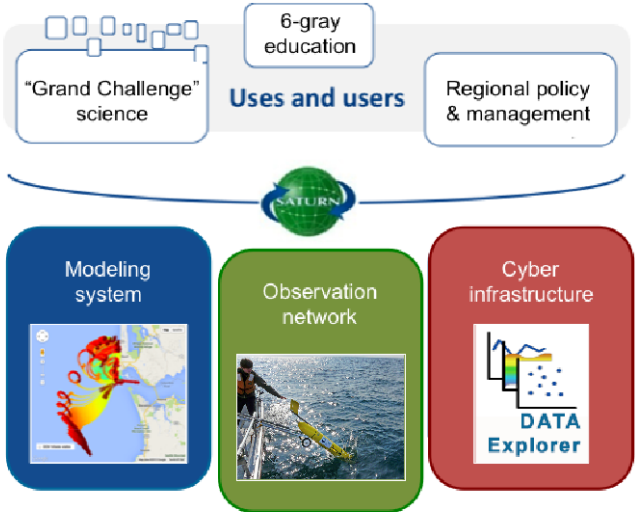
Coastal Margin Observation and Prediction at CRITFC



www.stccmop.org

CMOP Center for Coastal Margin Observation & Prediction

OREGON HEALTH & SCIENCE UNIVERSITY

Oregon State University OSU

UNIVERSITY of WASHINGTON

NSF NOAA USGS

IOOS LOBO

- History
- Observations
- Modeling

Charles Seaton, Sarah Riseman, Michael Wilkin

Goals of CMOP

- Maintain and expand a mature observation and modeling system for the Columbia River estuary and coastal ocean.
- Use CMOP capabilities as a base for addressing estuary and ocean questions and throughout the Columbia Basin.
- Integrate CMOP capabilities with tribal and regional needs.

CMOP and Salmon

CMOP modeling and observations have been interconnected with salmon research for over two decades:

- *Salmon at the River's End*
- Columbia River channel improvement project
  - Prediction, monitoring, and final assessment of salinity intrusion impacts
- Assessment of Columbia River plume features on smolt-to-adult-return ratio (SAR)
- Columbia River Treaty review assessment of ecosystem impacts from potential changes in hydrosystem management
- Salinity intrusion, temperature and dissolved oxygen observations in the Columbia River estuary

How did we get here?

1990-2000: LMER

- Science
- Designed to study Estuarine Turbidity Maxima (ETM)
- "Blind" cruises

1996-2006: CORIE

- Science & Translation
- Multi-purpose design (driver: circulation modeling)
- Physical sensors
- Endurance stations
- Real-time data
- Open-access data
- Model-informed cruises
- IOOS/NANOOS pilot project

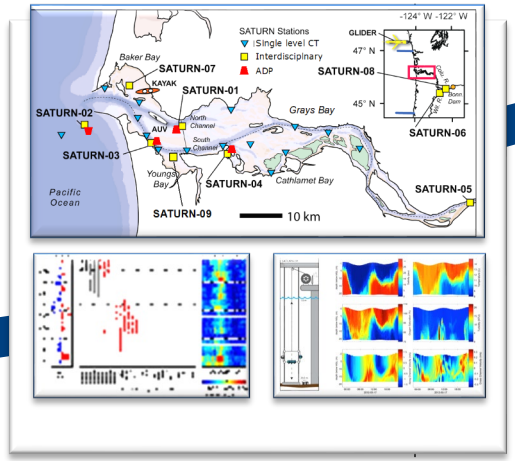
2006-2016: SATURN

- Science & Translation
- NSF-Science and Technology Center
- Multi-purpose design
- Interdisciplinary sensors
- Specialty endurance stations
- Pioneer array
- Coordinated campaigns
- Adaptive sampling
- IOOS/NANOOS sub-system

For historical context:

2007 – NOAA creates IOOS

2007 – OOI preliminary design

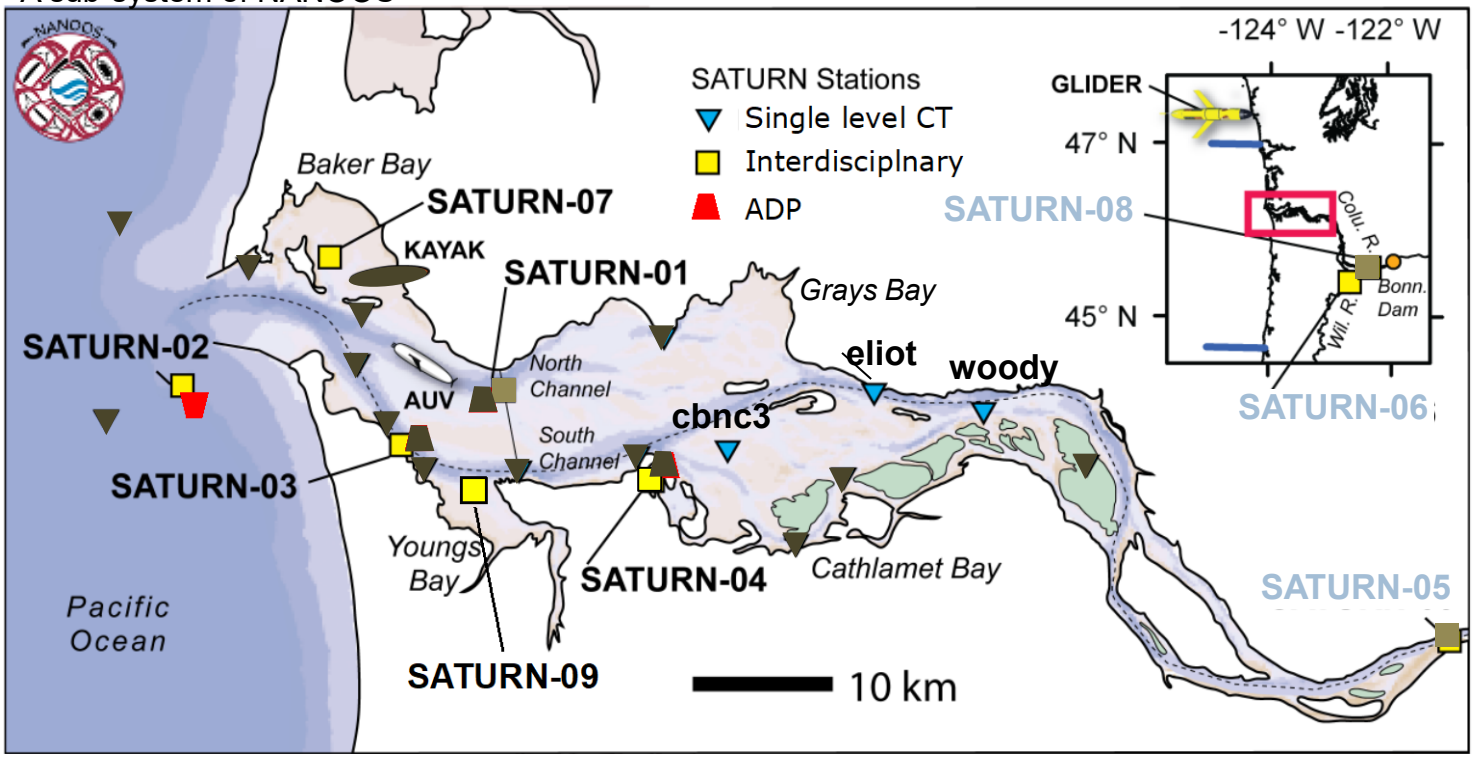


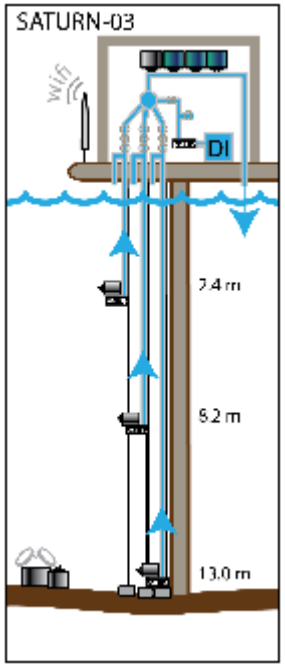
2020 onward: CMOP at CRITFC

- Interdisciplinary sensors
- Specialty endurance stations
- IOOS/NANOOS sub-system

