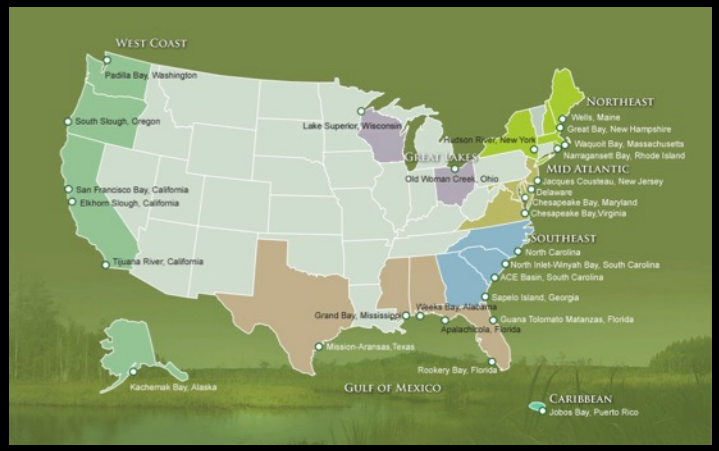
Estuaries 101

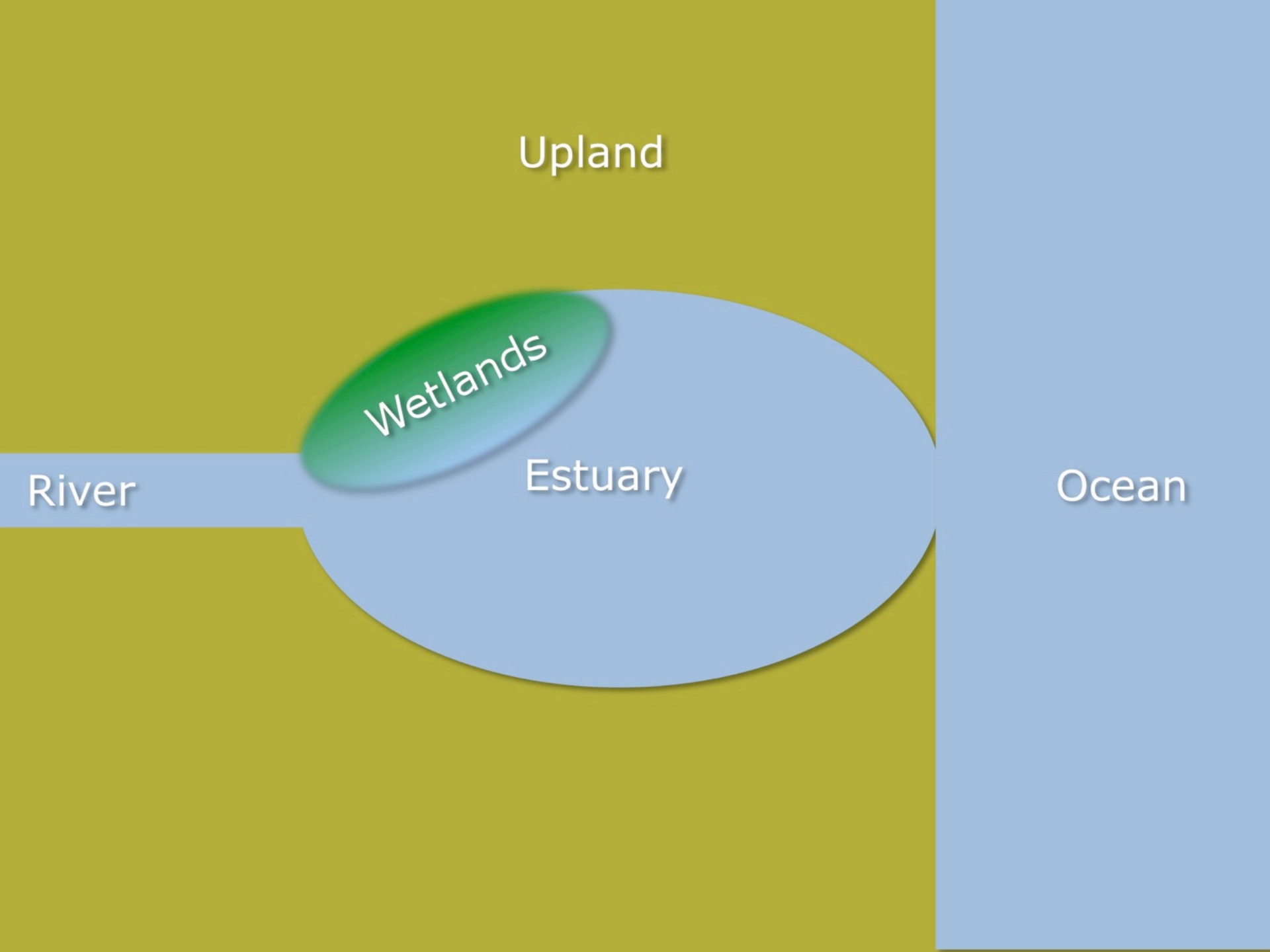
Jeff Crooks

Tijuana River National Estuarine Research Reserve
and the
Southwest Wetlands Interpretive Association

National Estuarine Research Reserve System
National Oceanic & Atmospheric Administration

- Federal – State Partnerships
- 29 Reserves established by the Coastal Zone Management Act
- Provide long-term protection of reserve resources for research
- Enhance awareness and understanding of estuarine areas, and provide suitable opportunities for education and interpretation
- Protect areas that contribute to typological and biogeographical balance of the system




Upland
Wetlands
River
Estuary
Ocean

Beach, dune, channel, salt marsh habitats

Riparian & freshwater habitats

Upland transition

Coastal mesas

Distribution and Loss of Coastal Wetlands

Values of Wetlands

- Economic (direct and indirect)
- Recreation and aesthetics
- Habitat / nursery
  - Threatened species
  - Harvested species
- Water storage and filtration
- Environmental buffering
- Global carbon cycle

TABLE 1.1. Estimated Relative Economic Values per Hectare of Services Provided by the World's Ecosystems

Ecosystem Type	US$ $ha^{-1}yr^{-1}$
Estuaries	22,832
Swamps/floodplains	19,580
Coastal sea grass/algae beds	19,004
Tidal marsh/mangrove	9,990
Lakes/rivers	8,498
Coral reefs	6,075
Tropical forests	2,007
Coastal continental shelf	1,610
Temperate/boreal forests	302
Open oceans	252

NOTE: From Constanza et al. (1997).

