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Project Summary

Vegetative Delineation of Coastal Salt Marsh Boundaries: Evaluation of Methodology

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This research compares six vegetative methods for determining West Coast coastal salt marsh boundaries. A common data set consisting of 22 transects from 13 Oregon and Washington coastal salt marshes is used in the evaluation. Multiple occurrence, joint occurrence, and the 5% technique require prior plant classification into salt marsh, upland, and nonindicator species; cluster analysis and the similarity indices require no initial classification. Close agreement between the methods suggests that plant preclassification and cover value determinations may be unnecessary to develop vegetative boundary locations. Examples of each method as applied to specific coastal salt marsh data are presented. Also included is an upland/wetland plant indicator classification list derived from a consensus of several West Coast plant specialists.

This Project Summary was developed by EPA's Environmental Research Laboratory, Corvallis, OR, to announce key findings of the research project that is documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The Federal Water Pollution Control Acts of 1972 and 1977 require that wetlands receive special consideration prior to any alteration. Justification for this legislation is based both on research and empirically derived values. Coastal salt marshes are important for export of energy-rich organic detritus and dissolved organic carbon, buffers against shoreline erosion, improvement of water quality, different stages in migratory and endemic animal life histories, plant habitat, and aesthetics.

To implement the Federal Water Pollution Control Acts, it is necessary to identify wetlands and determine wetland/upland boundaries. Boundary determination is often difficult because it frequently involves an ecotone interdigitating between upland and wetland. In order to identify the most appropriate methods for boundary determination, EPA funded five research projects to evaluate boundary location techniques and provide a generalized wetland plant species list.

This report: (1) evaluates methods used by the five research projects; (2) presents alternative methods; (3) recommends the best approach to wetland boundary delineation based on vegetation; and (4) provides appropriate plant lists and computer software to apply these methods to Pacific Coast salt marshes. The evaluation is based on salt marsh vegetation data, but it appears that the methods can be applied to other wetlands. Vegetation is only one of several boundary delineation alternatives. Soils and hydrology are important considerations; the ideal approach would probably combine these with vegetation.

Methods

The vegetation methods evaluated range from those based on indicator plant species lists to quantitative analytical techniques such as cluster analysis.

Indicator Species

Boundary determination by the indicator species method is largely empirical and based on changes in plant species. Boundaries are sited where vegetation shifts occur. The actual decision depends primarily on the expert judgment and taxonomic skill of the census taker or data interpreter. Because the determination tends toward subjectivity, this method may suffer under rigorous scrutiny.

Five Percent

This method is similar to that of the indicator species but uses cover values to quantify results. Plant cover values are taken from quadrats along a wetland/upland transect. Some variation in data interpretation may occur, but the boundary delineations are generally made at the point where five percent of the vegetation is either upland, proceeding from upland to wetland, or five percent wetland, proceeding from wetland to upland. Results are generally presented graphically (Figure 1 is a graphical presentation of results from the six quantitative methods applied to the common set).

Joint Occurrence

This numerical technique requires plant preclassification into marsh, upland, and non-indicator categories. It is based on a ratio of joint occurrences to independent occurrences. This technique suffers if the plant distribution is patchy. To partially correct for this problem, a standardized cumulative index is computed and values ar plotted to determine boundary location

Multiple Occurrence

Weighting coefficients are assigne to plants preclassified as in the join occurrence method and a multipl occurrence score is computed fo quadrats along the gradient. Th quadrat scores are plotted and th boundary location determined where a predetermined numerical shift occurs.

Cluster

This procedure uses floristic data without preclassification into marsh upland, and non-indicator categories Several measures can be used to develop the cluster program; the authors use the Bray-Curtis dissimilarity measure. The resulting dendrogram shows quadrat clusters forming at decreasing