The observation network (January 2022)

A sub-system of NANOOS





Interdisciplinary stations

Offshore (SATURN-02): May-Oct

Pt Adams (SATURN-03): Year-round

Tongue Pt. (SATURN-04): Year-round

Baker Bay (SATURN-07): Year-round

Youngs Bay (SATURN-09): Year-round

North Channel (SATURN-01): -2017

Physical stations

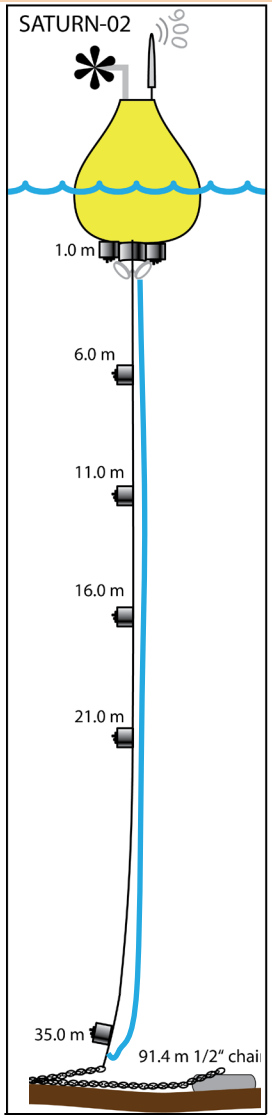
Elliott Pt. (eliot): Year-round, 2017-

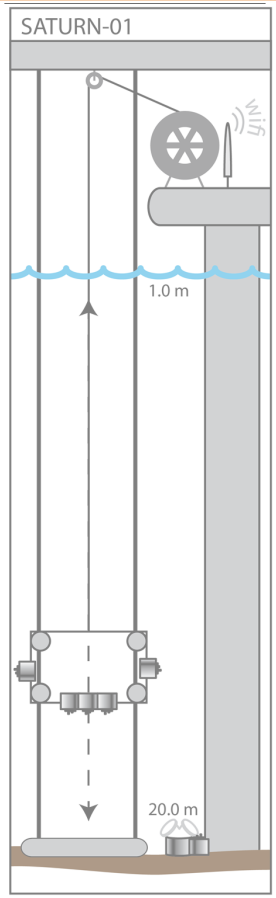
Cathlamet Bay (cbnc3): Year-round (no telemetry)

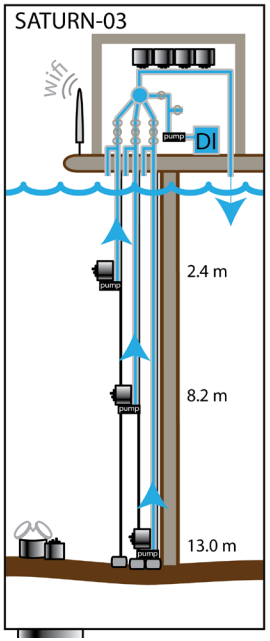
Woody Island (woody): Year-round

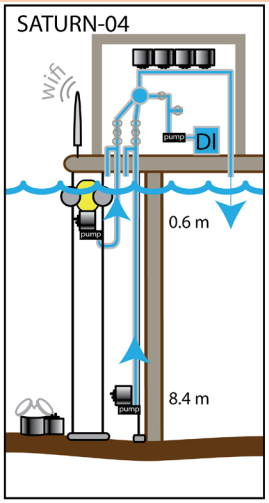
Upriver interdisciplinary stations:
SATURN-05 (Port Westward), SATURN-06 (Morrison Bridge), and SATURN-08 (Camas-Washougal) were developed by the Needoba-Peterson lab at OHSU as part of STC-CMOP in collaboration with USGS (-05, -06) and LCEP (-08). They did not transition to CRITFC-CMOP.

