

# Central and Northern California Coastal Marine Habitats: Oil Residence and Biological Sensitivity Indices

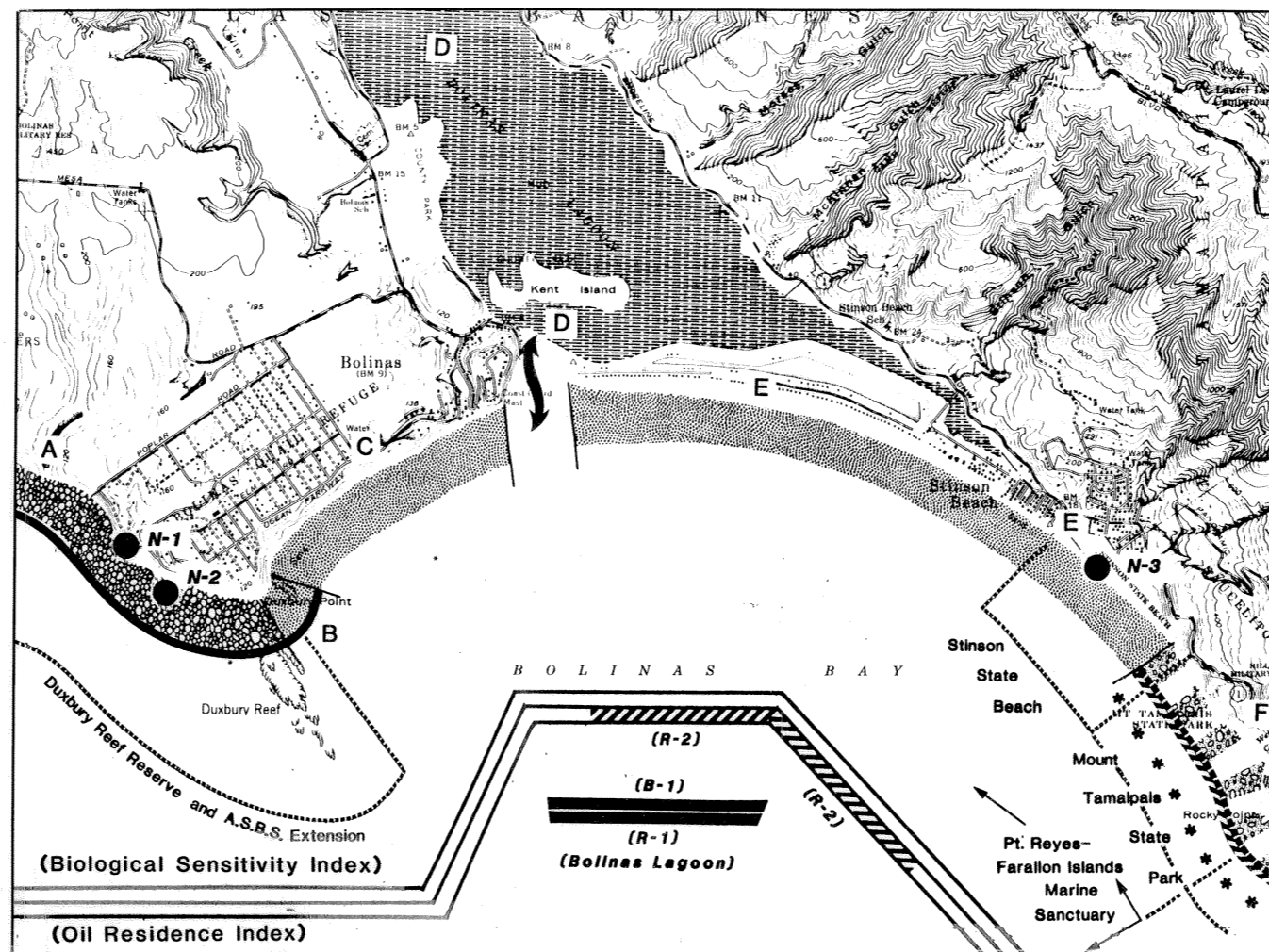
## 1:24,000 Map Series Legend Sheet: Geology

### Map Explanation

A section of one of the sensitivity analysis maps (Map #82) is reproduced here to illustrate the primary components of the mapping system and sensitivity indices. Each map includes a schematic representation of the indices that are used to estimate the environmental sensitivity to a large offshore oil spill along the California coast. The three principle components illustrated on each map are:

- a schematic illustration of physical shore-zone character
- the spatial distribution of sensitivity indices
- the seasonal variation in sensitivity indices

The development and use of each of these three components is outlined briefly below and on accompanying legend sheets. The main report should be consulted for a detailed explanation of the rationale that was used in the map development.



