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SHORELINES

A COASTAL ZONE MANAGEMENT PROGRAM

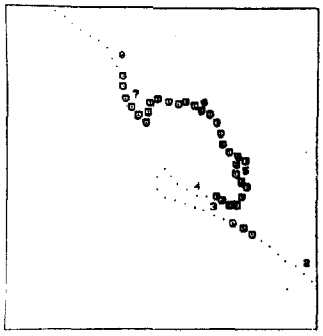
MAY 5 1976

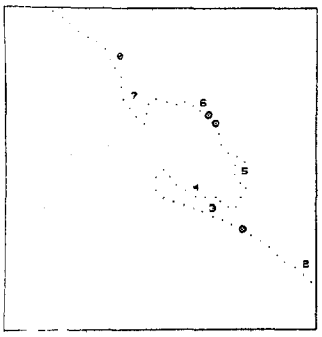
A METHODOLOGY FOR LOCATION AND CLASSIFICATION OF LAND USE ALONG THE SHORELINE

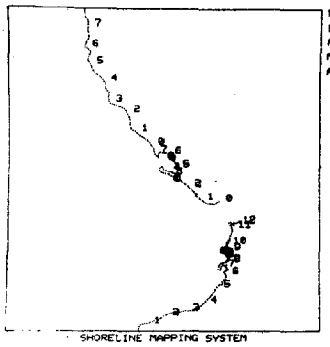
by

Karin E. Mesmer
Katie C. Swanson

COASTAL ZONE INFORMATION CENTER







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Mesmer, Karin E.

A METHODOLOGY FOR LOCATION AND CLASSIFICATION OF LAND USE ALONG THE SHORELINE

with a view towards quantifying historical trends in land-use change

SH09

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Objectives

The passage of the Washington State Shorelines Management Act of 1971 formally marked a period of increasing concern in Washington State over hitherto unplanned development along marine and fresh water shorelines. The need for development of a cohesive statewide planning effort was given further impetus with the federal Coastal Zone Management Act passed in 1972.

State legislation placed the Department of Ecology in a supportive role; local governments were delegated primary responsibility for developing shoreline inventories and formulating master programs to guide future development along their shoreline areas. For most local government agencies this task has posed the difficult initial problem of compiling an inventory of existing land use data along their shorelines. Information concerning land use is typically scattered among a variety of sources such as assessor's records and various permit application records. While such sources can provide a multitude of facts, the information is usually in a form difficult, if not impossible, to analyze for land use inventory purposes, especially when a general historical account of development is desired.

Although much recent work has been done in developing methods of land use classification for inventory purposes, the particular problems inherent in classifying and locating land use along a length of shoreline have not been addressed. The general objective in this project was to develop

a methodology specifically adapted to the analysis of shoreline land use. The procedure described utilizes aerial photography as the primary data source with an appropriate land use classification scheme. It can be used to generate a complete land use inventory on a localized scale at a variety of time points.

An important consideration in this project was the development of techniques which could be easily reproduced by local government planners who are often limited in the types of methods available to them and yet require information accurate on a fairly disaggregated scale. It is hoped that the methodology developed here will be of immediate practical use in aiding the inventory process at the local level.

The chosen area of application was the fifty mile marine shoreline of Snohomish County, Washington. This stretch of shoreline contains several broad categories of topographical features and associated uses, including agricultural flood plains, forested high bluffs, and intensively developed harbor areas.

Use of Aerial Photography

The use of aerial photography as a primary source for compiling data on shoreline land use has several distinct advantages over other methods. With the aid of low altitude aerial photographs substantive changes in land use are readily discernable and accurately located. Moreover, access to

photographs shown at a variety of time points enables the general pattern of development to be reconstructed. Familiarity with photographs of a region leads to the formation of a good mental picture or "feel" for the land-use patterns found in the study area.

Information extracted from aerial photographs is easily compiled on a base map; this is important since it allows specific geographic location of land-use data on a standardized base and permits such data to be related to other commonly mapped information (e.g. various types of boundaries or environmental information). Data for different time points can all be located on the same base, rendering the task of change detection that much easier.

Finally, information extracted from aerial photographs and recorded on a standardized base map is easily converted to numeric form by some method such as the one developed in this study. The data on land use type and location that can be extracted from aerial photographs is then in computer compatible form.

Fairly large scale imagery (about 1:12,000) was used for this project since these photographs would require the least sophisticated equipment to interpret. The Washington indices for aerial photography obtained from the Technical Services Division of the Department of Natural Resources were used to determine in what years aerial surveys were flown along the Snohomish County marine shoreline and by what agency. The photographs were then ordered directly from the negative owner.

Imagery was successfully obtained for four time points spanning the period from 1947 to 1969.*

Other Data Sources

With places that were particularly difficult to photo-interpret (e.g. Everett harbor area) imagery was supplemented with information obtained from city directories available at the Seattle Public Library. For any given year streets along the waterfront were identified on a map of the same period. Then the occupants were determined by locating the corresponding addresses in the street index of the appropriate city directory. This method was most successful in getting historical data for urban areas. In less developed regions most trouble spots were elminated with fields checks. Additional historical information was gathered by on-the-spot interviews of persons at the site. Other problems were solved by telephoning various county and municipal agencies or through personal knowledge.

