Coastal Habitat Mapping Program

ShoreZone

Oregon
Data Summary Report
June 2014

Prepared for:
Oregon Department of
Fish and Wildlife

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ShoreZone Coastal Habitat Mapping Data Summary Report

Oregon Survey Area

Prepared for:
Oregon Department of Fish and Wildlife

Prepared by:

Coastal & Ocean Resources
759A Vanalman Ave., Victoria BC V8Z 3B8 Canada
(250) 658-4050
www.coastalandoceans.com

Archipelago Marine Research Ltd
525 Head Street, Victoria BC V9A 5S1 Canada
(250) 383-4535
www.archipelago.ca

SUMMARY

ShoreZone is a coastal habitat mapping and classification system in which georeferenced aerial imagery is collected specifically for the interpretation and integration of geological and biological features of the intertidal zone and nearshore environment. The mapping methodology is summarized in Harper *et al* (2013).

This data summary report provides information on **geomorphic and biological features** of 2,633 km of shoreline mapped for the 2011 coastal survey of Oregon. The habitat inventory is comprised of 3,223 along-shore segments (units), averaging 817 m in length (based on the CUSP_OR shoreline)[1].

Organic shore types, usually dominated by fine sediment and marshes, are mapped along 1,202.1 km (45.7%) of the study area. *Bedrock* shore types (Shore Types 1-5) are uncommon with only 7.8% mapped. A third (33.7%) of the mapped coastal environment is characterized as Sediment-dominated shore types (Shore Types 21-30). Of these, wide sand flats (Shore Type 28) are the most common, mapped along 495.2 km of shoreline (18.8% of the total study area).

In terms of *Habitat Types* (a combination of substrate and exposure that is indicative of associated benthic communities), the Outer Coast (31% of the shoreline) is dominated by *exposed*, *immobile/partially-immobile* substrate (16%) and *exposed, mobile* substrate (13%). The Inner Coast makes up 69% of the total shoreline length and with the dominant habitat type as *organic/estuary* habitat (fine sediment and marshes; 46%) Repeatable assemblages of biota that can be recognized from the aerial imagery are termed *biobands*; 22 biobands have been mapped in Oregon to date. On the *Outer Coast* some of the most common biobands are: RED algae (54%, MUS (California mussels and goose barnacle complexes; 32%), SUR surf grass (18%) and NER bull kelp (15%). On the Inner Coast, salt marshes, as represented by the TRI bioband are mapped along 86% of the inner shoreline and eelgrass (ZOS bioband) is mapped along 28%.

Man-modified shorelines (Shore Types 32 and 33) are common around populated areas; 25.6% of the entire Oregon shoreline. The most common types of shore modification observed are landfill and riprap (466.3 km and 156.9 km respectively). Most anthropogenic features are concentrated in the larger communities of Tillamook, Newport and Coos Bay.

[1] Note: CUSP stands for Continuously Updated Shoreline Product by NOAA. CUSP_OR is a version that has been modified by the state of Oregon to include higher resolution shoreline for estuarine areas of Oregon. Previously reported ShoreZone mapping used a BLM shoreline that was shorter than the CUSP_OR shoreline.

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1 INTRODUCTION

1.1 Overview of the ShoreZone Coastal Habitat Mapping Program

The land-sea interface is a crucial realm for terrestrial and marine organisms, human activities, and dynamic processes. ShoreZone is a mapping and classification system that specializes in the collection and interpretation of aerial imagery of the coastal environment. Its objective is to produce an integrated, searchable inventory of geomorphic and biological features of the intertidal and nearshore zones which can be used as a tool for science, education, management, and environmental hazard planning.

ShoreZone imagery provides a useful baseline, while mapped resources (such as shoreline sediments, eelgrass and wetland distributions) are an important tool for scientists and managers. The ShoreZone system was employed in the 1980s and 1990s to map coastal features in British Columbia and Washington State (Howes 2001; Berry *et al* 2004). Between 2001 and 2003, ShoreZone imaging and mapping was initiated in the Gulf of Alaska, beginning with Cook Inlet, Outer Kenai, Katmai, and portions of the Kodiak Archipelago (Harper and Morris 2004).

The ShoreZone program continues to grow from Alaska to Oregon through the efforts of a network of partners, including scientists, managers, GIS specialists, and web specialists in federal, state, and local government agencies and in private and nonprofit organizations. The coastal mapping data and imagery are used for oil spill contingency planning, conservation planning, habitat research, development evaluation, mariculture site review, and recreation opportunities. Protocols and standards are updated through technological advancements (e.g. Harper *et al* 2013), and applications are developed that use ShoreZone data to examine modern questions regarding the coastal environment and nearshore habitats (Harney 2007, 2008). As of June 2014, mapped regions include close to 61,500 km of coastline Alaska and 45,000 km of coastline in British Columbia, Washington and Oregon. (Figures 1 and 2).

The ShoreZone mapping system provides a spatial framework for coastal habitat assessment on local and regional scales. Research and practical applications of ShoreZone data and imagery include:

- natural resource and conservation planning
- environmental hazard response
- spill contingency planning
- linking habitat use and life-history strategy of nearshore fish and other intertidal organisms
- habitat suitability modeling (for example, to predict the spread of invasive species or the distribution of beaches appropriate for spawning fish

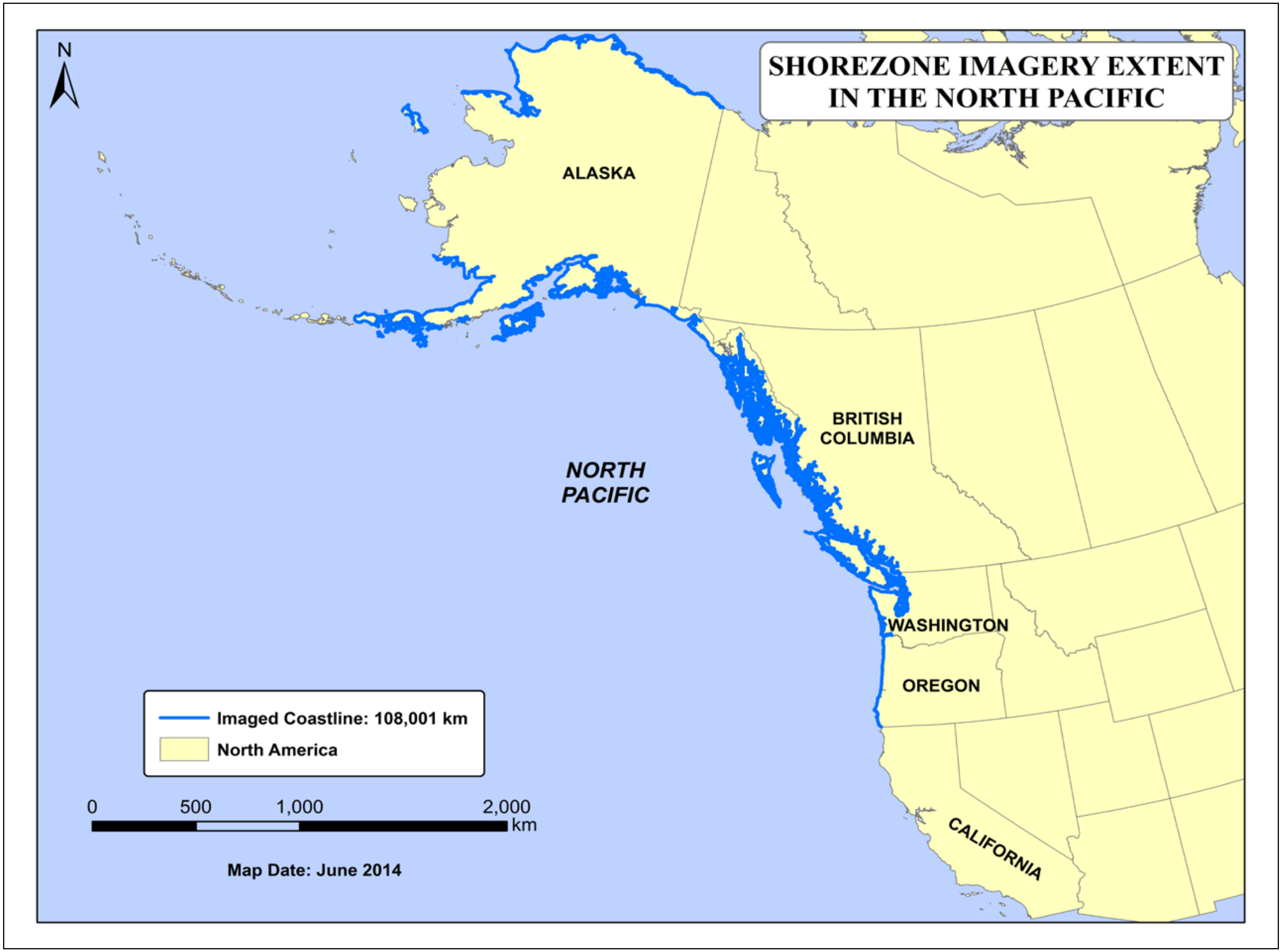

Figure 1. Extent of ShoreZone imagery in Alaska, British Columbia, and Washington State and Oregon (108,001 km)

Figure 2. Map of the study area in Oregon (2,633 km based on CUSP shoreline length)

- development evaluation and mariculture site review
- ground-truthing of aerial data on smaller spatial scales
- public use for recreation, education, outreach, and conservation

Details concerning mapping methodology and the definition of 2013 standards are available in the ShoreZone Coastal Habitat Mapping Protocol for Oregon (Harper *et al* 2013). This and other ShoreZone reports are available for download from the ShoreZone website at www.ShoreZone.org.

1.2 ShoreZone Mapping of Oregon

The field survey conducted in Oregon 2011 collected aerial video and digital still photographs of the coastal and nearshore zone during zero-meter tide levels and lower. The imagery and associated audio commentary are used to map the geomorphic and biological features of the shoreline according to the ShoreZone Coastal Habitat Mapping Protocol (Harper *et al* 2013).

The purpose of this report is to provide a summary of the physical (geomorphic) and biological data mapped in Oregon (Figure 2).

The along-shore length of shoreline mapped in the database is **2,633 kilometers** in 3,223 along-shore segments (units), averaging 817 m in length. The digital shoreline used for the ShoreZone mapping is referred to as the CUSP_OR shoreline. For the outer coast of Oregon, CUSP_OR is based primarily on the NOAA CUSP shoreline. But the inner coast shoreline was modified by the state of Oregon to capture “lost shoreline” where tide-water marshes that occurred landward of dykes and culverts commonly not included on digital shorelines. As such, the CUSP_OR digital shoreline includes both NOAA CUSP and other modifications from previously used digital shorelines (e.g., BLM).

2 PHYSICAL SHOREZONE DATA SUMMARY

2.1 Shore Types

The principal characteristics of each along-shore segment are used to assign an overall unit classification or "shore type" that represents the unit as a whole. ShoreZone mapping employs two along-shore **unit classification** systems: coastal shore types defined for British Columbia ("Shore Types") and the "Environmental Sensitivity Index" (ESI) class developed for oil-spill mitigation. A third shoreline classification system unique to ShoreZone ("Habitat Class") is defined in Section 3.4.

The Shore Type system is used to describe along-shore coastal units as one of 39 shore types defined on the basis of the geomorphic features, substrate, sediment texture, across-shore width, and slope of that section of coastline (after Howes *et al* 1994; Appendix A, Table A-2 & Table A-3). Coastal classes also characterize units dominated by organic shorelines such as marshes and estuaries (Shore Type 31), man-made features (Shore Types 32 and 33), high-current channels (Shore Type 34), glaciers (Shore Type 35), lagoons (Shore Type 36), inundated tundra (Shore Type 37), ground ice slumps (Shore Type 38) and low vegetated peat (Shore Type 39).

The occurrence of shore types in the study area is listed in Table 1. Grouped Shore Types are useful to illustrate mapped distributions (Figure 3) and to summarize data in graphic form (Figure 4). **Bedrock shorelines** (Shore Types 1-5) comprise 204.0 km (7.6%) of mapped shorelines. **Rock and sediment shorelines** (Shore Types 6-20) comprise of 6.5% of the shoreline (170.3 km). **Sediment-dominated shorelines** (Shore Types 21-30) show up along 887.2 km (33.7%) of the coast (Figures 5). Of these, wide sand flats (Shore Type 28) are the most common, mapped along 495.2 km of shoreline (18.8% of the total study area). **Organic** and **man-made shorelines** constitute the remaining coast with 45.6% and 6.4% respectively.

The NOAA Environmental Sensitivity Index (ESI Class) is a shoreline classification system developed to categorize coastal regions on the basis of their oil-spill sensitivity. The ESI system uses wave exposure and principal substrate type to assign alongshore coastal units a ranking of 1-10 to indicate the relative degree of sensitivity to oil spills (1=least sensitive, 10=most sensitive) as well as a general shore type (Peterson *et al* 2002; Appendix A, Table A-4). The ESI system is an integral component of oil-spill contingency planning. Substrate permeability is of principal importance in estimating the residence time of oil on the shoreline, thus sediment texture is a key element in determining the ESI class. The occurrence of ESI shore types in the study area are listed in Table 2.

Table 1. Summary of Shore Types

Substrate Type	Shore Type No.	Shore Type Description	Sum of Unit Length (km)	# of Units	% Occurrence (by length)	Cumulative Occurrence (%, km)
Rock	1	Rock Ramp, wide	13.4	14	0.5	7.6% 204.0km
	2	Rock Platform, wide	7.4	9	0.3	
	3	Rock Cliff	168.6	211	6.4	
	4	Rock Ramp, narrow	12.3	18	0.5	
	5	Rock Platform, narrow	2.2	8	0.1	
Rock & Sediment	6	Ramp w gravel beach, narrow	24.4	37	0.9	6.5% 170.3km
	7	Platform w gravel beach, wide	11.6	19	0.4	
	8	Cliff with gravel beach	28.4	49	1.1	
	9	Ramp with gravel beach	10.6	33	0.4	
	10	Platform with gravel beach	0.1	1	0.0	
	11	Ramp w gravel & sand beach, wide	16.6	39	0.6	
	12	Platform with G&S beach, wide	26.5	61	1.0	
	13	Cliff with gravel/sand beach	11.7	24	0.4	
	14	Ramp with gravel/sand beach	1.2	7	0.1	
	16	Ramp w sand beach, wide	8.7	21	0.3	
	17	Platform w sand beach, wide	18.2	41	0.7	
	18	Cliff with sand beach	11.7	32	0.4	
	19	Ramp w sand beach, narrow	0.2	2	0.0	
	20	Platform w sand beach, narrow	0.5	2	0.0	
Sediment	21	Gravel flat, wide	8.0	19	0.3	33.7% 887.2km
	22	Gravel beach, narrow	8.7	18	0.3	
	24	Sand & gravel flat or fan	74.6	173	2.8	
	25	Sand & gravel beach, narrow	54.5	133	2.1	
	26	Sand & gravel flat or fan	9.4	29	0.4	
	27	Sand beach	16.2	44	0.6	
	28	Sand flat	495.2	647	18.8	
	29	Mudflat	112.3	156	4.3	
	30	Sand beach	108.2	190	4.1	
Organics	31	Organics/Estuarine	1202.1	829	45.7	45.7% 1202.1km
Man-made	32	Man-made, permeable	167.2	343	6.3	6.4% 169.4km
	33	Man-made, impermeable	2.2	14	0.1	
Totals:			***2,632.9***	***3,223***	***100.0***	***100%***

*Note: Other Shore Types not observed.

