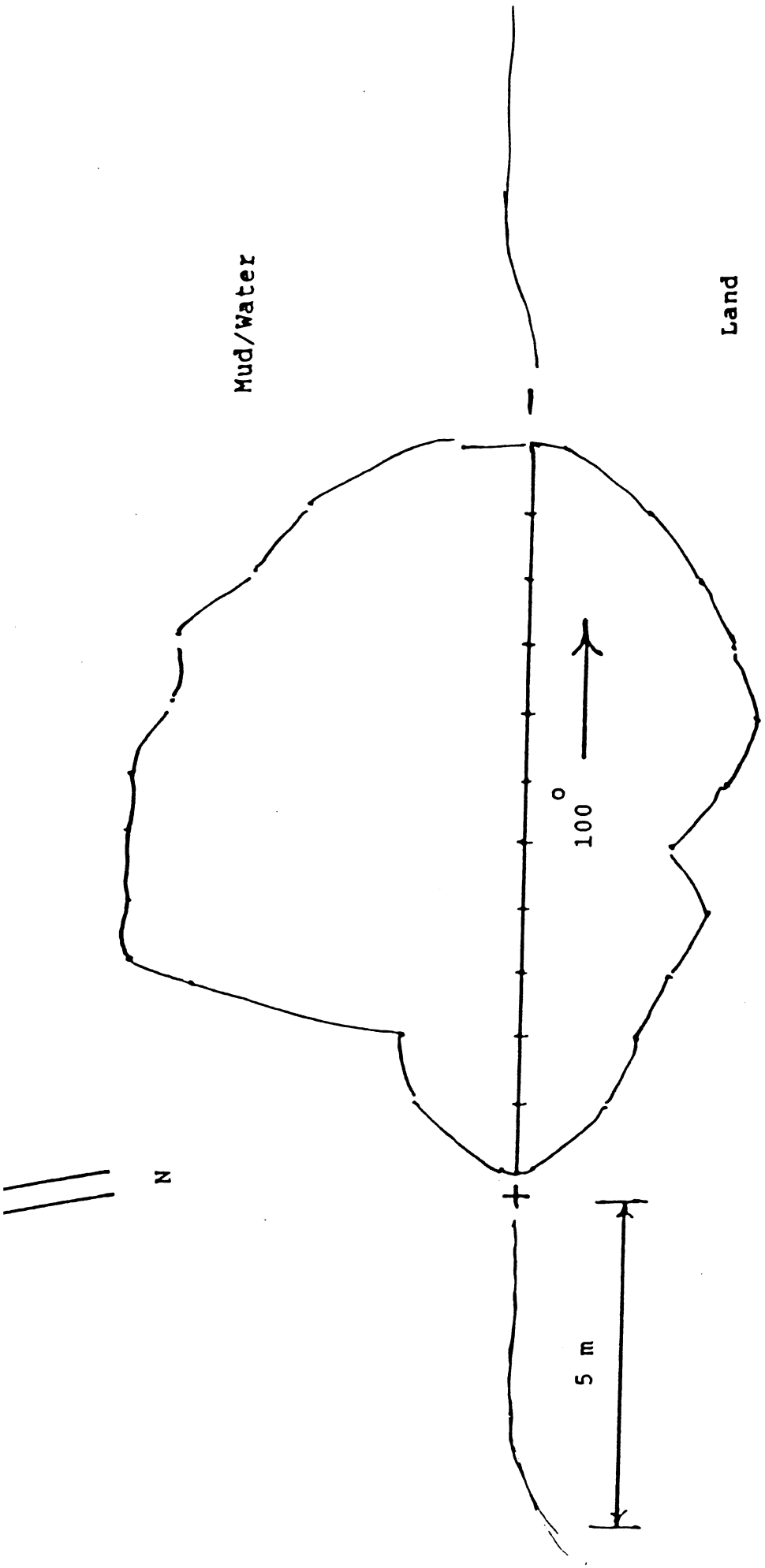

Figure 4. Spartina alterniflora stand 1.