Batzer and Sharitz 2006

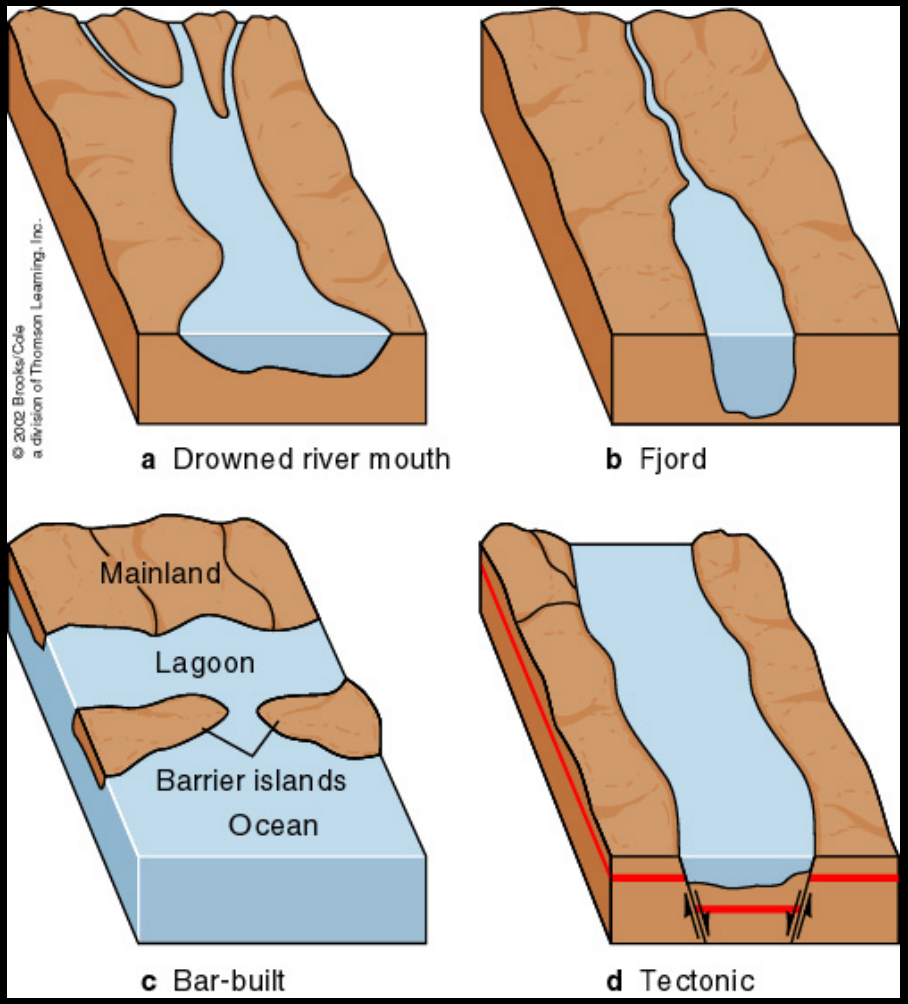
Estuarine Gradients

Horizontal
- Salinity
- Exposure
- Grain size
- Biota

Vertical
- Tidal level
- Depth in sediment

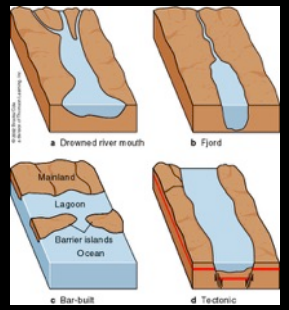
Human Impact

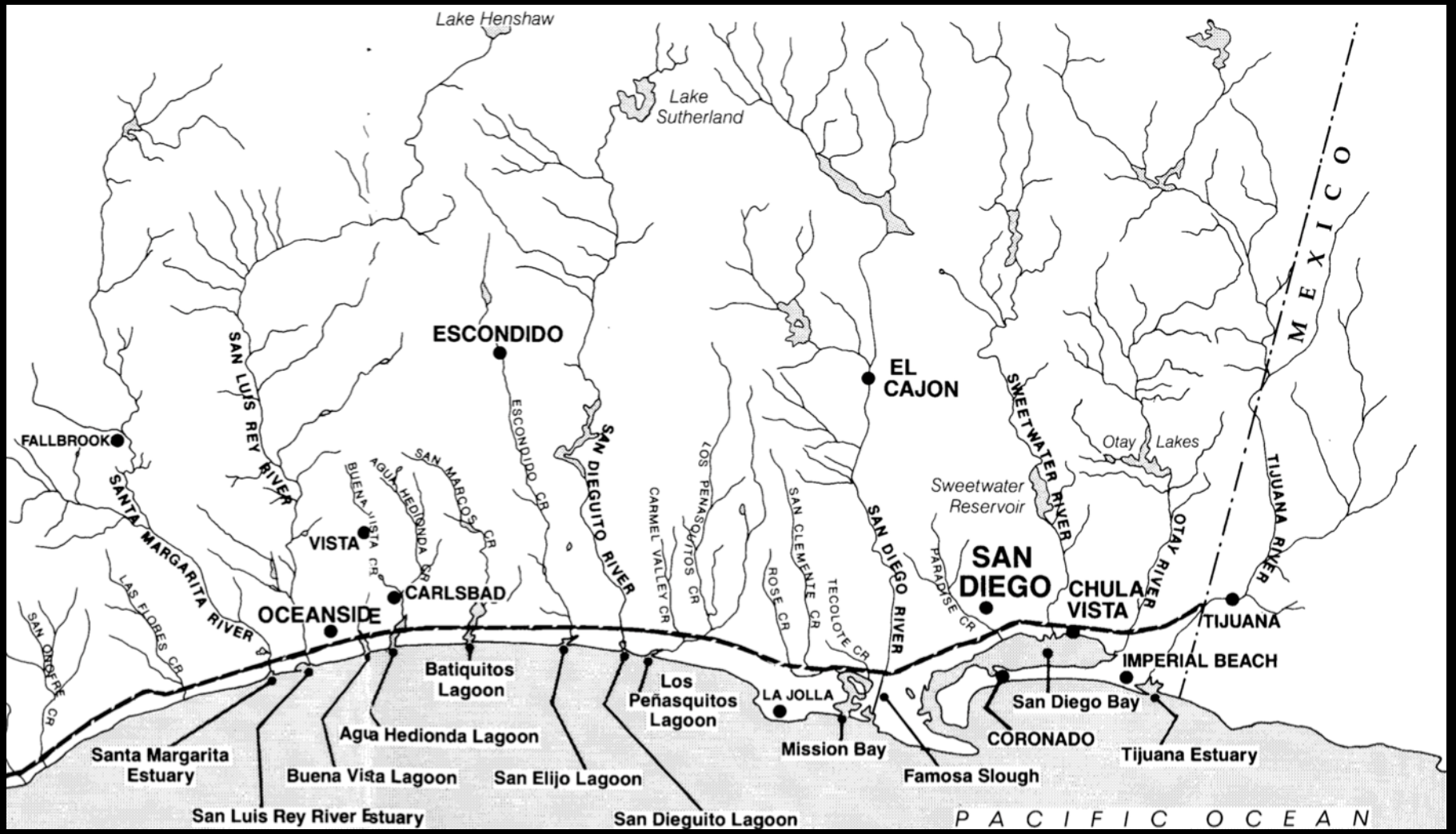
Estuarine Classification



Garrison

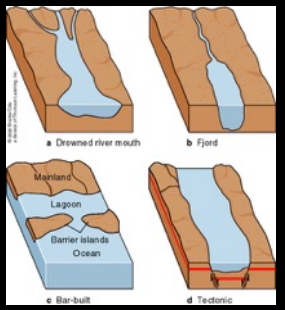
Estuarine Classification

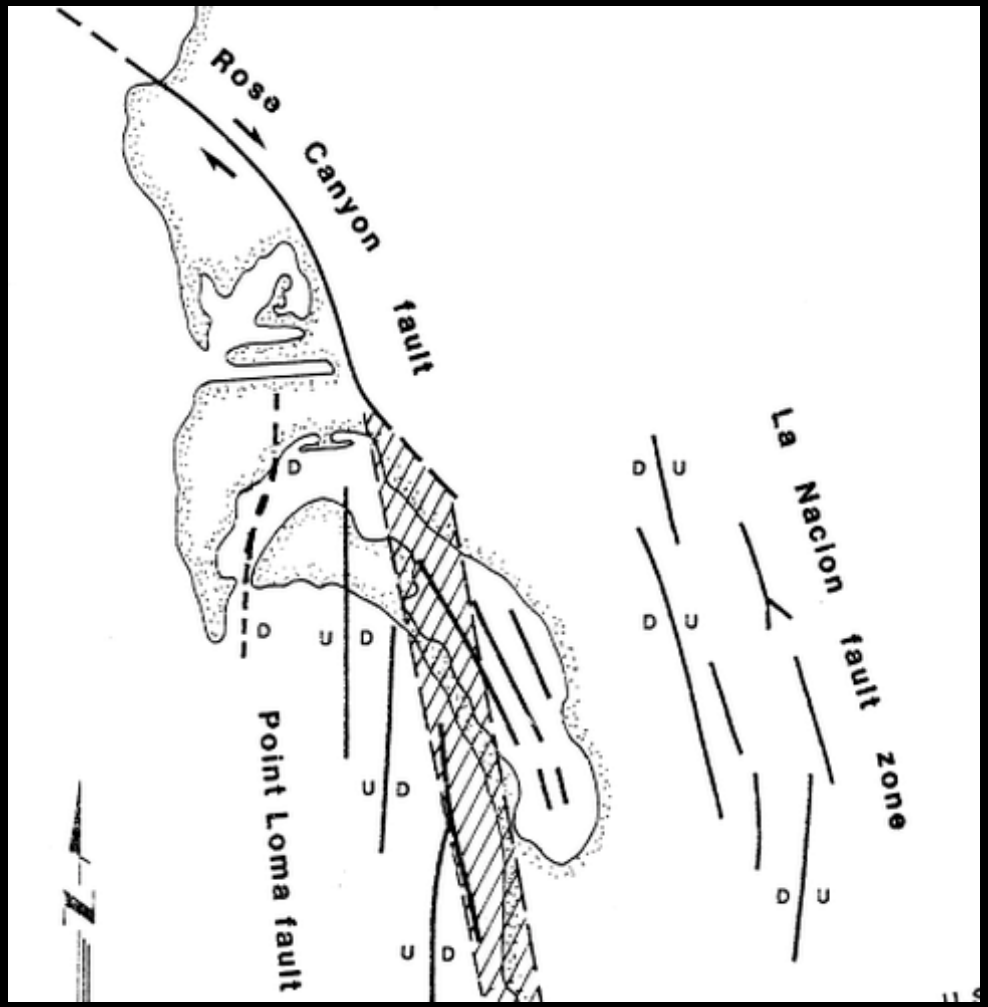




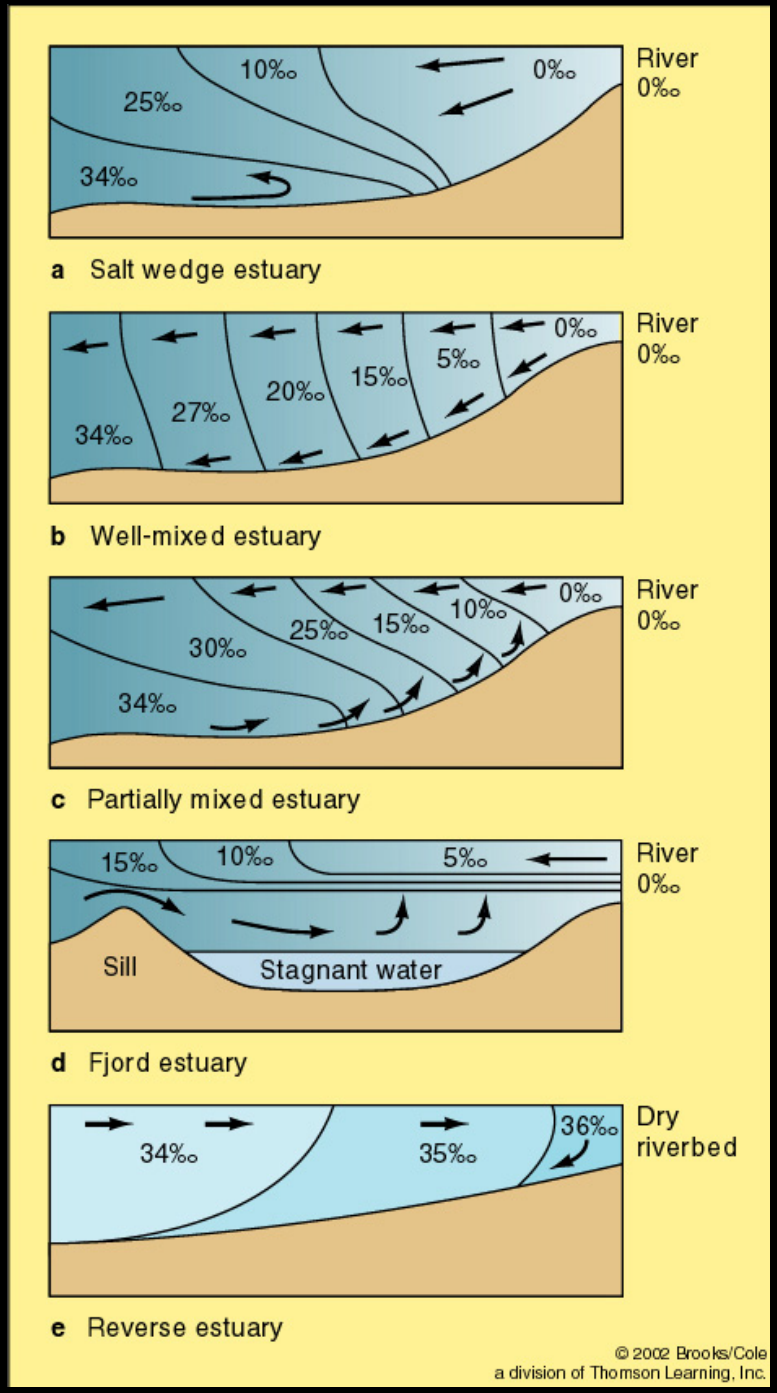
Marcus 1989

Estuarine Classification



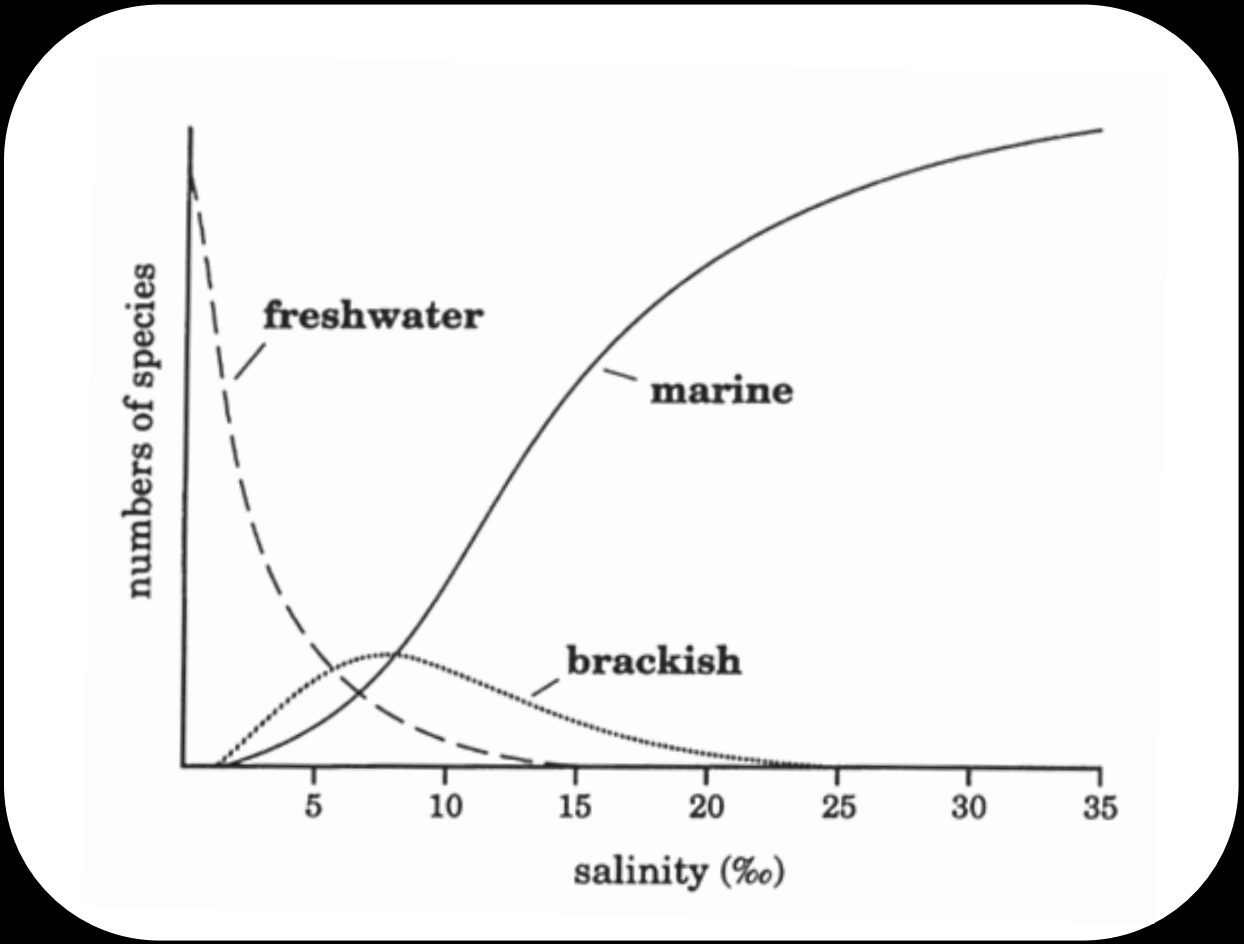


Salinity Gradients



Garrison

Species Diversity Along a Salinity Gradient



Raffaelli and Hawkins 1996

Exposure and Sediment Characteristics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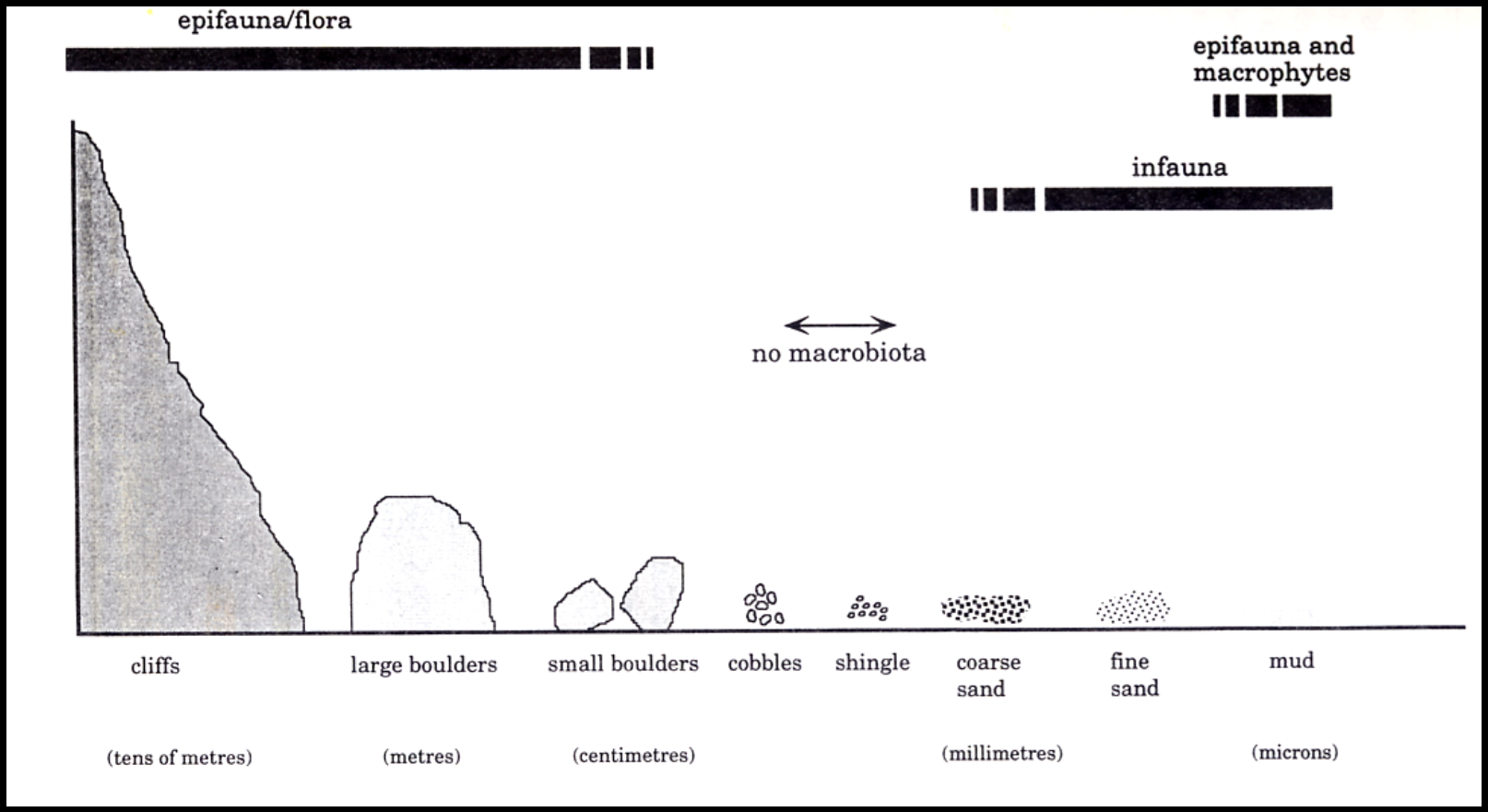
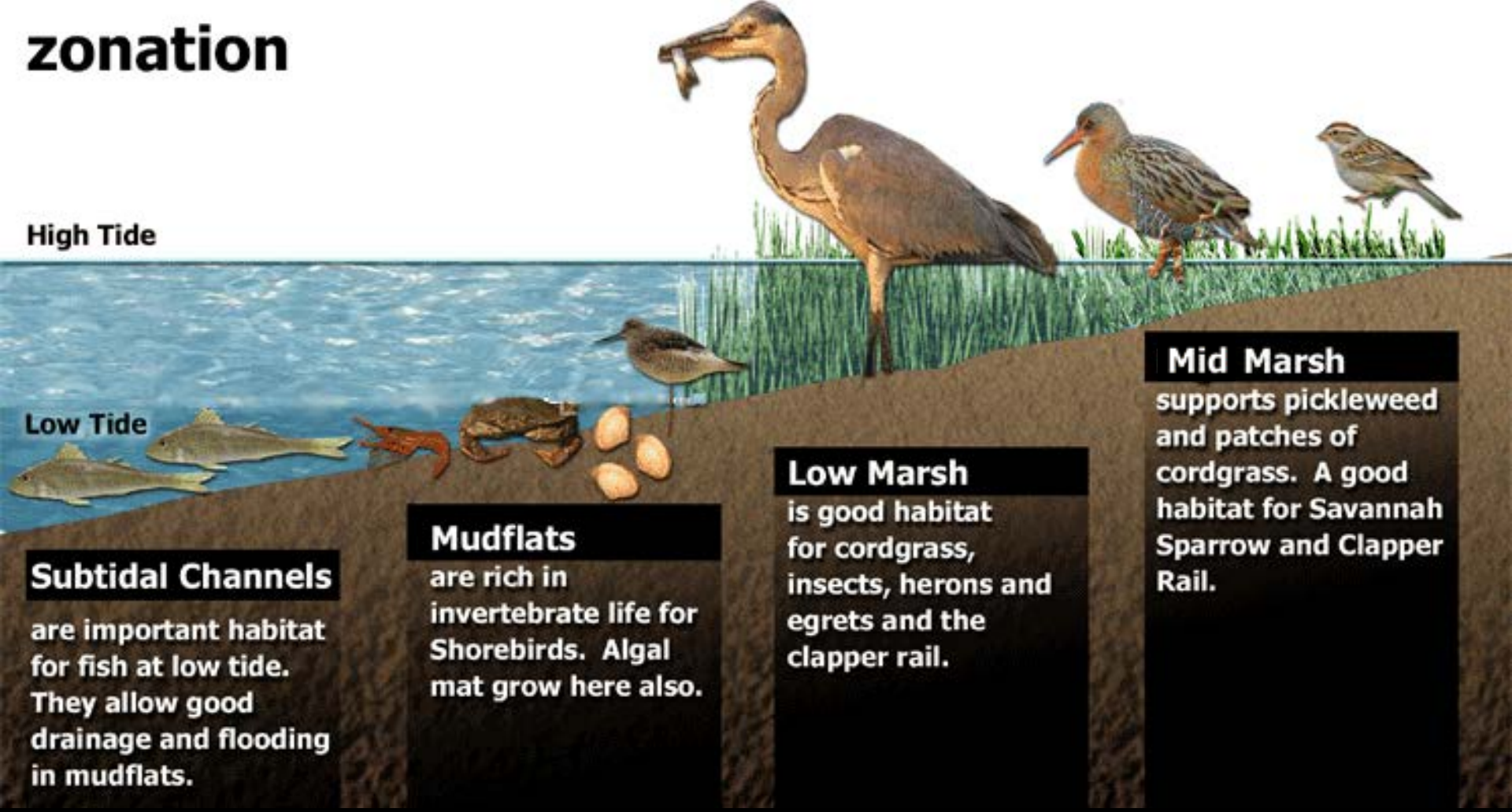
Energy, Grain Size, & Biota