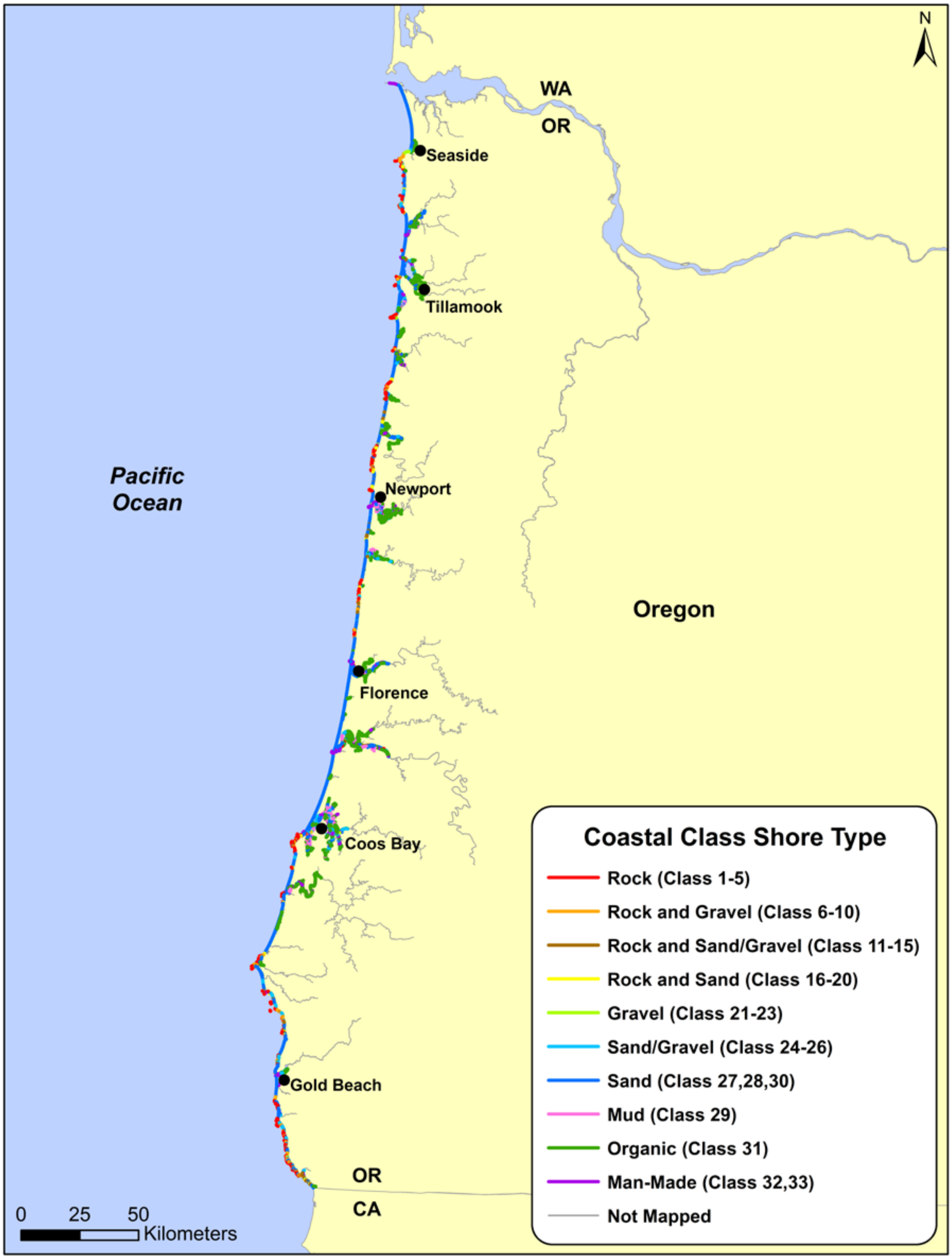

Figure 3. Map of the distribution of principal substrate types (on the basis of grouped Shore Types) in the Oregon study area. Data are listed by individual class and summarized by grouped classes in Table 1.

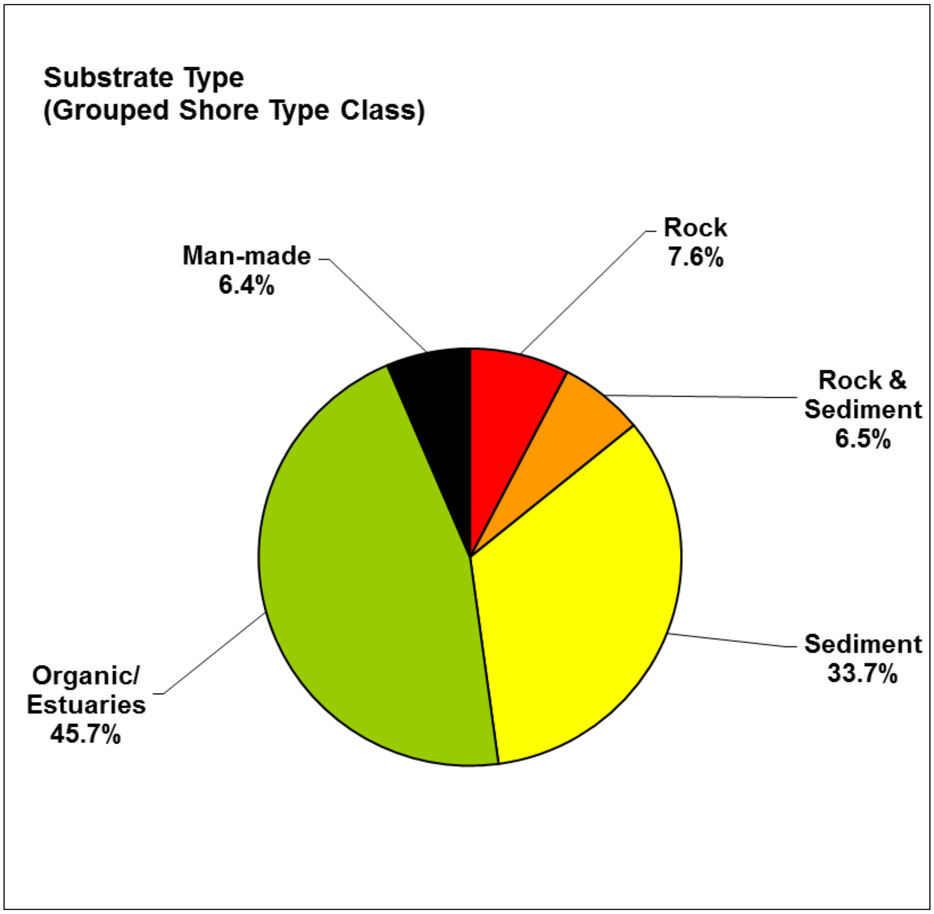

Figure 4. Relative abundance of principal substrate types (on the basis of grouped Shore Types) in the Oregon study area. Data are summarized in Table 1.

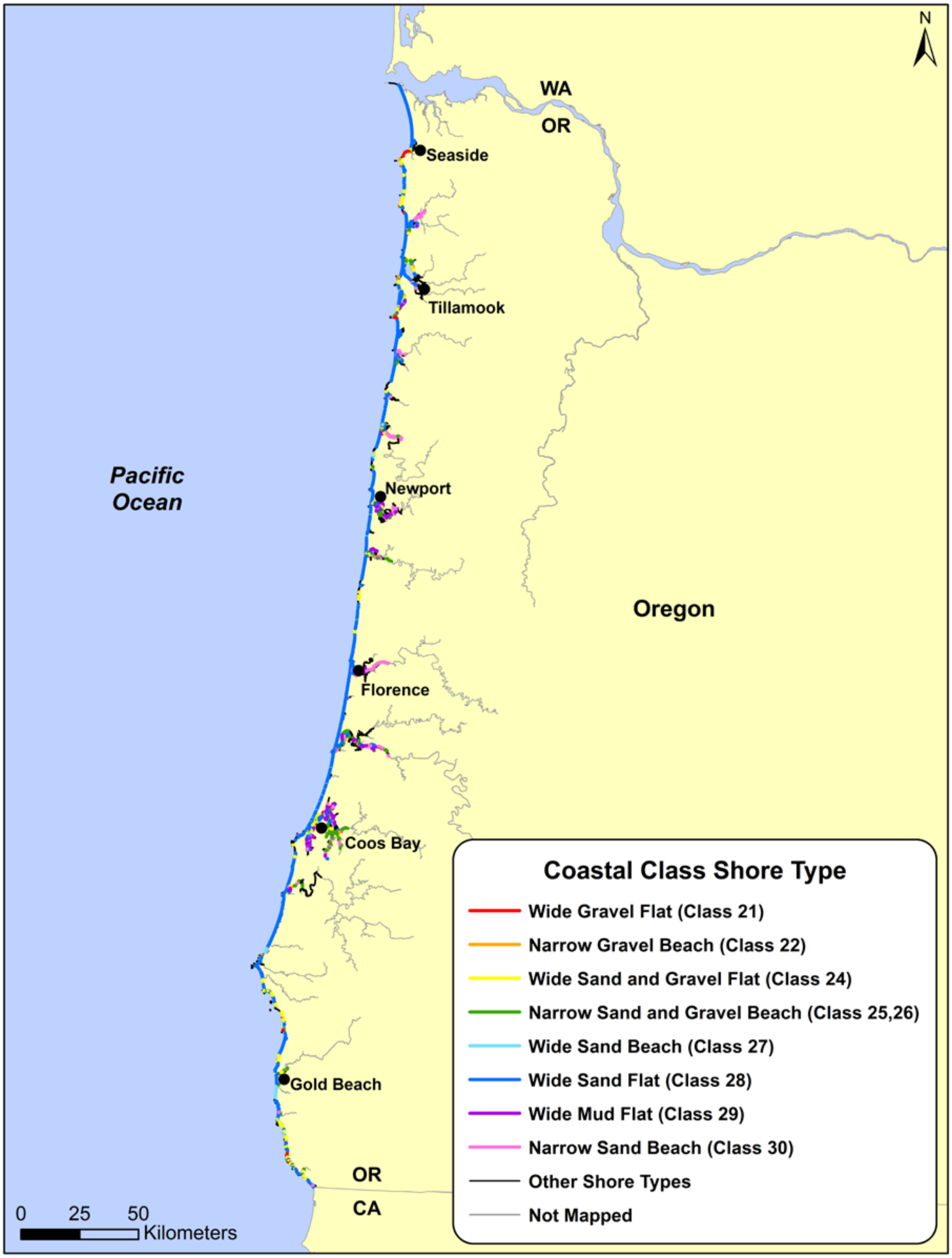

Figure 5. Map of the distribution of sediment shorelines (Shore Types, grouped by geomorphology) in the Oregon study area. Data are summarized in Table 1.

Table 2. Summary of Shore Types by ESI Class

Environmental Sensitivity Index (ESI)		Sum of Unit Length (km)	# of Units	% Occurrence (by length)
No.	Description			
1A	Exposed rocky shores; Exposed rocky banks	171.1	206	6.5%
1B	Exposed, solid man-made structures	13.3	15	0.5%
1C	Exposed rocky cliffs with boulder talus base	39.3	72	1.5%
2A	Exposed wave-cut platforms in bedrock, mud, or clay	26.8	37	1.0%
3A	Fine- to medium-grained sand beaches	184.5	360	7.0%
4	Coarse-grained sand beaches	40.7	73	1.5%
5	Mixed sand and gravel beaches	182.1	446	6.9%
6A	Gravel beaches (granules and pebbles)	2.2	5	0.1%
6B	Gravel beaches (cobbles and boulders)	53.5	98	2.0%
6C	Rip Rap (man-made)	32.7	58	1.2%
7	Exposed tidal flats	353.0	409	13.4%
8A	Sheltered scarps in bedrock, mud, or clay; sheltered rocky shores (impermeable)	10.9	38	0.4%
8B	Sheltered, solid, man-made structures; sheltered rocky shores (permeable)	47.8	125	1.8%
8C	Sheltered rip rap	28.3	53	1.1%
8D	Sheltered rocky rubble shores	0.3	1	0.0%
9A	Sheltered tidal flats	308.1	369	11.7%
9B	Vegetated low banks	265.2	261	10.1%
10A	Salt- and brackish-water marshes	824.7	565	31.3%
10B	Freshwater marshes	43.8	28	1.7%
10C	Swamps	4.9	4	0.2%
Totals:		***2,632.9***	***3,223***	***100.0%***

*Note: Other ESI Classes not observed.

2.2 Anthropogenic Shore Modifications

Shore-protection features and coastal access constructions such as seawalls, rip rap, docks, dikes, and wharves are enumerated in ShoreZone mapping data. When the Shore Modification section of the dataset is examined, it shows that 25.6% of the shoreline in Oregon has been modified, mostly in the populated areas of Tillamook, Newport and Coos Bay. The types of shore modification features (such as boat ramps, bulkheads, and rip rap) and their relative proportions of the intertidal zone are mapped into the database in the “SHORE_MOD” fields of the UNIT table (see Table A-1 for a description of these fields). The distribution of shore modifications mapped in the study area (Table 3) is shown in Figure 6.

Table 3. Summary of Shore Modifications

Shore Modification	# of Occurrences	Shoreline Length (km)	% of Shoreline
Landfill*	1,126	466.3	17.7%
Riprap	576	156.9	6.0%
Wooden bulkhead	204	21.5	0.8%
Concrete bulkhead	236	21.2	0.8%
Boat ramp	99	7.8	0.3%
Sheet pile	12	1.3	0.0%
Totals:	***2,253***	***674.9***	***25.6%***

*Dykes are included Landfill in the Shoreline Modification Table; they can be identified in the mapping database by searching for the forms Ak (Dyke) or Al (Breached Dyke) the Xshr Table.

