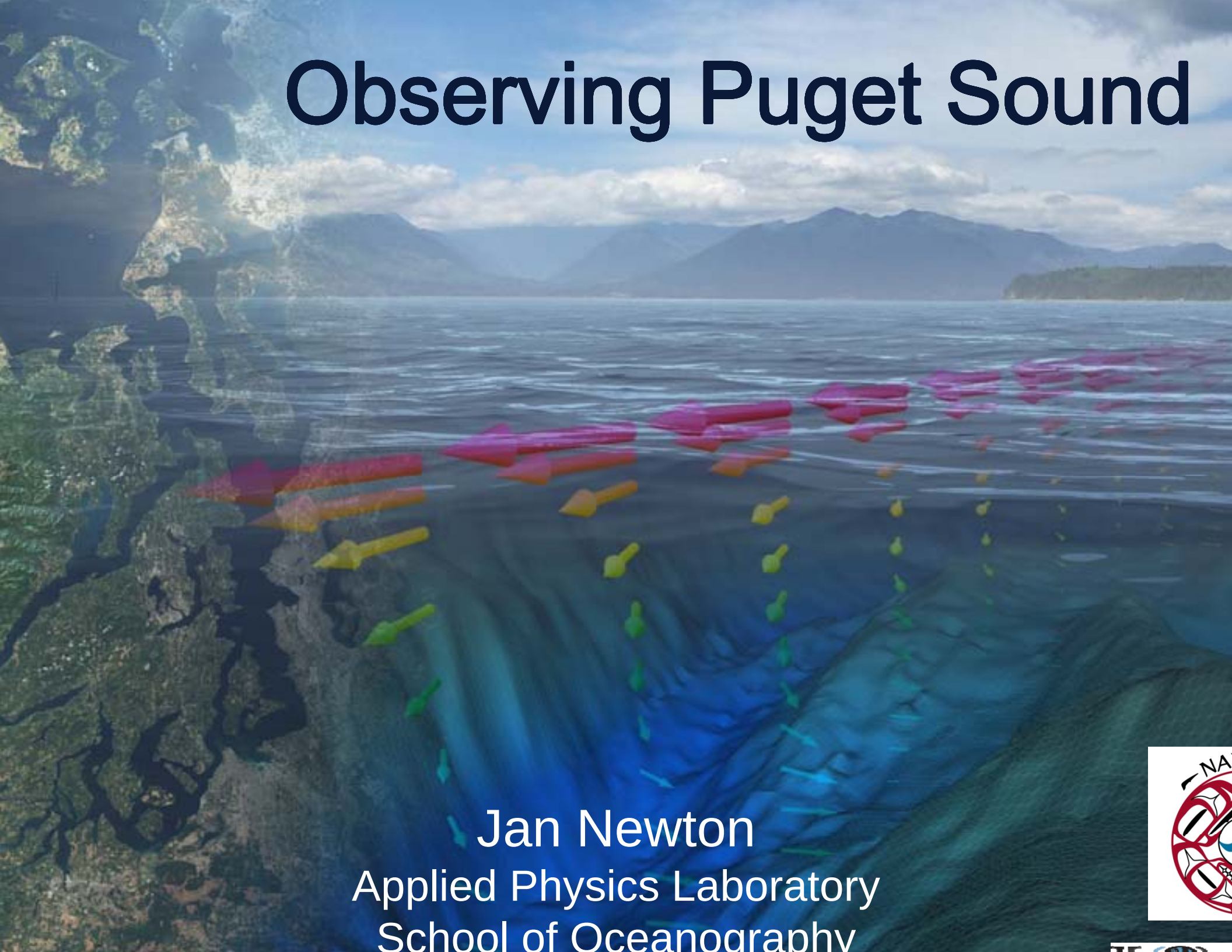
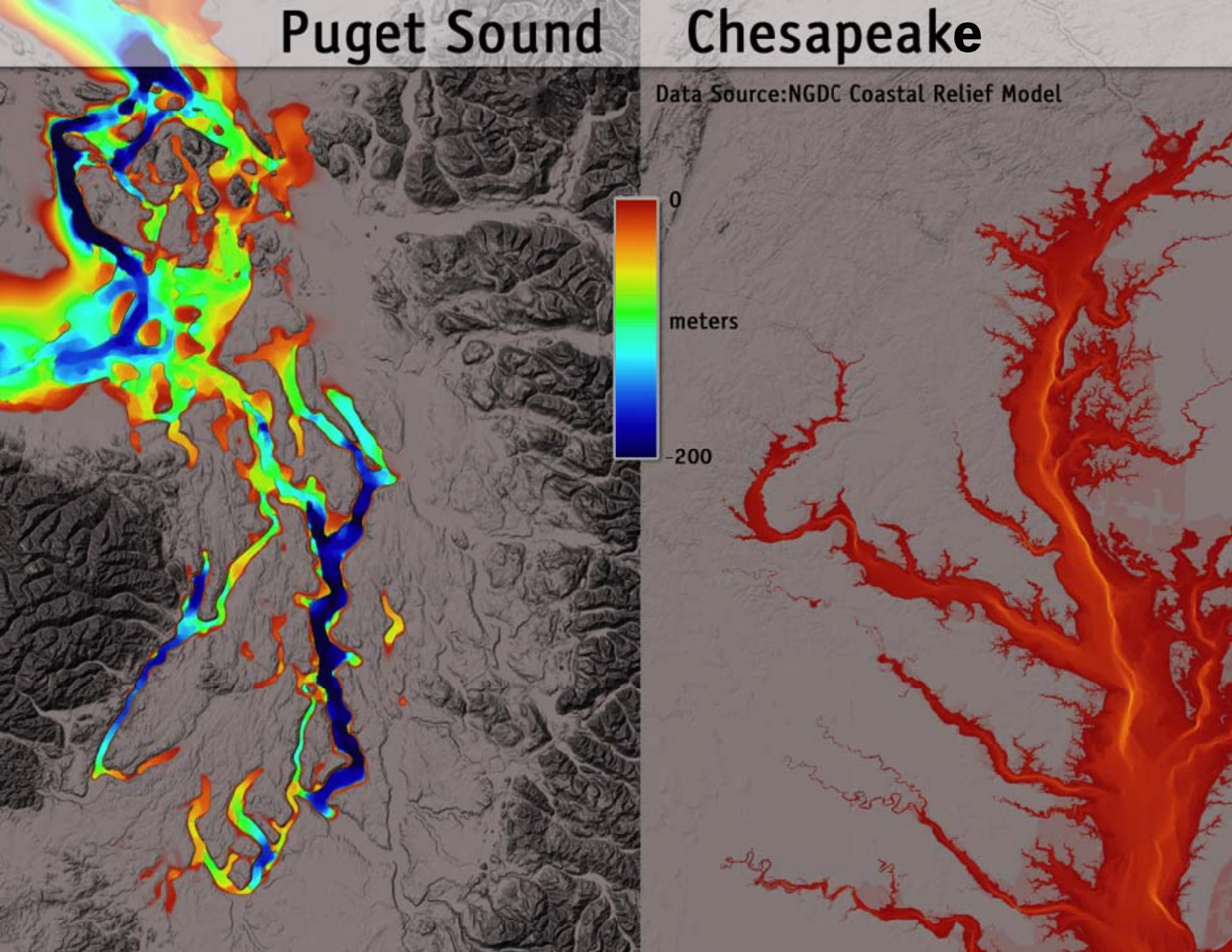
Observing Puget Sound



Jan Newton
Applied Physics Laboratory
School of Oceanography

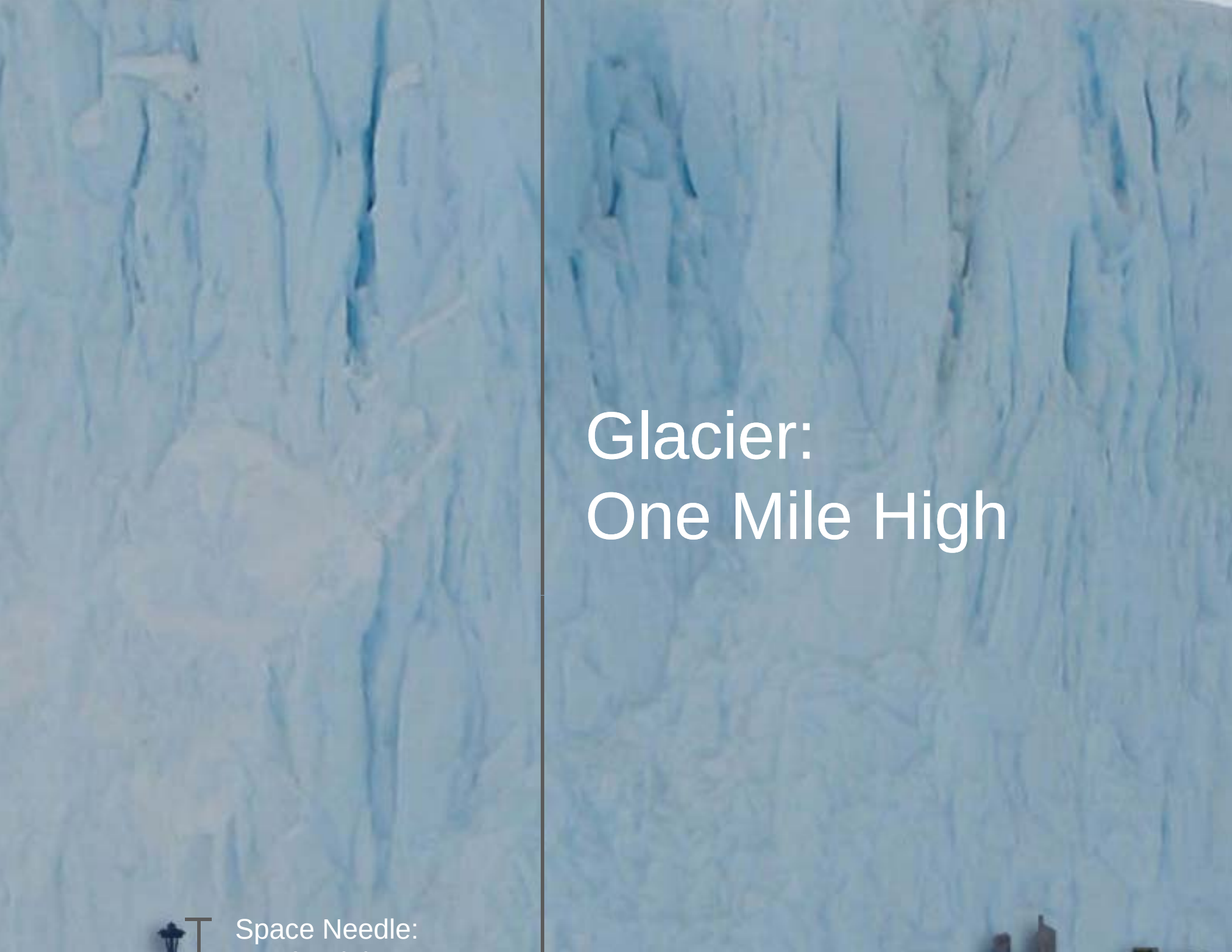
Puget Sound

Chesapeake Ba


Puget Sound
Chesapeake
Data Source:NGDC Coastal Relief Model
0
meters
-200

State through British Columbia to Alas
Most of this region has been added to
North America over the last 200 millio

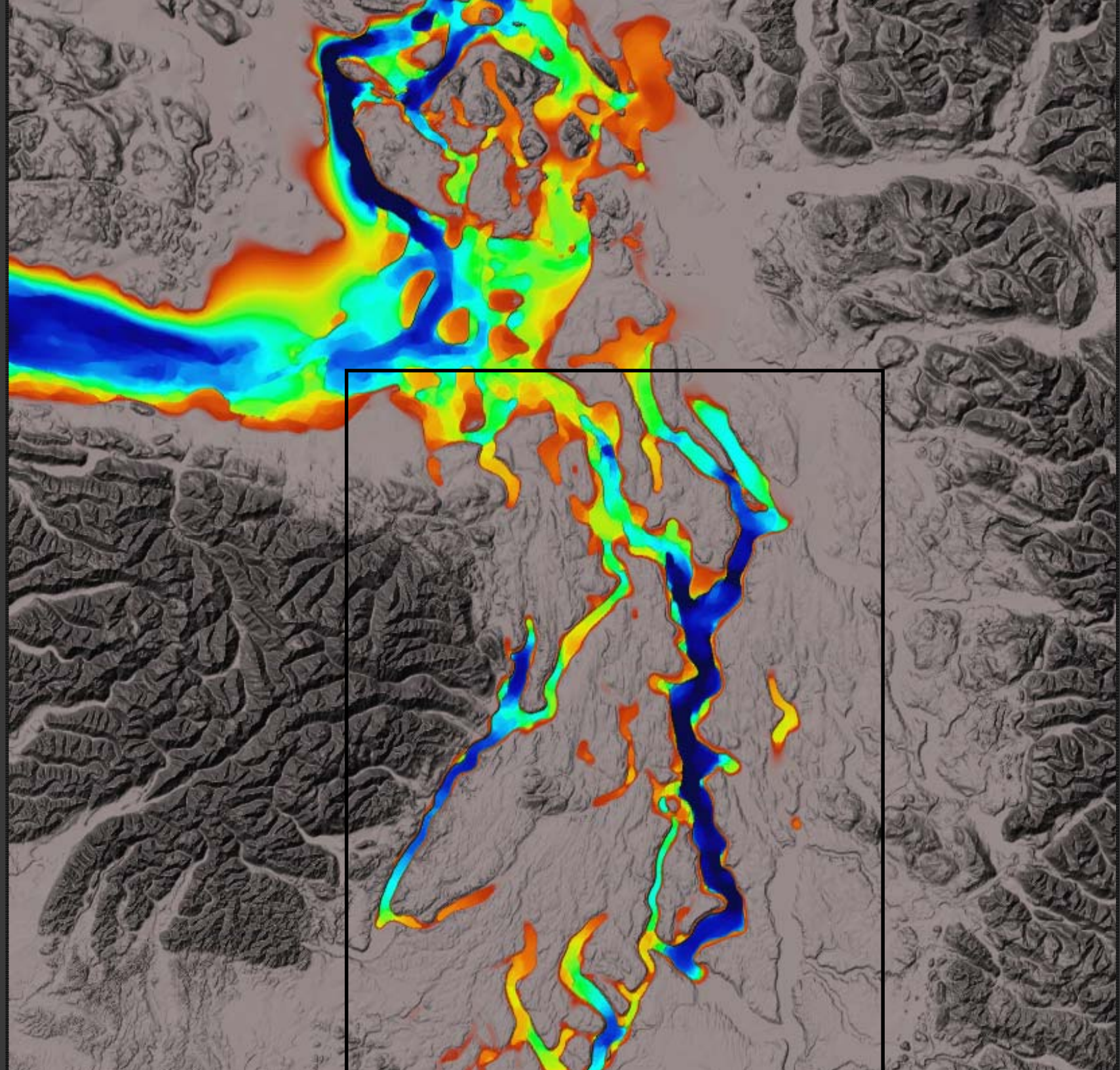
Space Needle
605 ft. high


Glacier:
One Mile High
Space Needle:

Sound
rd-like;
cial-cut
uarine
stem

eep

earshore
rrow



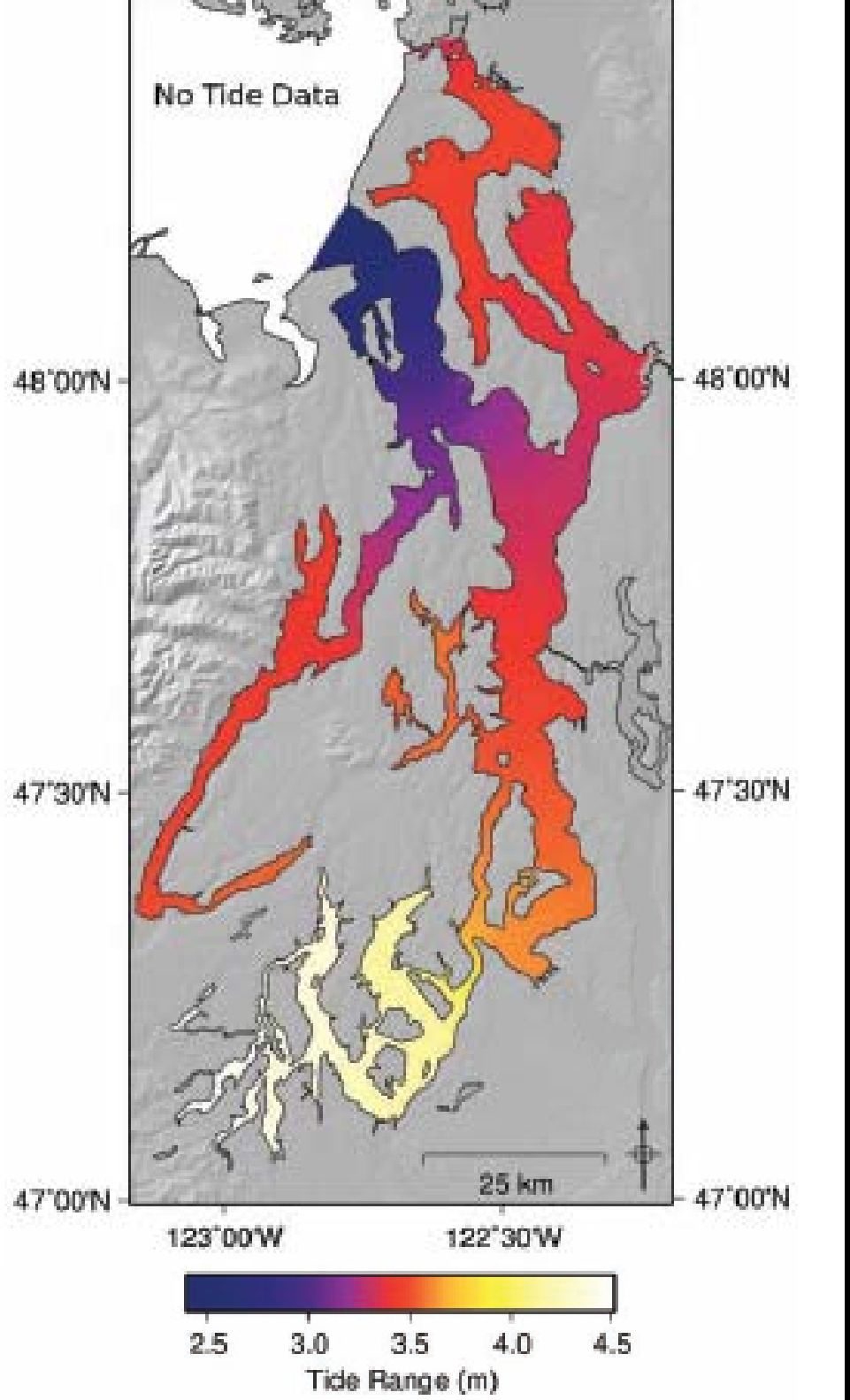
plications for the ecosystem:

- It is only a narrow “fringe” of nearshore habitat that supports many species at so point in their life cycle