### Spatial Distribution of the Oil Residence Index (ORI)

Three levels of concern are identified for potential residence periods of oil stranded in the shore zone. The definition of each level of concern is given below in the Oil Residence Index Legend. The spatial distribution of these indices along the coast is shown by a linear system of map patterns immediately seaward of the shore-zone character (e.g. Unit E has a secondary ORI). Where a major estuary or embayment is present (e.g. Unit D) the indices are shown offshore from the main coastal sensitivity indices and labeled; for example, Bolinas Lagoon (ORI identifier R-1) has a primary level of concern.

The three levels of concern indicated by the Oil Residence Index (ORI) are based on (1) wave exposure levels at the shoreline, and (2) sedimentation cycles that might cause oil burial. A primary level of concern is applied to shorelines where oil residence is likely to be long term (>1 yr.); this primary level of concern applies to areas with low wave-energy levels (i.e. sheltered coasts) where mechanical removal of stranded oil is likely to be slow. A secondary level of concern is applied to areas where removal of stranded oil might require days to months; areas subject to seasonal erosion-accretion patterns are included within this category. A tertiary level of concern is applied to shorelines where oil residence is likely to be of short duration (days to weeks) due to high wave exposure.

### Oil Residence Index Legend:

<b>PRIMARY CONCERN</b>		Lengthy oil-residence time (>1 yr.); low mechanical wave-energy levels at the shore likely to result in slow removal of oil from the shore zone.
<b>SECONDARY CONCERN</b>		Variable oil-residence time (days/months); subject to seasonal beach erosion/accretion cycles.
<b>TERTIARY CONCERN</b>		Short oil-residence time (days/weeks); high mechanical wave-energy levels at the shore likely to result in rapid removal of oil from the shore zone.

### Physical Shore-Zone Character

An inventory of the physical shore-zone character is included on each map. The physical character is summarized by the use of different map patterns that are presented at right in the Shore-Zone Component Legend. More detail on the physical shore-zone character is provided as a supplemental table using the coding scheme that is presented at the bottom of this Legend Sheet.

The map patterns are frequently used in combination, indicating that several morphologies or substrates are present on a given coastal segment. The alongshore extent of a given morphology is delineated by unit boundaries; morphologies within the unit boundaries are continuous in the alongshore direction. For example, Unit E on the map is a continuous sand beach that is represented by a single map pattern, whereas Unit F is more complex and includes a narrow, rocky intertidal zone interspersed with mixed sediment pocket beaches, a boulder veneer in the lower intertidal zone, and offshore rocks and reefs.

Estuaries or embayments are illustrated by a single map pattern (e.g. Unit D). The map pattern does not represent a single morphology or substrate, but rather represents areas of very low wave-energy levels such as coastal bays, estuaries, marshes, and protected harbors. Major embayments or estuaries (>10,000 m<sup>2</sup>) are shown by map patterns, whereas smaller estuaries (<10,000 m<sup>2</sup>) are not represented by a pattern because of cartographic size limitations. The upstream boundary of river-estuaries is usually gradational and a question mark on the landward boundary indicates uncertainty in the location of the boundary between the estuary and river.

Inlets, washover fans, and ground-truth stations that were surveyed as part of this study are shown by on-site symbols. A standardized set of observations was made at each primary ground-truth station during both the summer and winter. Miscellaneous observations of selected biological or physical parameters were made at the secondary ground-truth stations.

A key feature of the mapping system is the use of supplemental coding sheets that record a greater level than can be illustrated in a map format. The physical shore-zone coding sheet provides information on shore-zone dimensions, wave exposure, and across-shore zonation of morphology and substrate. A sample coding sheet and abbreviated legend is included below.

### Shore-Zone Component Legend:

ROCK SUBSTRATES	
	Narrow Intertidal Zone
	Wide Intertidal Platform
CLASTIC SUBSTRATES	
	Continuous } Sand Beach
	Pocket } Sand Beach
	Continuous } Granule Beach
	Pocket } Granule Beach
	Continuous } Mixed* Sediment Beach
	Pocket } Mixed* Sediment Beach
*Mixed Sediment: sand, gravel including pebble, cobble and boulder	
OTHER SHORE-ZONE COMPONENTS	
	Enclosed Bay, Lagoon, Estuary or Marsh
	Anthropomorphic or Man-made Substrates
SHORE-ZONE MODIFIERS	
	Boulder Veneer
	Offshore Reefs or Rocks
	Stable Inlet
	Ephemeral Inlet
	Washover Fan
	Primary } Ground-truth Station
	Secondary } Ground-truth Station

### Temporal Distribution of the Oil Residence Index (ORI)

Physical systems are not static in time and, as a result, potential oil-spill sensitivity of these systems may vary in time. The annual variation of estimated sensitivity is illustrated by graphs of the temporal variation of the Oil Residence Index, an example of which is provided below. Areas identified as primary or secondary concern are shown in relation to annual cycles of variability. Oil residence times may vary throughout the year as a result of seasonal variations in coastal processes or wave exposure. For example, seasonal beach sediment cycling could result in the burial of oil that is stranded in the shore zone. Buried oil could persist for periods of months during the seasonal beach accretion period (e.g. Unit E, ORI identifier R-2), which typically occurs from June through November.