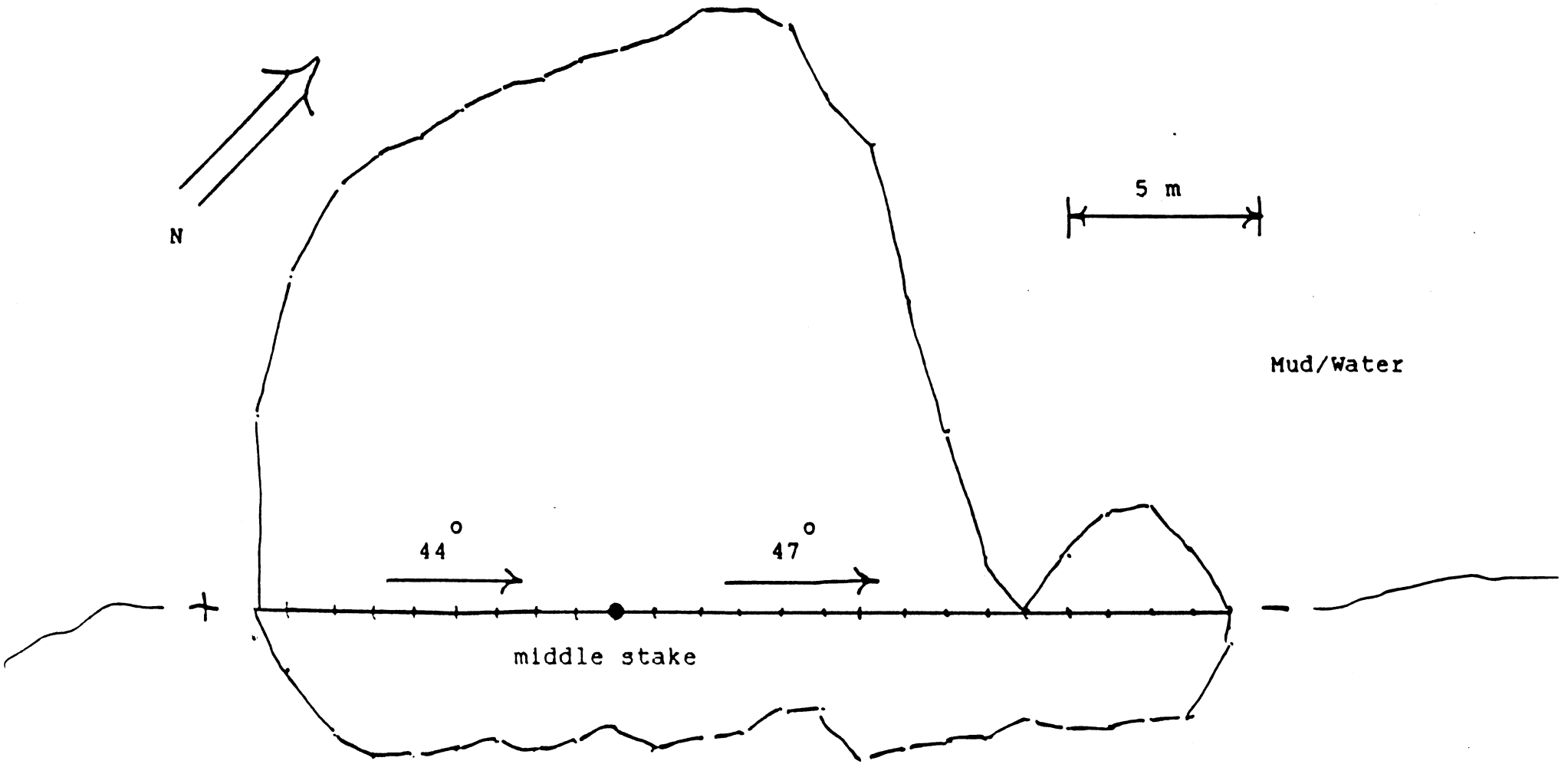

Figure 5. Spartina alterniflora stand 2.

