FINAL REPORT

TIDAL DATUMS AND CHARACTERISTICS OF THE UPPER LIMITS OF COASTAL MARSHES IN SELECTED OREGON ESTUARIES

A PILOT STUDY CONDUCTED FOR THE ENVIRONMENTAL PROTECTION AGENCY

BY

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NOVEMBER 15, 1976

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PREFACE

Based on field work conducted during the months of July and August 1976, the following report describes the characteristics of vegetation at the upper limit of intertidal wetland in five Oregon coastal marshes and relates vegetation characteristics to marsh zonation, elevations above Mean Sea Level and various tidal datums.

Logistic assistance was provided by the Department of Geography, Oregon State University and is acknowledged as is the preparation of site maps by Ted Boss.

Robert E. Frenkel

H. Peter Eilers

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INTRODUCTION

General Background

Of critical concern to the people of the United States is the maintenance of productive ecosystems. Among the most productive systems are estuaries and their associated intertidal marsh systems (Odum et al., 1974). The intertidal marsh serves as energy receptor and converter, its organic matter exported by tide to bay furnishes energy and nutrients for many aquatic organisms. Although the undisturbed marsh-estuary system has evolved responses to natural stresses such as fluctuating tide level and pendulations in salinity and nutrient loading, the natural system has been unable to survive in the face of man-made alterations such as filling, diking, draining, dredge spoil accumulation, and general industrial and residential pollution.

In recognition of the importance of estuaries as productive systems and of the endangered condition of these productive ecosystems, the Federal government and a number of states have enacted legislation encouraging protection of estuaries (CEQ, 1972, 1973, 1974; Coastal Zone Management Act of 1972). The Courts have also responded positively to need of protecting coastal wetlands (CEQ, 1973). A broader perspective for the integrity of wetlands is incorporated in Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (Sec.404, P.L. 92-500) wherein the Army Corps of Engineers may issue permits for discharge of dredged or fill material into navigable waters at specified disposal sites. Guidelines for the specification of disposal sites are to be developed by the Administrator of the Environmental Protection Agency with the Army Corps of Engineers. Furthermore, the Administrator in cooperation with the Corps is authorized to prohibit the specification of any defined area as a disposal site and to deny or restrict use of any defined area for specification as a disposal site when he determines that discharged material will have an unacceptable adverse effect on municipal water supplies, shell fish beds, fishery areas, wildlife or recreation areas (Sec. 404, P.L. 72-500).

To carry out its role under Section 404 of the Federal Water Pollution Control Act Amendments of 1972, the Environmental Protection Agency in cooperation with the Corps must be able to define areas considered as contiguous wetland to navigable water. It is the purpose of the research reported herein to define wetland using vegetative criteria and to relate the position of plant species and plant communities to elevation above mean sea level and ultimately to a local tidal datum. The results of this research will therefore help in setting Section 404 guidelines.

Project Tasks

Three tasks were carried out in the course of this research: (1) description of plant communities from below MHW through upland in five intertidal marshes in four Oregon estuaries distributed over 500 km (310 mi.) of coastline and ranging from highly saline marshes to fresh water intertidal marshes; (2) identification of the "upper limit of marsh" based on vegetative criteria for each marsh studied and the determination of elevation above MSL and with respect to a tidal datum of the upper limit of marsh; (3) determination of the elevation of the upper and lower limits of the ecotone between intertidal marsh and upland and the characteristics of this transition zone vegetation.

Literature Review

Although the relation between marsh vegetation and elevation above a tidal datum has been long recognized and studied (Chapman, 1960), research in the Pacific Northwest has been sparse. Johannessen (1961) in reporting on Oregon coastal salt marsh vegetation does not deal with the topic. Jefferson (1975), in a broad survey of Oregon salt marsh communities and plant succession sought to determine overriding environmental factors governing plant distribution patterns. She studied tidal submergence and exposure as one factor. Jefferson took 388 elevation measurements on a salt marsh on the west side of North Slough (Coos Bay), relating 38 plant species to elevation. A second set of 105 elevations was recorded for a high marsh 600 meters downstream of Criseter's Dock in Yaquina Bay. The Yaquina data were compared to local tide heights at the Marine Science Center, Newport and reported tidal measurements at Criseter's Dock. All measurements were corrected to MLLW by NOS table. Jefferson then tabulated elevation ranges of 36 species for the North Slough site. The Yaquina species data fit within the tabulated data. She also presented elevation ranges for seven salt marsh types but was unspecific as to from where the marsh data are derived except for a sand marsh at Pony Slough (Coos Bay) taken from Macdonald (1967). Community elevations were not determined. Taking MHHW (8.00 ft. (2.44 m) above MLLW) as a lower limit of the transition zone between intertidal marsh and upland, Jefferson's (1975) data identify the following main species (three or more occurrences): Grindelia integrifolia, Hordeum brachyantherum, Plantago maritima, Cordylanthus maritimus, and Potentilla pacifica. Jefferson (1975: 118) concludes that, "the tidal elevations of vascular salt marsh plants in Oregon . . . extend upward to a point between extreme high water and highest water during the growing season, based on 1971 data, which was the year the elevations were measured."

At Nehalem Bay, Eilers (1975) recognized an intertidal marsh below MHW, a transitional marsh between MHW and 9.05 ft. (2.76 m) above MLLW and an extra-tidal marsh 9.05 ft. above MLLW. Eilers recorded elevations for West Island and tied these to tidal data at nearby Wheeler. He related individual plant growth, plant communities, diversity patterns and a number of other characteristics to tidal datums and submergence period. Taking Eilers' high marsh, which is

9.05ft. above MLLW as the lower limit of a transition zone between intertidal marsh and upland, the following main plant species (importance based on above ground dry weight) are characteristic of, and restricted to, the marsh-upland transition: Carex obnupta, Oenanthe sarmentosa, Festuca rubra, Aster subspicatus, and Potentilla pacifica. Eilers pointed to the fact that species inhabiting the upper portion of the elevation gradient are more restricted in vertical range than those more seaward. Eilers' research also depicted community-elevation relations. A mosaic of three communities existed above 2.76 m above MLLW and below upland: Juncus-Agrostis-Festuca community, Carex-Aster-Oenanthe community, and Aster-Potentilla-Oenanthe community. These plant assemblages correspond to less than three hours maximum annual submergence with a period of May through July without any submergence.

A recent study by NOAA-NOS (1975) on the relation between the upper limit of coastal marshes and tidal datums investigated seven marshes in seven U.S. biogeographical regions. The study concluded (p. 84) that:

> the determination of the upper limit of the marsh by photogrammetric methods or by an equation expressing a relationship between the upper limit of the marsh and the mean range of the tide is doubtful. However, the criteria based either on a carefully selected constant elevation or a frequency of inundation level above MHW provide a datum which appears to adequately delimit the coastal marshes with only small variations from the true upper limits. . . .
> In this study it was determined that 2.5 feet above MHW gives the best overall fit for the marshes investigated. Therefore, it appears reasonable that MHW plus 2.5 feet be used as interim criteria pending further research to define the upper limits of coastal marshes.

The one exception to the 2.5 foot above MHW generalization was data collected for NOS at Ebey Slough near Everett, Washington in the Puget Sound where the mean elevation of the upper limit of marsh was 1.2 ft above MHW. In Yaquina Bay this would correspond to about 8.7 feet above MLLW and at Nehalem Bay 8.15 ft (2.49m) above MLLW. Clearly, this figure does not agree with data of either Jefferson or Eilers for defining the upper limit of marshes.

The NOS study reports that "the ULM is defined by Carex lyngbyei, Typha latifolia, with some Potentilla pacifica, Triglochin maritimum, Angelica lucida, Atriplex patula, Achillea millefolium, and Solanum dulcamara." This description is puzzling. Carex, Triglochin and Atriplex are commonly found in an intertidal position although they may transcend into the transition zone. They cannot be used to define the ULM. Solanum dulcamara is an introduced ornamental which occasionally enters the upper portion of marsh.

The three studies reported above are the only ones to date which relate intertidal marshes in the Pacific Northwest to tidal datums. Other than Eilers' (1975) study, which is localized, none adequately define the upper limit of marsh and the upper and lower elevations of the ecotone between intertidal marsh and upland. The NOAA-NOS (1975) study is sufficiently disparate in its report of Ebey Slough to raise questions as to the validity of the marsh data for the Slough as reported therein.

STUDY AREAS

Site selection

Intertidal marshes in Oregon mainly develop in estuaries and occasionally behind coastal sand spits. There are 21 estuaries in the state supporting a variety of intertidal marshes ranging from highly saline (Netarts) to fresh water (Columbia River). Of these, 14 were considered for the purposes of this study, those marshes in the six estuaries south of the Coquille River being either too disturbed or too small. Criteria for estuary and marsh selection included: (1) prior knowledge of marsh vegetation; (2) adequacy of the NOS tidal record, (3) freedom from human modification, (4) representativeness and diversity, and (5) ease of access. Specific estuary and marsh selection was agreed upon before initiating field work in conference with the EPA and an independent investigator (Jefferson and Jarvis).

General knowledge of all intertidal salt marsh vegetation was satisfactory for both teams of investigators. However, knowledge of both teams regarding non-saline marsh vegetation was poor. None-the-less, one non-saline intertidal marsh at Burnside, Columbia River estuary was selected for study.

Of 70 registered tidal projects reported by NOS, only four are primary tide gages: Charleston, Coos Bay Entrance (943-2780); South Beach, Yaquina Bay (943-5380); Garibaldi, Tillamook Bay (943 - 7540); and Astoria, Tongue Point (943-9040). Unfortunately, there were no satisfactory undisturbed intertidal marshes close to these primary tide stations. Attempts to locate secondary and other tidal gages in the field were unsuccessful; therefore, estuaries and intertidal marshes were selected with respect to established USGS and Oregon Highway Division bench marks. Bench marks were then related to reported tidal datums for the estuaries involved. One marsh, near the Marine Science

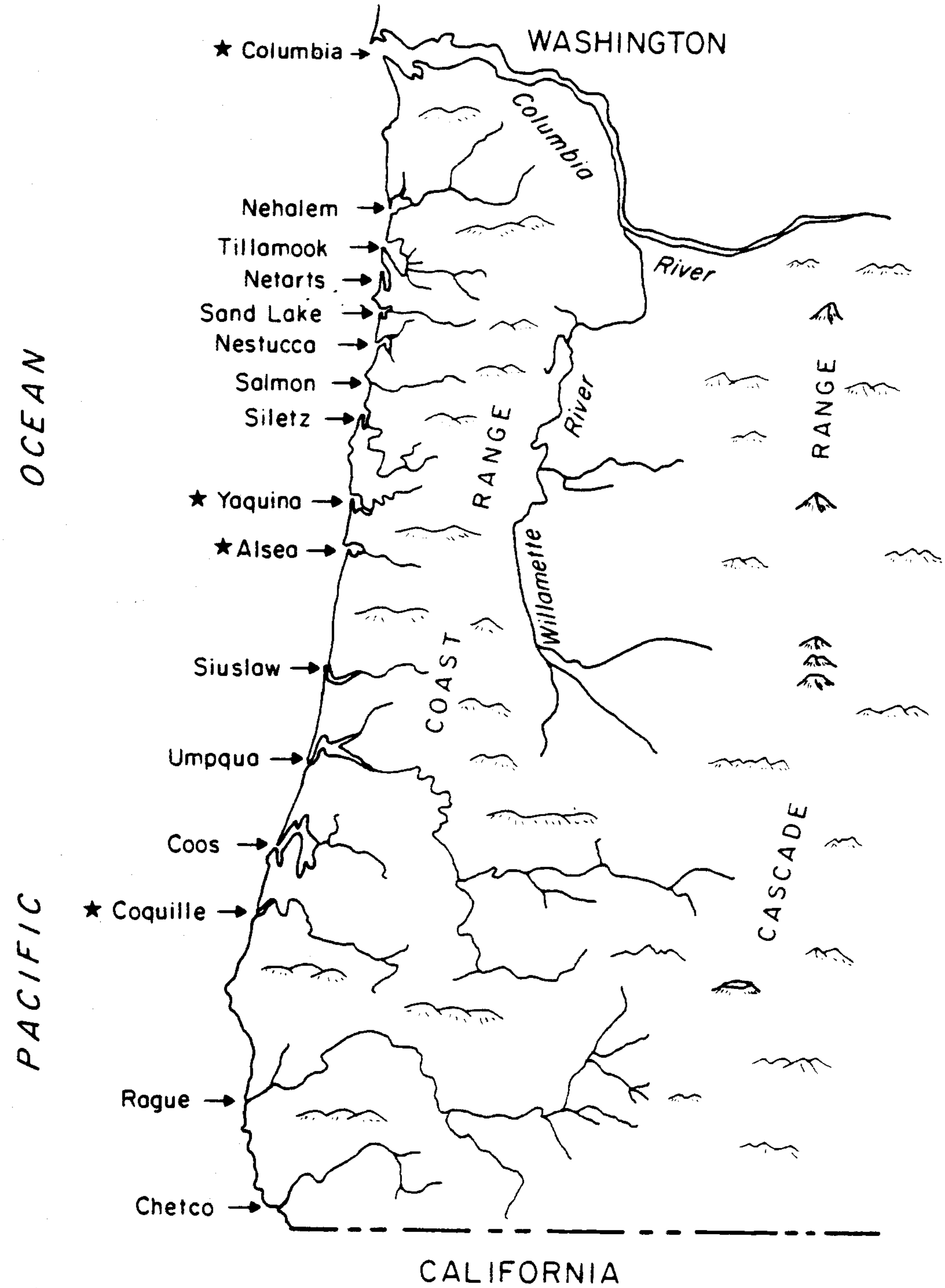

Figure 1. Oregon estuaries (Source: Bella and Klingeman, 1973:2). Estuaries marked with a star (★) were selected for study.

Center was selected because of proximity to a tide gage.

Marshes were eliminated from consideration if they exhibited obvious signs of diking, ditching, fill, intensive grazing, pollution or other human modification. Particularly important in this respect was to choose marshes where the transition between marsh and upland was undisturbed. Meeting this objective was especially difficult. In almost every case examined there was human disturbance at the upper limit of transition; for example, in the Columbia estuary a railroad embankment forms an artificial upland, and at Newport, this transition was affected by disturbed fill material. Of the five marshes studied, only two had undisturbed marsh-upland transitions. These were the north Waldport marsh, west of Drift Creek and the Bandon marsh.

Two considerations were involved in selecting marshes with respect to representativeness. First, we wanted marshes from highly saline to fresh-water and developed on sand to silt substrate. Second, we wanted to select marshes typical of the estuary in which they occurred.

Five marshes in four estuaries were selected (Figure 1): (1) at Newport, in Yaquina Bay, south of the Marine Science Center, (2) at Waldport on the north side of Alsea Bay about 0.8 km (0.5 mi.) west of Drift Creek, (3) at Waldport on the south side of Alsea Bay about 0.7 km (0.4 mi.) east of Eckman Lake, (4) at Bandon about 2 km (1.3 mi.) north of Bandon on the east side of the Coquille River, (5) at Burnside about 2.5 km (1.6 mi.) west of Settler Point and 6.7 km (4.2 mi.) southeast of Tongue Point in the Columbia Estuary. These five marshes together with West Island in Nehalem Bay from which detailed tidal datum-vegetation data are available (Eilers, 1975) span the variation in salinity, and marsh types characteristic of Oregon.

METHODS

Field Methods -- Leveling

Following the selection of the study area, temporary reference bench marks were established in the marsh. By differential leveling with a transit and stadia[1] from recovered United States Coast and Geodetic Survey and Oregon State Highway Department Bench marks (Table 1), the elevations of the marsh reference marks with respect to mean sea level were determined. To insure accuracy, the elevations determined were confirmed by closing to the original permanent bench mark. The stadia employed was 12 feet high and graduated by markings at 0.05 ft. intervals and thus could be easily seen at the distances required when crossing rivers and marsh creeks. Closing to within 0.1 ft. was considered acceptable for the purposes of this investigation.

Once established, the temporary bench marks served as leveling reference points for determining both the elevation of vegetation sample locations and points along the upper and lower boundaries of the transition from marsh to upland. Since study areas were all located in estuaries for which published tidal datums are available, marsh point elevations in feet above mean lower low water (MLLW) were also possible for surveyed points, although some extrapolation was required where study marshes were not in close proximity to tidal recording stations.

Field Methods -- Vegetation

Vegetation was floristically sampled along at least two transects on each marsh (Figure 2). Transects traversed intertidal vegetation zones from either unvegetated mudflat or primary tidal creek to upland. Transects were staked, flagged, bearings taken, and 50 x 50 cm quadrats located by tape at

[1] Lietz Type II transit and Holbro folding stadia.

Table 1. Recovered bench marks used in study

Study Site	Bench Mark Name	Elevation Above MSL (ft.)	Agency
Newport	A 590 (1965)	12.17	USGS
Waldport	20 6D2E3 1931	28.85	USBPR
Bandon	W 531 1954	27.54	OSHD
Burnside	Milepost 95 1934	25.67	USC&GS

Table 2. Braun-Blanquet cover-abundance classes.

Cover Class	Cover (percent)
+	present, insignificant cover
1	1-5
2	5-25
3	25-50
4	50-75
5	greater than 75

systematic intervals. In some marshes (Waldport North), intervals between quadrat location were 10 m where marsh vegetation composition did not change rapidly along the transect. At other marshes, where transitions were rapid, quadrat spacing was 2 m or less (Waldport South). Altogether, 190 quadrats were read. For each quadrat, an estimate of species cover was recorded by the standard Braun-Blanquet cover-abundance class as shown in Table 2. (Mueller-Dombois and Ellenberg, 1974). The percent of the surface occupied by drifted material and bare ground was also recorded.

A judgement was made in the field as to the extent of the transition zone. Transition zone vegetation was then sampled by 10 to 30 random placements of the 50 x 50 cm quadrat frame. Choice of the quadrat area was based on the species-area relations reported by Eilers (1975) and Jefferson(1975).

Upland vegetation was not sampled but an estimate was made of species abundance-cover based on walking, crawling and cutting through the dense undergrowth. In the case of Burnside intertidal marsh in the Columbia estuary, the transition zone and part of the intertidal marsh was a dense thicket of willow and required cutting a 25 m long swathe the length of the transect to upland. In this case, species cover estimates were recorded along the transect for vegetation zones which appeared more-or-less uniform in compostion. Species are listed in Appendix A and B for saline and non-saline marshes.

Analytical Methods -- Plant Species and Elevation

The relationship between plant species cover values and elevation was analyzed for each transect using a direct gradient approach (Whittaker, 1967). Transect profiles were constructed with elevation on the abscissa and distance from the lower end of the transect along the ordinate. Cover values for each plant species present in quadrats were plotted in tiers above the transect profile, yielding a visual impression of species composition through the transition to upland.

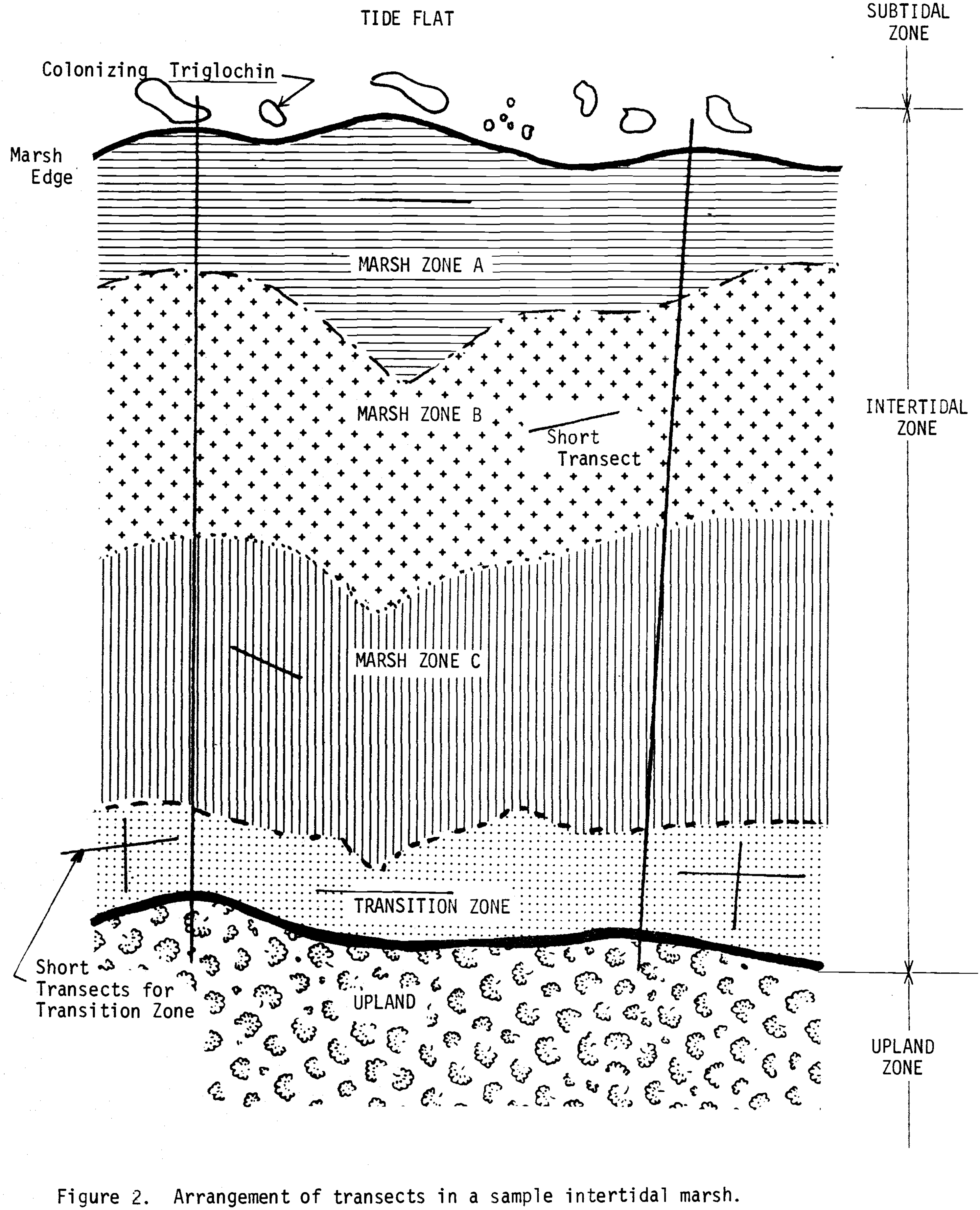

Figure 2. Arrangement of transects in a sample intertidal marsh.

Analytical Methods -- Community Patterns

Species data was key punched and analyzed separately for each marsh by the computer program PHYTO, developed by J.J. Moore (1972) whereby the initial steps of a Braun-Blanquet tabular analysis are achieved by computer choice of the two "best" pairs of opposing differential species. Further manipulation of the species-sample table was achieved by user-choice of species and samples. In this way, intertidal vegetation and transition zone vegetation was classified, for each marsh site, into distinct floristic groups.

Analytical Methods -- Transition Boundaries

Statistical analysis of the relationship between the elevation of the lower and upper transition boundaries was performed for each study area. First, mean elevations and standard deviations were calculated for the upper and lower limits of the transition based on field surveyed values. The means were then subjected to a test of equality using Student's t distribution. Exploration of these intramarsh relationships was followed by comparison of transition boundaries between marshes. Statistical tests were not performed on the latter comparisons.

Terminology

For the purposes of this report all elevations and distances will be expressed in feet and miles as appropriate. This divergence from metric units is necessary because of the uniform expression of tidal datums in feet.