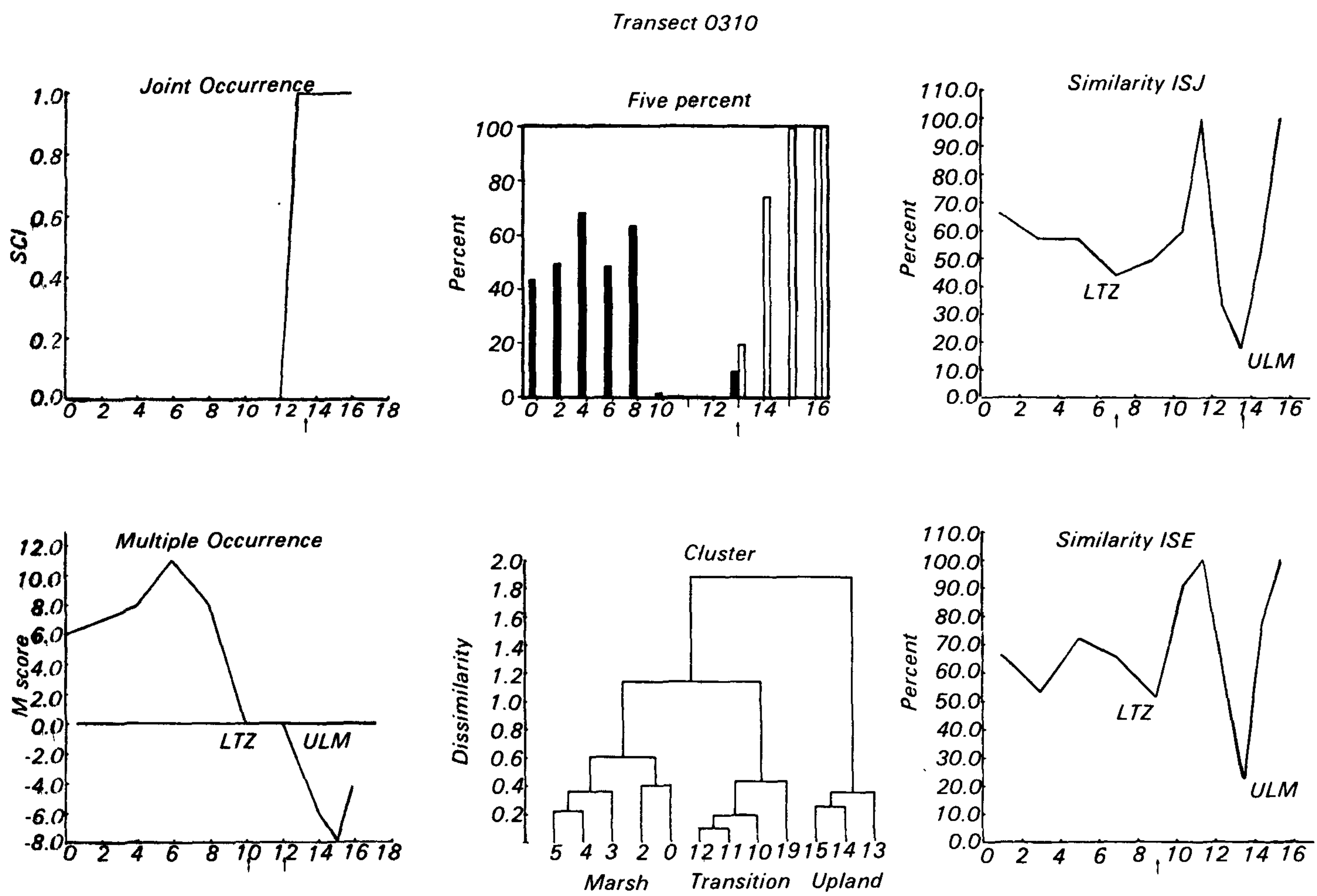

Figure 1. Comparison of six boundary determination methods for a single data set. Abscissa is transect distance in meters. LTZ - Lower Transition Zone Limit. ULM - Upper Marsh Limit.

dissimilarity levels. Interpretation is based on the cluster patterns, these generally grouping into upland, wetland, and transition zone.

Similarity ISJ and ISE

The ISJ index is based on adjacent quadrat plant presence/absence data. This procedure requires binary data and is attractive because it uses no preclassification. A modification of this technique using species quantities rather than just presence/absence is also evaluated. Both methods present the results graphically and the upper limit of marsh is located where the similarities are comparatively low.

Results

The indicator plant list upon which portions of this report are based was determined by consensus of EPA researchers and university botanical authorities. It has received extensive review but should not be considered a final compilation.

Each method, except for indicator species, was used to evaluate a common salt marsh data set. A lower limit of the transition zone and an upper limit of the marsh (wetland) were calculated for 22 transects. The primary effort was calculation of the upper marsh limit because of its significance in jurisdictional questions.

There was close agreement in boundary locations using these six different methods. The species classification techniques (five percent, joint occurrence, and multiple occurrence) had a high intragroup correlation, as did the nonclassification techniques (Table 1). Some variability appears to result from two transects which did not include sufficient upland and wetland; others are attributed to variations in methods. An important observation is that presence/absence yields results almost identical with the species-oriented techniques.

Discussion and Recommendations

The methods fall into two general categories: those which require plant preclassification and those which do not. Techniques requiring prior plant classification may be inherently biased. Nonclassification techniques rely more on quantitative analyses and are not as prone to this problem. An important result is that the presence/absence techniques seem to provide as valid a result as many of the classification techniques. A schematic is presented to guide the reader in adapting or determining techniques for a specific evaluation. It is critical that, whichever method is used, validation by a trained field person be done. It is also advisable to use either the cluster or similarity technique in conjunction with those based on species because their use further quantifies the results and makes them more objective.