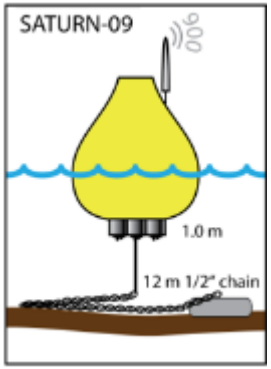
Station designs

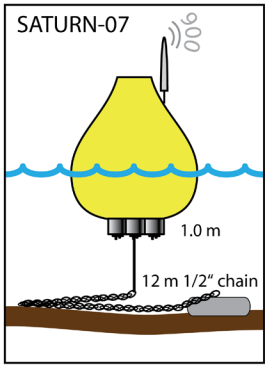


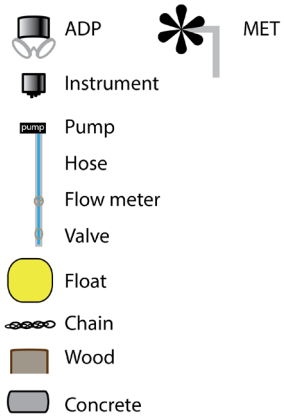








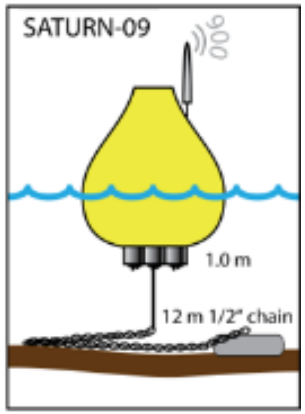




Challenges:

- High energy
- Strong & dynamic stratification
- Turbidity (visibility, clogging)
- Biofouling

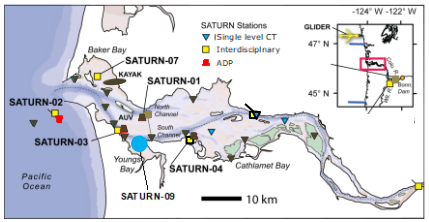
Observations: SATURN-09, Youngs Bay buoy



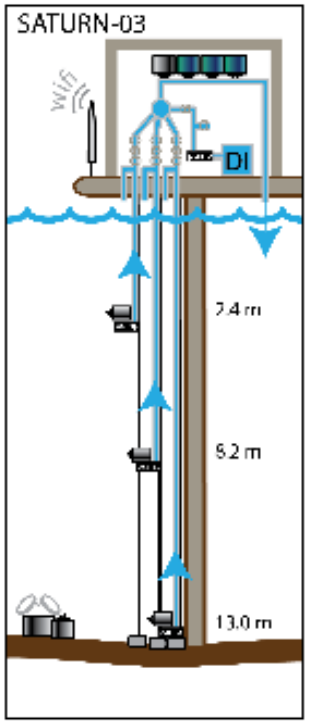
Buoys provide long-term sampling at points of interest in estuary and off-shore

On-deck maintenance visits extend continuous buoy deployment to a full year

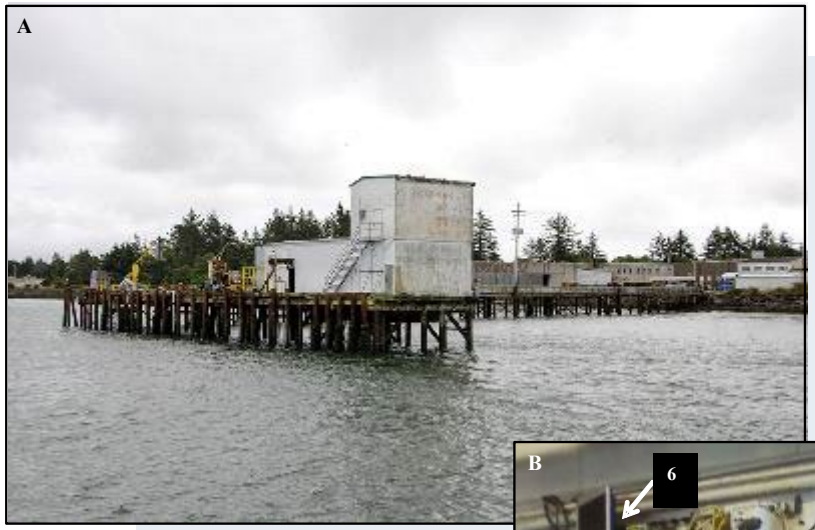
Collaboration with Clatsop Community College provides use of R/V Forerunner for marine operations