Intertidal wetlands have been frequently discussed with reference to certain zones (Figure 2). The lowest zone is the tide flat from about MLLW to the first colonizing vegetation such as *Triglochin maritimum*. The marsh vegetation is referred to as intertidal for plant cover subjected to inundation by

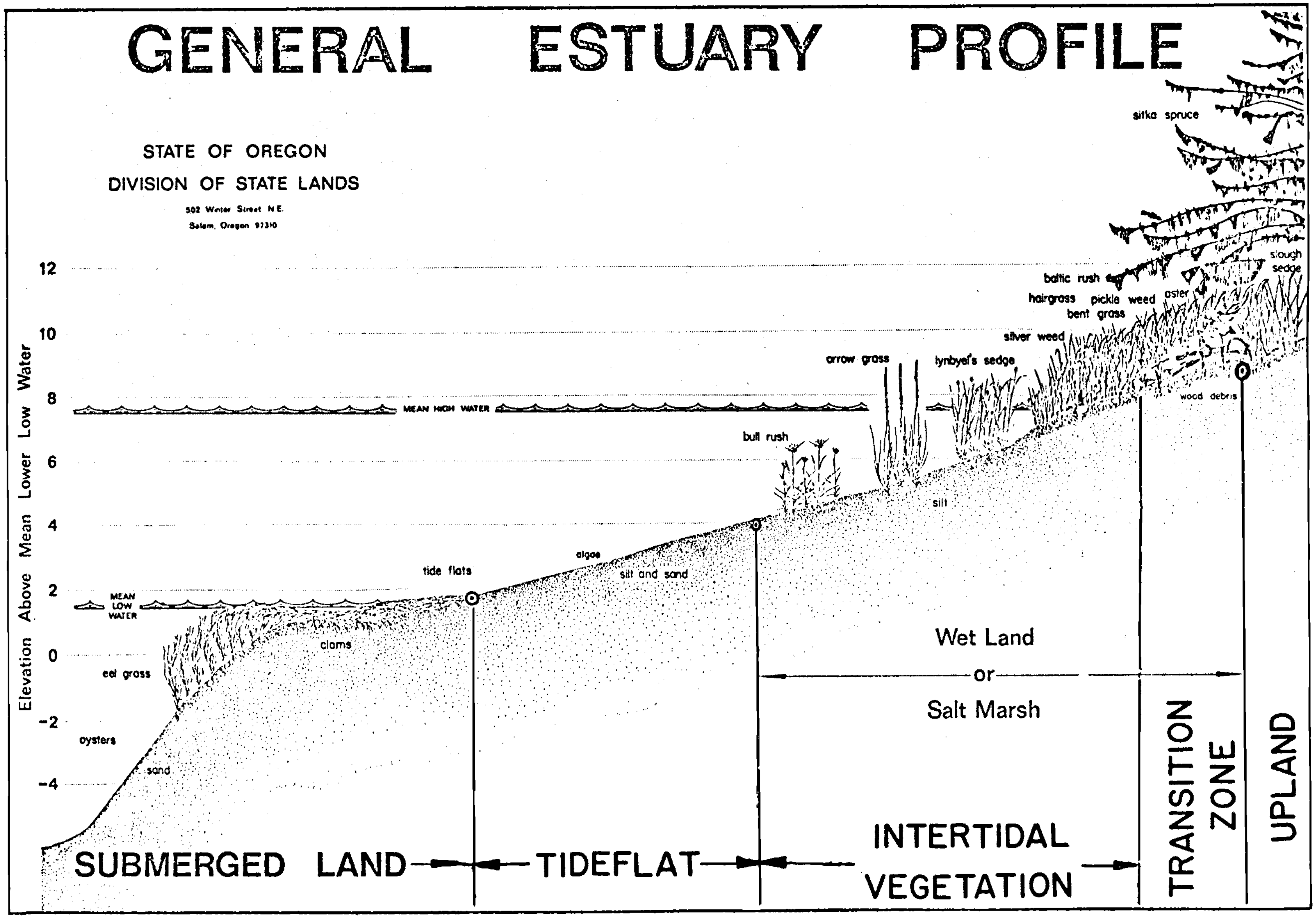

Figure 3. Vegetation zonation terminology across an estuary-marsh system (After: Division of State Lands, 1973).

at least seasonally high tides and extending from the upper limit of the tide flat to the lower limit of the transition zone. The transition zone refers to the ecotone between intertidal marsh and upland in which upland and intertidal species may both be present and where the zone is inundated by the most extreme tides and high water associated with winter storms. Upland refers to the zone generally beyond tidal influence where marsh species are generally absent and where terrestrial plants prevail.

Criteria

Criteria for the vegetational definition of the upper and lower transition were developed after an initial survey of a number of coastal marshes. For saline wetlands, the lower transition was defined by increased dominance of forbs (*Potentilla pacifica*, *Aster subspicatus*, *Achillea millefolium*) and diminished dominance by graminoids, especially a marked drop in *Deschampsia caespitosa* but often decreases in *Agrostis alba* and *Juncus arcticus*. The upper transition was marked by the dropping out of faculative halophytes such as *Potentilla pacifica*, *Distichlis spicata*, and *Grindelia integrifolia*; the sudden change from herbaceous form to shrub and tree form; and the appearance of numerous species characteristic of terrestrial vegetation.

For fresh water intertidal wetlands, the lower transition occurred within a tree shrub fringe with an overstory of *Physocarpus capitatus* and *Cornus stolonifera* and was marked by the prominence of *Impatiens noli-tangere* and *Athyrium filix-femina*. The upper transition was defined by the appearance of many terrestrial species such as *Polystichum munitum*, *Tellima grandiflora*, *Vaccinium* spp. and *Rubus* spp. and a shift from deciduous forest to coniferous forest overstory.

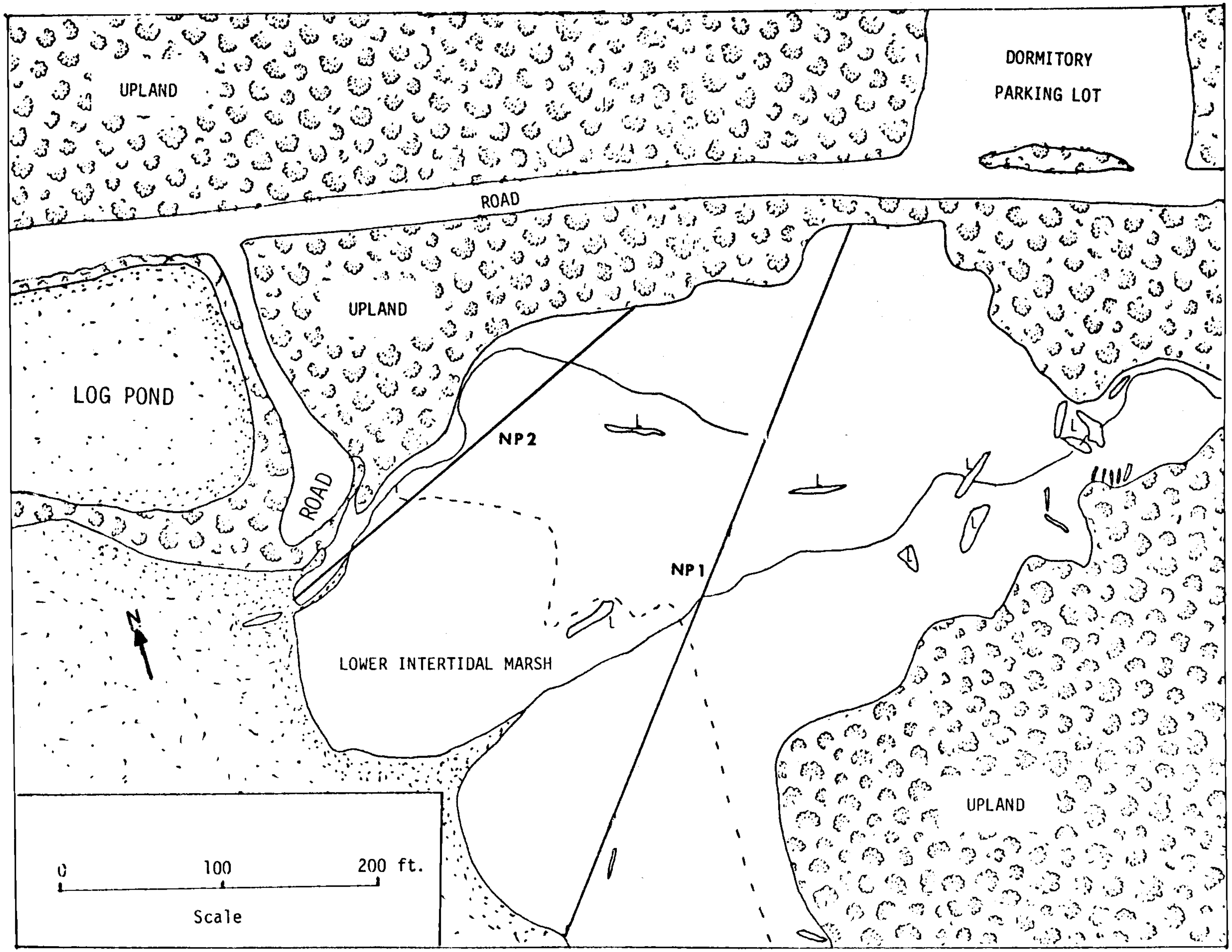

Figure 4. Newport Southbeach Marsh with transects NP1 and NP2.

RESULTS

Newport Southbeach Marsh

General Description

Two transects were established on a small, 3 ha, intertidal salt marsh which has developed on sandy substrate, about 1650 ft.(500 m) due south of the Oregon State University Marine Science Center (Figure 4). The eastern transect (NPI) was 460 ft. long; the western (NP2) was 260 ft. long. Jefferson (1975) mapped and classified this marsh as a Low Sand type. The marsh is enclosed by two older dikes to east and west respectively. The western dike has a dirt road on top and, in turn, encloses a log pond associated with an abandoned saw mill further to the west. The northern margin of the marsh is formed by a road embankment which supports many ruderal species. Two small creek systems drain the marsh. The western creek terminates in the marsh near its western edge. The other creek strikes northeast and drains effluent from the Marine Science Laboratory. Drifted material (large logs) is found throughout the marsh but is especially prevalent along the eastern edge in the area drained by the northeast draining creek.

The marsh is of recent origin as suggested by the following observations: (a) presence throughout of a number of species normally found as colonizers of the exposed tideflat (Salicornia virginica, Jaumea carnosa and Distichlis spicata); (b) poor development of high marsh (patchiness and species diversity); and, (c) the presence of much Salicornia virginica associated with Potentilla pacifica in the transition zone suggesting recent development of the transition zone.

Leveling was initiated at B.M. A590 (1965) near the entrance of the Marine Science Center. The level line was approximately 1500 feet along the road connecting the Marine Science Center and dormitory. Closing was within 0.10 feet.

Table 3. Selected species characteristic of various zones of the Newport Southbeach Marsh[1].

Species	Intertidal Marsh Lower	Intertidal Marsh Higher	Transition Zone	Upland
Triglochin maritimum	X	-		
Distichlis spicata	X	-		
Jaumea carnosa	X	-		
Salicornia virginica	X	-		
Cuscuta salina	X			
Plantago maritima	X			
Deschampsia caespitosa		X		
Juncus arcticus		X	X	
Festuca rubra		X	-	
Agrostis alba		X	X	
Grindelia integrifolia		-	-	
Potentilla pacifica			X	
Aster subspicatus			X	
Centaurium umbellatum			-	
Trifolium wormskjodii			-	
Koeleria cristata				X
Lotus uliginosus				X
Cytisus scoparius				X
Elymus mollis				X
Achillea borealis			-	X
Lathyrus palustris			-	X
Sonchus asper				X
Rubus laciniata				X
Hypochaeris radicata				X
Alnus rubra				X
Salix hookeriana				X

[1] X = species dominant, - = species may occur.

Vegetation Pattern

Species occurrence along the transects NP1 and NP2 are shown in Figures 5 and 6 together with elevation profiles based on 24 sample points. The same general pattern exists for both transects. A set of species (Distichlis spicata, Salicornia virginica, and Jaumea carnosa) characterize the lower marsh below 4.2 ft. (1.3 m). A second set of species appear in the upper intertidal marsh of which Deschampsia caespitosa was most prominent. A third group of species characterize the transition between the poorly developed high marsh and upland, the most important of which are Potentilla pacifica, Agrostis alba, Juncus arcticus, and Grindelia integrifolia.

Community patterns were identified with the aid of tabular analysis (Appendix C). As with the flow of species, four vegetation zones are recognized. First, a lower intertidal zone characterized by Triglochin maritimum and associated dominance by Distichlis spicata, Jaumea carnosa and Salicornia virginica was identified. The latter three species, however, transcend into a poorly defined intertidal high marsh where Deschampsia caespitosa, Agrostis alba, Festuca rubra and Grindelia integrifolia appear as dominants. A third zone, recognized as the transition zone, was characterized by Potentilla pacifica and high dominance of Juncus arcticus. The latter species also tended to appear in the Deschampsia zone. Lower intertidal species occasionally were present but with diminished cover. The fourth zone was upland recognized by many species not found in the marsh (Table 3).

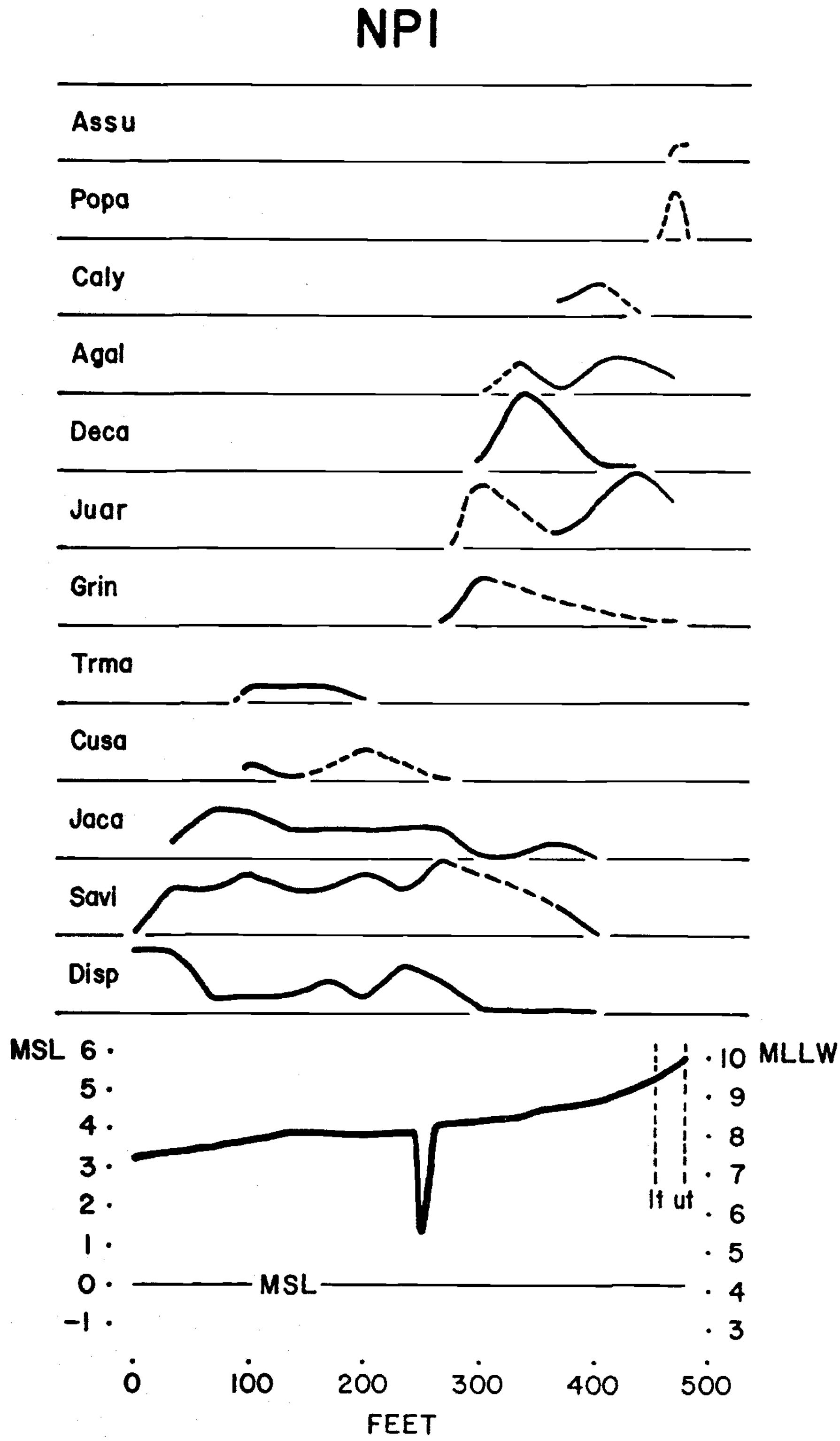

Figure 5. Species distribution and profile along transect NP1, Newport Southbeach Marsh.

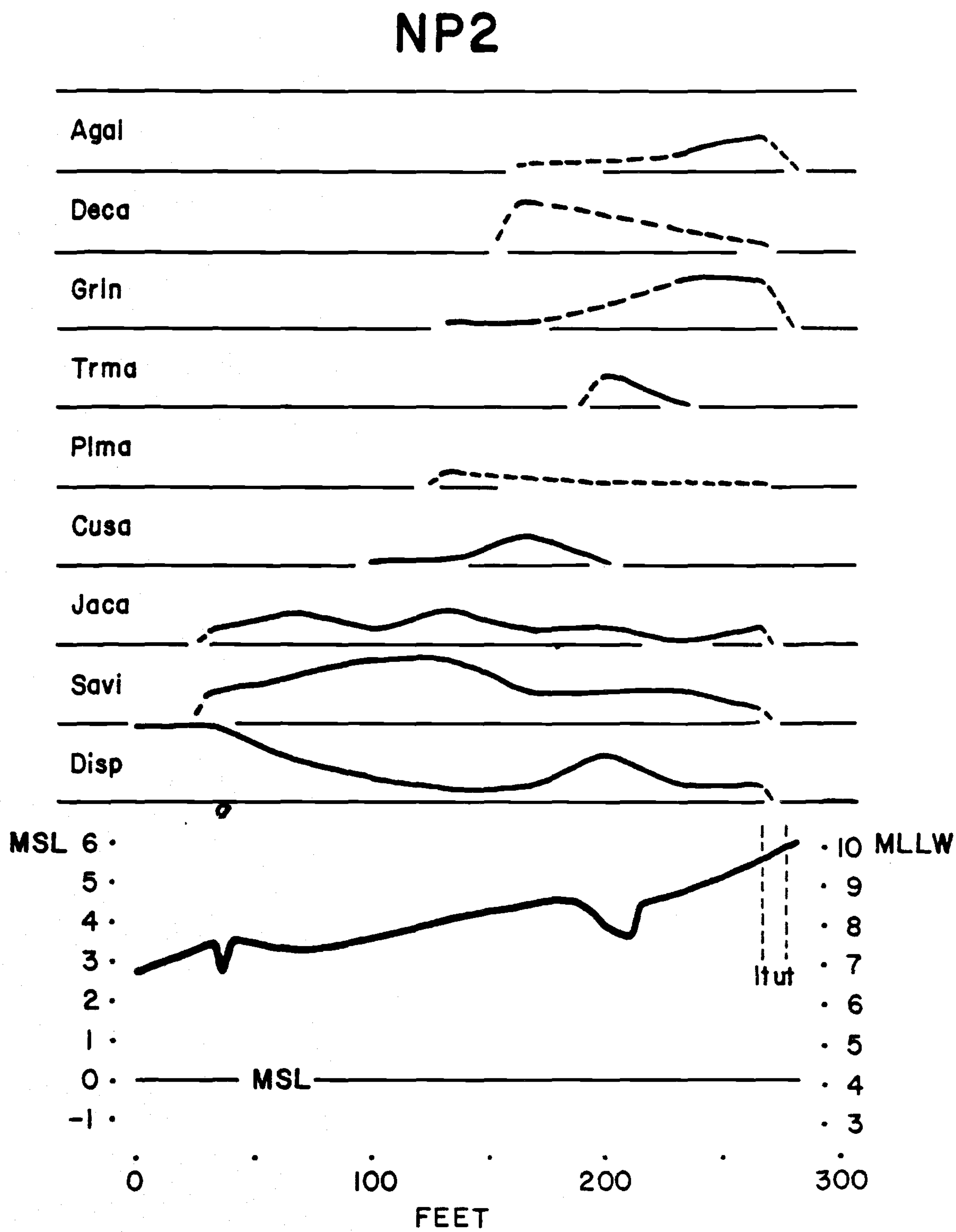

Figure 6. Species distribution and profile along transect NP2, Newport Southbeach Marsh.

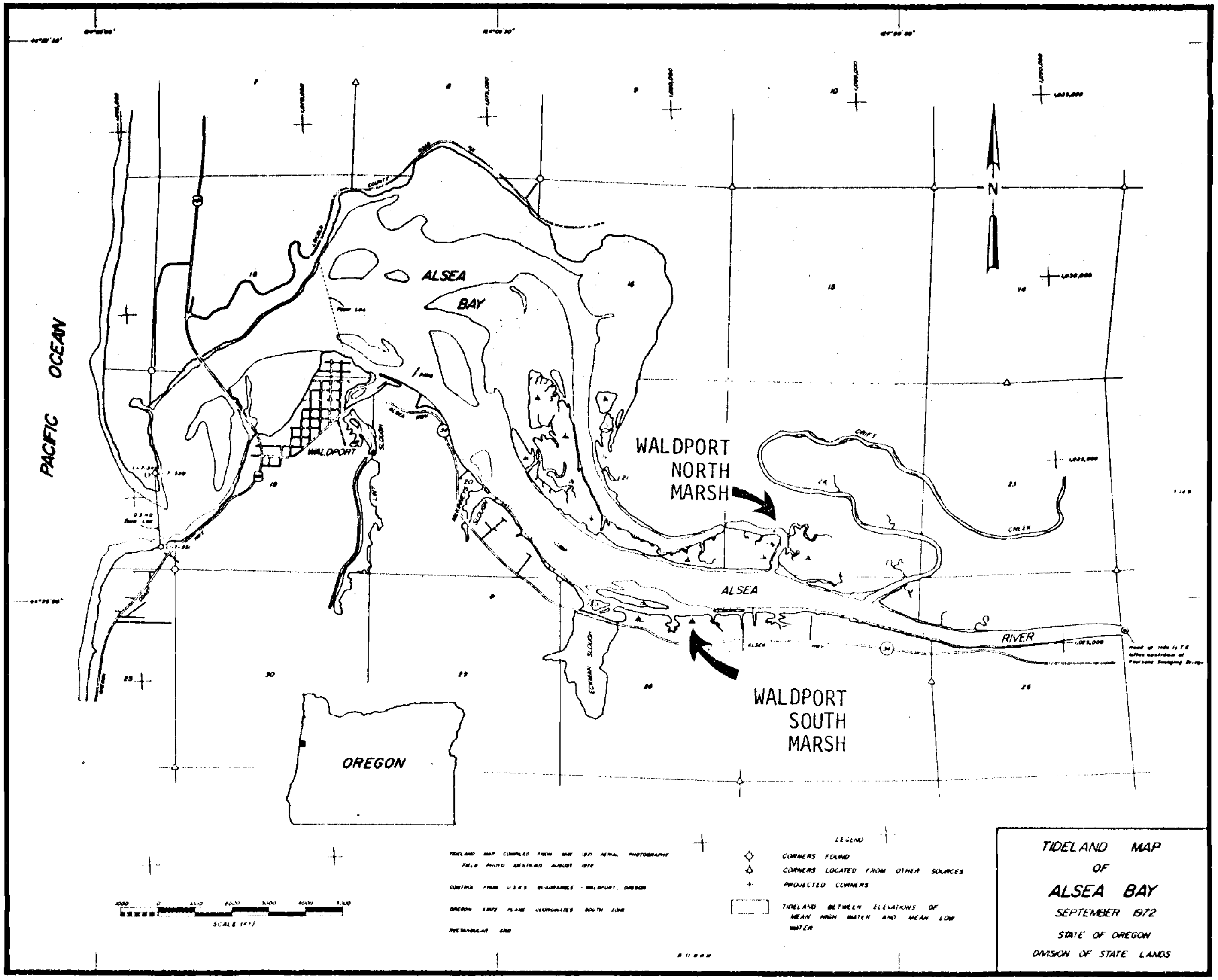

Figure 7. Alsea Bay with Waldport North and South Marshes. (Source: Division of State Lands, 1973).