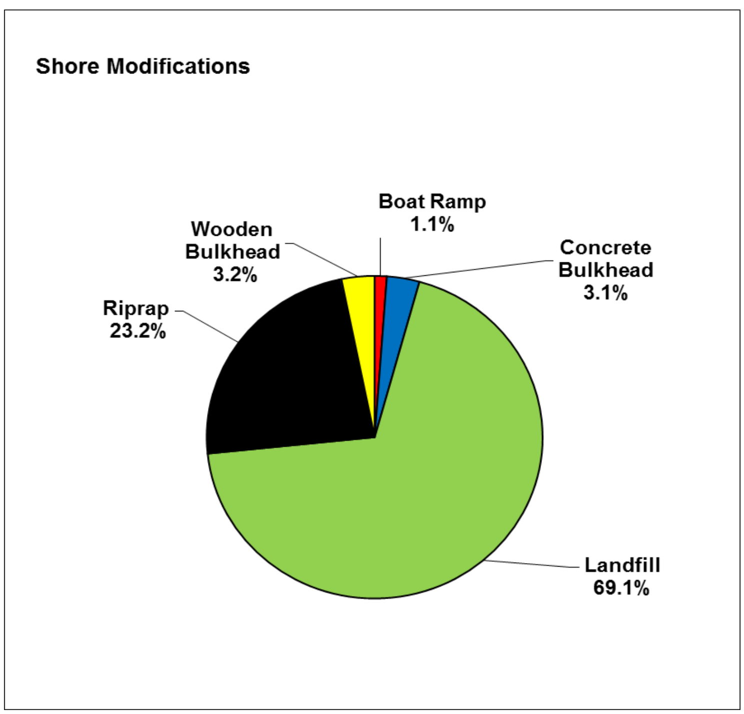

Figure 6. Distribution of Shore Modifications in Oregon Study Area

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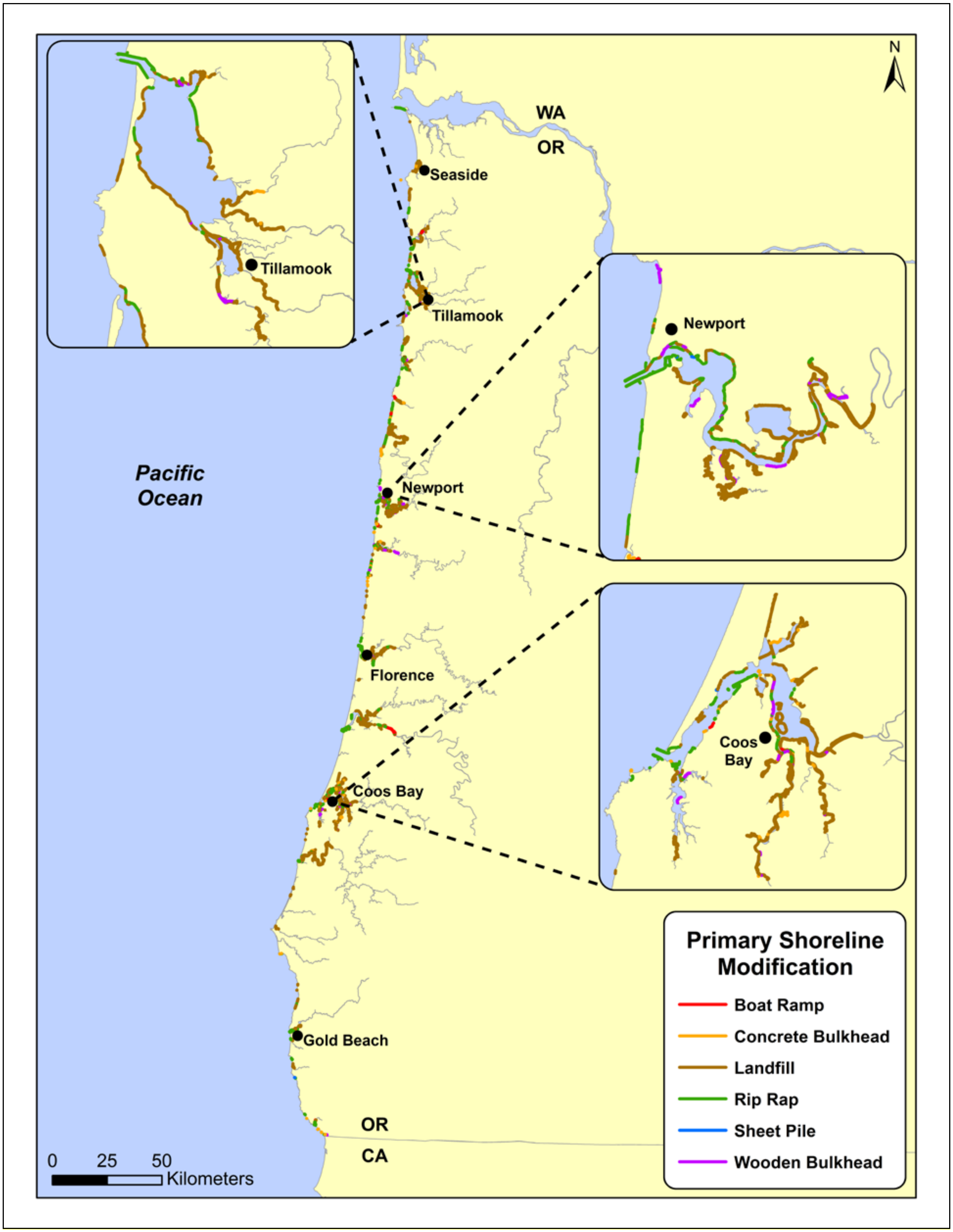


Figure 7. Map of the distribution of units in which shore modification features were observed in the Oregon study area. Data are summarized in Table 3.

2.3 Oil Residence Index (ORI)

The Oil Residence Index (ORI) is a rating between 1 and 5 that reflects the estimated persistence of spilled oil on a shoreline. A value of 1 reflects relatively short oil residence (days to weeks), while a value of 5 reflects potentially long oil residence times (months to years). An ORI value is applied to each across-shore component on the basis of sediment texture and wave exposure (Table A-6), as well as to each along-shore unit on the basis of shore type and wave exposure (Table A-7). For more information on the assignment of this attribute, refer to the ShoreZone Protocol (Harper *et al* 2013).

The dominance of lower wave exposures and sand-gravel sediment textures results in high Oil Residence Indices for over half of the shore segments: 54% have an ORI of 5, indicating oil residence times are on the order of months to years (Table 4; Figure 8).

Table 4. Summary of Oil Residence Index

Relative Persistence	Oil Residence Index (ORI)	Estimated temporal persistence	Shoreline Length (km)	Shoreline Length (%)
Short	1	Days to weeks	196.4	7.5
	2	**Weeks** to months	514.1	19.5
Moderate	3	Weeks to **months**	322.2	12.2
	4	**Months** to years	186.4	7.1
Long	5	Months to **years**	1,413.9	53.7
Totals:			***2,632.9***	***100.0%***

2.4 Biogeographic Regions

To assist with data manipulation, ODFW wished to add information on geographic regions or features and on salinity regimes. Table A-22 (Appendix A) contains information on the codes that are included in the Geodatabase.

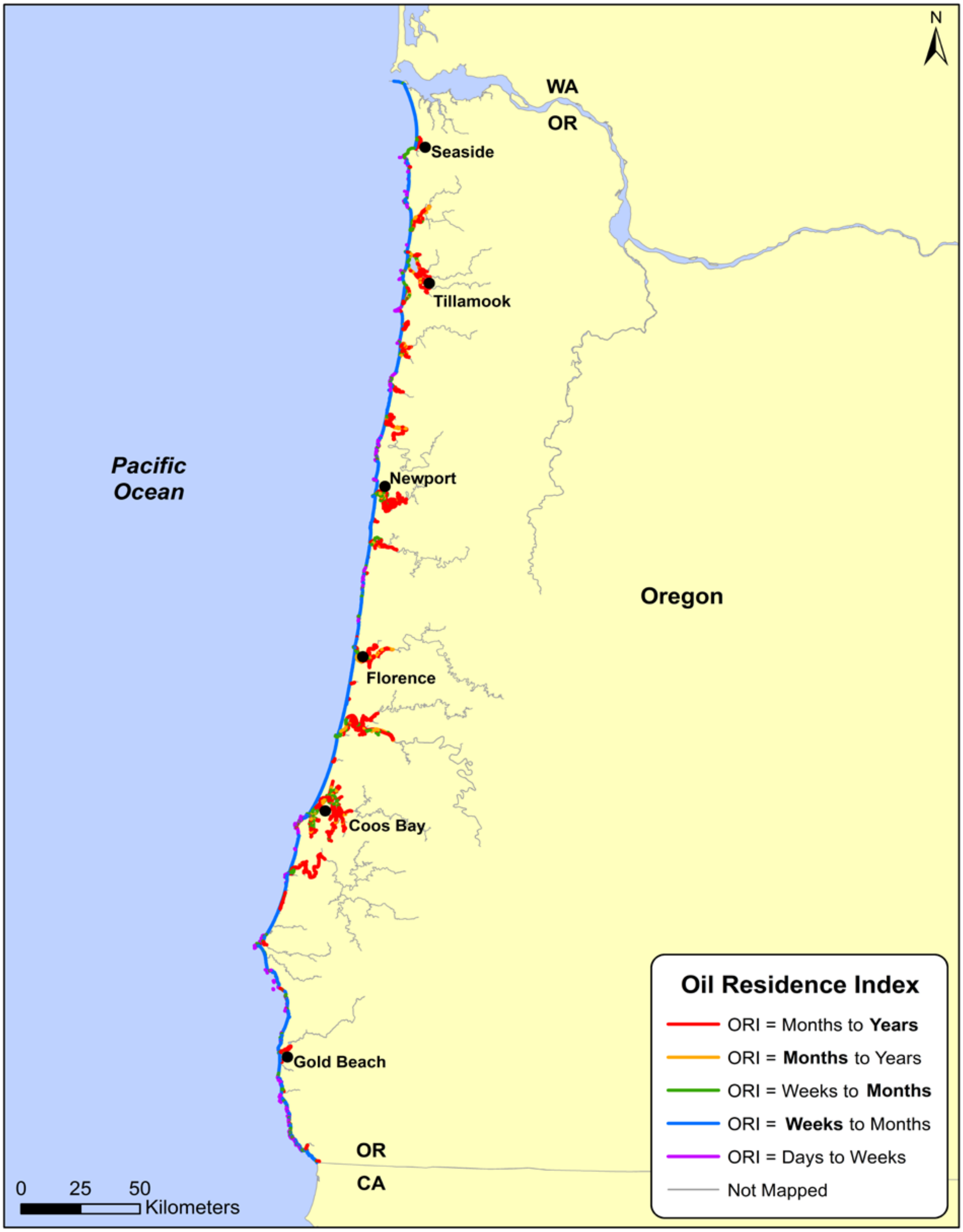


Figure 8. Oil Residence Index (ORI) for shorelines in Oregon, based on substrate type and wave exposure (Appendix A, Table A-7).

3 BIOLOGICAL SHOREZONE DATA SUMMARY

Biological ShoreZone mapping is based on the observation of patterns of biota in the coastal zone, with data recorded on the occurrence and extent of species assemblages (called **biobands**). The observations of presence, absence and relative distribution of the biobands are recorded in the mapping within each alongshore unit. Based on those observations, an interpreted classification of **biological wave exposure** and **habitat class** is assigned.

3.1 BioAreas

In Oregon, coastal habitats are either high energy beaches or rocky headlands of the outer coast, or are in the sheltered estuaries and river deltas in the inner coast. To recognize region-specific species assemblages, as well as to identify broad-scale trends in coastal habitats, two **bioareas** have been defined in Oregon (Figure 9 and Appendix A, Table A-8), the outer Oregon coast and the inner Oregon coast. A similar approach was applied in British Columbia and Alaska to recognize the broad-scale eco-regional differences and seven bioareas have been defined there for the ShoreZone mapping (Harper *et al* 2013, Harper and Morris 2014).

Bioareas are delineated on the basis of observed regional differences in the distribution of lower intertidal biota, nearshore canopy kelps, and coastal habitats. In Oregon, two bioareas have been described to distinguish between regional patterns on the high energy outer coast (Oregon – Outer Coast, OREO) and the protected, estuary-dominated inner coast (Oregon – Inner Coast, OREI).

Figure 9. Bioareas identified in Oregon study area.

3.2 Biobands

A **bioband** is an observed assemblage of coastal biota, found on the shoreline at characteristic wave energies, substrate conditions and typical across-shore elevations. Biobands are spatially distinct, with alongshore and across-shore patterns of color and texture that are visible in aerial imagery (Figures 10 through13). Biobands usually occur in a characteristic across-shore elevation and are coded in each unit as if drawing a profile across the shore, from the high supratidal to the shallow nearshore subtidal.

Biobands are named for the dominant species or group that best describes the band, and each bioband is defined by a set of *indicator* and *associated* species. Some biobands are named for a single *indicator* species (such as the Eelgrass bioband (ZOS) for which the indicator species is *Zostera marina*), while others represent an assemblage of co-occurring species (such as the Red Algae bioband (RED)). Indicator species are the species that are most commonly observed in the band. Biobands mapped in Oregon are listed in Table 5.

The distribution of each bioband observed in every unit is recorded in the database. Bioband occurrence is recorded as *patchy* or *continuous* for all biobands except for the Splash Zone bioband (VER), which is recorded from an estimate of the across-shore width (*narrow, medium* or *wide*). A distribution of *patchy* is defined as 'visible in less than half of the along-shore unit length' and *continuous* is defined as 'visible in more than half of the unit's along-shore length'.

Further descriptions of Oregon biobands can be found in Appendix A, Table A-16.

Example photos of Oregon biobands can be found in the ShoreZone Coastal Habitat Mapping Protocol for Oregon (Harper *et al* 2013).

Table 5. Oregon Biobands

Zone	Bioband Name	Bioband Code
Supratidal	Splash Zone	VER
	Shrub Meadow	MSH
	High Grass Meadow	MAG
	Dune Grass	GRA
	European Beach Grass	AMM
	Sedges	SED
	Salt Marsh	TRI
Upper to Mid-Intertidal	Barnacle	BAR
	Rockweed	FUC
	Green Algae	ULV
	Blue Mussel	BMU
	California Mussel	MUS
	Bleached Red Algae	HAL
	Oyster	OYS
	Red Algae	RED
Lower Intertidal and Nearshore Subtidal	Alaria	ALA
	Soft Brown Kelps	SBR
	Mud Flat Shrimp	CAL
	Dark Brown Kelps	CHB
	Surfgrass	SUR
	Eelgrass	ZOS
Subtidal	Giant Kelp	MAC
	Bull Kelp	NER

Figure 10. Salt marsh bioband (TRI), with sedge bioband (SED) near Nehalem, in Nehalem Bay (photo or11_or_02478.jpg).

Figure 11. European Beach Grass bioband (AMM) with bare mobile sandy beaches in the intertidal, in Florence, near Joaquin Miller State Park (photo or12_or_07971.jpg).

Figure 12. Supratidal green algae (ULV) band with barnacles (BAR), lush surfgrass (SUR) and red algae (RED) on a high energy platform in Boiler Bay near Lincoln Beach (photo or11_or_04650.jpg).

Figure 13. Intertidal barnacle (BAR), California mussel (MUS) and foliose red algae (RED) with nearshore bull kelp (NER) on the south side of Cape Lookout (photo or11_or_01681.jpg).

3.2.1 Biobands mapped on the Inner Coast of Oregon

The occurrence of each bioband on the Inner Coast of is shown in Table 6 and Figure 14. The inner coast of Oregon is dominated by the Salt Marsh (TRI) bioband which was the most commonly mapped, with 86% of the coast having either patchy or continuous Salt Marsh observed. Sedges (SED) and Green Algae (ULV) biobands were the next most commonly mapped bands as either patchy or continuous on 68% and 45%, respectively, of the mapped shoreline. Eelgrass (ZOS) bioband, in the nearshore subtidal, was mapped along 27% of the inner coast as either patchy or continuous.

Small amounts of the biobands usually associated with stable substrate (Barnacle (BAR), Rockweed (FUC), Blue Mussel (BMU), California Mussel (MUS) and Red Algae (RED) biobands) were observed in the Inner Oregon coast (Table 6 and Figure 14). Only trace amounts of biobands associated with higher wave energies (such as Bull Kelp (NER) and Dark Brown Kelp (CHB)) were observed in the Inner Coast, and always in the transitional areas to the higher energy Outer Coast.

Table 6. Bioband Abundances Mapped on the Inner Oregon Coast.

BioBand		Continuous		Patchy		Total	% of Mapped
Name	Code	(km)	%	(km)	%	(km)	
Shrub Meadow	MSH	237	13	165	9	402	22
High Grass Meadow	MAG	65	4	64	4	129	7
Dune Grass	GRA	18	1	42	2	60	3
European Dune Grass	AMM	35	2	33	2	68	4
Sedges	SED	861	48	366	20	1226	68
Salt Marsh	TRI	1242	69	307	17	1549	86
Barnacle	BAR	58	3	24	1	81	5
Rockweed	FUC	62	3	39	2	101	6
Green Algae	ULV	491	27	310	17	801	45
Blue Mussel	BMU	0	0	<1	<1	<1	<1
California Mussel	MUS	<1	<1	<1	<1	<1	<1
Bleached Red Algae	HAL	<1	<1	<1	<1	<1	<1
Oyster	OYS	<1	<1	3	<1	4	<1
Red Algae	RED	27	1	14	1	40	2
Alaria	ALA	0	0	0	0	0	0
Soft Brown Kelp	SBR	8	<1	11	1	19	1
Mud Flat Shrimp	CAL	24	1	33	2	57	3
Dark Brown Kelp	CHB	1	<1	4	<1	5	0.3
Surfgrass	SUR	<1	<1	3	<1	3	0.2
Eelgrass	ZOS	332	19	161	9	494	27
Giant Kelp	MAC	0	0	0	0	0	0
Bull Kelp	NER	0.2	0	0.7	0	1	0

