California Rapid Assessment Method (CRAM) for Wetlands: Estuarine Module

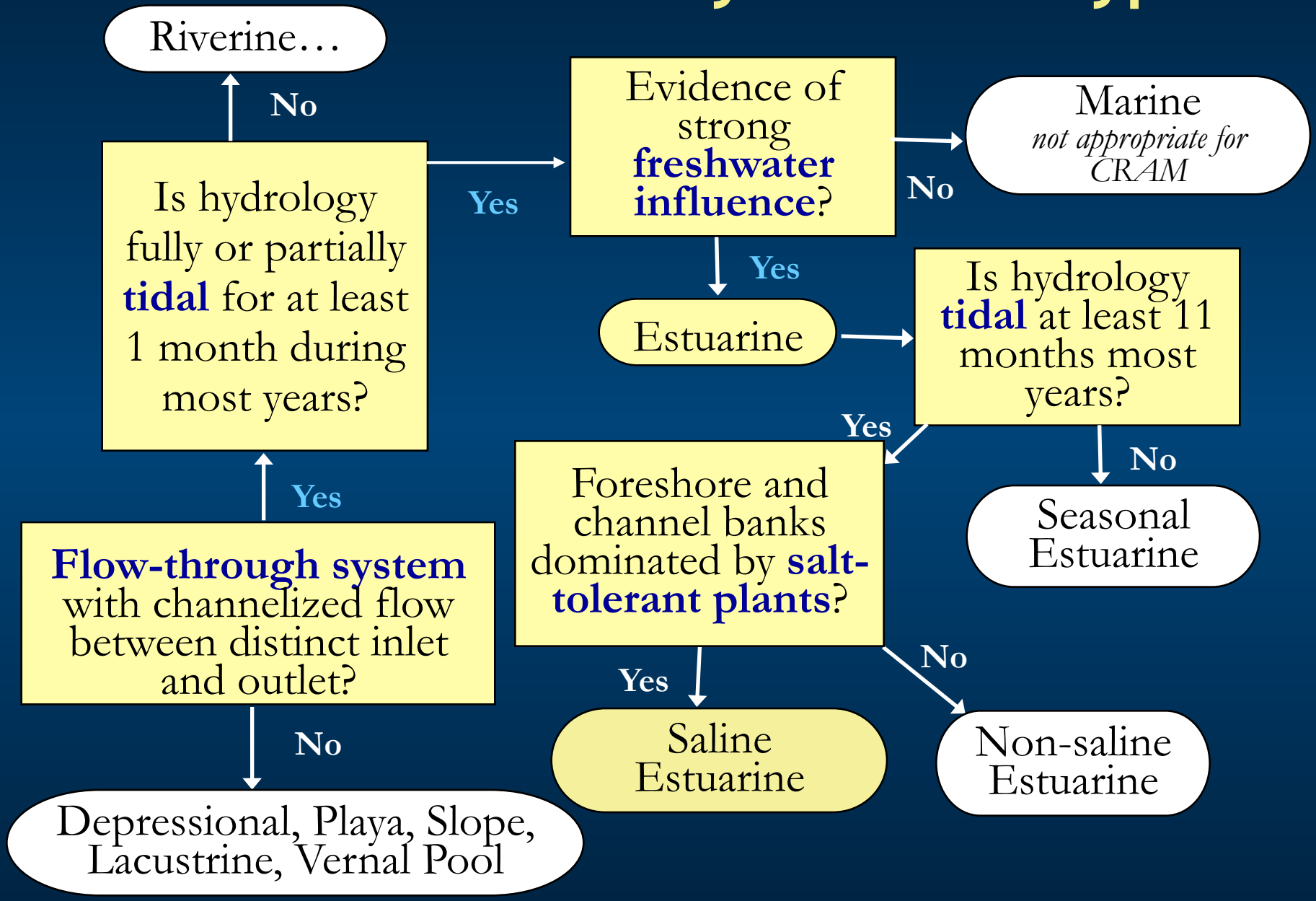
Classification and Characteristics

San Elijo Lagoon, San Diego County, CA

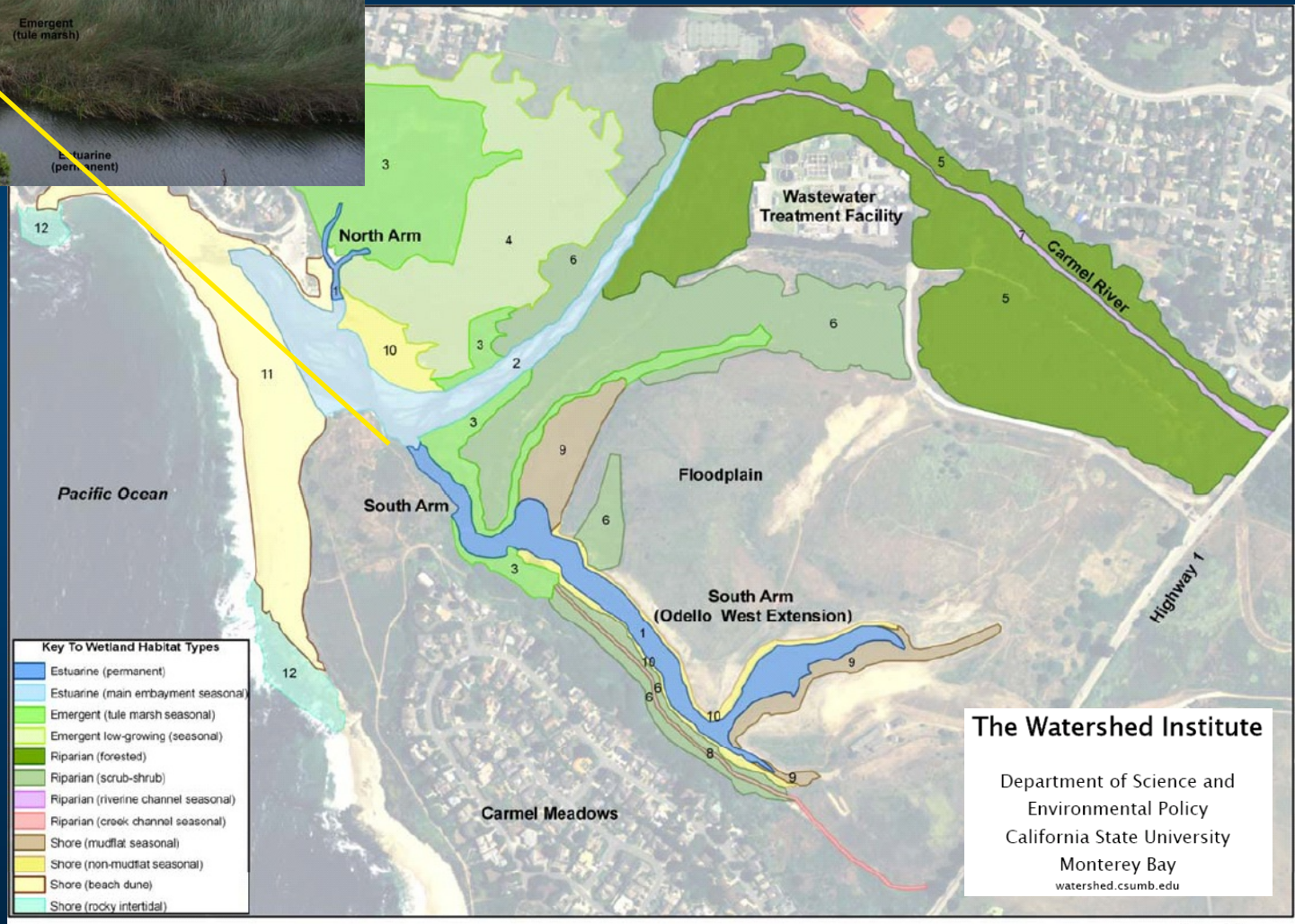
Estuaries

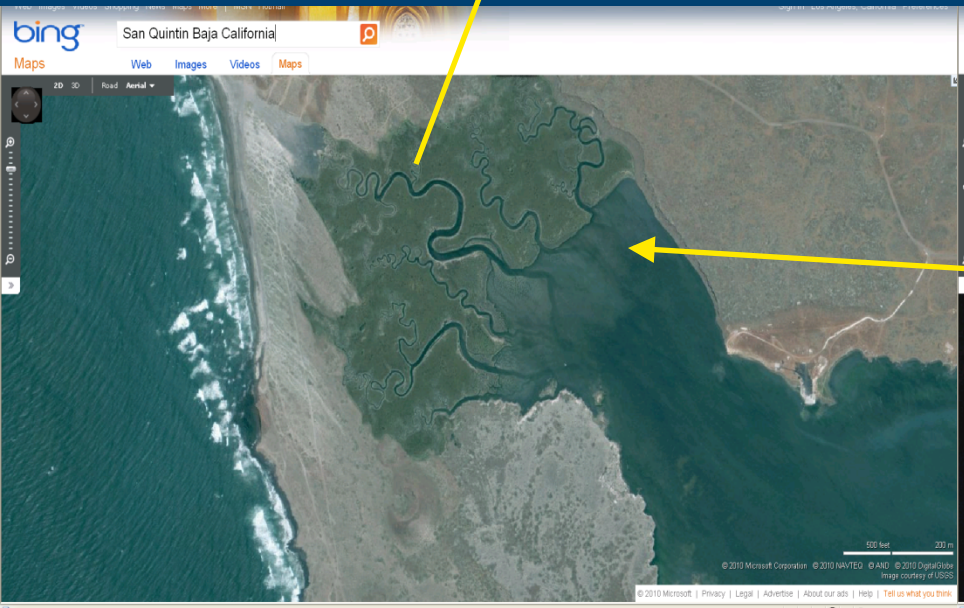
- Terminology
- Tides
- Zonation
- Approaches to Classification
  - Geoforms; Ferren et al. (1996)
  - Estuarine Inventory
  - Bar-built Estuaries
  - Plant Species, Competition, Physical Stress (Salinity)