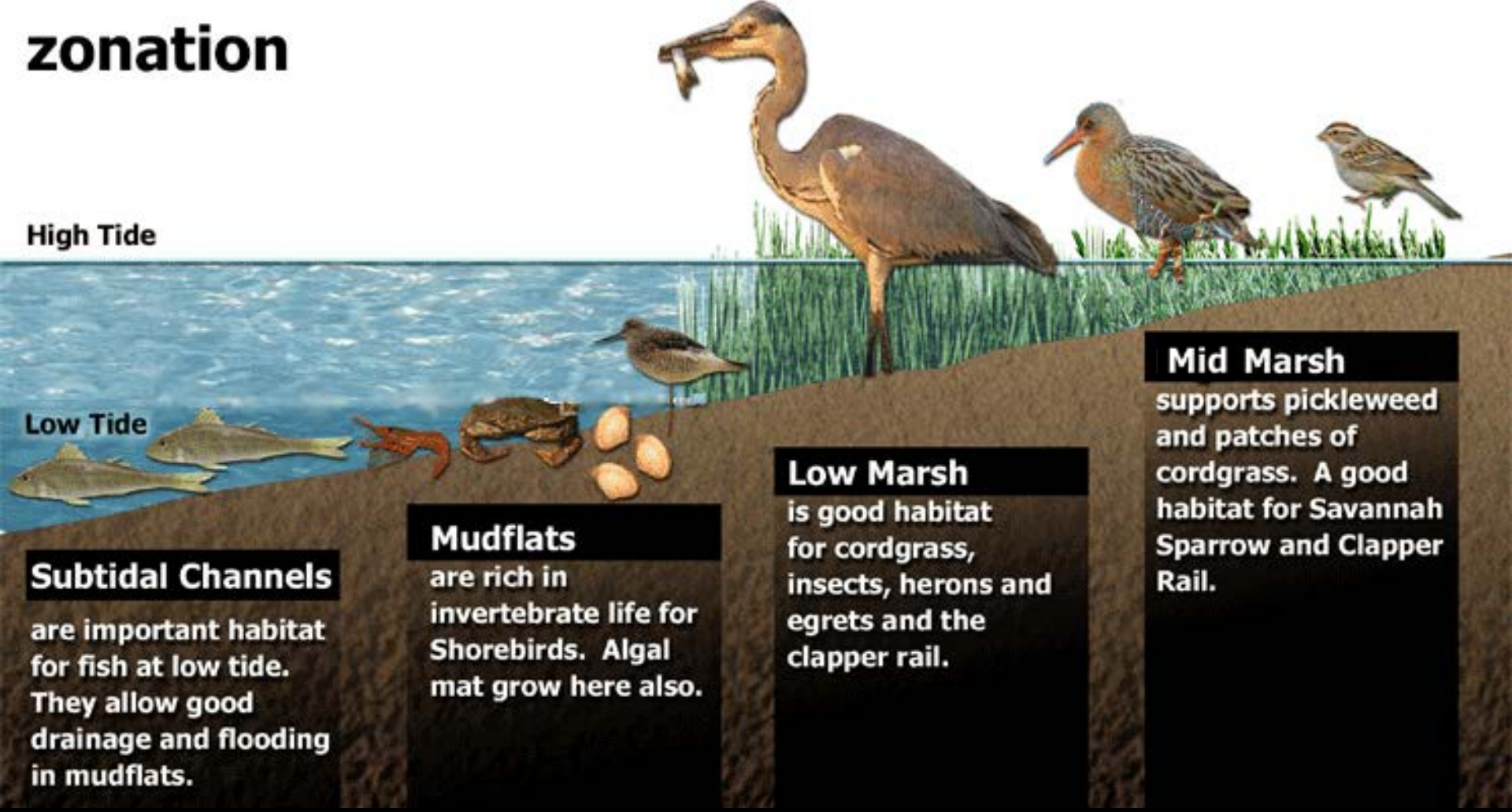


Raffaelli and Hawkins 1996



Zonation patterns in southern California estuaries

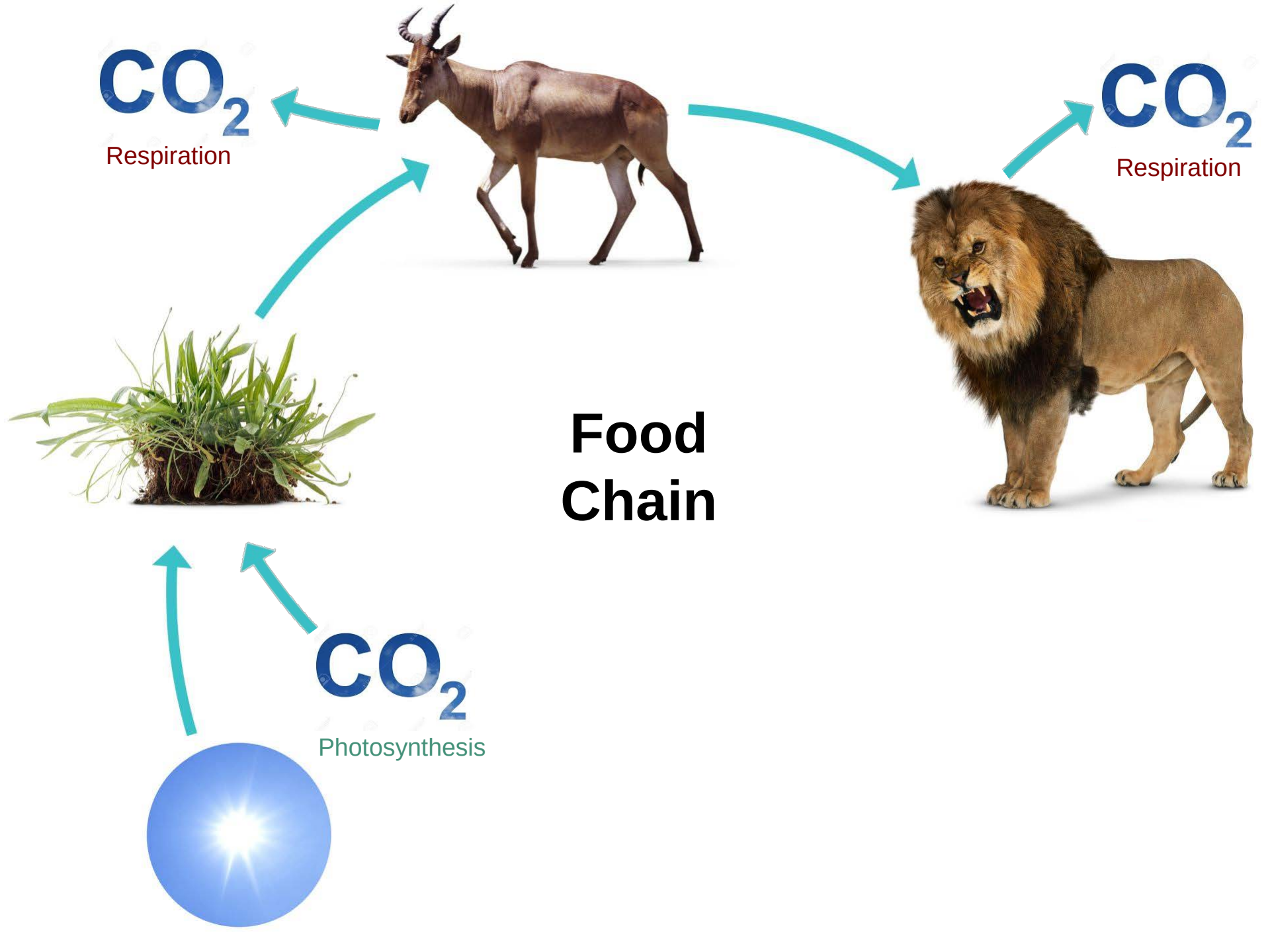
Amigos de Bolsa Chica



Zonation patterns in southern California estuaries

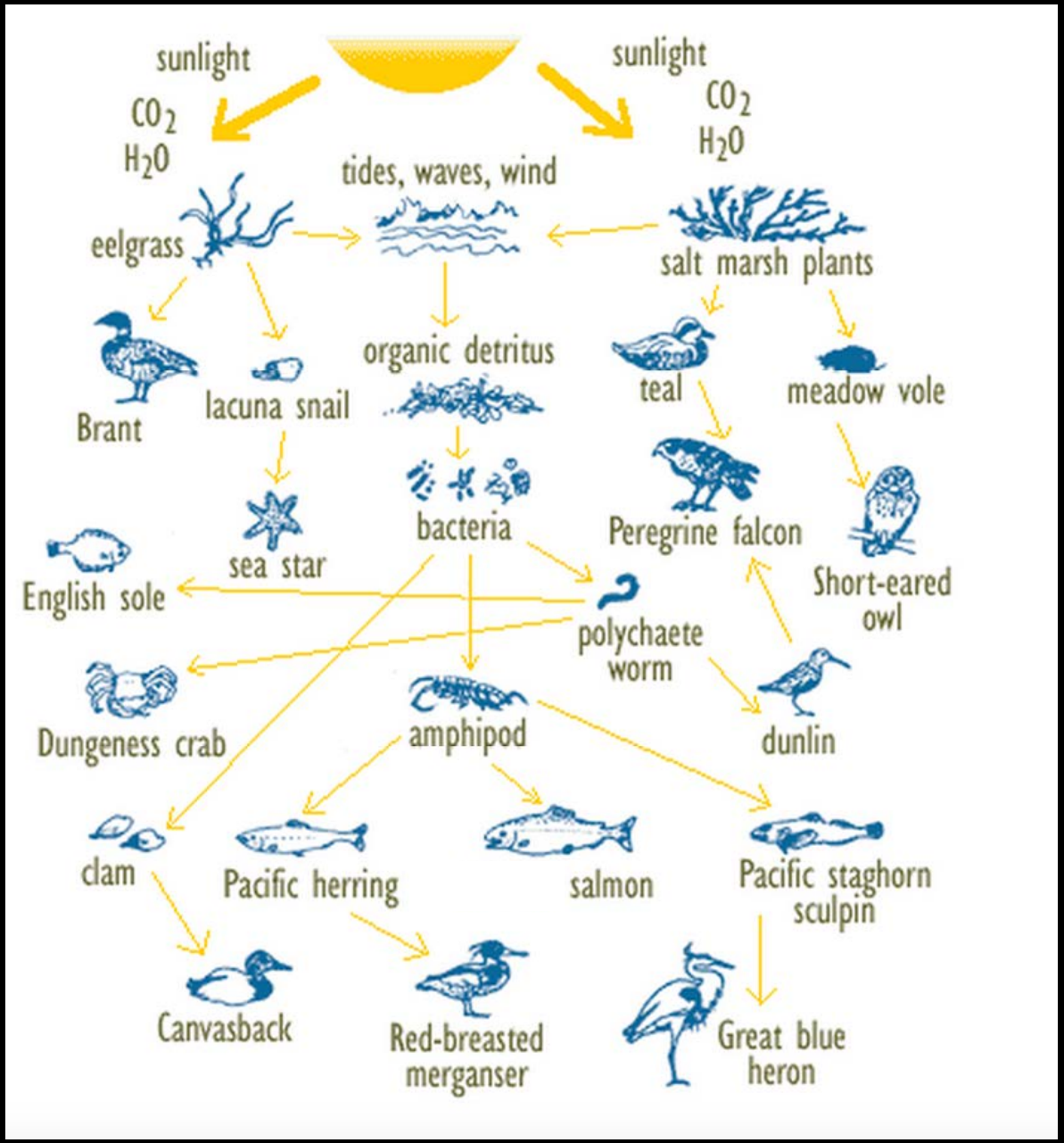
Amigos de Bolsa Chica

Food Chain

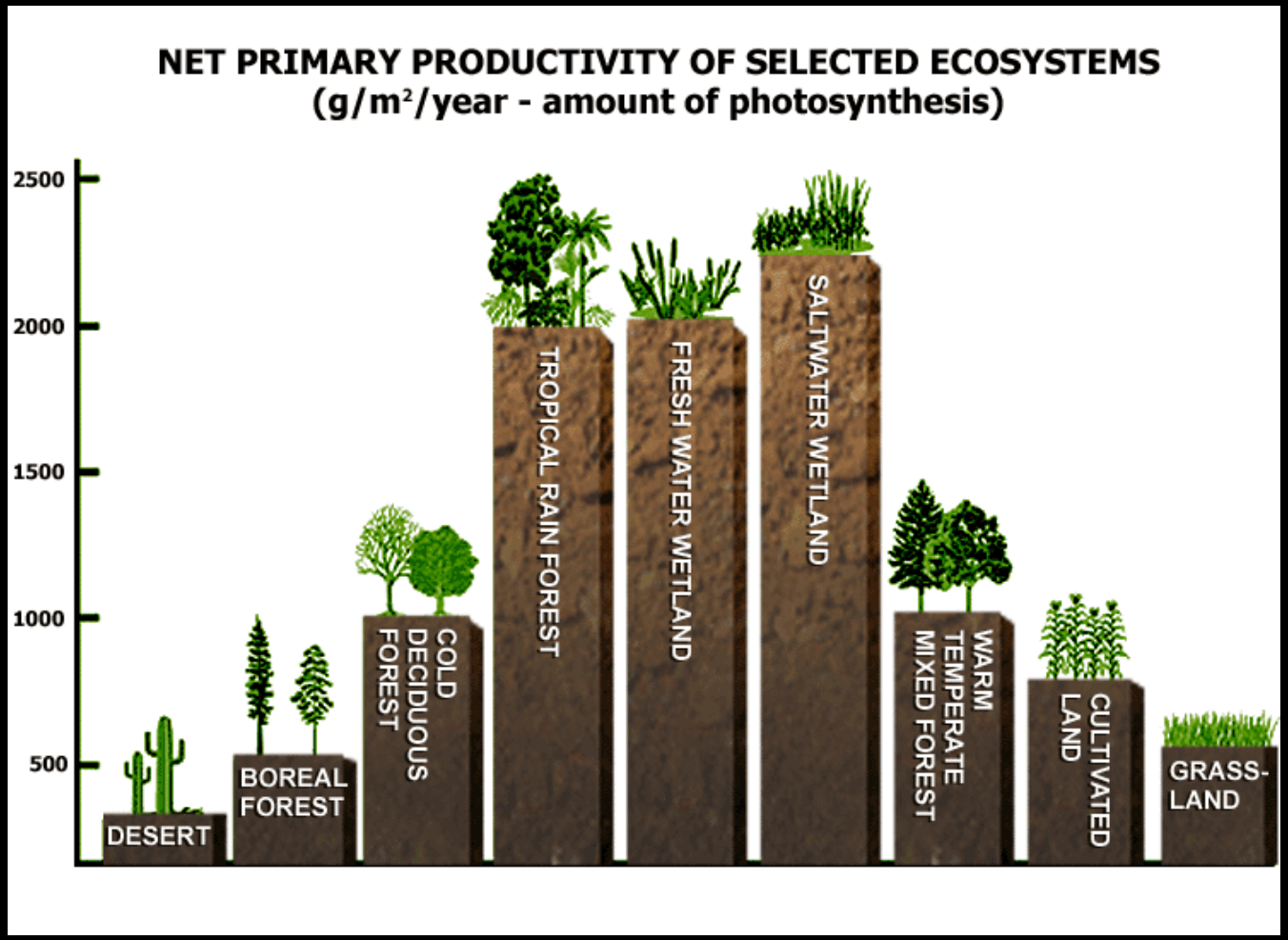


Salt Marsh Food Web

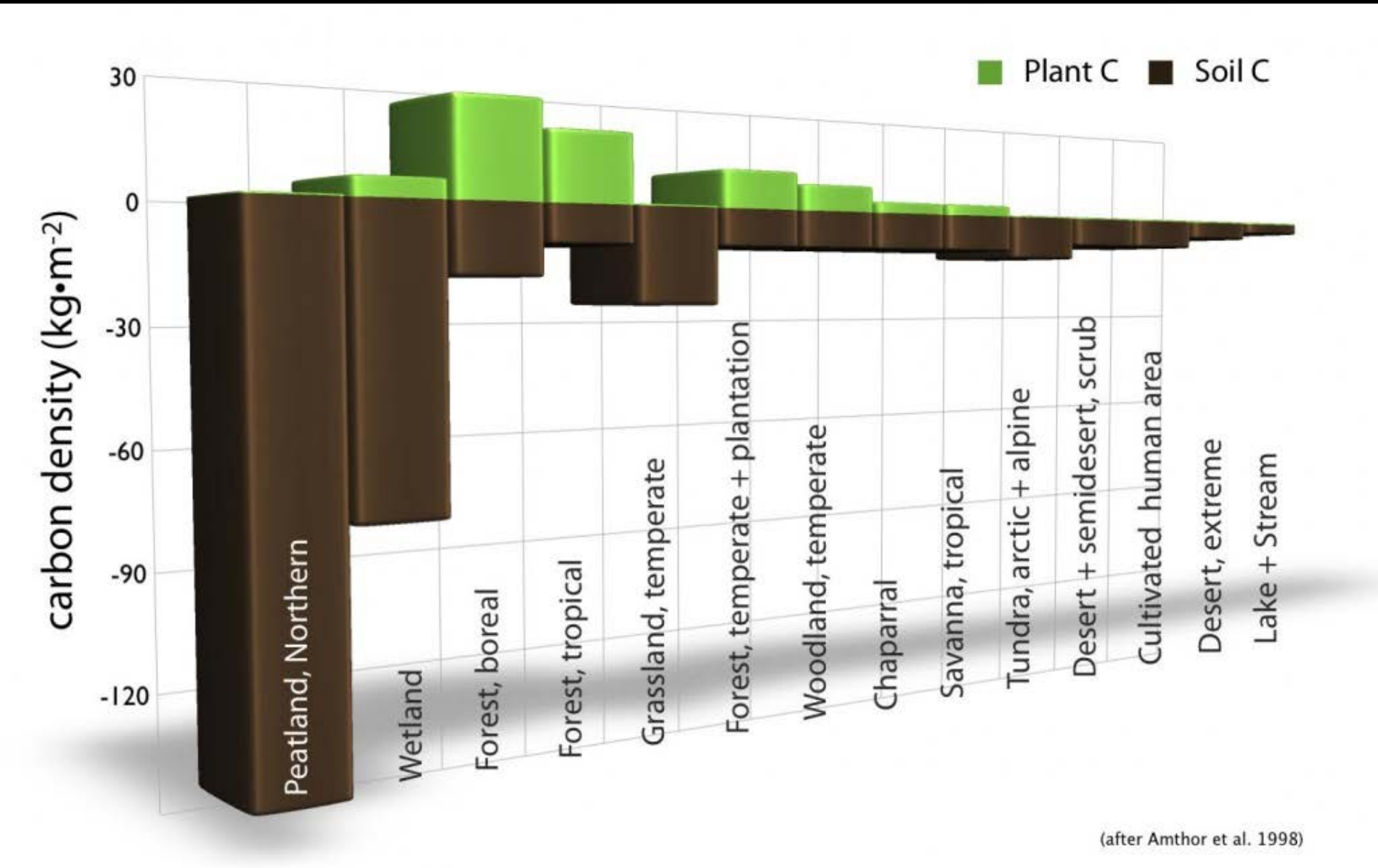
Detritus-based



Productivity of Saltmarshes



Aboveground vs. Belowground Carbon



Carbon Sequestration

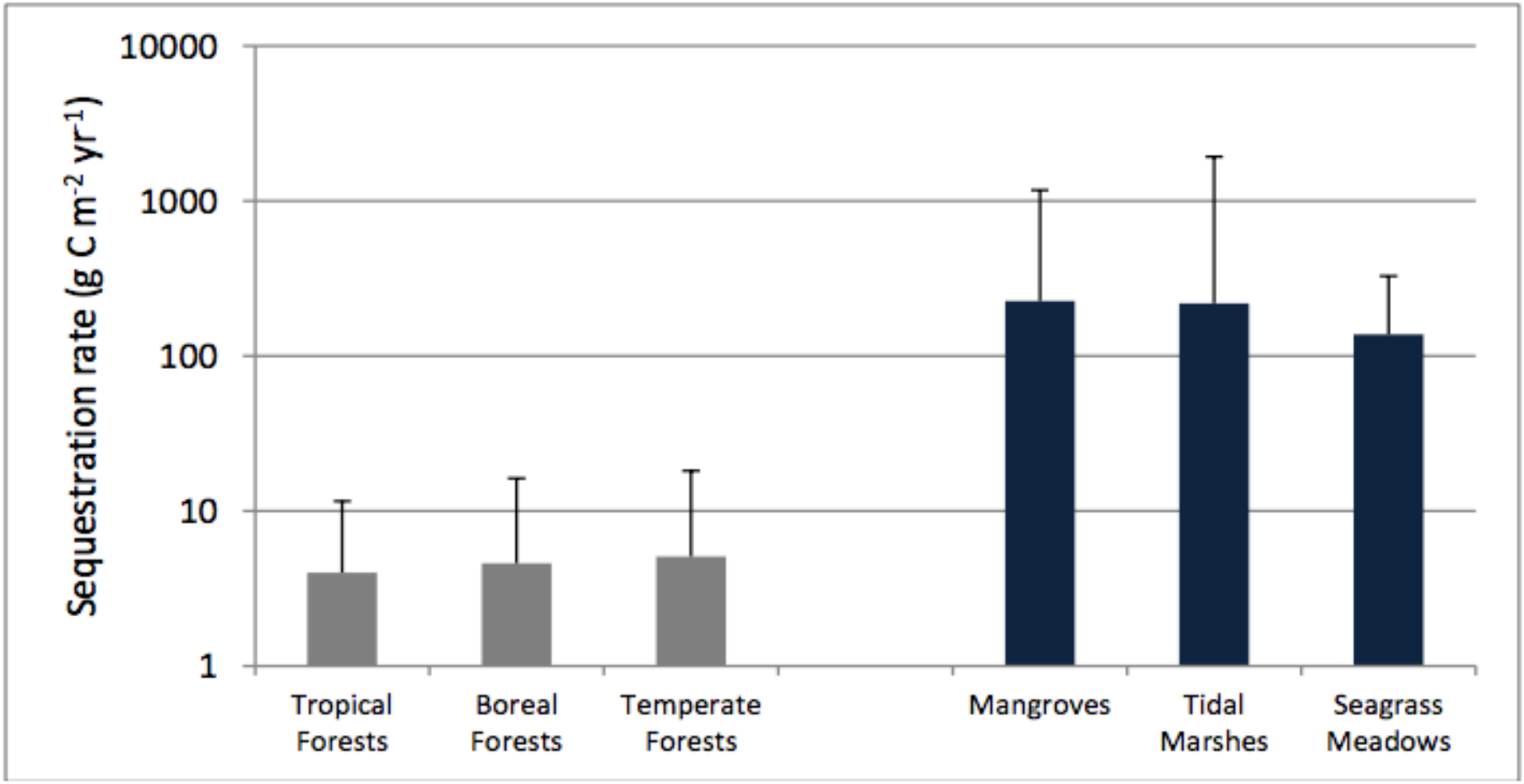


Figure 1. Annual mean carbon sequestration rates for blue carbon habitats per unit area compared to terrestrial forest habitats (error bars indicate maximum rates of accumulation). The annual sequestration rate of a given ecosystem is the quantity of CO_2 removed from the atmosphere and/or ocean and trapped in natural habitats (Modified from McLeod et al. 2011).

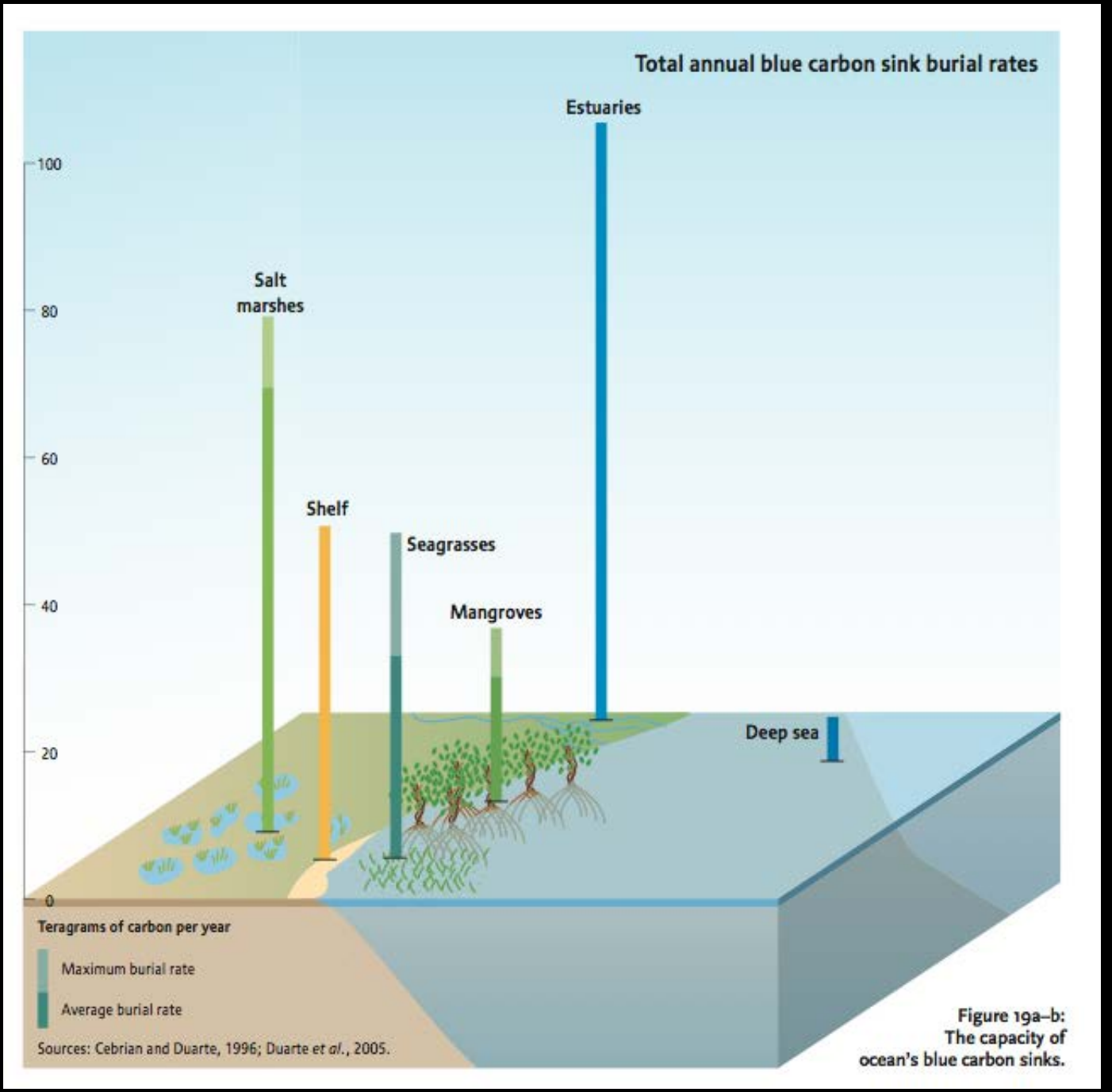
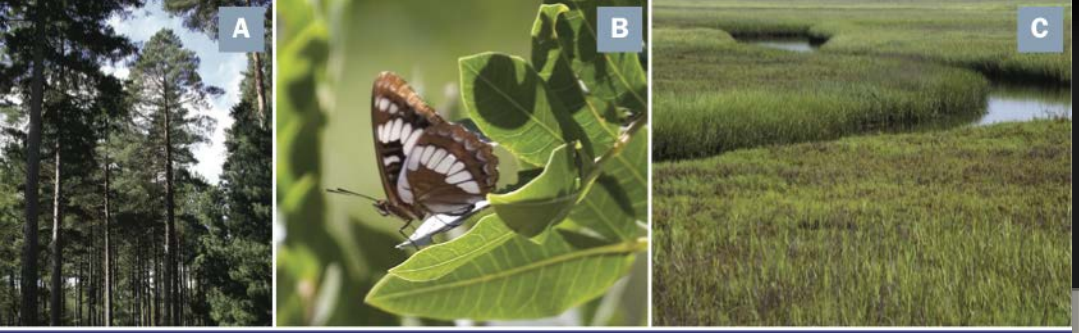


Figure 19a–b: The capacity of ocean's blue carbon sinks.

Tijuana River Watershed

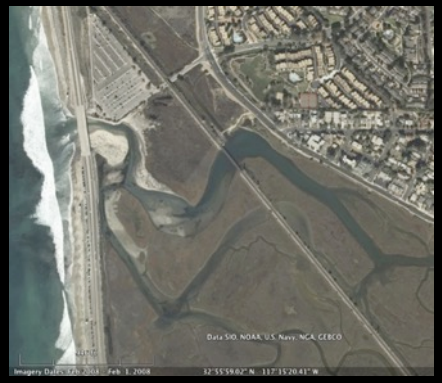


Diverse binational watershed with varied habitats: A) pine forest B) riparian habitat C) salt marsh

Current land uses in the watershed include: A) urban areas B) semi-urban development C) ranches in the Valley