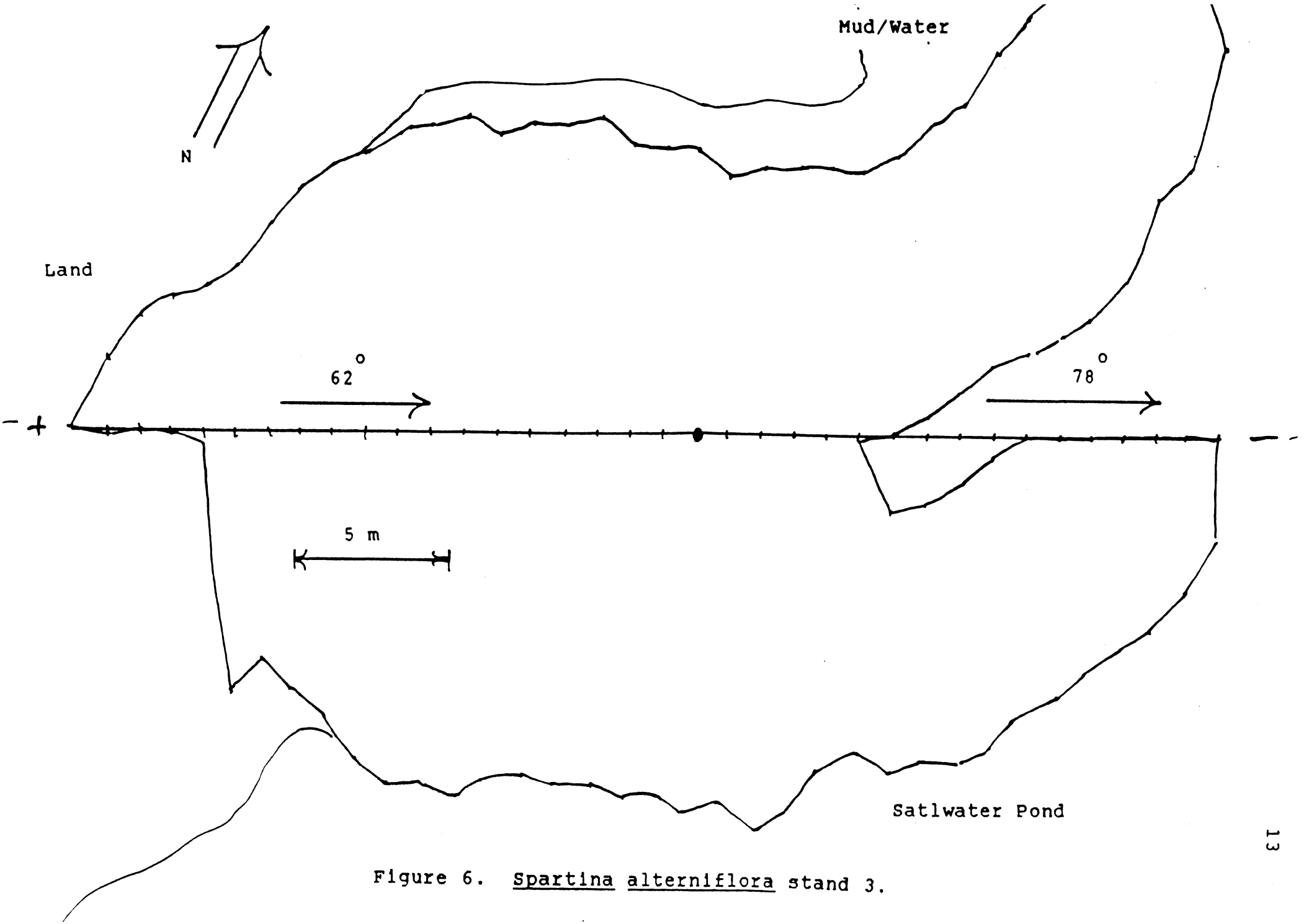

Figure 6. Spartina alterniflora stand 3.

note: scale is different from the other mapped stands.

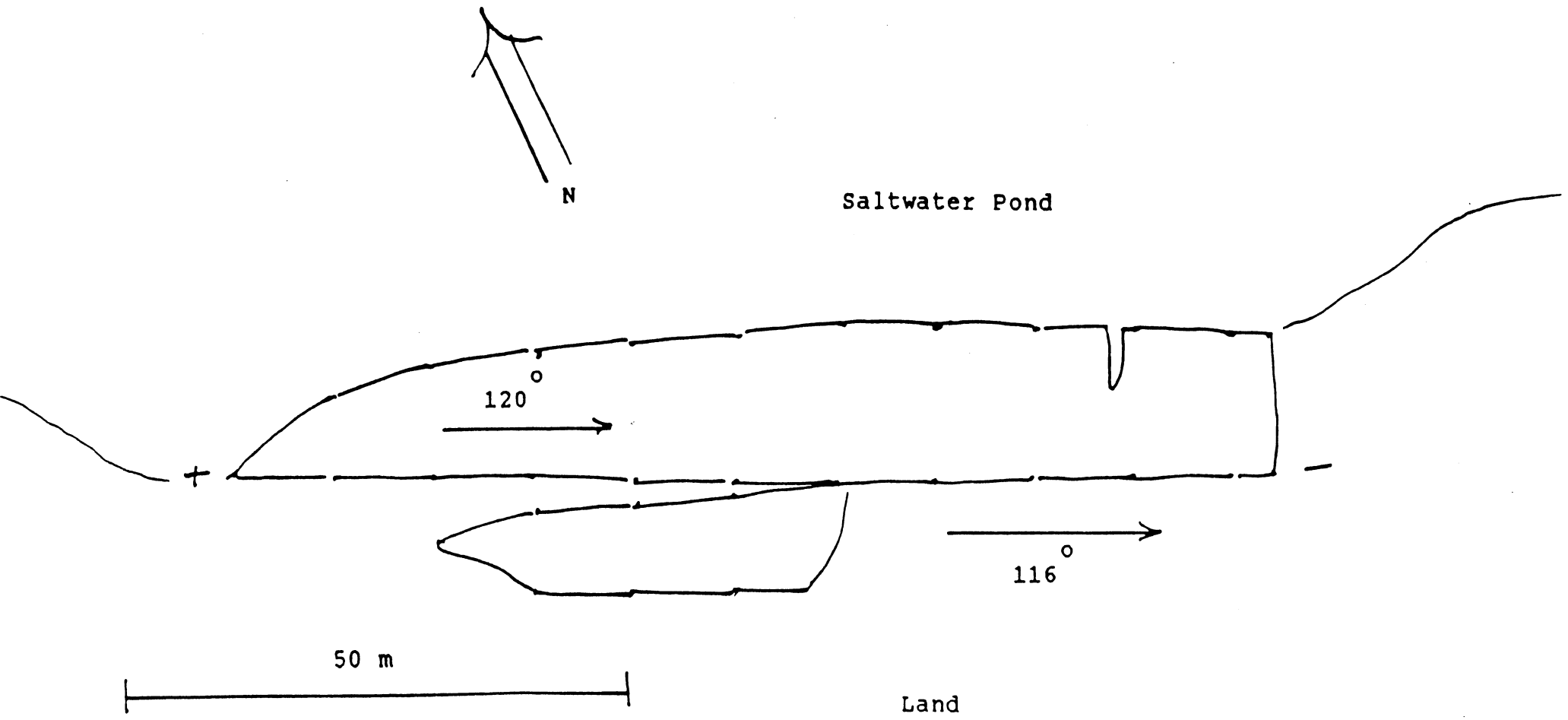

Figure 7. Spartina alterniflora stand 4.