  - Classification on Natural Closure Patterns: Templates for Restoration and Management
    - Jacobs et al. (2011); SCCWRP TR 619a Revised

Identify Wetland Type



Seasonal or Non-Saline Estuarine

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San Quintin Baja California
Maps
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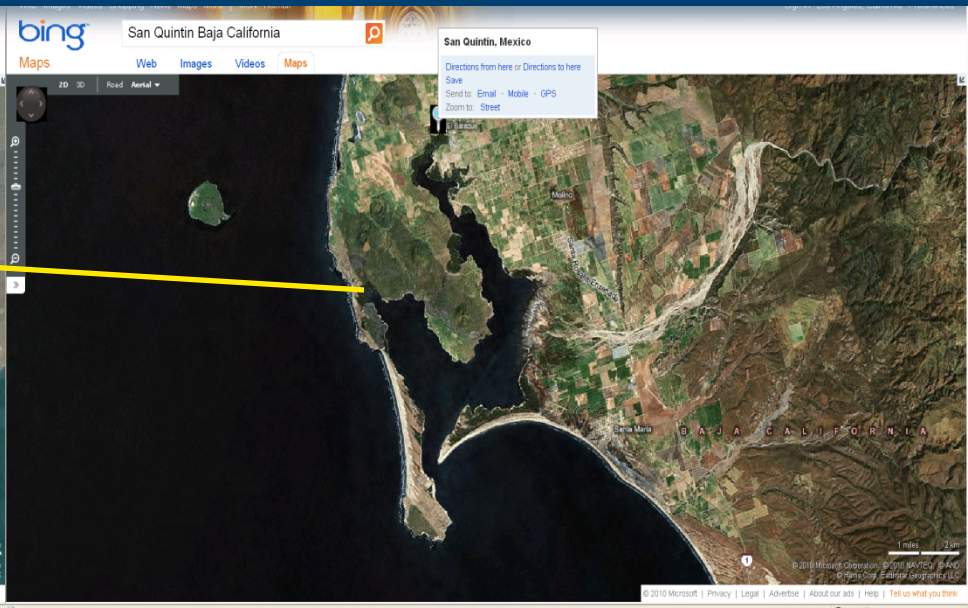
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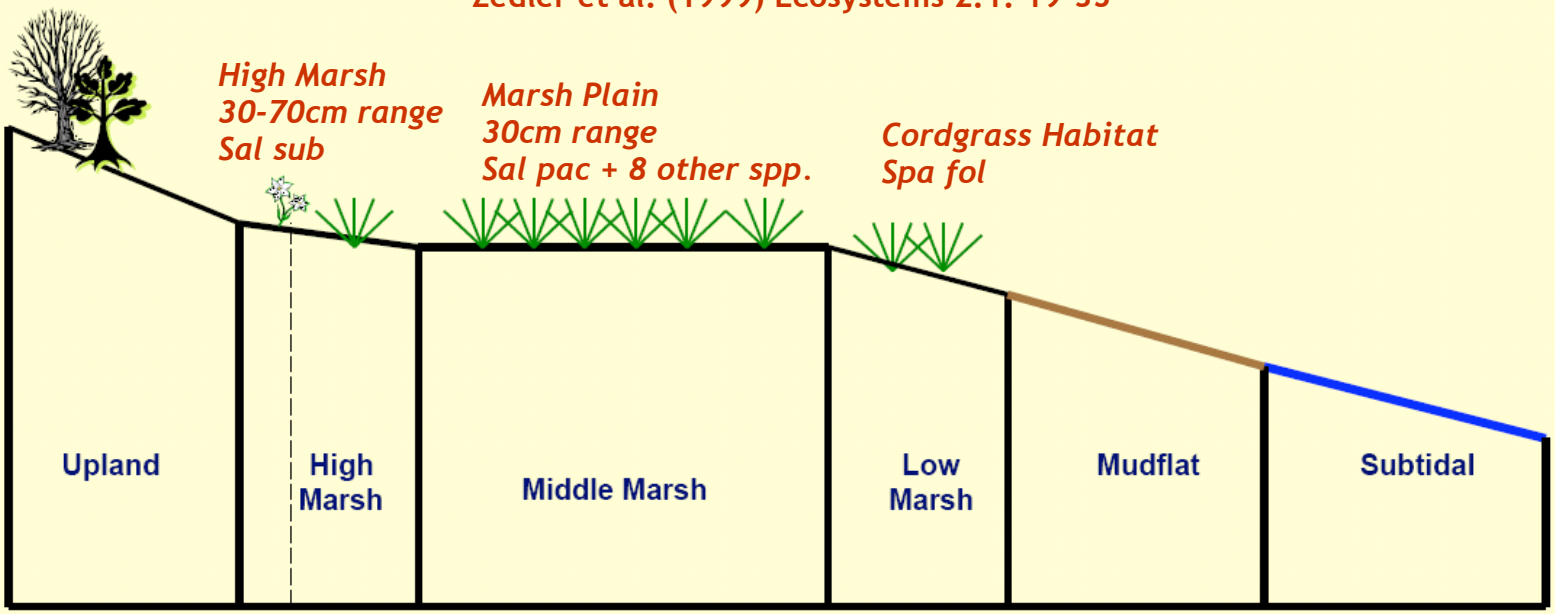
B A J A C A L I F O R N I A