Land-Use Classification System

The choice of a land-use classification system is a crucial first step in a study of this sort. Many such systems have been developed and are currently used by governmental agencies

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*Although more recent aerial photographs were available, 1969 was selected as the base year, since a shoreline inventory had already been completed for this year by the Snohomish County Planning Department.

at various levels. It was necessary to select a classification system which contained the desired attributes and was applicable to the data, the method of collection and the objectives of the study. Since the marine shoreline of Snohomish County was the prototype for study, it was deemed desirable to use a modification of the classified system used by the Snohomish County Planning Department, or at least maintain some correspondence between it and the system chosen. This was particularly desirable since the data collected in this prototype study might eventually be used by the Snohomish County planners.

The following sections discuss the above considerations, describe the land-use classification system chosen, and the modifications made to it.

A. Desirable Attributes of a Classification System

The area of study and the nature of the data source imposed two important constraints on the classification system to be chosen. The system had to provide a broad classification framework within which categories existed or could be devised to identify special uses located only on a shoreline. Furthermore, the nature of the primary data source called for a system in which the different classifications could in almost every case be identified from aerial photographs, occasionally supplemented by other sources of information.

An important aim of this study was to develop a methodology for historical studies of land-use along the shoreline. Therefore, the classification system had to contain categories which, over time, would allow identification of historical trends in land use. For example, it was desirable to identify several levels of residential density, so that changes in density could be observed over a span of several years.

Another consideration involved ease of replication. The descriptions of categories had to be complete and guidelines for making arbitrary decisions carefully explained, so the classification could be replicated with similar results. This last point led us to recognize the advantages of using a standardized classification system. Such a system would insure not only ease of replication, but compatibility between studies done at different locations.

B. Snohomish County Classification System

The land-use classification system used in preparing the Snohomish County Shorelines Inventory was a modified version of a classification system developed for the New York State Land Use and Natural Resources Inventory (LUNR).

Although the modified LUNR code was adequate for classification of land-use at a single time point, as was done in the Snohomish County Inventory, new categories were needed to more closely identify changes in land use among

several time points. Further, a more rigorous definitional framework was required for the system to be easily used by many different groups or agencies with consistent results. Because of the desirability of keeping the new system compatible with the existing one, the modified LUNR code does form the basis for many classification categories at the most detailed level. The LUNR letter code system was also retained for recording of data.

C. U.S. Geological Survey Circular 671

LUNR provided one of the two major components in the United States Geological Survey (USGS) classification system. USGS Circular 671 "A Land-Use Classification System for Use with Remote Sensor Data" (hereafter referred to as the Circular) was designed as a national standardized classification system which would be adaptable for studies done at the regional, state or local level, while retaining compatibility with currently used classification systems.

As a result of the attributes of the USGS system--its compatibility with the present Snohomish County classifications, its universal applicability and its orientation toward serial photography--it was selected as the classification system for this project.

The system provides the user with an organized and standardized classification framework with the option of specifying categories at the most detailed level. It allows

the user to devise special categories to identify any unusual uses or mixtures of uses peculiar to the area under study. At the same time, it is assured that by aggregating this detailed information to the next highest level of categorization, the results of two or more studies will be compatible.

Basically, the system outlined in the Circular has a four-level structure. Each level corresponds to a type or source of information as follows:

Classification Level	Source of Information
I	Satellite imagery, with very little supplemental information
II	High-altitude and satellite imagery combined with topographic maps
III	Medium-altitude aerial photography (1:20,000) combined with detailed topographic maps and substantial amounts of supplemental information
IV	Low-altitude imagery with most of the information derived from supplemental sources

Thus, the degree of detail in categorization increases through the four levels as the amount of information that can be extracted from the imagery and the amount of supplemental information also increase.

The authors of the Circular distinguish the terms of "land use" (present use of land in the sense of human activity) and "land cover" (natural vegetation and man-made constructions on the land surface). They recognize that from imagery alone certain activities can often be directly inferred from land cover (for example, agricultural activity), while others such as recreational activity can often be identified only through complementary techniques. In light of this, the first and second level categories usually represent land cover, while land use in the activity sense appears in categories of the third and fourth level.

In the Circular, a detailed definitional structure is presented only for the more generalized Levels I and II. It is left to the user of the system to modify these levels as necessary, to devise and define Level III and IV categories suitable to his particular study and to establish guidelines for making any arbitrary classification decisions.

Circular 671 is free on application to the U.S. Geological Survey, Washington, D.C. 20242

D. The Modified Version

Table 1 contains the structure of Level I and II categories as given in the Circular, notations are provided to indicate which categories were used unchanged and which were used with altered definition.