### Temporal Variation of the Oil Residence Index:

IDENTIFIER	FEATURE	MONTH														
		J	F	M	A	M	J	J	A	S	O	N	D			
R-1	Permanent inlet, Bolinas Lagoon															
R-2	Beach berm															

### Coding Sheet Explanation

The presentation of a coding sheet with each map allows the map format to be kept relatively clean and simple, while at the same time, the coding sheets provide a highly detailed description of the physical shore-zone character. The shoreline is subdivided into alongshore units and across-shore components. A unit describes an association of across-shore components that is continuous alongshore. Unit boundaries are delineated by a significant change of morphology or substrate in one or more of the across-shore components.

An abbreviated coding legend describes the codes that are used on each coding sheet. The main text should be consulted for a complete description of the codes and rationale.

#### UNIT IDENTIFIER

The identifier keys the coding-sheet information to a site-specific location on the map.

#### ALONGSHORE LENGTH

The alongshore length of the unit is recorded in kilometers. In the case of estuaries, protected bays and lagoons, only the alongshore length of the connecting inlet is recorded; this measurement does not necessarily reflect the alongshore length or the area of the protected embayment (see report for a summary of embayment shoreline lengths).

#### ACROSS-SHORE WIDTH

The across-shore width of the intertidal zone is recorded in metres. A range of minimum to maximum shore-zone widths is recorded for units where the intertidal-zone width varies in the alongshore direction. No intertidal zone width is recorded for estuaries, protected bays, or lagoons.

#### WAVE-EXPOSURE INDEX

This descriptor provides a relative index, on a scale of 1 to 10, of wave-energy levels at the shore (1 represents low levels of wave exposure; 10 represents high levels of wave exposure). The exposure level is determined from consideration of fetch distances and shoreline crenulation as related by a wave exposure matrix (see main report).

#### ACROSS-SHORE COMPONENTS

Dominant morphologic and textural character of each across-shore component, is described in a landward to seaward sequence. Each component consists of a geomorphic form descriptor and a substrate descriptor: e.g., (form) Bb,Cg (texture)

The primary geomorphic forms are initially described by a series of 12 codes:

A Anthropogenic	E Coastal Bay, Lagoon, Estuary	P Platform
B Beach	I Inlet	R River
C Cliff	M Marsh	S Bar/Trough
D Dune	O Offshore Rocks	T Delta

Each of these groups is then further modified by codes as indicated below.

<b>Anthropogenic (A)</b>	e causeway	j jetty	m marina	t trench
	f float	g groin	r boat ramp	s seawall
				w wharf
<b>Beach (B)</b>	b berm	i inclined slope	s storm ridge	
	c washover channel	m multiple intertidal bars	t low-tide terrace	
	f beach face	r single intertidal bar	w washover	
<b>Cliff (C)</b>	a active or erosional	p passive	c caves present	
<b>Dune (D)</b>	b blowout	f foredune	s ridge and swale	
	d stabilized	r random form	l longitudinal	
<b>Coastal Bay, Lagoon, Estuary (E)</b>	b enclosed bay	e estuary		
<b>Inlet (I)</b>	e ephemeral	a opening fixed by offshore structures		
	s stable	f flood-tidal delta	l ebb-tidal delta	
<b>Marsh (M)</b>	c tidal creek			
<b>Offshore Rocks (O)</b>	e intertidal reef	s sea stack		
	r rock outcrop (>2 m above M.S.L. and <10 m in width or length)			