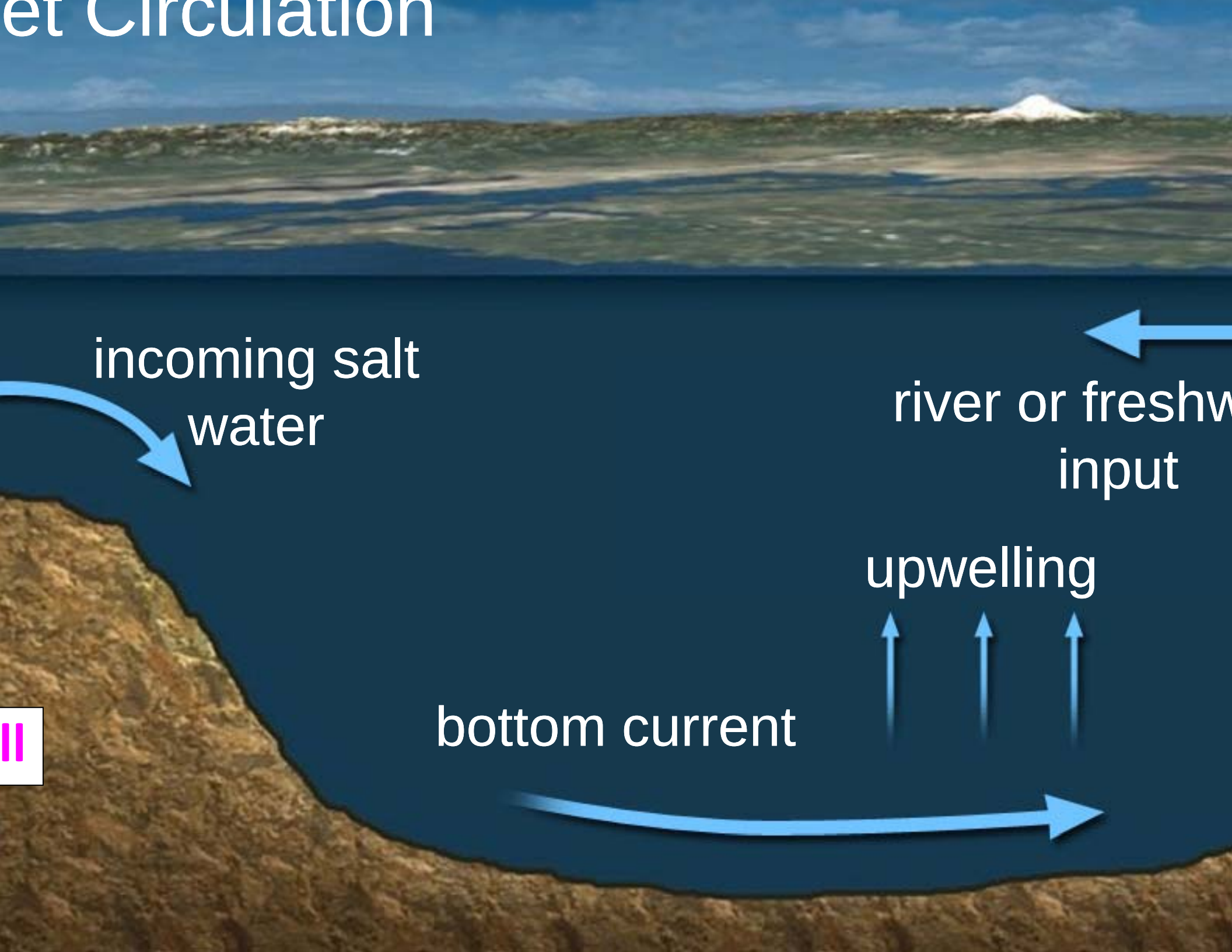
- Because narrow, we have less ‘leeway’ regarding destruction of nearshore habit

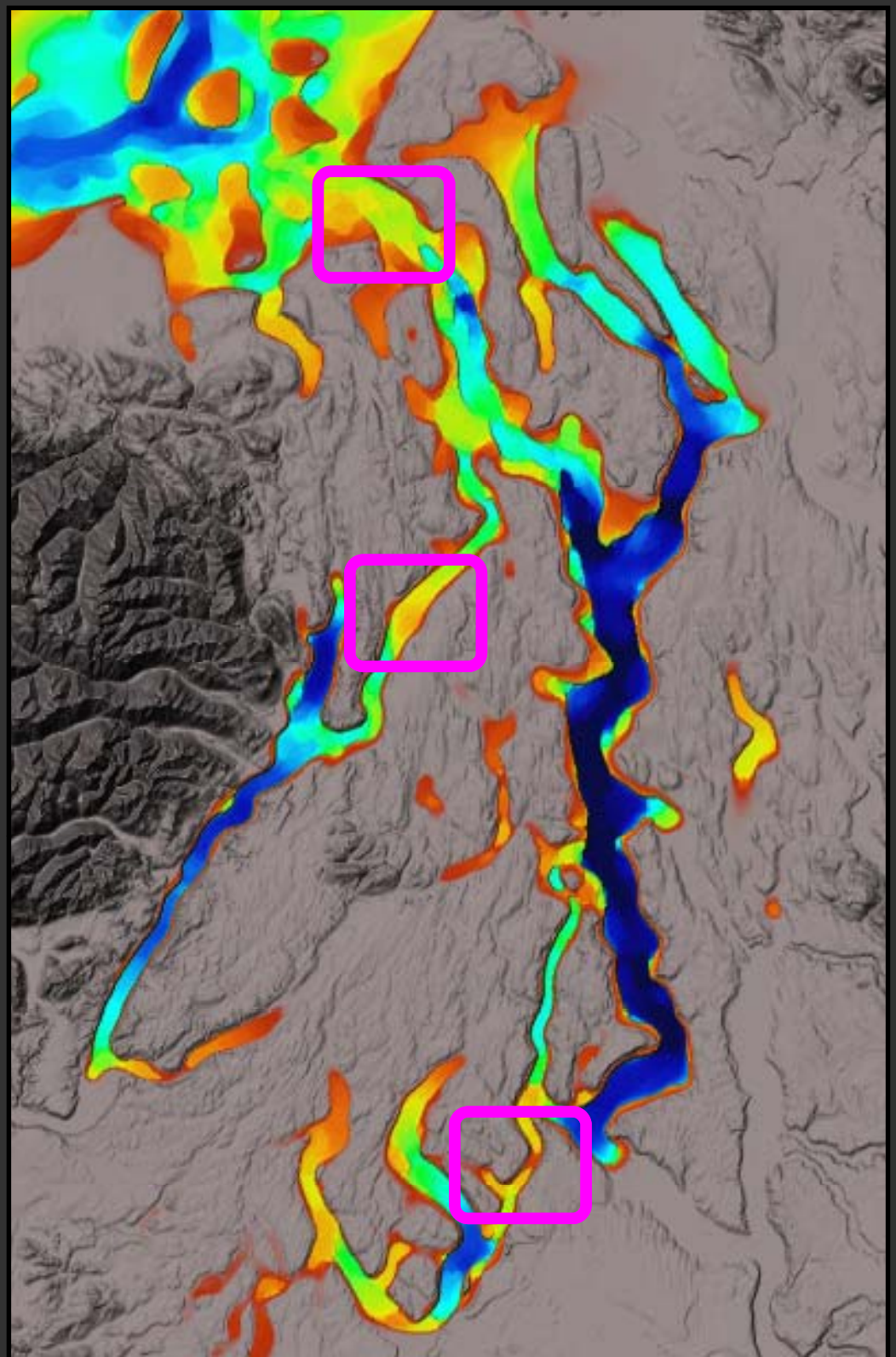
- Removing or degrading a portion of the nearshore habitat in Puget Sound does n have the same proportional effect on the

und
es

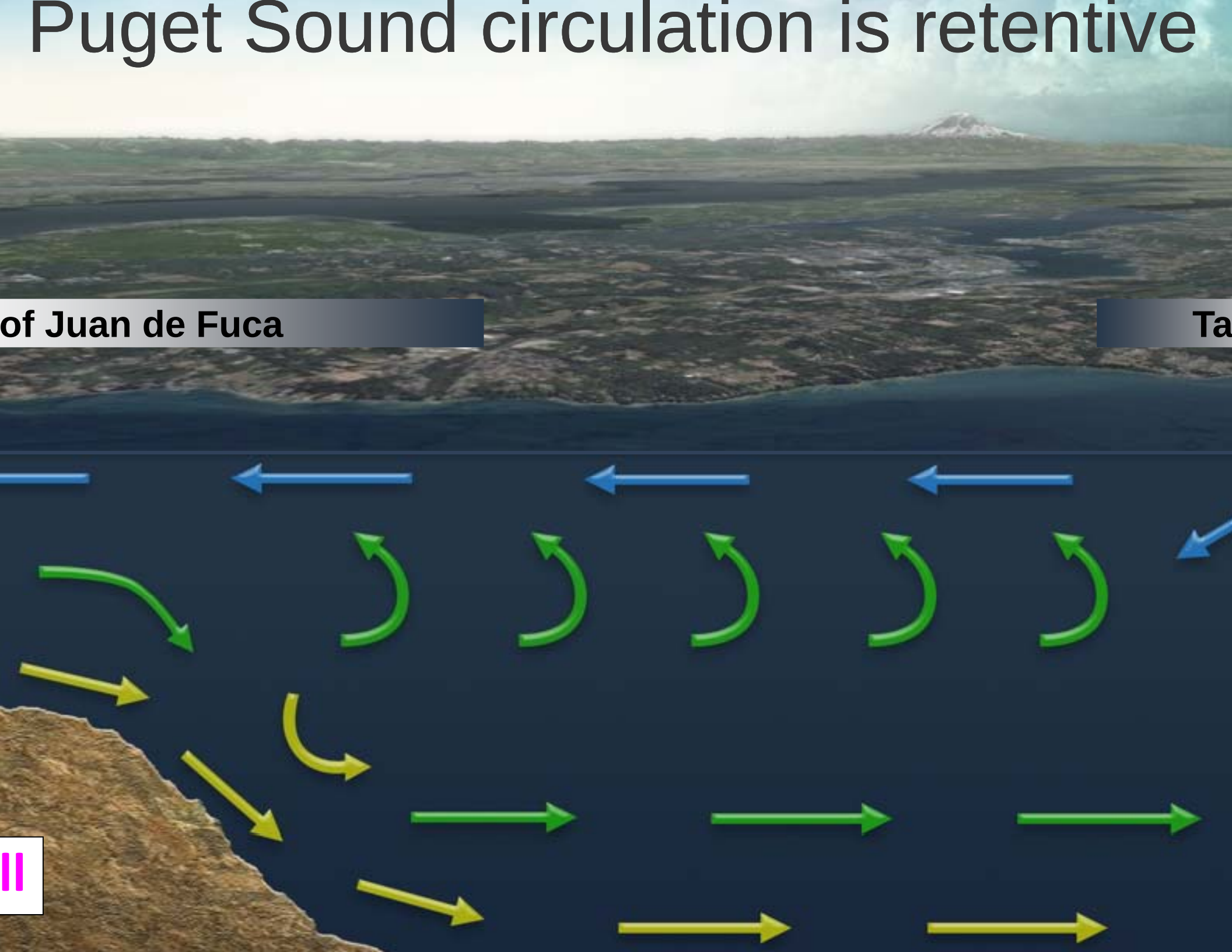


- **Tidal range:**
  2.5 – 4.5 mete
- **Tidal prism:**
  5% (3-11%) of
  (169 km^3)
- **Current speeds:**
  >1 m s^{-1} to wea


et Circulation
incoming salt water
river or freshw input
upwelling
bottom current


0 me

Puget Sound circulation is retentive



plications for ecosystem:

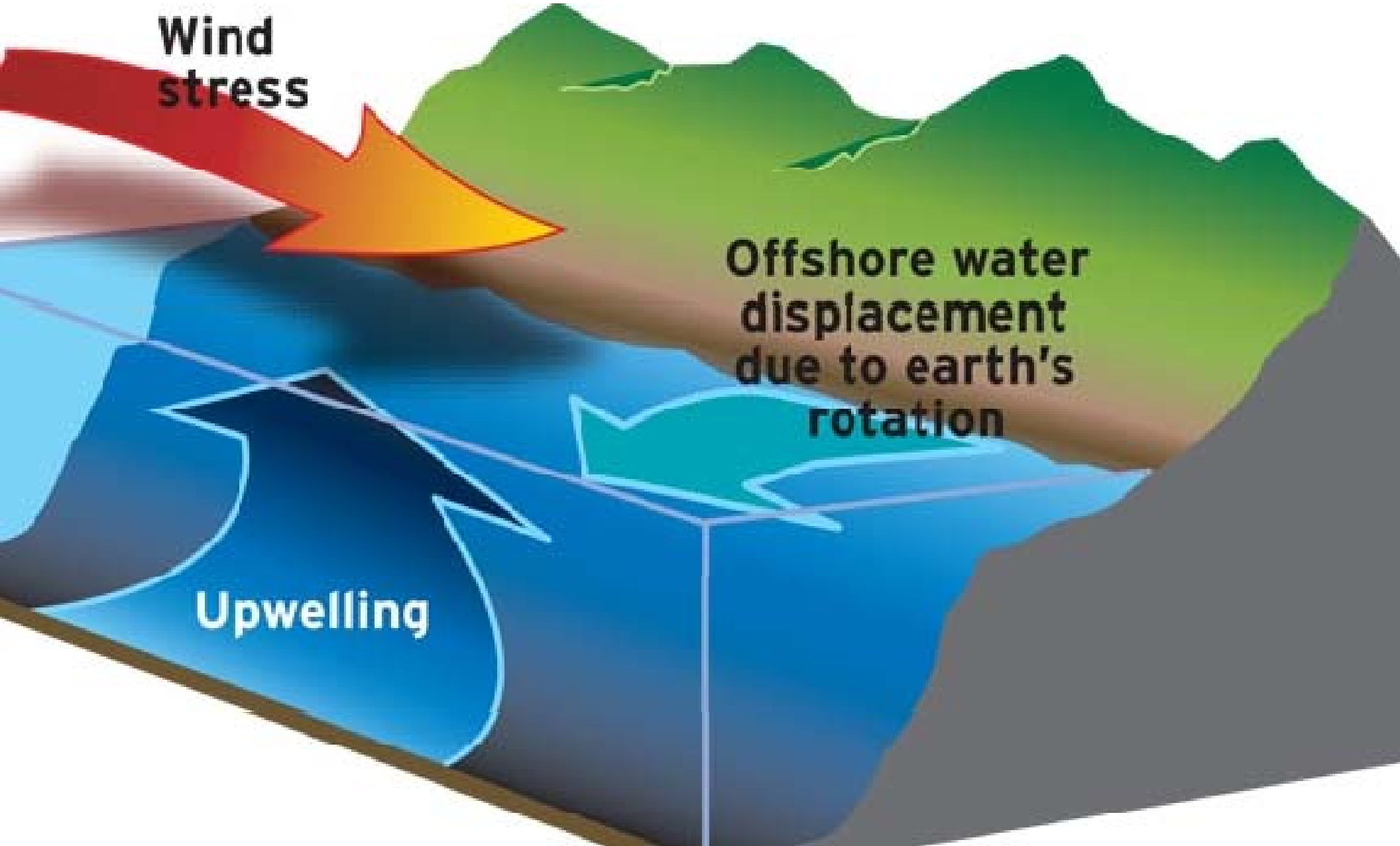
- Inputs to Puget Sound stay around for a long time…
  - Long-lasting effects that can be de-coupled from source elimination
- Biota in Puget Sound have a high degree of residency
- Both good and bad: this is why Puget Sound is highly productive, but also highly retentive of contaminants