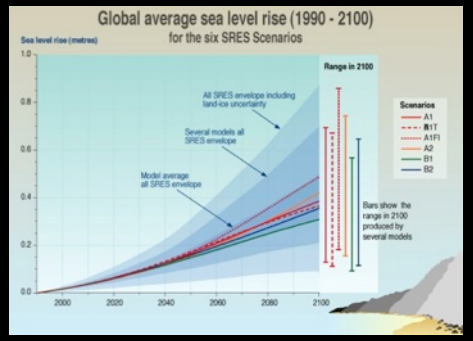
Threats

Habitat Degradation



Overexploitation

Invasive Species



Climate Change

Sediment Loading

Pollutants & Trash

Hydrology

Adaptive Management

Adaptive management is an iterative process of optimal decision-making in the face of uncertainty, with an aim to reducing that uncertainty over time via research and monitoring*

*from Wikipedia

Adaptive Management – Invasive Species

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Archive of Spotlight Feature Articles

Invasion and Impacts of Tamarisk in Tijuana Estuary Salt Marshes, and Ecosystem Recovery After Its Removal

(Left) Tamarisk in bloom. Photo: Jil M. Swearingen, USDI National Park Service

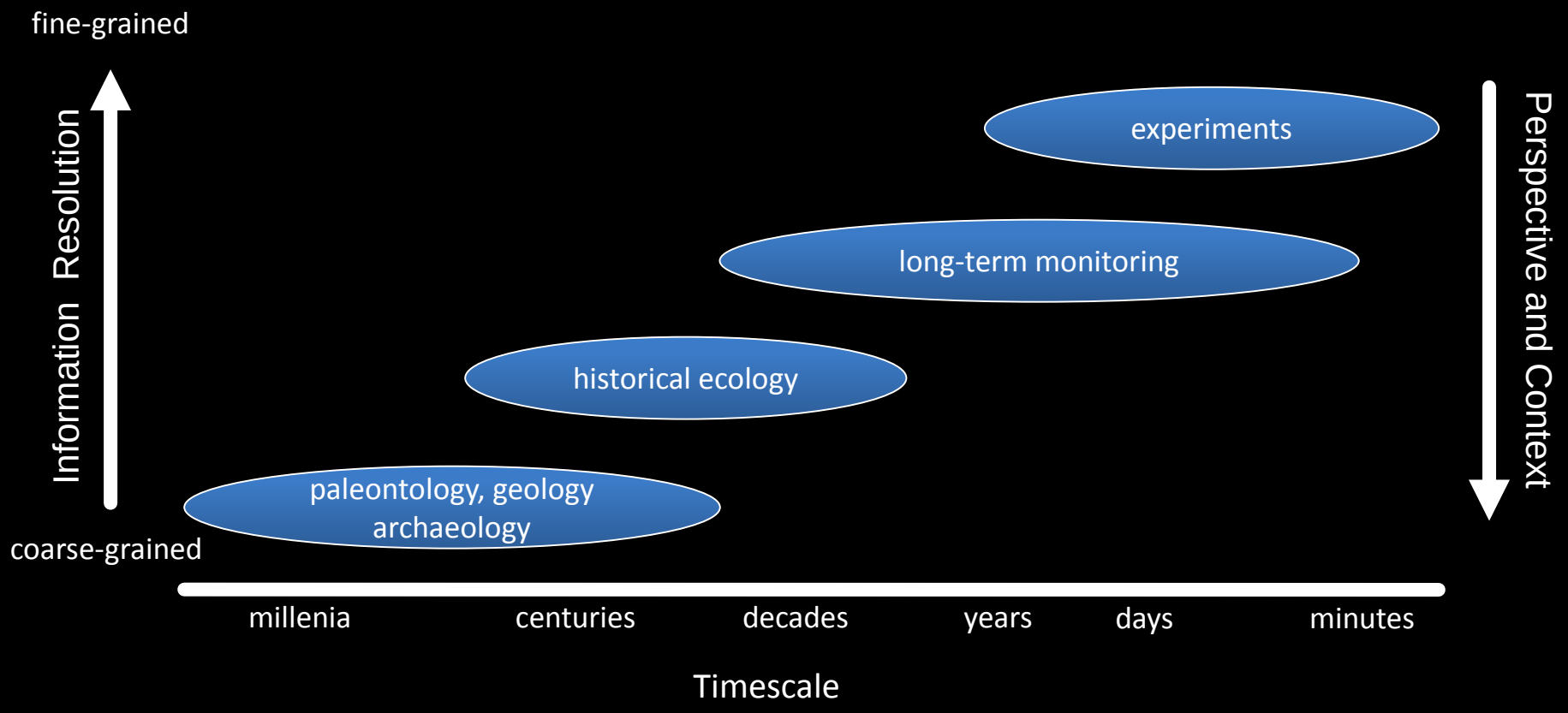
(Right) Reserve Research Coordinator Jeff Crooks points to tamarisk growing along the Tijuana River banks. Photos: Christina Johnson, California Sea Grant

Adaptive Restoration

Goals

- Re-create lost habitat and control invasive species
- Increase tidal prism and ability to export sediments
- Beneficially use excavated material
- Conduct research to steer future actions

Science-Based Ecosystem Management - Sources of Information



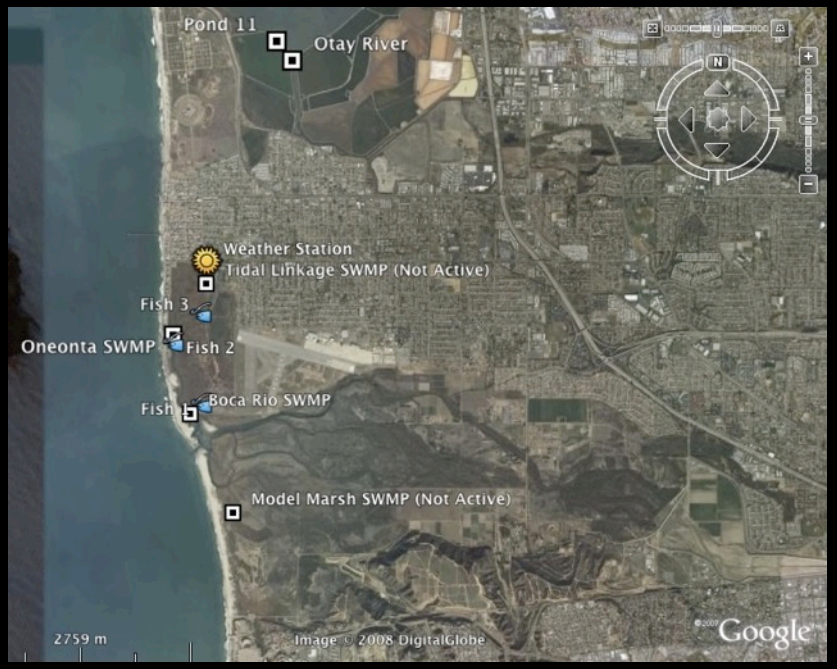
Ecosystem Monitoring:

Assessing “Vital Signs” and Fostering Adaptive Management

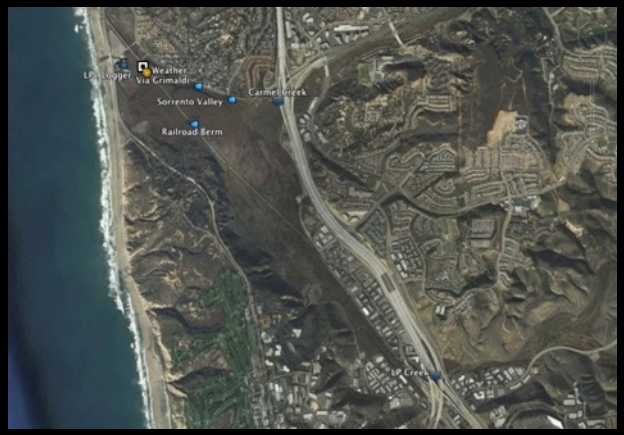
PERL and TRNERR

- Water: Temperature, Salinity, Dissolved Oxygen, Turbidity, pH, Depth
- Nutrients / Chlorophyll a
- Weather: Temperature, Humidity, Wind, Rainfall, Barometric Pressure, Light
- Topography / Bathymetry
- Soil Salinity
- Vegetation
- Invertebrates
- Fish
- Birds

South San Diego Bay



Tijuana River Estuary



Los Peñasquitos Lagoon

SWMP

- Water Quality
  - Data sondes
    - 2 to 4 week deployments
    - Record salinity, temperature, dissolved oxygen, pH, turbidity, chlorophyll
    - Data from the sonde is uploaded and goes to the Central Data Management Office for QA/QC
    - Once data has been approved for the public it is available to download at http://cdmo.baruch.sc.edu/

Boca Rio

Oneonta Slough

South Bay

Pond Eleven

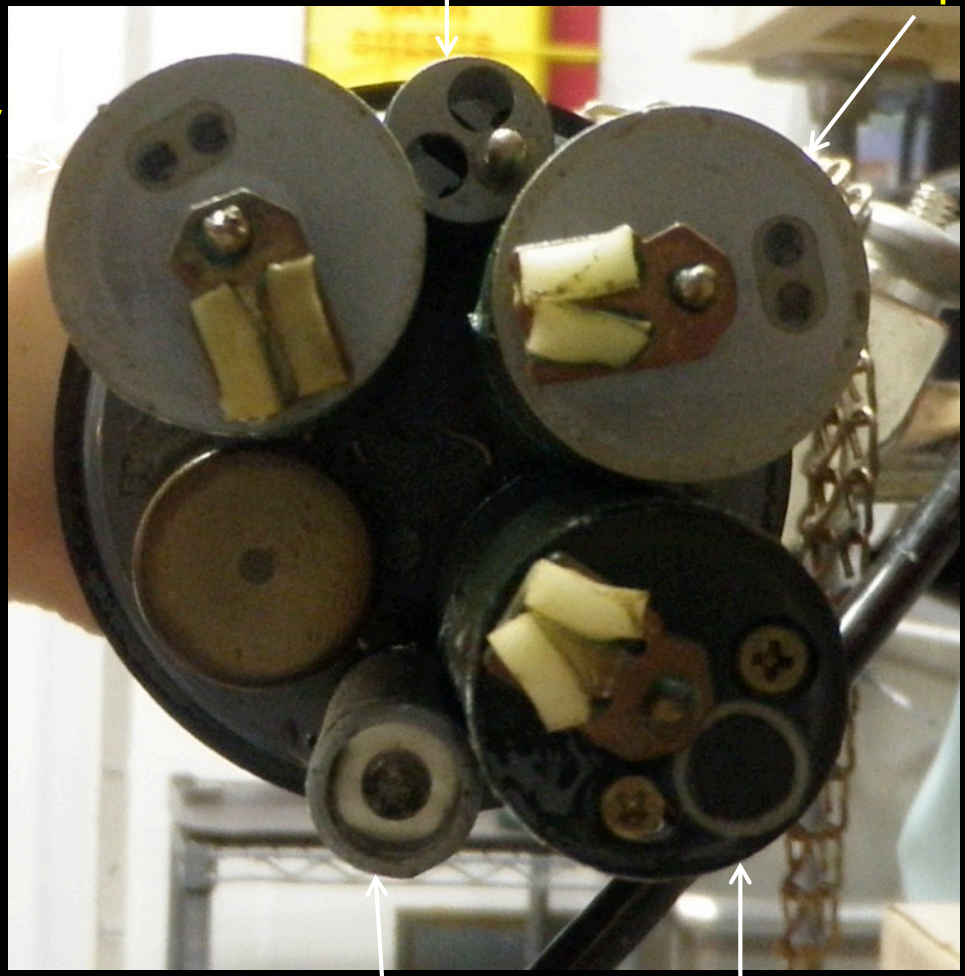
DataSonde Sensors

Depth

Turbidity

Conductivity/Temperature

Chlorophyll

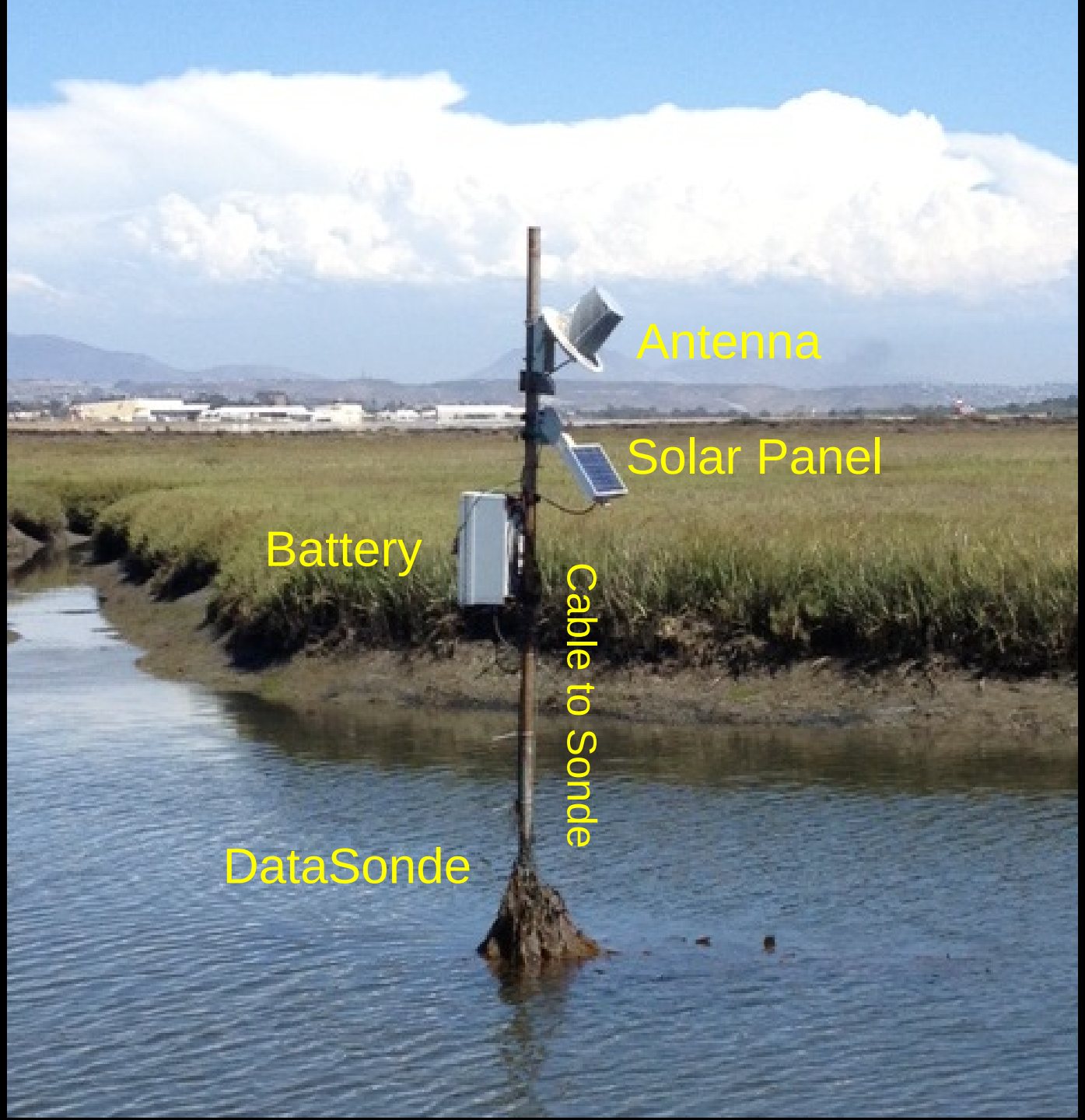


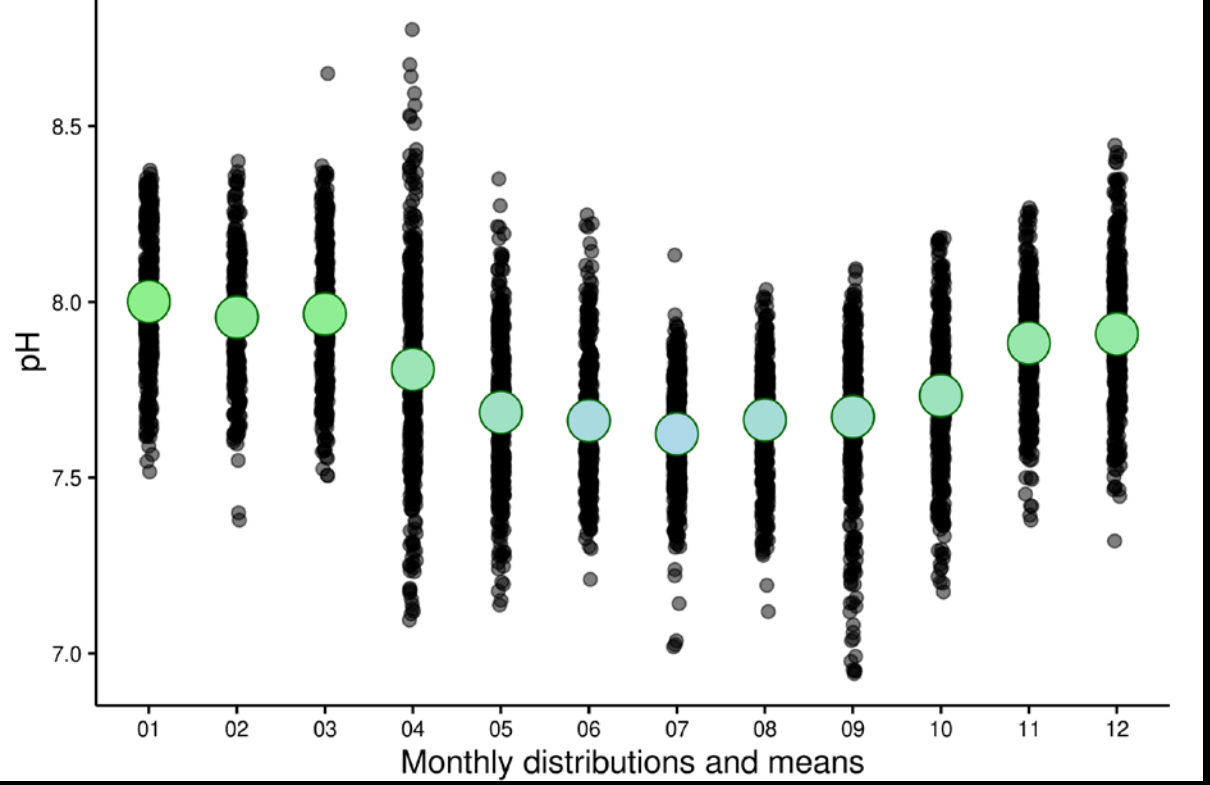
pH

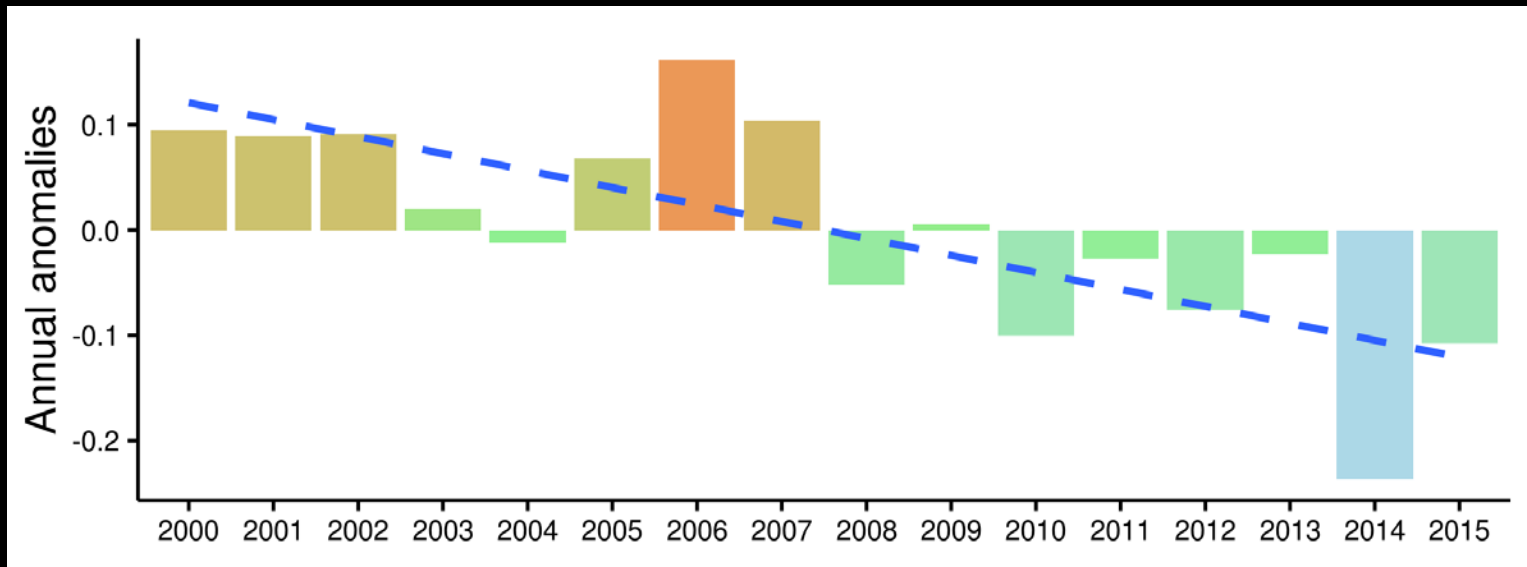
Dissolved Oxygen

- Two sondes designated per site
  - Continuous data recording
  - Equipment failure – can take a day to a month for repairs