This paper evaluates methods using coastal salt marsh vegetation data. The authors presume the methods to have a broader application than solely salt marshes. It is also essential to recognize that environmental factors are critical to boundary determinations. Additional work must be done with soil and hydrology prior to the selection of a "best" technique. The vegetative methods will facilitate wetland boundary determinations until a more comprehensive approach is possible.

Table 1. *Lower Transition Zone Limit (LTZ) and Upper Limit of Marsh (ULM) as Determined by 6 Methods Applied to 22 Transects from Frenkel et al. (1978). Limits Expressed as Distance (m) Along Transect Where Distance Increases from Marsh to Upland*

		Five Percent		*Joint Occurrence*		*Multiple Occurrence*		*Cluster*		*Similarity ISJ*		*Similarity ISE*				
Transect Number	*Location*	*LTZ*	*ULM*	*LTZ*	*ULM*	*LTZ*	*ULM*	*LTZ*	*ULM*	*LTZ*	*ULM*	*LTZ*	*ULM*	*ULM Mean*	*ULM S.D.*	*ULM Range*
	Oregon															
0105	Coquille Estuary	11.0	14.5	9.0	14.5	11.5	13.0	9.0	14.5	11.5	15.5	12.5	14.5	14.4	0.8	2.5
0208	Coos Bay	16.5	19.5	16.5	21.5	—	21.0	—	19.5	—	21.5	—	21.5	20.8	1.0	2.0
0301	Alsea Bay	9.0	15.5	—	15.5	10.0	15.0	9.0	15.5	9.0	15.5	9.0	15.5	15.4	0.2	0.5
0310	Alsea Bay	—	13.0	—	13.5	10.0	12.0	9.0	13.5	7.0	13.5	9.0	13.5	13.2	0.6	1.5
0402	Yaquina Bay	—	19.5	—	19.5	—	18.5	13.5	19.5	13.5	19.5	13.5	19.5	19.3	0.4	1.0
0407	Yaquina Bay	4.5	19.5	4.5	19.5	7.5	19.5	1.5	19.5	10.5	19.5	10.5	19.5	19.5	0.0	0.0
0704	Nehalem Bay	1.0	11.0	1.0	11.5	—	8.0	7.0	15.5	—	9.0	—	9 0	10.7	2.7	7.5
0706	Nehalem Bay	10.5	13.0	10.5	13.5	10.5	11.1	10.5	15.5	7.0	16.5	12.5	16.5	14.4	2.2	5.4
0710	Nehalem Bay	—	16.0	—	15.5	—	15.0	—	15.5	—	15.5	—	15.5	15.5	0.3	1.0
	Washington															
0804	Willapa Bay	14.5	15.5	14.5	16.5	11.0	15.0	9.0	15.5	9.0	15.5	9.0	15.5	15.6	0.5	1.5
0808	Willapa Bay	—	—	—	—	8.0	—	5.0	15.5	—	—	—	—	—	—	—
0809	Willapa Bay	15.0	22.5	—	22.5	15.0	22.0	19.0	22.5	20.5	22.5	19.0	22.5	22.4	0 2	0.5
0910	Willapa Bay	84.5	87.5	—	87.5	63.5	87.5	—	87.5	65.0	87.5	65.0	87.5	87.5	0.0	0.0
1001	Willapa Bay	256.0	265.0	—	265.0	248.0	259.0	—	259.0	—	249.0	—	249.0	257.7	7 2	16.0
1103	Grays Harbor	105.5	146.0	105.5	147.5	117.5	129.5	117.5	147.5	117.5	147.5	98.0	147 5	144 3	7 3	18.0
1201	Grays Harbor	18.5	19.5	—	19.5	—	19.0	17.0	19.5	17.0	19.5	17 0	19 5	19 4	0.2	0.5
1606	Thorndyke Bay	—	—	—	—	—	—	—	—	—	10.5	—	10.5	—	—	—
1610	Thorndyke Bay	—	6.0	3.5	7.5	—	3.0	—	10 5	—	10.5	—	10.5	8.0	3.1	7.5
1611	Thorndyke Bay	9.0	12.5	—	12.5	6.0	12.0	—	10.5	4.5	10.5	4.5	10.5	11.4	1.0	2.0
1612	Thorndyke Bay	—	21.5	—	21.5	1.0	20.0	12.0	23.5	—	12.0	12.0	23.5	20.3	4.3	11.5
1703	Snohomish Estuary	—	7.5	—	7.5	—	6.0	—	31.5	—	31.5	—	31.5	19 3	13.4	25.5
1802	Oak Bay	—	26.0	—	25.5	—	25.5	—	25.5	10.5	25.5	19.5	25.5	25.6	0.2	0.5

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The complete report, entitled "Vegetative Delineation of Coastal Salt Marsh Boundaries: Evaluation of Methodology," (Order No. PB 83-107 441; Cost: $10.00, subject to change) will be available only from:

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