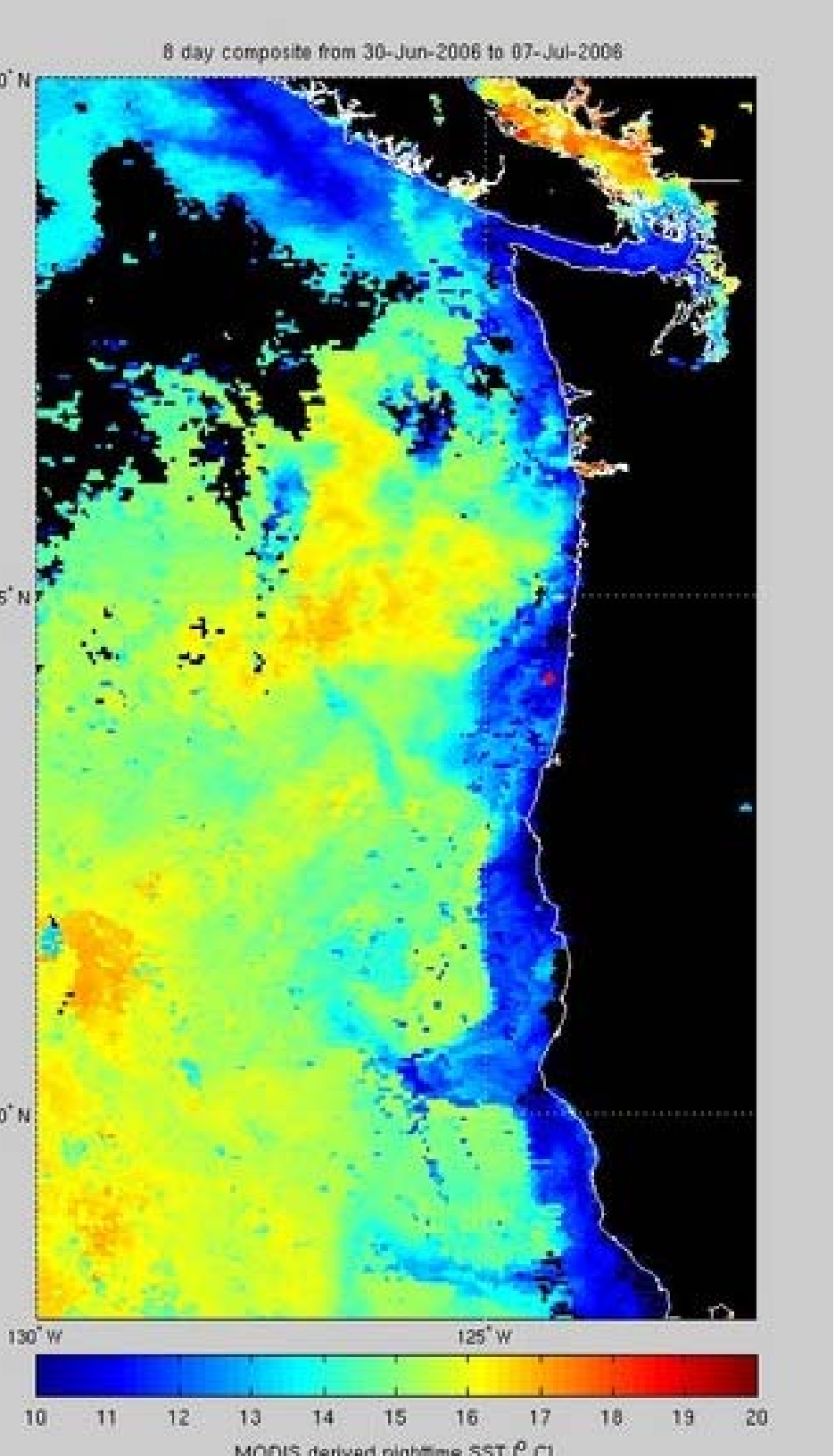
have st
influence
cli

Global influen

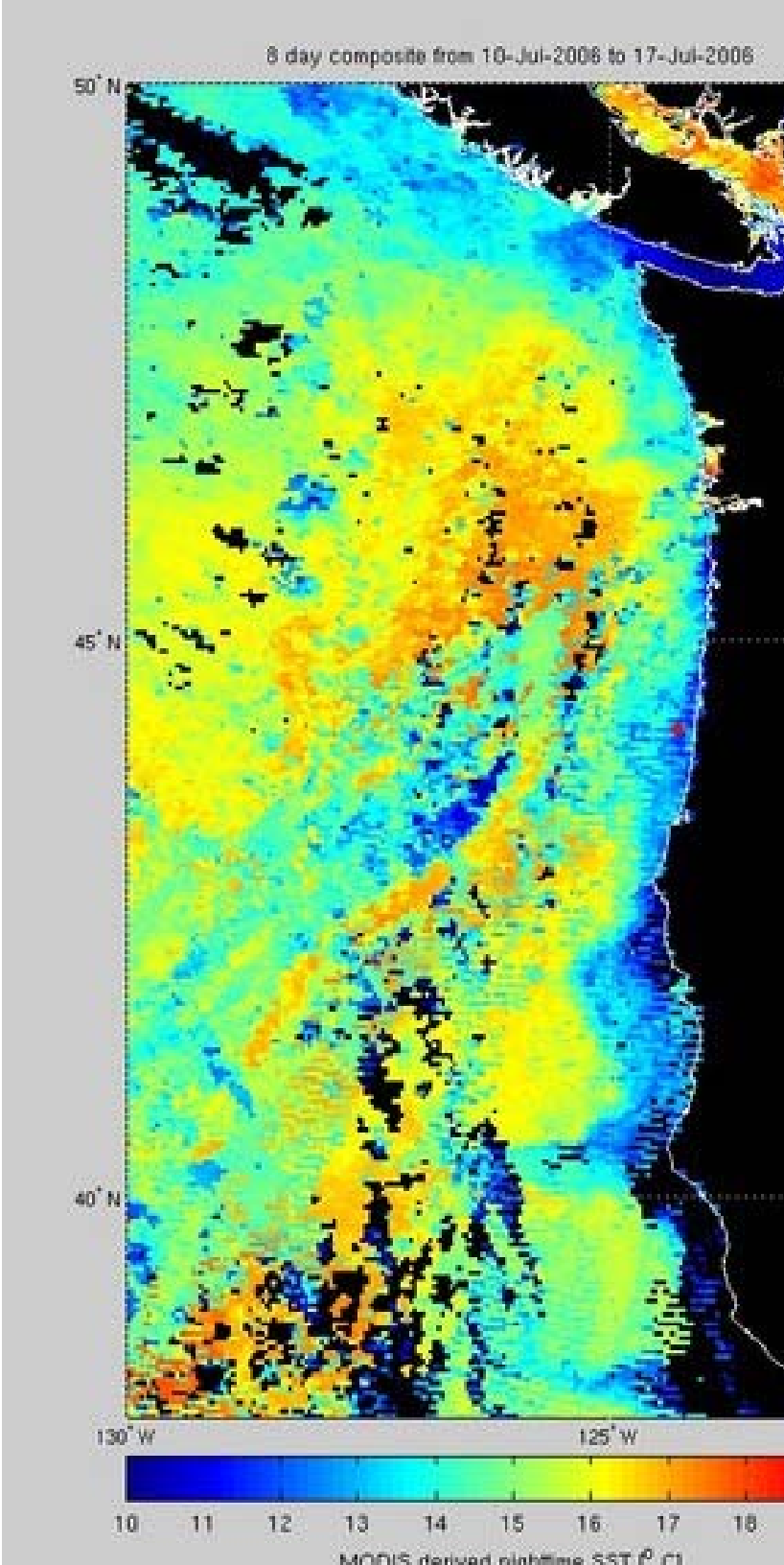
ocean co
watershed co
local

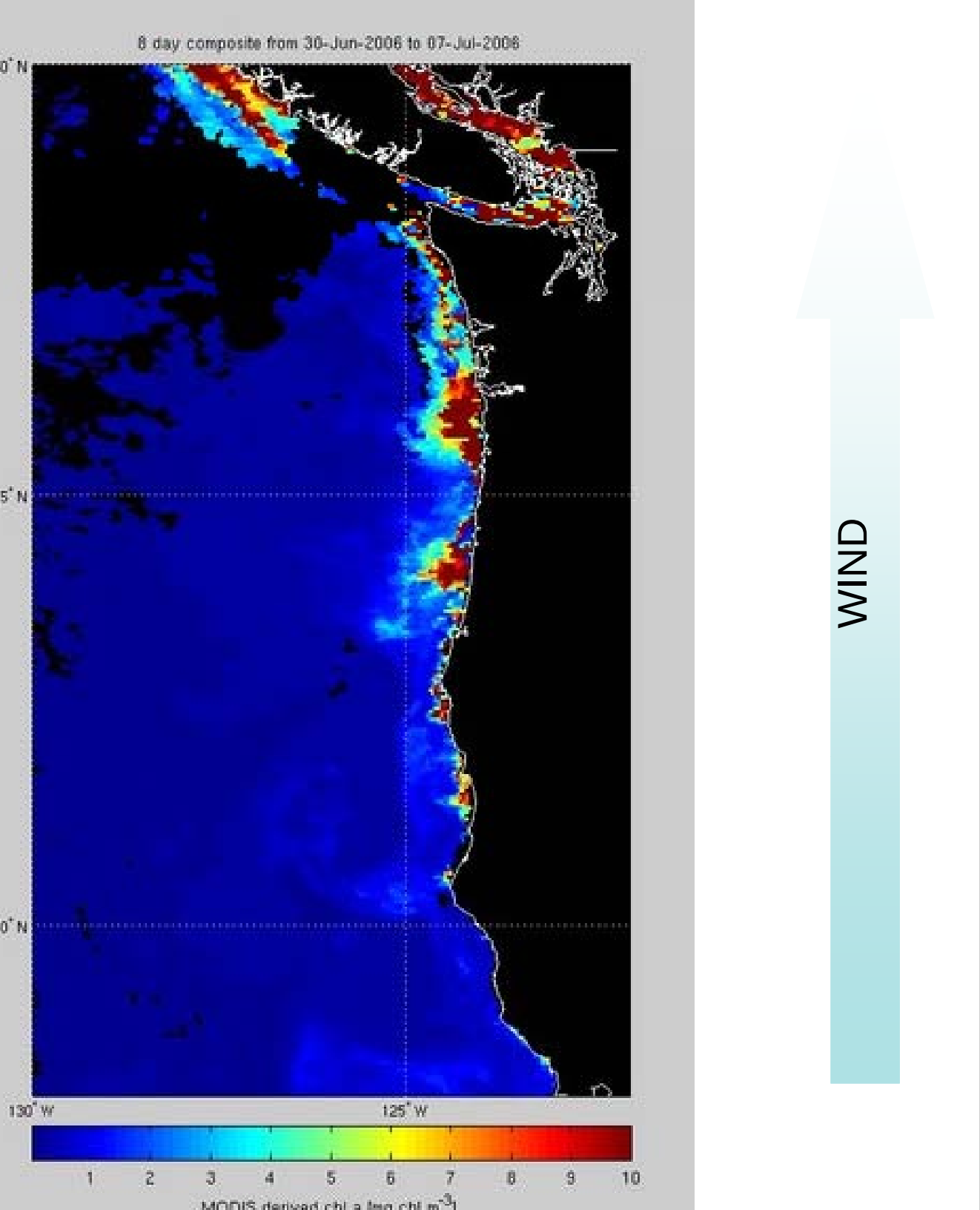
Coastal Upwelling



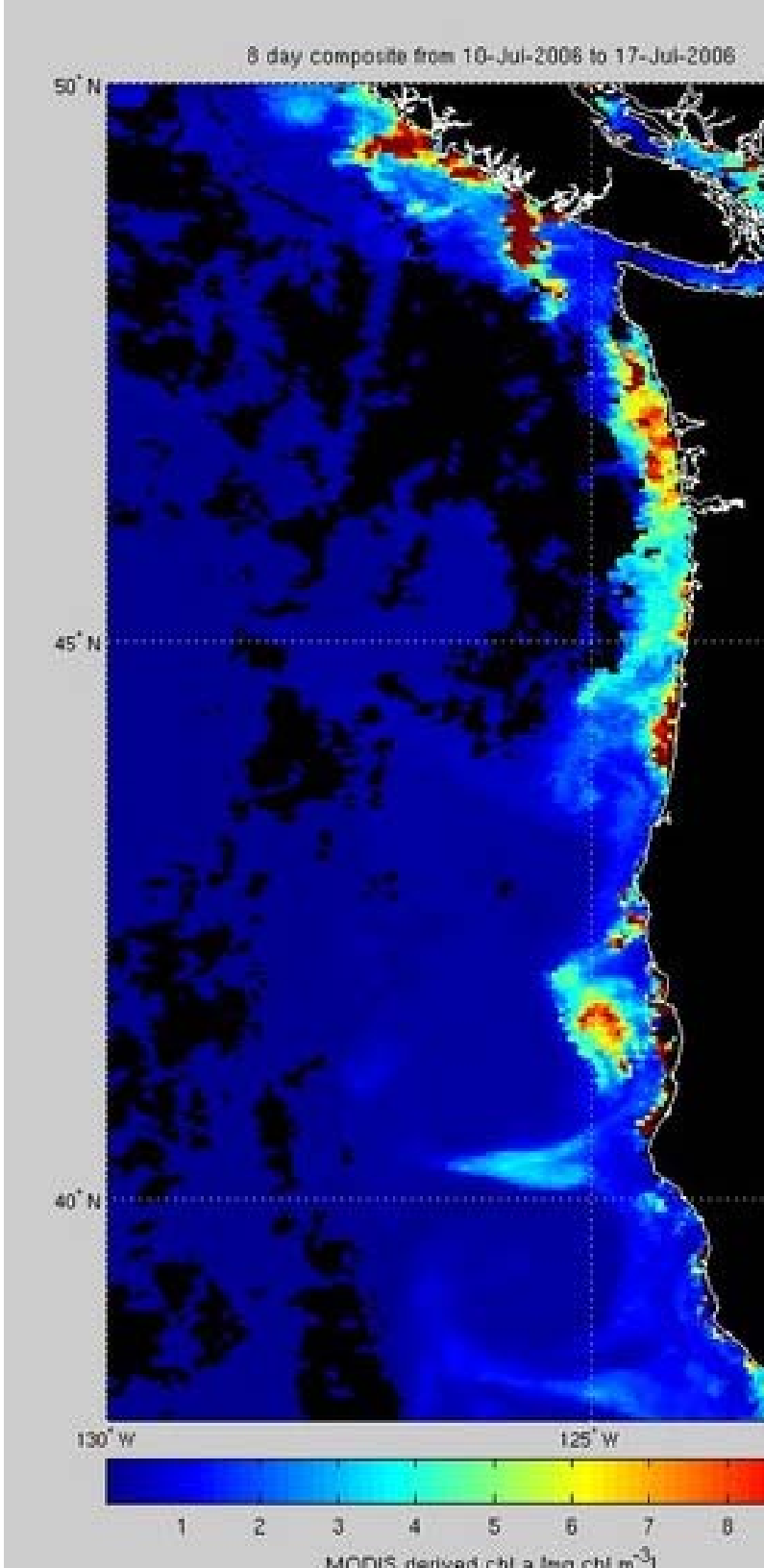

8 day composite from 30-Jun-2006 to 07-Jul-2006
0˚ N
5˚ N
0˚ N
130˚ W
125˚ W
10 11 12 13 14 15 16 17 18 19 20
MODIS derived nighttime SST (°C)

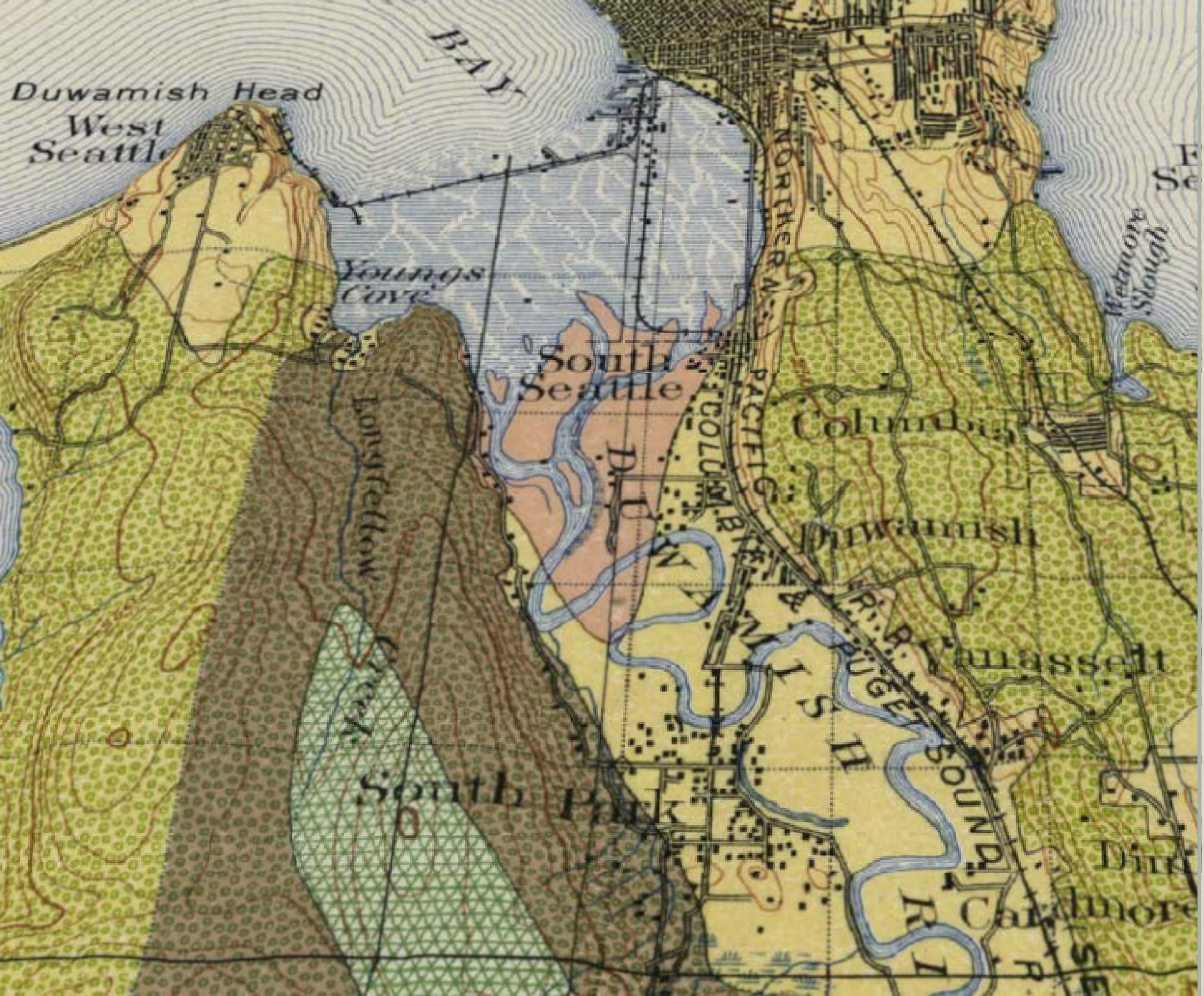
WIND


8 day composite from 10-Jul-2006 to 17-Jul-2006
50˚ N
45˚ N
40˚ N
130˚ W
125˚ W
10 11 12 13 14 15 16 17 18
MODIS derived nighttime SST (°C)

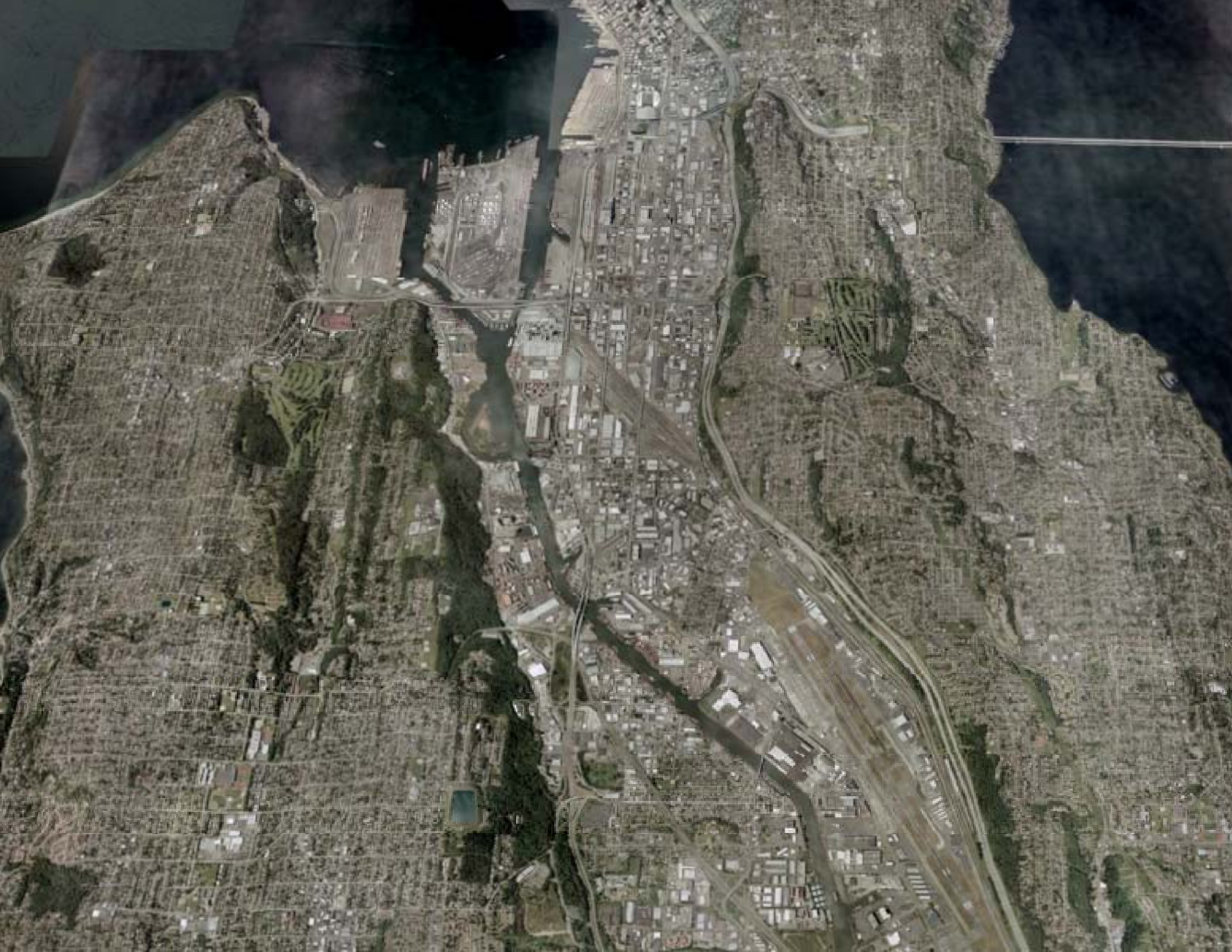

8 day composite from 30-Jun-2006 to 07-Jul-2006
0° N
5° N
0° N
130° W
125° W
1 2 3 4 5 6 7 8 9 10
MODIS derived chl a [mg chl m-3]

WIND

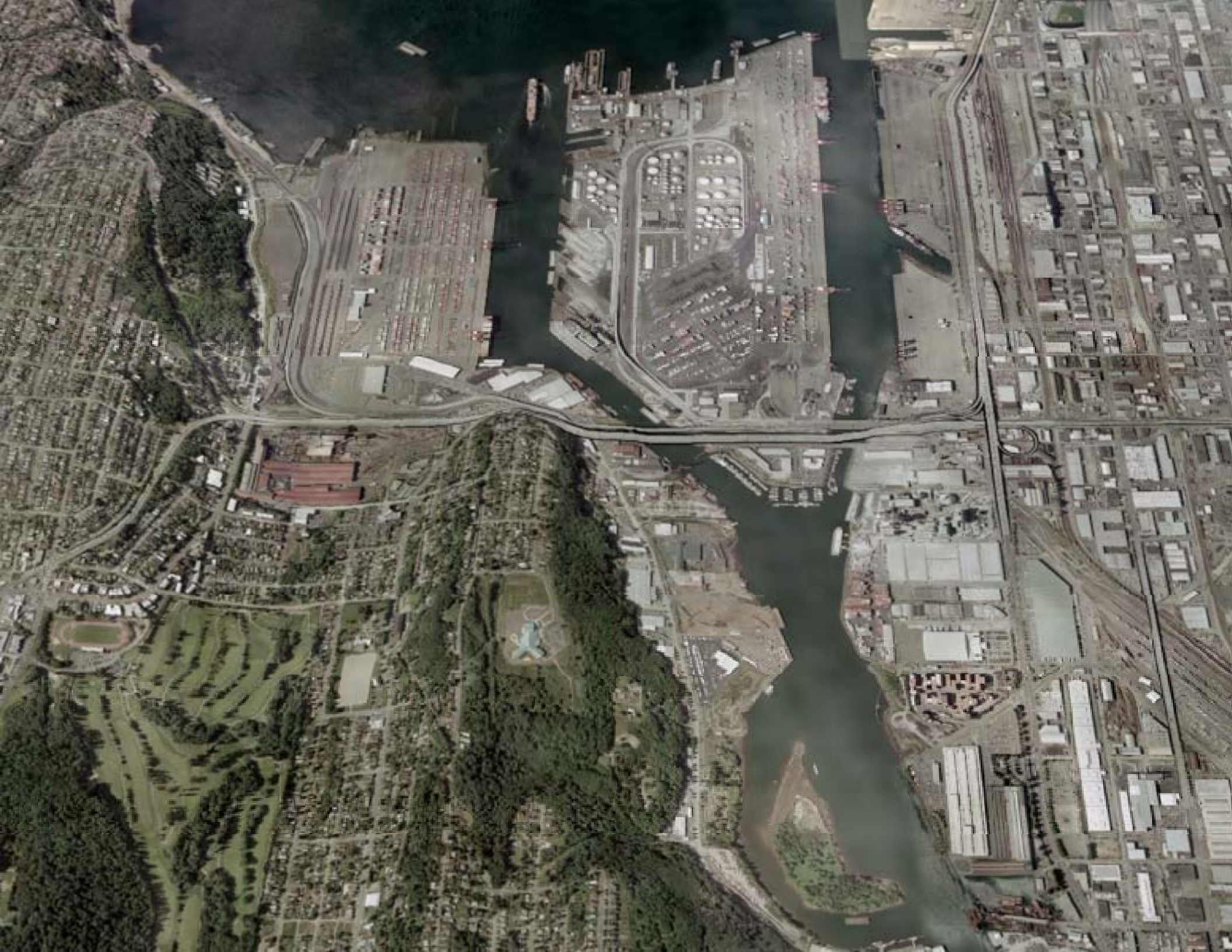

8 day composite from 10-Jul-2006 to 17-Jul-2006
50° N
45° N
40° N
130° W
125° W
1 2 3 4 5 6 7 8
MODIS derived chl a [mg chl m-3]