6600EDS V2
Multiparameter Water Quality Sonde

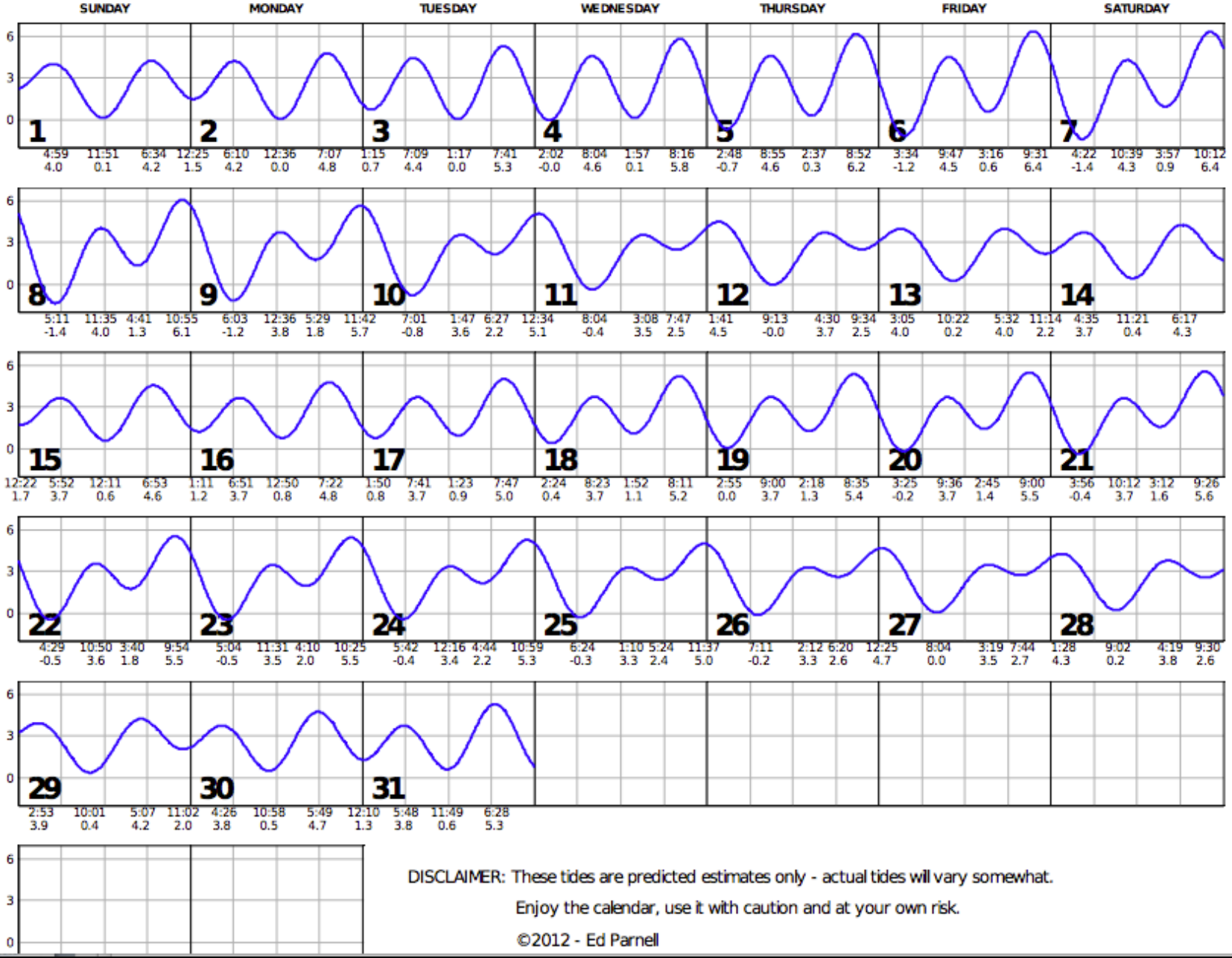

Antenna
Solar Panel
Battery
Cable to Sonde
DataSonde


pH
8.5
8.0
7.5
7.0
01
02
03
04
05
06
07
08
09
10
11
12
Monthly distributions and means


Annual anomalies
0.1
0.0
-0.1
-0.2
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

May 2016

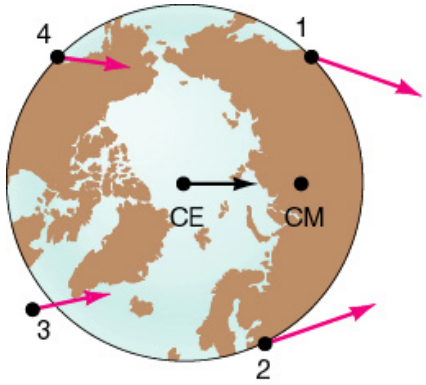
Tide Predictions for Scripps Institution of Oceanography Pier



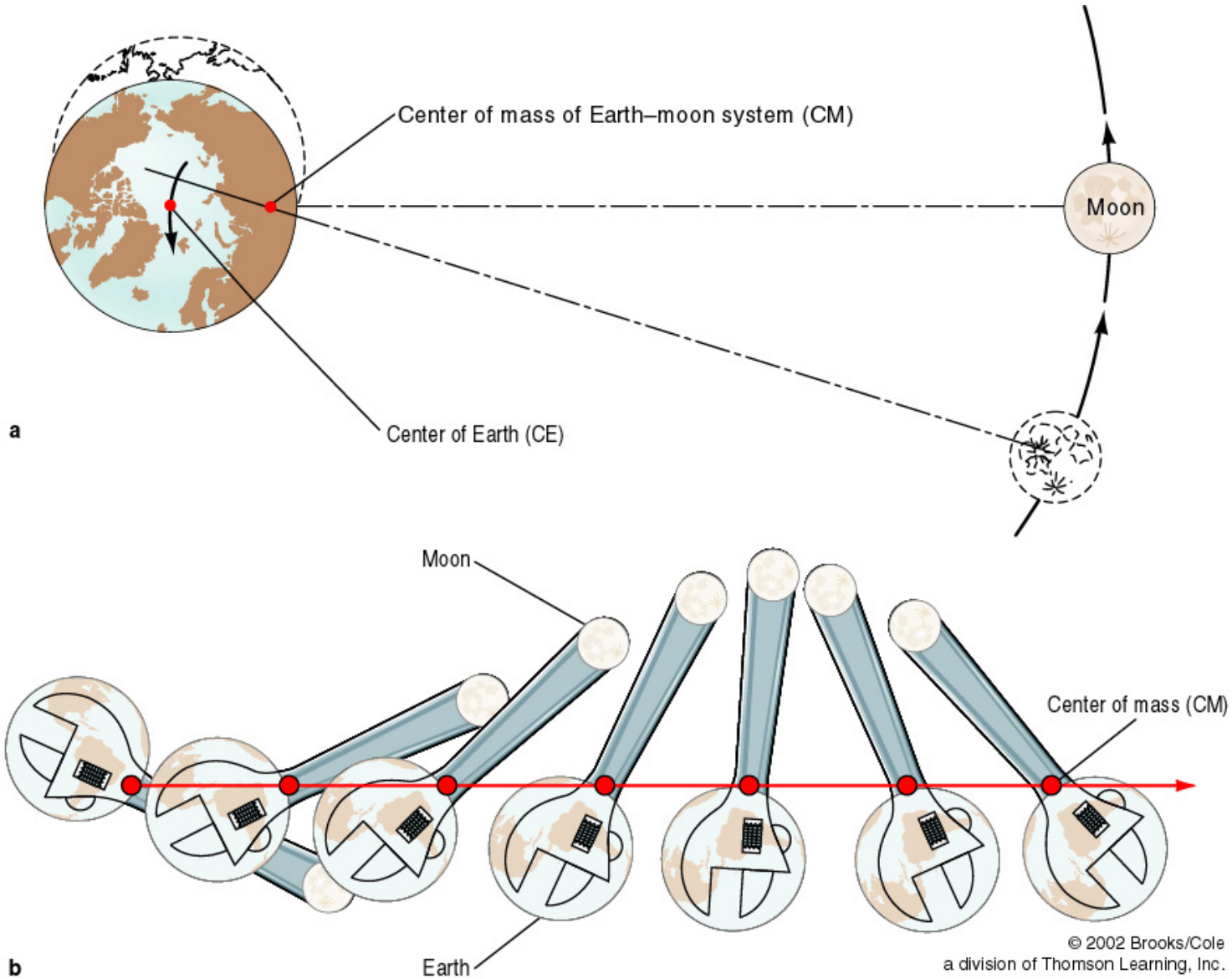
DISCLAIMER: These tides are predicted estimates only - actual tides will vary somewhat.

Enjoy the calendar, use it with caution and at your own risk.

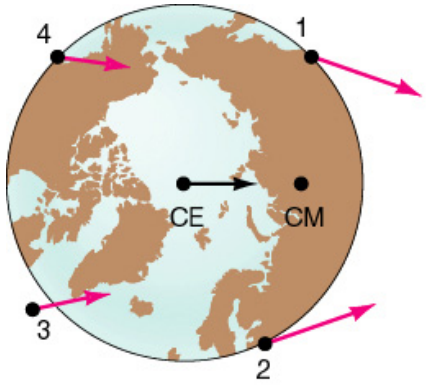
Gravity



CE = Center of Earth
CM = Center of mass



Gravity



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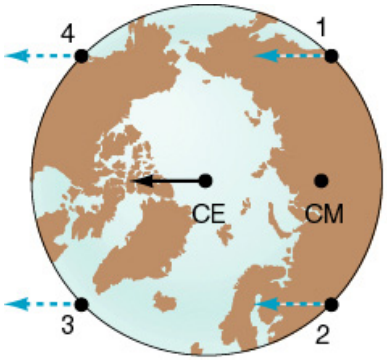
CM = Center of mass

Inertia



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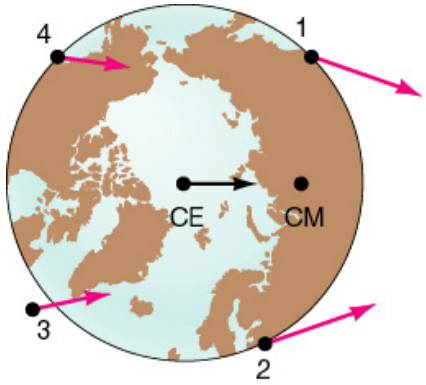

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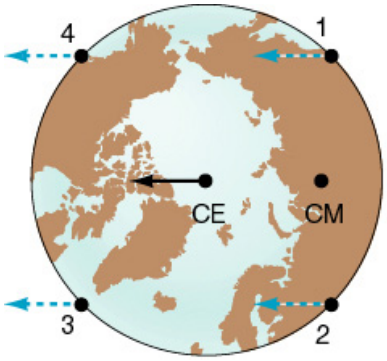

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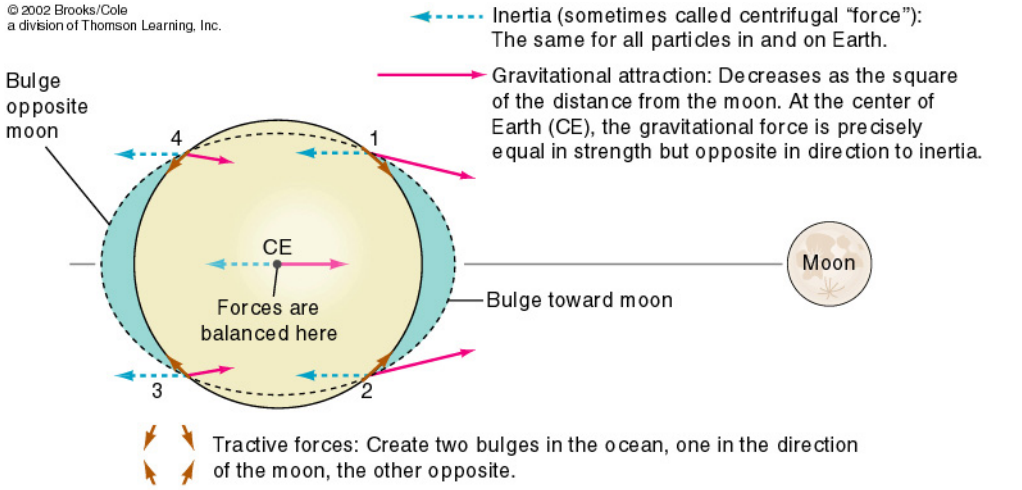
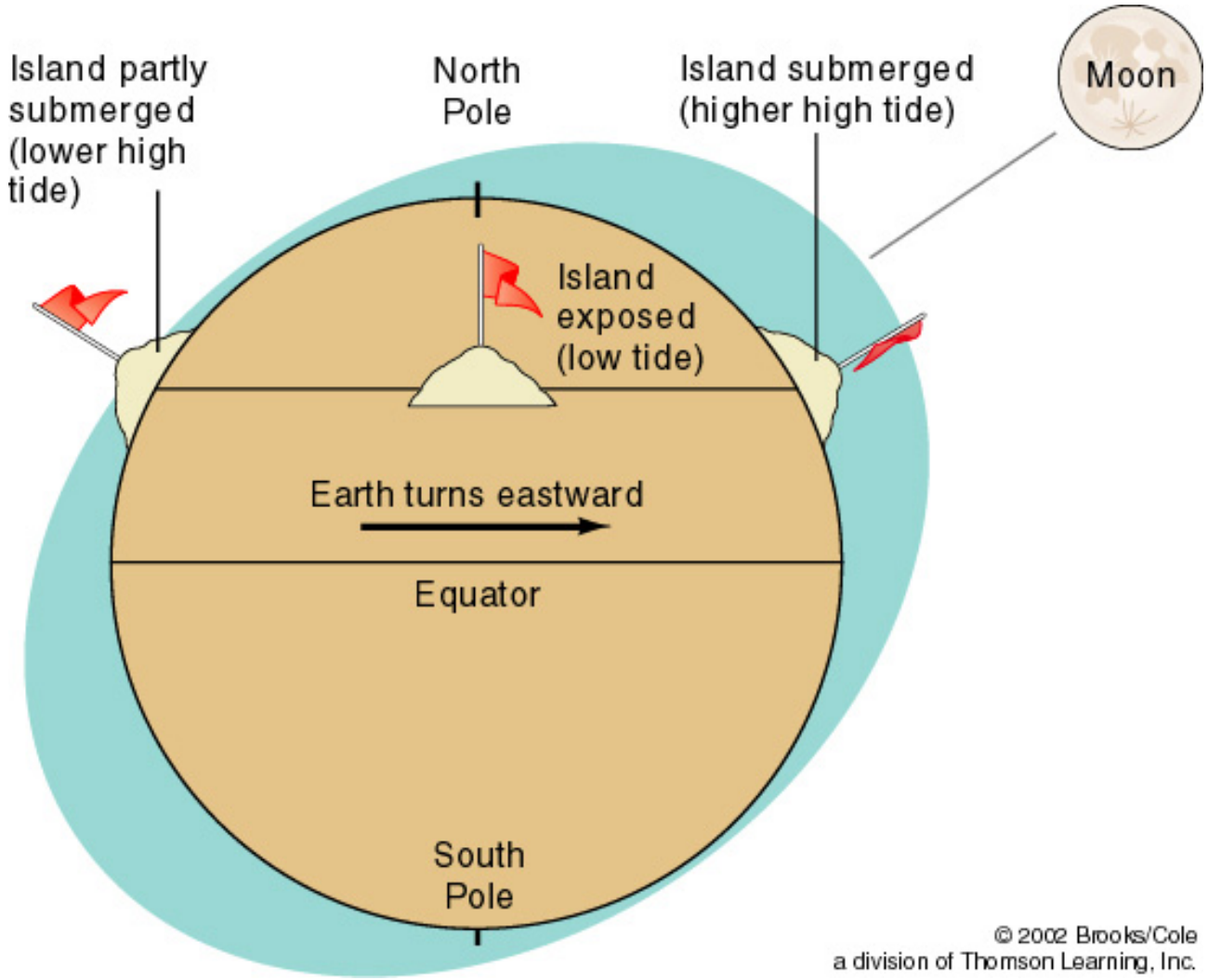
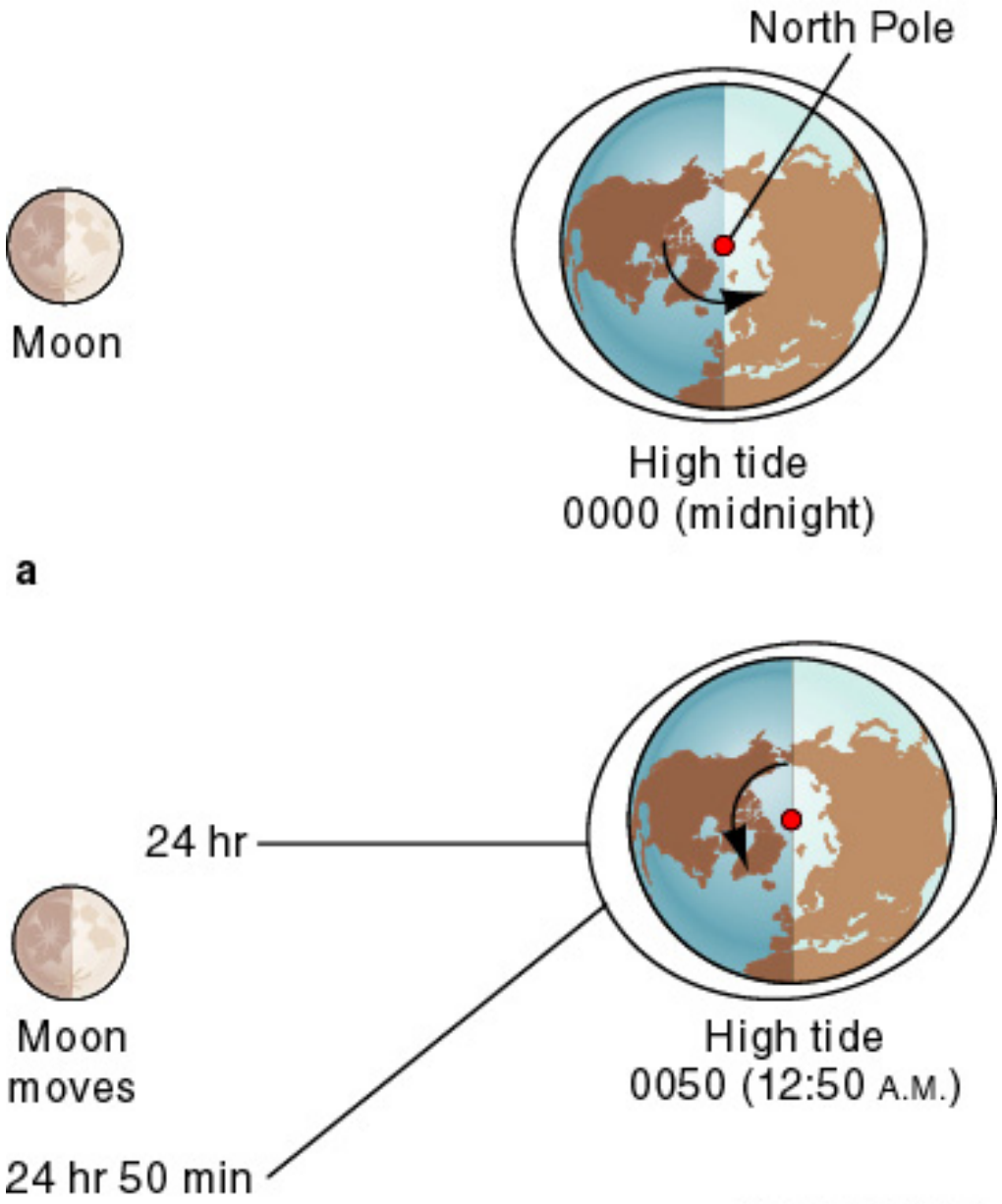
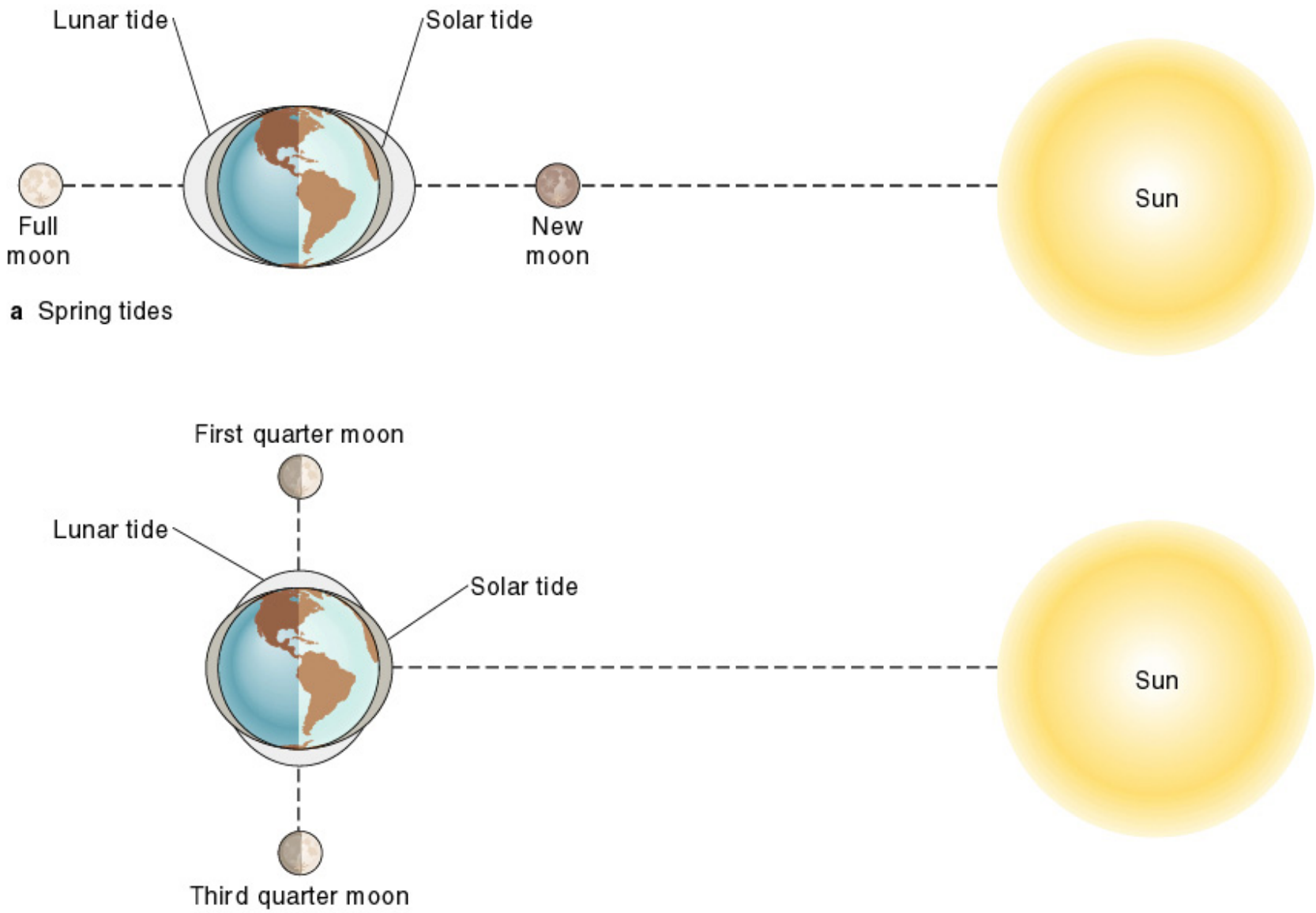
Difference Between the Two