Wetlands Portal Habitat Definitions

- **Estuarine—open water**
  - The area of open water that is apparent during an average low tide
  - The open water area includes the pannes and ponds on the vegetated marsh plain. Open water and non-vegetated areas have less than 5% absolute cover of vegetation.
- **Estuarine—mudflat**
  - The area lacking vegetation that exists below the marsh plain that is exposed during the average low tide
- **Estuarine—submerged aquatic vegetation**
  - Some estuarine wetlands have **submerged aquatic vegetation**, such as eel grass, that is partially exposed during the average low tide.
- **Estuarine—marsh**
  - The vegetated marsh plain that is above the average high tide

Tidal Habitat Zones

Consideration of: Elevation / Landscape Position / Species
Zedler et al. (1999) Ecosystems 2:1: 19-35



Mean Higher High Water	= Average of higher high daily tides
Mean High Water	= Average of all high tides
Mean Sea Level	= Average of all recorded water levels
Mean Low Water	= Average of all low tides
Mean Lower Low Water	= Average of lower low daily tides
Highest water level	= Maximum water level during monitoring period
Lowest water level	= Minimum water level during monitoring period

Tides

- Diurnal –
  - 1 high, 1 low per 24 hrs
- Semidiurnal –
  - two highs, two lows per 24 hrs (equal)
- Mixed Semidiurnal –
  - two highs, two lows per 24 hrs (non-equal)

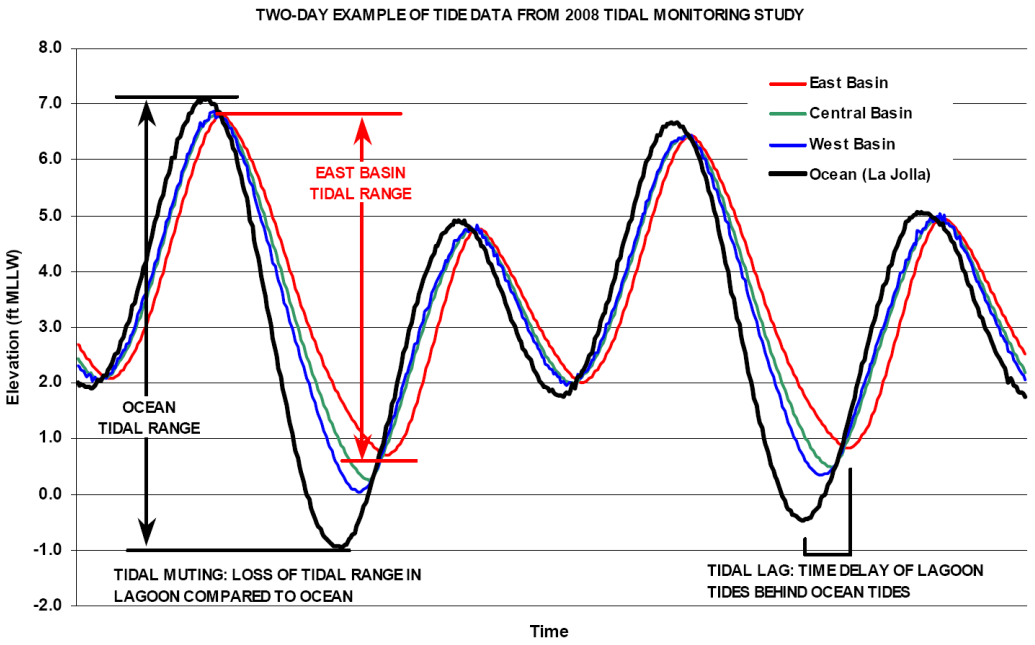


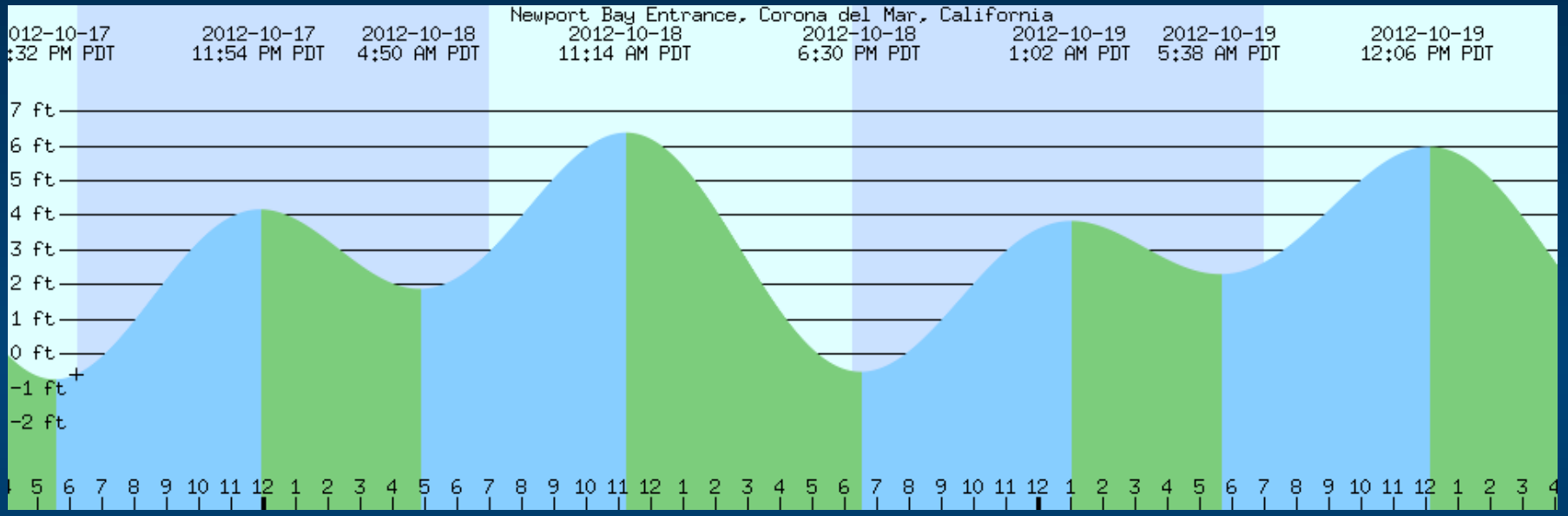
Figure 2-1. Example of tidal muting and tidal lag on plotted tides.

Batiquitos Lagoon Long-term Biological Monitoring Program Final Report *2.0 Physical Evolution*

"Latency" = delay with respect to time; natural situation due to location within estuary.