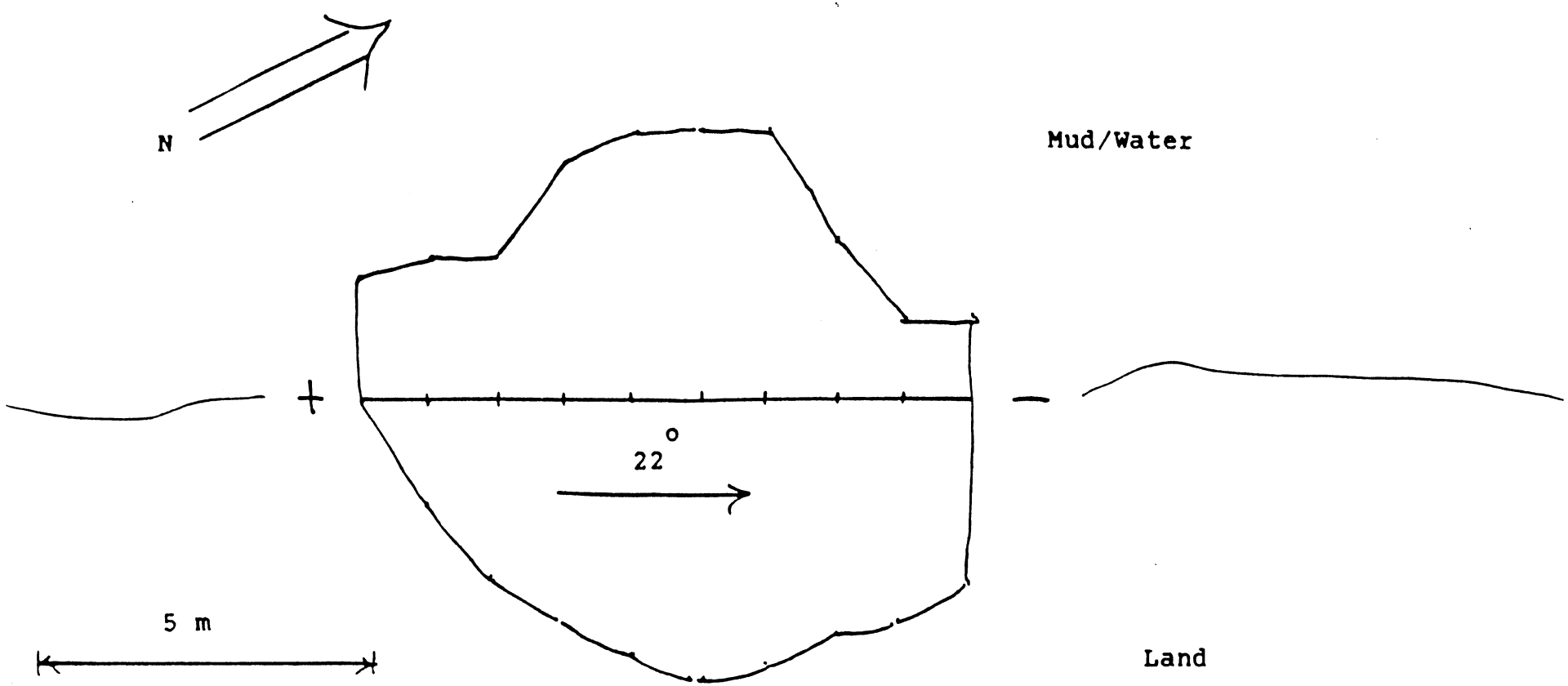

Figure 8. Spartina alterniflora stand 5.