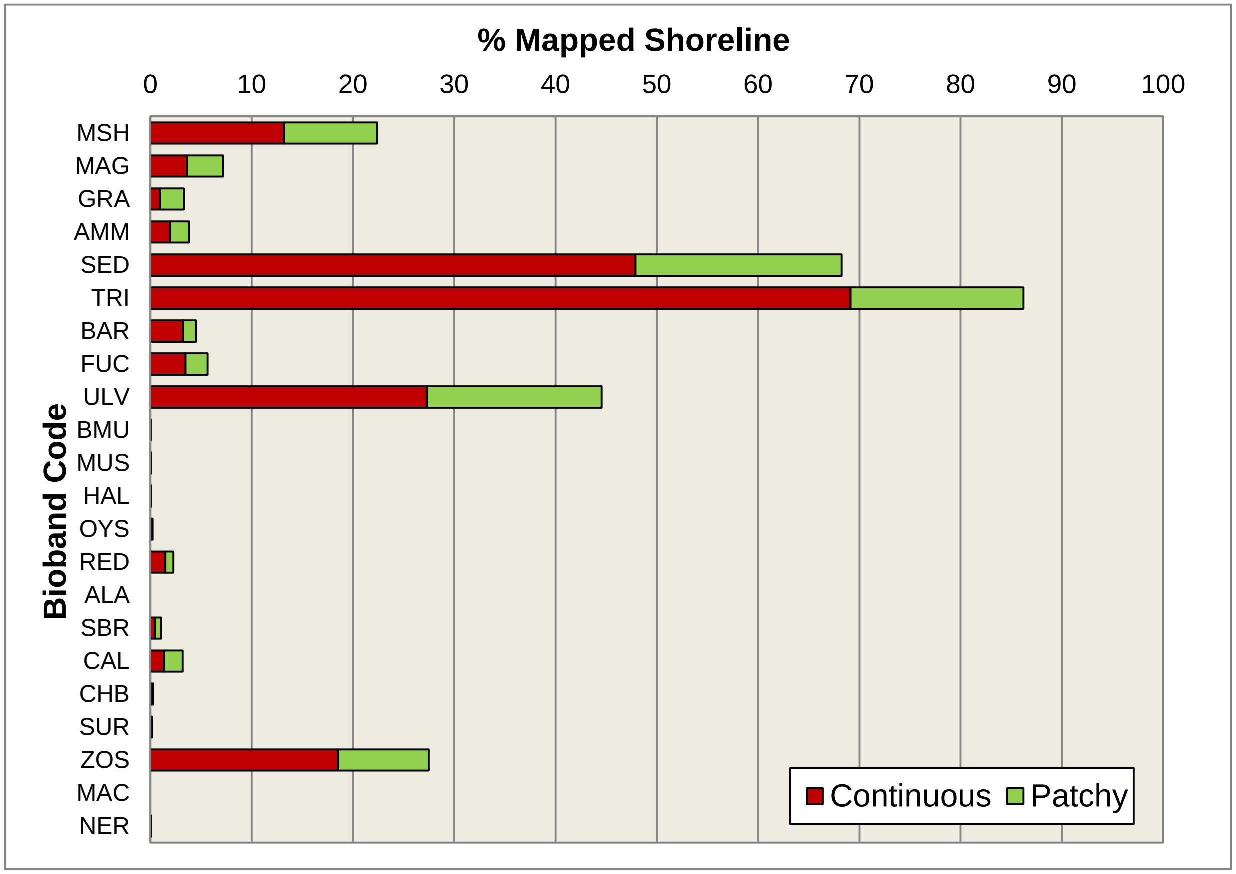


Figure 14. Bioband abundances mapped on the Inner Oregon coast.

3.2.2 Biobands mapped on the Outer Coast of Oregon

The occurrence of each bioband mapped on the outer Oregon coast, dominated by high energy sand beaches and rocky headlands, are shown in Table 7 and Figure 13.

Red algae bioband (RED) was the most commonly mapped, with 54% of the outer coast mapped as either patchy or continuous. Barnacles (BAR) and European Beach Grass (AMM) biobands were the next most commonly mapped bands as either patchy or continuous on 48% and 38%, respectively. Dark Brown Kelps (CHB) and Surfgrass (SUR), both indicators of immobile substrate and higher exposures, were relatively common along the outer coast (Table 7 and Figure 15). Bull Kelp, a nearshore canopy kelp, was mapped on 15% of the outer coast although Giant Kelp (MAC) was only mapped at one location (Cape Arago) along the Oregon coast, comprising less than 1% of the shoreline.

Table 7. Bioband Abundances Mapped on the Outer Oregon Coast.

BioBand		Continuous		Patchy		Total	% of Mapped
Name	Code	(km)	%	(km)	%	(km)	
Shrub Meadow	MSH	3	<1	0	0	3	<1
High Grass Meadow	MAG	0	0	10	1	10	1
Dune Grass	GRA	13	2	13	2	26	3
European Dune Grass	AMM	256	31	63	8	319	38
Sedges	SED	0	0	14	2	14	2
Salt Marsh	TRI	33	4	22	3	54	7
Barnacle	BAR	325	39	73	9	397	48
Rockweed	FUC	14	2	24	3	38	5
Green Algae	ULV	97	12	173	21	269	32
Blue Mussel	BMU	21	2	18	2	38	5
California Mussel	MUS	189	23	89	11	278	33
Bleached Red Algae	HAL	39	5	20	2	59	7
Oyster	OYS	0	0	0	0	0	0
Red Algae	RED	377	45	72	9	449	54
Alaria	ALA	1	<1	1	<1	2	<1
Soft Brown Kelp	SBR	6	1	8	1	13	2
Mud Flat Shrimp	CAL	0	0	1	<1	1	<1
Dark Brown Kelp	CHB	207	25	125	15	332	40
Surfgrass	SUR	59	7	95	11	154	18
Eelgrass	ZOS	0	0	0	0	0	0
Giant Kelp	MAC	1	<1	1	<1	2	<1
Bull Kelp	NER	66	8	58	7	124	15

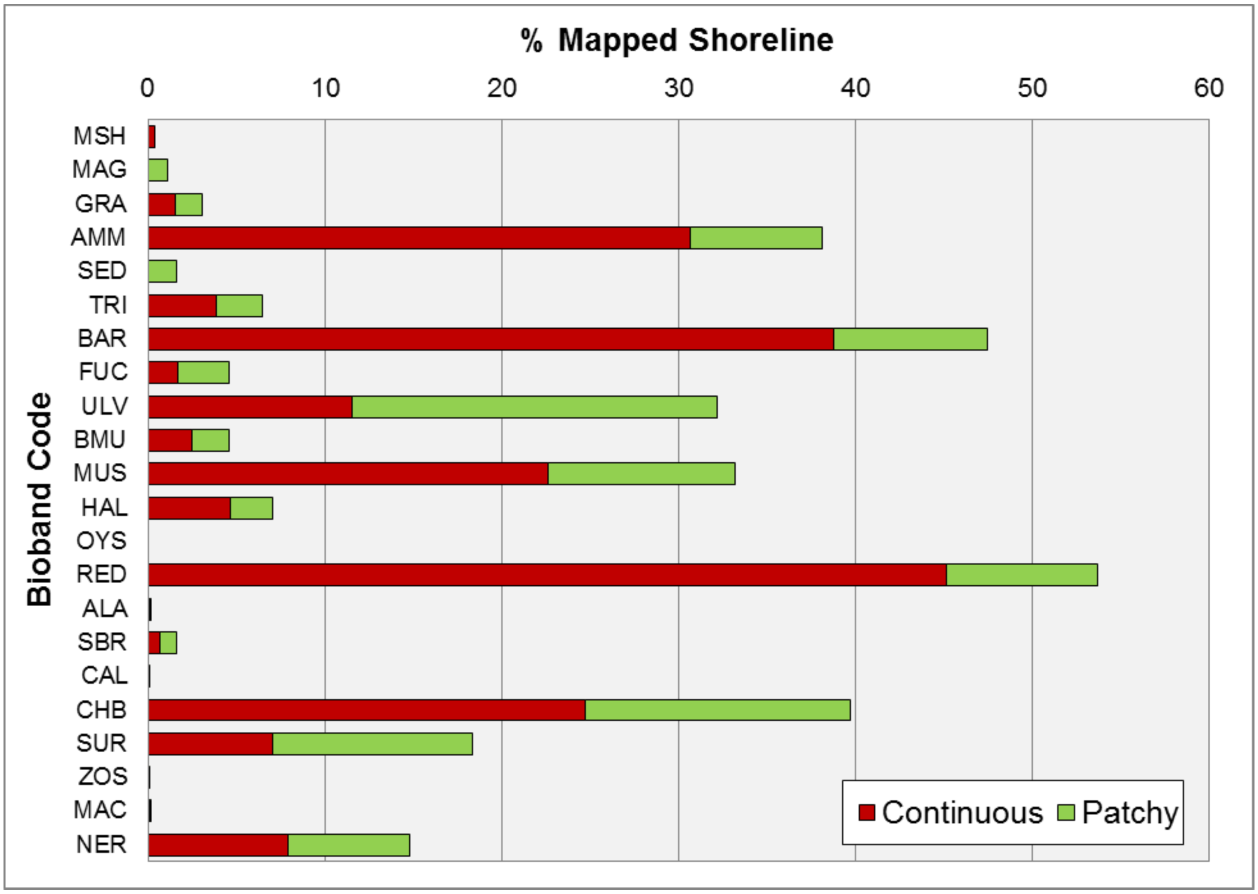


Figure 15. Bioband abundances mapped on the Outer Oregon coast.

3.2.3 Distribution of biobands mapped on the inner and outer coasts

<u>Upper Salt Marsh biobands: Shrub Meadow and High Grass Meadow</u>
Two new biobands were described for biological mapping supratidal (A zone) salt marsh areas in Oregon: the Shrub Meadow (MSH) and High Grass Meadow (MAG) biobands. Both are found nearly exclusively along the inner Oregon coast (Figure 16). The biobands are not as wide spread as the more common lower salt marsh biobands but are always associated with adjacent low marsh in estuary areas.

<u>Lower Salt Marsh biobands: Sedges and Salt Marsh</u>
The two most wide-spread biobands in the supratidal (A zone) which indicate estuarine habitats include the Sedge (SED) and Salt Marsh (TRI) biobands (Figure 17). Each of these two biobands is dominated by rooted vascular plants, with the Salt Marsh bioband having the most diverse species composition, including a number of salt-tolerant grasses, herbs and sedges (Appendix A, Table A-16).

Lower intertidal flats biobands: Oyster and Mud Flat Shrimp

Two biobands that were mapped in the mudflats found on the lower estuary areas of the Oregon inner coast were the Oyster (OYS) bioband and the Mud Flat Shrimp (CAL) bioband (Figure 18). The Oyster bioband are areas of oyster aquaculture that are currently mapped in less than 1% of the inner Oregon coast mapped area. The Mud Flat Shrimp bioband is observed on 3% of the mapped inner Oregon coastline in sand/mud flats in larger estuaries, where textured surface of flats indicates presence of infauna.

Outer Oregon coast mussel biobands: Blue Mussels and California Mussels

The most wide-spread of the two mussel biobands was the California Mussel (MUS) bioband which is a complex of California mussels (*Mytilus californianus*), gooseneck barnacles (*Pollicipes polymerus*) and thatched barnacles (*Semibalanus cariosus*). The California Mussel bioband was mapped along approximately one-third of the outer Oregon coast. (Table 7 and Figure 19).The Blue Mussel (BMU) bioband is observed as distinct black patches on bedrock or boulder areas and was uncommonly mapped in Oregon as a bioband.

Kelp biobands: Bull Kelp, Soft Brown Kelp and Dark Brown Kelp

Almost all of the kelp biobands were mapped on the outer coast of Oregon (Figure 20) in the higher wave exposures, with a few areas of Soft Brown Kelp bioband mapped on immobile substrates in lower estuary areas. The benthic bladed kelps can also occur as understory with canopy kelps, and all large kelps attach to hard substrate.

Seagrass biobands: Eelgrass (ZOS) and Surfgrass (SUR)

Eelgrass (ZOS) is found in fine sediments in estuaries, lagoons or channels and semi-protected and lower wave exposures. Surfgrass (SUR) is always attached to hard substrates and occurs in semi-protected to semi-exposed wave energies. Eelgrass was not mapped on the outer coast, but was common on the lower intertidal areas in the inner coast. Surfgrass was observed only along the rocky shores on the outer coast (Figure 21).

Figure 16. Distribution of upper salt marsh biobands: Shrub Meadow (MSH) and High Grass Meadow (MAG) in Oregon study area.

Figure 17. Distribution of lower salt marsh biobands: Salt Marsh (TRI) and Sedge (SED) in Oregon study area.

Figure 18. Distribution of lower intertidal flats biobands: Mud Flat Shrimp (CAL) and Oyster (OYS) in Oregon study area.

Figure 19. Distribution of outer Oregon coast combined mussel biobands: California Mussel (MUS) and Blue Mussel (BMU) in Oregon study area.

Figure 20. Distribution of outer Oregon coast canopy kelp and combined benthic kelp biobands: Bull Kelp (NER), Giant Kelp (MAC) and combined benthic kelps: Soft Brown Kelp (SBR), Dark Brown Kelp (CHB) in Oregon study area.

Figure 21. Distribution of seagrass biobands: Eelgrass (ZOS) and Surfgrass (SUR) in Oregon study area.

3.3 Biological Wave Exposure

Biological wave exposure categories range from Very Protected (VP) to Very Exposed (VE) and are defined in ShoreZone on the basis of a typical set of biobands. When present the observed and relative abundance of biota in each alongshore unit is used to determine the classification for the biological wave exposure. The assemblages of biota observed are then used as a proxy for the energy conditions at that site (Appendix A, Tables A-18 to A-21). The six biological wave exposure categories are the same as those used in the physical mapping (Appendix A, Tables A-4 and A-9).

In units where no attached biota was visible, the biological wave exposure was inferred from biota observed in adjacent units. The biological exposure attribute is used in the look up matrix for determining the Oil Residence Index (ORI) (Appendix A, Table A-6).

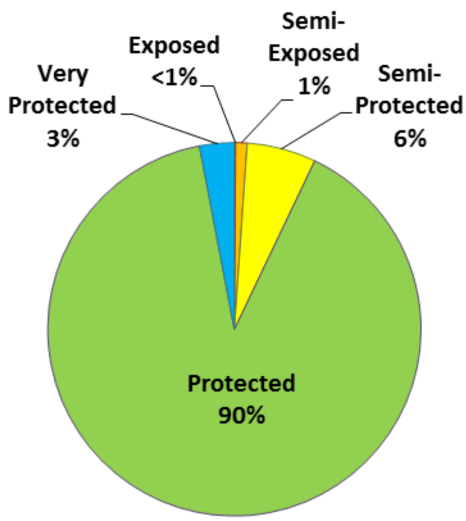
For more information and examples about ShoreZone biobands, biological wave exposure and habitat class definitions see the Alaska regional data summary reports and protocols (Harper and Morris 2014) available for download from the ShoreZone website at http://alaskafisheries.noaa.gov/shorezone/ . For information and examples specific to the Oregon coastline, the Oregon ShoreZone protocols (Harper *et al*. 2013) are available for download at http://www.coastalatlas.net/shorezone/ .

The occurrence of the biological wave exposure categories mapped in the inner and the outer Oregon coast bioareas are summarized in Table 8 and in Figures 22 and 23. Most of the outer coast is classified as *Exposed,* while most of the inner coast is *Protected.* The transition between these two bioareas tends to occur over a relatively short distance, often at the outlets of the large and small rivers found along the coast. These transitional areas are characterized by dramatic changes in wave energy and associated biotic communities making them areas of increased habitat complexity.

Table 8. Summary of Wave Exposures mapped on the Oregon coast.

		Inner Coast		Outer Coast	
Wave Exposure		Shoreline Length (km)	% of Shoreline	Shoreline Length (km)	% of Shoreline
Name	Code				
Very Exposed	VE	0	0	0	0
Exposed	E	1	<1	772	92
Semi-Exposed	SE	21	1	51	6
Semi-Protected	SP	111	6	6	<1
Protected	P	1608	90	7	<1
Very Protected	VP	55	3	0	0
Totals		**836**	**100**	**1797**	**100**

INNER COAST BIOAREA



OUTER COAST BIOAREA

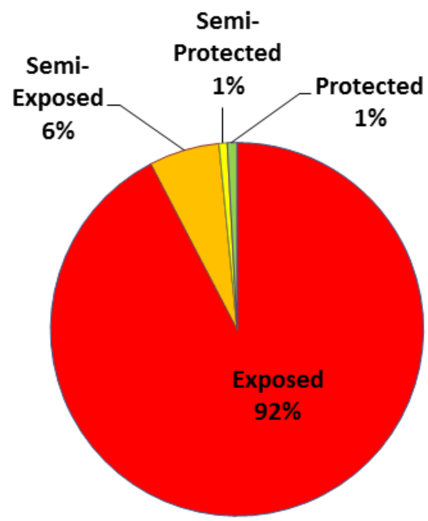


Figure 22. Occurrence of biological wave exposures mapped on the inner and outer Oregon coast bioareas.