In the application of this system to land-use classification on the Snohomish County marine shoreline, a problem was encountered in the use of the 05-Water category. As defined in the Circular, "the Water category includes all areas within the land mass of the United States that are predominantly or persistently water covered." Minimum size criteria and exceptions to the classification are given; the five Level II categories describe various types of water bodies.

The problem arose from the very nature of the shoreline as a land-water interface. If the shoreline was to be defined for this study as a corridor including water, subtidal and intertidal areas, and also land above the ordinary high water mark, then a double classification would be necessary. That is, for any given length of shoreline one would measure both a length of water and a length of land use or cover. Since primary interest in this project is in land uses, the shoreline was defined as a corridor extending from the ordinary high water mark to a point 200 feet inland, as given in the Washington State Shorelines Management Act of 1971.

This would then mean that the water below the ordinary high water mark is ignored, that is, the 05-Water category is not included. However, since it was important to recognize and classify uses on the water that are related to shore activities, the Water category is used only to identify uses on the water at Level III. Where no use exists, the

Table 1

Level I	Level II
*01. Urban and Built-up Land	
	01. Residential
	02. Commercial and Services
	03. Industrial
	04. Extractive
	**05. Transportation, Communication, and Utilities
	06. Institutional
	07. Strip and Clustered Settlement
	**08. Mixed
	09. Open and Other
*02. Agricultural Land	
	01. Cropland and Pasture
	02. Orchards, Groves, Bush Fruits, Vineyards, and Horticultural Areas
	03. Feeding Operations
	04. Other
*03. Rangeland	
	01. Grass
	02. Savannas (Palmetto Prairies)
	03. Chapparal
	04. Desert Shrub
*04. Forest Land	
	01. Deciduous
	**02. Evergreen (Coniferous and Other)
	03. Mixed
**05. Water	
	01. Streams and Waterways
	02. Lakes
	03. Reservoirs
	04. Bays and Estuaries
	05. Other
*06. Nonforested Wetland	
	**01. Vegetated
	02. Bare
*07. Barren Land	
	01. Salt Flats
	02. Beaches
	03. Sand Other Than Beaches
	04. Bare Exposed Rock
	05. Other
*08. Tundra	
	01. Tundra
*09. Permanent Snow and Icefields	
	01. Permanent Snow and Icefields

LEGEND

* = used unchanged
** = used with altered definition

water itself is "cover" and is not identified. Moreover, in the measuring process described in a later section, only uses or cover above the high water mark were measured. In this way a "double counting" of any given length of shoreline was avoided.

The Level II Water categories were altered somewhat to include marine waters. Definitions for these and the Level III categories are given in Appendix I. It should be noted that minimum size criteria for water body types were drawn from the Washington State Shorelines Management Act of 1971.

Some additional definitional changes were made at Level II in other than the Water category. For a complete survey of the alterations the definitions given in Appendix I may be compared with those of the Circular.

Recording Method

For interpreting the photos a five-inch diameter illuminated magnifier was used. A three diopter lens with an auxiliary four diopter lens together gave 1 3/4 X magnification. At this level it was fairly easy and inexpensive to interpret aerial photographs up to a scale of 1:15,000. Heavily developed commercial and industrial areas usually required additional information for accurate identification.

Since the study was limited to the marine shoreline of Snohomish County from ordinary high water to 200 feet inland, it was feasible to treat this corridor as a line in the recording of use classifications. However, the

methodology is completely suitable for the compilation of data on an areal scale. Step 4 could be altered to allow for two-dimensional quantification of the data by using a grid overlay.

The actual recording of the data was divided into five steps. Sample forms can be found in Appendix II.

1. All land-use classifications observed on the base year photos were marked off onto mylar overlays placed over 7 1/2 minute series USGS quadrangles. This resulted in ten overlays, one for each quadrangle covering the county marine shoreline.
2. Similar overlays were marked off for each of the other selected years for which there were data, but only deviations from base year use classifications were indicated. Note: comparisons were made with the base line year only.
3. For each time interval compared, forms were filled out by quadrangle noting all changes in land use classifications. Each change was numbered sequentially beginning at the southern end of each quadrangle. The base year and comparison year photos indicating the change were tabled along with a description of the exact nature of the change.
4. The area of study was subdivided in order to facilitate quantification of the data. In this instance, the

shoreline was broken into five drainage sub-basins, which turned out to be a natural division between general types of areas. The length of each sub-basin shoreline was approximated by small straight line segments and marked off in .10 miles. Using this scale as a reference, the length of each use classification was determined to the nearest .02 mile. (This step was done separately from the photo interpretation so that any bias incurred by the presence of an arbitrary scale would be avoided.

Decision Rules

In the process of aggregating and categorizing the data some of the decisions made were necessarily arbitrary. The following is a list of conventions observed in interpreting and coding information.