Duwamish Head
West Seattle
BAY
Youngs Cove
South Seattle
Longfellow Creek
South Park
NORTHERN PACIFIC
COLUMBIA & PUGET SOUND R.R.
Columbia
Duwamish
Vanasselt
Wetmore Slough



Youngs
Cove
South
Seal



eople who live in Puget Sound region:

- 1770 (pre small-pox): 37,000
- 2005: 4 million
- 2020: 5 million

iles of Puget Sound shoreline = 2500

- Armored then: 0
- Armored now: 810

decline in

- Seabirds: 1980's – 2000's: 57-90%
- Cherry Point herring: 1970's – 2000's: 90%
- Rockfish egg production: 1970's – 2000's: ~90%
- Resident Orca whales: 1996 – 2003: 15%

PugetSoundPartnership

our sound, our community, our chance

R MISSION

ate a single, unified Action Agenda to guide the
ection and restoration of Puget Sound by 2020.

ement the Action Agenda

se public awareness regarding threats to the
nd and channel energy and resources into
essary actions.

l the entire system accountable for results.

ystem Recovery Goals

ies and food webs:

hy, sustaining populations of native species in Puget Sound, including a robust food

er quantity:

and stream flow and ground water levels sufficient to sustain people, fish, and wil
he natural functions of the environment

tat:

althy Puget Sound where freshwater, estuary, nearshore, marine, and upland
ats are protected, restored, and sustained

er quality:

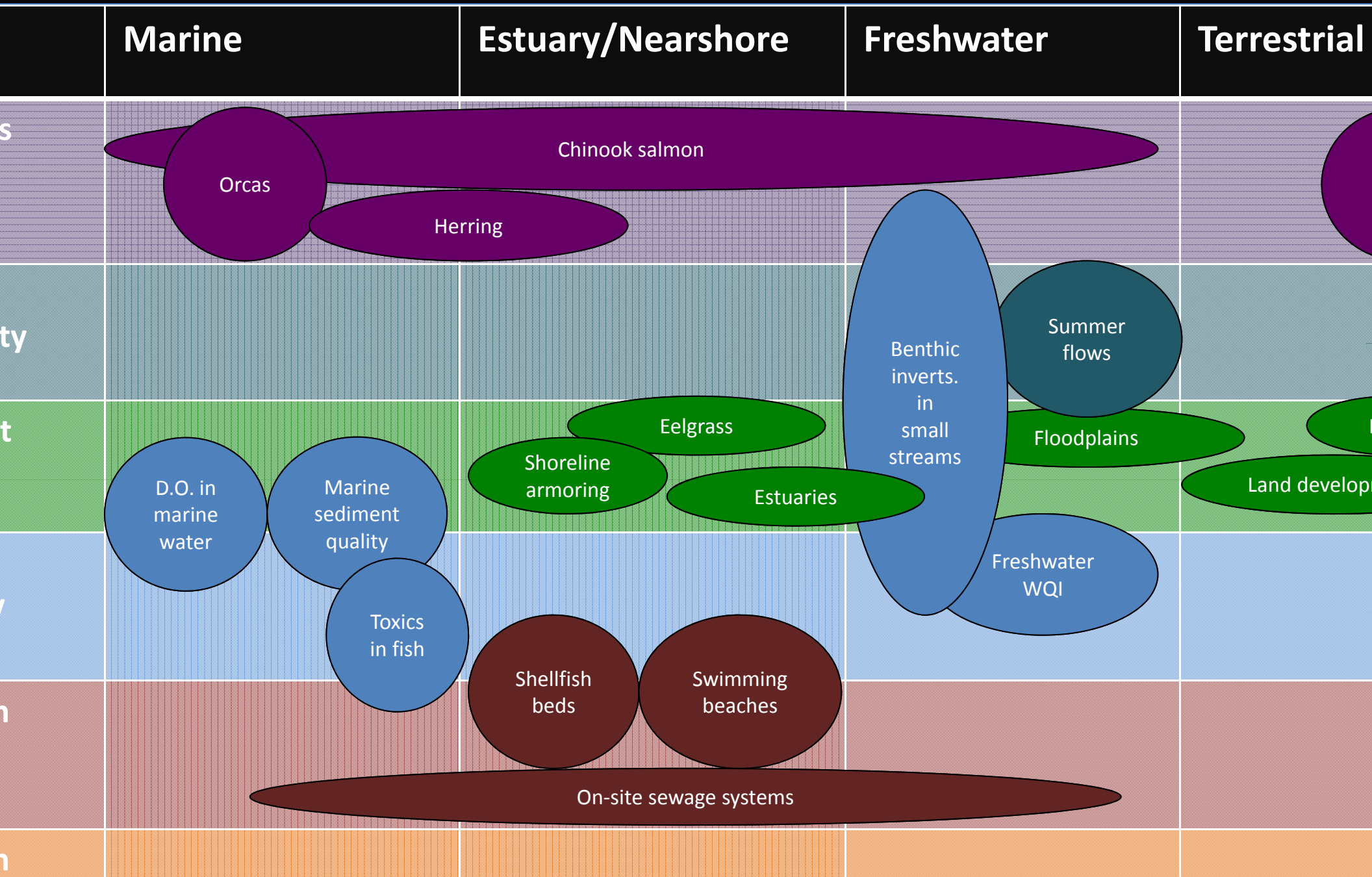
rs and sediments of sufficient quality so that waters are safe for drinking, swimmi
ish harvest and consumption, and other human uses and enjoyment, and are not
ful to the native marine mammals, fish, birds, and shellfish

an health:

lthy human population supported by a healthy Puget Sound

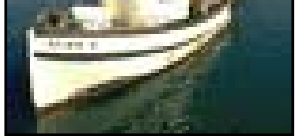
an quality of life:

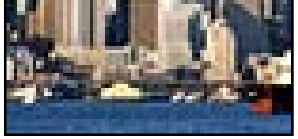
2020 targets to address Puget Sound ecosystem recovery



- Protect
- Restore
- Prevent water pollution at its source
- Work together
- Implementation, monitoring, and accountability

Atmospheric Exchange





Impacts (health impacts, well be

sition, carbon
bsorption

Harvest, aquaculture, consuming seafood, recreation, etc.

lgal
ygen
n food

Marine/ Estuarine Species and Food Webs

Salmon, bald eagles

Aquatic/ Terrestrial Food Webs

Contaminants in Orcas, pathogen transfer

Nutrient inputs, toxic impacts on food webs

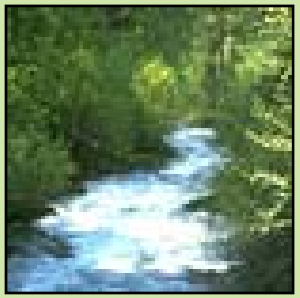
Vegetative cover in riparian zone, aquatic insect abundance and diversity

e

Eelgrass shelter for Dungeness crab, herring spawn on kelp fronds

Water Quality

Contaminant loadings, freshwater impacts on marine circulation

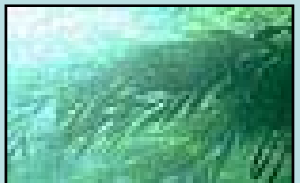
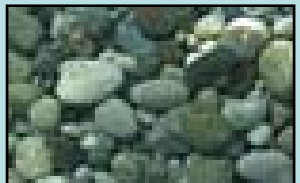
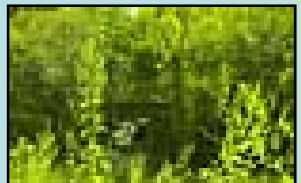


Freshwater Flows/Quality

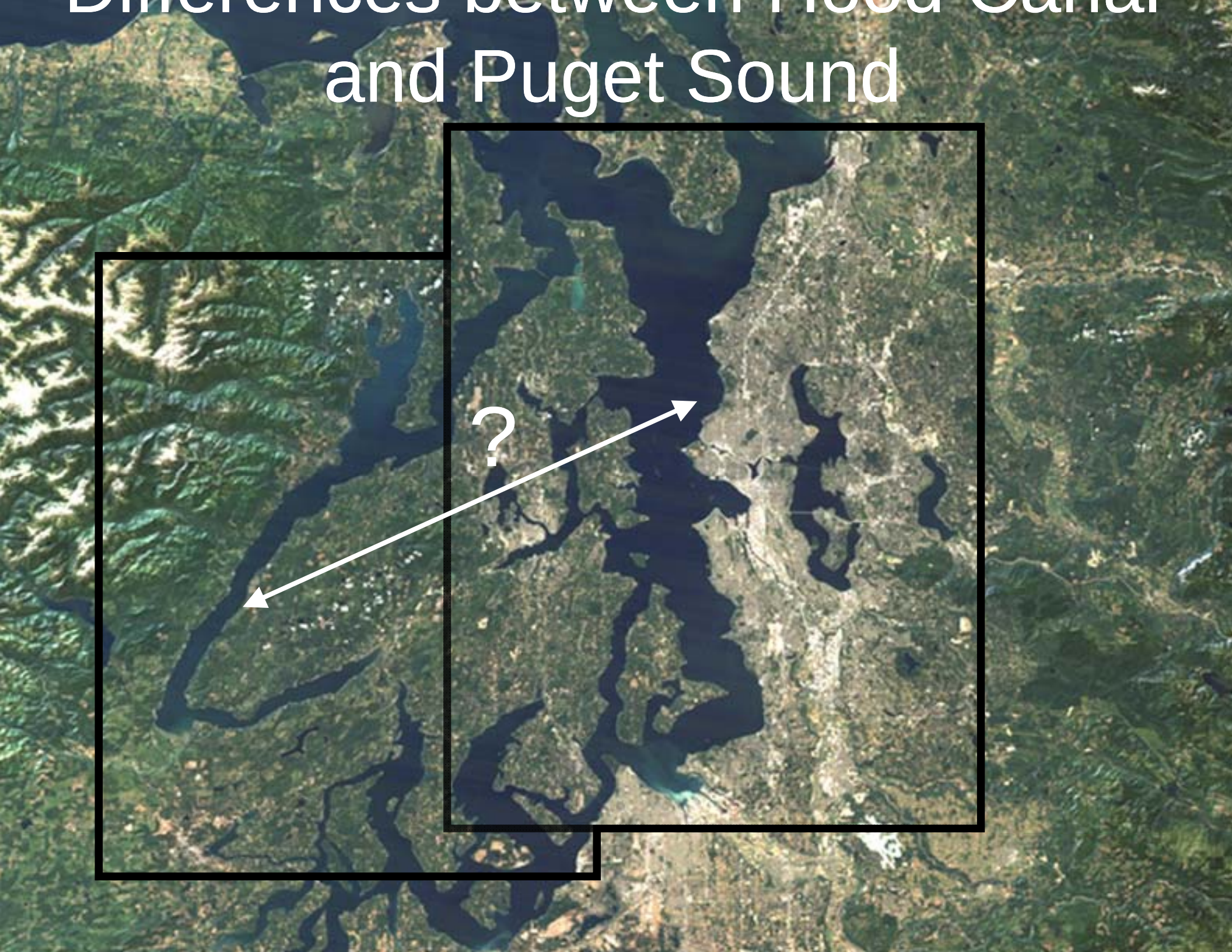
Suspended sediments reduce light for eelgrass, kelp beds filter particulates

Beach nourishment from stream sediments, stream flows balance salinity and sustain marsh plants

S

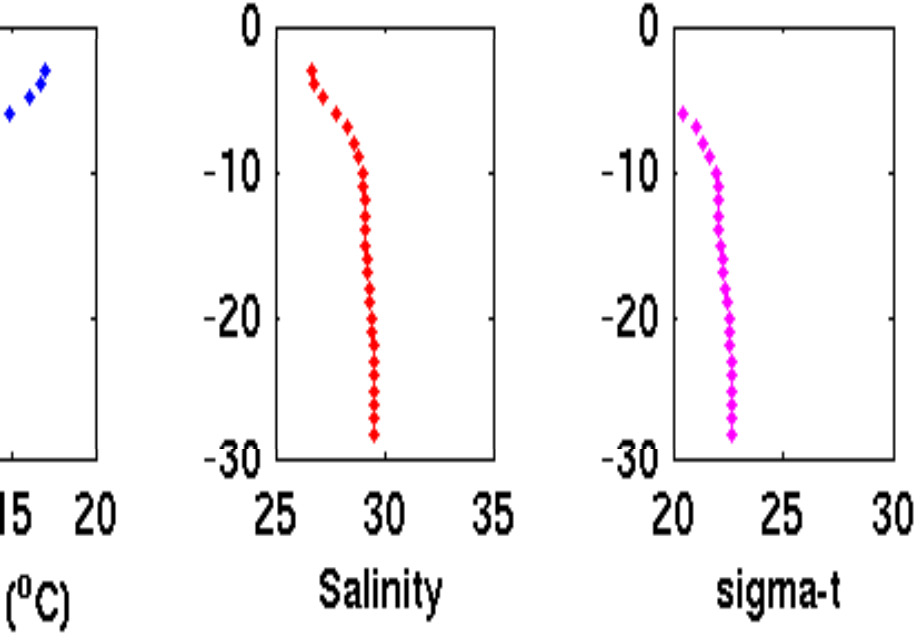




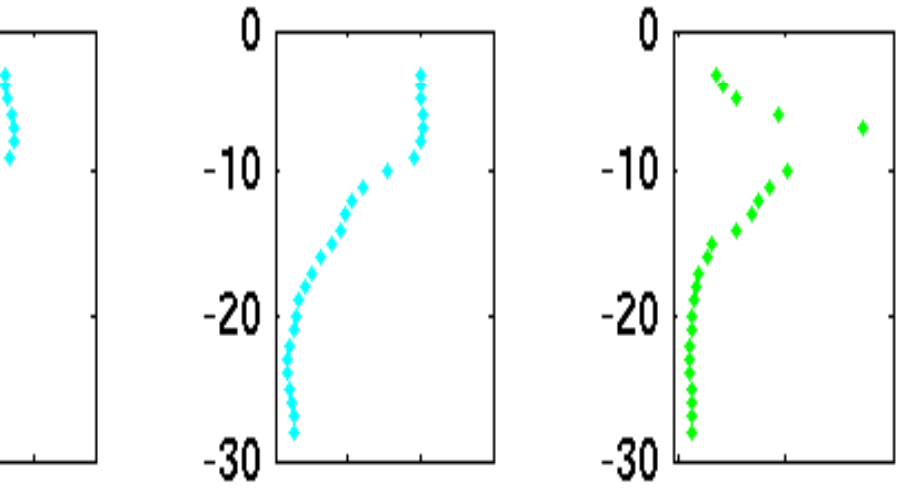
Differences between Hood Canal and Puget Sound