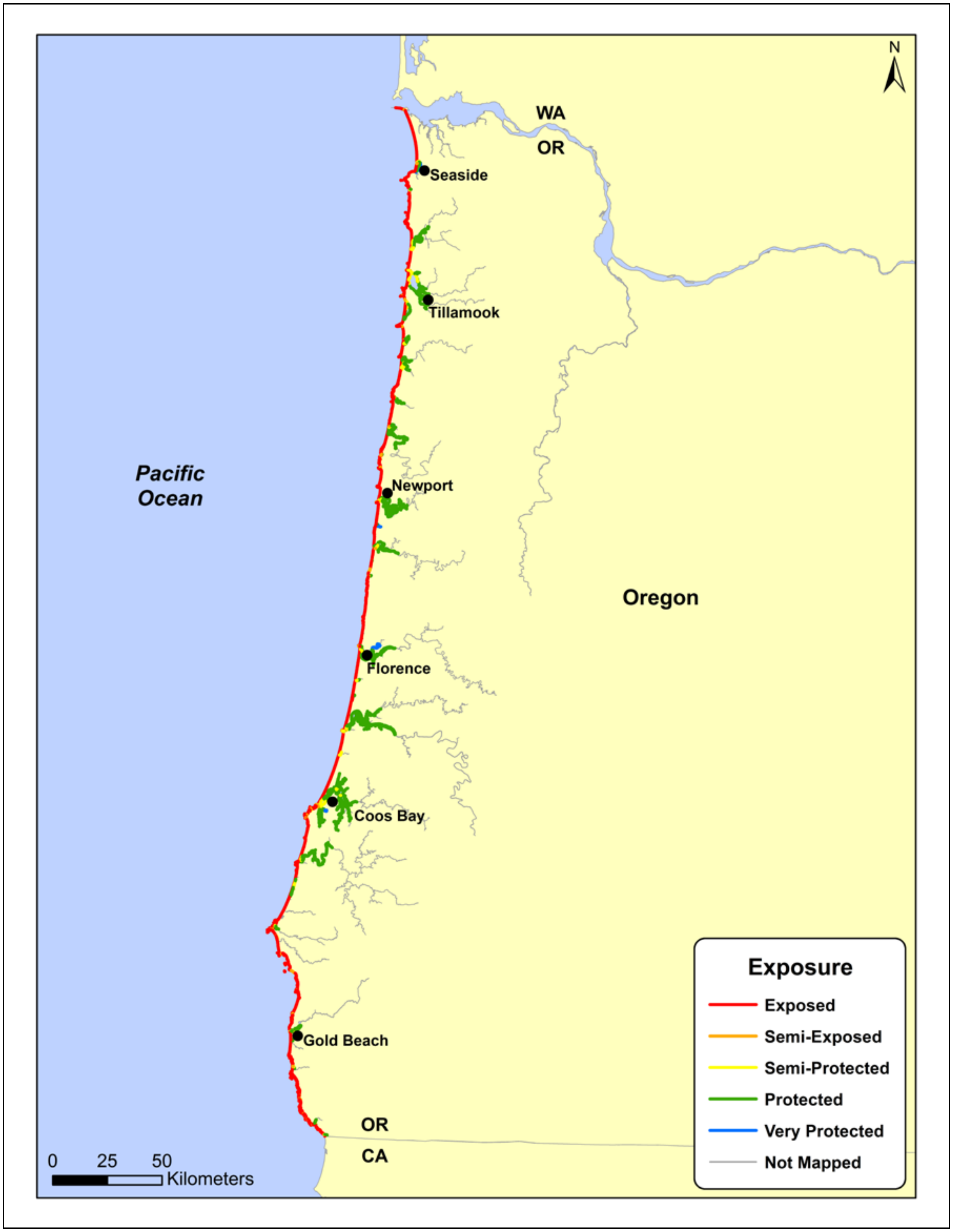


Figure 23. Biological wave exposure in the Oregon study area.

3.4 Habitat Class

Habitat Class is a summary classification that combines both physical and biological characteristics observed for a particular shoreline unit. The classification is based on biological wave exposure and geomorphic characteristics. The habitat class category is intended to provide a single attribute to summarize the biophysical features of the unit, based on an overall classification made from the detailed attributes that have been mapped.

The habitat class is a classification assigned by the biological mapper, determined from the biological wave exposure in combination with the 'dominant structuring process' and geomorphic features of the unit. Wave energy is the most common structuring process, and less commonly observed habitats are those structured by current, estuarine/fluvial processes or anthropogenic structures.

The three categories of wave energy-structured habitat classes, based on substrate mobility, are as follows:

- **Immobile** or stable substrates, such as bedrock or large boulders, enabling a well-developed epibenthic assemblage to form;
- **Partially Mobile** mixed substrates such as a rock platform with a beach or sediment veneer where the development of a full bioband assemblage is limited by the partial mobility of the sediments;
- **Mobile** substrates such as sandy beaches where coastal energy levels are sufficient to frequently move sediment, thereby limiting the development of epibenthic biota.

Habitat classes determined by dominant structuring processes other than wave energy are:

- **Estuary** complexes, with freshwater stream or river flow, delta form at the stream mouth and fringing wetland and salt marsh biobands;
- **Current-Dominated** channels where high tidal currents support assemblages of biota typical of higher energy sites than would be found at the site if wave energy was the structuring process (these units are usually associated with lower wave exposure conditions in adjacent shore units);
- **Anthropogenic** features where the shoreline has undergone human modification (e.g., areas of rip rap or fill, dyked fields, marinas and landings);
- **Lagoons**, which have enclosed coastal ponds of brackish or salty water.

Further definition and explanation of Habitat Class codes are listed in Appendix A (Tables A-10 and A-11) and in the Oregon ShoreZone protocols (Harper *et al*. 2013) which can be downloaded at http://www.coastalatlas.net/shorezone/ .

The occurrence of habitat class categories mapped for the Oregon coast are summarized in Figures 24 through 26 and in Table 9.

The occurrence of Habitat Classes in the two bioareas reflect the differences in the coastal habitats of the two regions. On the *Inner Coast*, over half of the shoreline length is classified as Estuary/organic habitat (Table 9; habitat dominated by fines ad marsh). On the *Outer Coast*, most of the shoreline is classified as either immobile or partially mobile exposed or as bare, high energy mobile sand beaches (Table 9). The transition between the two bioareas reflects dramatic habitat changes which can correspond to increased biodiversity.

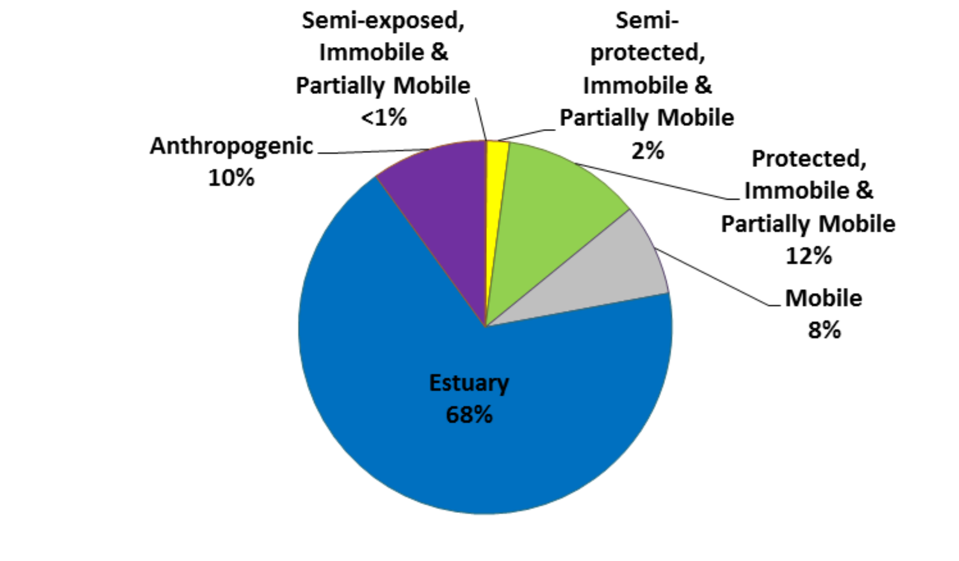


Figure 24. Summary of Habitat Class categories in the inner Oregon coast study area.

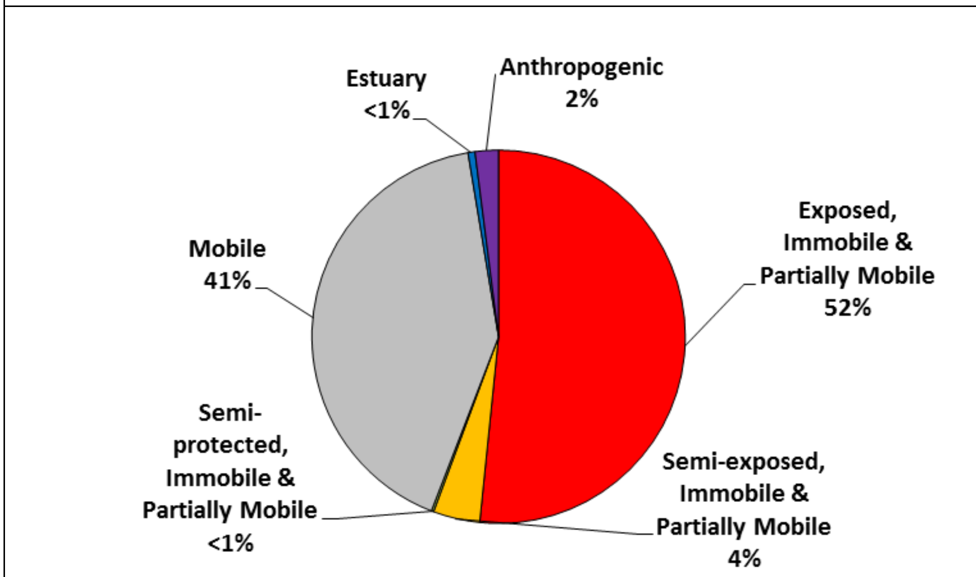


Figure 25. Summary of Habitat Class categories in the outer Oregon coast study area.

Table 9. Summary of Occurrence of Oregon Habitat Classes

Dominant Structuring Process	Habitat Class		Inner Oregon coast		Outer Oregon coast	
	Exposure Category	**Substrate Mobility**	**Length (km)**	**% of Mapping**	**Length (km)**	**% of Mapping**
Wave Energy	Exposed (E)	Immobile & Partially Mobile	0	0	424	16%
	Semi-exposed (SE)	Immobile & Partially Mobile	2	<1%	37	1%
	Semi-protected (SP)	Immobile & Partially Mobile	40	1%	3	<1%
	Protected (P)	Immobile & Partially Mobile	222	8%	0	0
	E, SE, SP, P, VP*	Mobile	135	5%	344	13%
Fluvial/ Estuarine processes	Estuary/organics		1,217	46%	8	<1%
Current energy	Current dominated		0	0	0	0
Man-modified	Anthropogenic		181	7%	20	1%
Lagoon **	Lagoon (not inlcuded in total shoreline length because it is a secondary habitat type)		33	1%	10	<1%
TOTALS:			**1,797**	**69%**	**836**	**31%**

* Very Protected (VP) only occurs on the Inner Coast of Oregon.
** Lagoons are classified as *secondary habitat class* Appendix A, Table A – 10 and A -- 11.

Figure 26. Distribution of selected Habitat Classes in Oregon study area to date.

4 CONCLUSIONS & RECOMMENDATIONS

4.1 Conclusions

1. The ShoreZone project covers much of the tide-water portion of Oregon and includes the outer coast and all of the estuaries excepting the Columbia River system. The system will allow for the searching of a wide variety of attributes that are captured in the ShoreZone dataset. One can examine all the information for a small site or one can look for the distribution of a single attribute of large region (e.g., locations of eelgrass in the Yaquina estuary).

2. The attributes in ShoreZone provides an important tool for habitat capability modelling for a wide variety of species. For example, ShoreZone has been used in British Columbia and Alaska for identifying high probability sites for invasive green crabs (Harney 2007). ShoreZone attributes of substrate, exposure and associations with marshes and eelgrass were used to identify and map these sites. This same query could now be applied to the Oregon dataset.

3. Co-registered imagery, when fully implemented on the website, will allow users of ShoreZone to examine actual photos and video that were used to interpret the cataloged data.

4.2 Recommendations

1. We are often asked how ShoreZone might be used as a monitoring tool. In general, ShoreZone does not provide sufficient resolution of attributes to be used in change detection. However, it is an excellent tool for selecting sites that can be used for monitoring; the ShoreZone information allows interpolation of results from such sites to much broader sections of coast.

2. Another frequent question is: how often should ShoreZone be updated? As climate change affects the coastal zone, shorelines may move in position but usually the shoreline habitat does not change – that is, a low-energy, eroding cliff shoreline is still a low-energy, eroding cliff habitat even though the shoreline position has changed. It may be that changes in technology may drive the need for updating more than environmental change. In 2003, ShoreZone was still using film and a few hundred photos per day were being collected. But in 2013, digital technology allows thousands of georeferenced photos to be collected in a day. Given that technology is changing so rapidly, it may be that changes in imagery acquisition or delivery will provide a more compelling reason to update the ShoreZone project.

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6 ACKNOWLEDGMENTS

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Dave Fox of the Oregon Department of Fish and Game managed this and contributed many valuable suggestions over the several years since the project was initiated. Andy Lanier of the Oregon Coastal Zone Management program also provided valuable assistance throughout the project.

APPENDIX A DATA DICTIONARY

Appendix Table	Description
A-1	Data dictionary for UNIT table
A-2	Classification of shore types employed in ShoreZone mapping
A-3	Environmental Sensitivity Index (ESI) Shore Type classification
A-4	Exposure matrix used for estimating observed physical exposure (EXP_OBSER) on the basis of fetch distance
A-5	Oil Residence Index (ORI) definitions
A-6	Oil Residence Index (ORI) look-up matrix based on exposure (columns) and substrate type (rows)
A-7	Data dictionary for BIOUNIT table
A-8	Definition of BIOAREAS
A-9	Exposure Codes used in *Biounit* Table
A-10	Habitat Class Codes
A-11	Habitat Class Definitions
A-12	Data dictionary for across-shore component table (XSHR)
A-13	‘Form’ Code Dictionary
A-14	‘Material’ Code Dictionary
A-15	Data dictionary for the BIOBAND Table
A-16	Bioband Definitions
A-17	Data dictionary for the PHOTO Table
A-18 – A- 21	Biobands and Indicator Species for BIOLOGICAL EXPOSURES

Table A-1. Data dictionary for UNIT table

Field Name	Description
UnitRecID	Automatically-generated number field; the database “primary key” for unit-level relationships
PHY_IDENT	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0); this field is completed by the database manager using an update query
REGION	2-digit coastal region number (see reference maps and GIS materials)
AREAS	2-digit coastal area number (see reference maps and GIS materials)
PHY_UNIT	4-digit physical along-shore unit number; segmented during physical mapping and delineated on paper maps and in GIS
SUBUNIT	Set to 0 for line features (units) or non-zero for point features (also called variants); several subunits in a unit are numbered sequentially (1, 2, 3…) according to the order occurring within the unit (based on UTC time)
TYPE	Single-letter description of Unit type: a (L)ine [unit] or (P)oint feature [variant]
BC_CLASS	Coastal class or “shore type” of the unit based primarily on substrate type, across-shore width, and slope (Table A-2)
ESI	Environmental Sensitivity Index shore unit classification (Table A-3)
LENGTH_M	Along-shore length in meters; calculated after digitizing using ArcGIS and updated using database query
GEO_MAPPER	Last name of the physical mapper
GEO_EDITOR	Last name of the physical mapper who QA/QCs the work (10% of all units are reviewed by an editor)
GEO_MAP_DATE	the mapping date
VIDEOTAPE	Title of the videotape (DVD imagery) used for mapping; naming convention for Oregon is ORG11_OR_02, in which ORG11 is the region and year, OR is the team, 02 is tape
HR	Hour at which unit starts; based on the first two digits of the 6-digit UTC time on video when start of unit is at center of screen
MIN	Minute at which unit starts; based on third and fourth digits of 6-digit UTC time on video when start of unit is at center of screen
SEC	Seconds at which unit starts; based on the last two digits of the 6-digit UTC time on video when start of unit is at center of screen
EXP_OBSER	Estimate of wave exposure as observed by the physical mapper, as a function of the relative fetch (Table A-4), with a consideration of geomorphology.
ORI	Oil Residence Index indicates a possible residence time of heavy oils stranded on the shore. It is largely determined by wave exposure (or energy) levels and shore substrate types (see Tables A-5 and A-6)
SED_SOURCE	Estimated sediment source for the unit: (A)longshore, (B)ackshore, (F)luvial, (O)ffshore, (X) not identifiable
SED_ABUND	Code indicating the relative sediment abundance within the shore-unit, (A)bundant, (M)oderate, (S)carce