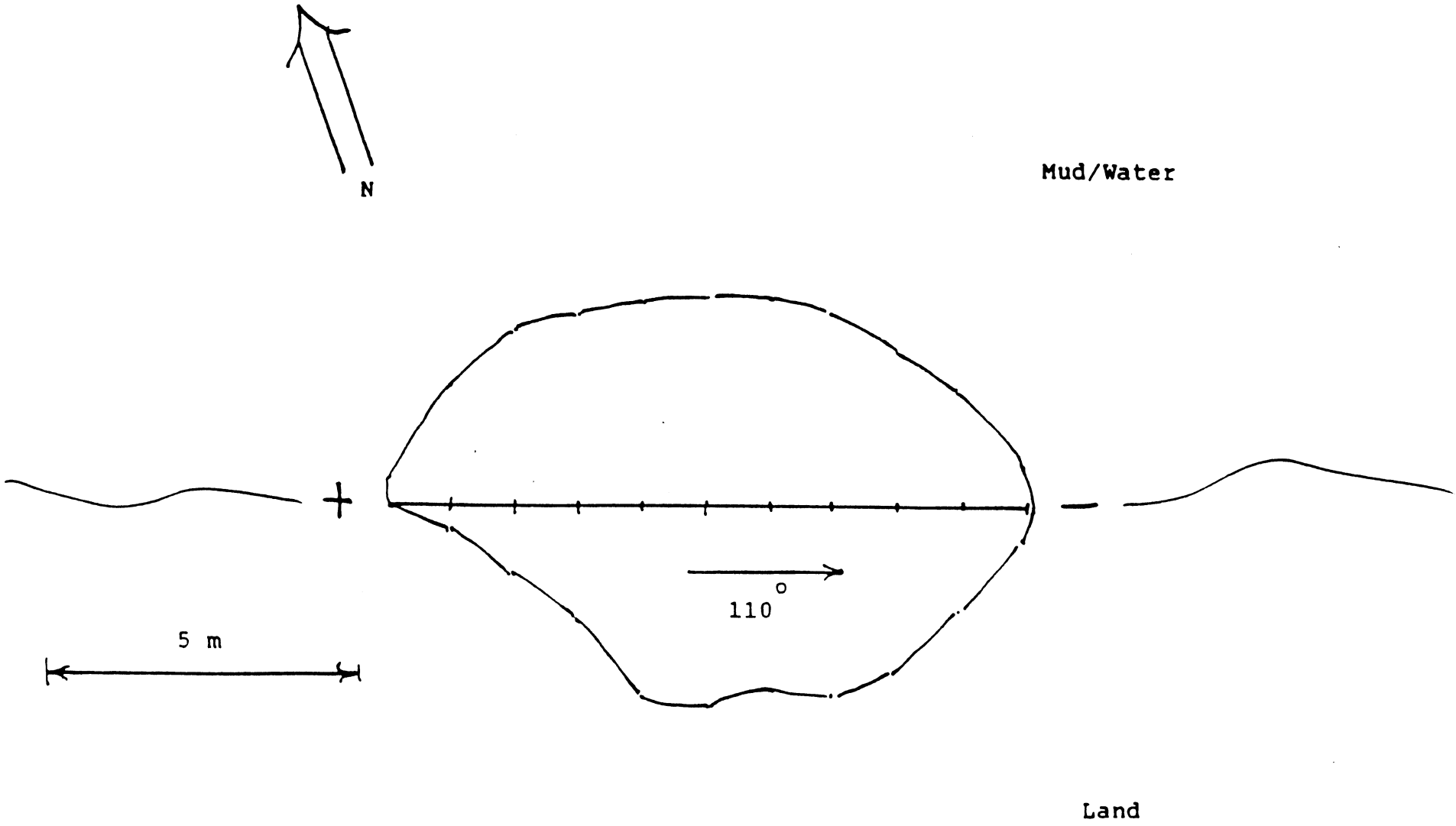

Figure 9. Spartina alterniflora stand 6.