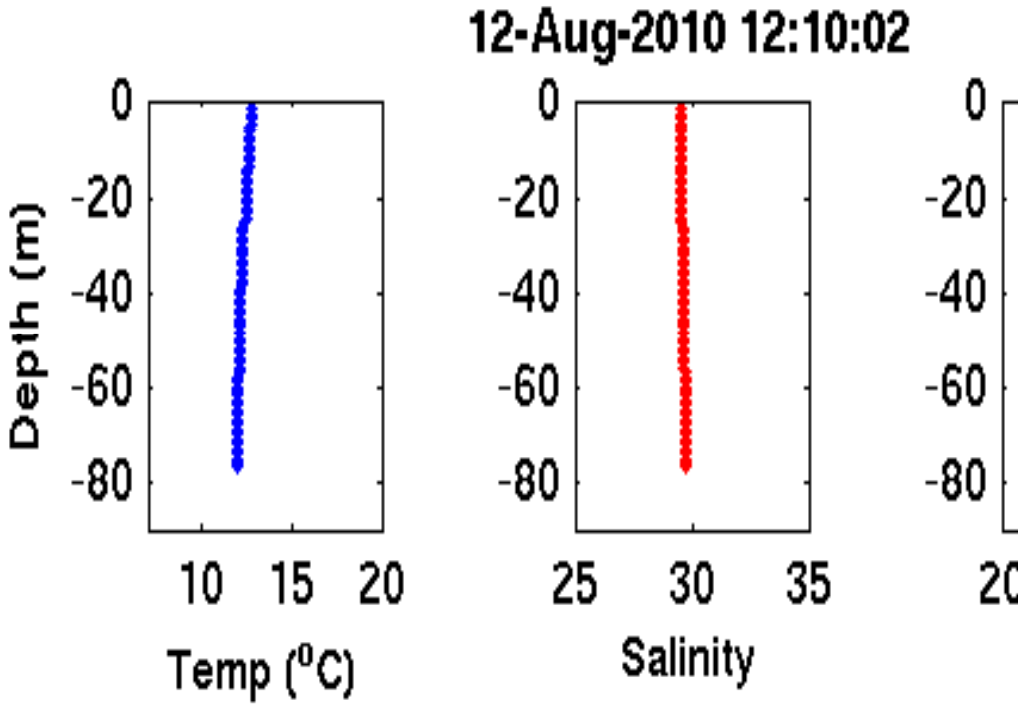


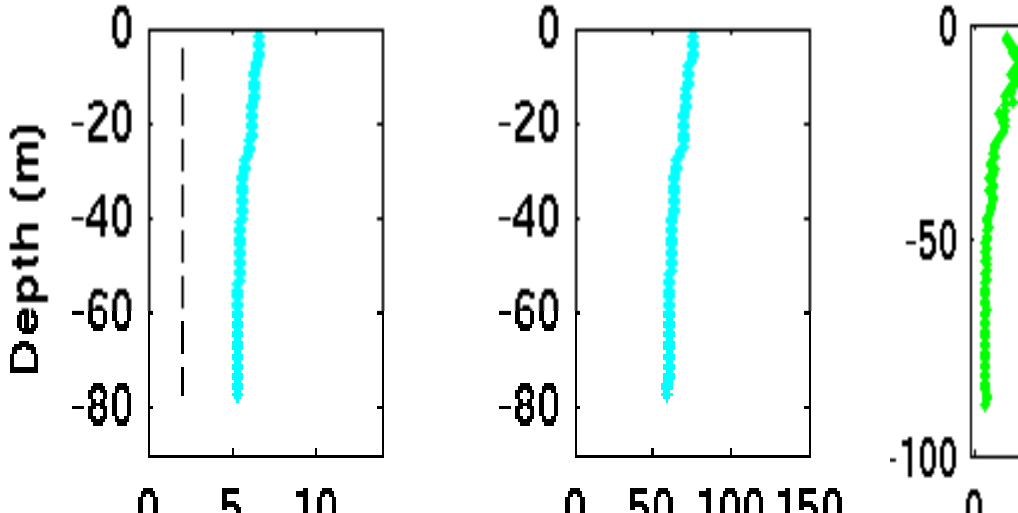
ithin Hood Canal

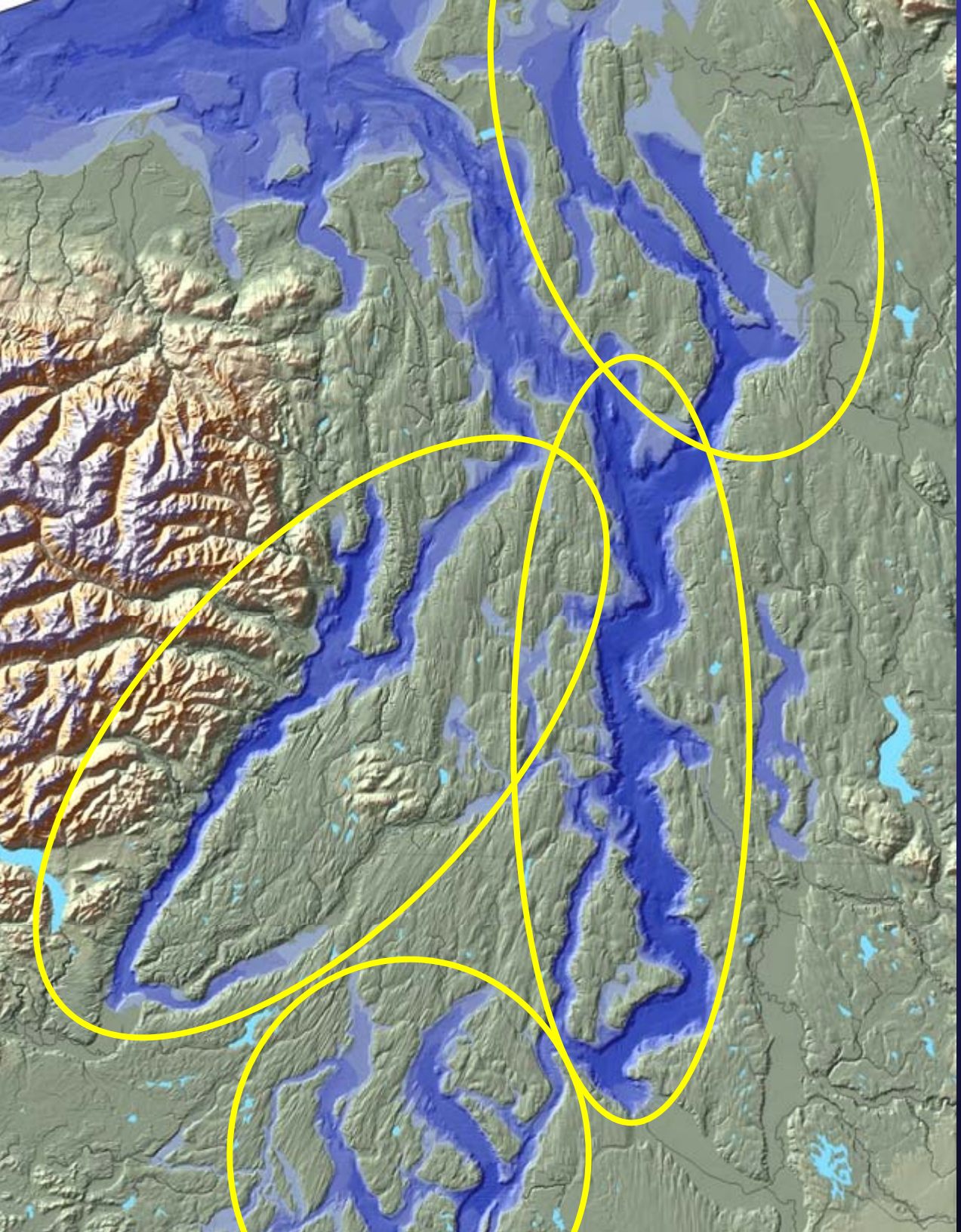
Within Puget Soun





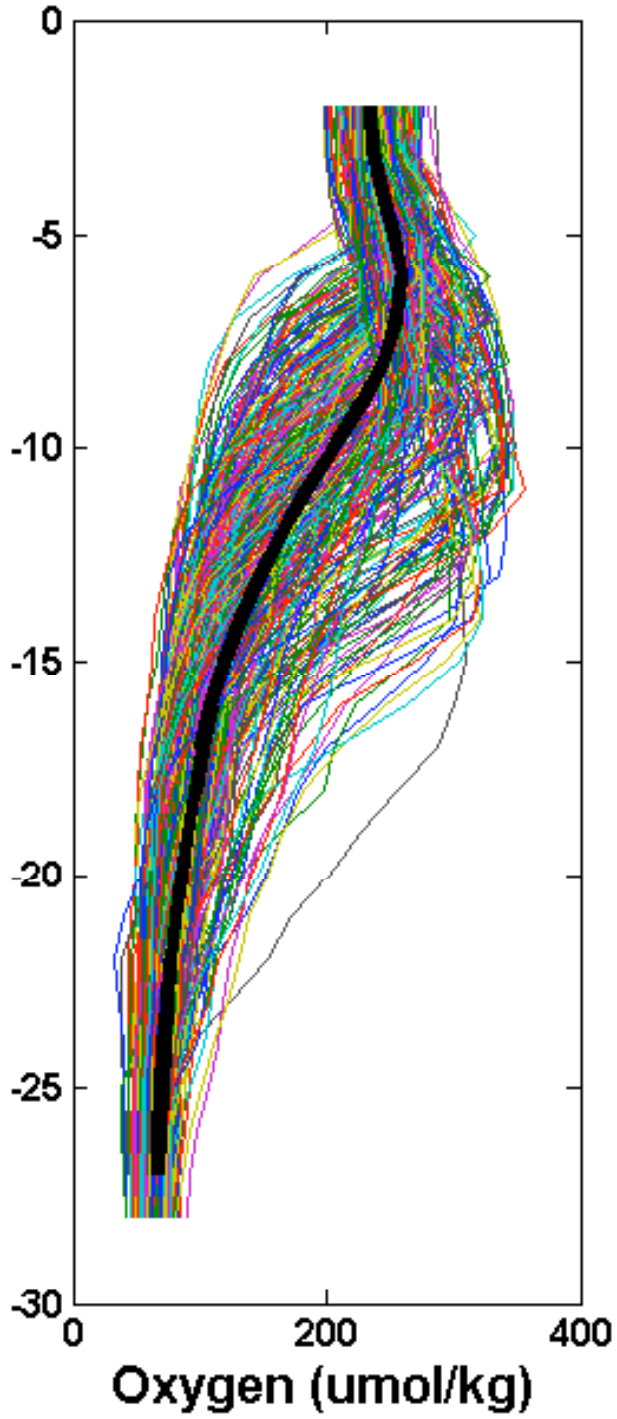


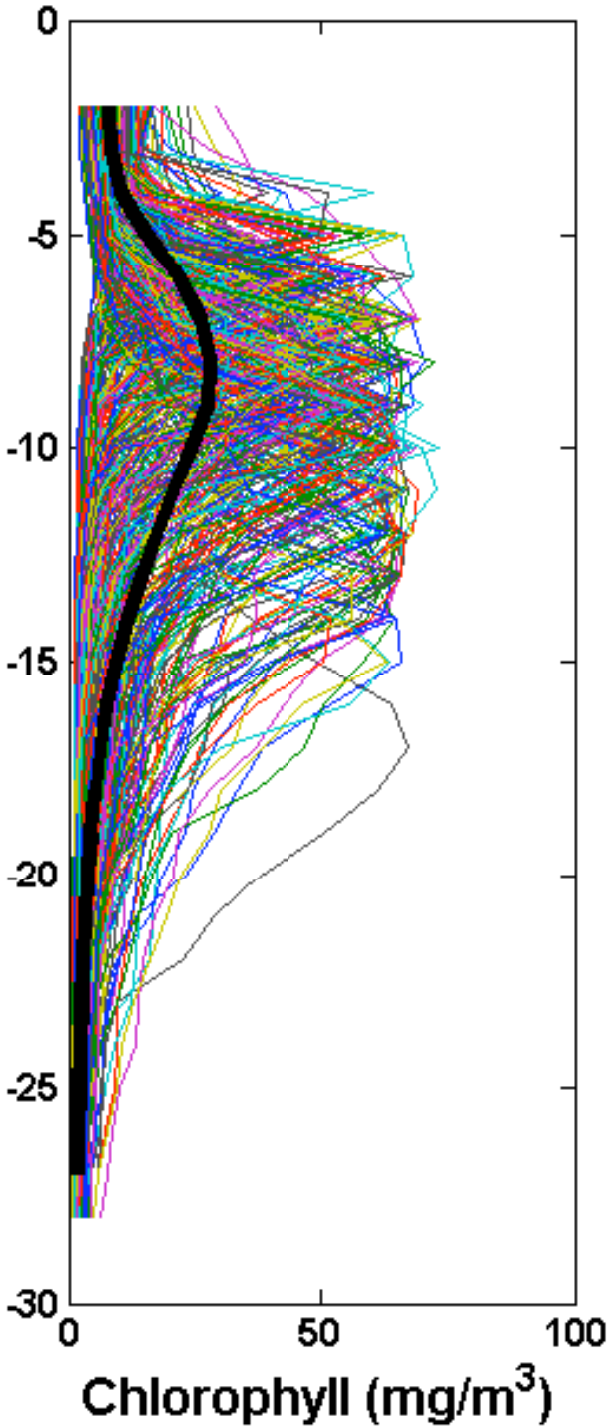


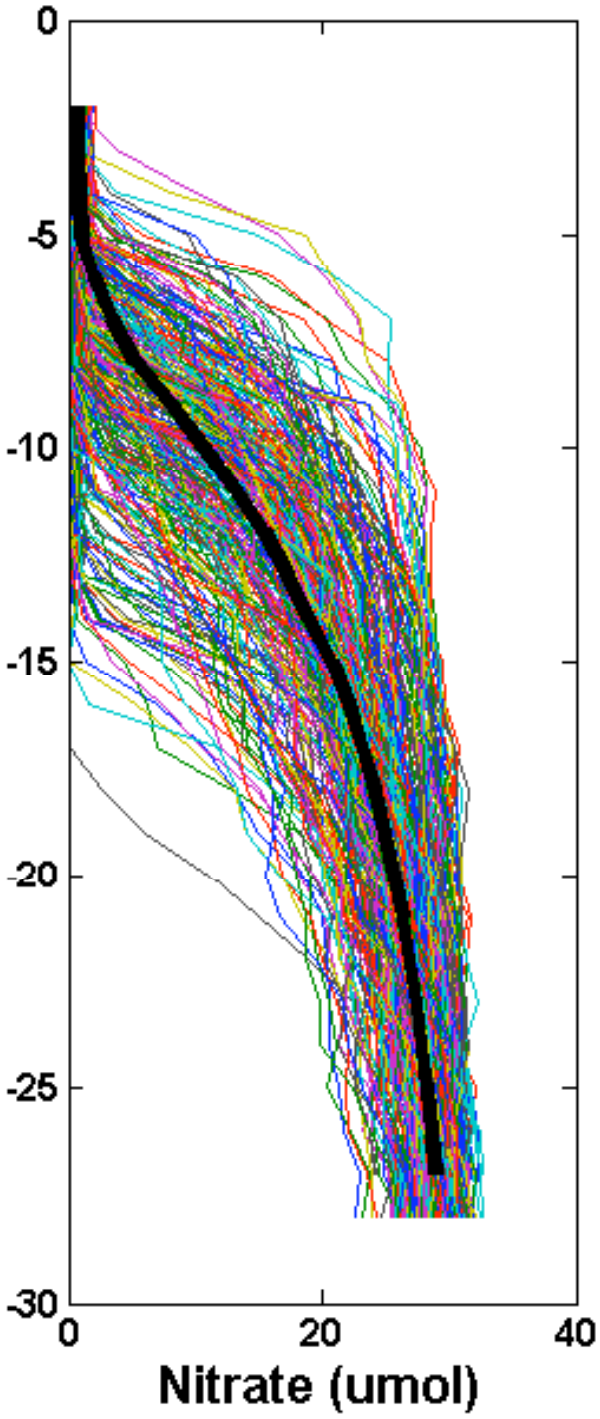


Basins

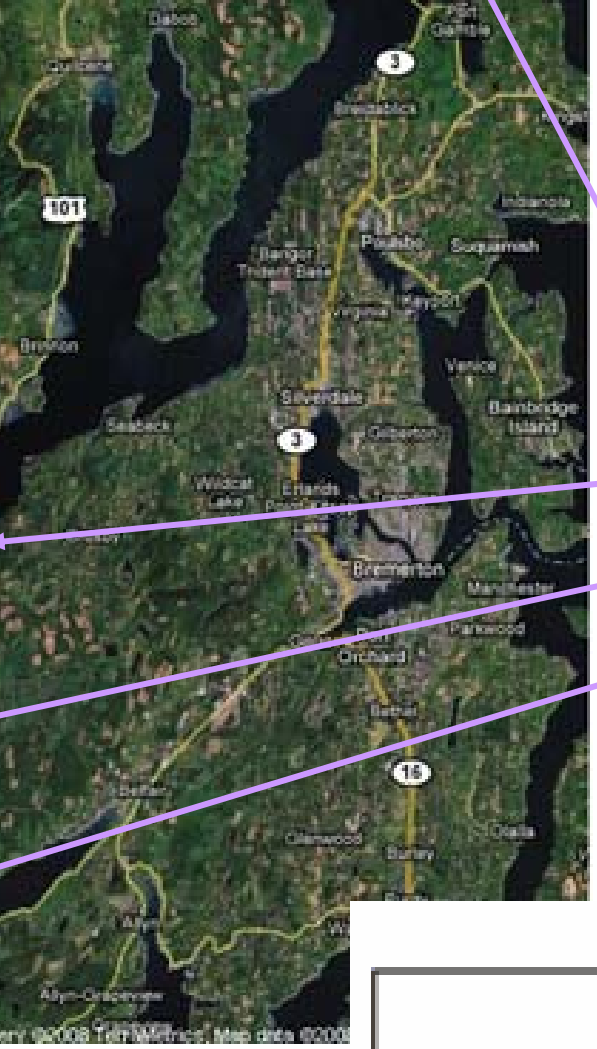
- Hood Canal: slow circulation
- Main Basin: fastest circulation
- Whidbey Basin: mos freshwater input
- South Sound: strong mixing, slower circu


0
-5
-10
-15
-20
-25
-30
0
200
400
Oxygen (umol/kg)


0
-5
-10
-15
-20
-25
-30
0
50
100
Chlorophyll (mg/m3)

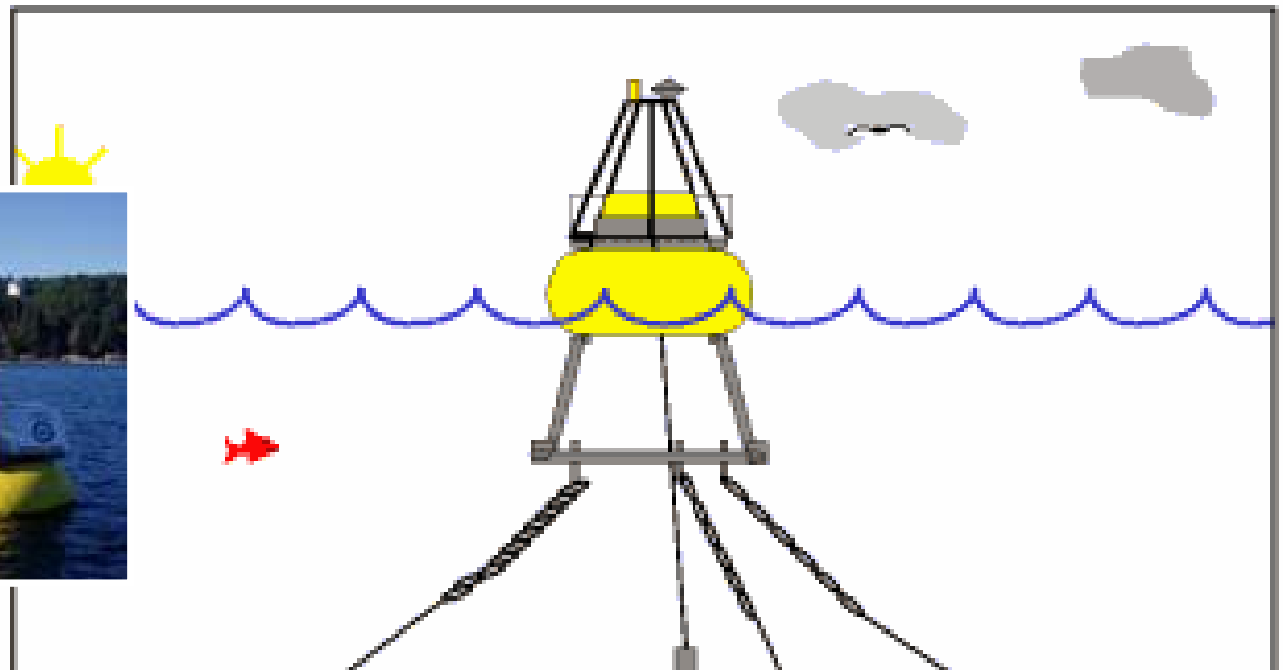

0
-5
-10
-15
-20
-25
-30
0
20
40
Nitrate (umol)

ORCA buoys



4 buoys, 4 locations…

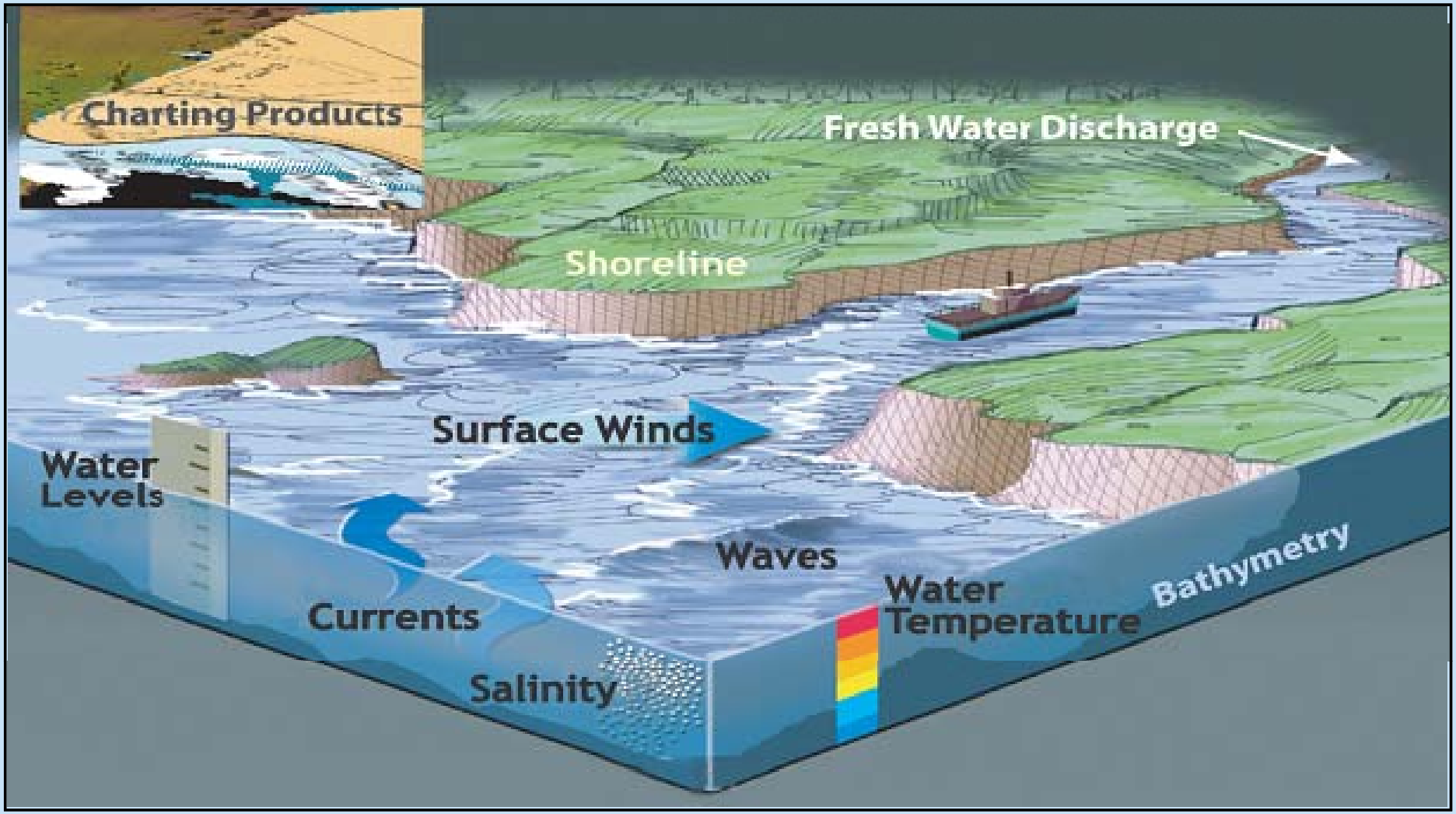
1) North of HC Bridge
2) Hama Hama River
3) Hoodsport
4) Sister's Point



A."