Elevation Relations

Elevations of the four vegetation zones in the Southbeach Marsh, Newport, are based on spot data from two transects and 25 points for the lower boundary of the transition zone and 30 points for the boundary between the transition zone and upland.

	Above MSL	(No)
Lower Intertidal - Higher Intertidal	4.2 ft.	(2)
Higher Intertidal - Transition (Lower Transition)	5.29 ft.	(25)
Transition - Upland (Upper Transition)	5.84 ft.	(30)

Statistical analysis of these data and comparison with data from other marshes appears in the discussion section. It is noteworthy that the two authors, independently, determined the position of the upper and lower boundaries of the transition zone based on 12 to 15 measurments, each, within 0.06 feet for the lower transition and within 0.15 feet for the upper transition (Appendix H).

Waldport North Marsh

General Description

Waldport North marsh is part of an extensive marsh system which has formed on the northside of Alsea Bay on both sides of Drift Creek (Figure 7). The marsh is located about 0.5 mi. west of the mouth of Drift Creek at the sharp westerly bend in the main tidal channel (now blocked off by a dike) which parallels the present deep water channel. The marsh is almost all mature high intertidal marsh with a sharp break at the tidal creek of about 2 m (6.5 ft.). Active erosion of the marsh edge is taking place as evidenced by the bank and frequent slumps into the tidal channel. Slumped material is colonized by the tall form of Carex lyngbyei.

The upper portion of the marsh is choked with drifted log material deposited there during exceptionally high water and tides (personal communication with

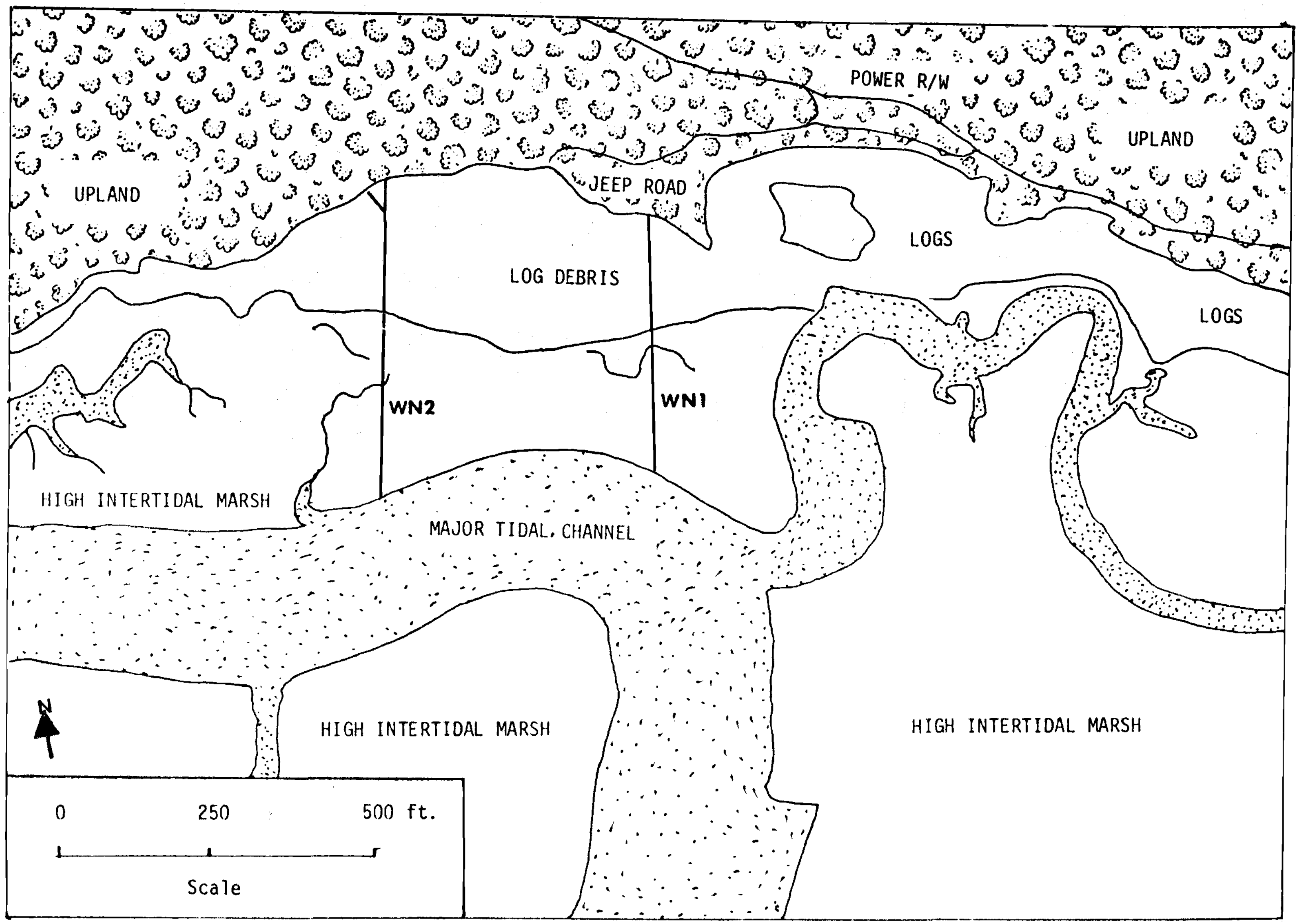

Figure 8. Waldport North Marsh with Transect WN1 and WN2.

Bosworth, at Oaklands). The amount of stranded material on the northside of the Bay (carried by southwest wind-driven waves) contrasts with its sparsity on the south side of the bay.

The marsh is bounded to the east by a deep tidal creek which reaches almost to upland and to the west by a series of prominent creek systems (Figure 8). The upper portion of the marsh is choked by drifted log material which has accumulated in a depression, possibly an old tidal channel.

Two transects (WN1) and (WN2) were established west of the two transects surveyed by Jefferson and Jarvis. Both transects were about 500 feet long and oriented roughly south to north, WN1 about 200 feet east of WN2. The transects intercepted a number of creeks and much stranded material.

The marsh was classified as a mature high marsh (Jefferson, 1975) and is netted by a complex pattern of creeks, many of which are partly obscured by a thatch of vegetation. Potentilla pacifica is widespread throughout the marsh, although often with minor cover.

Leveling was initiated at a B.M. "20 6D2E3 1931" near Oaklands. A line was taken across the Alsea River to a marsh east of Drift Creek; thence, northwest across the creek and across a very large, and hazardous marsh immediately east of the study marsh. Closing was along the margin of the north marsh system across the river and along Highway 34. Closing was within 0.10 feet.

Vegetation Pattern

Species distribution based on 33 samples along transects WN1 and WN2 is depicted in Figures 9 and 10 together with elevation profiles. The relatively flat profile marked by frequent creeks is common to both profiles. Both show a low levee close to the main creek, approximately 60 ft. from the start. Both show a slight depression just below the beginning of the transition zone in

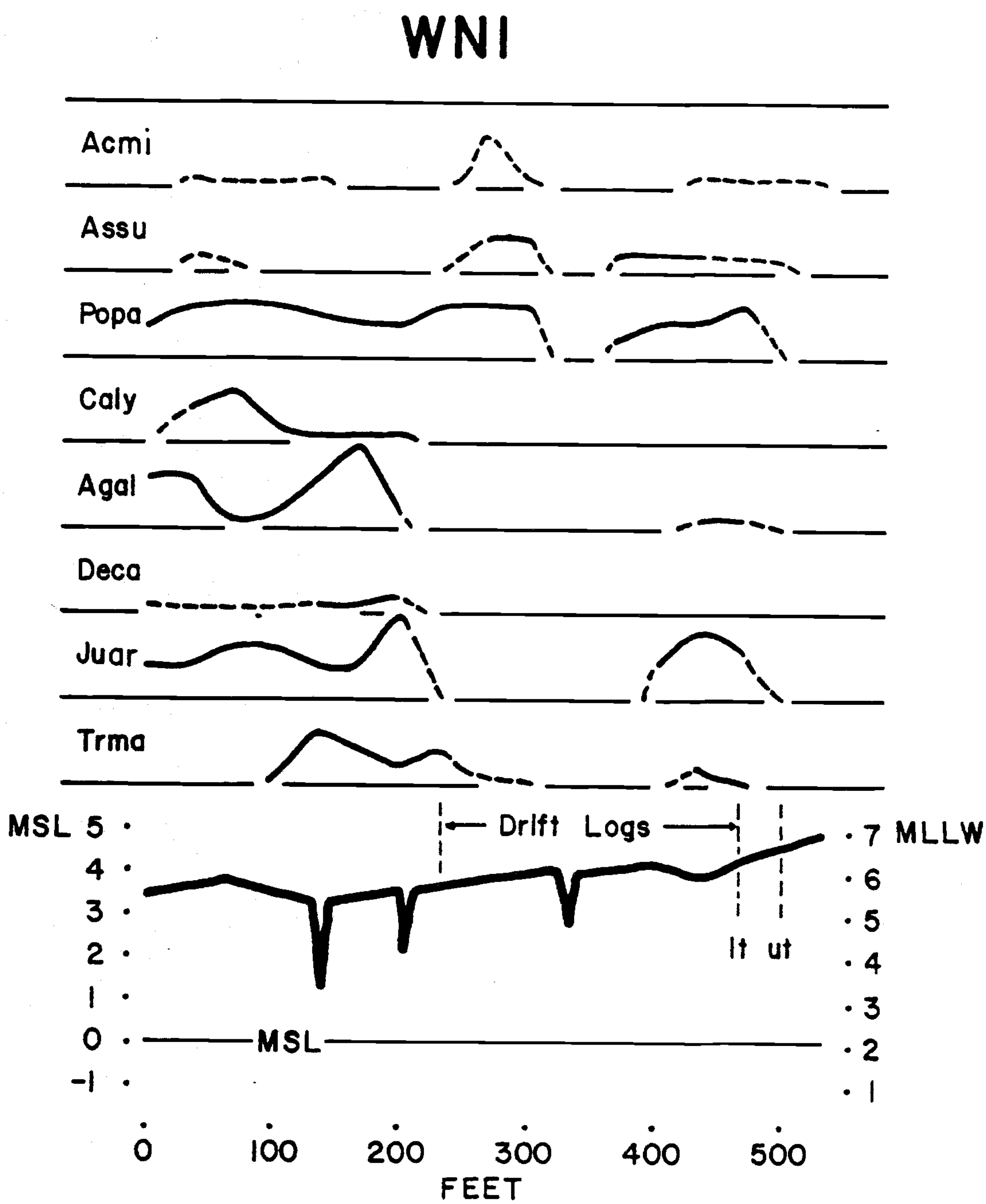

Figure 9. Species distribution and profile across transect WN1, Waldport North Marsh.

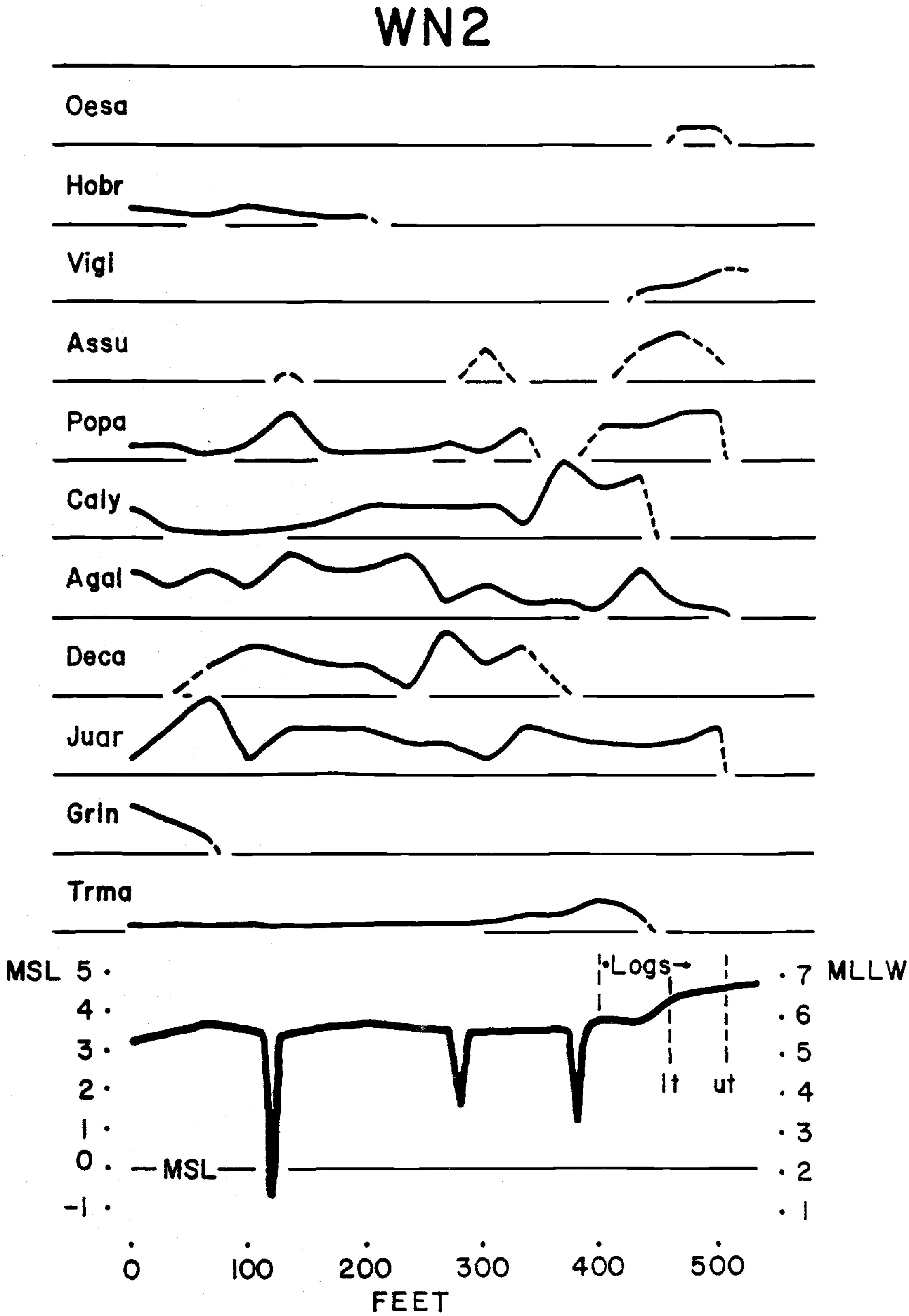

Figure 10. Species distribution and profile across transect WN2, Waldport North Marsh.

the area of drift log debris accumulation. The mature high marsh is marked by Agrostis alba, Juncus arcticus, and Deschampsia caespitosa (WN2 only). Potentilla pacifica and Juncus arcticus, occurring throughout the marsh, peak at higher elevations and dominate the transition zone. As with the Newport data, Deschampsia caespitosa drops out before the transition zone is reached. The transition zone is marked by the increased prominence of such species as Aster subspicatus, Oenanthe sarmentosa, and Vicia gigantea.

Community patterns are obscure (Appendix D). The lowest elevation community appears to be a high, mature, intertidal marsh identified by the presence of Triglochin maritimum, Carex lyngbyei with Glaux maritima, and Atriplex patula. A drier phase and higher phase of this marsh was marked by the presence of Deschampsia caespitosa, Hodeum brachyantherum, and Grindelia integrifolia. Potentilla pacifica, Juncus arcticus, and Agrostis alba occur throughout the marsh and cannot be used to identify any particular zone; however, Potentilla appeared dominant in most transition zone samples. Oenanthe sarmentosa, Galium aparine, Holcus lanatus, Angelica lucida, and Vicia gigantea all helped identify transition zone vegetation. Transition zone was marked throughout by stranded log debris.

While it was difficult to define in a precise way the community characteristics, the change from transition zone to upland was sharp. Upland was marked by Picea sitchensis, Vaccinium ovatum, Lonicera involucrata and many other terrestrial species. Marsh species dropped out.

Elevation Relations

Elevations of the three zones, tentatively identified at Waldport North, are based on spot data from two transects 10 points each from the upper and lower boundaries of the transition zone.

	Above MSL	(No)
Mature High Marsh - Transition (Lower Transition)	4.20 ft.	(10)

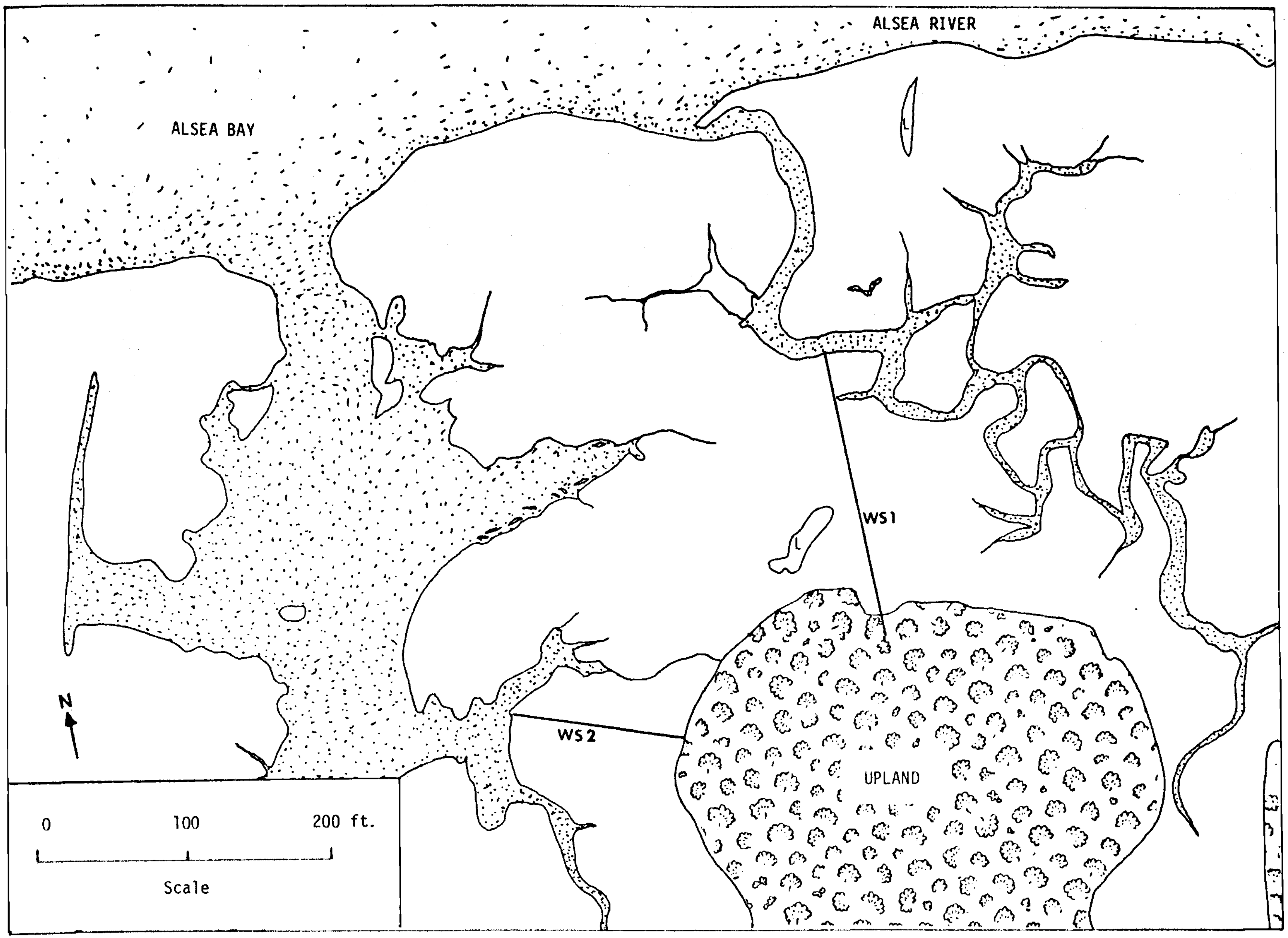

Figure 11. Waldport South Marsh with transects WS1 and WS2.

Transition - Upland (Upper Transition)	4.47 ft.	(10)

Statistical analysis of these data and a comparison with data from other marshes appears in the discussion section.

Waldport South Marsh

General Description

Situated about one mile east of Eckman Lake, Waldport South Marsh is undiked and open to a network of creeks to the east and to a major salient of tidal water to the west (Figure 11). A trailer park bounding the marsh on the east does not appear to affect it, nor does Highway 34 which is located immediately to the south of the marsh area. The upland has been created by a lobe of fill material now supporting a dense growth of Sitka spruce and alder. Jefferson (1975) classified the marsh as Mature High Marsh.

Initial reconnaissance of the marsh suggested a sharp lower transition boundary and a clear distinction between marsh and upland.

Leveling initiated at B.M. "20 6D2E3 1931", near Oaklands, followed along Highway 34 to the marsh. Closing was within 0.02 feet.

Vegetation Patterns

Two transects (WS1 and WS2) were staked, taped and surveyed. The more easterly, WS1, was 200 feet long and extended from a primary tidal creek to the distrubed upland fill material; sample interval was 5 m. The western, WS2, was 125 feet long, also with a 5 m sample interval (Figure 11).

Species distribution along the transect based on 25 samples is shown in Figures 12 and 13 together with an elevation profile for each transect. Both figures show an almost identical suite of species flows. The lowest marsh, near MSL, is occupied by the tall form of <u>Carex lyngbyei</u>, followed, with

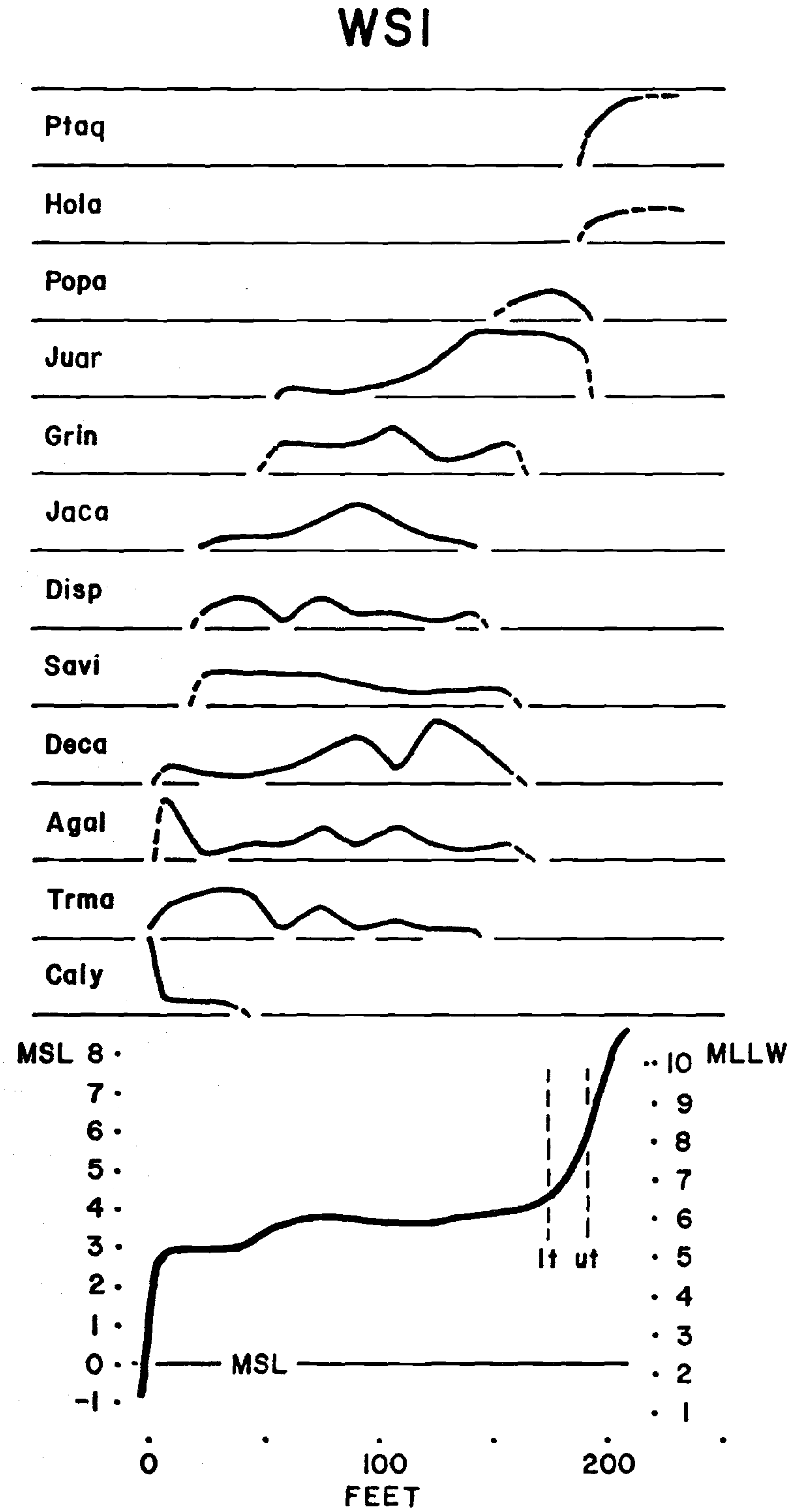

Figure 12. Species distribution and profile along transect WS1, Waldport South Marsh.