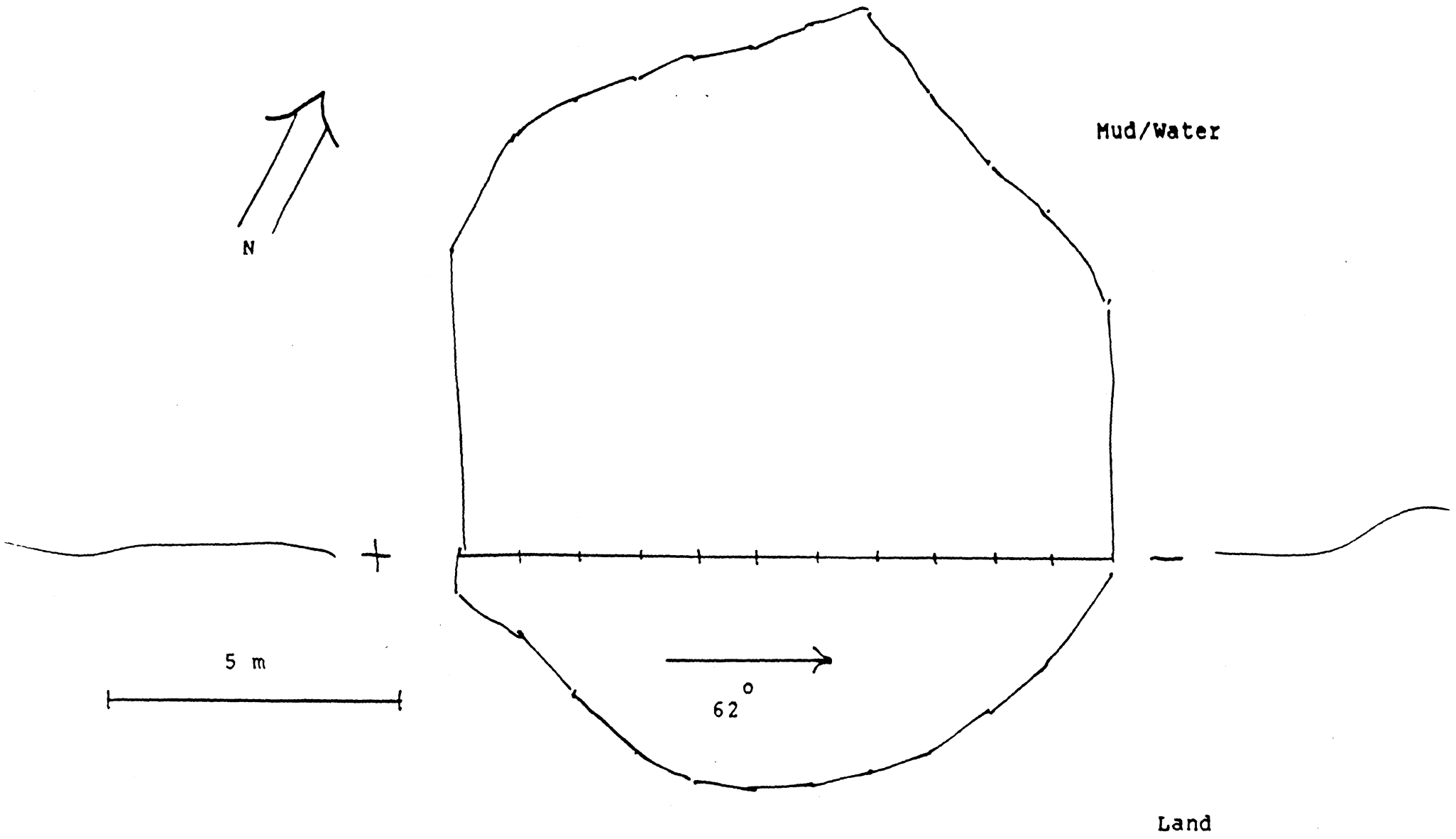

Figure 10. Spartina alterniflora stand 7.

Table 1. Cover by cover classes for the dominant species at every meter along transect 1, 5 May 1987. Cover was estimated at 20 and 70 cm for every meter; the 20 cm cover class is reported first and the 70 cm cover class second.

Cover class: 1 2 3 4 5 6 7
Range of cover (%): <1 1-5 5-25 25-50 50-75 75-99 100

Species	Meter 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Spartina	3-7	7-3	5-7	5-6	6-6	7-7	7-7	6-7	6-6	5-4	5-6	6-6	4-7	6-6	5-6	3-5	4-5	1-6	5-5	-3	5-6	6-6	7-6	6-6	6-6	6-7	6-6
Salicornia																											
Distichlis																											
Atriplex																											
Elymus																											
Cytisus																											
grass																											
forbs																											
mud	3-		-6	3-	3-2	1-1		1-	1-2	5-5	5-1	1-1	5-	1-2	5-1	6-3	5-2	7-2	5-3	7-6	6-2	1-1	1-1	1-1	2-1	2-	2-1
detritus																											
driftwood																											
sand																											

Species	Meter 28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Spartina	7-5	6-5	6-5	6-6	5-	6-	1-																				
Salicornia				2-5	2-7	5-6	7-4	6-4	5-4	6-4	5-2																
Distichlis						-3	3-4	2-4	2-2			-1															
Atriplex								1-1	-3	2-3	-4	3-4	4-4	3-3	5-4	3-2		2-									-3
Elymus										2-1	-2	3-1		-1	-2	1-		-5	-3	3-	-2				-7		-3
Cytisus																						-3	3-7	7-7	7-		
grass																	5-7	6-5	5-5	2-2	2-	2-	6-			2-3	
forbs													1-2	2-2		2-		3-	-2	2-6	6-4	3-5				5-	1-2
mud	1-3	2-3	2-1	3-	1-				1-																		
detritus											-4	2-4	3-3	3-	2-	3-3			2-		-3	2-				2-	3-3
driftwood											5-	3-		2-4	3-2	-4	3-	1-									6-
sand																										-5	

Species	Meter 55	56	57	58	59	60
Spartina						
Salicornia						
Distichlis	2-					
Atriplex		2-3				
Elymus	-3	-3	5-5	5-5	1-3	
Cytisus						
grass		2-				
forbs			2-			
mud						
detritus		5-		2-	-5	3-6
driftwood				-2	5-	6-2
sand	7-6	5-5	5-5	3-2	3-	

Table 2. Cover by cover classes for the dominant species at every meter along transect 2, 5 May 1987. Cover was estimated at 20 and 70 cm for every meter; the 20 cm cover class is reported first and the 70 cm cover class second.

Cover class: 1 2 3 4 5 6 7
Range of cover (%): <1 1-5 5-25 25-50 50-75 75-99 100

	Meter																										
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Spartina	7-7	6-7	6-5	7-7	7-7	7-7	7-7	7-7	7-7		-6	7-6	7-7	7-6	6-7	7-6	6-7	6-6	4-3	-3	6-6	6-6	6-7	6-5	6-	2-	
Salicornia																			2-2	6-3	-3			3-3	3-5	6-6	6-6
Distichlis																									-3	-1	1-
Atriplex																										-1	
Elymus																											-1
Cytisus																											
grass																											
forbs																											
mud	7-	2-	3-3						2-	7-7	7-3	1-2		-3	1-	-1	2-	2-1	6-3	3-3	2-1	2-1	2-	2-2	2-		
detritus																											
driftwood																											
sand																											

	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Spartina																											
Salicornia																											
Distichlis																											
Atriplex	3-4	2-1	4-3	3-4	6-3																						
Elymus	3-5	6-4	5-	3-3	2-	3-4	4-6	6-6	6-2	3-2	2-2	5-5	5-				3-3	3-	4-	6-6	5-2	3-2					
Cytisus											5-	1-4	1-7	7-7	7-7	7-7		-7	3-								
grass						4-4			-4	6-6	4-6	5-5	5-				2-2										
forbs					-3	2-	2-1	1-1	1-1	2-							4-4	3-		2-							
mud	3-																					6-6	7-7	7-7	7-7		
detritus	2-	2-4	-5	5-2	3-2																						
driftwood																				2-	-6						
sand																		3-	6-6	2-2	5-						

ible 3. Cover by cover classes for the dominant species at every meter along transect 3, 5 May 1987. Cover was stimated at 20 and 70 cm for every meter; the 20 cm cover class is reported first and the 70 cm cover class second.