[continued]

Table A-1. Data dictionary for UNIT table (continued)

Field Name	Description
SED_DIR	One of the eight cardinal points of the compass indicating dominant sediment transport direction (N, NE, E, SE, S, SW, W, NW). (X) Indicates transport direction could not be discerned from imagery.
CHNG_TYPE	Code indicating the stability of the shore unit, reflecting the relative degree of “measurable change” during a 3-5 year time span: (A)ccretional, (E)rosional, (S)table
SHORENAME	Name of a prominent geographic feature near the unit (from nautical chart or gazetteer)
UNIT_COMMENTS	Text field used for miscellaneous comments and notes during physical mapping
SHORE_PROB	Comment on nature of difference between digital shoreline and observed shoreline
SM1_TYPE	2-letter code indicating the *primary* type of shore modification occurring within the unit: BR = boat ramp; CB = concrete bulkhead; DK = dyke; LF = landfill; SP= sheet pile; RR = rip rap and WB = wooden bulkhead
SM%	Estimated % occurrence of the primary shore modification type in tenths (i.e. “2” = 20% occurrence with the unit alongshore)
SM2_TYPE	2-letter code indicating the *secondary* type of shore modification occurring within the unit
SM2%	Estimated % occurrence of the *secondary* type of shore modification occurring within the unit
SM3_TYPE	2-letter code indicating the *tertiary* type of shore modification occurring within the unit
SM3%	Estimated % occurrence of the *tertiary* seawall type in tenths (i.e., “2” = 20% occurrence within the unit)
SMOD_TOTAL	Total % occurrence of shore modification in the unit in tenths
RAMPS	Number of boat ramps that occur within the unit; ramps must impact some portion of the shore-zone and generally be constructed of concrete, wood or aggregate
PIERS_DOCK	Number of piers or wharves that occur within the unit; piers or docks must extend at least 10 m into the intertidal zone; does not include anchored floats
REC_SLIPS	Estimated number of recreational slips at docks of the unit; based on small boat length ~<50’
DEEPSEA_SLIP	Estimated number of slips for ocean-going vessels in the unit; based on ship length ~>100’
ITZ	Sum of the across-shore width of all the intertidal components (B zones) within the unit
EntryDate ModifiedDate	Date and time the unit was physically mapped (or modified)

Table A-2. Classification of shore types employed in ShoreZone mapping

(after Howes *et al* [1994] "BC Class" system in British Columbia)

SUBSTRATE	SEDIMENT	WIDTH	SLOPE	COASTAL CLASS	NO.
ROCK	N/A	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Rock Ramp, wide	1
			FLAT (<5°)	Rock Platform, wide	2
		NARROW (<30 m)	STEEP (>20°)	Rock Cliff	3
			INCLINED (5-20°)	Rock Ramp, narrow	4
			FLAT(<5°)	Rock Platform, narrow	5
ROCK & SEDIMENT	GRAVEL	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Ramp with gravel beach, wide	6
			FLAT (<5°)	Platform with gravel beach, wide	7
		NARROW (<30 m)	STEEP (>20°)	Cliff with gravel beach	8
			INCLINED (5-20°)	Ramp with gravel beach	9
			FLAT (<5°)	Platform with gravel beach	10
	SAND & GRAVEL	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Ramp w gravel & sand beach, wide	11
			FLAT (<5°)	Platform with G&S beach, wide	12
		NARROW (<30 m)	STEEP (>20°)	Cliff with gravel/sand beach	13
			INCLINED (5-20°)	Ramp with gravel/sand beach	14
			FLAT (<5°)	Platform with gravel/sand beach	15
	SAND	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Ramp with sand beach, wide	16
			FLAT (<5°)	Platform with sand beach, wide	17
		NARROW (<30 m)	STEEP (>20°)	Cliff with sand beach	18
			INCLINED (5-20°)	Ramp with sand beach, narrow	19
			FLAT (<5°)	Platform with sand beach, narrow	20
SEDIMENT	GRAVEL	WIDE (>30 m)	FLAT (<5°)	Gravel flat, wide	21
		NARROW (<30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Gravel beach, narrow	22
			FLAT (<5°)	Gravel flat or fan	23
	SAND & GRAVEL	WIDE (>30 m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	n/a	
			FLAT (<5°)	Sand & gravel flat or fan	24
		NARROW (<30 m)	STEEP >20°)	n/a	
			INCLINED (5-20°)	Sand & gravel beach, narrow	25
			FLAT (<5°)	Sand & gravel flat or fan	26
	SAND / MUD	WIDE (>30m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Sand beach	27
			FLAT (<5°)	Sand flat	28
			FLAT (<5°)	Mudflat	29
		NARROW (<30m)	STEEP (>20°)	n/a	
			INCLINED (5-20°)	Sand beach	30
			FLAT (<5°)	n/a	n/a
	ORGANICS	n/a	n/a	Estuaries	31
ANTHRO-POGENIC	Man-made	n/a	n/a	Man-made, permeable	32
			n/a	Man-made, impermeable	33
CHANNEL	Current	n/a	n/a	Channel	34
GLACIER	Ice	n/a	n/a	Glacier	35

Table A-3. Environmental Sensitivity Index (ESI) Shore Type classification

(after Petersen *et al* 2002)

ESI No.	Description
1A	Exposed rocky shores; exposed rocky banks
1B	Exposed, solid man-made structures
1C	Exposed rocky cliffs with boulder talus base
2A	Exposed wave-cut platforms in bedrock, mud, or clay
2B	Exposed scarps and steep slopes in clay
3A	Fine- to medium-grained sand beaches
3B	Scarps and steep slopes in sand
3C	Tundra cliffs
4	Coarse-grained sand beaches
5	Mixed sand and gravel beaches
6A	Gravel beaches; Gravel Beaches (granules and pebbles
6B	Gravel Beaches (cobbles and boulders)
6C	Rip rap (man-made)
7	Exposed tidal flats
8A	Sheltered scarps in bedrock, mud, or clay; Sheltered rocky shores (impermeable)
8B	Sheltered, solid man-made structures; Sheltered rocky shores (permeable)
8C	Sheltered rip rap
8D	Sheltered rocky rubble shores
8E	Peat shorelines
9A	Sheltered tidal flats
9B	Vegetated low banks
9C	Hypersaline tidal flats
10A	Salt- and brackish-water marshes
10B	Freshwater marshes
10C	Swamps
10D	Scrub-shrub wetlands; mangroves
10E	Inundated low-lying tundra

Table A-4. Exposure matrix used for estimating observed physical exposure (EXP_OBSER) on the basis of fetch distance

Maximum Fetch (km)	Modified Effective Fetch (km)				
	<1	**1 - 10**	**10 - 50**	**50 - 500**	**>500**
<1	very protected	n/a	n/a	n/a	n/a
<10	protected	protected	n/a	n/a	n/a
10 – 50	n/a	semi-protected	semi-protected	n/a	n/a
50 – 500	n/a	semi-exposed	semi-exposed	semi-exposed	n/a
>500	n/a	n/a	semi-exposed	exposed	exposed & very exposed

Codes for exposures:	very protected	**VP**
	protected	**P**
	semi-protected	**SP**
	semi-exposed	**SE**
	exposed	**E**
	very exposed	**VE**

Table A-5. *Oil Residence Index* (ORI) Definitions

Persistence	Oil Residence Index	Estimated persistence
Short	1	Days to weeks
	2	Weeks to months
Moderate	3	Weeks to months
	4	Months to years
Long	5	Months to years

Table A-6. *Oil Residence Index* (ORI) Look-up Matrix

Substrate	VE	E	SE	SP	P	VP
rock	1	1	1	2	3	3
man-made, impermeable	1	1	1	2	2	2
boulder	2	3	5	4	4	4
cobble	2	3	5	4	4	4
pebble	2	3	5	4	4	4
sand w/ pebble, cobble, or boulder	1	2	3	4	5	5
sand w/o pebble, cobble, or boulder	2	2	3	3	4	4
mud	999	999	999	3	3	3
organics/vegetation	999	999	999	5	5	5
man-made, permeable	2	2	3	3	5	5

Table A-7. Data Dictionary for Biounit Table

Field Name Code	Description
UnitRecID	**Unit Record ID:** Automatically-generated number field; the database “primary key” required for relationships between tables
PHY_IDENT	**Physical_Ident** is a unique code to identify each unit, assigned by physical mapper; defined as an alphanumeric string determined by the codes for: Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0), where ‘12’ is Region 12, ‘03’ is Area 3, ‘0552’ is the Unit number, and ‘0’ is the Subunit number.
BIOAREA	**Bioarea:** Geographic division used to describe regional differences in observed biota and coastal habitats (Bioarea codes and descriptions listed in Table A-8)
EXP_BIO	**Biological Wave Exposure:** A classification of the wave exposure category within the Unit, assigned by the Biological mapper, based on observed indicator species and biobands (Table A-9)
HAB_CLASS	**Habitat Class**: Code for a classification of overall habitat category within the Unit, assigned by the biological mapper. Based on the Biological Exposure (EXP_BIO) and the geomorphic features of the shoreline (Table A-10 and A-11).
HAB_CLASS_LTRS	**Habitat Class** in alphabetic code: translation in the HAB CLASS lookup table (Table A-11)
HAB_OBS	**Habitat Observed**: Original Habitat code categories used to classify Habitat Type; not used in current protocol but kept for backward-compatibility with earlier projects; replaced by HAB_CLASS
BIO_SOURCE	**Biomapping Source:** The source data used to interpret coastal zone biota: (V)ideotape, (V2) **-** lower quality video imagery, (S)lide, (I)nferred
HAB_CLASS2	**Secondary Habitat Class**: Code for a classification of secondary Lagoon-type habitat within the Unit, assigned by the biological mapper. Based on the Biological Exposure (EXP_BIO) and lagoon habitat types (Table A-10 and A-11)
HC2_SOURCE	**Secondary Habitat Class Source:** Source used to interpret the Secondary Habitat Class (HAB_CLASS2) as: OBS(erved) as viewed from video, L(oo)KUP refering to ‘Form’ Code Lo or Lc in XSHR table
HC2_Note	**Secondary Habitat Class Comment:** comment field for Secondary Habitat Class (HAB_CLASS2)
RIPARIAN_PERCENT	**Riparian Percent Overhang:** Estimate of the percentage of alongshore length of the intertidal zone, in which the shoreline is shaded by overhanging riparian vegetation; all substrate types (Expanded definition in Table A-10)
RIPARIAN_M	**Riparian Overhang Meters:** Calculated portion of the unit length, in meters, of riparian overhang in the intertidal (B) zone, using LENGTH_M field of UNIT table, and RIPARIAN_PERCENT of BIOUNIT table; all substrate types.
BIO_UNIT_COMMENT	**Biological Comments**: regarding the along-shore unit as a whole. Included as deliverable data, as note format.
BIO_MAPPER	**Biological Mapper:** The initials of the biological mapper that provided the biological interpretation of the imagery
PHOTO	Still Photo in Unit: **Yes/No tick box** to indicate if high resolution photo is available for the Unit. (see BIOSLIDE table)
DateAdded DateModified	**Date/Time Mapped or Modified:** Date and time the unit was physically mapped (or modified)

Table A-8. Definitions of the BIOAREA attribute in BIOUNIT table.

Bioarea Name	Bioarea Code	Bioarea Suffix *	Geographic Extent	Characteristics
Oregon – Outer Coast	OREO	Not used	Outer coast of Oregon, all tidal waters	Semi-exposed to very high wave exposures, broad sandy beaches with extensive dune formations and high energy rocky headlands, rock reefs and offshore islands.
Oregon – Inner Coast	OREI	Not used	Inner coasts of Oregon, including tidal influenced waters in estuaries and lower river mouths	Semi-protected and lower wave exposures, primarily estuarine and riverine systems. Broad salt marsh features at river mouths, usually enclosed by barrier bar and sand spit features at ocean confluences. Much of the estuary shoreline is modified by dykes, fill and pilings with extensive marsh and meadow areas converted to agricultural uses.

*Note that ShoreZone mapping in British Columbia and Alaska define over a dozen regional 'bioareas' based on geographic differences in lower intertidal species assemblages and overall geomorphic features of the regions. For example, the Strait of Georgia in BC is mapped as a separate bioarea to the outer coast of Vancouver Island; and Southeast Alaska is mapped as several different bioareas to reflect differences in lower intertidal indicator species and canopy kelp distributions.

A suffix number is applied to four lower intertidal biobands (HAL, RED, SBR, CHB) to distinguish between regional differences in species composition of these bands in different bioareas. See the ShoreZone Alaska protocol (Harney et al, 2008; Harper and Morris 2011) and recent summary reports for Alaska ShoreZone mapping, (available for download at www.shorezone.org) for further description of bioareas in other ShoreZone regions.

Table A-9. *Biological Wave Exposure* Codes

Biological Wave Exposure	
Name	**Code**
Very Exposed	VE
Exposed	E
Semi-Exposed	SE
Semi-Protected	SP
Protected	P
Very Protected	VP

Table A-10. Expanded descriptions for HABITAT CLASS, SECONDARY HABITAT CLASS, and RIPARIAN fields of the BIOUNIT table.

Attribute	Description
HAB_CLASS	**Habitat Class** attribute is a classification of the biophysical characteristics of an entire unit, and provides a single attribute that describes the typical intertidal biota and the associated biological wave exposure together with the geomorphology. That is, a typical example of a Habitat Class includes a combination of biobands, and their associated indicator species (which determine the Biological Exposure category) and the geomorphological features of the Habitat Class. The biological mapper observes and records the biobands in the unit, if any, and determines the Biological Exposure Category (EXP_BIO). The Habitat Class is determined on the basis of presence/absence of biobands, exposure category, geomorphology, and spatial distribution of biota within the unit. Within the database, an alpha code provides a summary indicator of habitat. (Table A-11), in which the matrix includes all combinations of Dominant Structuring Process, with associated substrate mobility and general geomorphic type on the vertical axis, and Biological Exposure on the horizontal axis.
HAB_CLASS2	The '**Secondary Habitat Class**' was added as an attribute in the BioUnit Table during biological mapping of the Kodiak Archipelago in Alaska in order to specifically identify lagoon habitats. Many backshore lagoons were observed in the Kodiak region, and they represent an unusual coastal habitat that differs from other estuaries and marshes. Backshore lagoons are also a coastal feature in Oregon. Units classified as lagoons contain brackish or salt water contained in a basin with limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal. Single units classified as lagoons often have the lagoon form in the A zone; however, some lagoons are large and may encompass several units when the lagoon form is mapped as the C zone.
RIPARIAN_PERCENT	As an attribute in the BIOUNIT table, the **Riparian_Percent** value is intended to be an index for the potential habitat for upper beach spawning fishes. The value recorded in the **Riparian_Percent** field is an estimate of the percentage of the unit's total alongshore length in which riparian vegetation (trees and shrubs) shades the upper intertidal zone. Shading of the highest high water line is a good estimate of riparian shading; therefore, shading of wetland herbs and grasses is not included in the estimate, nor is any shading of the splash zone alone. Shading must be visible in the upper intertidal zone, and the shading vegetation must be woody trees or shrubs. Riparian overhanging vegetation is also an indicator of lower wave exposures, in which the splash zone is narrow. Shading may occur in on sediment-dominated or in rocky intertidal settings.