1. In cases where two or more uses occurred parallel to the shoreline, higher priority was given to the use closest to the water, if this use reflected any degree of development or alteration of the natural shoreline. This meant that where a developed use closest to the water did not take up a full third of the 200 foot corridor, a joint use classification was still assigned. In other instances where a developed use closest to the shore took up at least a third of the corridor, any undeveloped uses behind it were not acknowledged. The rationale behind this decision was that developed uses

closest to the ordinary high water mark have a greater impact on the shoreline environment and its future development. In addition, such uses to some degree constrain the types and intensity of uses behind them. Note that in an areal rather than a linear accounting of land use this convention would be unnecessary.

2. Where the marine shoreline met the mouth of a river, the marine shoreline boundary was chosen as the most prominent point on either side of the river mouth. In diked areas, the river mouth was defined to be the outermost tide gate.
3. In marshy areas backed by diked farmland, the shoreline was defined by the location of the dike.
4. Land fill, dredging, extensive new port structures, beach accretion, etc. were recognized as altering the location and extent of the shoreline. The total shoreline length was considered variable and allowed to fluctuate. In this way extensive alterations of the natural shoreline, especially in harbor areas, could be quantitatively measured. A minimum width criterion of 100 feet was established in order to avoid distortion of shoreline length caused by the inclusion of narrow spits, piers, etc.

APPENDIX I

A LAND-USE CLASSIFICATION SYSTEM FOR USE WITH REMOTE SENSOR DATA*

modified for land-use classification on the Snohomish County marine shoreline

*U.S. Geological Survey Circular 671

A LAND-USE CLASSIFICATION SYSTEM
FOR USE WITH REMOTE SENSOR DATA*

modified for land-use classification on the Snohomish County marine shoreline

Satellite imagery, little supplemental information	High-altitude and satellite imagery, and topographic maps	Medium altitude photos, topo maps, and supplemental information	In any category, as much as 1/3 intermixture of another use is allowed without changing the basic classification. See USGS Circular 671 for more detailed definitions.	
Level I	Level II	Level III	Definition	Code
01. Urban and Built-up Land	01. residential	01. multi-unit	multiple-unit structures; apartments, etc.	Rm
		02. single-unit low density	single unit houses on lots of more one acre, large intervening spaces	Rsl
		03. single-unit med. density	single unit houses on lots of width 100 to 200 ft., some intervening spaces	Rsm
		04. single-unit high density	houses on lots of width 100 ft. or less with little intervening space	Rsh
		05. site prep., construction	lots under residential site preparation or construction	Rc
	02. commercial & services		Used predominantly for sale of products and services. Includes commercial recreational except those classified as Open.	
		01. water-related	businesses actively utilizing a shoreline location as part of a commercial operation	Cw
		02. not water-related	businesses not actively utilizing a shoreline location	Cx
		03. site prep., construction	commercial operation at site preparation or construction stage	Cc

*U.S. Geological Survey Circular 671

Level I	Level II	Level III	Definition	Code
	03. industrial		Light and heavy manufacturing, industrial parks	
		01. water-related	industries actively utilizing a shoreline location as a part of industrial operation	Iw
		02. not water-related	industries not actively utilizing a shoreline location	Ix
		03. site prep., construction	industrial operation at site preparation or construction stage	Ic
	04. extractive		Surface and subsurface mining operations, including abandoned areas and strip mined areas that have not re-established cover	
		01. water-related	mining operations that can only be conducted at a shoreline location	Ew
		02. not water-related	mining operations that can be conducted at other than shoreline locations	Ex
	05. transportation, communication, & utilities			
		01. roads	inc. interchanges, limited access right-of-way; no minimum width criterion if parallel to shoreline	Th
		02. railroad	inc. associated structures; no minimum width criterion if parallel to shoreline	Tr
		03. ports	airports, seaports, lakeports inc. structures and facilities directly operated by port authority	Tp
		04. comm. & utilities	transport of water, gas, oil, & electricity; areas used for airwave communication; not used if use is less than 1/3 total area	Tu

Level I	Level II	Level III	Definition	Code
	06. institutional & public services		includes all buildings, grounds, parking lots. Usually requires supplemental information to identify at Level III.	
		01. education	inc. all associated areas	Ne
		02. religious	inc. all associated areas	Nr
		03. health	inc. all associated areas	Nh
		04. correction	inc. all associated areas	Nc
		05. military	inc. supporting land uses (commercial, service, residential) on a military base	Nm
		06. public safety	police and fire	Pp
		07. dumps	solid waste facilities (dumps, land fill, sludge ponds, etc.)	Pd
		08. sewage	inc. all associated areas	Ps
		09. water supply	inc. all associated areas	Pw
		10. private	private clubs, organizations, etc.	Np
		11. mixed	any combination of above categories in same building, or clustered buildings Use specific comb. of codes, e.g. Ne/h	
	07. strip and clustered settlement		see Circular. Separate uses must be indistinguishable at altitude being used.	