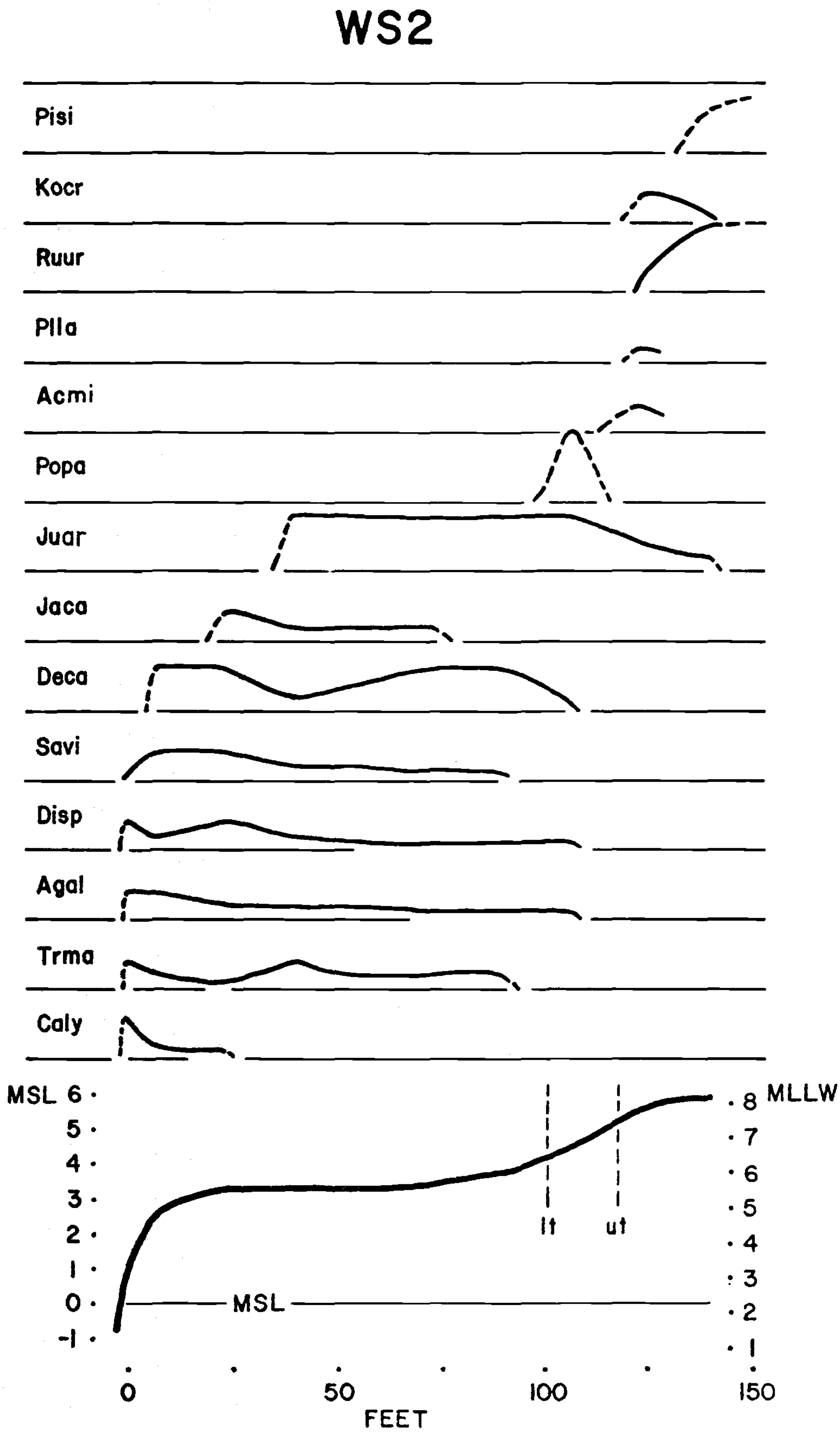

Figure 13. Species distribution and profile along transect WS2, Waldport North Marsh.

increasing elevation, by Triglochin maritimum, Agrostis alba, Distichlis spicata, Salicornia virginica and Deschampsia caespitosa. All of these species drop out before the transition zone. The transition zone is marked by the entry of Potentilla pacifica, accompanied by Juncus arcticus, the Juncus appearing in the upper portion of the intertidal marsh. The foregoing marsh species drop out altogether when upland is reached.

Plant community segregation is quite clear (Appendix E) with three widespread marsh communities and a disturbed upland assemblage. The lowest community, and the one most subject to tidal inundation, is dominated by Carex lyngbyei and Triglochin maritimum although other species characteristic of the next higher community may enter. This community is confined to the creek edges and slumped material characteristic of creek margins. The intertidal marsh is marked by a combination of Agrostis alba, Juncus arcticus, Deschampsia caespitosa, Triglochin maritimum, Distichlis spicata, Jaumea carnosa, Salicornia virginica, and Glaux maritima. A drier phase of this community is characterized by the entry of Grindelia integrifolia.

The transition zone is identified by strong dominance of Potentilla pacifica with frequent presence of Achillea millefolium. Both Juncus arcticus and Agrostis alba are also present in the transition zone. Upland is marked by the lack of intertidal species and the entry of such species as Rubus, Pteridium aquilinum and Holcus lanatus.

Elevation Relations

The Carex lyngbyei community occurred below 2.0 ft. above MSL (4.3 ft. above MLLW) which is in the range of the occurrence of Eilers' (1975) Carex community at Nehalem. The intertidal marsh below the transition zone ranged between 3.0 and 3.5 ft. above MSL. (5.3 to 5.8 ft. above MLLW). The lower and upper boundaries of the transition zone were determined, respectively, by

20 and 30 sample points. In this determination the two authors independently

	Above MSL	(No)
Intertidal Marsh - Transition (Lower Transition)	4.17 ft.	(20)
Transition - Upland (Upper Transition)	5.17 ft.	(30)

marked the upper and lower boundaries. For the lower transition, estimates, for 10 (RF) and 5 (PE) samples respectively, were within 0.03 ft.; and, for the upper transition for 10 (RF) and 5 (PE) samples respectively, were within 0.18 ft. Statistical analysis of the elevation relation of this marsh compared with the others in the discussion section.

Bandon Salt Marsh

General Description

An extensive, complex intertidal marsh system has developed to the east of the main Coquille River channel, about one mile north of Bandon (Figure 14). Since the marsh system spreads over 0.5 mi. from the river channel to upland, a linear segment of mature high marsh (Jefferson, 1975) which extends from a prominent tidal channel to upland over a width of 100 to 400 feet was selected for study (Figure 15). The upper portion of the marsh was covered by stranded log debris; the lower marsh exhibited weak zonation. A fence extending from a dense Sitka spruce forest upland cut across, at right angles to the marsh, to the tidal channel. A second fence had been erected near the upper limit of marsh. Although, it is known that cattle graze the unimproved marsh, there had been no grazing prior to data collection, July 22-23, and there was no sign of marsh vegetation deterioration under cattle grazing of previous years.

The upland in this area is composed of a fossil sand dune complex (Johannessen, 1961) and a low Sitka spruce moist forest with an understory of skunk cabbage marks the upland. There is evidence in the age structure of the upland spruce

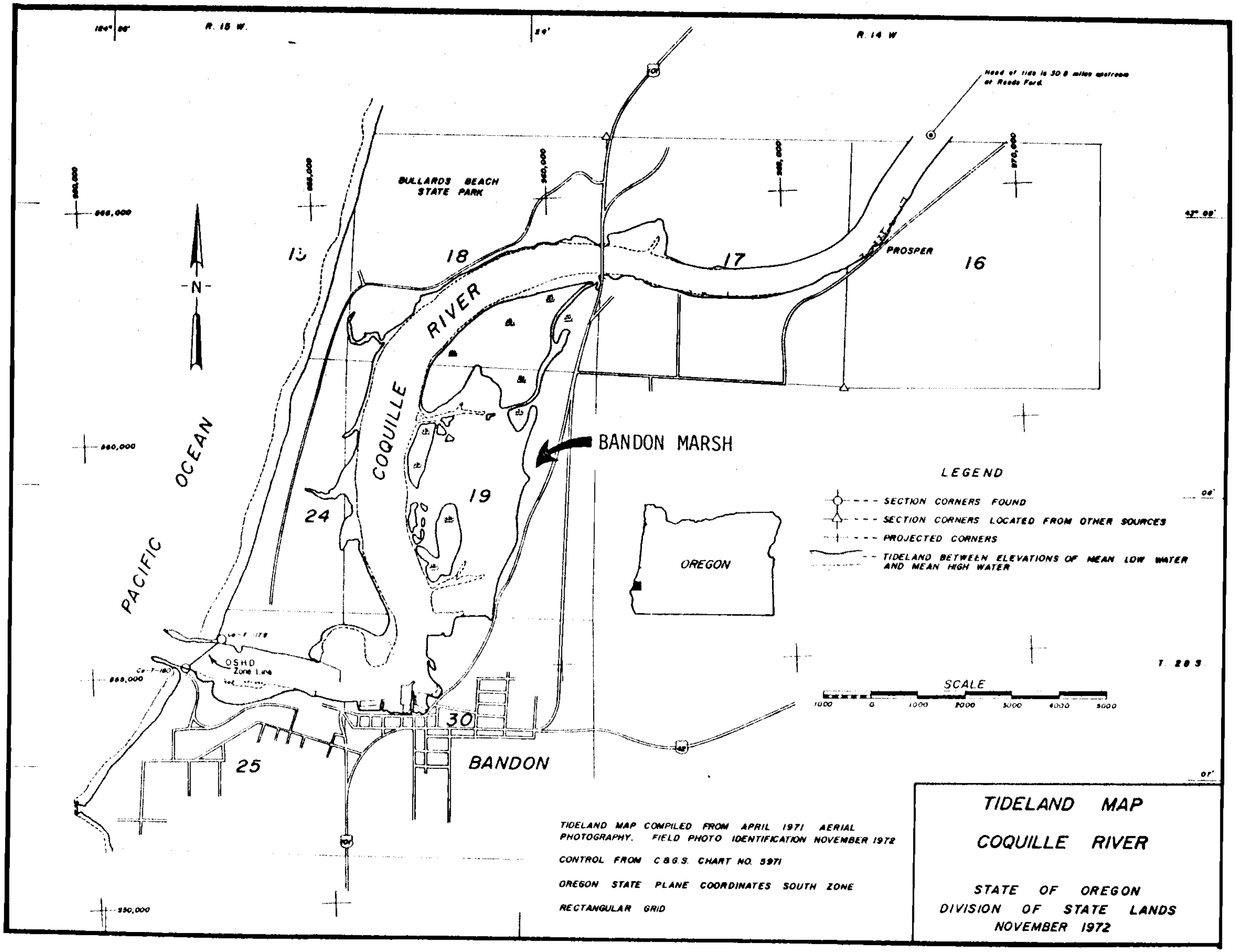

Figure 14. Coquille River Estuary and Bandon Saltmarsh. (After: Division of State Lands, 1973).

forest that the upland vegetation is advancing into the marsh and that the stranded log material in the present transition zone is aiding the bayward advance of the marsh. Indeed, there was evidence of strand material 25 m (80 ft.) into the Sitka spruce forest. The advance of upland vegetation into this marsh is consistent with Johannessen's (1961) interpretation of the recent progradation of the Bandon salt marsh complex.

Additional complexity in this marsh was contributed by fresh water seepage that altered the species composition of the higher intertidal marsh. Species, such as Scirpus americanus, S. cernuus, S. validus, and Eleocharis palustris gave evidence of this condition. Fresh water seepage was not unexpected, given the extensive fossil dune system and the porousness of such a sandy substrate and the probable interruption by dunes of an integrated stream network.

Levelling was initiated at B.M. "W 531 1954" at the southeast end of the Highway 101 bridge over the Coquille River, thence along the road and along the marsh. Closing was by the same route and was within 0.07 ft.

Vegetation Pattern

Three transects were surveyed (Figure 15). The most northern (BA1) extended over 200 ft. with quadrat spacing every 10 m, starting with the tidal creek. Elevation profile along the transect (Figure 16) exhibited a relatively steep gradient, 1.5%, followed by a flattening out in the transition zone. The central 220 foot transect (BA2) also initiating in the tidal creek, displayed a relatively flat profile in the intertidal marsh with a steep gradient as the transition zone was approached (Figure 17). Again, the transition zone was relatively flat. Transect BA3, 160 ft. long, showed similar profile characteristics to transect BA2 (Figure 18), again with a flattening in the transition zone.

Species composition along all three transects exhibited the same trends (Figures 16, 17, 18). The creek edge, 2 ft. above MSL, was dominated by

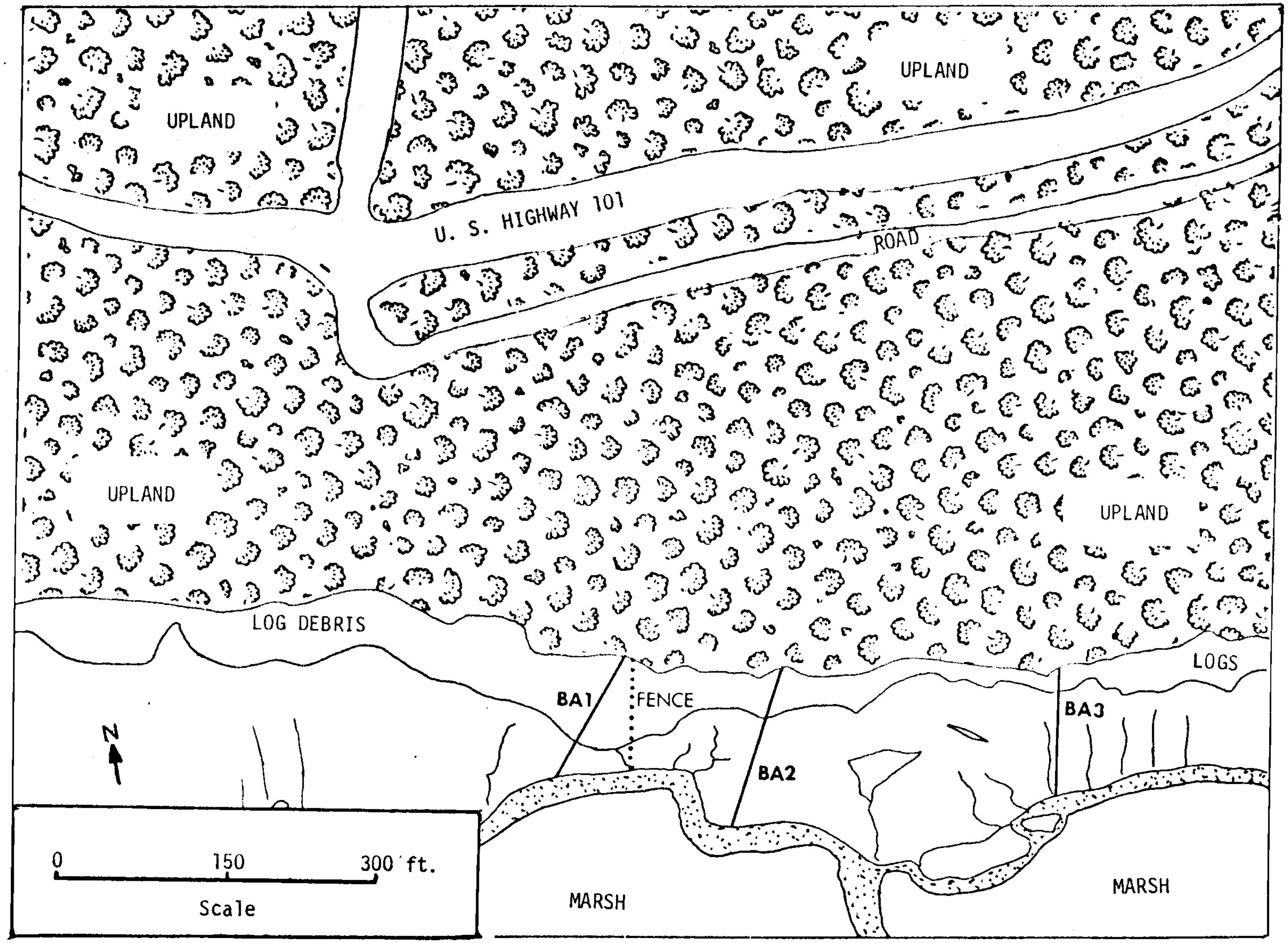

Figure 15. Bandon Salt Marsh with transects BA1, BA2, and BA3.

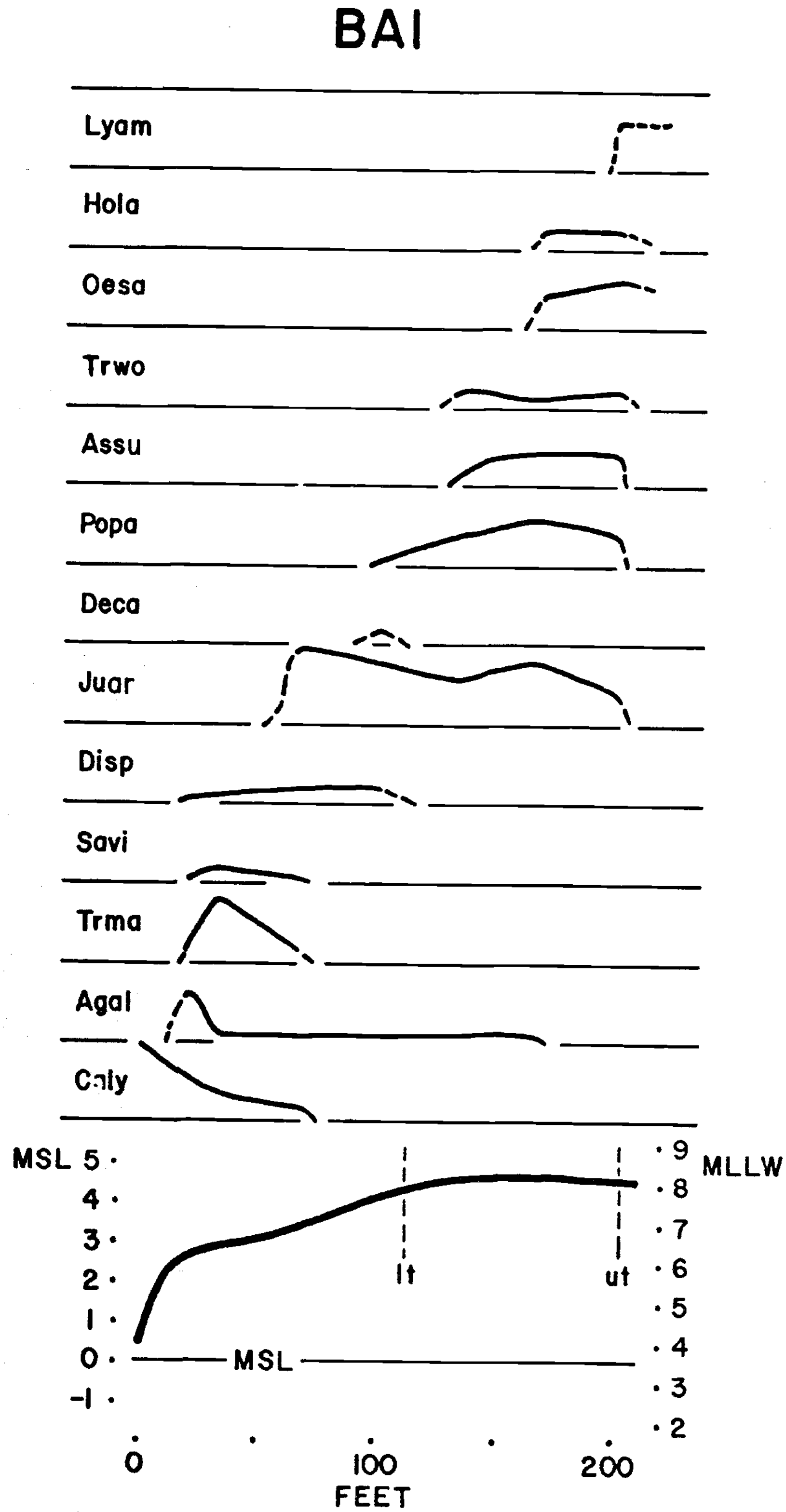

Figure 16. Species distribution and profile along transect BA1, Bandon Salt Marsh.

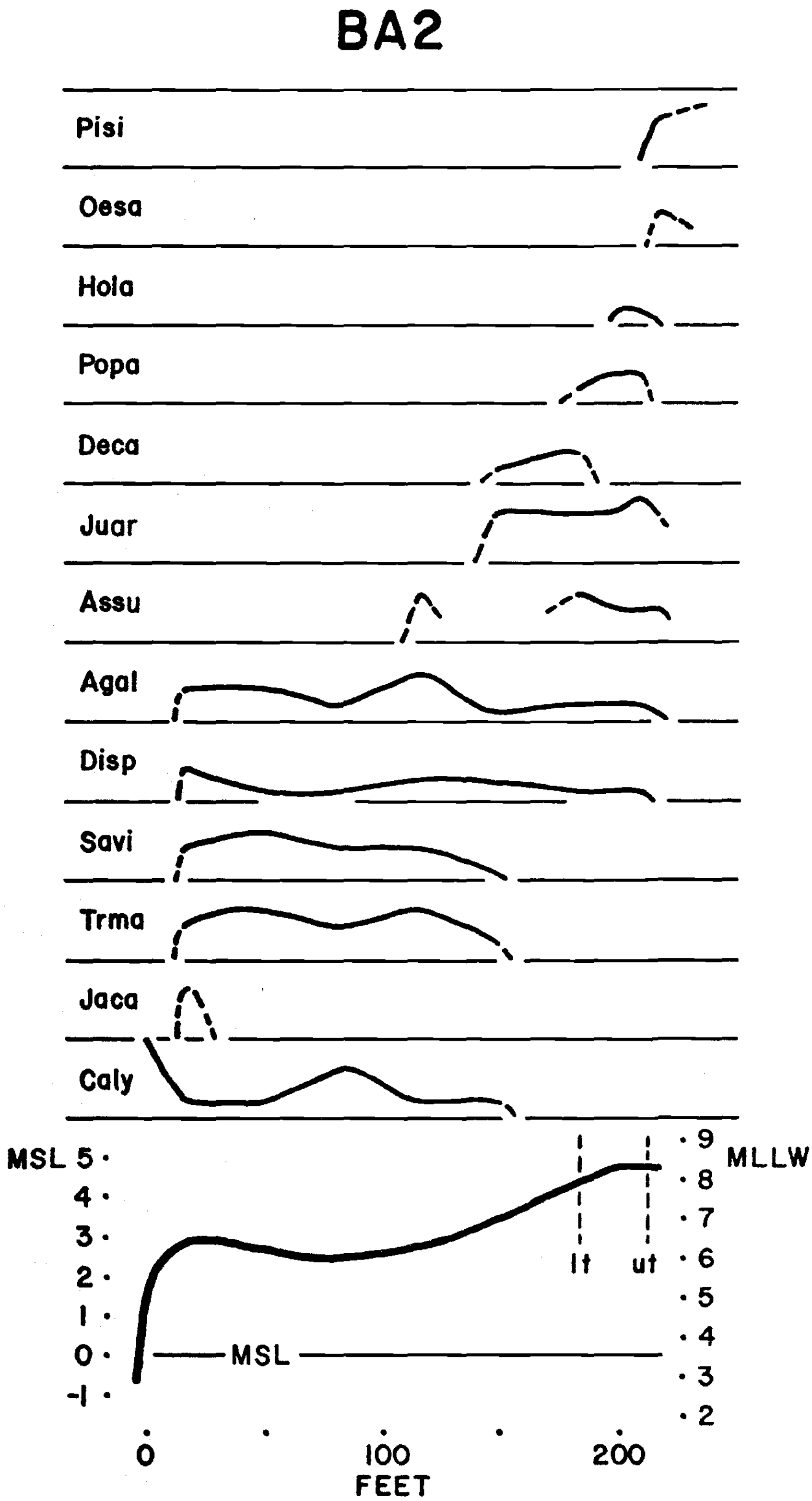

Figure 17. Species distribution and profile along transect BA2, Bandon Salt Marsh.