Table A-11. Codes for HABITAT CLASS and SECONDARY HABITAT CLASS attributes, in the BIOUNIT table.

Dominant Structuring Process	Substrate Mobility	Coastal Type	Description	Biological Exposure Category					
				Very Exposed (VE)	Exposed (E)	Semi-Exposed (SE)	Semi-Protected (SP)	Protected (P)	Very Protected (VP)
Wave energy	Immobile	Rock or Rock & Sediment or Sediment	The epibiota in the immobile mobility categories is influenced by the wave exposure at the site. In high wave exposures, only solid bedrock shorelines will be classified as 'immobile'. At the lowest wave exposures, even pebble/cobble beaches may show lush epibiota, indicating an immobile Habitat Class.	VE_I	E_I	SE_I	SP_I	P_I	VP_I
	Partially Mobile	Rock & Sediment or Sediment	These units describe the combination of sediment mobility observed. That is, a sediment beach that is bare in the upper half of the intertidal with biobands occurring on the lower beach would be classed as 'partially mobile'. This pattern is seen at moderate wave exposures. Units with immobile bedrock outcrops intermingled with bare mobile sediment beaches, as can be seen at higher wave exposures, could also be classified as 'partially mobile'.	VE_P	E_P	SE_P	SP_P	P_P	VP_P
	Mobile	Sediment	These categories are intended to show the 'bare sediment beaches', where no epibenthic macrobiota are observed. Very fine sediment may be mobile even at the lowest wave exposures, while at the highest wave exposures; large-sized boulders will be mobile and bare of epibiota.	VE_M	E_M	SE_M	SP_M	P_M	VP_M
Fluvial/ Estuarine processes		Estuary	Units classified as the 'estuary' types always include salt marsh vegetation in the upper intertidal; are always associated with a freshwater stream or river and often show a delta form. Estuary units are usually in lower wave exposure categories.	VE_E	E_E	SE_E	SP_E	P_E	VP_E
Current energy		Current-Dominated	Species assemblages observed in salt-water channels are structured by current energy rather than by wave energy. Current-dominated sites are limited in distribution and are rare habitats.	VE_C	E_C	SE_C	SP_C	P_C	VP_C
Glacial processes		Glacier	These HABITAT CLASSES do not occur in Oregon.	VE_G	E_G	SE_G	SP_G	P_G	VP_G
Anthropogenic		Anthropogenic – Impermeable	Impermeable modified Habitats are intended to specifically note units classified as Coastal Class 33. These Habitat Classes are mapped to specifically inventory modified shoreline.	VE_X	E_X	SE_X	SP_X	P_X	VP_X
		Anthropogenic – Permeable	Permeable modified Habitats are intended to specifically note shore units classified as Coastal Class 32. These Habitat Classes are mapped to specifically inventory modified shoreline.	VE_Y	E_Y	SE_Y	SP_Y	P_Y	VP_Y
Lagoon		Lagoon	Units classified as Lagoons in the Secondary Habitat Class contain brackish or salty water that is contained within a basin that has limited drainage. They are often associated with wetlands and may include wetland biobands in the upper intertidal.	VE_L	E_L	SE_L	SP_L	P_L	VP_L

Shaded boxes indicate Habitat Classes which do not occur in Oregon

Table A-12. Data dictionary for across-shore component table (XShr)
(after Howes *et al* 1994)

Field Name	Description
UnitRecID	Automatically-generated number field; the database "primary key" for unit-level relationships
XshrRecID	Automatically-generated number field; the database "primary key" for across-shore relationships
PHY_IDENT	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0)
CROSS_LINK	Unique across-shore identifier; an alphanumeric string comprised of the PHY_IDENT followed by the Zone and Component separated by slashes (e.g. 12/03/0552/0/A/1)
ZONE	Code indicating the across-shore position (tidal elevation) of the component: (A) supratidal, (B) intertidal, (C) subtidal
COMPONENT	Subdivision of zones, numbered from highest to lowest elevation in across-shore profile (e.g. A1 is the highest supratidal component; B1 is the highest intertidal; B2 is lower intertidal)
Form1	Principal geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix1	Veneer indicator field; blank = no veneer; "v" = veneer
Mat1	Material (substrate and/or sediment type) that best characterizes Form1, described by a specific set of codes (Table A-12)
FormMat1Txt	Automatically-generated field that is the translation of codes used in Form1 and Mat1 into text
Form2	Secondary geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix2	Veneer indicator field; blank = no veneer; "v" = veneer
Mat2	Material (substrate and/or sediment type) that best characterizes Form2, described by a specific set of codes (Table A-12)
FormMat2Txt	Automatically-generated field that is the translation of codes used in Form2 and Mat3 into text
Form3	Tertiary geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix3	Veneer indicator field; blank = no veneer; "v" = veneer
Mat3	Material (substrate and/or sediment type) that best characterizes Form3, described by a specific set of codes (Table A-12)
FormMat3Txt	Automatically-generated field that is the translation of codes used in Form3 and Mat3 into text
Form4	Fourth-order geomorphic feature within each across-shore component, described by a specific set of codes (Table A-11)
MatPrefix4	Veneer indicator field; blank = no veneer; "v" = veneer
Mat4	Material (substrate and/or sediment type) that best characterizes Form4, described by a specific set of codes (Table A-12)
FormMat4Txt	Automatically-generated field that is the translation of codes used in Form4 and Mat4 into text
WIDTH	Mean across-shore width of the component (e.g. A1) in meters
SLOPE	Estimated across-shore slope of the mapped geomorphic Form in degrees; must be consistent with Form codes (Table A-11)
PROCESS	Dominant coastal process affecting the morphology: (F)luvial, (M)ass wasting (landslides), (W)aves, (C)urrents, (E)olian (wind, as with dunes) (O)ther
COMPONENT_ORI	Oil Residence Index on the basis of substrate type; 1 is least persistent, 5 is most persistent (Tables A-5 and A-6)

Table A-13. ‘Form’ Code Dictionary (after Howes *et al* 1994)

A = Anthropogenic

a	pilings, dolphin
b	breakwater
c	log dump
d	derelict shipwreck
f	float
g	groin
h	shell midden
i	cable/ pipeline
j	jetty
k	dyke
l	breached dyke
m	marina
n	ferry terminal
o	log booms
p	port facility
q	aquaculture
r	boat ramp
s	seawall
t	landfill, tailings
u	tide gates
w	wharf
x	outfall or intake
y	intake
z	beach access

B = Beach

b	berm (intertidal or supratidal)
c	washover channel
f	face
i	inclined (no berm)
m	multiple bars / troughs
n	relic ridges, raised
p	plain
r	ridge (single bar; low to mid intertidal)
s	storm ridge (occas marine influence; supratidal)
t	low tide terrace
v	thin veneer over rock (also use as modifier)
w	washover fan

C = Cliff

stability/geomorph

a	active / eroding
p	passive (vegetated)
c	cave

slope

i	inclined (20°-35°)
s	steep (>35°)

Cliff cont.

height

l	low (<5m)
m	moderate (5-10m)
h	high (>10m)

modifiers (optional)

f	fan, apron, talus
g	surge channel
t	terraced
r	ramp

D = Delta

b	bars
f	fan
l	levee
m	multiple channels
p	plain (no delta, <5°)
s	single channel

E = Dune

b	blowouts
i	irregular
n	relic
o	ponds
r	ridge/swale
p	parabolic
v	veneer
w	vegetated

F = Reef

(no vegetation)

f	horizontal (<2°)
i	irregular
r	ramp
s	smooth

I = Ice

g	glacier

L = Lagoon

o	open
c	closed

M = Marsh

c	tidal creek
d	dead marsh by salt intrusion
e	levee
f	drowned forest
h	high
l	mid to low (discontinuous)
o	pond
s	brackish, supratidal
t	tidal swamp, shrub/scrub

O = Offshore Island

(not reefs)

b	barrier
c	chain of islets
t	table shaped
p	pillar/stack
w	whaleback

elevation

l	low (<5m)
m	moderate (5-10m)
h	high (>10m)

P = Platform

(slope <20°)

f	horizontal
g	surge channel
h	high tide platform
i	irregular
l	low tide platform
r	ramp (5-19°)
t	terraced
s	smooth
p	tidepool

R = River Channel

a	perennial
i	intermittent
m	multiple channels
s	single channel

T = Tidal Flat

b	bar, ridge
c	tidal channel
e	ebb tidal delta
f	flood tidal delta
l	levee
p	tidepool
s	multiple tidal channels
t	flats

Table A-14. 'Material' Code Dictionary (after Howes *et al* 1994)

A = Anthropogenic

a	metal (structural)
c	concrete (loose blocks)
d	debris (man-made)
f	fill, undifferentiated mixed
o	concrete (solid cement blocks)
r	rubble, rip rap
t	logs (cut trees)
w	wood (structural)

B = Biogenic

c	coarse shell
f	fine shell hash
g	grass on dunes
l	dead trees (fallen, not cut)
o	organic litter
p	peat
t	trees (living)

C = Clastic

a	angular blocks (>25cm diameter)
b	boulders (rounded, subrounded,>25cm)
c	cobbles
d	diamicton (a poorly-sorted sediment mixture containing a range of particle sizes in a mud matrix)
f	fines/mud (mix of silt/clay, <0.0.63 mm diameter)
g	gravel (unsorted mix pebble, cobble, boulder >2 mm)
k	clay (compact, finer than fines/mud, <4 μm diameter)
p	pebbles
r	rubble (boulders>1 m diameter)
s	sand (0.063 to 2 mm diameter)
$	silt (0.0039 to 0.063 mm)
x	angular fragments (mix of block/rubble)
v	sediment veneer (used as modifier)

R = Bedrock

rock type:

i	igneous
m	metamorphic
s	sedimentary
v	volcanic

rock structure:

1	bedding
2	jointing
3	massive

SEDIMENT TEXTURE

(Simplified from Wentworth grain size scale)

GRAVELS

boulder > 25 cm diameter	
cobble	6 to 25 cm diameter
pebble	0.5 cm to 6 cm diam

SAND

very fine to very coarse:
0.063 mm to 2 mm diameter

FINES ("MUD")

includes silt and clay

silt	0.0039 to 0.063 mm
clay	<0.0039 mm

TEXTURE CLASS BREAKS

sand / silt	63 μm (0.063 mm)
pebble / granule	0.5 cm (5 mm)
cobble / pebble	6 cm
boulder / cobble	25 cm

SHORE MODIFICATIONS

BR	boat ramp
CB	concrete bulkhead
DK	dyke
LF	landfill
RR	riprap
SP	sheet pile
WB	wooden bulkhead

'Percent of unit length' for Shore Modification recorded to nearest ten percent, with default value for Shore Modification = 0

Note: The 'material' descriptor consists of one primary term code and associated modifiers (e.g. Cash). If only one modifier is used, indicated material comprises 75% of the volume of the layer (e.g. Cs). If more than one modifier is used, they are ranked in order of relative volume. A surface layer can be described by prefix *v* for veneer (e.g. vCs/R). Grayed items are not used in the Alaska ShoreZone program.

Table A-15. Data Dictionary for the *Bioband* Table

Field	Description
UnitRecID	Automatically-generated number field; the database "primary key" required for relationships between tables
XshrRecID	Automatically-generated number field; the database "primary key" required for relationships between tables
PHY_IDENT	Unique physical identifier; an alphanumeric string comprised of the Region, Area, Unit, and Subunit separated by slashes (e.g. 12/03/0552/0)
CROSS_LINK	Unique alphanumeric identifier of component made up of: REGION, AREA, PHYS_UNIT, SUBUNIT, ZONE and COMPONENT fields
VER	Bioband for Splash Zone (black lichen **VER***ucaria*) in supratidal (Table A-16)
MSH	Bioband code for Shrub Meadow, upper salt marsh shrub fringe (Table A-16)
MAG	Bioband code for High Grass Meadow, upper salt marsh grass meadow (Table A-16)
GRA	Bioband code for Dune **GRA**ss in supratidal (Table A-16)
AMM	Bioband code for European Beach Grass (**AMM**ophilia spp) (Table A-16)
SED	Bioband for **SED**ges in supratidal (Table A-16)
TRI	Bioband for Salt Marsh grasses, including ***TRI****glochin* and other salt tolerant grasses, herbs and sedges, in supratidal. Same bioband included in Washington ShoreZone. (Table A-16)
BAR	Bioband for **BAR**nacle (*Balanus/Semibalanus*) in upper intertidal (Table A-16)
FUC	Bioband for Rockweed, the **FUC***us*/barnacle in upper intertidal (Table A-16)
ULV	Bioband for Green Algae, including mixed filamentous and foliose greens (**ULV***a* sp.*, Cladophora, Acrosiphonia*) in mid-intertidal (Table A-16)
BMU	Bioband for **B**lue **MU**ssel (*Mytilus trossulus*) in mid-intertidal (Table A-16)
MUS	Bioband for California **MUS**sel/gooseneck barnacle assemblage (*Mytilus californianus/Pollicipes polymerus*) in mid-intertidal (Table A-16)
HAL	Bioband for Bleached Red Algae, including mixed filamentous and foliose reds in mid-intertidal (Table A-16)
OYS	Bioband code for **OYS**ter, primarily cultured on mud flats, mid-intertidal (Table A-16)
RED	Bioband for **RED** Algae, including mixed filamentous and foliose reds (*Odonthalia, Neorhodomela, Mazzaella,* coralline algae) in lower intertidal (Table A-16)
ALA	Bioband for ribbon kelp, **ALA***ria* spp. (Table A-16)
SBR	Bioband for **S**oft **BR**own Kelps, including unstalked large-bladed laminarians, in lower intertidal and nearshore subtidal (Table A-16)
CAL	Bioband for infaunal mud flat shrimp (***CAL****lianassa*), in sand/mud flats in larger estuaries. Same bioband included in Washington ShoreZone. (Table A-16)
CHB	Bioband for Dark Brown Kelps, including stalked bladed dark **CH**ocolate-**B**rown kelps in lower intertidal and nearshore subtidal (Table A-16)
SUR	Bioband for **SUR**fgrass (*Phyllospadix*) in lower intertidal and nearshore subtidal (Table A-16)
ZOS	Bioband for **ZOS***tera* (Eelgrass) in lower intertidal and subtidal (Table A-16)
ZOS2	*Zostera* occurrence data taken from EPS mapping data of some of the Oregon estuaries
MAC	Bioband for Giant Kelp (**MAC***rocystis spp*) in nearshore subtidal (Table A-16)
NER	Bioband for Bull Kelp (**NER***eocystis luetkeana*) in nearshore subtidal (Table A-16)
NER2	Nereocystis occurrence data taken from ODFW mapping data.