over class: 1 2 3 4 5 6 7
inge of cover (%): <1 1-5 5-25 25-50 50-75 75-99 100

	Meter																										
ecies	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
artina	7-6	5-6	7-6	7-7	6-6	7-7	5-7	6-6	5-6	5-6	5-5	7-6	7-6	6-7	5-6	4-5	3-4	6-4	3-5	2-2							
licornia																		-2	3-3	5-6	5-7	5-6	3-6				
stichlis																			-2		3-2	3-1	3-	-2	4-3		
riplex																							-1	3-	4-	3-2	4-4
ynus																					-1	2-	2-2	4-1	-3	-3	
rtisus																											
ass																										3-	-1
rbs																									2-1	3-6	3-2
id	-3	2-2	-2		2-2		3-	2-2	3-2	3-2	3-3	-2	-2	2-	3-2	5-3	5-6	2-4	3-4	2-							
tritus																									-4		4-3
iftwood																									-2		
nd																											

	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
artina																											
licornia																											
stichlis																											
riplex	-1	5-1	3-4	2-2	1-1			-2	-3			-1	3-	3-1	3-3							1-2					
ynus						2-1		-1				2-	2-2	-2	3-1	2-2	2-	2-2	3-2	-2	-3		2-				
rtisus																											
ass	6-6	-3	5-1	5-6	5-5		4-6	4-6	5-6	-3	3-2	5-4	3-6	5-2	3-2	3-4	3-6	5-4	5-4	7-5	5-6	5-6	3-4	-7	2-		
rbs	2-1	2-2	3-1	2-2	2-2	4-1	-2	4-1	3-	2-1	2-	3-	4-3	-6	4-4	4-3	5-3	4-5	3-5	-4	4-2	4-4	-2				
id																											
tritus		3-4	-6																								
iftwood							5-1	3-	-2	5-6	5-6	-5												2-			7-7
nd																							5-3	6-	6-7	7-7	6-7