Level I	Level II	Level III	Definition	Code
	08. mixed		No minimum population criterion applied. Used where either: (1) 2 uses split linearly along the shoreline within the 200 foot corridor (2) uses are mixed according to areal criteria given in the Circular	
		50.	usually, railroad right-of-way is parallel to shore and nearest water; other use listed is behind railroad up to 200 foot line. Positions may be reversed in some cases.	Tr/Rc
		51.		Tr/Rsl
		52.		Tr/Rsm
		53.		Tr/Rsh
		54.		Tr/Cw
		55.		Tr/Iw
		56.		Tr/Ps
		57.		Tr/Op
		58.		Tr/Ou
		59.	railroad and highway share 200-foot corridor	Tr/Th
		60.	highway and public safety facility	Th/Pp
		61.	port facility and water-related industry	Tp/Iw
		62.	port facility and water-related commercial	Tp/Cw
		63.	highway and residential medium-density	Th/Rsm
		64.	highway and water-related commercial	Th/Cw
		65.	highway and residential construction	Th/Rc
		66.	water supply and commercial	Pw/Cx
		67.	water supply and water-related commercial	Pw/Cw

Level I	Level II	Level III	Definition	Code
		68.	mixed forest and residential categories are used when: (1) forest cover and residential use are split linearly, parallel to the shoreline and (2) neither predominates by more than 2/3 of total area This usually occurs where there is a forested bank above the water, with residential use at the top. Appropriate residential density is determined in the usual manner.	Fnm/Rsl Fnm/Rsm
	09. open and other (urban)		open land may be in intensive use which does not require structures	
		01. public park or rec. area (urban)	park or recreation area where in aggregate little natural cover remains and use is intensive; often contains many structures, paved areas, and maintained grounds.	Op
		02. commercial open space	open use only (e.g. golf course, cemetery) otherwise classified as 02-commercial	Oc
		03. designated open space	designated for tax treatment purposes (may be difficult to distinguish)	Os
		04. urban undeveloped	undeveloped land within an urban setting	Ou
		05. fish hatch. and ladders	inc. all related areas on the land	Oh
		06. other	inc. small blocks of less intensive or nonconforming uses that become isolated within an urban setting	Ot

Level I	Level II	Level III	Definition	Code
02. Agriculture			Land used primarily for production of farm commodities	
	01. cropland & pasture			
		01. cropland	agric. land used for production of crops	Ac
		02. pasture	agric. land used for grazing	Ap
		03. irrigated cropland		Ai
	02. orchards	(no level III)	inc. groves, vineyards, bush fruit areas, nurseries, floricultural areas, seed and sod areas	Ar
	03. feeding operations	(no level III)	cattle feed lots, large poultry farms, hog and furbearing animal farms	Af
	04. other	01. inactive	farm land not in current use, but with no natural cover yet established	Ao
		02. structures	farm houses, barns, other out-buildings (excluding those for feeding operations)	As
	05. mixed	51. cropland/ levee	cropland with level forming shoreline boundary; indicates reclaimed cropland on floodplain	Ac/l
		52. pasture/ levee	same as above, only pasture	Ap/l

Level I	Level II	Level III	Definition	Code
03. Rangeland			Land where potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs	
04. Forest Land			Lands at least 10% stocked by trees capable of producing timber or other wood products that exert an influence on the climate or water regime.*	
	01. deciduous		trees are predominantly those whose leaves fall at the end of the growing period	
		01. natural	forest land not designated for a particular use activity, or relatively free of human influence	Fn-d
		02. commercial	privately owned forest land designated for logging (inc. commercial tree farm)	Fc-d
		03. park or rec. area	park or rec. area where natural forest cover is relatively undisturbed and use is extensive; few structures, paved areas, etc.	Fr-d
	02. coniferous		trees are predominantly cone-bearing evergreens	
		01. natural	same as defined for deciduous forest	Fn-c
		02. commercial	same as defined for deciduous forest	Fc-c
		03. park or rec. area	same as defined for deciduous forest	Fr-c
		04. tree farm	Christmas tree farm (excludes commercial tree farms for timber)	Ff-c

*under Washington State Shorelines Management Act of 1971, federally-owned lands are excluded

Level I	Level II	Level III	Definition	Code
	03. mixed vegetation		Used where neither deciduous nor coniferous trees predominate by two-thirds	
		01. natural	same as defined for deciduous forest	Fn-m
		02. commercial	same as defined for deciduous forest	Fc-m
		03. park or rec. area	same as defined for deciduous forest	Fr-m
	04. mixed with use		usually where use and forest are split linearly along shoreline within 200 feet	
		51.	railroad and natural deciduous forest	Tr/Fnd
		52.	railroad and natural coniferous forest	Tr/Fnc
		53.	railroad and natural mixed forest	Tr/Fnm
		54.	highway and natural deciduous forest	Th/Fnd
05. Water			At Level III this category identifies uses on the water directly related to, and usually with a physical connection to, a shore activity	
	01. streams & waterways		rivers, creeks, canals,and other linear fresh water bodies, excluding segments upstream of a point where the mean annual flow is 20 cubic feet per second or less*	H-s