Newport Bay Entrance

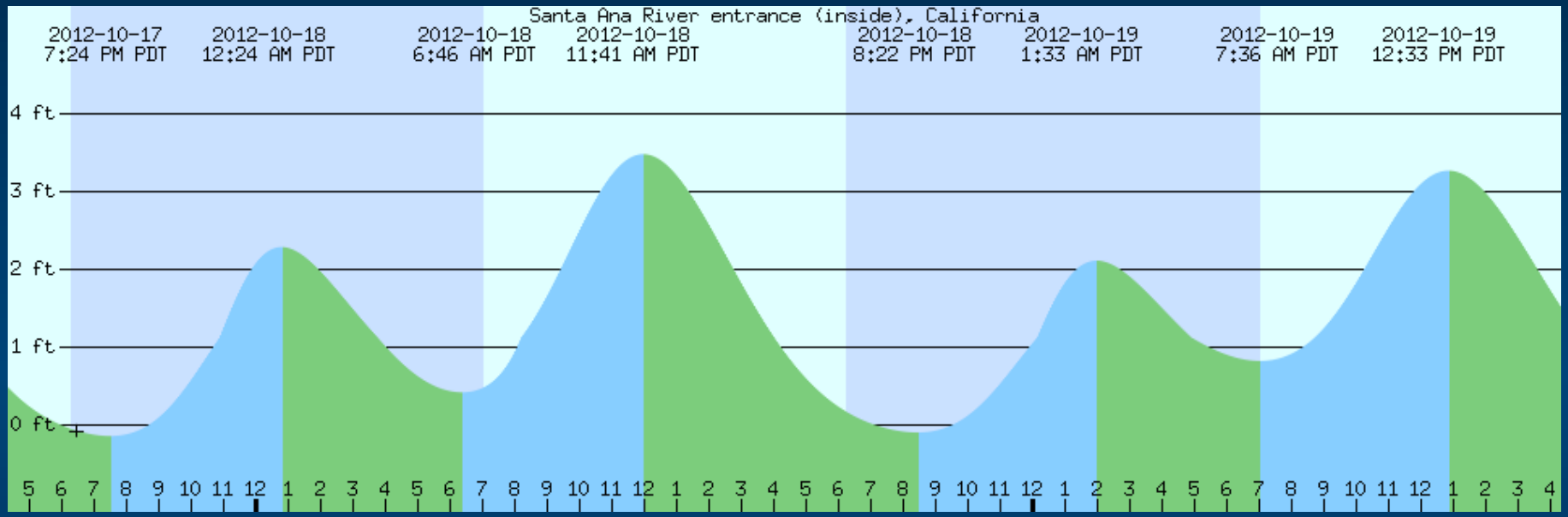
Corona del Mar, CA



- 2010-10-18 4:50 AM PDT 1.86 feet Low Tide
- 2010-10-18 11:14 AM PDT 6.37 feet High Tide
- 2010-10-18 6:30 PM PDT -0.53 feet Low Tide
- 2010-10-19 1:02 AM PDT 3.82 feet High Tide
- *http://www.mobilegeographics.com:81/locations/4149.html*

Santa Ana River Entrance

Newport Beach, CA



- 2010-10-18 6:46 AM PDT 0.39 feet Low Tide
- 2010-10-18 11:41 AM PDT 3.49 feet High Tide
- 2010-10-18 8:22 PM PDT -0.10 feet Low Tide
- 2010-10-19 1:33 AM PDT 2.13 feet High Tide
- *http://www.mobilegeographics.com:81/locations/5605.html*

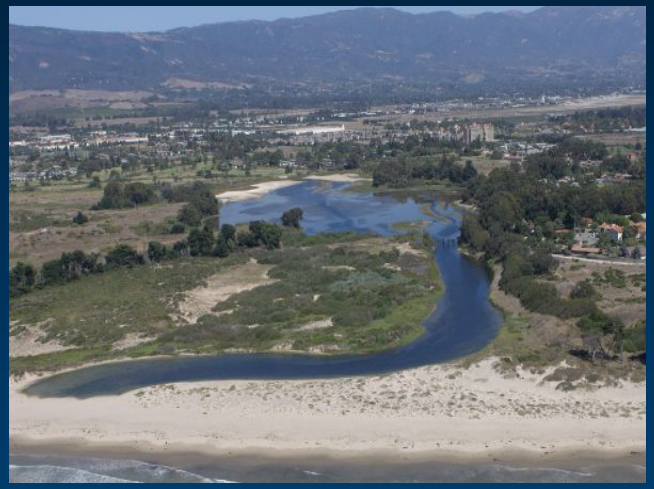
Estuarine Classification: Geoforms – Types of Estuaries

- Riverine
  - River Mouth Estuary, Drowned River Valley (Coastal Plain Estuary), Canyon Mouth Estuary, Deltaic Estuary, Salt Wedge Estuary, Tidal Freshwater Marsh
- Lagoon
  - Coastal Lagoon, Slough, Barrier Island Estuary, Bar-built Estuary, Tidal Inlet
- Embayment
  - Open embayment
  - Enclosed bay
- Structural Basin Estuaries
  - Tectonic activity; Carpinteria Salt Marsh
- Artificial Drain Estuaries
- Fjord
  - New Zealand, Norway, Alaska; none in California

Inventory of California's Estuaries

Geoform	Tidal Connection	No. of Systems
Enclosed Bay	Perennial	30
Lagoons	Perennial	15
	Intermittent	33
	Ephemeral	46
River Mouth	Perennial	11
	Intermittent	270
Total		405

Perennially Tidal



Intermittent Tidal (open 2 weeks- 11 months per year)

Ephemeral Tidal (Only open during extreme storm events)

Non-tidal (Not known to open)

Estuarine Classification

(M. Sutula, SCCWRP)

Geoform	Tidal Regime
Enclosed Bay	Perennial
Lagoon	Perennial Intermittent Ephemeral Permanently closed
River mouth	Perennial Intermittent