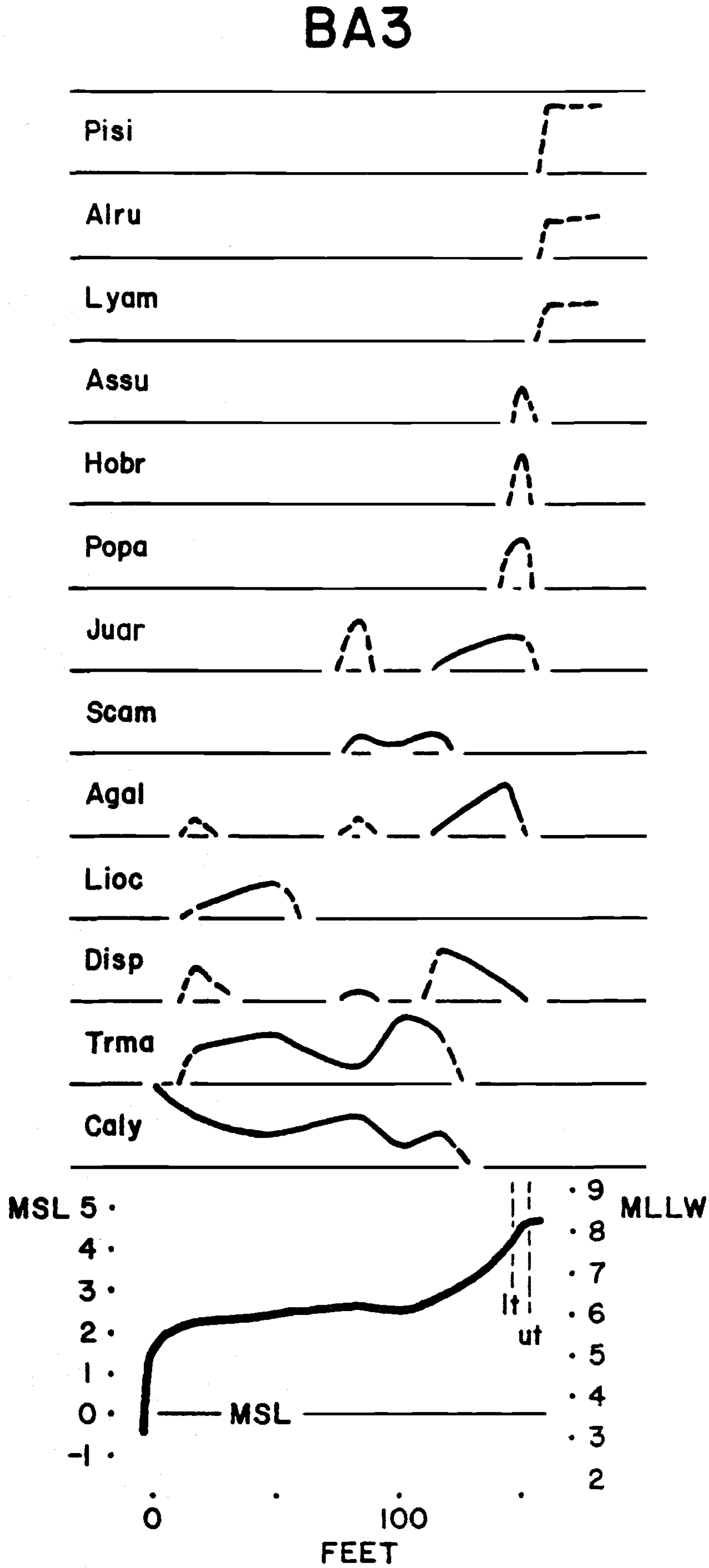

Figure 18. Species distribution and profile along transect BA3, Bandon Salt Marsh

Carex lyngbyei which then dropped out above 3 ft. above MSL. The intertidal marsh, was identified by Triglochin maritimum, Salicornia virginica, and Distichlis spicata in all three transects. Agrostis alba was prominent in the higher intertidal and extended into the transition zone. Deschampsia caespitosa, occupied a narrow zone just bayward of the transition zone. The lack of Deschampsia in this marsh may, in part, be due to its recency. The transition zone was clearly marked by the entry of Potentilla pacifica, Aster subspicatus, and Trifolium wormskjodii. Oenanthe sarmentosa and Holcus lanatus identified the uppermost part of the transition zone.

Four communities based on 41 samples were isolated and identified by computer manipulation of tabular data (Appendix F): (1) a lower intertidal marsh community characterized by complete dominance of the tall form of Carex lyngbyei; (2) a central intertidal marsh characterized by the short form of Carex lyngbyei, Triglochin maritimum, and Salicornia virginica and Distichlis spicata; (3) a transition zone identified by the dominance of Potentilla pacifica, Aster subspicatus and Trifolium wormskjodii but also substantial presence of Juncus arcticus and Agrostis alba, two species which occur in the intertidal marsh as well; and, (4) an upper transition zone marked by Oenanthe sarmentosa and Holcus lanatus.

Elevation Relations

Elevation ranges of some of the communities identified above were determined by spot data for the three transects and 20 points for the lower and 22 points for the upper transition zone boundary.

	Above MSL	(No)
Tall Carex lyngbyei	0-1.8 ft.	(3)
Intertidal - Transition (Lower Transition)	4.35 ft.	(20)
Transition - Upland (Upper Transition)	4.55 ft.	(22)

Statistical analysis of these data appears in the discussion section.

Burnside Intertidal Marsh

General Description

Situated four miles southeast of Tongue Point and 1.6 miles west of Settler Point on the south shore of the lower Columbia River Estuary, Burnside Intertidal Marsh is the least saline of the marshes studied (Figure 19). Jefferson took salinity measurements at this site in August 1973 during a 2-9 ft. above MLLW tidal cycle (Tongue Point) and recalled "figures as being 2-7 ppt surface water" salinities (Jefferson pers. comm.). The Spokane, Portland and Seattle Railroad cuts across the site. The railroad embankment blocks a large marshy embayment, except for a railroad bridge which permits confluence of the embayment with the estuary (Figure 20). The railroad ballast forms the "upland" for the marsh to the north (estuary side) and therefore presents a highly disturbed upland, the site for the transects. Fringing the west side of the embayment is a narrow strip of open marsh adjacent to a shrub thicket which, in turn, abuts into a steeply rising upland with Sitka spruce and western hemlock. This fringing marsh with associated upland provided a reasonably undisturbed transition zone and was the location of the south transect.

The Columbia River intertidal marshes, at their lower margins, have robust graminoid physiognomy and are subject to daily tidal submergence. The upper portion of the intertidal marsh consists of tangled shrub thickets (fens) and submerged deciduous poplar and ash forests subjected to inundation during the highest tides. Unfortunately, this single sample location was not representative of the total array of Columbia River intertidal marshes. Because of the shrub thicket, a sighting and access right-of-way had to be cut by brush hook.

Levelling was initiated at a USC&GS triangulation marker 95 "Milepost 95

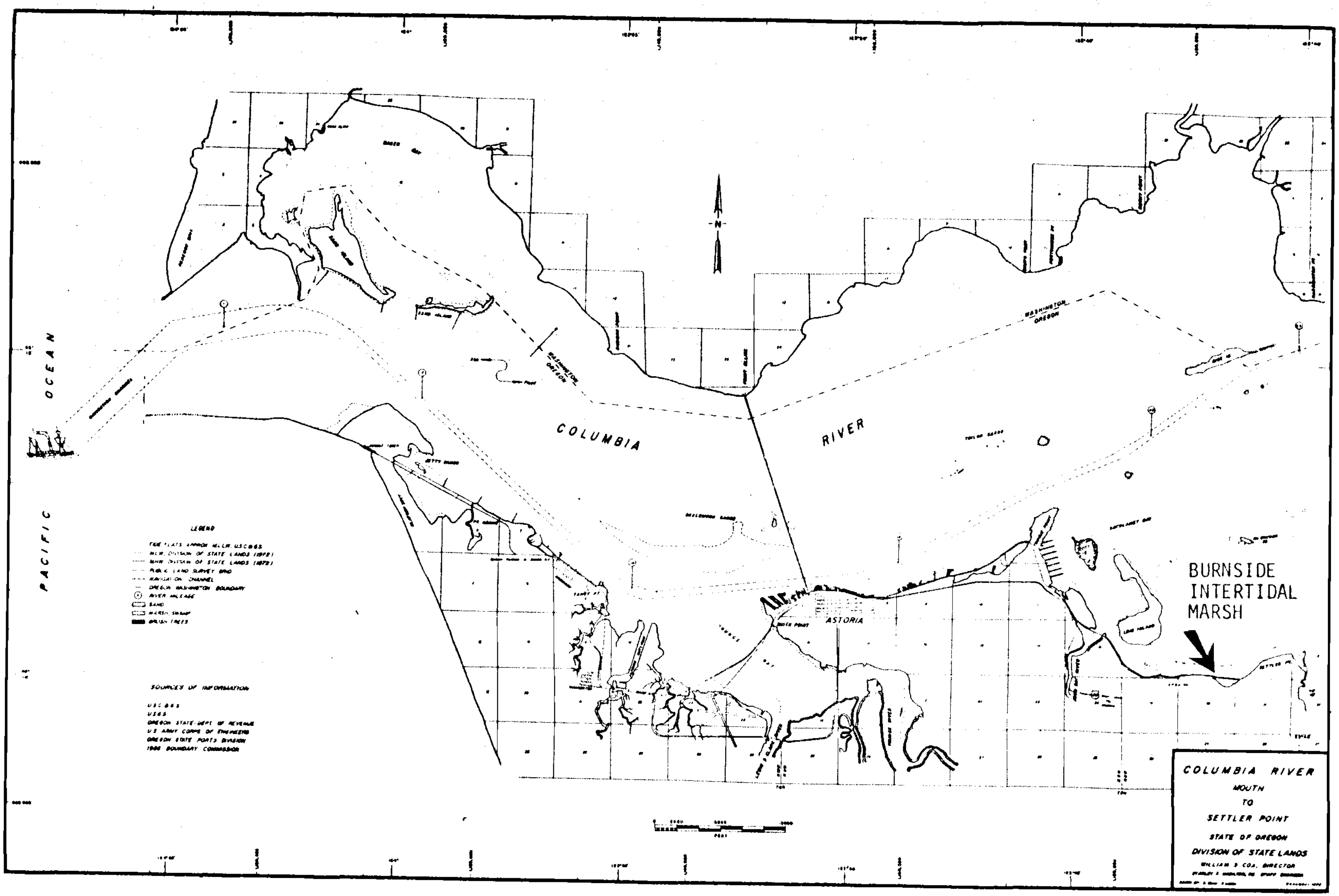

Figure 19. Lower Columbia River Estuary with Burnside Intertidal Marsh. (Source: Division of State Lands, 1973).

1934" along the "old" Highway 30 and was carried along the railroad to the marsh site. Closing was within 0.06 ft.

Vegetation Pattern

Species distribution along three transects is shown in Figures 21, 22 and 23. Transect BN1, located on the estuary side of the railroad, was essentially an open marsh with no true transition zone, as the railroad ballast intercepted the transect and the marsh was partially submerged during high tide. The profile (Figure 21) shows a lower intertidal marsh, almost completely submerged during daily high tide below 2 ft. above MSL. A sharp nick, of about one foot, separates the low tidal marsh from an intertidal marsh which grades from 2.5 ft. above MSL into a transition zone. The tidal marsh is dominated by Eleocharis palustris and Carex lyngbyei. The Carex remains in the intertidal marsh but is associated with such species as Sium suave, Glyceria grandis, and Polygonum hydropiper.

Transect BN2, about 200 ft. to the west of BN1, was 40 ft. long but traversed a well-defined transition zone also merging into the upland created by the railroad ballast (Figure 22). The low tidal marsh at this transect was unvegetated with the intertidal marsh starting at 3 ft. above MSL. The intertidal marsh was marked at its outer margin by rich assemblage of species and in its inner margin by a species-poor shrub thicket. Carex lyngbyei and Polygonum hydropiper give way to the shrub complex with Salix piperii, S. sitchensis, and Physocarpus capitatus. The transition zone is marked by a shrub overstory and herbaceous dominance of Impatiens noli-tangere and a very robust growth of Athyrium filix-femina. Upland is identified by species as Holcus lanatus, Polystichum munitum, Alnus rubra, and Picea sitchensis.

Transect BS1 based on 19 samples (Figure 23), on the embayment side of the railroad bridge, was 110 ft. long with 30 ft. of open marsh and then

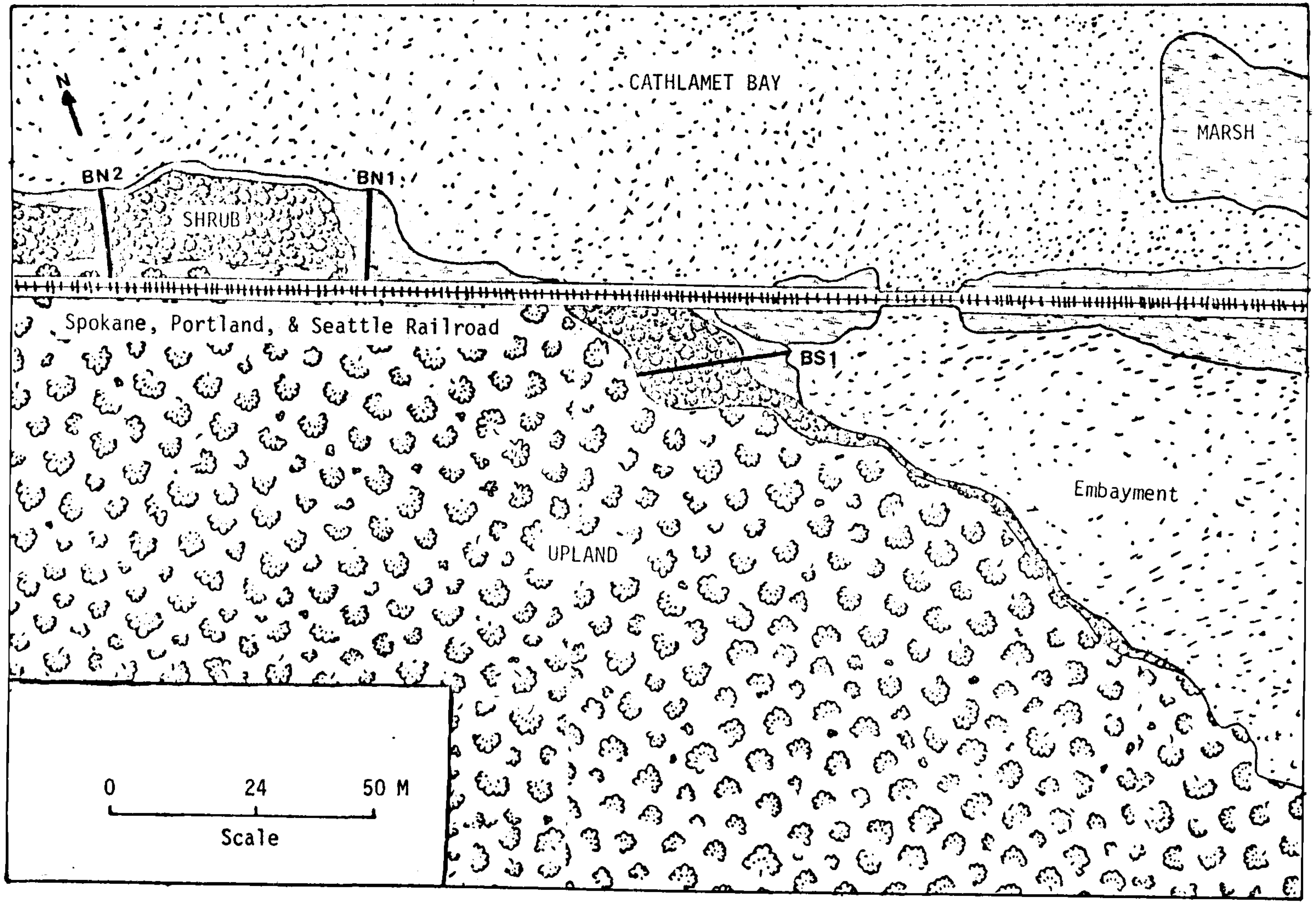

Figure 21. Burnside Intertidal Marsh with transects BN1, BN2, and BS1.

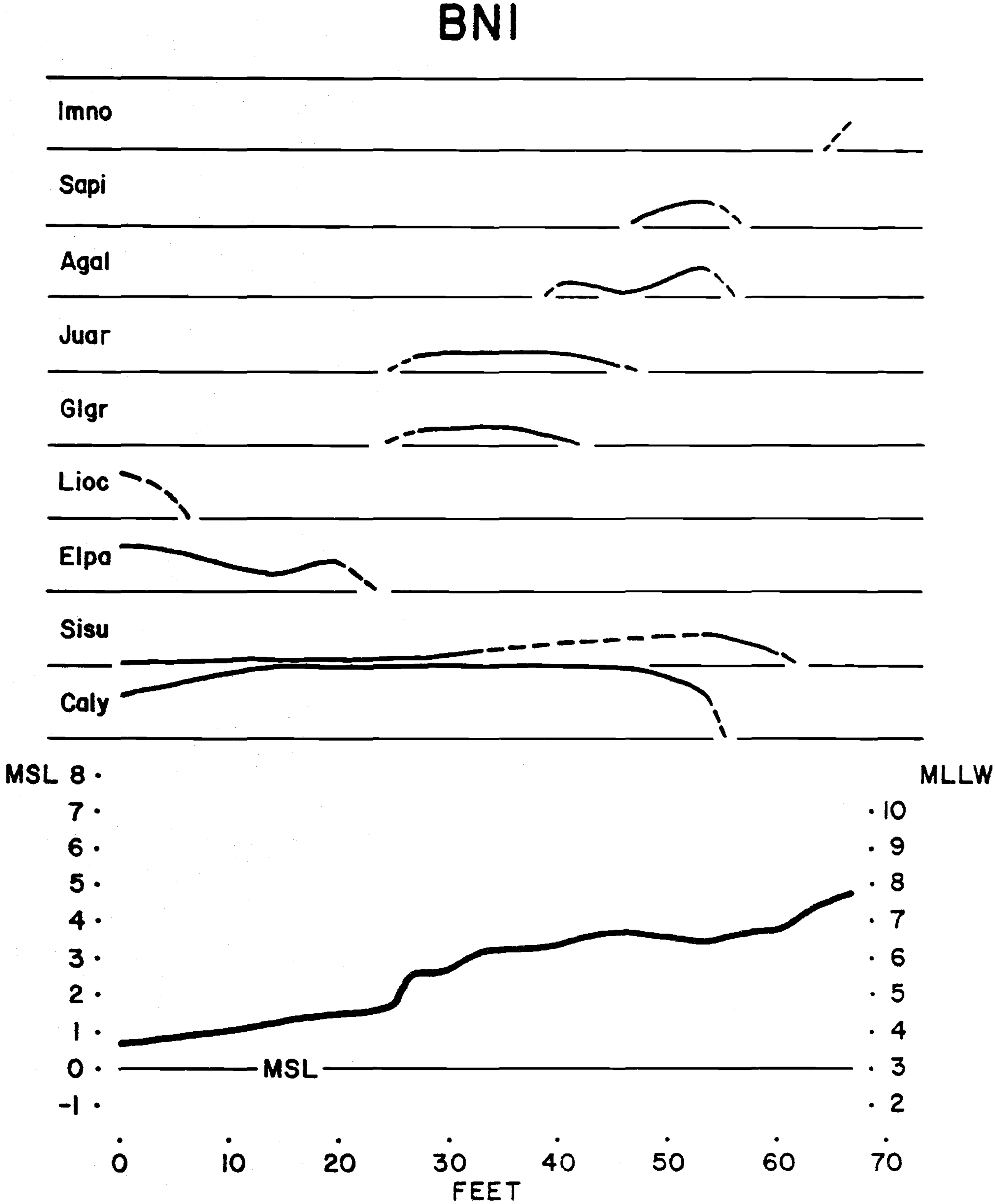

Figure 22. Species distribution and profile along transect BN1, Burnside North Intertidal Marsh.

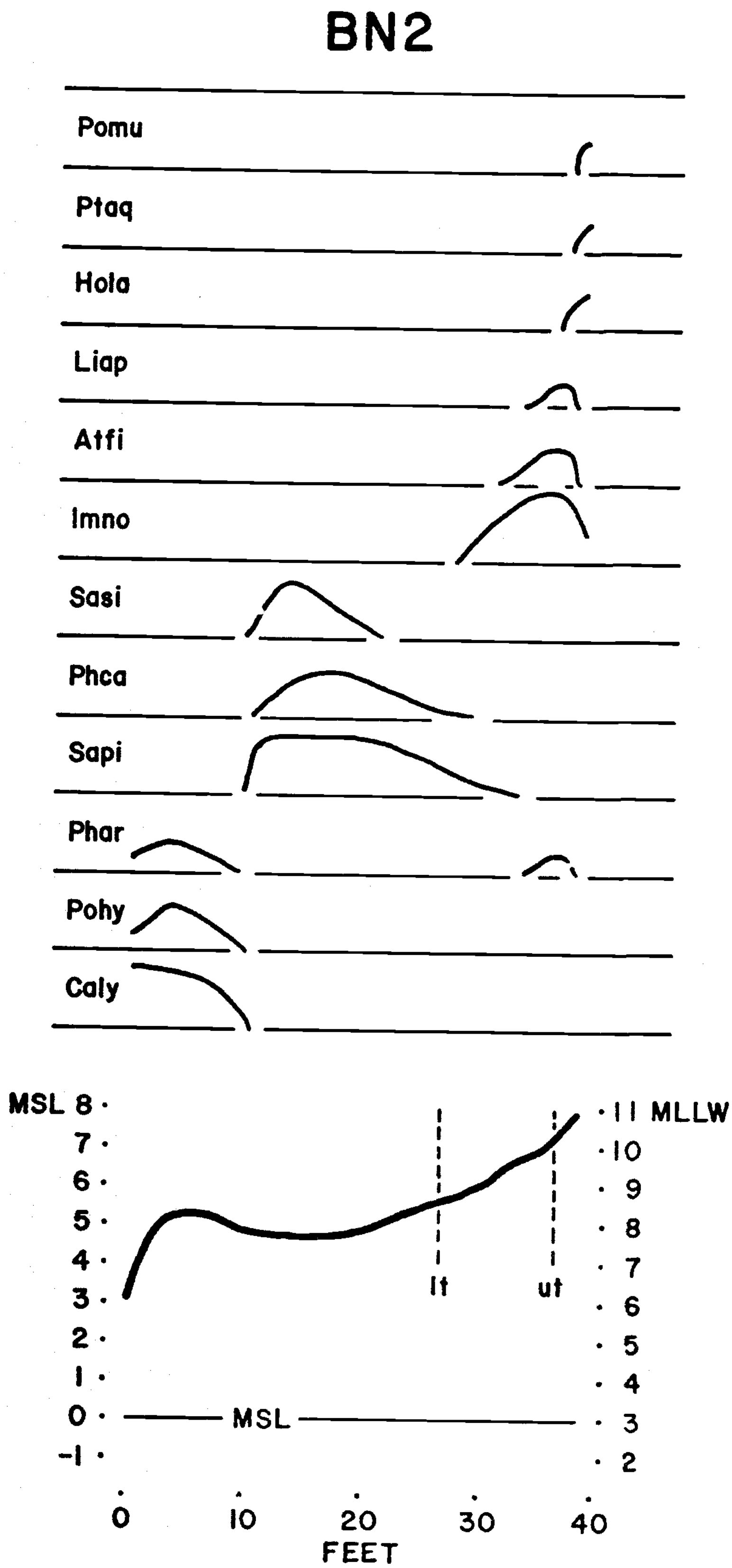

Figure 23. Species distribution and profile along transect BN2, Burnside North Intertidal Marsh.