Part of NAN
Observing

Fundamental Issue:



We are limited and poorly coordinated with respect to environmental data supporting fundamental societal needs

ngress: We need a system that c
fill societal needs for ocean data

- Must be sustained
- Must be driven by users
- Must be responsive to regional needs
- Must fill needs from end to end

The Integrated Ocean Observing
System is designed to fill this need

AN OBSERVING SYSTEM

Seven goals, one syste

prove predictions of ***climate change and weather***

prove the safety and efficiency of ***maritime operation***

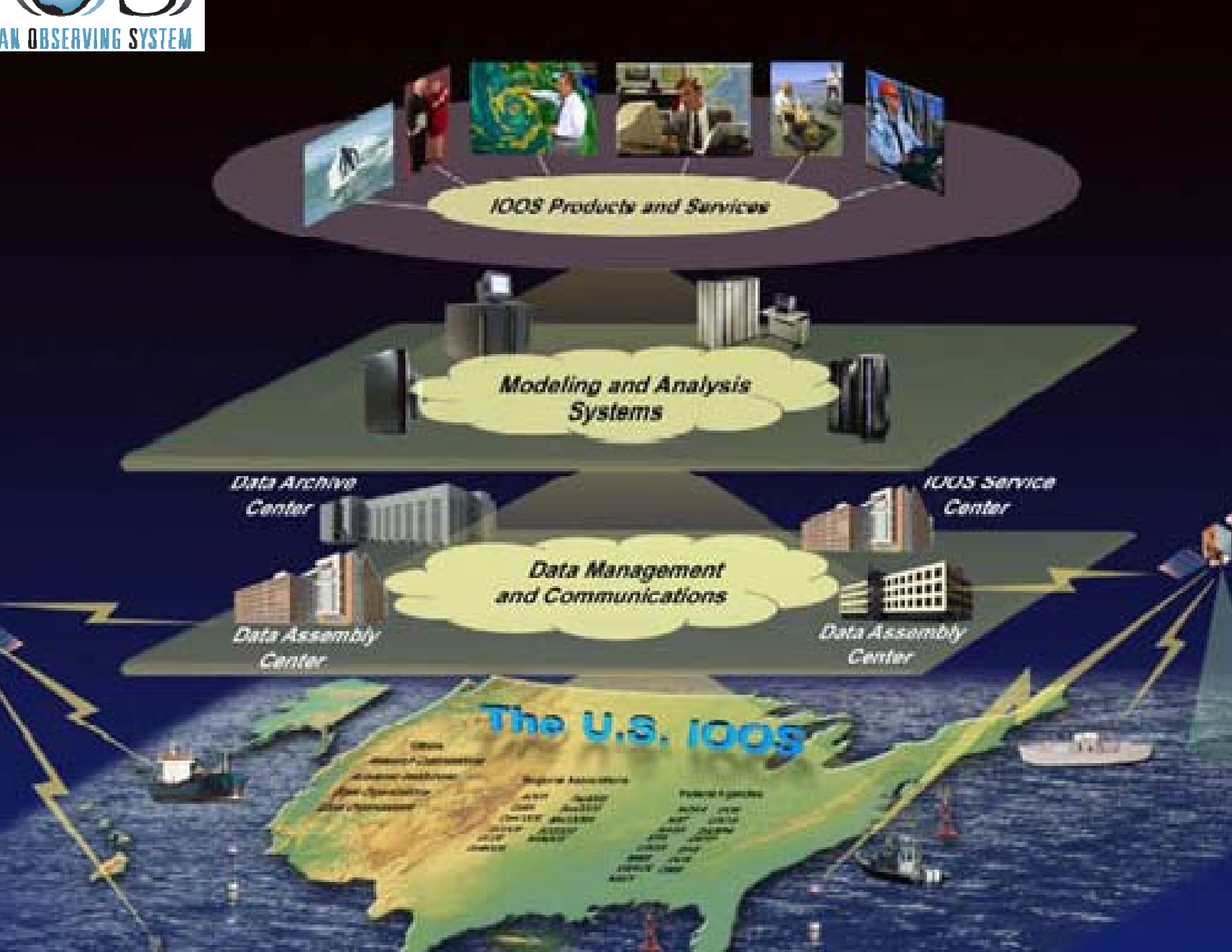
prove forecasts of ***natural hazards*** and mitigate effec

prove ***homeland security***

himize ***public health risks***

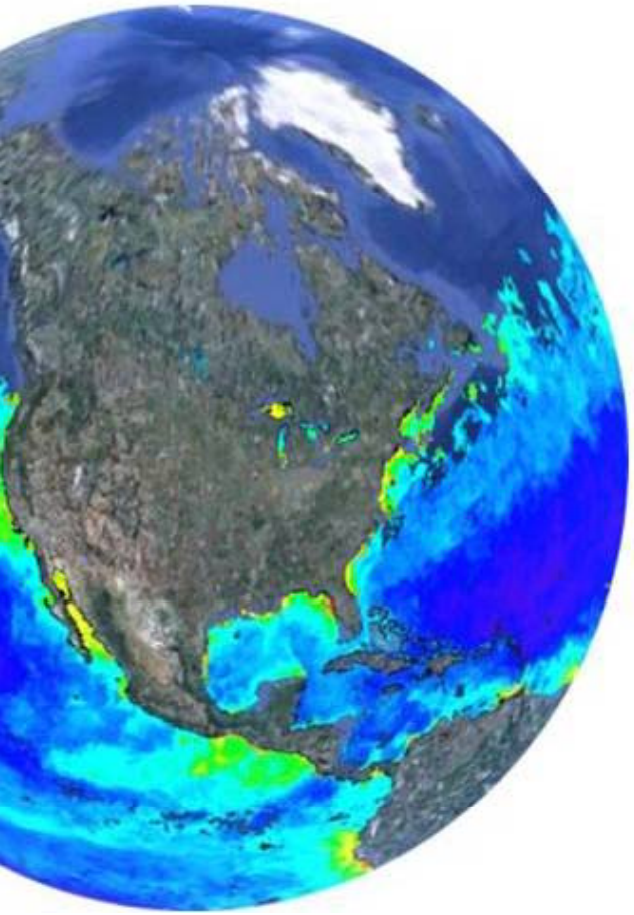
otect and restore ***healthy coastal ecosystems***

stain living marine ***resources***


AN OBSERVING SYSTEM
IOOS Products and Services
Modeling and Analysis Systems
Data Archive Center
IOOS Service Center
Data Management and Communications
Data Assembly Center
Data Assembly Center
The U.S. IOOS

17 Federal Agencies

US IOOS:
Global Componen
Coastal Compone



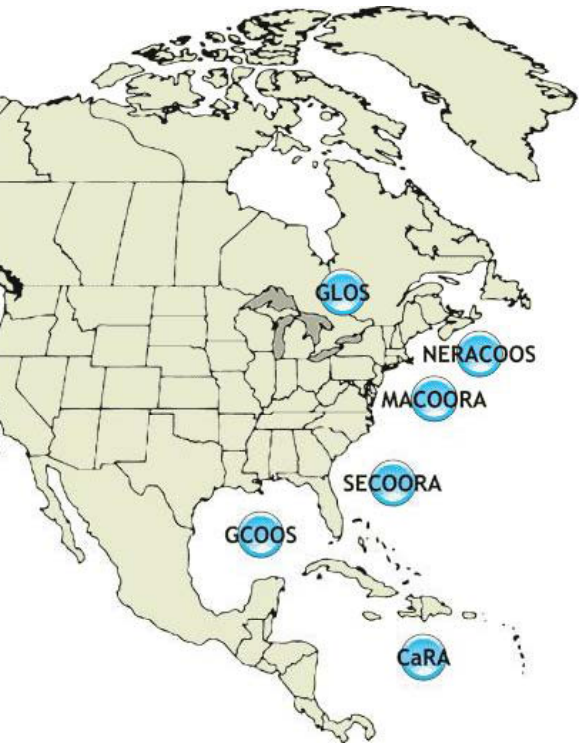
- National Observations
- Data Management Architect
- Basin and Regional Modeling
- Leads the Regional Compone

Regional Associations for
Coastal and Ocean Observing

a Regional Approach

INTEGRATED OCEAN OBSERVING SYSTEM

CONSISTENT NATIONAL CABABILITY



assure

Reg. Assn's

Leverage and Link

engage

nwest Association of Networked Ocean Observing Syst

The Integrated Ocean Observing System (IOOS)
Regional Association for the Pacific NW

www.nanoos.org

NOOS Governing Council Members

ean Inquiry Project
Dept of Land Conservation & Development
frider Foundation
e Boeing Company
egon State University
get Sound Partnership
versity of Washington
T Labs, Inc.
egon Health and Sciences University
leute Indian Tribe
Dept of Geology and Mineral Industries
mboldt State University
rine Exchange of Puget Sound
Dept of Ecology
cific Northwest National Laboratory
t of Newport
get Sound Harbor Safety Committee
und Ocean Systems, Inc.
uncil of American Master Mariners
od Canal Salmon Enhancement Group
cific Northwest Salmon Center

24. Western Association of Marine Laboratorie
25. Science Applications International Corpora
26. OR Dept of Fish and Wildlife
27. King County Dept Natural Resources & Pa
28. Quinault Indian Nation
29. Western Resources and Applications
30. OR Dept of State Land
31. Columbia River Crab Fisherman's Associa
32. Port of Neah Bay
33. Northwest Research Associates
34. Pacific Ocean Shelf Tracking Project
35. WA Dept of Fish and Wildlife
36. Northwest Aquatic and Marine Educators
37. Seattle Aquarium
38. NOAA Northwest Fisheries Science Center
39. Port Gamble S'Klallam Tribe
40. The Nature Conservancy
41. Portland State University
42. NOAA Olympic Coast National Marine San
43. VENUS/University of Victoria
44. University of Oregon

ANOOS
iorities:

aritime Operations

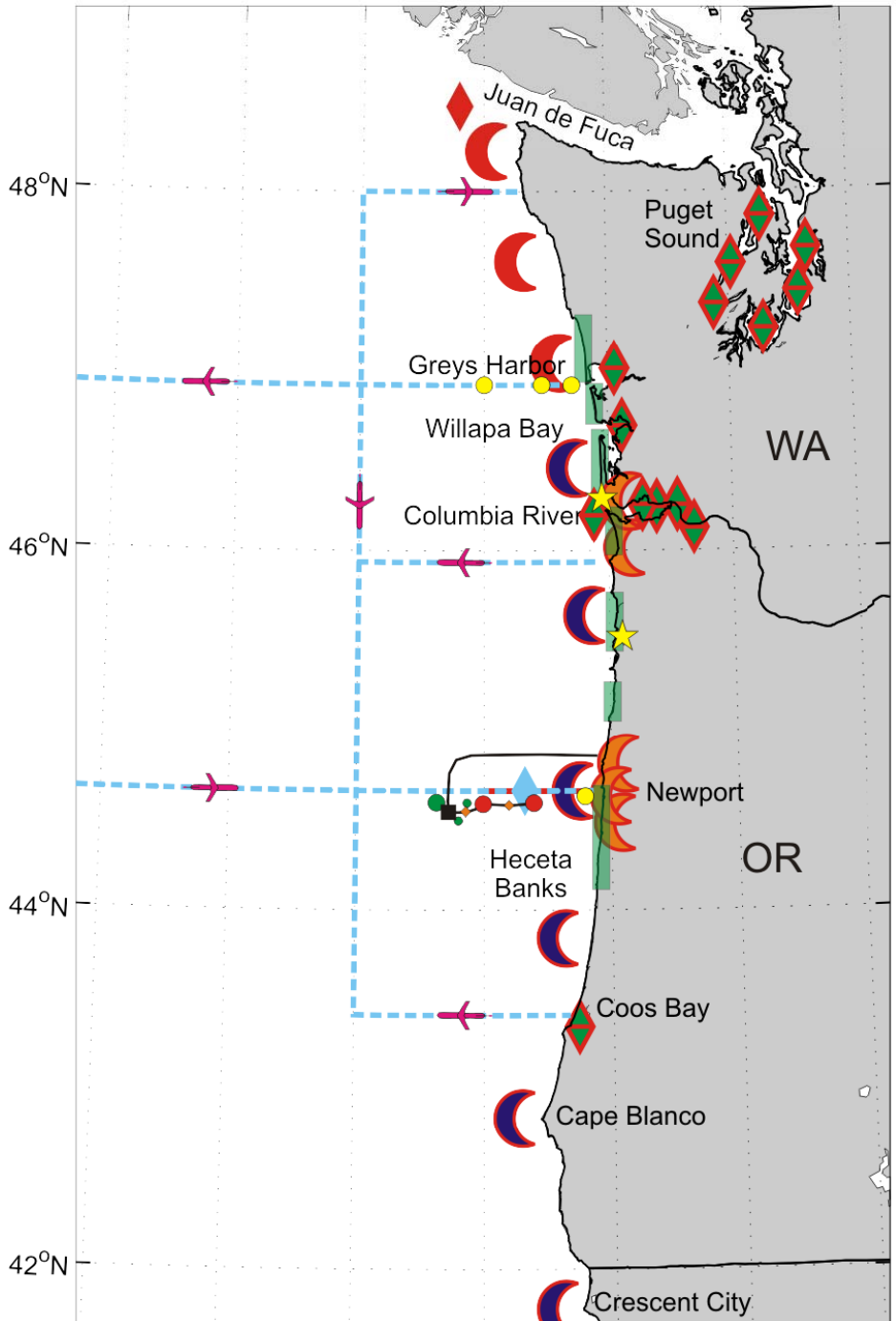
cosystem Impacts
Assessment

sheries & Marine
iodiversity

oastal Hazards

imate

PNW Ocean Observing Systems Design



NANOOS RCOOS Enhancement Conceptual Design

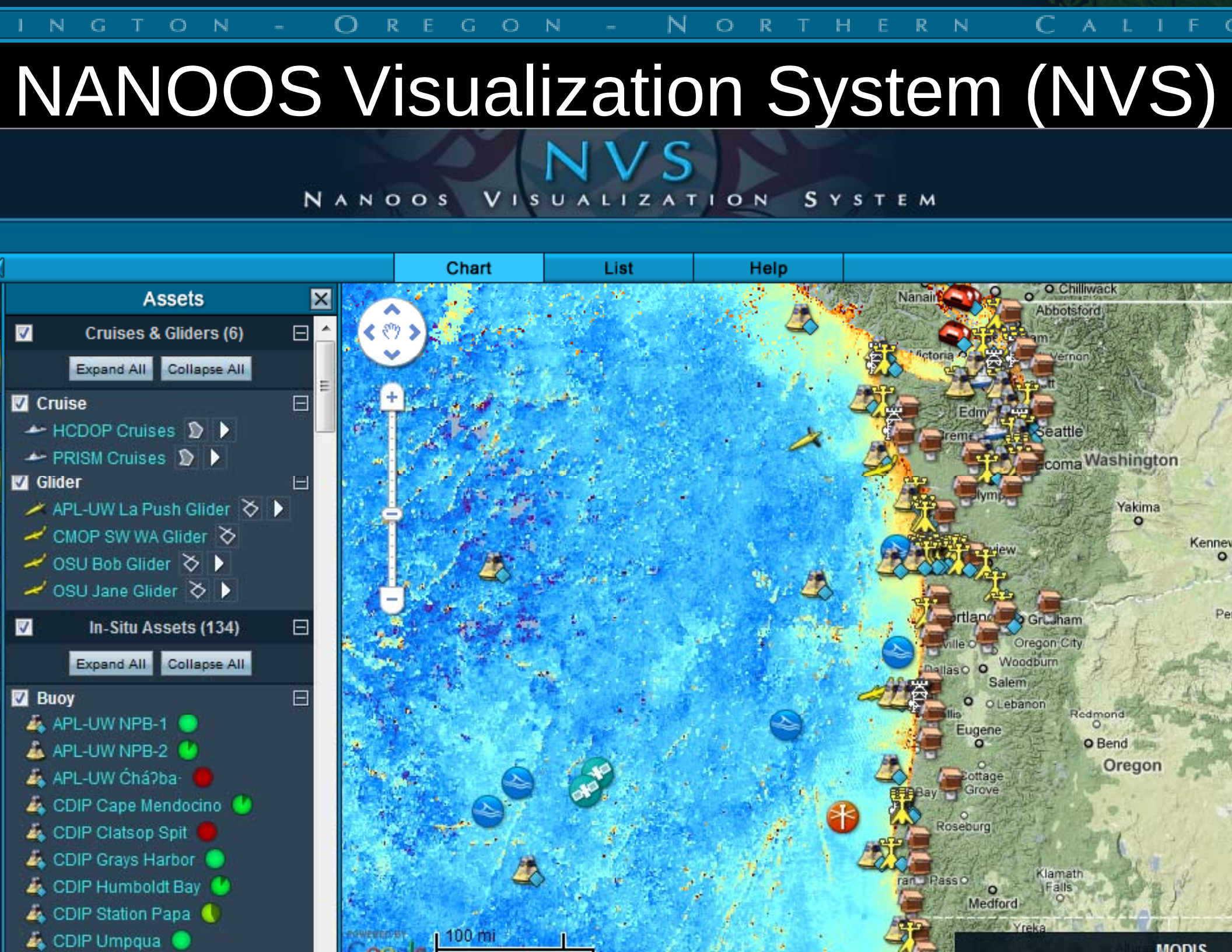
- Proposed new coastal buoy
- Existing coastal buoy to be sustained
- Existing estuarine buoys* to be sustained in partnership
- Existing glider track to be sustained
- Proposed new long-range HF site
- Existing long-range (180 km range) HF site to be sustained in partnership
- Existing standard-range (50 km range) HF site to be sustained in partnership
- Proposed new port wave radars
- Shoreline assessment to be sustained in partnership