Geoform and tidal connection influence susceptibility to eutrophication

Perennially Tidal Enclosed Bay

Intermittently Tidal Lagoon

Permanently closed Lagoon

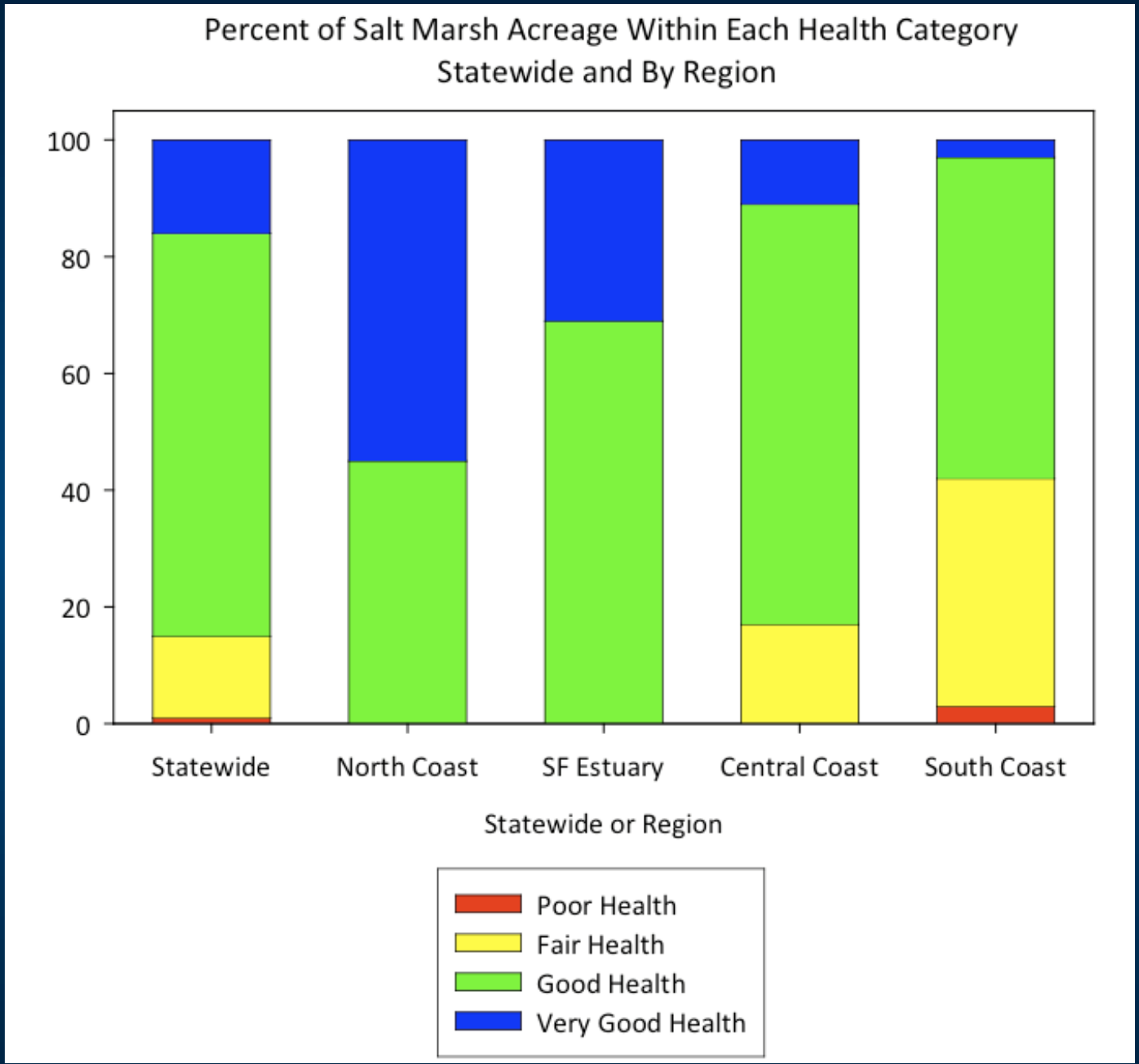
Intermittently Tidal River Mouth

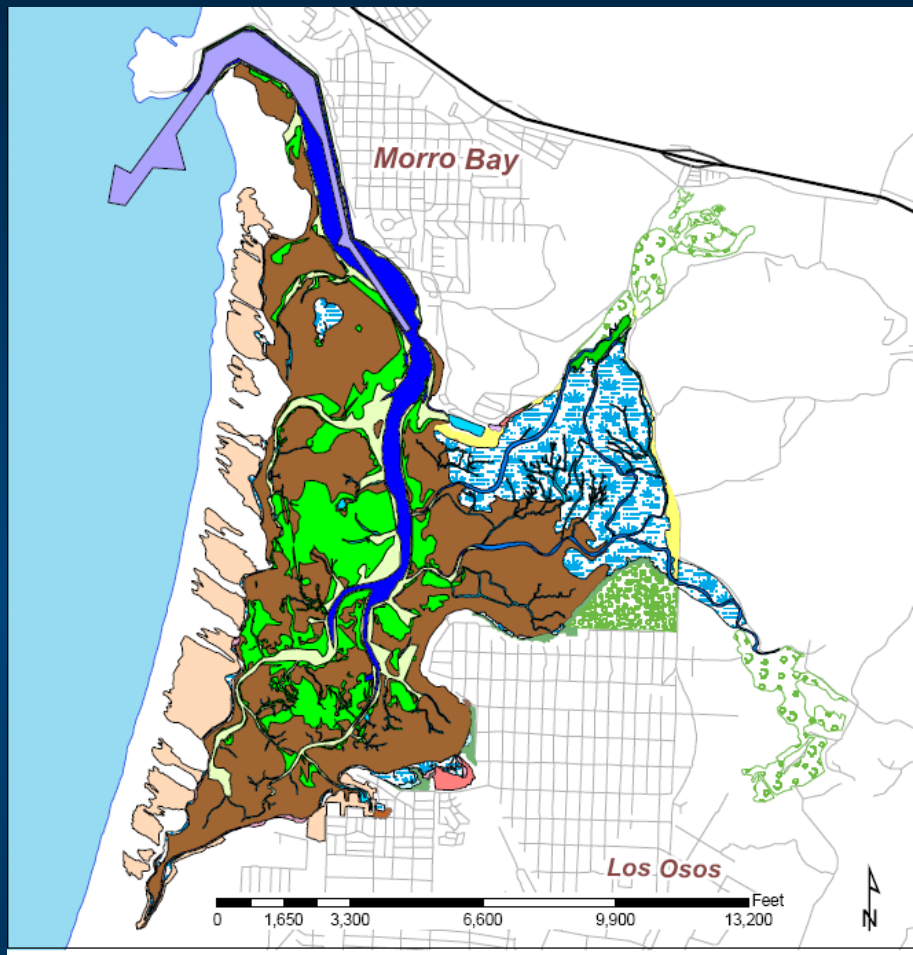
Estuarine Conceptual Classification

Geoform	Surface Water Tidal Connection	No. Sites
Enclosed Bays	Perennial	29
Lagoons	TOTAL	105
	Perennial	14
	Intermittent/seasonal	46
	Ephemeral	16
	Permanently closed	29
River mouth	TOTAL	275
	Perennial	11
	Intermittent/seasonal	264
	large (>20 m)	34
	small (<20 m)	230

California Estuaries/Salt Marshes

- In 2007, a rapid assessment was conducted on a probability-based sample of the State's approximately 44,456 acres of perennially tidal salt marshes. Following are a few of the important findings of this study:
  - 85% of the State's salt marshes were in good to very good health; 35% of salt marsh acreage had scores reflecting very good hydrology and marsh plant community structure; 65% was found to have large, intact buffers.
  - 50 % of acreage scored in the fair to poor category with respect to their physical structure.
  - Salt marsh health generally declined from Northern to Southern California, consistent with a trend in increasing urbanization from north to south.
  - Dikes and levees were among the most frequent and most severe physical stressors identified statewide.

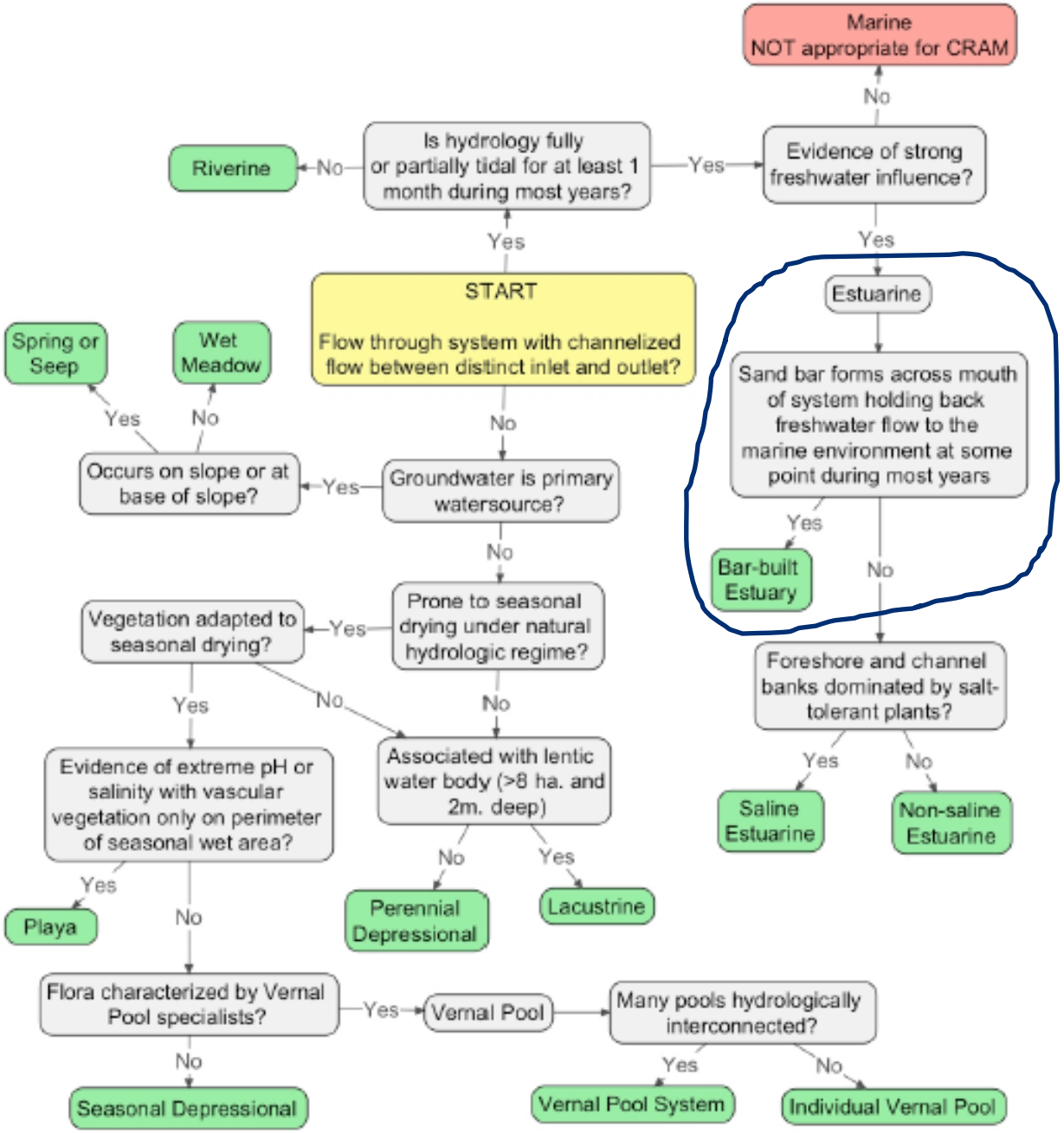

Percent of Salt Marsh Acreage Within Each Health Category
Statewide and By Region
100
80
60
40
20
0
Statewide
North Coast
SF Estuary
Central Coast
South Coast
Statewide or Region
Poor Health
Fair Health
Good Health
Very Good Health