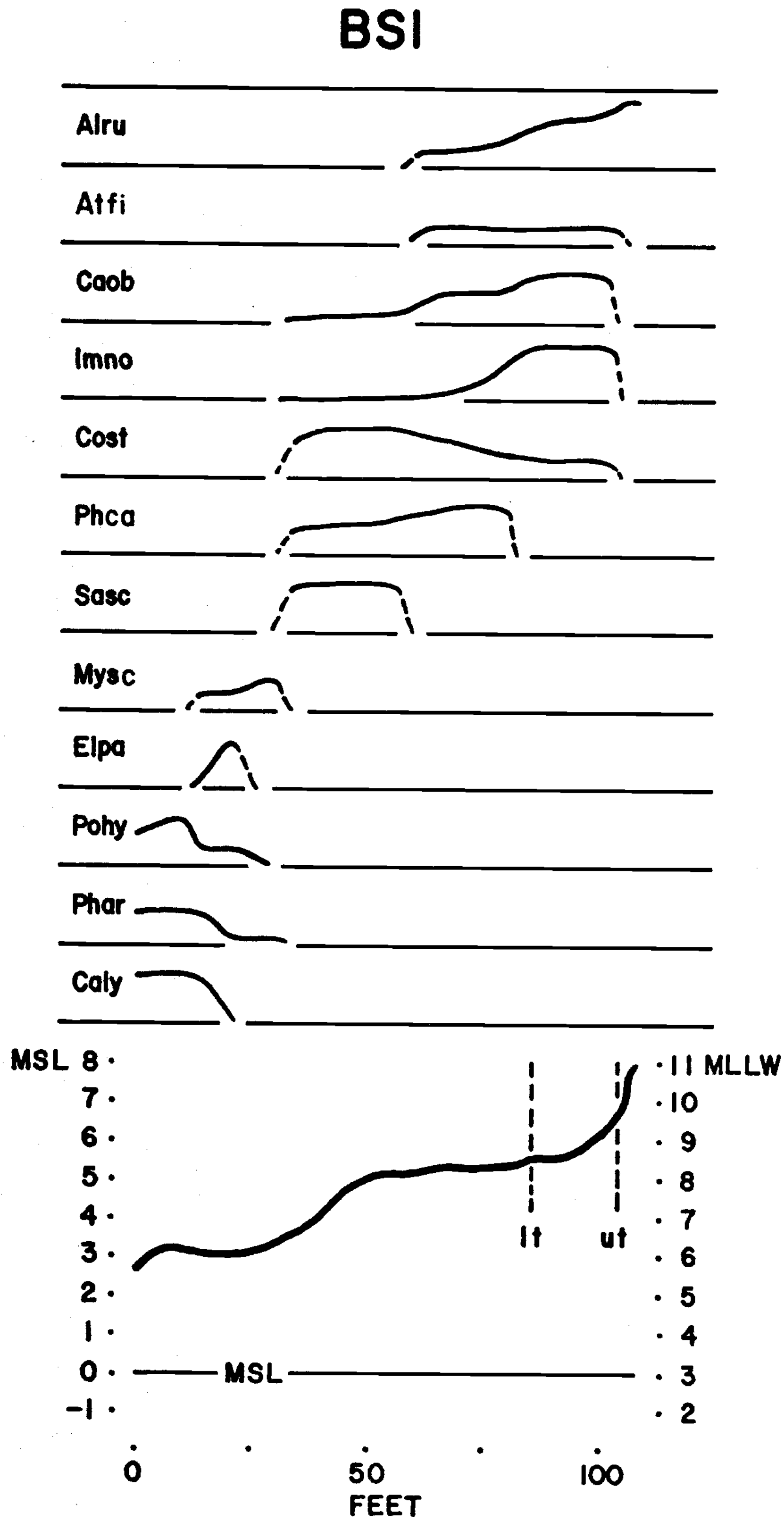

Figure 24. Species distribution and profile along transect BS1, Burnside South Intertidal Marsh.

an abrupt tangle of shrubs. As with BN2, the tidal marsh was unvegetated, with the open fringing marsh extending from 3 ft. above MSL to about 3.5 ft. Species distribution along this transect is very similar to that of BN2 except that Cornus stolonifera enters as one of the shrub species and Carex obnupta together with Impatiens noli-tangere mark the understory of the transition zone.

Community analysis of the intertidal vegetation based on 26 samples (Appendix G) breaks down into three assemblages: (1) an intertidal marsh group with Carex lyngbyei, Polygonum hydropiper, Saggitaria latifolia, Bidens cernua, Eleocharis palustris, Alisima plantago-aquatica, Sium suave, Oenanthe sarmentosa, and Myostis scorpioides; (2) a shrub thicket dominated by Salix spp., Physocarpus capitatus, Cornus stolonifera and in the understory, Lysichitum americanum; and (3), a transition zone in which a basic shrub thicket with Cornus stolonifera and Alnus rubra dominant, has characteristic understory species such as Impatiens noli-tangere, Athyrium filix-femina, and Carex obnupta. The upland is distinguished by non-marsh species such as Picea sitchensis, Tsuga heterophylla, Polystichum munitum, Tellima grandiflora, and Rubus spp.

Elevation Relations

Transect elevations were based on 45 points. The tabulation below gives the elevation above MSL. No clear elevation was determined for the lower transition, however, an estimate is based on 2 points. The upper transition is based on 9 points.

	Above MSL	(No)
Lower Tidal	2.8 ft.	(3)
Intertidal (open)	2.8 ft.	(3)
Intertidal (shrub)	4.0 ft.	(2)
Lower Transition	5.34 ft.	(2)
Upper Transition	7.18 ft.	(9)

DISCUSSION

Vegetation Pattern--Saline Marshes

No single plant species can be used unequivocally to define the upper limit of intertidal saline marsh. Species distribution data and community analysis of the four coastal salt marshes studied, however, show consistent patterns. In the vicinity of Mean Tide Level there develops a colonizing marsh edge community made up variously, depending on substrate character, of Triglochin maritimum, Salicornia virginica, Scirpus maritimus and Carex lyngbyei. This intertidal colonizing vegetation was not investigated thoroughly in this study but forms the lowest community in an elevation sequence and frequently shows high species dominance and low diversity (Eilers, 1975).

Intertidal Marsh: At slightly below MHW an intertidal marsh develops with the following species in various combinations (Table 4). There is a tendency for these species to segregate out into a low intertidal marsh assemblage and high intertidal marsh assemblage as indicated in Table 4. Only species which show strong dominance or clear segregation are listed.

Table 4. Species common to the low and high intertidal salt marsh.

Species	Position
Agrostis alba v. palustris	H
Atriplex patula v. hastata	H
Carex lyngbyei	L
Deschampsia caespitosa v. longiflora	L
Distichlis spicata	L
Glaux maritima	L
Jaumea carnosa	L
Juncus arcticus ssp. occidentalis	H
Orthocarpus castillejoides	L/H
Plantago maritima v. juncoides	L
Salicornia virginica	L
Spergularia macrotheca	L
Triglochin maritimum	L

The majority of these species are associated with low intertidal marsh, but since a marsh builds up over time, many of these species survive as relicts in the higher marsh. Also, in the topographically uneven high intertidal marsh, depressions among clumps of _Deschampsia_, for example, often support species commonly more dominant in lower portions of the marsh; e.g., _Glaux maritima_ and _Salicornia virginica_

Transition zone: The transition zone between intertidal high marsh and upland is characterized by the entry of many different species that are not found in the intertidal marsh, and, the disappearance or general diminishing of the intertidal species. Two exceptions to this generalization occur: _Juncus arcticus_ and _Agrostis alba_ both remain important in the transition zone. Typical transition zone species are listed in Table 5 with suggestions as to their elevation segregation.

Table 5. Species common to the salt marsh transition zone.

Species	Position
Achillea millefolium	H
Agrostis alba v. _palustris_	L/H
Angelica lucida	H
Aster subspicatus	H
Conioselinum pacificum	L/H
Festuca rubra v. _littoralis_	L/H
Galium trifidum v. _pacificum_	H
Grindelia integrifolia v. _macrophylla_	L/H
Hordeum brachyantherum	L/H
Oenanthe sarmentosa	H
Potentilla pacifica	L/H
Trifolium wormskjoldii	H

Strong dominance by _Potentilla pacifica_ was often noted in the transition zone; however, such species as _Aster subspicatus_, _Conioselinum pacificum_, and _Oenanthe_ sarmentosa together with the aforementioned Juncus and Agrostis often identified the transition zone.

Because of its position above MHHW at the upper margin of marsh, the transition zone was frequently covered by stranded logs and other tidal- and storm-carried debris. The role of the debris in building up marsh due to decay, in interrupting drainage systems, and as a localized site for upland plants to colonize was not investigated.

The presence or absence of drift logs was not sufficient evidence to define the transition zone boundaries. In Waldport North Marsh a strandline of drift logs accumulated massively in the transition zone, being driven to this location by southwest winter storms. Across the bay, in Waldport South Marsh, there were virtually no drift logs and, the few that were there, were scattered through the marsh. In this case, the transition zone could only be defined floristically.

Upland: Vegetation beyond the influence of tidal inundation varied in its species composition depending on substrate, drainage, and disturbance. Often upland was defined by a sharp topographic break but sometimes there was a shallow depression between the transition zone and upland. Regardless, species composition in the upland lacked intertidal species, being dominated almost exclusively by terrestrial species. Tree and shrub physiognomy characterized upland while the marsh and transition zone of tidal salt marshes were herbaceous. This physiognomic pattern was not completely the case for the intertidal non-saline marshes.

Vegetation Pattern--Non-Saline Marshes

Only one marsh in the Columbia Estuary was studied. Species composition of the marsh, its physiognomy and the nature of the transition zone differed from the saline marshes discussed above.

A submerged intertidal marsh of Scirpus spp., Carex lyngbyei and Eleocharis palustris gave way to a very rich intertidal marsh with plants frequently exceeding 1.5 m (5 ft.) in height. Table 6 lists some of the more prominent species in this open (non-shrubby) marsh. The above list is based on visits

Table 6. Species common in the open intertidal fresh water marsh.

Species	Species
Agrostis alba v. palustris	Polygonum coccineum
Alisma plantago-aquatica	Polygonum hydropiper
Bidens cernua	Polygonum persicaria
Caltha asarifolia	Ranunculus orthorhynchus
Carex lyngbyei	Rorripa islandica v. glabrata
Epilobium glandulosum	Saggitaria latifolia
Glyceria grandis	Scirpus microcarpus
Helenium autumnale v. grandiflora	Senecio triangularis
Habenaria dilatata v. albiflora	Sium suave
Lycopus uniflorus	Typha angustifolia
Mentha arvensis v. glabrata	Veratrum viride
Mimulus dentatus	
Myosotis scorpioides	

to several other marsh sites along the Columbia River Estuary but all species were present in the Burnside Marsh.

A striking characteristic of the Columbia River intertidal marshes was a deciduous shrub and tree zone which was very poorly colonized by herbaceous species because of deep shade. The shrub-tree zone also exhibited much horizontal stem development and suspended litter. The base of the shrubs was inundated at high tide. Table 7 lists common species in this zone. The shrub zone also acts as a physical barrier and stranded material frequently accumulates in front of the shrub thicket. Elsewhere Populus trichocarpa and Fraxinus latifolia were prominent in this zone.

Table 7. Species common in the shrub zone of Burnside Intertidal Marsh.

Species	Species
Cornus stolonifera	Salix lasiandra
Lysichitum americanum	Salix piperi
Physocarpus capitatus	Salix scouleriana
Pyrus fusca	Salix sitchensis
Ribes inerme	

Transition zone vegetation, established in a narrow band between the inundated shrub-tree zone and upland, was identified by three, herb-layer species above all others: Impatiens noli-tangere, Carex obnupta and Athyrium filix-femina. Common species in the fresh water intertidal transition are listed in Table 8.

Table 8. Species common to the transition zone of the intertidal fresh water marsh.

Species	Species
Alnus rubra	Holcus lanatus
Aster subspicatus	Hypericum formosum
Athyrium filix-femina	Impatiens noli-tangere
Carex obnupta	Lysichitum americanum
Cornus stolonifera	Spirea douglasii
Equisetum hymenale	Vicia gigantea

Upland vegetation was distinguished clearly by such terrestrial species as Polystichum munitum, Tellima grandiflora, Picea sitchensis, Tsuga heterophylla, Vaccinium spp. and Rubus spp.

Table 9. Mean elevation above mean sea level, standard deviation and Student's t for comparison of means for transition boundaries.

Marsh	$\bar{X}$	SD	n	t
Newport				
Lower	5.29	.25	25	
Upper	5.84	.28	30	7.69*
Waldport North				
Lower	4.20	.14	10	
Upper	4.47	.18	10	3.63*
Waldport South				
Lower	4.17	.11	20	
Upper	5.17	.23	30	18.41*
Bandon				
Lower	4.35	.25	20	
Upper	4.55	.24	22	2.52**
Burnside				
Lower	5.34	-0-	2	
Upper	7.18	.37	9	

* Significantly different at P > .005
** Significantly different at P = .01

Intermarsh Comparison of Lower and Upper Transition Zone Elevations

Elevations above MSL of the lower and upper boundaries of the transition zone of all five marshes are shown in Table 9 and Figure 24 together with a statistical evaluation demonstrating, for all saline intertidal marshes except Bandon Marsh, that the lower transition elevation is significantly different at $P > 0.005$ from the upper transition elevation (Table 9). For Bandon Marsh, where the transition zone was topographically flat, the upper and lower transition zone boundary elevations were significantly different at $P=0.01$.

The elevation of the lower transition showed greater consistency among the saline intertidal marshes than the upper transition elevation (Figure 24). Both the Newport Southbeach Marsh and the Burnside Intertidal Marsh had transition zone boundaries at significantly higher elevations than the other saline marshes. Greater consistency among lower transition elevations was due to the low gradient in marsh near the lower transition in contrast to the steeper gradient, and often sharp break in slope, at upper transition.

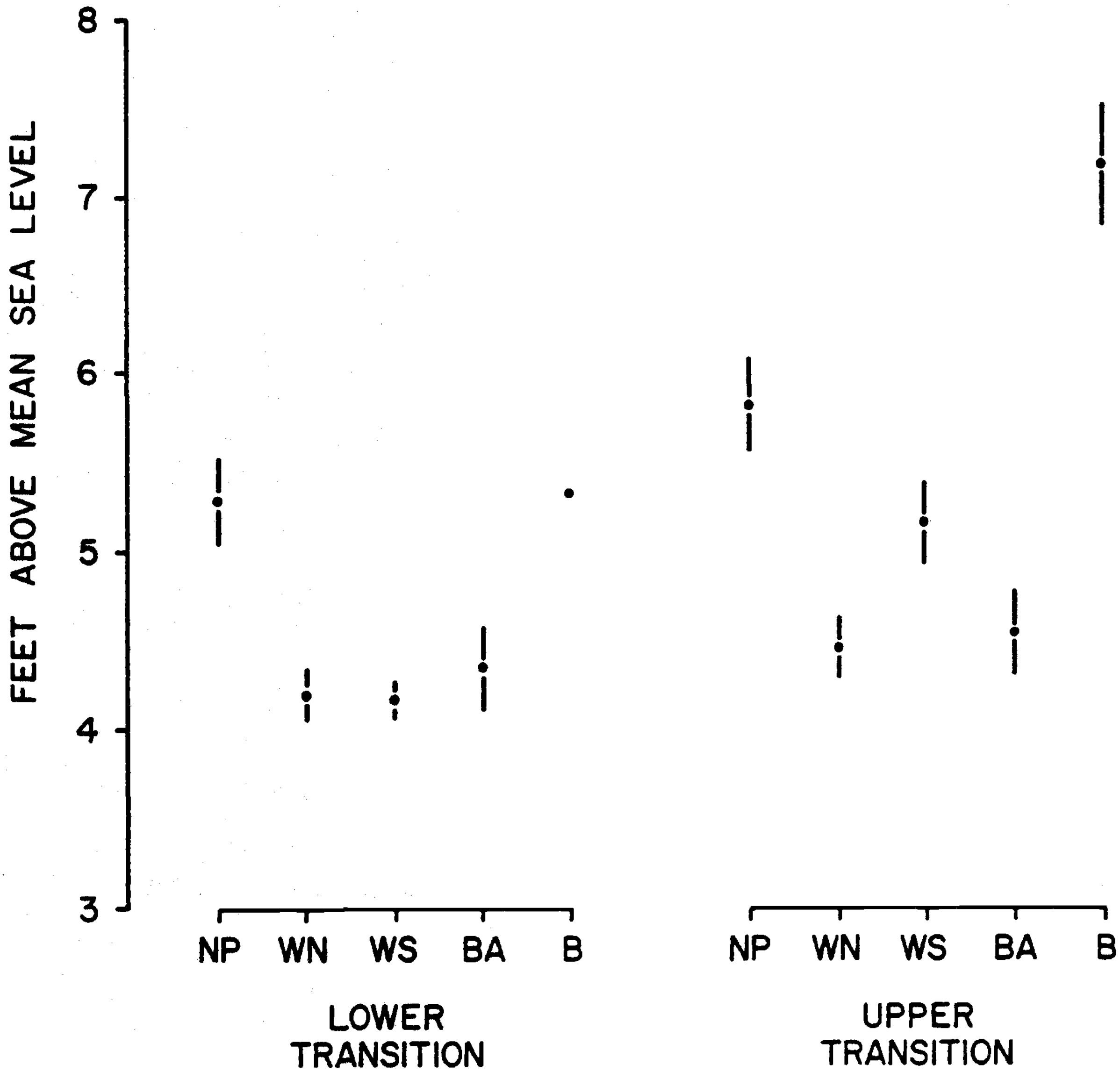

Figure 24. Mean elevation above MSL and one standard deviation above and below the lower and upper transition zone boundaries of five intertidal Oregon marshes.

Comparison of mean lower transition and mean upper transition tidal elevations between marsh study areas might be expected to yield valuable insight into the general position of the transition to upland in Oregon marshes. However, direct comparisons between marshes of one estuary and another, or of two marsh locations in one estuary, should be approached with caution for several reasons. The most important of these is that all estuaries on the Oregon coast do not experience identical tidal range (as defined by the difference between MLLW and MHHW). Even locations within a single estuary experience different tidal fluctuations depending on position relative to the mouth. Goodwin _et al_ (1970) studied the tidal regime in several Oregon estuaries and found that tidal amplitude generally increases toward the mouth although in the Yaquina estuary the situation is reversed. Eilers (1975) found a decrease of tidal range inland from the mouth in the Nehalem estuary. These variations imply that tide levels expressed with reference to MLLW for one marsh location can be compared to another marsh location only when both positions experience the same mean tidal range. Figure 25 illustrates this relationship. The mean elevation of the lower transition of Waldport South is 6.47 ft. above MLLW while that of Waldport North is 6.30 ft. Since the tidal range is greater at the former location, it follows that the elevation of the lower transition is also greater.

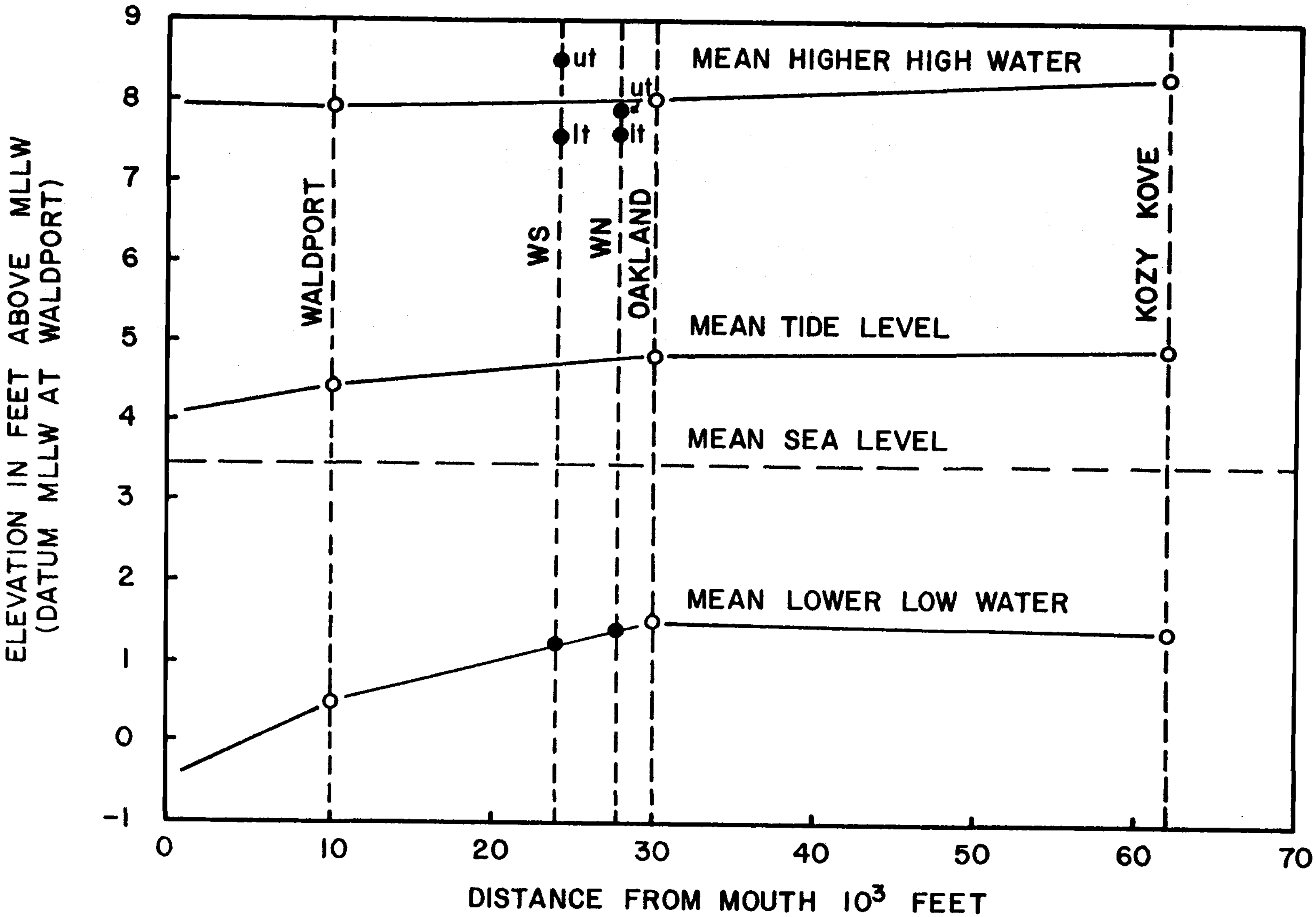

Figure 25. Elevations of various tidal datums with reference to MLLW as a function of distance from the mouth of the Alsea River (source: Goodwin, et al., 1970).

Referencing transition boundaries to MHW and MHHW (Tables 10 and 11) reveals greater accord, since tidal fluctuation is not directly considered and vegetation at the transition is likely to be more sensitive to high tides than to tidal range.