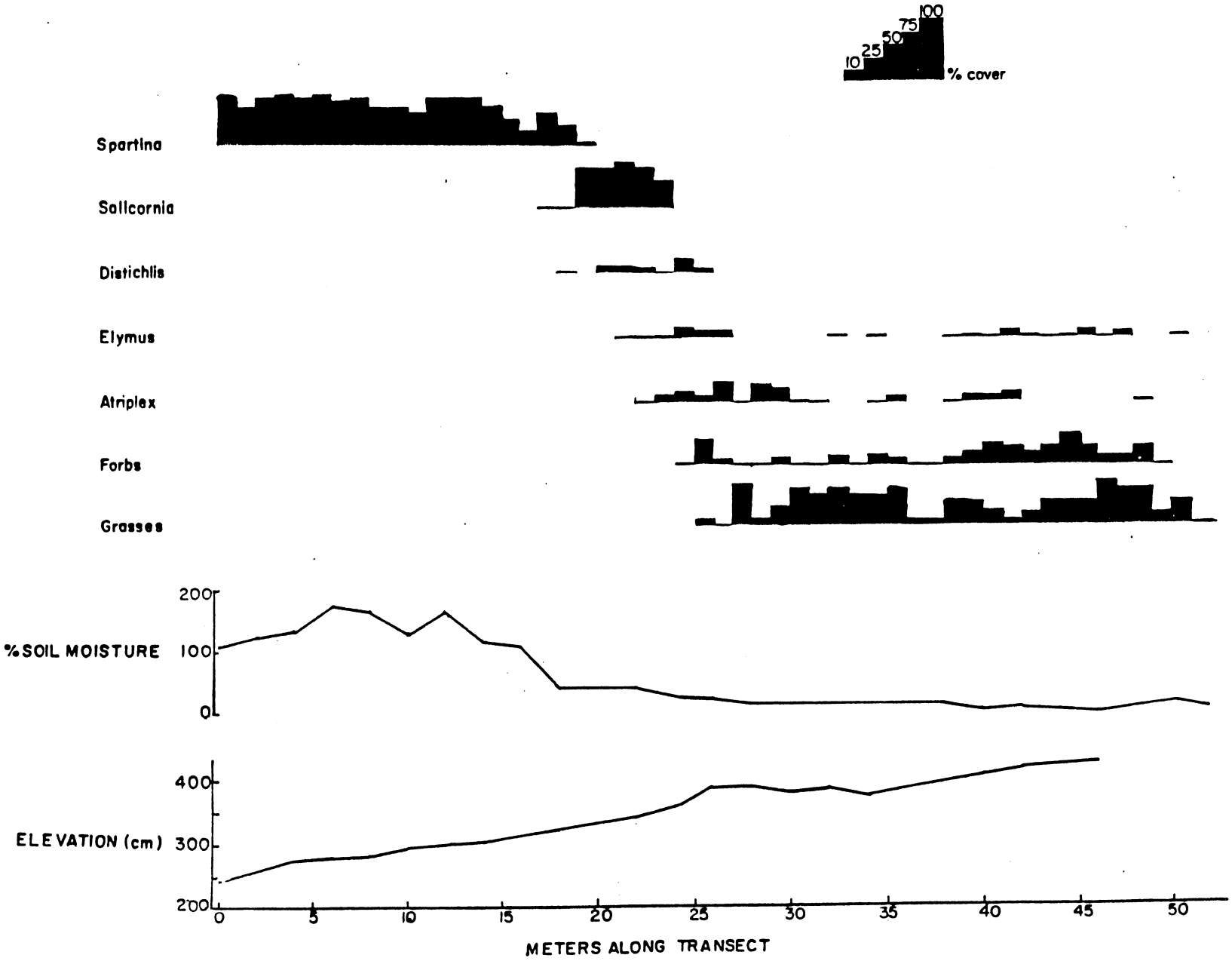

Figure 11. Transect 3 from water edge across Dike Island showing the distribution of salt marsh species, elevational profile, and percent soil moisture. Soil moisture decreased significantly.

soil varied from muddy to sandy/detritus. At meter 16 the soil consistancy changed from mud/detritus to mud/sand and soil moisture changed from 109.5% to 40.1% at meter 16. Salicornia began to appear at meter 16 and S. alterniflora disappeared at meter 19.

DISCUSSION

Exactly how much S. alterniflora was planted and where it was planted is unknown. However it is apparent that S. alterniflora in Padilla Bay spreads by rhizomes (vegetatively), and by storms transporting small clumps to other areas. This conclusion is supported by the evidence which follows. S. alterniflora has a circular growth habit, each stand is connected with the same rhizome. Upon viewing aerial photographs of 1968 and 1978 of the west tip of Dike Island and personally viewing this area it is obvious that the circular patches are increasing in size. We saw three small patches of S. alterniflora along the shoreline of Telegraph slough. Two of these clumps were dead with no root growth. They appeared to have been deposited during a high tide. Possibly a violent storm increased wave action enough to break off small clumps of S. alterniflora which were then brought to the shoreline by tide, deposited and began to grow. With this observation in mind, stands 1,2,5,6 and 7 may have been spread in this way (Fig. 2). Stands 3 and 4 which are located around a man-made pond have two duck blinds located within them. The size of the S. alterniflora stands and their isolation from tidal influence strongly suggests these were planted by someone.

Five small stands on the north side of Dike Island can be detected in the 1968 and 1978 aerial photographs (Fig. 3). We did not do an intensive measurement of these stands but did place stakes in the middle of them and take overall length and width measurements. The total area covered by the five stands is approximately 2400 m2. Only 25% of each clump consists of live S. alterniflora. The remainder of the area is covered by short dead stubbles. A significant observation here is that there are a few small patches of Salicornia appearing within the old stubbles of the S. alterniflora. Areas of Salicornia growth are also appearing on the south side of Dike island where the major growth stands have died back and only stubbles and mud remain within the S. alterniflora or surrounded by S. alterniflora.

It appears the major growth of the S. alterniflora is spreading out into the mud flats. Wind and high tide is likely the major source of location spread while rhizome growth increases the size of each stand. Parker and Aberle (1979) detected no seed formation in the S. alterniflora in Padilla Bay. If seed production does appear here the spread rate of S. alterniflora could increase rapidly (Kunze 1987).

RECOMMENDATIONS

The introduction of S. alterniflora to Padilla Bay is affecting the habitat of the resident flora and fauna. To what degree is unknown, plus whether that be a positive or negative is relative to ones position on habitat management.

There are two general views associated with the management of a potentially successful introduced species. In the case of S. alterniflora within the Puget Sound region one view is to eradicate the species entirely and the other is to manage and monitor the species within the habitat it is found.

S. alterniflora has a potential negative impact on the native flora and fauna in the area it has been introduced. Jim Hidy of the Willapa National Wildlife Refuge has contracted a study of the 450 acres of S. alterniflora in Willapa Bay, it's growth, habitat and potential methods of eradication.

In May of 1975, Parker and Aberle (1979) applied the herbicides Atrizene, Amitol T, Tordon 10 K and Roundup to selected plots of S. alterniflora in the Puget Sound region. None were effective to control this saltmarsh cordgrass. It is also noted by Parker and Aberle (1979) that S. alterniflora offers no food supplies to the migrant waterfowl of Padilla Bay. They state the benefits from cordgrass introductions do not outweigh the detrimental effects from loss of productivity on critical waterfowl habitat. Therefore, cordgrass should be eliminated from all Washington intertidal areas.

S. alterniflora in Padilla Bay, because the stands are of managable size and of its association with a National Estuarine Research Reserve lends itself to an excellent opportunity for a long term study. Growth and spread rates, the potential development of viable seed, and the effect S. alterniflora has on the native organisms in Padilla Bay are beneficial to the studies of introduced species.

With little effort our methods could be repeated on a yearly basis. We recommend that the S. alterniflora in Padilla Bay should continue to be monitored. The minimum of what should be done is to repeat our measurements of the seven stands and the transects on Dike Island. One should watch for viable seed production and the spread of new clumps. Further studies may include determining the tolerance of S. alterniflora to inundation which will reveal its elevational limits. In turn this will aid in estimating the spread of S. alterniflora into the bay.

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List of the Dominant Species

Atriplex patula
Cytisus scoparius
Distichlis spicata
Elymus mollis
Salicornia virginica
Spartina alterniflora