Federal Channel
Main Channel
Marsh Channel
Marina
Subtidal Habitat
Eelgrass
Mudflat
Saltmarsh
Degraded Riparian
Herbaceous Fringe
Robust Fringe
Woody Fringe
Riparian
Coastal Dune Scrub
Upland
Upland Cypress
Upland Eucalyptus
Upland Eucalyptus/Cypress
Upland-Elfin Forest
Stream Channel

Morro Bay Existing Habitats

Figure 3.2: Flowchart to determine wetland type and sub-type.



What is a Bar-built Estuary

Evidence of a strong freshwater influence (fluvially dominated)

Ocean influence through periodic marine inputs

A sand bar creates a barrier to ocean and increases water elevation seasonally

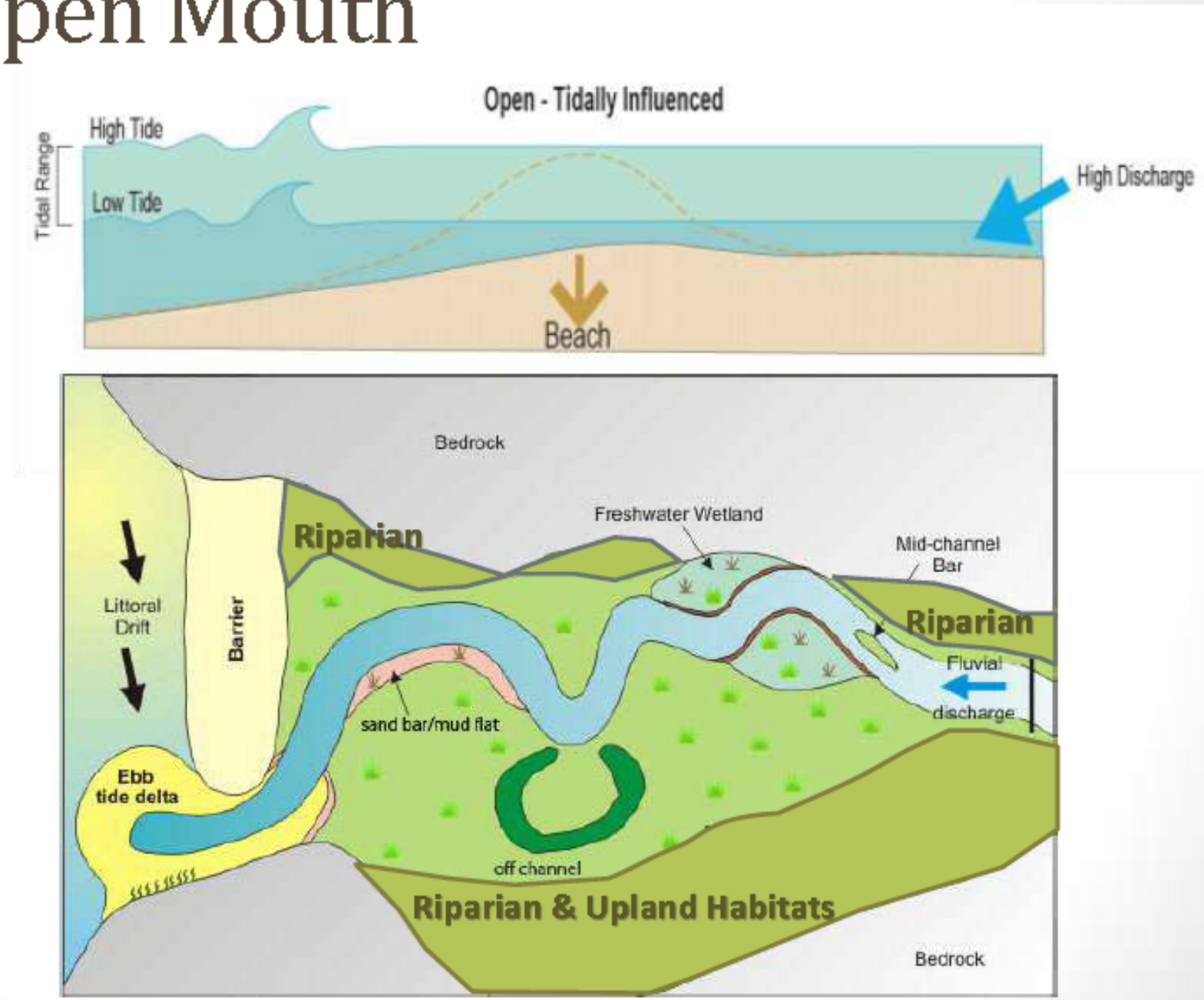
Inventory of California Bar-Built Estuaries