*minimum size requirement set by Washington State Shorelines Management Act of 1971. (SMA)

Level I	Level II	Level III	Definition	Code
		01. private	private docks, piers, and boathouses	Hp-s
		02. commercial	commercial docks, piers, and boat-houses	Hc-s
		03. industrial	industrial docks, piers, other structures	Hi-s
		04. logs	log boom and storage on the water	Hl-s
		05. aquaculture	the cultivation of the natural produce of water	Ha-s
		06. bridges	self-explanatory	Hb-s
		07. public	public docks, piers, other structures	Hd-s
	02. lakes and reservoirs		fresh water bodies of water and artificial impoundments of water greater than 20 acres in areal extent*	H-1
		01. private	as above	Hp-1
		02. commercial	as above	Hc-1
		03. industrial	as above	Hi-1
		04. logs	as above	Hl-1
		05. aquaculture	as above	Ha-1
		06. bridges	as above	Hb-1
		07. public	as above	Hd-1

*minimum size requirement set by SMA.

Level I	Level II	Level III	Definition	Code
	03. estuaries		"that portion of a coastal stream influenced by the tide of the marine waters into which it flows and within which the sea water is measurably diluted with fresh water..."**	H-e
		01. private	as above	Hp-e
		02. commercial	as above	Hc-e
		03. industrial	as above	Hi-e
		04. logs	as above	Hl-e
		05. aquaculture	as above	Ha-e
		06. bridges	as above	Hb-e
		07. public	as above	Hd-e
	04. protected marine		marine waters protected from wind and wave action either by natural features (as a bay) or by man-made features. If the indentation of an embayment is so shallow that the water area would be less than the area of a semicircle drawn with the straight line connecting its head lands as diameter, it is not considered protected.	H-p
		01. private	as above	Hp-p
		02. commercial	as above	Hc-p
		03. industrial	as above	Hi-p
		04. logs	as above	Hl-p
		05. aquaculture	as above	Ha-p
		06. bridges	as above	Hb-p
		07. public	as above	Hd-p

*Final Guidelines, Shoreline Mgt. Act of 1971; DOE, 6/20/72.

Level I	Level II	Level III	Definition	Code
	05. open marine		marine waters not protected from wind and wave action. Coastal waters and waters of Puget Sound are included unless protected in the sense of the previous definition.	H-o
		01. private	as above	Hp-o
		02. commercial	as above	Hc-o
		03. industrial	as above	Hi-o
		04. logs	as above	Hl-o
		05. aquaculture	as above	Ha-o
		06. bridges	as above	Hb-o
		07. public	as above	Hd-o
06. Nonforested Wetland			seasonally flooded basins and flats, meadows, marshes and bogs (wetland areas with 10% forest crown cover are placed in 04-Forest Land). Marshes and bogs are areas with a high water table, formed by the filling of shallow water areas by sedimentation and vegetative decay.	
	01. freshwater vegetated	(no level III)	vegetated nonforested wetland where forest crown cover is less than 10% or vegetation is nonwoody, and influencing water is fresh.	Wf
	02. marine vegetated	(no level III)	vegetated nonforested wetland where forest crown cover is less than 10% or vegetation is nonwoody, and influencing water is salt.	Wk

Level I	Level II	Level III	Definition	Code
	03. bare	(no level III)	nonvegetated wetland, i.e. tide flats	Wt
07. Barren Land			Land of limited ability to support life and little or no vegetation, excluding land temporarily barren due to man's activities	
	01. salt flats	(no level III)	flat-floored bottoms of interior desert basins	Bf
	02. beaches		smooth, sloping accumulations of sand and gravel along shorelines, with stable surface inland	
		01. natural	beach relatively free of human influence	Bb
		02. park or rec. area	beach used as a park or rec. area but left in a relatively natural state; no bulkheads, boat ramps, shelters, etc.	Br
	03. sand other than beaches	(no level III)	primarily dunes (accumulations of sand of aeolian origin) of deserts, shorelines, coastal plains, flood plains, and deltas	Bs
	04. bare exposed rock	(no level III)	exposed bedrock and accumulations of rock without vegetative cover	Be

Level I	Level II	Level III	Definition	Code
	05. other	(no level III)	mixture of above, or Level II sub-category not clearly identifiable	Bo
	06. mixed with use		usually where use is linear and parallel to shoreline within 200 foot corridor	
		51.	railroad and natural beach	Tr/Bb
		52.	railroad and recreational beach	Tr/Br
08. Tundra			cold, treeless lands with vegetative cover of moss, lichen, grasses, and shrubs	
09. Permanent Snow & Ice-fields			those that survive summer ablation	