### Coding Sheet:

UNIT IDENTIFIERS	A	B	C	D	E	F
ALONGSHORE LENGTH (km)	7.0	0.3	1.8	0.4	4.2	1.6
ACROSS-SHORE WIDTH (m)	50-500	50	100-150	-	75	10-20
WAVE EXPOSURE	10	10	10	1-10	10	10
ACROSS-SHORE COMPONENTS (morphology, texture)	Ca,Rs Bf,Cgr Pl,Rs	Ca,Rs Bf,Cs Pf,Rs	Ca,Rs Bf,Cs Bt,Csb	Eb,Cms If,Cs Is,Cs Ie,Cs	Dsd,Cs Bf,Cs Bt,Cs S,Cs	Ca,Rs Bi,Cg Ore,Rs Ca,Rs Bi,Cr Ore,Rs
Primary						
Secondary						
MICRO RELIEF	S	S	S	-	S	R
MACRO RELIEF	R	R	R	-	S	R
SUMMARY CHARACTERISTICS	RPb	RPbs	bs	IsE	bs	Rb'mvO
OIL RESIDENCE INDEX	3	3	3	1	2	3
GROUND TRUTH	3	0	1	0,4	2,3,4	0

#### Platform (P)

h high-tide platform	f horizontal	t terraced
l low-tide platform	r ramp	i irregular

#### River (R)

b braided	m multiple	s single channel
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#### Bar/Trough (S)

subtidal	r with rip channels
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#### Delta (T)

c channel	m multiple channels	p delta plain
f fan	s single channel	v crevasse
l levee		

Substrate type or sediment texture are described in detail by a series of codes. The sediments or materials of the shore are initially coded into one of four groups:

A anthropogenic materials	C clastic sediments
B biogenic sediments	R bedrock

Each of these groups is then further modified by texture or composition as indicated below.

#### Anthropogenic materials (A)

a metal	n concrete (solid)	w bark or wood debris
d debris, rubble	t logs	
e concrete (individually formed)	u wood (structural; e.g., pilings or boards)	

#### Biogenic sediments (B)

l trees or wood particles	o organic litter
s shell hash (with a texture as described below)	

#### Clastic sediments (C)

b boulder	s sand	m mud
c cobble	sl silt	g gravel
p pebble	f clay	r rubble

#### Bedrock (R)

i igneous	m metamorphic	s sedimentary
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Where more than one texture is present in an across-shore component, several substrates or textures may be indicated. Where one texture physically overlies another, it is indicated by a slash (e.g. Ca/Rs, sand over rock). Where several mutually exclusive textures occur within a component, such as rock outcrops within a sand beach, a colon is used to indicate that association (e.g., Cs:R).

#### MICRO-RELIEF

The descriptor provides an index of the surface roughness of the substrate; the micro-relief index applies to relief variations of less than 1 m. The micro-relief surface roughness is described by two codes as follows:  
R micro-relief is rough  
S micro-relief is smooth

#### MACRO-RELIEF

The descriptor provides an index of the intermediate roughness of the substrate; the macro-relief index applies to relief variations of greater than 1 m. The macro-relief surface roughness is described by two codes as follows:  
R macro-relief is rough (e.g. hummocky in nature)  
S macro-relief is smooth

#### SUMMARY CHARACTERISTICS

This descriptor summarizes the repeatable shore-zone morphologies and modifiers for each unit (e.g., the patterns shown on the map). The descriptor provides a more general summary of the shore-zone character than is given by the across-shore components characteristics (above). Summary codes are:

R:	rock substrate, narrow intertidal zone
RP:	rock substrate, wide intertidal platform
bs:	continuous
b's:	pocket
bg:	continuous
bg:	pocket
bm:	continuous
b'm:	pocket
	(mixed sediment: sand, gravel, including pebble, cobble, and boulder)
E:	enclosed bay, lagoon, estuary or marsh
A:	anthropogenic (man-made) substrate
Is:	stable
Ie:	ephemeral
V:	boulder veneer, usually lower intertidal zone
O:	offshore reefs, outcrops or sea stacks

#### Examples:

bs:	continuous sand beach
RPbs:	rock platform with continuous sand beach
Rb'mO:	narrow, rocky intertidal zone with mixed-sediment pocket beaches and rock outcrops offshore
RPb'gvO:	rock platform with granule pocket beaches, a boulder veneer in the lower intertidal zone, and offshore rock outcrops

#### RESIDENCE INDEX

An estimate of potential oil-residence time for each unit is provided by three descriptive codes. Where a potential residence time varies within a unit, a range of residence indices is provided. Summary codes are:  
1 lengthy oil-residence time (>1 yr)  
2 residence time variable (days/months)  
3 residence time short (days/weeks)

#### GROUND-TRUTH CODE

This descriptor provides the user with information on the detail of field ground truthing that was conducted within each unit. Ground-truth codes are:  
0 no field observations available  
1 miscellaneous, short-term field observations from alternative sources available  
2 M.M.S. secondary ground-truth station  
3 M.M.S. primary ground-truth station  
4 detailed field observations or long-term studies available

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**M.M.S. Map Legend**  
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