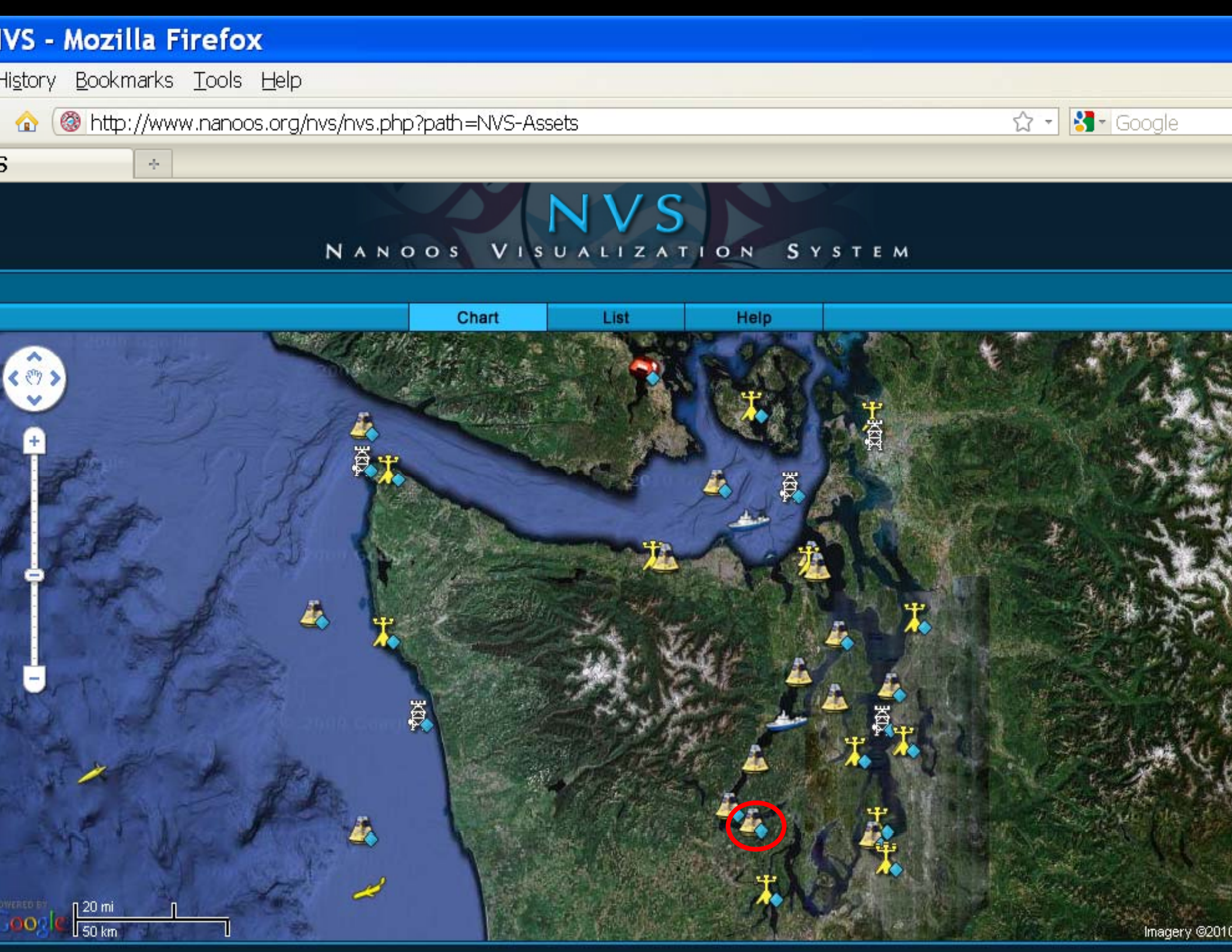
***estuarine buoys are more numerous than symbols**

OOI Conceptual Design

- Coastal mooring
- Cabled mooring
- Deepwater column mooring
- High voltage primary node
- Medium voltage primary node

NANOOS Visualization System (NVS)




VS - Mozilla Firefox
History Bookmarks Tools Help
http://www.nanoos.org/nvs/nvs.php?path=NVS-Assets
Google
NVS
NANOOS VISUALIZATION SYSTEM
Chart
List
Help
20 mi
50 km
Imagery ©2010

VS - Mozilla Firefox

History Bookmarks Tools Help

http://www.nanoos.org/nvs/nvs.php?path=NVS-Assets

Google

NVS

NANOOS VISUALIZATION SYSTEM

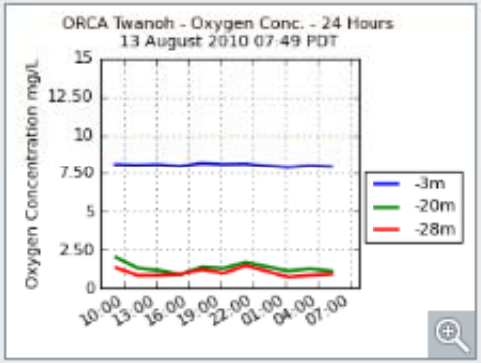
Chart | List | Help

Observations | Forecasts | Comparator

Profiling Buoy at Twanoh - Hood Canal *Website*

Location: Puget Sound, Washington **Lat:** 47.375 **Lon:** -123.0083
Provider: ORCA-UW **Data Source:** NANOOS-APL

Data Updated: 13 Aug 2010 5:18 PDT



	-20m:	2.5 µg/L
	-28m:	2.2 µg/L
Nitrate		
	-3m:	-8.4 µmol/kg
	-20m:	-8.4 µmol/kg
	-28m:	--.- µmol/kg
Oxygen Conc.		
	-3m:	8 mg/L
	-20m:	1.1 mg/L
	-28m:	0.9 mg/L
Oxygen Pct. Sat.		

24 Hours | 7 Days | 30 Days

Link

20 mi
50 km

Imagery ©2010

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VS - Mozilla Firefox

History Bookmarks Tools Help

http://www.nanoos.org/nvs/nvs.php?path=NVS-Assets

Google

NVS

NANOOS VISUALIZATION SYSTEM

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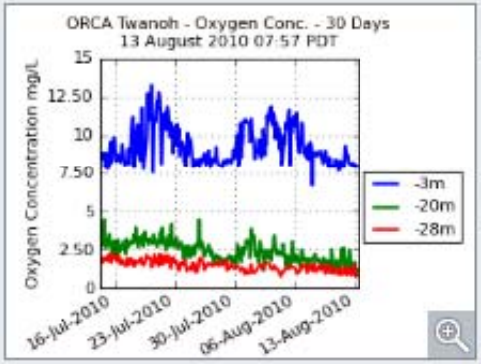

Chlorophyll		
-3m:	7.2	µg/L
-20m:	2.5	µg/L
-28m:	2.2	µg/L
Nitrate		
-3m:	-8.4	µmol/kg
-20m:	-8.4	µmol/kg
-28m:	--.-	µmol/kg
Oxygen Conc.		
-3m:	8	mg/L
-20m:	1.1	mg/L

24 Hours | 7 Days | 30 Days

Link

20 mi
50 km

Imagery ©2010

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NVS

NANOOS VISUALIZATION SYSTEM

Chart | Data | Plots | Matrix

Sections

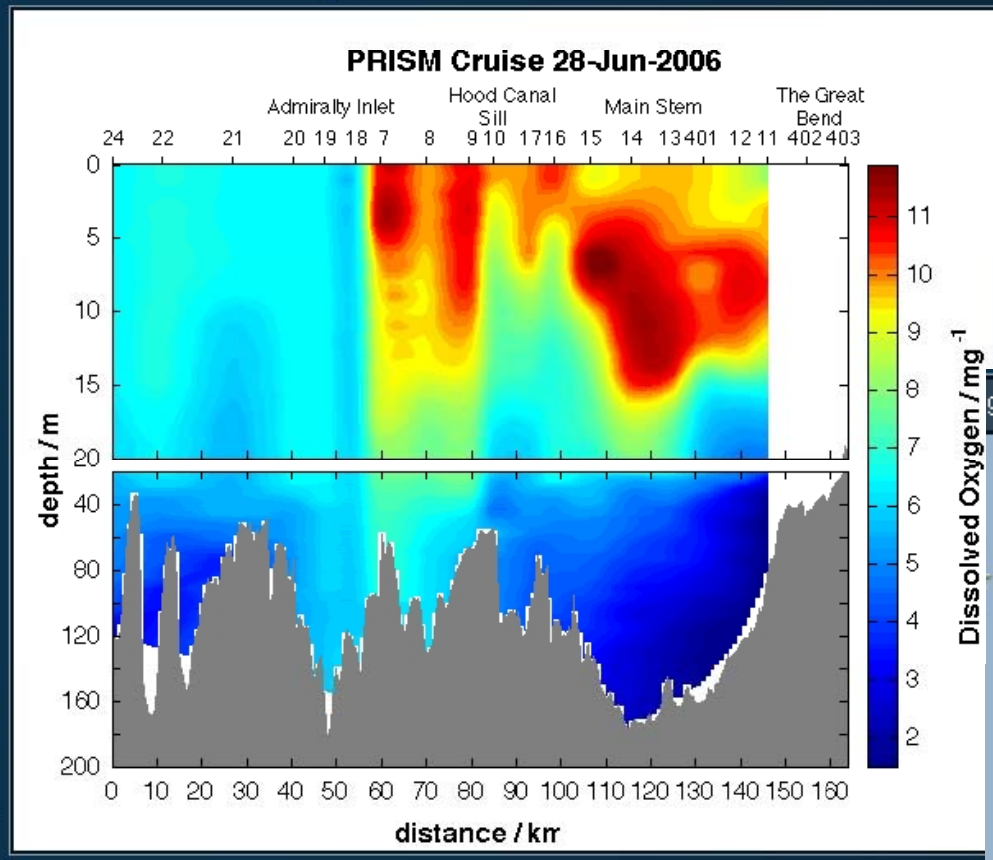
Whidbey Island

Cruises

2006 June

Variables

Oxygen Concentration - Uncalibrated



NANOOS Home

erves cruise data

Serves buoy dat

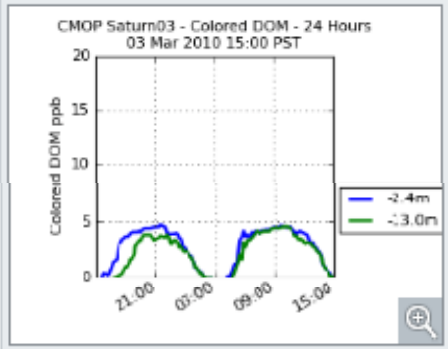
932

SATURN-03

Location: Columbia Estuary, Oregon Lat: 46.2 Lon: -1

Provider: CMOP Data Source: NANOOS-CMOP

Data Updated: 3 Mar 2010 15:10

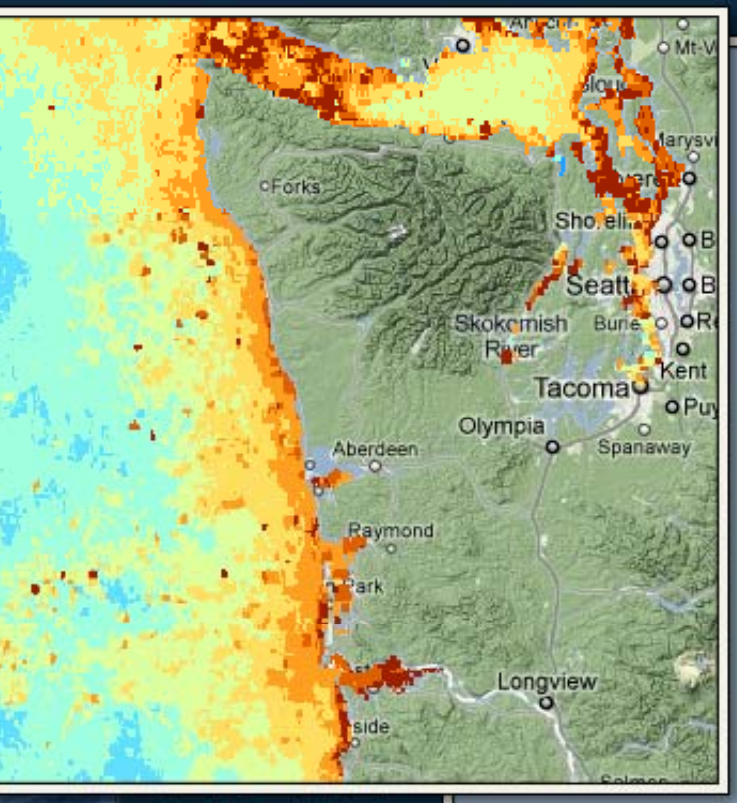


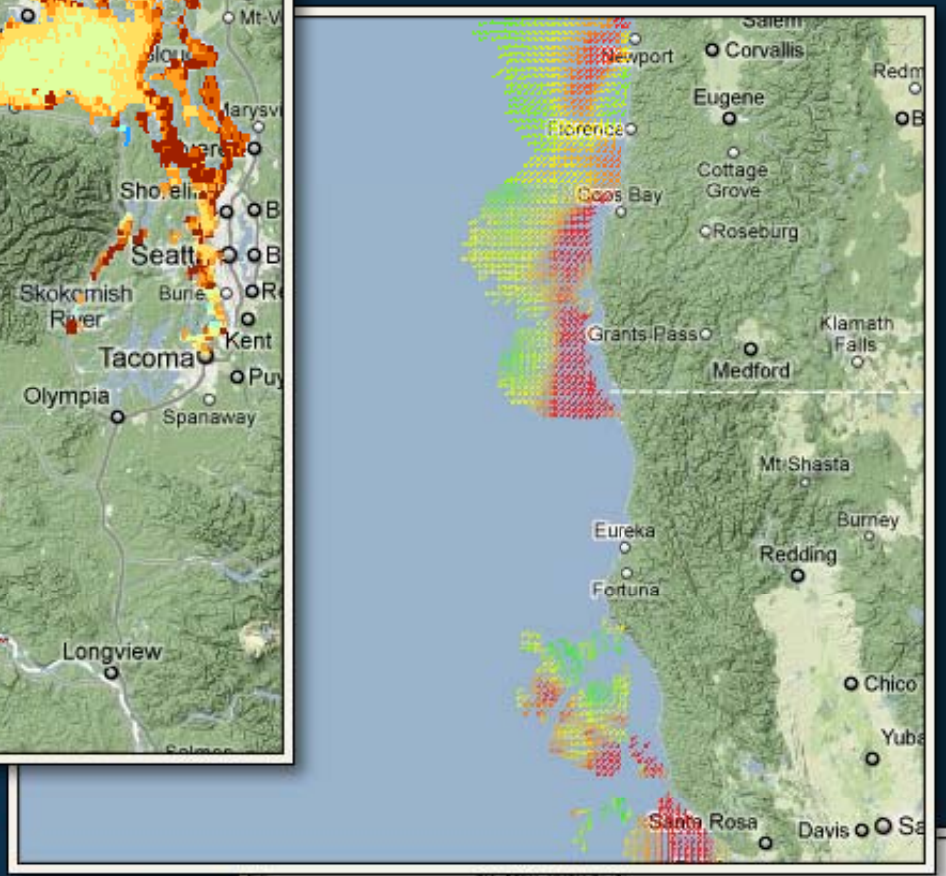
-2.4m
-13.0m
Quantum
-2.4m
-13.0m
Salinity
-2.4m
-13.0m
Water Te
-2.4m
-13.0m

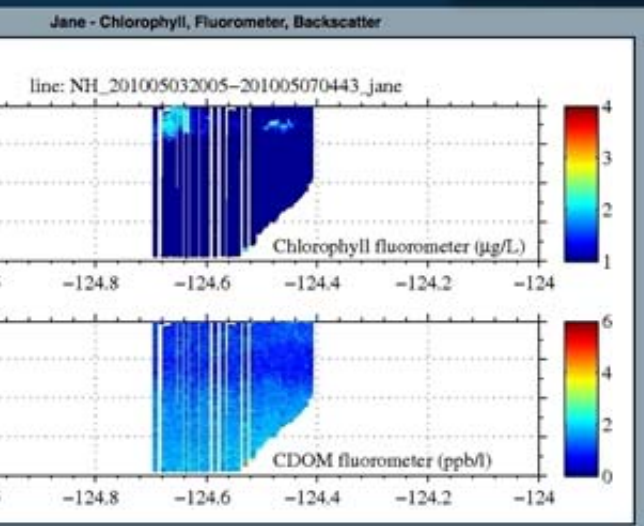
24 Hours | 7 Days | 30 Days

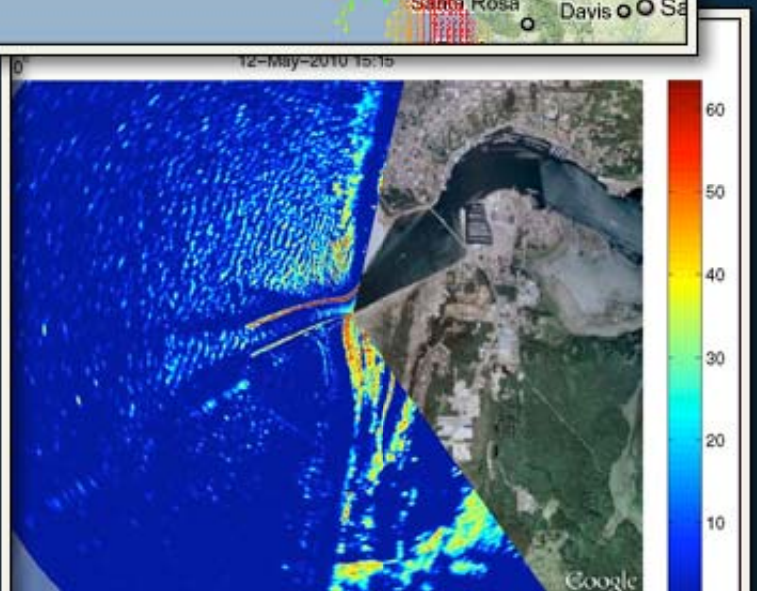
Link

NVS Version 1.6 - Products





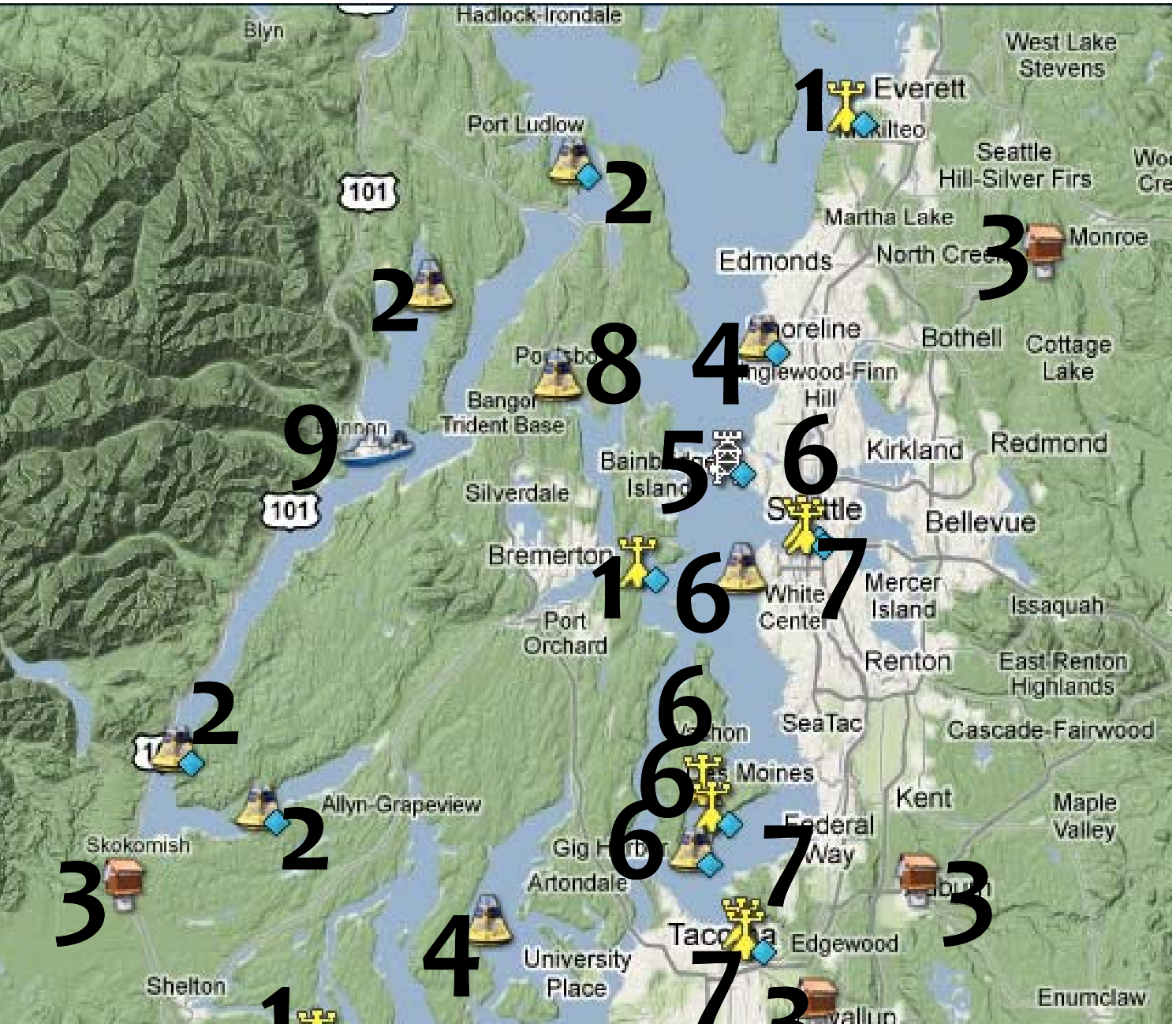




- In-Situ Observati
- AVHRR & MODIS
- PRISM Cruise Da
- HF Radar
- OSU Gliders
- NH-10
- X-Band Radar
- *and More*

value of NANOOS

NANOOS is a community of people that
data through one place for quicker decisio



1. Washington Dept of Ecology
2. Oceanic Remote Chemical-optical Analyzer (*ORCA*)
3. USGS
4. University of Washington – Applied Physics Lab
5. NOAA National Data Buoy Center
6. King County
7. NOAA National Ocean Service
8. IntelliCheck Mobilisa
9. Hood Canal Dissolved Oxygen Program

Marine water monitoring strateg

ze different platforms to get different information, collectively
ielding full picture:

ixed profiling moorings: Located in the major basins, these autonomous asset
sed to collect data to evaluate high-resolution dynamics, interannual variation,
ffects from processes such as tidal forcing. The data enable the calculation of n
ransport over tidal cycle, provide input for dynamical models, and key real-time
ata that can be used for early warning system e.g., ocean acidification.

ixed depth moorings: These autonomous assets provide more spatial definitio
specially in bays/inlets and in well mixed areas. The data enable the calculation
ter-basin tidal and net transport of oxygen, freshwater and tidal height (weath
elated anomalies) as well as provide information about the system-wide signal
ropagation of water quality variables.

ight/ship based system: The data will provide the opportunity for high quality
ensor calibration, thus assuring accuracy and inter-calibration of the autonomo
ensors networks over time.