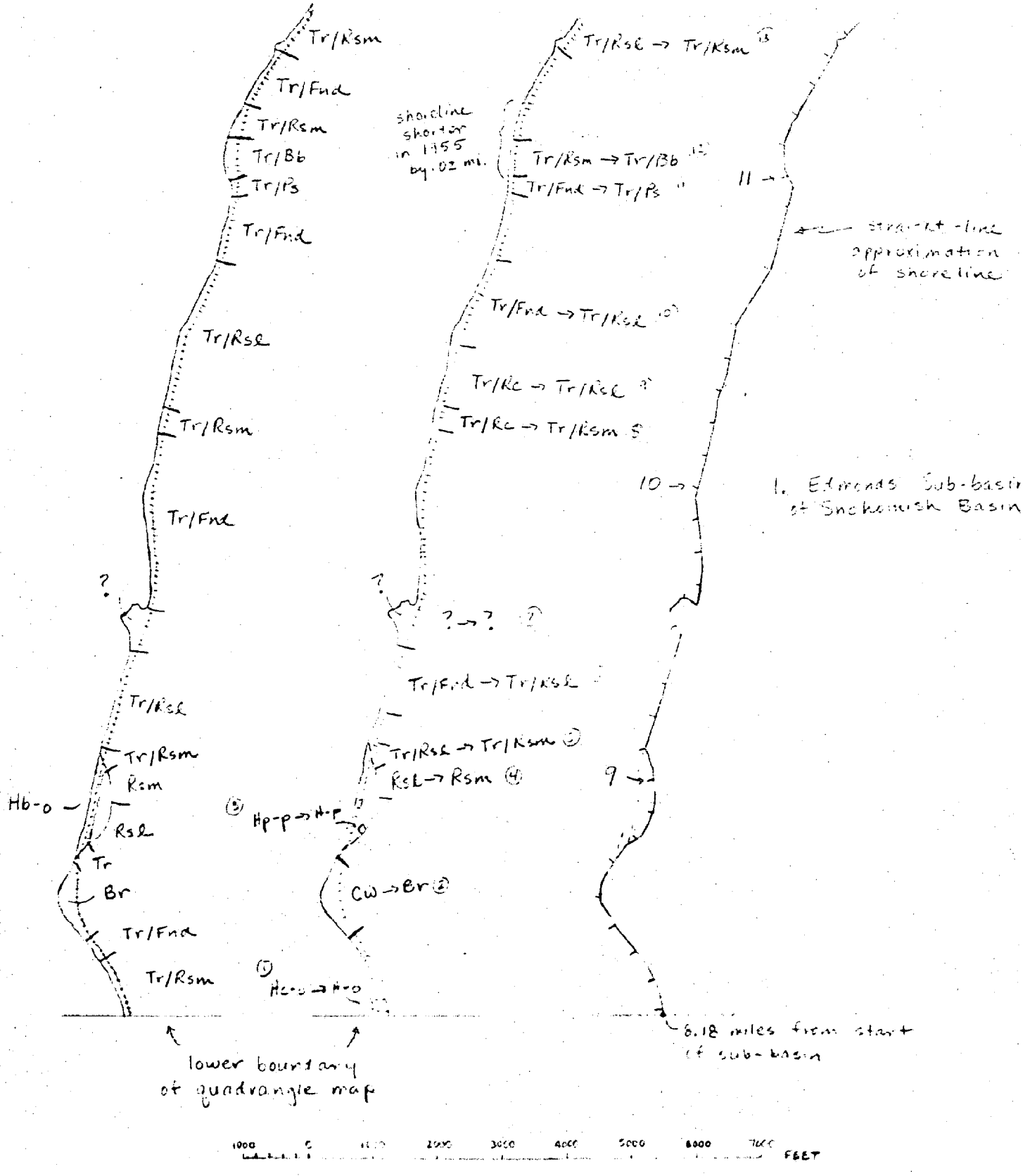
Level I	Level II	Level III	Definition	Code
Auxiliary Codes:				
88	88	88	uses that are not identifiable from either aerial photographs or supplemental sources of information.	?
99	99	99	that length of shoreline that at some did not exist and was created or lost due to natural process or man-made fill.	DNE

APPENDIX II

EXAMPLES OF RECORDING METHOD

including sample forms and examples of the
mylar overlay system for a base year
and one comparison year

Example of Overlay System



EXAMPLE OF CHANGE SHEET

Quadrangle Mukilteo

Year 1955

#	Photo '55	Photo '69	1955→1969 change	Description
1.	4S-6	43A-16	Hc-0→H-0	1955: large dock and boat-house. Gone in 1969.
2.	4S-6	43A-16	Cw→Br	1955: boat rental and fishing resort since 1930's. 1969: Picnic Point County Park. Leased from Chevron Land Dev. Co. Undeveloped park. ref: Mr. Taylor, Sno. Co. Parks
3.	4S-6	43A-16	Hp-p→H-p	1969: no dock (private)
4.	4S-4	43A-15	Rsl→Rsm	1969: about 6 more houses
5.	4S-4	43A-15	Tr/Rsl →Tr/Rsm	1969: more houses
6.	4S-4	43A-15	Tr/Fnd →Tr/Rsl	1955: no houses or cleared areas
7.	4S-4	43A-15	?→?	1955: spit with a few structures. 1969: spit more defined, two large boats, may be change. No road to spit.
8.	4S-4	43A-17	Tr/Rc→ Tr/Rsm	area is cleared and next to road in 1955; med. dens. res in 1969
9.	4S-2	43A-17	Tr/Rc→ Tr/Rsl	same as above in 1955; low density res. in 1969
10.	4S-2	43A-17	Tr/Fnd→ Tr/Rsl	road is >200 feet. Forest 1955, one house 1969
11.	4S-2	43A-17	Tr/Fnd →Tr/Ps	Forest 1955; sewage treatmen plant 1969.
12.	4S-2	43A-17	Tr/Rsm →Tr/Bb	Beach not there in 1955 so houses fall within 200 ft.
13.	4S-2	43A-19	Tr/Rsl →Tr/Rsm	1955: few houses with large lots & woods 1969: new roads and houses