Table 10. Tidal datums for marsh study areas expressed in feet with reference to MLLW.

	Tidal Datum				
Marsh	MSL	MLLW	MTL	MHW	MHHW
Newport[1]	4.16	0.00	4.40	7.50	8.20
Waldport North[2]	2.07	0.00	3.45	5.96	6.71
Waldport South[2]	2.30	0.00	3.58	6.12	6.90
Bandon[1]	3.59	0.00	3.70	6.30	7.00
Burnside[1]	3.03	0.00	4.35	7.60	8.30

[1]U. S. Department of Commerce

[2]Goodwin _et al_ (1970)

It should be realized that only the Newport Southbeach Marsh could be directly tied to a primary tidal datum (the bench mark is referenced to Tidal Project 943-5380).

Table 11. Lower transition mean (LT) and upper transition mean (UT) with reference to Mean Sea Level and individual tidal datums expressed in feet.

	MSL		MHHW		MHW		MLLW	
Marsh	LT	UT	LT	UT	LT	UT	LT	UT
Newport	5.29	5.84	1.25	1.80	1.95	2.50	9.45	10.00
Waldport North*	4.20	4.47	-0.44	-0.17	0.31	0.58	6.27	6.54
Waldport South*	4.17	5.17	-0.43	0.57	0.35	1.35	6.47	7.47
Bandon	4.35	4.55	0.94	1.14	1.64	1.84	7.94	8.14
Burnside	5.32	7.18	0.05	1.91	0.75	2.61	8.35	10.21
Mean	4.67	5.44	0.27	1.05	1.00	1.78	7.70	8.47

*Mean lower low water, MHW and MHHW reference values adjusted in accordance with data in Goodwin _et al_ (1970) since marsh study areas were not located near tidal recording stations.

The data in Table 11 may be placed in context by relating the values to those reported in other studies discussed earlier in the literature review. The NOAA - NOS (1975) study places the "upper limit of marsh" (ULM) at 2.5 ft. above MHW. Included in that study was the "aberrant" figure from Ebey Slough, Puget Sound, where the

ULM was 1.2 ft. above MHW. The ULM corresponds to the upper transition in this study, where the mean for all five marshes, was 1.78 ft. above MHW and for the four saline marshes 1.57 ft. above MHW. Based on the criteria developed in this investigation, Eilers' (1975) study at Nehalem Bay identified the lower transition at 1.90 ft. above MHW (2.46 m above MLLW) and the upper transition at 2.56 ft. above MHW. For comparison purposes, too many assumptions are necessary to use Jefferson's (1975) Yaquina Bay data. It seems, therefore, that a precise relation between upper limit of marsh (upper transition) and a tidal datum does not hold, although the upper limit of marsh is to be expected in the vicinity of 2.0 ft. above MHW. Data reported in this study are within the range of the data reported in the NOAA-NOS (1975) research.

Therefore, to use tidal elevations as a basis for decisions involving land use is premature. Further study, including a larger sample and accurate in-marsh tidal data is necessary. Also, tidal data should include duration of submergence in addition to elevation and frequency of high water since submergence period is of prime importance to marsh species composition (Chapman, 1964). Yet, if the premise that plants are sensitive indicators of environment, is taken, it follows that preoccupation with a single factor such as tide level will yield only partial understanding at best. Therefore, it would seem that the definition of transition to upland should rest on shifts in species composition and that while approximate tide levels might be assigned, they should not be considered a substitute for phytosociological evidence.

CONCLUSIONS

For the purposes of this study of five intertidal Oregon marshes, the upper limit of marsh (ULM) corresponded with the boundary between upland, which was beyond the influence of normal seasonal tidal innundation, and the intertidal wetland, which was subjected to, at least, seasonal tidal innundation.

1. A transition zone exists between upland and the strictly intertidal marsh.
2. The transition zone of coastal salt marsh is identified by the presence of _Potentilla pacifica_, _Aster subspicatus_, and _Oenanthe sarmentosa_. For fresh water intertidal marshes, _Impatiens noli-tangere_, _Carex obnupta_, and _Athyrium filix-femina_ characterized the transition zone.
3. A single species can not be used to define the transition zone nor the ULM but combinations of species are a reasonably accurate means of identifying the transition zone (Table 5).
4. The intertidal saline marsh is denoted by the dominance of halophytic species (Table 4) while the intertidal freshwater marsh is characterized by non-halophytic semiaquatic species (Table 6) and is marked by a distinctive shrub-tree zone (Table 7).
5. Upland was identified by the presence of non-halophytic species, often species characteristic of forest communities.
6. Accumulation of drift logs can not be used alone to identify the transition zone

7. The mean elevation of the lower transition boundary was 1.00 ft. above MHW and 4.67 ft above MSL and the mean elevation of the upper transition boundary was 1.78 ft. above MHW and 5.44 ft. above MSL.
8. Accurate site-specific tidal data are difficult to attain in the field in a given marsh. These data vary with respect to distance from the mouth of the estuary and from estuary to estuary. In-marsh tidal data is required.
9. A tidal-referenced position of the ULM and transition zone boundaries is variable from marsh-to-marsh, especially when referenced to MLLW. Referencing of the transition zone boundary to MHW or MHHW provides more consistent results.
10. Mean ULM for five Oregon intertidal marshes was 1.78 ft. above MHW.

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APPENDIX A

Species List from Saline Marsh Sites[2]

Symbol	Botanical Name	Common Name	Marsh Position[1]
Acmi	Achillea millefolium L.	western yarrow	T/U
Agal	Agrostis alba L. var. palustris (Huds.) Pers.	creeping bentgrass	H/T
Alru	Alnus rubra Bong.	red alder	U
Amar	Ammophila arenaria (L.) Link	European beachgrass	U
Anlu	Angelica lucida L.	seacoast angelica	T
Assu	Aster subspicatus Nees	Douglas aster	T
Atpa	Atriplex patula L. var. hastata (L.) Gray	shore orache	L/H
Baor	Barbarea orthocerus Ledeb.	American wintergreen	T
Caly	Carex lyngbyei Hornem. var. robusta (Bailey) Cronq.	Lyngbye's sedge	L
Caob	Carex obnupta Bailey	slough sedge	T
Ceum	Centaurium umbellatum Gilib.	common centaury	T
Ci--	Cirsium spp.	thistle	T/U
Copa	Conioselinum pacificum (Wats.) Coult. and Rose	Pacific hemlock-parsley	T
Coco	Cotula coronopifolia L.	bird brassbuttons	L
Cusa	Cuscuta salina Engelm.	alkali dodder	L/H
Deca	Deschampsia caespitosa (L.) Beauv. var. longiflora Beal	tufted hairgrass	H
Disp	Distichlis spicata (L.) Greene	seashore saltgrass	L/H
Elpa	Eleocharis palustris (L.) R. and S.	creeping spikesdege	L
Epwa	Epilobium watsonii Barbey in Brew. and Wats. var. watsonii	Watson's willowweed	T/U
Erar	Erechtites arguta DC.	cut-leaved coast fireweed	T/U
Feru	Festuca rubra L. var. littoralis Vasey	red fescue	T/U
Gaap	Galium aparine L.	cleavers	U
Gatr	Galium trifidum L. var. pacificum Wieg.	small bedstraw	T/U
Gash	Gaultheria shallon Pursh	salal	U
Glma	Glaux maritima L.	sea milkwort	L/T
Grin	Grindelia integrifolia DC. var. macrophylla (Greene) Cronq.	gumweed	T
Hela	Heracleum lanatum Michx.	cow parsnip	T/U
Hola	Holcus lanatus L.	common velvetgrass	T/U
Hobr	Hordeum brachyantherum Nevaski	meadow barley	H/T
Hyra	Hypochaeris radicata L.	spotted catsear	U

Appendix A (cont.)

Symbol	Botanical Name	Common Name	Marsh Position
Jaca	Jaumea carnosa (Less.) Gray	jaumea	L/H
Juar	Juncus arcticus Willd. susp. occidentalis Lint	baltic rush	H/T
Jule	Juncus lesueurii Boland.	salt rush	T
Kocr	Koeleria cristata (L.) Pers.	prairie junegrass	U
Lapa	Lathyrus palustris L.	marsh peavine	T/U
Lioc	Lilaeopsis occidentalis Coult. and Rose	western lilaeopsis	L
Loin	Lonicera involucrata (Rich.) Banks	bearberry honeysuckle	U
Loul	Lotus uliginosus Schkuhr.	lotus	T/U
Lyam	Lysichitum americanum Hult. and St. John	skunk cabbage	U
Madi	Maianthemum dilatum (Wood) Nels. & Macbr.	false lily-of-the-valley	U
Myca	Myrica californica Cham.	waxmyrtle	U
Oesa	Oenanthe sarmentosa Presl.	water parsley	T
Orca	Orthocarpus castillejoides Benth.	paint brush owl-clover	L/H
Phar	Phalaris arundinacea L.	reed canary grass	T/U
Pisi	Picea sitchensis (Bong.) Carr.	Sitka spruce	U
Plla	Plantago lanceolata L.	ribwort plantain	U
Plma	Plantago maritima L. ssp. juncoides (Lam.) Hult.	seaside plantain	L/H
Plco	Plectritis congesta (Lindl.) DC.	rosy plectritis	H
Popr	Poa pratensis L.	Kentucky bluegrass	U
Popa	Potentilla pacifica Howell	Pacific silverweed	H/T
Ptaq	Pteridium aquilinum (L.) Kuhn.	bracken	U
Pupu	Puccinellia pumila (Vasey) A.S. Hitchc.	dwarf alkaligrass	L
Ru--	Rubus spp.	blackberry	
Rucr	Rumex crispus L.	curly dock	U
Ruma	Rumex maritimus L.	seaside dock	H/T
Ruoc	Rumex occidentalis Wats. var. procerus (Greene) Howell	western dock	T
Savi	Salicornia virginica L.	Virginia glasswort	L/H
Saho	Salix hookeriana Barr.	coast willow	U
Scac	Scirpus acutus Muhl.	viscid bulrush	H
Scam	Scirpus americanus Pers.	three-square	H
Scce	Scirpus cernuus Vahl	low clubrush	L
Scma	Scirpus maritimus Vahl	seacoast bulrush	L
Scva	Scirpus validus Vahl	American great bulrush	H/T

Apendix A (cont.)

Symbol	Botanical Name	Common Name	Marsh Position
Spca	Spergularia canadensis (Pers.) G. Don var. occidentalis Rossbh.	Canada sandspurry	L
Spma	Spergularia macrotheca (Hornem.) Heynh.	beach sandspurry	L
Stca	Stellaria calycantha (Ledeb.) Bong. var. sitchana (Steud.) Fern.	starwort	L
Taof	Taraxacum officinale Weber	dandelion	U
Trpr	Trifolium pratense L.	red clover	U
Trwo	Trifolium wormskjoldii Lehm.	springbank clover	T/U
Trco	Triglochin concinnium Davy var. concinnium	graceful arrowgrass	L
Trma	Triglochin maritimum L.	seaside arrowgrass	L/H
Tshe	Tsuga heterophylla (Raf.) Sarg.	western hemlock	U
Vaov	Vaccinium ovatum Pursh.	evergreen huckleberry	U
Vigi	Vicia gigantea Hook.	giant vetch	T/U
Viad	Viola adunca Sm.	western long-spurred violet	U

[1]Marsh position based on zone in which species is most frequently found L = lower intertidal marsh, H = high intertidal marsh, T = transition between intertidal marsh and upland, U = upland.

[2]Nomenclature follows Hitchcock, et al (1955-1961).

APPENDIX B

Species List from Burnside Intertidal Marsh[2]

Symbol	Botanical Name	Common Name	Marsh Position[1]
Acci	Acer circinatum Pursh	vine maple	U
Agal	Agrostis alba L. var. palustris (Huds.) Pers.	creeping bentgrass	H
Agsc	Agrostis scabra Willd.	tickle-grass	U
Alpl	Alisma plantago-aquatica L.	American water plantain	L
Alru	Alnus rubra Bong.	red alder	U
Assu	Aster subspicatus Nees	Douglas' aster	T
Atfi	Athyrium filix-femina (L.) Roth	ladyfern	T/U
Besy	Beckmannia syzigachne (Steud.) Fern.	slough grass	H
Bice	Bidens cernua L.	nodding beggar-tick	H
Caas	Caltha asarifolia DC.	elkslip	H
Caly	Carex lyngbyei Hornem.	Lyngbye's sedge	L
Caob	Carex obnupta L.H. Bailey	slough sedge	T
Cost	Cornus stolonifera Michx.	red-osier dogwood	H/T
Dagl	Dactylis glomerata L.	orchardgrass	U
Deca	Deschampsia caespitosa (L.) Beauv. var. longiflora Beal	tufted hairgrass	H
Dipu	Digitalis purpurea L.	foxglove	U
Elpa	Eleocharis palustris (L.) R.&.S.	creeping spikesedge	H
Elgl	Elymus glaucus Buckl.	blue wildrye	U
Epgi	Epipactus gigantea Dougl.	giant helleborine	H
Epgl	Epilobium glandulosum Lehm.	common willowweed	H
Epwa	Epilobium watsonii Barbey	Watson's willow-herb	U
Eqhy	Equisetum hymenale L.	Dutch rush	T
Eqpa	Equisetum palustris L.	marsh horsetail	H/T
Erph	Erigeron philadelphicus L.	Philadelphia daisy	H
Gaap	Galium aparine L.	cleavers	U
Gapa	Galium parisiense L.	wall bedstraw	U
Gatr	Galium trifidum L.	small bedstraw	U
Gash	Gaultheria shallon Pursh	salal	U
Glgr	Glyceria grandis Wats.	reed mannagrass	H
Hadi	Habenaria dilatata (Pursh) Hook. var. albiflora Correll	white orchis	H

Appendix B (cont.)

Symbol	Botanical Name	Common Name	Marsh Position[1]
Heau	Helenium autumnale L. var. grandiflora (Nutt.) T.&G.	sneezeweed	H/T
Hola	Holcus lanatus L.	common velvetgrass	T/U
Hyfo	Hypericum formosum H.B.K.	western St. John's-wort	T
Imno	Impatiens noli-tangere L.	touch-me-not	T
Juar	Juncus arcticus Willd.	arctic rush	L/H
Juox	Juncus oxymeris Engelm.	pointed rush	H
Kocr	Koelaria cristata Pers.	prairie junegrass	U
Labi	Lactuca biennis (Moench) Fern.	blue lettuce	U
Lapa	Lathyrus palustris L.	marsh peavine	H
Liap	Ligusticum apiifolium (Nutt.) Gray	celery-leaved lovage	T
Lioc	Lilaeopsis occidentalis Coult. & Rose	western lilaeopsis	L
Lyun	Lycopus uniflorus Michx.	northern bugleweed	H
Lyam	Lysichitum americanum Hult. & St. John	skunk cabbage	T
Mear	Mentha arvensis L. glabrata (Benth.) Fern.	corn mint	H
Mide	Mimulus dentatus Nutt.	toothleaved monkey-flower	H
Mysc	Myosotis scorpioides L.	common forget-me-not	H/T
Oesa	Oenanthe sarmentosa Presl. & DC.	water parsley	H
Phar	Phalaris arundinacea L.	reed canarygrass	H/T
Phca	Physocarpus capitatus (Pursh.) Kuntze	pacific ninebark	H/T
Pisi	Picea sitchensis (Bong.) Carr.	Sitka spruce	U
Poco	Polygonum coccineum Muhl.	water smartweed	H
Pohy	Polygonum hydropiper L.	marshpepper smart-weed	L/H
Pohy2	Polygonum hydropiperoides Michx.	water pepper	H
Pope	Polygonum persicaria L.	heartweed	H
Povu	Polypodium vulgare L.	licorice fern	U
Pomu	Polystichum munitum (Kaulf.) Presl.	swordfern	U
Popa	Potentilla pacifica Howell	pacific silverweed	H
Prva	Prunella vulgaris L.	self-heal	H
Ptaq	Pteridium aquifolium (L.) Kuhn.	bracken fern	U
Pyfu	Pyrus fusca Raf.	western crabapple	H/T
Raor	Ranunculus orthorhynchus Hook.	straightbeak butter-cup	H
Riin	Ribes inerme Rydb.	whitestem gooseberry	H/T
Rois	Rorripa islandica (Oed.) Barbas glabrata (Lun.) Butters & Abbe	marsh yellowcress	H

Appendix B (cont.)

Symbol	Botanical Name	Common Name	Marsh Position
Rupa	Rubus parviflorus Nutt.	thimbleberry	U
Rudi	Rubus discolor Weihe & Nees	Himalayan blackberry	U
Rusp	Rubus spectabilis Pursh	salmonberry	U
Ruco	Rumex conglomeratus Murr.	clustered dock	H/T/U
Rucr	Rumex crispus L.	curly dock	H/T/U
Sala	Saggitaria latifolia Willd.	wapato	L/H
Sala2	Salix lasiandra Benth.	red willow	H/T
Sapi	Salix piperi Bebb.	Piper's willow	H/T
Sasc	Salix scouleriana Barr.	Scouler's willow	H/T
Sasi	Salix sitchensis Sanson in Bong.	Sika willow	H/T
Scmi	Scirpus microcarpus Presl.	small-fruited bulrush	H
Scva	Scirpus validus Vahl.	American great bulrush	L/H
Setr	Senecio triangularis Hook.	arrowleaf groundsel	H
Sisu	Sium suave Walt.	hemlock water parsnip	L/H
Spem	Sparganium emersum Rehmann var. emersum	simple stem burweed	L
Spdo	Spirea douglasii Hook.	Douglas spirea	T/U
Stca	Stellaria calycantha (Ledeb.) Bong.	northern starwort	H
Tegr	Tellima grandiflora (Pursh) Dougl.	Alaskan fringecup	U
Trwo	Trifolium wormskjodii Lehm.	springbank clover	H
Tshe	Tsuga heterophylla (Raf.) Sarg.	western hemlock	U
Tyan	Typha angustifolium L.	lesser cattail	H
Vapa	Vaccinium parvifolium Smith	red huckleberry	U
Vevi	Veratuum viride Ait.	American false hellebore	H
Vigi	Vicia gigantea Hook.	giant vetch	T

[1]Marsh position: L = Lower Intertidal Marsh, only exposed at low water
H = High Intertidal Marsh, inundated at high water
T = Transition between intertidal and upland
U = Upland, not inundated

[2]Nomenclature follows Hitchcock, et al (1955-1961).

APPENDIX C

Community Tabulation for Newport Southbeach Marsh

FREQUENCY (Percent) Intertidal Zone	Trans. Zone	Total	SPECIES Code	Serial Number	SAMPLES Intertidal Zone: Lower	Upper	Transition Zone
20	14	34	CODE	SERIAL NUMBER	1........ 1...+	...	2......... 3...
					12345678901234	567890	12345678901234
				..TRANSITION ZONE SPECIES			
15.0	64.3	35.3	11	GRINDELIA INTEGRIFOLIA	+ +	+	21223 1 3 3 +
0.0	35.7	14.7	20	FESTUCA RUBRA			23 1 + 3
0.0	42.9	17.6	17	POTENTILLA PACIFICA			+ 3 3 + 23
				..INTERTIDAL SPECIES			
25.0	28.6	26.5	13	DESCHAMPSIA CAESPITOSA		3+35+	1 1 1 +
15.0	14.3	14.7	14	GLAUX MARITIMA		1+ +	1 +
40.0	0.0	23.5	6	CUSCUTA SALINA	+ +++ +21	2	
25.0	7.1	17.6	3	TRIGLOCHIN MARITIMUM	11 2 +1		+
15.0	7.1	11.8	7	PLANTAGO MARITIMA	1 1 +		+
35.0	0.0	20.6	4	TRIGLOCHIN CONCINNUM	+++ + + ++		
100.0	42.9	76.5	1	DISTICHLIS SPICATA	54451323211321	11++++	1 1+ + 1 1
85.0	28.6	61.8	2	SALICORNIA VIRGINICA	+32334333425442	+2	1 1 2 1
55.0	42.9	67.6	3	JAUMEA CARNOSA	1132122221223	1+1+	1 ++ + + 1
				..OTHER SPECIES			
25.0	64.3	41.2	15	AGROSTIS ALBA		+2+22	3333 5 1 2 13
15.0	71.4	38.2	12	JUNCUS ARCTICUS		31 5	2 2 44+5 4 332
10.0	7.1	8.8	16	CAREX LYNGBYEI		21	1
10.0	7.1	8.8	9	ORTHOCARPUS CASTILLEJOIDES	+ +		+
10.0	0.0	5.9	5	SPERGULARIA CANADENSIS	+ +		
10.0	0.0	5.9	10	ATRIPLEX PATULA	+	+	
5.0	0.0	2.9	19	SPERGULARIA MACROTHECA	+		
0.0	7.1	2.9	24	HYPOCHAERIS RADICATA			+
0.0	7.1	2.9	23	LATHYRUS PALUSTRIS			1
0.0	7.1	2.9	22	EPILOBIUM WATSONII			1
0.0	7.1	2.9	21	CENTAURIUM UMBELLATUM			+
0.0	7.1	2.9	18	ASTER SUBSPICATUS			1
					12345678901234	567890	12345678901234

ORDER OF RELEVES (SER.NO./POS.ON DISK/REL.NO./NO.OF SPP.) NEWPORT SOUTHBEACH

1	2	3	4	5	6	7	8	9	10	11	12	13	14
16	1	2	17	3	18	19	8	6	5	20	22	9	7
16	1	2	17	3	18	19	8	6	5	20	22	9	7
1	2	4	5	4	4	5	4	7	5	7	5	6	6
15	16	17	18	19	20	21	22	23	24	25	26	27	28
4	21	13	12	11	14	30	34	31	33	10	27	32	25
4	21	13	12	11	14	30	34	31	33	10	27	32	25
7	8	9	7	5	5	6	7	4	6	7	2	8	2
29	30	31	32	33	34								
23	28	24	26	15	29								
23	28	24	26	15	29								
6	2	9	2	5	4								

APPENDIX D

Community Tabulation for Waldport North Marsh

FREQUENCY (Percent) Intertidal Zone	Trans. Zone	Total	SPECIES	SAMPLES Intertidal Zone	Transition Zone (Lower ¦ Upper)
22	20	42	CODE SERIAL NUMBER	0....... 1........ 2. 1234567890123456789012	......¦ 3......... 4.. 3456789¦0123456789012
			.TRANSITION ZONE SPECIES		
0.0	40.0	19.0	31 OENANTHE SARMENTOSA		¦
4.5	35.0	19.0	23 VICIA GIGANTEA		¦1 1111 + 11
9.1	40.0	23.8	26 GALIUM APARINE	+ + +	¦1 1 22 +11
18.2	45.0	31.0	25 ACHILLEA MILLEFOLIUM	+ +1+	¦+++++1 ++
					¦1 +2 222++3
			.INTERTIDAL SPECIES		
77.3	5.0	42.9	16 CAREX LYNGBYEI	3512 1+2 123 +2+242+	¦ +
91.9	10.0	47.6	8 TRIGLOCHIN MARITIMUM	11++ 1+2++2+3+++1 11	+ ¦ +
45.5	10.0	28.6	13 DESCHAMPSIA CAESPITOSA	3+421 2 2+ 2 3	++ ¦
22.7	0.0	11.9	14 GLAUX MARITIMA	+++ + +	¦
			.OTHER SPECIES		
77.3	95.0	85.7	17 POTENTILLA PACIFICA	2 1+2233 2+ 11+23124	223312¦3334333232+
96.4	95.0	95.7	12 JUNCUS ARCTICUS	3 322351 33252131 2142	223 2¦4243342313 21+
95.5	65.0	81.0	15 AGROSTIS ALBA	+1141311 13+33322332+2	354 ¦ 11++1 +111 +
18.2	70.0	42.9	19 ASTER SUBSPICATUS	221 1	+21 ¦333 1 1 3+2212
18.2	10.0	14.3	29 HORDEUM BRACHYANTHERUM	+ + 1 1	¦ + +
0.0	25.0	11.9	1 DISTICHLIS SPICATA		3+++¦ +
9.1	5.0	7.1	11 GRINDELIA INTEGRIFOLIA	1 3	¦ +
0.0	15.0	7.1	27 GALIUM TRIFLORUM		¦ ++ +
0.0	15.0	7.1	34 ANGELICA LUCIDA		¦ 2 3+
0.0	10.0	4.8	32 HOLCUS LANATUS		¦ ++
0.0	10.0	4.8	36 ERECHTITES ARGUTA		¦ 13
0.0	5.0	2.4	37 PHALARIS ARUNDINACEAE		¦ +
0.0	5.0	2.4	35 CAREX OBNUPTA		+¦
4.5	0.0	2.4	30 TRIFOLIUM WORMSKJOLDII	+	¦
4.5	0.0	2.4	23 LATHYRUS PALUSTRIS	+	¦
4.5	0.0	2.4	10 ATRIPLEX PATULA	+	¦
				1234567890123456789012	3456789¦0123456789012