The two forces that can move the ocean are balanced only at the center of Earth (point CE). Elsewhere the net imbalance is a small force that causes ocean water to converge into two equal "bulges," as shown.





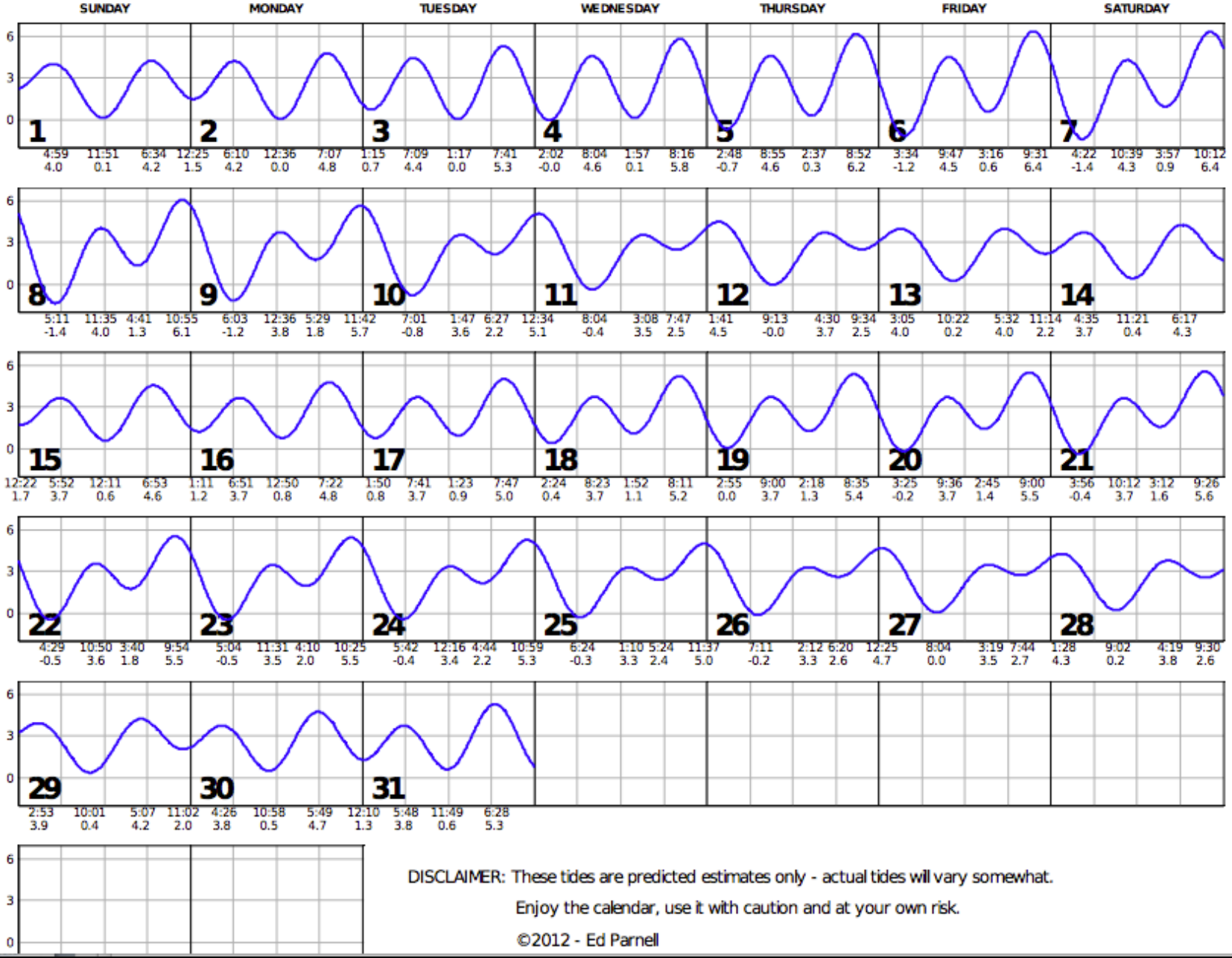


a Spring tides

b Neap tides

May 2016

Tide Predictions for Scripps Institution of Oceanography Pier



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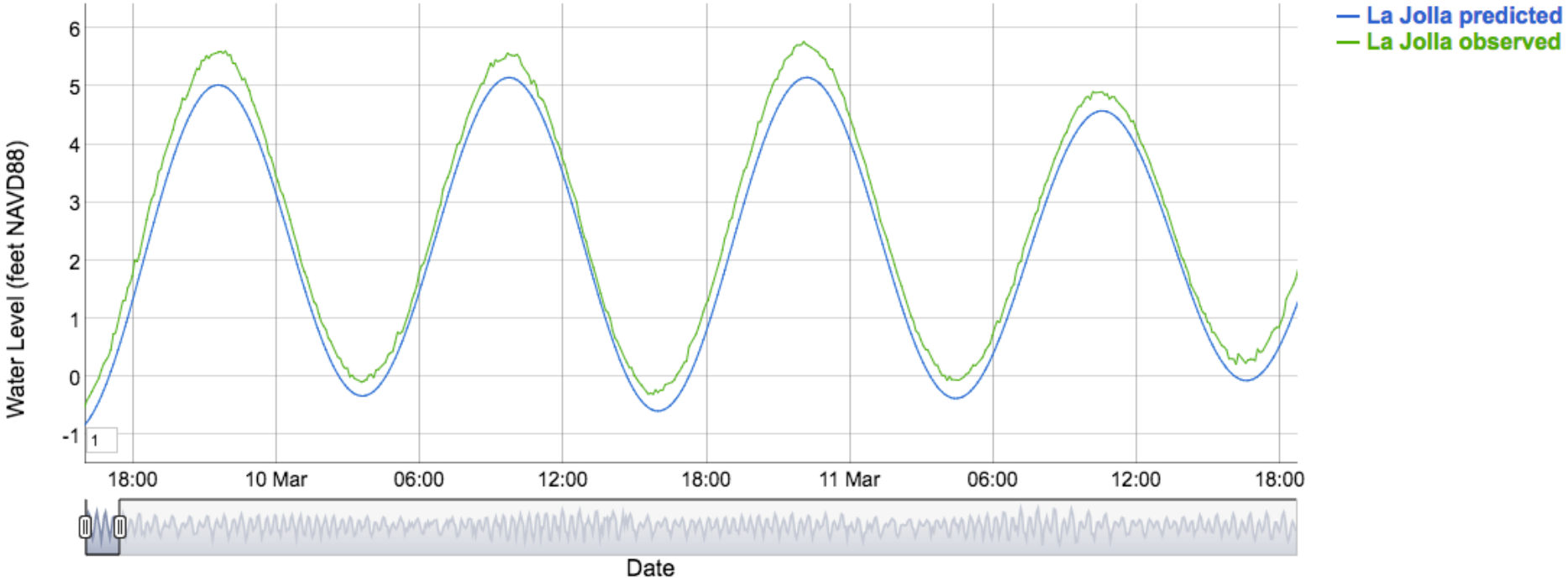
Graphs: OS All Parameters OS Water Levels w/ La Jolla

TRNERR Oneonta Slough station water levels with NOAA La Jolla

All data is preliminary and has not undergone any QAQC procedures



Show Series:

- [x] NOAA at La Jolla (predicted)
- [x] NOAA at La Jolla (observed)
- [ ] TRNERR Oneonta Slough

Chart Options:

- [x] Connect points

(caution also connects missing data)

NOTES:

- All times are Pacific Standard Time
- La Jolla is sampled at 6 min intervals
- TRNERR station at 15 min intervals

Graphs: OS All Parameters OS Water Levels w/ La Jolla

TRNERR Oneonta Slough station water levels with NOAA La Jolla

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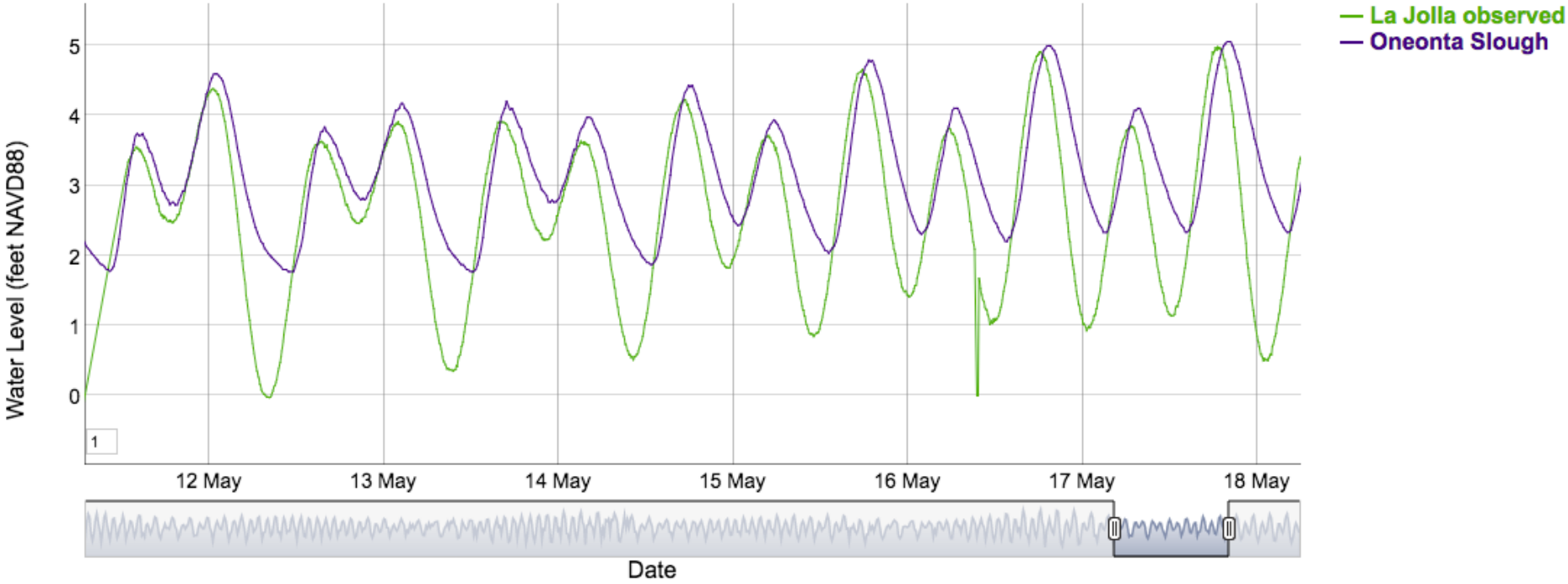