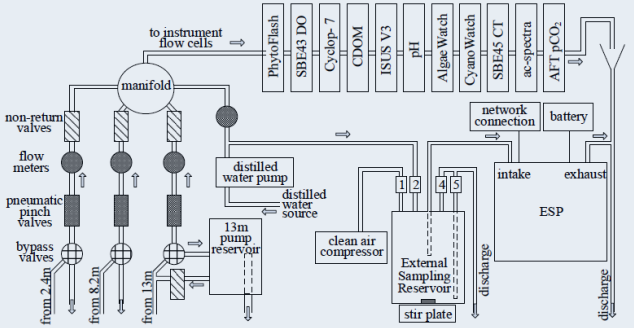


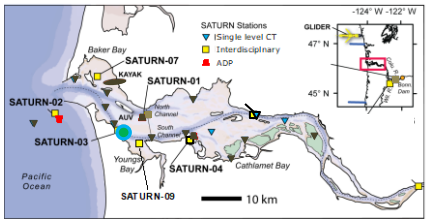
SATURN-03: Pt. Adams Pier Station

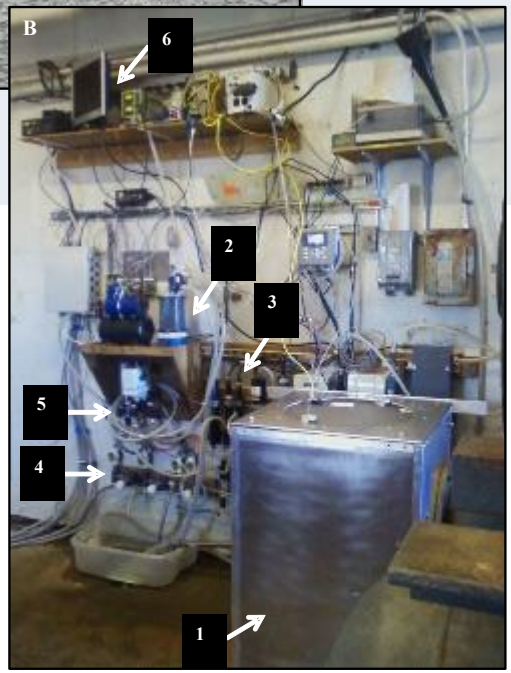


Pier stations enable powerful adaptive sampling



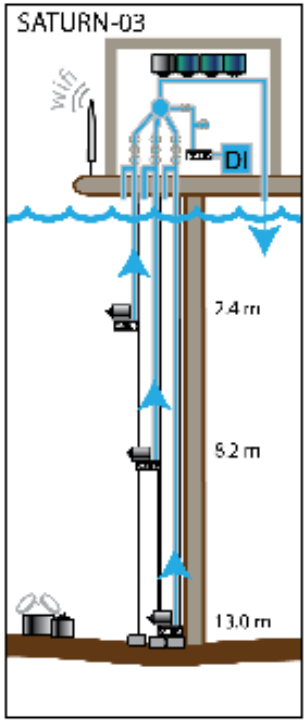


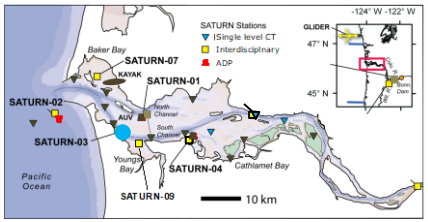




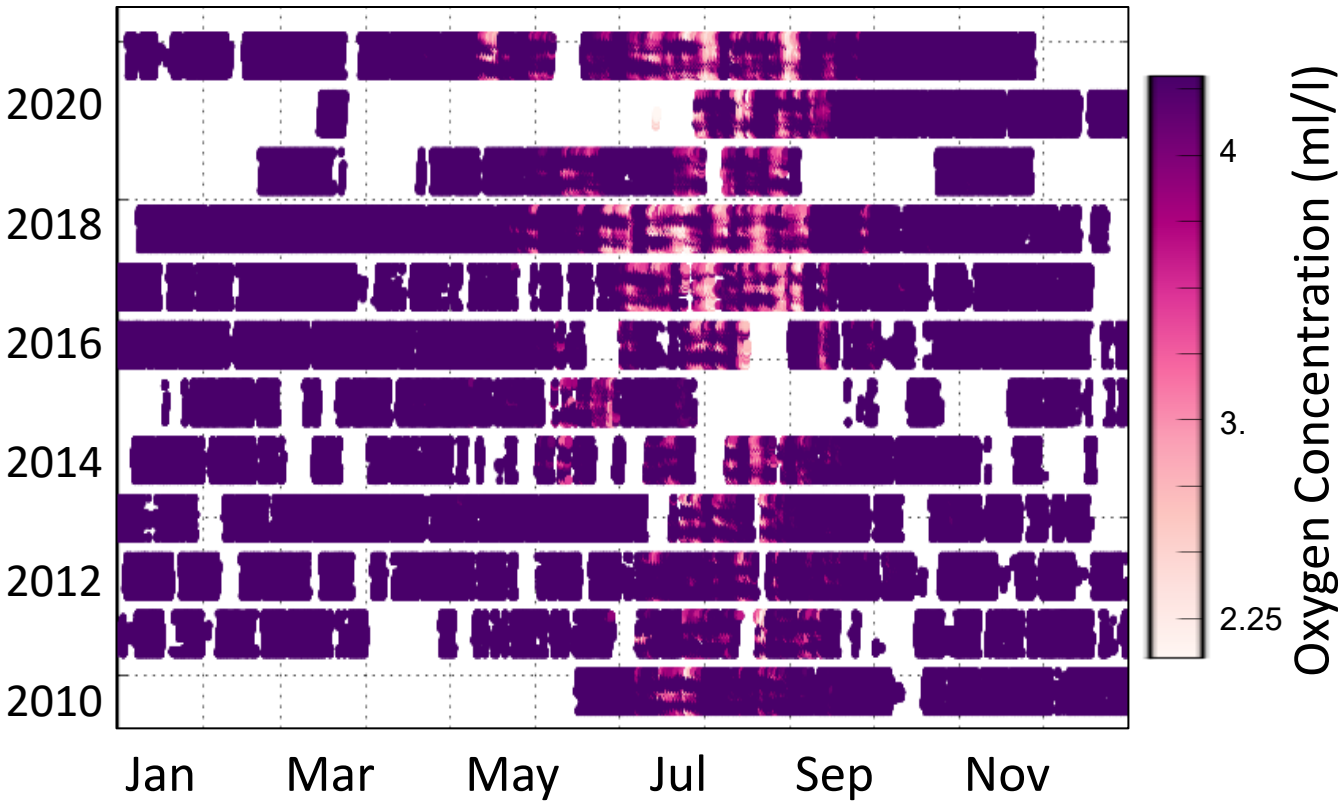