ORDER OF RELEVES (SER.NO./POS.ON DISK/REL.NO./NO.OF SPP.) WALDPORT NORTH

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3	26	25	22	23	20	7	28	8	4	21	27	17	5	15
37	61	60	57	58	55	41	63	42	38	56	62	52	39	50
3	4	7	6	6	5	6	5	2	5	7	6	8	5	7
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
16	24	30	2	18	13	29	1	6	19	10	11	12	35	31
51	59	65	36	53	48	64	35	40	54	44	46	47	85	66
5	9	6	7	7	6	5	4	4	5	3	3	3	5	9
31	32	33	34	35	36	37	38	39	40	41	42			
38	14	33	37	41	32	36	34	42	39	40	9			
88	49	93	87	91	67	86	84	92	89	30	43			
6	7	8	6	7	6	7	8	8	8	10	4			

APPENDIX E

Community Tabulation for Waldport South Marsh

FREQUENCY (Percent)				SPECIES		SAMPLES		
Intertidal Zone	Trans. Zone	Upland	Total			Intertidal Zone	Trans. Zone	Up-land
17	13	4	34	CODE	SERIAL NUMBER	0........ 1....... 12345678901234567	.. 2......... 8901234567890	3... 12345
				..UPLAND SPECIES				
0.0	0.0	100.0	11.8	41	RUBUS SPP			3+53
0.0	0.0	75.0	8.8	32	HOLCUS LANATUS			1 12
0.0	0.0	75.0	8.8	43	MOSS			12 1
0.0	0.0	50.0	5.9	42	PTERIDIUM AQUILINUM			2 4
				..TRANSITION ZONE SPECIES				
0.0	76.9	75.0	38.2	25	ACHILLEA MILLEFOLIUM		+111++2133	+2 1
5.9	100.0	25.0	44.1	17	POTENTILLA PACIFICA	+	1523434554549	1
0.0	15.4	0.0	5.9	18	ASTER SUBSPICATUS		24	
				..INTERTIDAL SPECIES				
29.4	7.7	0.0	17.6	11	GRINDELIA INTEGRIFOLIA	32212	2	
11.8	0.0	0.0	5.9	20	FESTUCA RUBRA	32		
23.5	0.0	0.0	11.8	6	CUSCUTA SALINA	++++		
41.2	0.0	0.0	20.6	16	CAREX LYNGBYEI	53111+ +		
41.2	0.0	0.0	20.6	10	ATRIPLEX PATULA	+++++ + +		
88.2	23.1	0.0	52.9	13	DESCHAMPSIA CAESPITOSA	+31+12333123417	1+ +	
100.0	0.0	0.0	50.0	5	TRIGLOCHIN MARITIMUM	+231232111+12++++		
82.4	7.7	0.0	44.1	1	DISTICHLIS SPICATA	211 21++ 1121++2	+	
70.6	0.0	0.0	35.3	3	JAUMEA CARNOSA	+ 1111 +273112		
64.7	7.7	0.0	35.3	2	SALICORNIA VIRGINICA	+22 11 +112 22	1	
58.8	15.4	0.0	35.3	14	GLAUX MARITIMA	++ ++++++++	++	
				..OTHER SPECIES				
94.1	84.6	0.0	79.4	15	AGROSTIS ALBA	2+24111+++221111	1+ 1+++++133	
47.1	92.3	75.0	67.6	12	JUNCUS ARCTICUS	+4444+ 2+	444+55534523	321
11.8	7.7	0.0	8.8	29	HORDEUM BRACHYANTHERUM	1+	+	
0.0	7.7	0.0	2.9	30	TRIFOLIUM WORMSKJOLDII		1	
0.0	15.4	0.0	5.9	31	OENANTHE SARMENTOSA		+ +	
0.0	0.0	50.0	5.9	26	GALIUM APARINE			1 +
0.0	0.0	50.0	5.9	45	CIRSIUM SPP			12
0.0	0.0	50.0	5.9	46	KOELERIA CRISTATA			2+
0.0	0.0	25.0	2.9	48	PICEA SITCHENSIS			3
0.0	0.0	25.0	2.9	40	PLANTAGO LANCEOLATA			1
0.0	0.0	25.0	2.9	24	HYPOCHAERIS RADICATA			+
0.0	0.0	25.0	2.9	44	TRIFOLIUM PRATENSE			+
0.0	0.0	25.0	2.9	47	VIOLA ADUNCA			+
0.0	7.7	0.0	2.9	49	TARAXACUM OFFICINALE		+	
0.0	7.7	0.0	2.9	50	POA PRATENSIS		+	
						12345678901234567	8901234567890	12345

ORDER OF RELEVES (SER.NO./POS.ON DISK/REL.NO./NO.OF SPP.) WALDPORT SOUTH

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	15	3	16	2	4	18	19	20	21	10	8	6	7	9	5
96	110	98	111	97	99	113	114	115	116	105	103	101	102	104	100
2	6	7	6	5	8	9	9	9	6	10	10	9	8	8	10
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
17	11	22	12	32	26	28	25	29	27	30	34	31	33	13	23
112	106	117	107	127	121	123	120	124	122	125	129	126	128	108	118
9	8	6	4	5	5	4	4	4	4	5	5	6	2	8	7
33	34														
24	14														
119	109														
7	8														

APPENDIX F

Community Tabulation for Bandon Salt Marsh

FREQUENCY (Percent)			SPECIES		SAMPLES	
Intertidal Zone	Trans. Zone	Total			Intertidal Zone	Transition Zone (Lower / Wet / Upper)
17	24	41	CODE	SERIAL NUMBER	0........ 1........ 12345678901234567	.. 2........ 3........ 4 890123456789012345678901
			.TRANSITION ZONE SPECIES			
0.0	29.2	17.1	32	HOLCUS LANATUS		211111+
0.0	20.8	12.2	31	OENANTHE SARMENTOSA		12 23 2
0.0	29.2	17.1	35	CAREX OBNUPTA		4111211
5.9	95.8	58.5	17	POTENTILLA PACIFICA	+	134221+2223344444432422
5.9	87.5	53.7	18	ASTER SUBSPICATUS	3	331 33 +121112321222222
0.0	79.2	46.3	30	TRIFOLIUM WORMSKJOLDII		11++ 1 121+1+1+11++ +1
			.INTERTIDAL SPECIES			
94.1	0.0	39.0	16	CAREX LYNGBYEI	55521333322211111	
76.5	4.2	34.1	8	TRIGLOCHIN MARITIMUM	3312213421413	+
47.1	0.0	19.5	2	SALICORNIA VIRGINICA	3+ 2 12+ +2	
23.5	0.0	9.8	9	ORTHOCARPUS CASTILLEJOIDES	+ + + +	
23.5	0.0	9.8	14	GLAUX MARITIMA	++ ++	
23.5	0.0	9.8	33	SCIRPUS ACUTUS	11 ++	
			.OTHER SPECIES			
70.6	91.7	82.9	15	AGROSTIS ALBA	23111++2+ +3+	113311 23+1332111 +1++1+
29.4	100.0	70.7	12	JUNCUS ARCTICUS	3+ 5 3 4	34422223332444444543424+
70.6	25.0	43.9	1	DISTICHLIS SPICATA	++2++3+21 111	1 1 + + + +
11.8	8.3	9.8	13	DESCHAMPSIA CAESPITOSA	1 1	2 1
0.0	12.5	7.3	29	HORDEUM BRACHYANTHERUM		13 +
0.0	12.5	7.3	36	ERECHTITES ARGUTA		+ 1 +
0.0	8.3	4.9	27	GALIUM TRIFLORUM		+ +
0.0	8.3	4.9	40	PLANTAGO LANCEOLATA		1 1
0.0	8.3	4.9	39	RUMEX CRISPUS		1 +
0.0	8.3	4.9	43	PICEA SITCHENSIS		+3
0.0	4.2	2.4	51	LYSICHITUM AMERICANUM		3
0.0	4.2	2.4	29	VICIA GIGANTEA		2
0.0	4.2	2.4	54	LONICERA INVOLUCRATA		+
11.8	0.0	4.9	52	SCIRPUS CERNUUS	2 1	
11.8	0.0	4.9	53	LILAEOPSIS OCCIDENTALIS	2 +	
5.9	0.0	2.4	3	JAUMEA CARNOSA	3	
5.9	0.0	2.4	5	SPERGULARIA CANADENSIS	+	
5.9	0.0	2.4	6	CUSCUTA SALINA	+	
5.9	0.0	2.4	10	ATRIPLEX PATULA	+	
					12345678901234567	890123456789012345678901

ORDER OF RELEVES (SER.NO./POS.ON DISK/REL.NO./NO.OF SPP.) BANDON MARSH

1	2	3	4	5	6	7	8	9	10	11	12	13	14
9	19	1	21	11	2	20	12	22	24	3	10	4	23
138	148	130	150	140	131	149	141	151	153	132	139	133	152
1	1	1	5	5	5	6	5	6	6	7	8	8	3
15	16	17	18	19	20	21	22	23	24	25	26	27	28
14	13	5	15	34	27	25	36	35	37	38	39	6	26
143	142	134	144	163	156	154	165	164	166	167	168	135	155
9	8	6	6	5	5	5	4	6	3	5	5	9	9
29	30	31	32	33	34	35	36	37	38	39	40	41	
40	41	28	29	30	31	33	7	16	32	8	17	18	
169	170	157	158	159	160	162	136	145	161	137	146	147	
6	7	7	8	6	6	7	7	7	7	10	7	7	

APPENDIX G

Community Tabulation for Burnside Intertidal Marsh

FREQUENCY (Percent) Intertidal Zone	Trans. Zone		Total	CODE	SPECIES (SERIAL NUMBER)	SAMPLES Intertidal Zone / Trans. Zone (0........ 1.........2. / 1234567890123456789012)
17	5	0	22			
					....TRANSITION ZONE SPECIES	
0.0	60.0	0.0	13.6	32	CORNUS STOLONIFERA	32 1
5.9	60.0	0.0	18.2	31	LYSICHITUM AMERICANUM	+ 12 1
0.0	60.0	0.0	13.6	30	IMPATIENS NOMINATA	+13
0.0	40.0	0.0	13.6	35	CAREX OBNUPTA	+2 3
0.0	40.0	0.0	9.1	39	ATHYRIUM FILIX-FEMINA	1 1
0.0	60.0	0.0	9.1	33	PHYSOCARPUS CAPITATUS	23
			13.6	36	ALNUS RUBRA	1 34
					....INTERTIDAL SPECIES	
82.4	0.0	0.0	63.6	1	CAREX LYNGBYEI	3 55 5554333 22+3
58.8	0.0	0.0	45.5	14	SIUM SUAVE	++1+1++++ 2
47.1	0.0	0.0	36.4	6	SAGGITARIA LATIFOLIA	+ + ++1+ ++
47.1	0.0	0.0	36.4	5	POLYGONUM HYDROPIPER	+ ++ 21 3+1
41.2	0.0	0.0	31.8	7	AGROSTIS ALBA	1 + 1 12 1 2
35.3	0.0	0.0	27.3	10	ELEOCHARIS PALUSTRIS	3 2 12 + 3
35.3	0.0	0.0	27.3	4	BIDENS CERNUA	+++ +1+
23.5	0.0	0.0	18.2	2	PHALARIS ARUNDINACEA	22+ 2
23.5	0.0	0.0	18.2	9	ALISMA PLANTAGO-AQUATICA	+ ++ 1
23.5	0.0	0.0	18.2	20	JUNCUS ARCTICUS	111 +
					....OTHER SPECIES	
47.1	40.0	0.0	45.5	8	OENANTHE SARMENTOSA	+ 1+111++ + 1
17.6	40.0	0.0	22.7	12	MYOSOTIS SCORPIOIDES	12 1 + 1
17.6	0.0	0.0	13.6	15	SCIRPUS ACUTUS	++ 1
17.6	0.0	0.0	13.6	3	EPILOBIUM GLANDULOSUM	+ +1
23.5	0.0	0.0	18.2	22	POTENTILLA PACIFICA	+++ +
17.6	0.0	0.0	13.6	46	SENECIO TRIANGULARIS	1+ 1
17.6	0.0	0.0	13.6	24	MIMULUS DENTATUS	+1 +
17.6	0.0	0.0	13.6	16	GLYCERIA GRANDIS	11+
11.8	0.0	0.0	9.1	17	POLYGONUM PERSICARIA	1+
11.8	0.0	0.0	9.1	19	STELLARIA CALYCANTHA	+ +
5.9	0.0	0.0	4.5	13	LILAEOPSIS OCCIDENTALIS	3
5.9	0.0	0.0	4.5	23	RANUNCULUS ORTHORHYNCHUS	+
11.8	20.0	0.0	13.6	26	SALIX SCOULERIANA	+ 23
17.6	0.0	0.0	13.6	28	HYPERICUM FORMOSUM	1 + +
5.9	0.0	0.0	4.5	21	HABENARIA DILATA ALBIFLORA	+
5.9	0.0	0.0	4.5	29	SCIRPUS MICROCARPUS	1
5.9	0.0	0.0	4.5	44	DESCHAMPSIA CAESPITOSA	1
0.0	20.0	0.0	4.5	25	SALIX LASIANDRA	2
0.0	20.0	0.0	4.5	27	SALIX SITCHENSIS	+
0.0	20.0	0.0	4.5	34	RIBES INERME	+
0.0	20.0	0.0	4.5	37	LIGUSTICUM APIFOLIUM	+
0.0	20.0	0.0	4.5	38	VICIA GIGANTEA	+
0.0	20.0	0.0	4.5	40	SPIREA DOUGLASII	+
0.0	20.0	0.0	4.5	57	TELLIMA GRANDIFLORA	+
0.0	20.0	0.0	4.5	60	RUBUS SPECTABLIS	3
0.0	20.0	0.0	4.5	62	PTERIDIUM AQUILINUM	+
0.0	20.0	0.0	4.5	70	PICEA SITCHENSIS	+
0.0	20.0	0.0	4.5	71	GAULTHERIA SHALLON	1
0.0	20.0	0.0	4.5	72	POLYSTICHUM MUNITUM	4
			4.5	73	VACCINIUM PARVIFOLIUM	+
						1234567890123456789012

ORDER OF RELEVES (SER.NO./POS.ON DISK/REL.NO./NO.OF SPP.) BURNSIDE INTERTICAL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	16	17	18	21	15	19	14	13	3	1	5	7	4	2
182	186	187	188	181	185	189	184	183	173	171	175	177	174	172
5	7	7	11	5	5	11	6	6	6	7	10	5	5	7
16	17	18	19	20	21	22								
6	20	8	9	22	10	11								
176	190	178	179	192	180	191								
8	5	10	7	2	10	8								

APPENDIX H

Elevation Data for Intertidal Marshes

Newport Southbeach Marsh

B.M. A590 (1965) is 12.17 ft. above MSL

Marsh Control Point is 6.78 ft. above MSL

Transect NP1 (North)

Dist. (m)	MSL (ft.)	Remarks
0	3.23	Marsh edge
20	3.53	
40	3.89	
60	3.85	
72.8	3.90	
75.2	1.38	
76.8	3.90	
80	4.08	
100	4.23	
115	4.58	
120	4.68	
140	5.53	

Transect NP2 (South)

Dist. (m)	MSL (ft.)	Remarks
0	2.70	Marsh edge
10	3.42	Creek bank
11	2.70	Creek
12.4	3.48	Creek bank
20	3.33	
40	4.03	
49.1	4.23	
53.7	4.58	
60	3.80	"pan"
63	3.49	Creek
64.2	4.40	
80	5.43	

Lower Transition

REF* MSL (ft.)	HPE* MSL (ft.)
5.45	5.48
5.45	5.45
5.30	5.57
5.45	5.15
5.45	5.24
5.55	5.35
5.29	4.95
5.07	5.24
5.05	5.22
4.78	
5.65	$\overline{x}$ = 5.29
5.65	
5.42	
4.90	
5.27	
4.76	Total $\overline{x}$ = 5.29
$\overline{x}$ = 5.28	

Upper Transition

REF* MSL (ft.)	HPE* MSL (ft.)
6.05	5.75
6.15	6.42
6.11	5.97
5.97	6.35
6.04	5.85
5.90	6.16
5.78	5.65
5.56	5.44
5.42	5.83
5.62	6.05
5.15	5.82
6.05	5.84
5.57	
5.65	$\overline{x}$ = 5.93
5.65	
5.74	Total $\overline{x}$ = 5.84
5.80	
5.85	
$\overline{x}$ = 5.78	

* REF = Boundary determined by R.E. Frenkel
HPE = Boundary determined by H.P. Eilers

Waldport North Marsh (Drift Creek)

B.M. 20 6D2E3 1931 is 28.85 ft. above MSL

Marsh Control Points are: A = 7.58 ft., B = 5.76 ft., c = 3.70 ft. above MSL

Transect WN1 (East)

Dist. (m)	MSL (ft.)	Remarks
0	3.46	
20	3.83	
40	3.31	
40.7	1.26	Creek
60	3.57	
61.4	2.11	Creek
80	3.81	
97	4.01	Creek
100	2.76	
120	4.20	
120+	3.80	Ditch
(130)		

Transect WN2 (West)

Dist. (m)	MSL (ft.)	Remarks
0	3.23	
20	3.70	
38	-0.69	Creek
40	3.41	
60	3.71	
80	3.56	
82	1.60	Creek
100	3.50	
107	1.19	Creek
120	3.83	
135	4.31	
130	3.66	"Y leg"
140	4.38	"
150	4.51	"

Lower Transition

Lower Ditch * MSL (ft.)	Upper Ditch * MSL (ft.)
3.66	4.31
3.41	4.21
3.66	3.97
3.60	4.21
3.31	4.01
3.44	4.31
3.33	4.31
3.52	4.11
3.73	4.12
3.66	4.41
$\overline{X}$ = 3.53	$\overline{X}$ = 4.20

Upper Transition

MSL (ft.)
4.60
4.72
4.70
4.24
4.53
4.51
4.26
4.21
4.40
4.48
$\overline{X}$ = 4.47

* "Lower Ditch" was a depressed zone between the intertidal high marsh and transition zone where much drift material collected in a former tidal creek. "Upper Ditch" was judged as typical lower transition.

Waldport South Marsh

B.M. 20 6D2E3 1931 is 28.85 ft. above MSL

Marsh Control Point is 3.78 ft. above MSL

Transect WS1 (East)

Dist. (m)	MSL (ft.)	Remarks
-0.92	-0.80	Creek
0	1.01	
2	2.85	
7	2.94	
12	3.00	
17	3.63	
22	3.75	
27	3.74	
32	3.64	
37	3.65	
42	3.85	
47	3.93	
52	4.23	
57	5.70	
59.5	7.55	

Transect WS2 (West)

Dist. (m)	MSL (ft.)	Remarks
-0.5	-0.78	Creek
0	1.36	
2	2.59	
7	3.29	
12	3.39	
17	3.30	
22	3.49	
27	3.74	
32	4.40	
37	5.53	
42	5.86	

Lower Transition

REF* East	REF* West	HPE* East
4.19	4.11	4.25
4.26	4.15	4.19
4.25	4.03	4.16
4.15	4.17	4.33
4.17	4.04	4.45
4.15	4.22	
4.38	4.08	$\overline{x}$ = 4.28
4.25	3.96	
4.11	4.07	
4.02	4.12	Total $\overline{x}$ = 4.17
$\overline{x}$=4.19	$\overline{x}$=4.10	

Upper Transition

REF* East	REF* West	HPE* East	HPE* West
4.65	5.23	5.07	4.80
5.07	5.27	5.45	5.02
5.20	5.10	5.04	5.11
5.35	5.02	5.43	5.01
5.54	5.14	4.92	5.43
5.24	5.39		
5.13	5.31	$\overline{x}$ = 5.18	$\overline{x}$ = 5.07
4.88	5.58		
5.05	5.58		
5.05	4.89	Total $\overline{x}$ = 5.17	
$\overline{x}$=5.12	$\overline{x}$=5.57		

* REF = Boundary determined by R.E. Frenkel

HPE = Boundary determined by H.P. Eilers

Bandon Salt Marsh*

B.M. W531 1954 is 27.54 ft. above MSL

Marsh Control Points are: A = 4.51 ft. and B = 5.94 ft. above MSL

Transect BA1 (North)			Transect BA2 (Middle)			Transect BA3 (South)		
Dist (m)	MSL (ft.)	Remarks	Dist (m)	MSL (ft.)	Remarks	Dist (m)	MSL (ft.)	Remarks
0	4.62	Trees	0	4.71	Trees	0	4.55	Trees
10	4.72		2	4.73		2	3.91	
20	4.65		5	4.66		10	2.85	
30	4.18		10	4.33		15	2.56	"pan"
40	3.38		20	3.49		20	2.66	
50	2.93	Creek edge	30	2.86		30	2.44	
54	2.73	Levee	40	2.56	Creek edge	40	2.36	
60	0.48	Tall Caly	50	2.76		45	1.68	
			60	2.93		46	-0.04	Creek
			65	1.84	Tall Caly			
				-0.65	Creek			

Lower Transition		Upper Transition	
MSL (ft.)	MSL (ft.)	MSL (ft.)	MSL (ft.)
4.61	4.34	4.06	4.69
4.46	4.65	4.41	4.76
4.41	3.86	4.06	4.52
4.76	4.17	4.21	4.76
4.46	4.43	4.41	4.76
4.67	4.66	4.70	4.75
4.50	4.21	4.76	4.61
4.34	4.16	4.66	4.51
4.07	3.95	4.75	4.71
4.28	4.08	4.66	4.69
		4.54	
	$\overline{x}$ = 4.35	4.06	$\overline{x}$ = 4.55

*Transects were measured from upland to tidal creek.

Burnside Intertidal Marsh

B.M. Milepost 95 1934 is 25.67 ft. above MSL.

Control Points are: 12.24 ft. and 4.66 ft. above MSL.

Transect BS1

Dist. (m)	MSL (ft.)	Remarks
0	2.70	
2	3.19	
4	3.06	
6	3.02	
8	3.13	
10	3.58	Trees
12	4.02	
14	4.80	
16	5.13	
18	5.13	
20	5.34	
22	5.26	
24	5.35	
26	5.51	
28	5.56	
30	6.11	
31.5	6.64	Upland
32	7.51	
32.3	7.86	

Transect BN1

Dist. (m)	MSL (ft.)	Remarks
0	0.66	
2	0.96	
4	1.22	
6	1.47	
7.5	1.65	Slope break
8	2.63	
9	2.62	
10	3.22	
12	3.34	
14	3.67	
16	3.47	
18	3.77	
19	4.37	R.R. ballast
20	4.77	

Transect BN2

Dist (m)	MSL (ft.)	Remarks
0	3.15	
1	5.11	
2	5.24	
3	4.82	
4	4.76	
5	4.78	
6	4.89	
7	5.32	Trees
8	5.75	
9	6.04	
10	6.74	
11	7.27	TZ
11.3	7.77	Pomu

Upper Transition Boundary

MSL (ft.)	Remarks
7.27	Tegr on Alru stump
7.20	Atfe & Gatr
7.24	Imno & Tegr
7.11	Imno & Atfe
6.34	Imno & Pomu
7.27	Imno, Tegr & Hola
7.18	Eqhe & Pomu