Slides adapted from:
Ross Clark & Kevin O'Connor
H20 Conference 2012

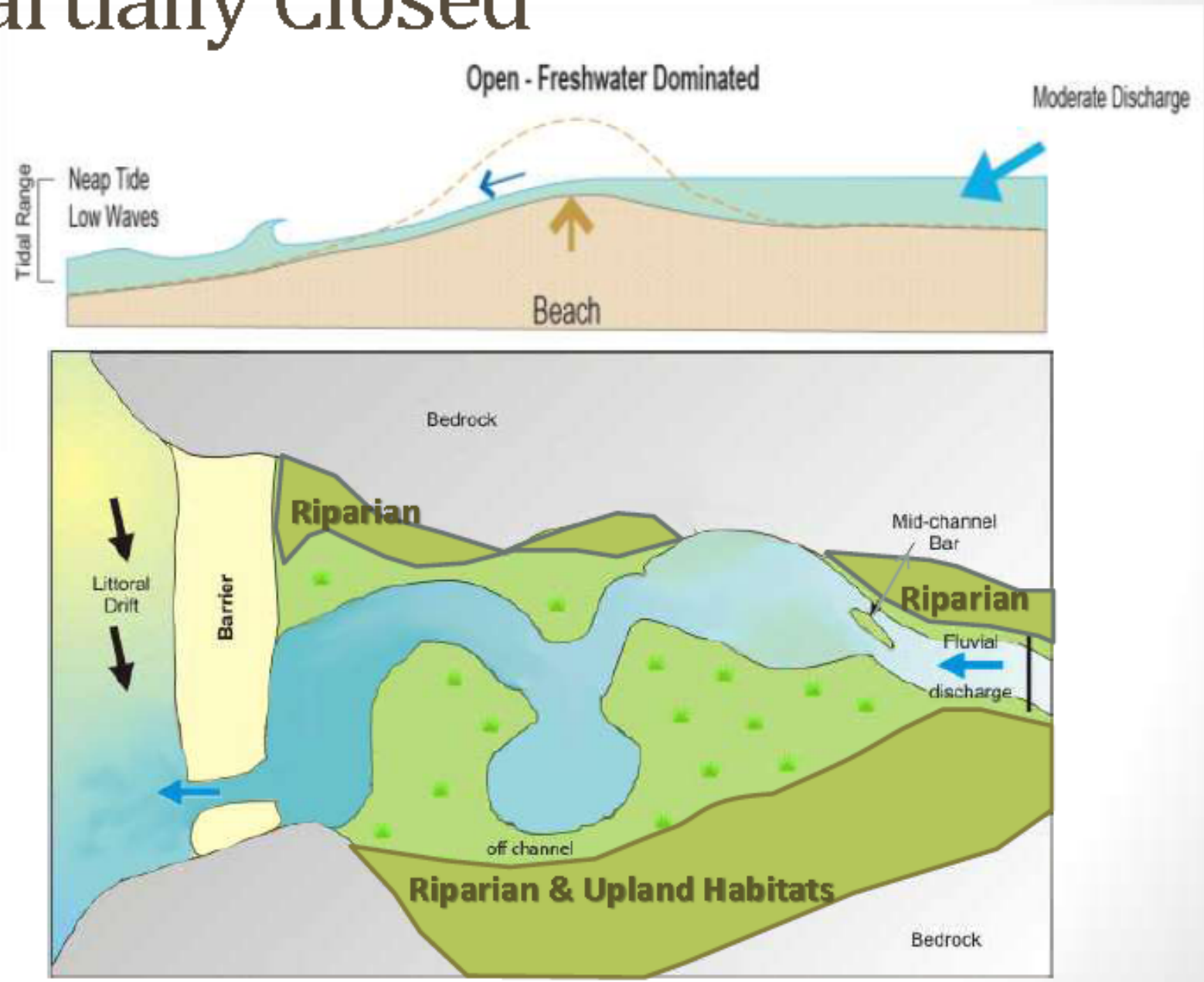
California 2012 BBE Survey

- CRAM Ambient Assessment
- Marsh Vegetation Surveys
- Channel Cross Sections
- Water Chemistry Profile
- Beach Berm Topography.
- Historical Change Analysis
- Watershed Inventory
- T&E Species listings
- Water Elevation Monitoring

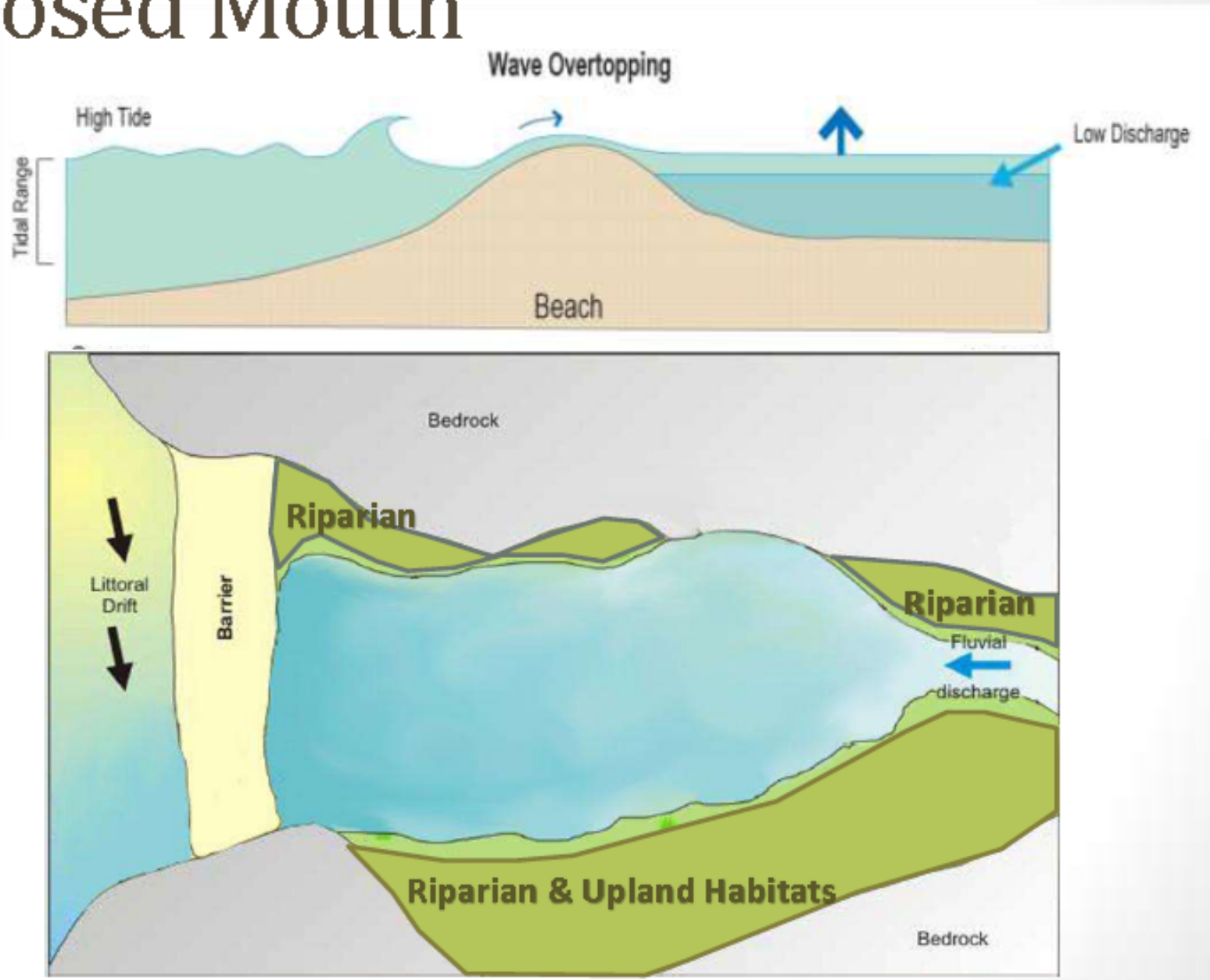
Open Mouth


Open - Tidally Influenced
High Tide
Low Tide
Tidal Range
High Discharge
Beach
Bedrock
Riparian
Freshwater Wetland
Mid-channel Bar
Riparian
Littoral Drift
Barrier
Fluvial discharge
sand bar/mud flat
Ebb tide delta
off channel
Riparian & Upland Habitats
Bedrock