Lab-in-a-shed allows weekly calibration and maintenance and has been used for adaptively collecting water and genetic samples in-context.

Power of long timeseries

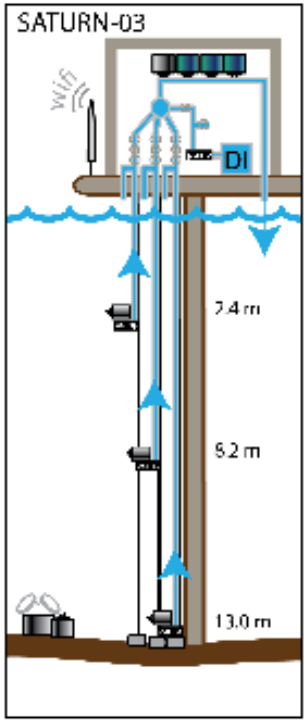


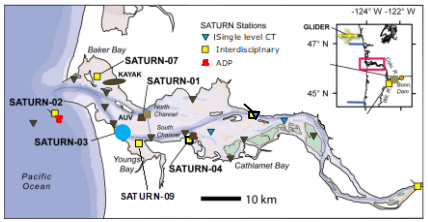


11-year History of Oxygen Saturation
at 8.2m depth at Pt. Adams (SATURN-03)