Example of Code Sheets for Base Year and Comparison Year

Quadrangle Mukilteo
Year 1969

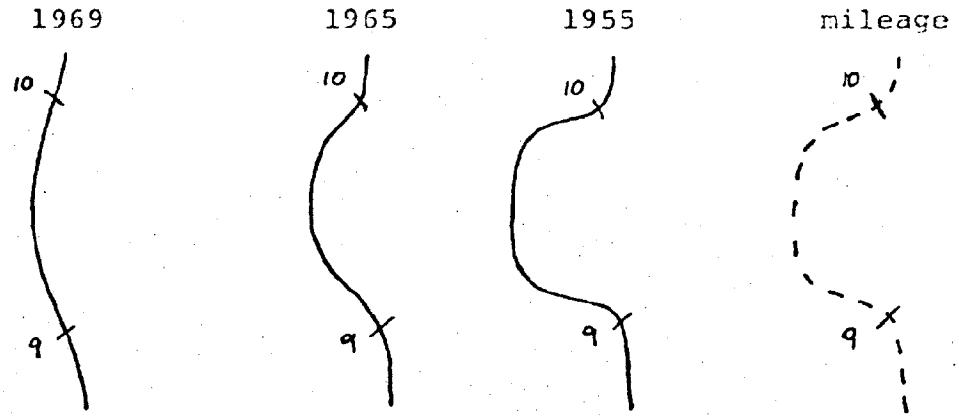
#	Sub-basin	Mile # Start	Length of Use	Use Type	Code
	1	08.18	0.20	Tr/Rsm	010852
	"	08.38	0.08	Tr/Fnd	040451
	"	08.46	0.26	Br	070202
	"	08.72	0.08	Tr	010502
	"	08.80	0.14	Rsl	010102
	"	08.94	0.10	Rsm	010103
	"	09.04	0.08	Tr/Rsm	010852
	"	09.12	0.32	Tr/Rsl	010851
	"	09.44	0.20	?	888888
	"	09.64	0.54	Tr/Fnd	040451
	"	10.18	0.08	Tr/Rsm	010852
	"	10.26	0.48	Tr/Rsl	010851
	"	10.74	0.20	Tr/Fnd	040451
	"	10.94	0.06	Tr/Ps	010856
	"	11.00	0.14	Tr/Eb	070651
	"	11.14	0.12	Tr/Rsm	010852
	"	11.26	0.20	Tr/Fnd	040451
	"	11.46	0.36	Tr/Rsm	010852

Quadrangle Mukilteo
Year 1955

#	Sub-basin	Mile # Start	Length of Use	Use Type	Code
	1	08.46	0.26	Cw	010201
	"	08.94	0.10	Rsl	010102
	"	09.04	0.08	Tr/Rsl	010851
	"	09.22	0.22	Tr/Fnd	040451
	"	10.18	0.08	Tr/Rc	010850
	"	10.26	0.20	Tr/Rc	010850
	"	10.46	0.28	Tr/Fnd	040451
	"	10.94	0.06	Tr/Fnd	040451
	"	11.00	0.12	Tr/Rsm	010852
	"	11.12	0.02	DNE	999999
	"	11.46	0.36	Tr/Rsl	010851

The "Did Not Exist" category is used when there is a change in shoreline length between the base year and a comparison year. The shoreline may have been longer along some segment in either year; the photographs themselves should be used as the basis for such an observation, not the USGS quadrangle map. Since the mileage overlay is constructed after the photo analysis is completed, it should measure the longest shoreline segment regardless of the year in which it occurred.

By convention, in a year in which the shoreline segment was shorter the difference in length is coded as "Did Not Exist" as if it were the northern portion of that segment. This was done because all measurements were made from south to north. A hypothetical example is given below to clarify this procedure.



For simplicity's sake assume the use along the segment was the same in all three years; for example, natural beach (Bb).

The code sheets for the three years would describe this segment as follows:

	mile # start	length	use
1955	9.0	1.0	Bd
1965	9.0	0.5	Bd
	9.5	0.5	DNE
1969	9.0	0.3	Bd
	9.3	0.7	DNE

DATE DUE

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