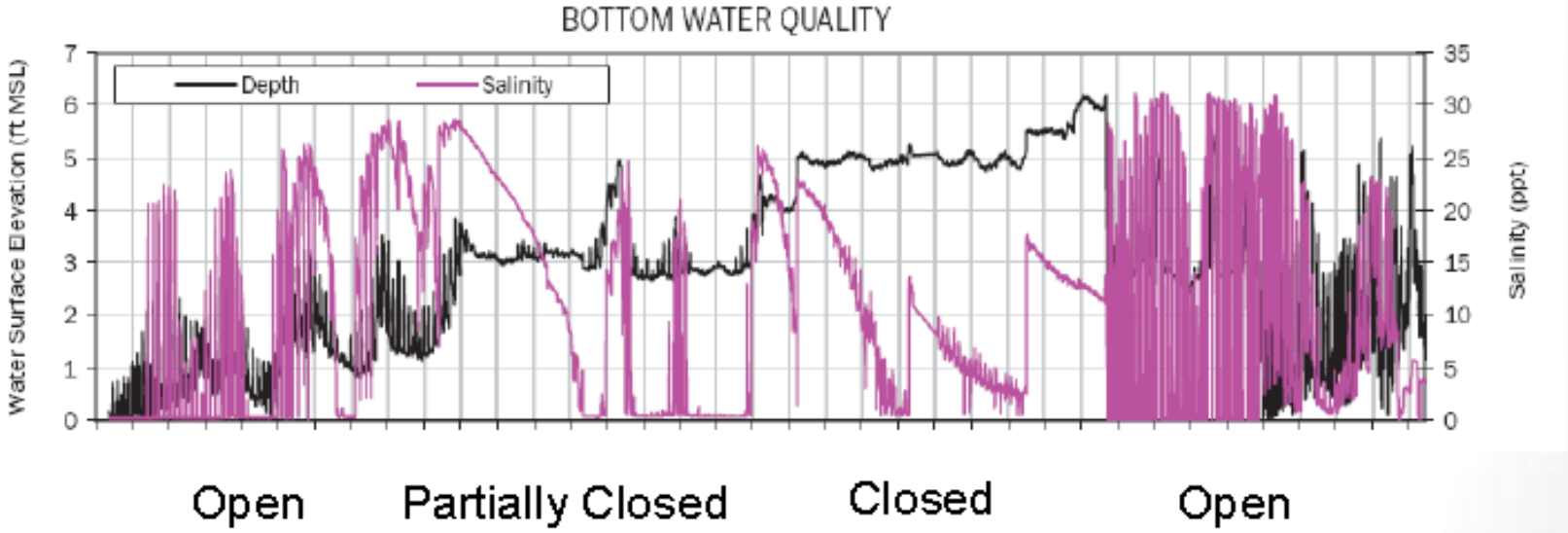
Partially Closed



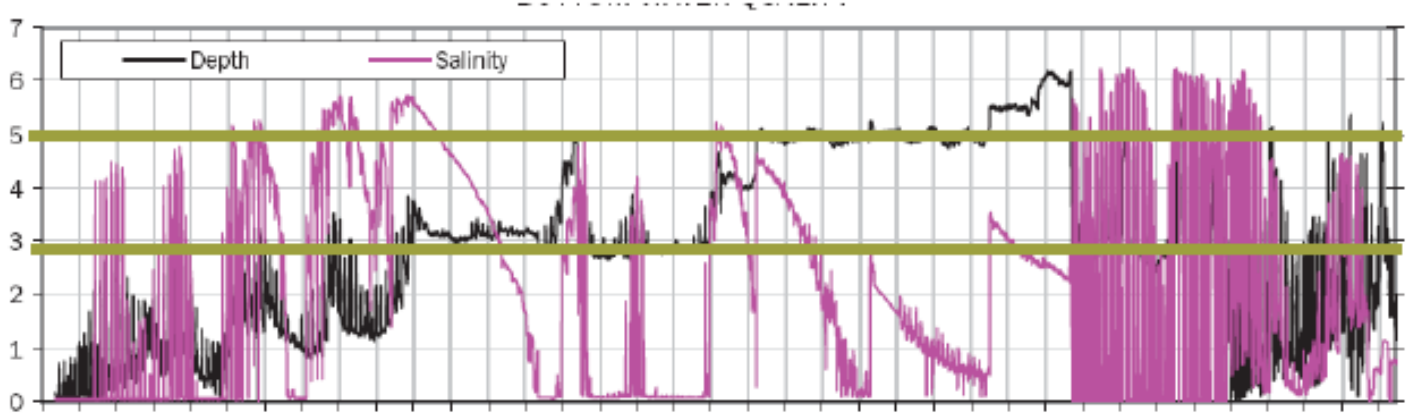
Closed Mouth



Hydro-graph shows seasonality of a bar-built estuary



Inundation of Lagoon Marsh



High Marsh Habitat

Mid-Marsh/
Backwater Habitat

Open Partially Closed Closed Open

Scott Creek Lagoon

Pajaro River Lagoon

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California Coastal Records Project, www.Californiacoastline.org

Soquel Creek Lagoon

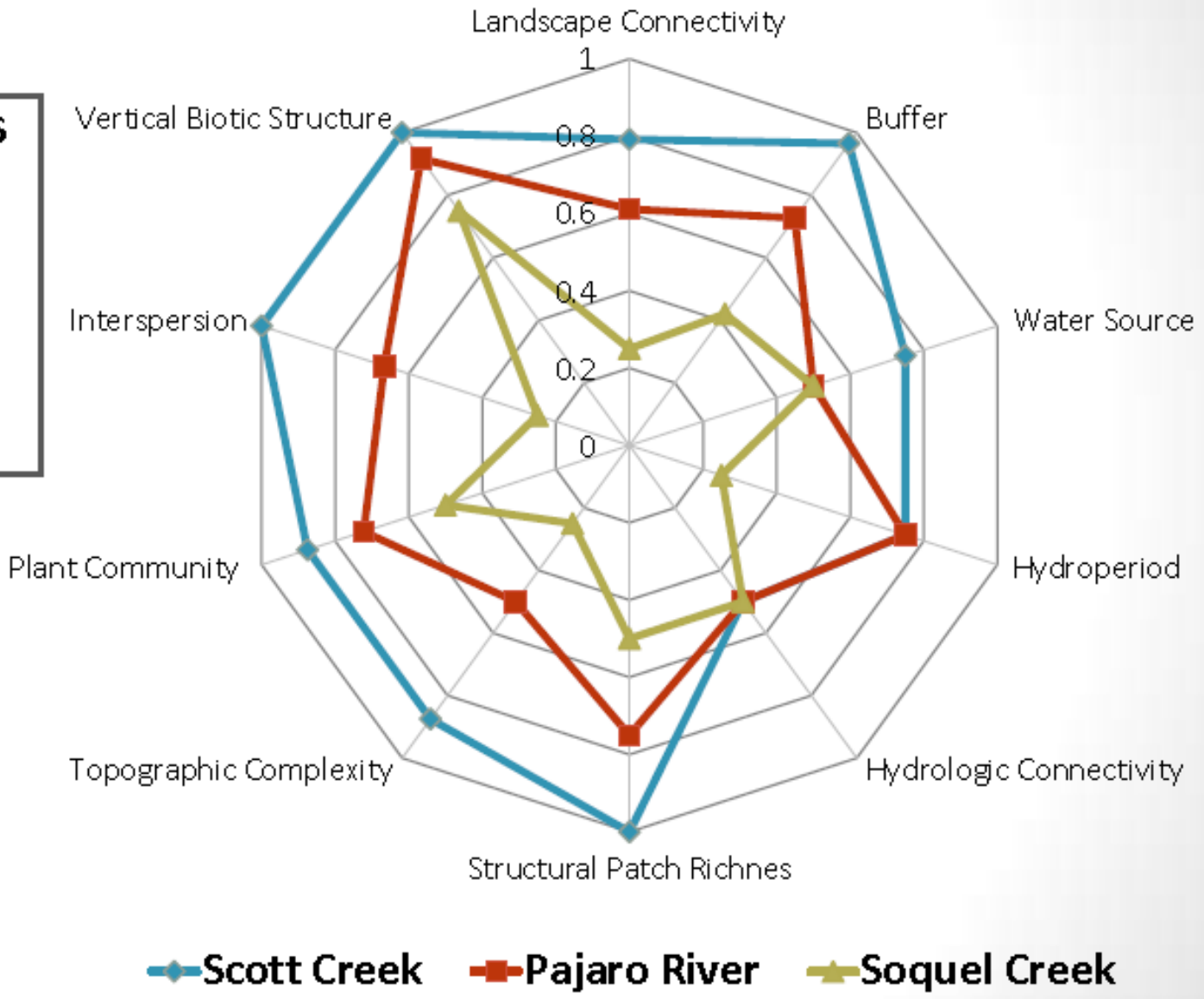
Comparison of CRAM Scores (2011)

CRAM INDEX SCORES

Scott Creek: 86

Pajaro River: 66

Soquel Creek: 41



Just when you have it all figured out…

- Altered Conditions
  - Dikes, levees change hydrology
  - Reduced extent of tidal action
  - Adjacent runoff vs. tidal influence
  - Urban context
  - Invasive plants
  - Novel habitats