TEGRATED OCEAN OBSERVING SYSTEM

NANOOS

Northwest Association of Networked Ocean Observing Systems

Welcome to NANOOS, the Pacific Northwest regional ocean observing system of IOOS (Integrated Ocean Observing System), an integrated network of regional systems.

NANOOS is creating customized information and tools for Washington, Oregon, and Northern California with these areas of emphasis:

- Maritime Operations
- Ecosystem Assessment
- Fisheries & Biodiversity
- Coastal Hazards
- Climate

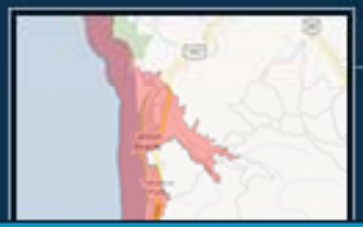
Noteworthy

NANOOS Visualization System - Version 2.5

Announcing the release of NVS 2.5. New features include settings for how units are displayed and the range of plot y-axis. If you are logged into your myNANOOS account, the settings are automatically saved. New forecast overlays from CMOP (Coastal Margin Observation & Prediction) and NAM (North American Mesoscale) are also available. Try NVS 2.5 and tell us what you think.

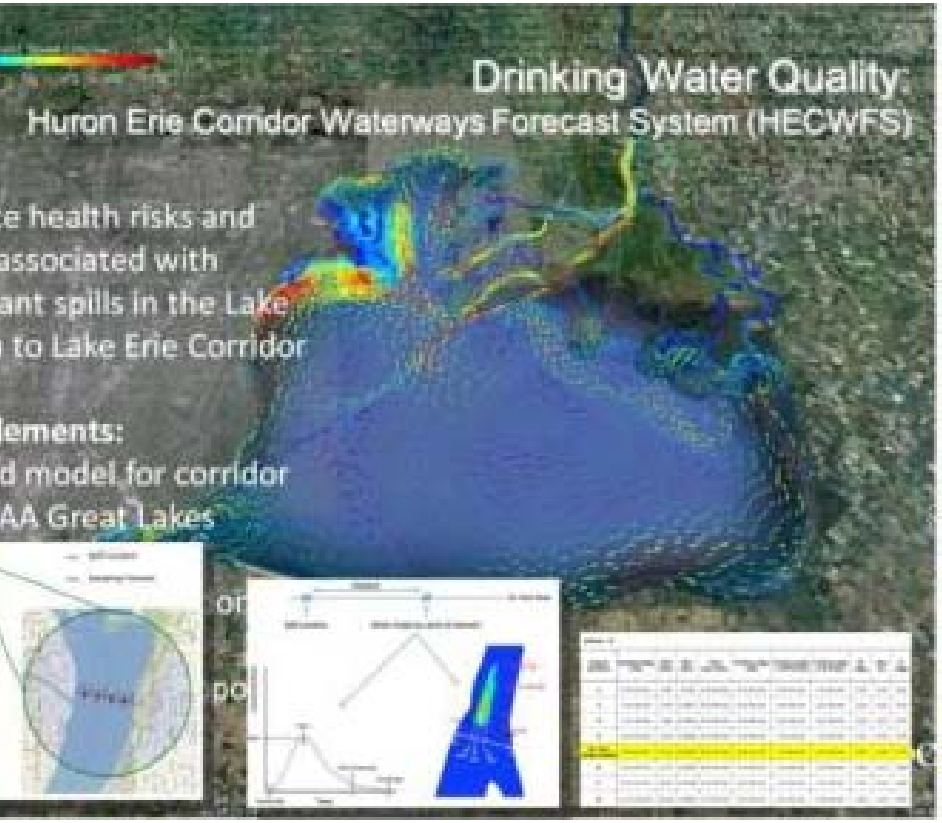
Honshu Earthquake and Tsunami 2011

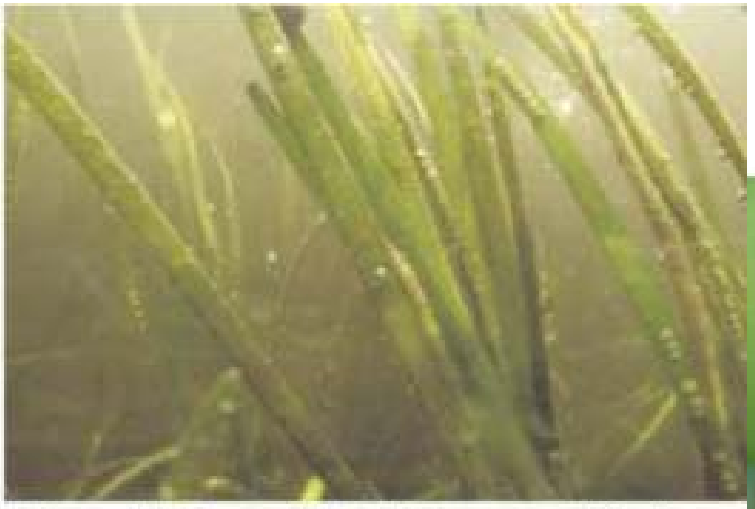
An informational page about the magnitude 9.0 earthquake that occurred off the eastern coast of Japan on March 11, 2011, and the resulting tsunami that hit the US Pacific Northwest 9 hours later.



Tsunami Evacuation Zones for the Oregon Coast - Interactive Map

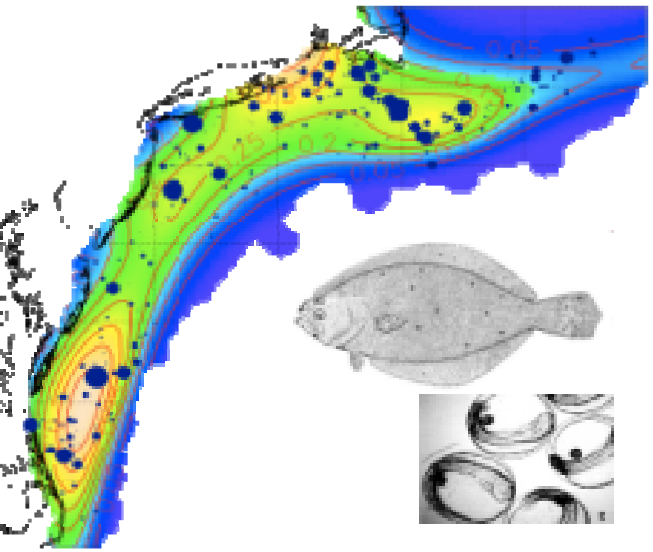
The Oregon Department of Geology and Mineral Industries and the NANOOS User Products and DMAC team, is pleased to announce the release of new tsunami inundation maps developed for the southern Oregon coast (Bandon to Brookings) and for Cannon Beach on the north coast, now accessible through the NANOOS/DOGAMI Tsunami Hazards Portal





Great Bay, NH Buoy - high resolution data to determine nutrient impact on eel grass - resulted in recommended change to EPA regulations

s to understand larval transport



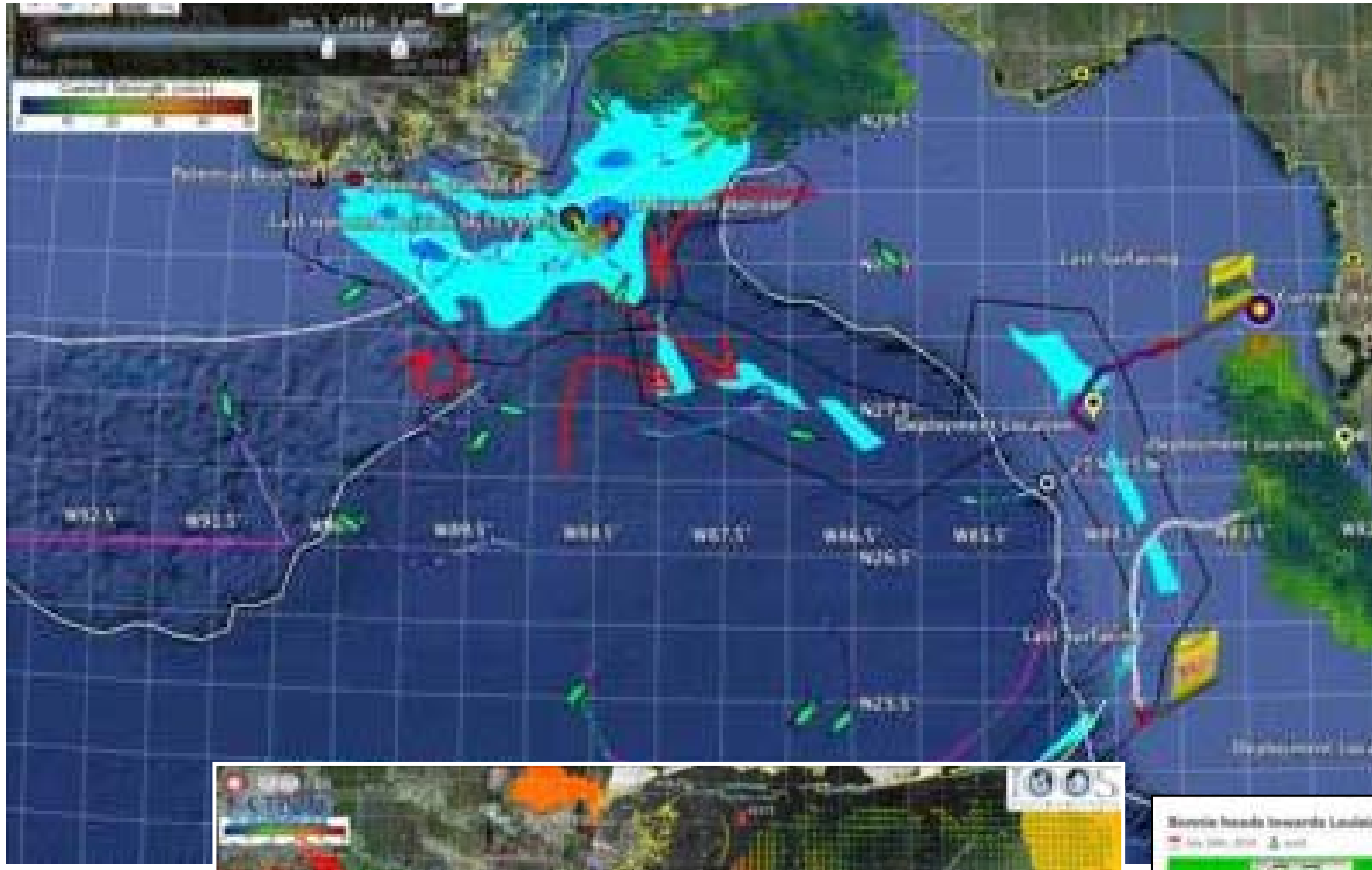
Gliders: Dissolved Oxyg water quality monitorin

partnership
ated ability to:

deploy technologies:
and HF radar, saving
es/improving safety

/Imagery ingested into
Navy models

similation improved spill
e decision-making and
nderstanding



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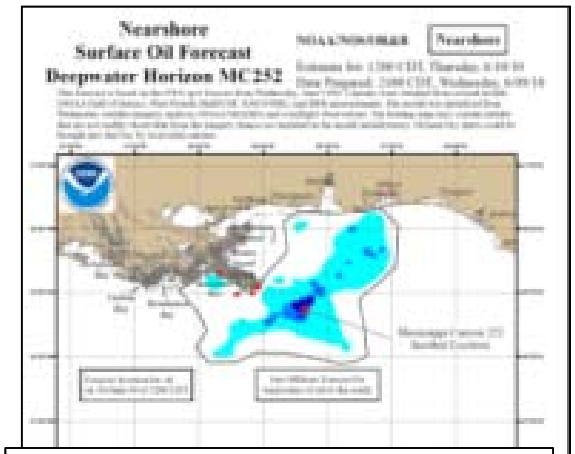
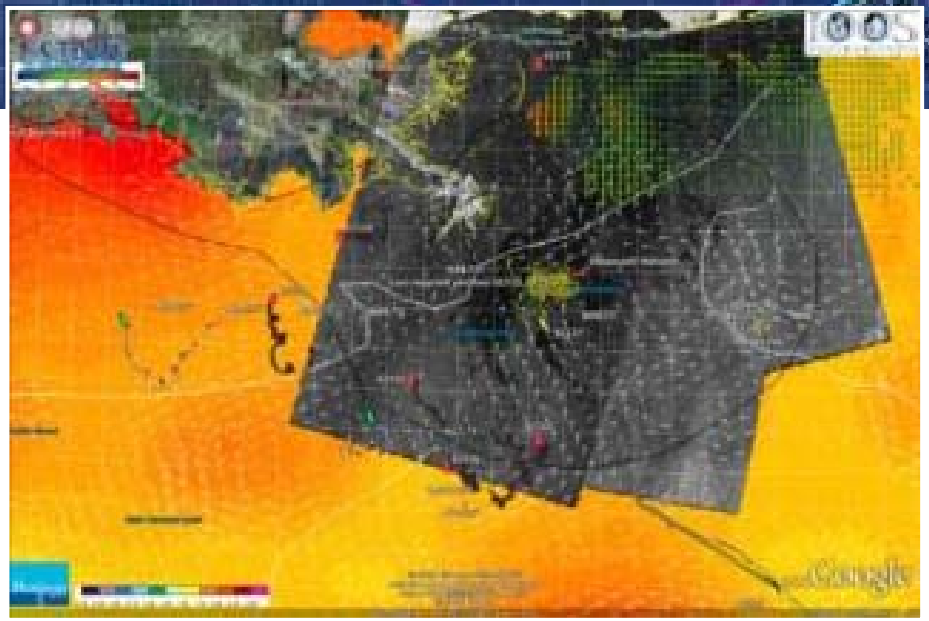
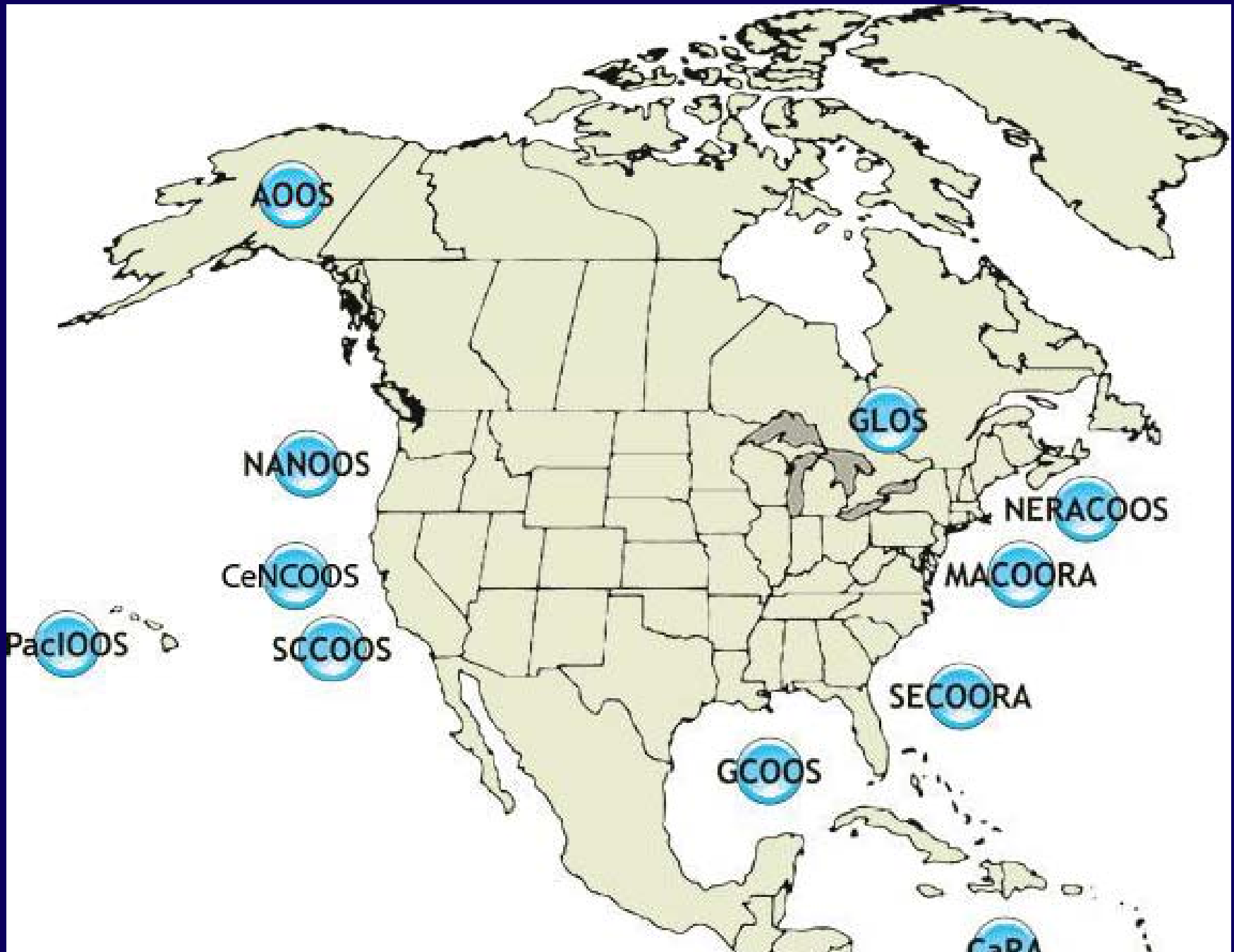


HFR data informed NOAA 's trajectory forecasts



HFR validation of SABGOM Forecast with satellite detected oil slicks

Briefing

INTEGRATED OCEAN OBSERVING SYSTEM

Find the IOOS RA in your area