Table A-16. Oregon Bioband Definitions*

Zone	Bioband Name	Bioband Code	Color	Indicator Species	Physical Description	Biological Wave Exposure	Associate Species
A supratidal	**Splash Zone**	**VER**	Black or bare rock	*Verrucaria* sp. Encrusting black lichens Bare rock substrate	Visible as a dark stripe, on bare rock, marking the upper limit of the intertidal zone. This band is recorded by width: Narrow (N), Medium (M) or Wide (W)	Very Exposed to Very Protected	*Littorina* sp.
A supratidal	**Shrub Meadow**	**MSH**	Pale green			Very protected to Protected	
A supratidal	**High Grass Meadow**	**MAG**	Pale grassy green or beige			Very protected to Protected	
A supratidal	**Dune Grass**	**GRA**	Pale blue-green	*Leymus mollis*	Native dune grass found in small patches in undisturbed sand dunes and in salt marsh. This band is often associated with driftwood log line on beaches or as clumps in upper salt marsh elevations	Exposed to Protected	*Lathyrus japonica* *Juncus lesueurii*
A supratidal	**European Beach Grass**	**AMM**	Beige-green	*Ammophila* spp	Outer coastal sand dunes, forming clumps and stabilizing active dunes.	Exposed to Semi Exposed	*Hypochaeris radicata* *Lupinus littoralis* *Fragaria chiloensis* *Aira praecox* *Aira caryophyllea*
A supratidal	**Sedges**	**SED**	Bright green to yellow-green	*Carex lyngbyei*	Appears in wetlands around lagoons and estuaries. Always associated with freshwater. This band often seen as patches, usually at upper elevation of TRI band	Semi Protected to Very Protected	*Carex* spp.
A supratidal	**Salt Marsh**	**TRI**	Light, bright, or dark green, with red-brown	*Triglochin maritimum* *Distichlis spicata* *Deschampsia caespitosa*. *Plantago maritima* *Scirpus americanus* *Salicornia virginica*	Appears around estuaries, marshes, and lagoons. Always associated with freshwater. Separated as 'high marsh' and 'low marsh' as gradation of assemblages according to elevation/salt water inundation. TRI can be sparse grasses and herbs on coarse sediment or a wetter, peaty meadow with assemblage of herbs, grasses and sedges	Semi Exposed to Very Protected	*Carex* spp. *Potentilla pacifica* *Spergularia marina* *Juncus* spp *Eleocharis* sp *Atriplex patula*
upper B intertidal	**Barnacle**	**BAR**	Grey-white to pale yellow	*Balanus glandula* *Chthamalus* spp *Semibalanus cariosus*	Visible on bedrock or large boulders. Can form an extensive band in higher exposures where not overtopped by algal canopy.	Exposed to Protected	*Hildenbrandia* spp *Endocladia muricata* *filamentous green algae* *Porphyra* sp. *Fucus distichus*

Continued on next page

*Associated species listed for **European Beach Grass** (AMM) and for Salt Marsh (TRI) summarized from Christy *et al*, (1998) and from Hoffnagel and Olson (1974).

Table A-16 (continued). Oregon Bioband Definitions*

Zone	Bioband Name	Bioband Code	Color	Indicator Species	Physical Description	Exposure	Associate Species
upper B intertidal	**Rockweed**	**FUC**	Golden-brown	*Pelvetiopsis* spp *Fucus* spp *Mastocarpus* spp	Appears on bedrock cliffs and boulder, cobble or gravel beaches. Commonly occurs at the same elevation as the barnacle band.	Semi Exposed to Protected	*Balanus glandula* *Mazzaella cornucopiae* *Semibalanus cariosus* *Ulva sp.* *Endocladia muricata*
B intertidal	**Green Algae**	**ULV**	Green	*Ulva sp.* *Enteromorpha* spp	Found on a variety of substrates. This band can consist of filamentous and/or foliose green algae. Filamentous species often form a low turf of dark green.	Exposed to Protected	*Filamentous red algae*
B intertidal	**Blue Mussel**	**BMU**	Black or blue-black	*Mytilus trossulus* *M. galloprovinicialis*	Visible on bedrock and on boulder, cobble or gravel beaches. Appears in dense clusters that form distinct black patches or bands, either above or below the barnacle band.	Very Exposed to Protected	*Balanus glandula* *Semibalanus cariosus* Filamentous red algae
B intertidal	**California Mussel**	**MUS**	Grey-blue	*Mytilus californianus* *Pollicipes polymerus*	Dominated by a complex of California mussels (*Mytilus californianus*) and gooseneck barnacles (*Pollicipes polymerus*), with thatched barnacles (*Semibalanus cariosus*).	Very Exposed to Semi Exposed	*Postelsia palmaeformis* *Semibalanus cariosus* *M. trossulus*
B intertidal	**Bleached Red Algae**	**HAL**	Olive, golden or yellow-brown	*Mazzaella* spp *Ondonthalia* spp *Other foliose & filamentous red algae*	Common on bedrock platforms, and cobble or gravel beaches. Distinguished from the RED band only by color, and often is same species as RED	Exposed to Semi Protected	Other filamentous and foliose red algae Filamentous green algae
B intertidal	**Oyster**	**OYS**	Dark beige to brown		Generally inconspicuous and of limited extent, areas of oyster aquaculture on mudflats, in particular in Coos Bay	Very protected to Protected	Filamentous brown algae Filamentous green algae
B intertidal	**Red Algae**	**RED**	Corallines: pink or white Foliose or filamentous: Dark red, bright red, or red-brown.	*Corallina* sp. *Lithothamnion* sp. *Neoptilota* sp. *Odonthalia* sp. *Neorhodomela* sp. *Mazzaella* sp.	Appears on most substrates except fine sediments. Lush coralline algae indicates highest exposures; diversity of foliose red algae indicates medium to high exposures, and filamentous species, often mixed with green algae, occur at medium and lower exposures.	Very Exposed to Semi Protected	Other foliose and filamentous red algae *Pisaster ochraceus* *Nucella* sp. *Katharina tunicata* Large brown kelps of the CHB bioband
B & C intertidal, subtidal	**Alaria**	**ALA**	Dark brown or red-brown	*Alaria marginata*	Common on bedrock cliffs and platforms, and on boulder/cobble beaches. This often single-species band has a distinct smooth, shiny, ribbon-like texture.	Exposed to Semi Protected	Foliose red algae *Saccharina* sp. *Laminaria* sp.

Table A-16 (continued) Oregon Bioband Definitions.

Zone	Bioband		Color	Indicator Species	Physical Description	Exposure	Associate Species
	Name	Code					
B & C intertidal, subtidal	**Soft Brown Kelps**	**SBR**	Yellow-brown, olive brown or brown.	*Saccharina latissima. Sargassum muticum*	This band is defined by non-floating large bladed browns kelps and appears to be of limited distribution on the Oregon coast.	Semi Exposed to Very Protected	Other filamentous brown algae and bladed kelps
B & C intertidal, subtidal	**Mud Flat Shrimp**	**CAL**	mottling on sand flats, burrows	*Neotrypaea californiensis Upogebia pugettensis*	On sand/mud flats in larger estuaries, where textured surface of flats indicates presence of infauna	Protected to Very Protected	bivalves and worms
B & C intertidal, subtidal	**Dark Brown Kelps**	**CHB**	Dark chocolate brown	*Laminaria setchelli Lessoniopsis littoralis Saccharina sessile (smooth) Egregia menziesii*	Found at higher wave exposures, these stalked kelps grow in the lower intertidal. Blades are leathery, shiny, and smooth. A mixture of species occurs at the moderate wave exposures, while single-species stands of *Lessoniopsis* occur at high exposures.	Very Exposed to Semi Exposed	*L. sinclairii. Costaria costata Alaria sp.* Filamentous and foliose red algae Coralline red algae
B & C intertidal, subtidal	**Surfgrass**	**SUR**	Bright green (may bleach to beige at upper extent)	*Phyllospadix scouleri Phyllospadix torreyi.*	Appears in tide pools on rock platforms, often forming extensive beds. This species has a clearly defined upper exposure limit of Semi-Exposed and its presence in units of Exposed wave energy indicates a wide across-shore profile, where wave energy is dissipated by wave run-up across the broad intertidal zone.	Semi Exposed to Semi Protected	Foliose and coralline red algae
B & C intertidal, subtidal	**Eelgrass**	**ZOS**	Bright to dark green	*Zostera marina*	Commonly visible in estuaries, lagoons or channels, generally in areas with fine sediments. Eelgrass can occur in sparse patches or thick dense meadows.	Semi Protected to Very Protected	*Porphyra sp.*
B & C intertidal, subtidal	**Eelgrass**	**ZOS2**			Data taken from an existing EPS report and associated shape files. It was not mapped in ShoreZone and only for slected estuaries.		
C subtidal	**Giant Kelp**	**MAC**	Golden-brown	*Macrocystis* spp	Canopy-forming giant kelp, long stipes with multiple floats and fronds. If associated with NER, it occurs inshore of the bull kelp.	Semi Exposed to Protected	*Nereocystis luetkeana*
C subtidal	**Bull Kelp**	**NER**	Dark brown	*Nereocystis luetkeana*	Distinctive canopy-forming kelp with many long strap-like blades growing from a single floating bulb atop a long stipe. Can form an extensive canopy in nearshore habitats. Often indicates higher current areas if observed at lower wave exposures.	Very Exposed to Semi Protected	*Egregia menziesii Macrocystis* spp
C subtidal	**Bull Kelp**	**NER2**			Data taken from ODFW mapping. Not mapped in ShoreZone. For selected coastal sections only		

Table A-17. Data Dictionary for the Photos Table

Field Name	Description
PhotoID	A unique numeric ID assigned to each slide or photo
UnitRecID	Automatically-generated number field; the database “primary key” required for relationships between tables
PhotoName	A unique alphanumeric name assigned to each slide or photo
ImageName	Full image name with .jpg extension (required to enable “PhotoLink”)
TapeTime	Exact UTC time during aerial video imaging (AVI) survey when digital image was collected; used to link photo to digital trackline and position
PhotoDescription	Text field for biological comments regarding the digital photo
ImageType	Media type of original image: “Digital” or “Slide"
FolderName	Name of the folder in which digital images are stored (required to enable “PhotoLink”)
PhotoLink	Enables linkage to photos placed in directories near the database
PHY Good Example?	When set to “Y,” photo is geomorphological representative of a particular feature or classification type
PhotoComment	Text field for geomorphological comments regarding the digital photo

Table A-18. Biobands and Indicator Species for Biological Exposures: Very Exposed (VE) and Exposed (E)

Zone	Species	Bioband Name	Bioband Code
Supratidal & Upper Intertidal	*Ammophila sp* *	European Beach Grass	AMM
	Verrucaria	Splash Zone	VER
	Balanus glandula	Barnacle	BAR
	Semibalanus carriosus	California Mussel	MUS
Lower Intertidal & Subtidal	*Postelsia palmaeformis*	California Mussel	MUS
	Mytilus californianus	California Mussel	MUS
	Pollicipes polymerus	California Mussel	MUS
	Coralline red algae	Red Algae	RED
	Lessoniopsis littoralis	Dark Brown Kelps	CHB
	Laminaria setchellii	Dark Brown Kelps	CHB
	Nereocystis luetkeana	Bull Kelp	NER

* Associated with open coast sand dunes at Exposed wave energies

Table A-19. Biobands and Indicator Species for Biological Exposures: Semi-Exposed (SE)

Zone	Species	Bioband Name	Bioband Code
Supratidal & Upper Intertidal	*Ammophila* sp.*	European Beach Grass	AMM
	Verrucaria	Splash Zone	VER
	Balanus glandula	Barnacle	BAR
	Pelvetiopsis spp.	Rockweed	FUC
	Semibalanus carriosus	California Mussel	MUS
	Mytilus californianus	California Mussel	MUS
	Pollicipes polymerus	California Mussel	MUS
	Postelsia palmaeformis	California Mussel	MUS
Lower Intertidal & Subtidal	mixed filamentous and foliose red algae	Red Algae	RED
	Phyllospadix sp.	Surfgrass	SUR
	Laminaria setchellii	Dark Brown Kelps	CHB
	Saccharina subsimplex	Dark Brown Kelps	CHB
	Saccharina sessile (smooth morph)	Dark Brown Kelps	CHB
	Nereocystis luetkeana	Bull Kelp	NER

* Associated with open coast sand dunes at Semi-exposed wave energies

Table A-20. Biobands and Indicator Species for Biological Exposures: Semi-Protected (SP)

Zone	Species	Bioband Name	Bioband Code
Supratidal & Upper Intertidal	*Triglochin maritimum* *****	Salt Marsh	TRI
	Deschampsia caespitosa *****	Salt Marsh	TRI
	Plantago maritima *****	Salt Marsh	TRI
	Carex lyngbyei *****	Sedges	SED
Lower Intertidal & Subtidal	*Balanus glandula*	Barnacle	BAR
	Semibalanus carriosus	Barnacle	BAR
	Fucus distichus	Rockweed	FUC
	Mytilus trossulus	Blue Mussel	BMU
	Ulva spp.	Green Algae	ULV
	Bleached mixed red algae	Bleached Red Algae	HAL
	Mixed red algae including *Odonthalia*	Red Algae	RED
	Saccharina latissima	Soft Brown Kelps	SBR
	Zostera marina	Eelgrass	ZOS

***** Associated with estuaries and fringing salt marsh at this wave exposure.

Table A-21. Biobands and Indicator Species for Biological Exposures: Protected (P) and Very Protected (VP)

Zone	Species	Bioband Name	Bioband Code
Supratidal & Upper Intertidal	*Carex lyngbyei*. *****	Sedges	SED
	Deschampsia caespitosa *****	Salt Marsh	TRI
	Plantago maritima *****	Salt Marsh	TRI
	Glaux maritima *****	Salt Marsh	TRI
	Balanus glandula	Barnacle	BAR
	Fucus distichus	Rockweed	FUC
Lower Intertidal & Subtidal	*Ulva* spp.	Green Algae	ULV
	Zostera marina	Eelgrass	ZOS

***** Associated with estuaries and fringing wetlands at this wave exposure.

Table A-22 Codes for Special Features in the Oregon Dataset

<table>
<tr><th>Special Feature</th><th>Bio Area</th><th>BioGeog1 Code</th><th>BioGeog1 Description</th><th>BioGeog2</th></tr>
<tr><td rowspan="15">Biogeographic Regions</td><td rowspan="6">Ocean (Outer Coast)</td><td>H1</td><td>Major headland</td><td>Geographic name</td></tr>
<tr><td>H2</td><td>Minor headland</td><td>“</td></tr>
<tr><td>R1</td><td>Reef (rocky shoreline)</td><td>“</td></tr>
<tr><td>RS</td><td>Rock & beach (partially mobile substrate)</td><td>“</td></tr>
<tr><td>S1</td><td>Beach (mobile substrate)</td><td>“</td></tr>
<tr><td>MM</td><td>Man made</td><td>“</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="7">Estuary (Inner Coast)</td><td>E1</td><td>Highly river-dominated drowned river mouth</td><td>“</td></tr>
<tr><td>E2</td><td>Moderately river-dominated drowned river mouth</td><td>“</td></tr>
<tr><td>E3</td><td>Tide-dominated drowned river mouth</td><td>“</td></tr>
<tr><td>E4</td><td>Blind – Drowned river mouth</td><td>“</td></tr>
<tr><td>E5</td><td>Bar built</td><td>“</td></tr>
<tr><td>E6</td><td>Tidally restricted coastal creek</td><td>“</td></tr>
<tr><td>E7</td><td>Marine Harbor/Cove</td><td>“</td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td rowspan="4">Salinity Regime</td><td colspan="2">Code</td><td colspan="2">Description</td></tr>
<tr><td colspan="2">MR</td><td colspan="2">Marine salinity regime</td></tr>
<tr><td colspan="2">ER</td><td colspan="2">Estuarine salinity regime</td></tr>
<tr><td colspan="2">RR</td><td colspan="2">River salinity regime</td></tr>
</table>

<table>
<tr><th>Special Feature</th><th>Bio Area</th><th>BioGeog3 Code</th><th>BioGeog3 Description</th></tr>
<tr><td rowspan="6">Biogeographic Regions</td><td>Ocean (Outer Coast)</td><td>Littoral Cell Name</td><td>Names indicate shoreline extent of coastal littoral cells</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Estuary (Inner Coast)</td><td>CON</td><td>Conservation Estuary</td></tr>
<tr><td>DDD</td><td>Deep Draft Development Estuary</td></tr>
<tr><td>NAT</td><td>Natural Estuary</td></tr>
<tr><td>SDD</td><td>Shallow Draft Development Estuary</td></tr>
</table>

Notes: 1. Special Oregon Features are catalogged in the Unit Table of the Geodatabase
2. The features have a 1:1 relationship with the Unit Lines. That is, each feature occurs only once for each unit line.
3. Biogeographic regions and features were assigned by ODFW
4. Salinity regimes were assigned using maps by Scranton.
5. BioGeog1 estuary types based on Lee II, H.; Brown, C.A. (eds.) 2009. Classification of regional patterns of environmental drivers and benthic habitats in Pacific Northwest estuaries. U.S. EPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Western Ecology Division. EPA/600/R-09/140. 298 pp.
6. BioGeog3 littoral cells based on “Littoral Cells of the Oregon coast, Oregon Coastal Management Program (2001) (provided by Oregon Department of Land Conservation and Development, 2014).
7. BioGeog3 estuary types represent Oregon Statewide Planning Goal 16 estuary classification.