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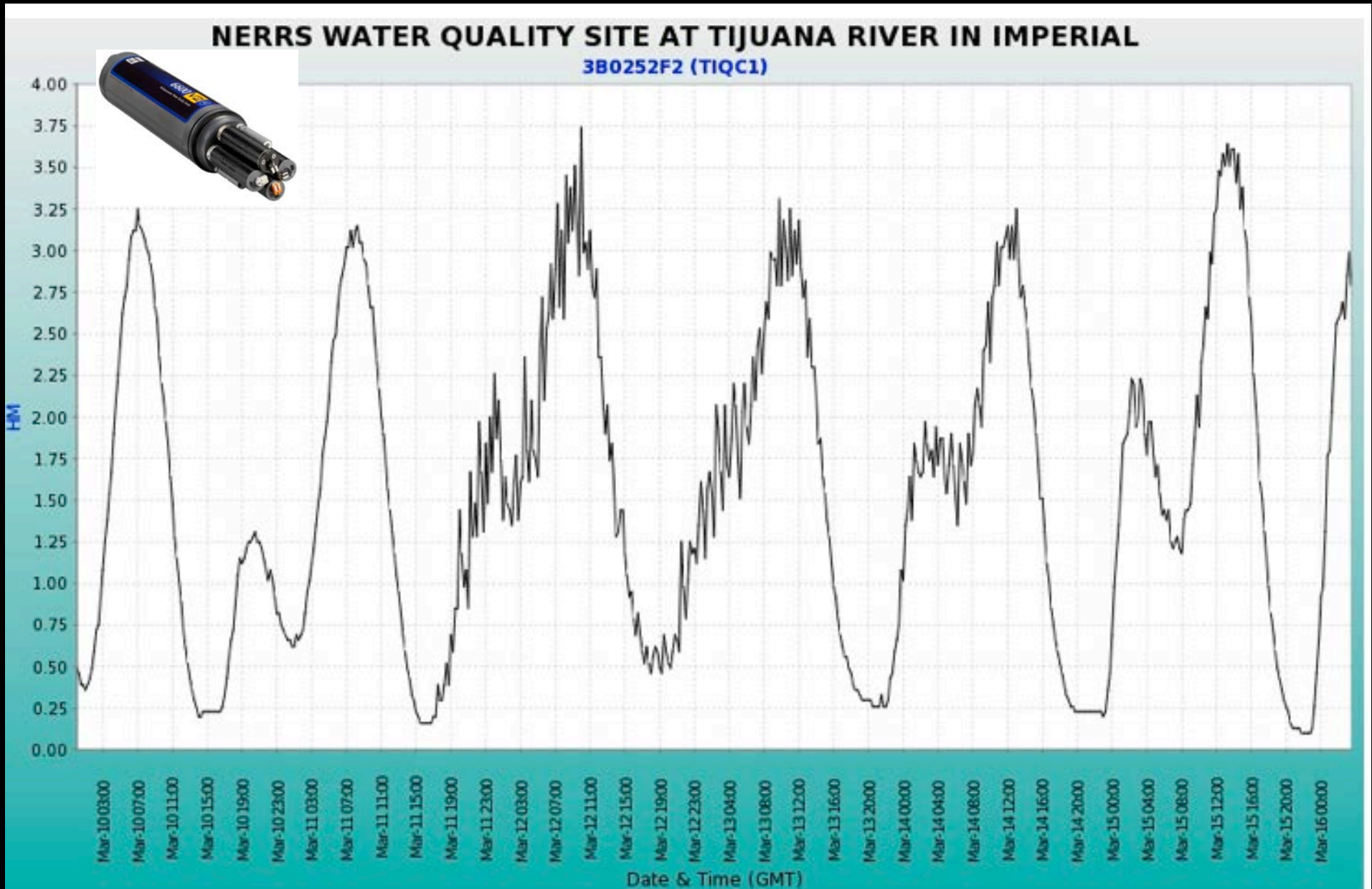
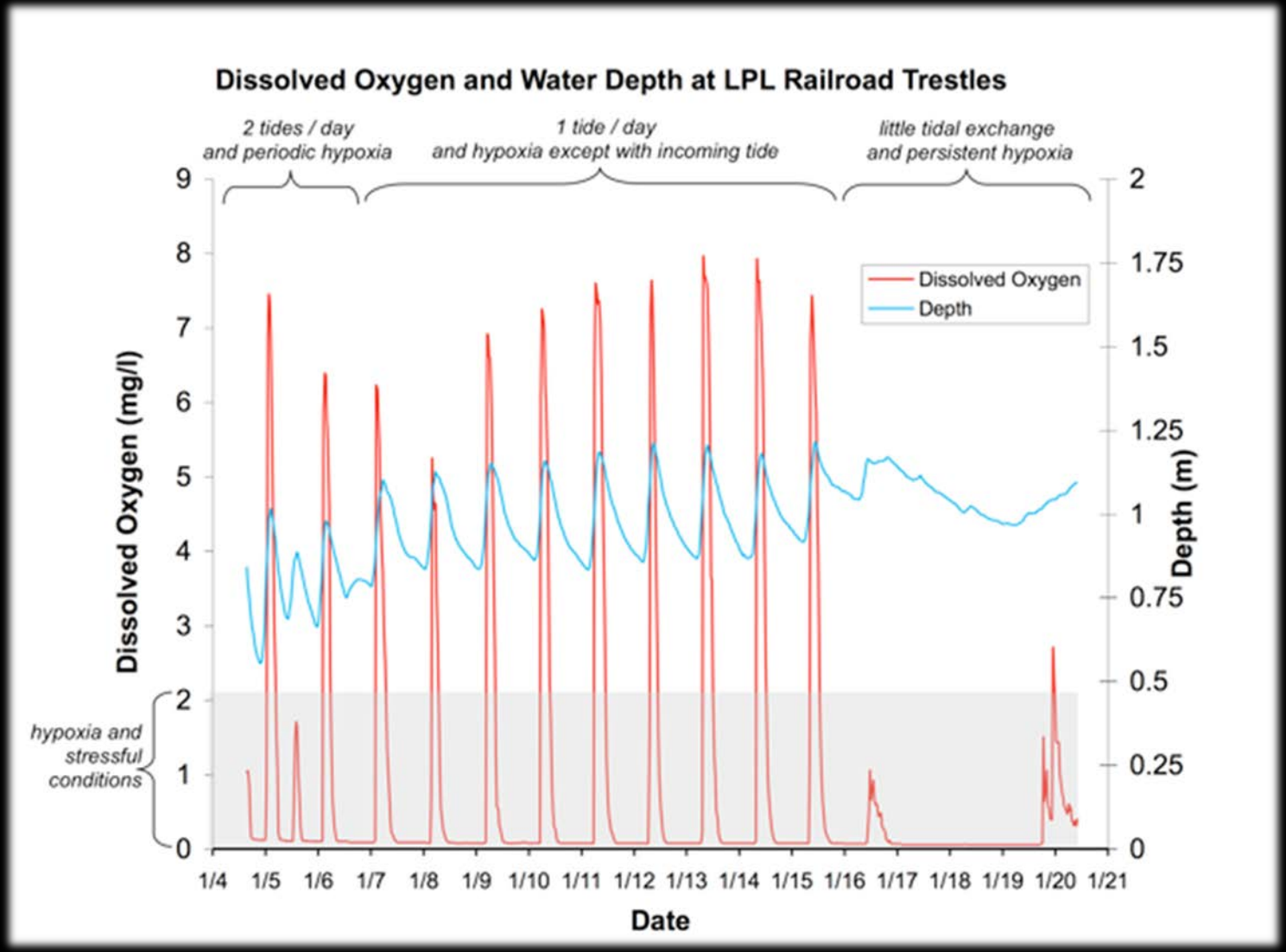
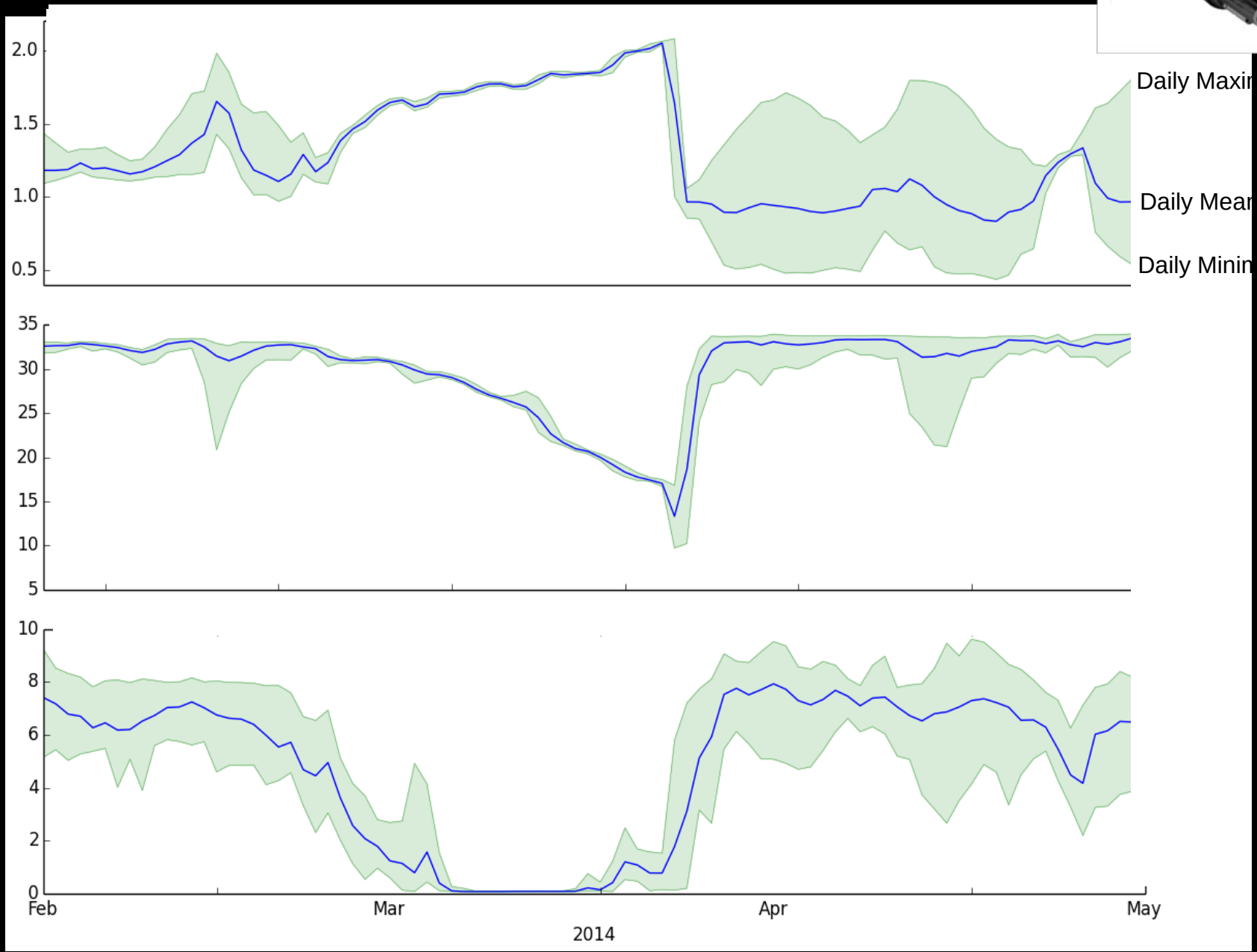
Water Levels – March 2011



Onset of Mouth Closure and Low-Oxygen Conditions



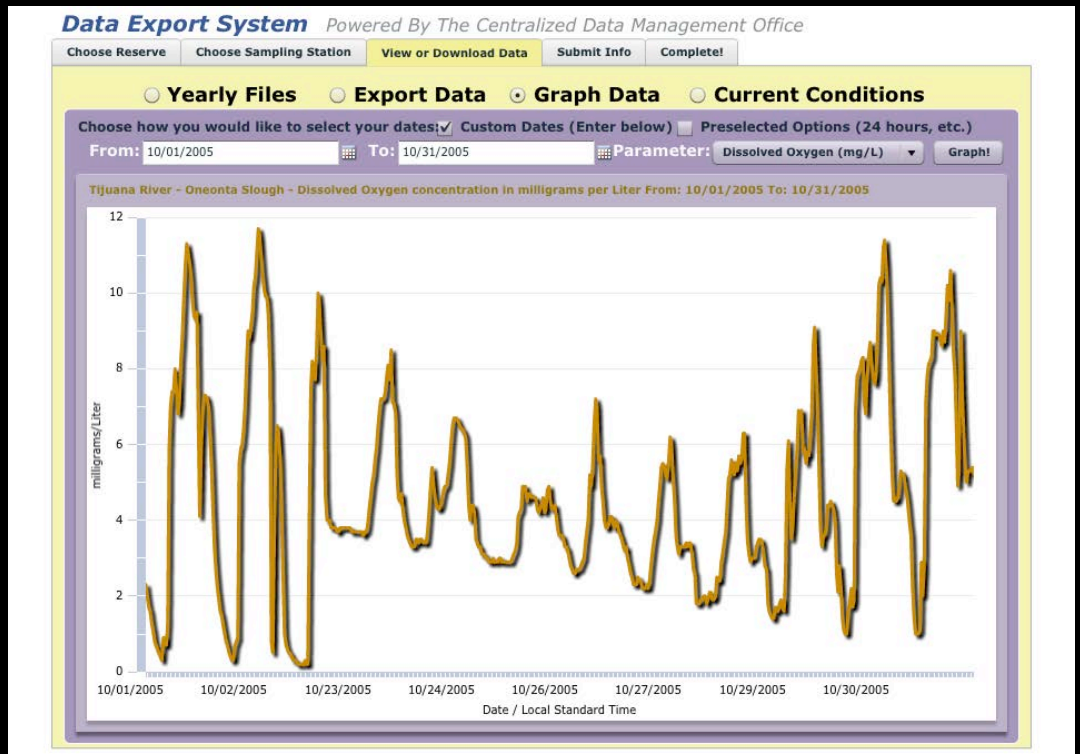


Daily Maxi

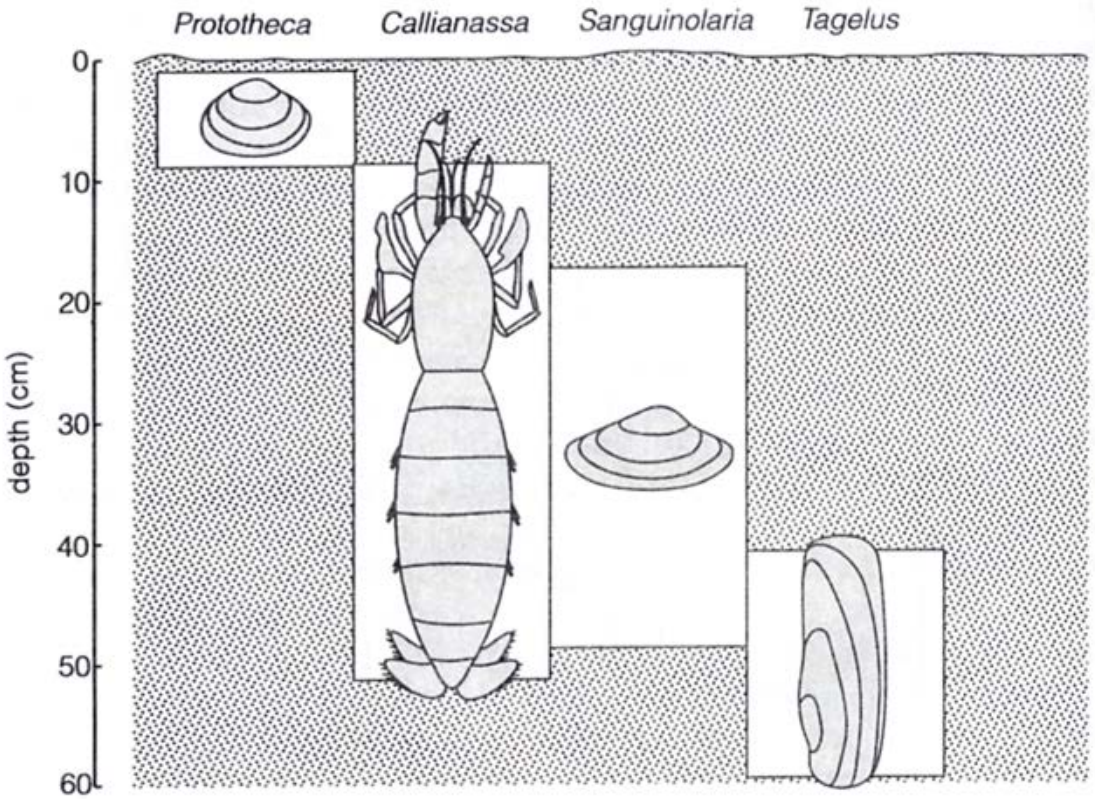
Daily Mean

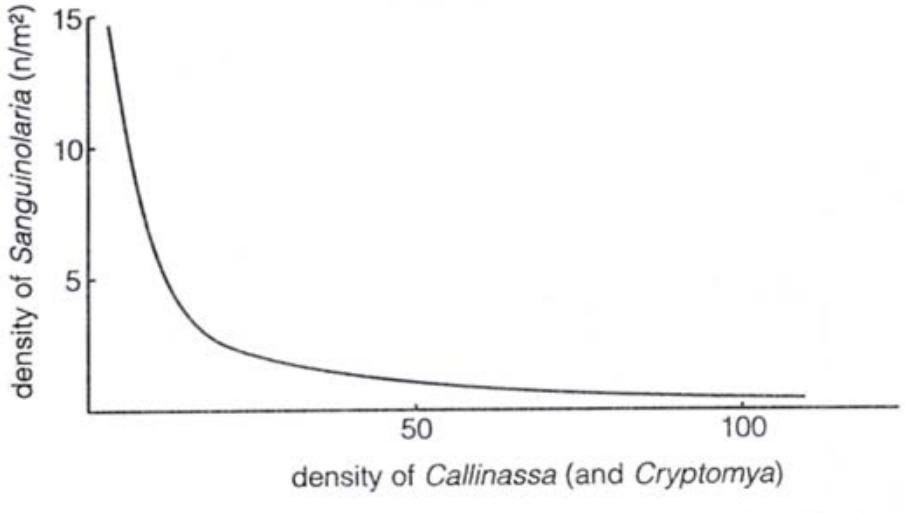
Daily Minin

Fish Kill – October 2005



Oxygen Depletion





Three-dimensional zonation patterns in soft substrates

Raffaelli and Hawkins 1996