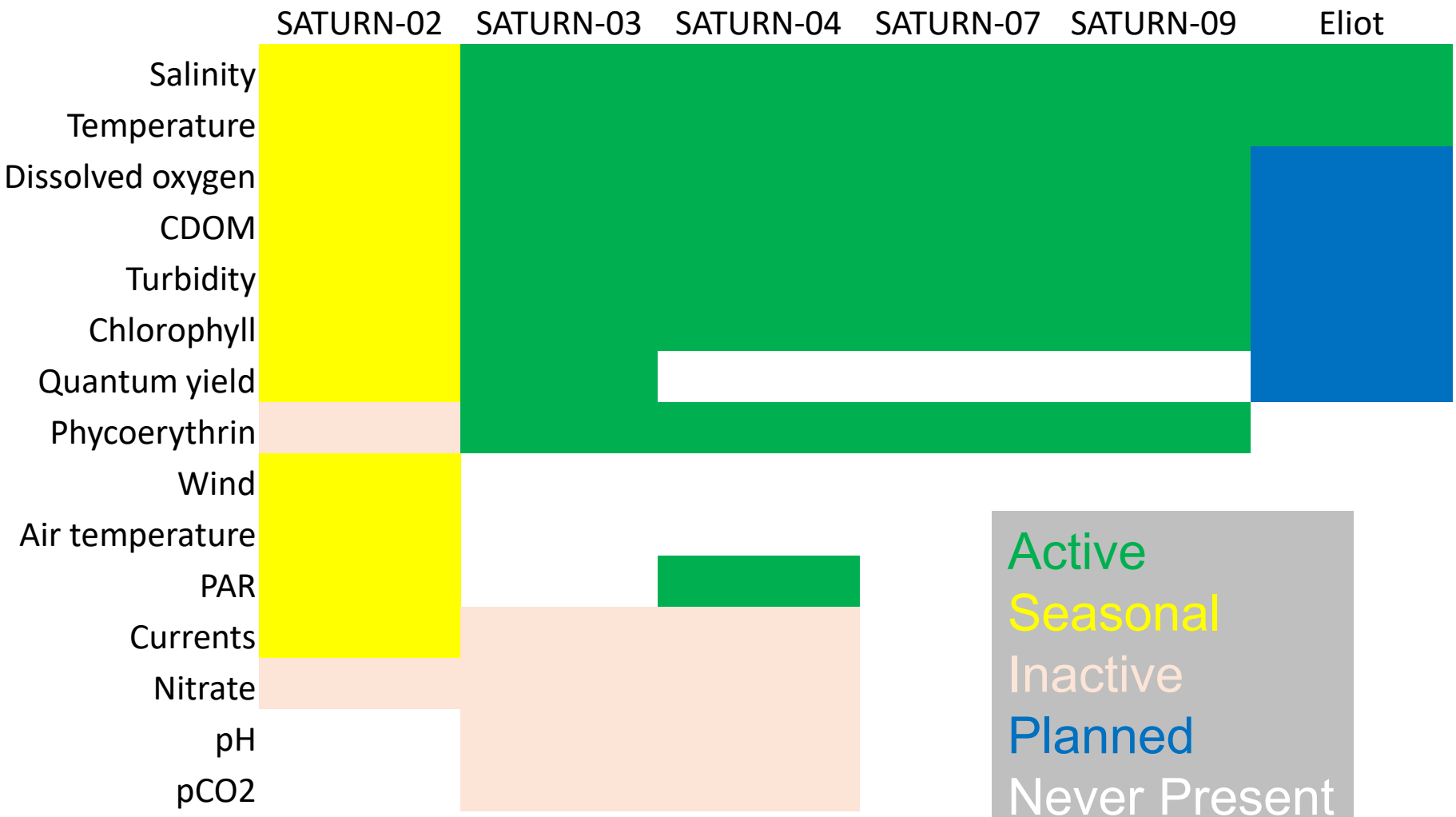
Power of long timeseries





11-year History of Oxygen Saturation at 2.4m depth at Pt. Adams (SATURN-03)

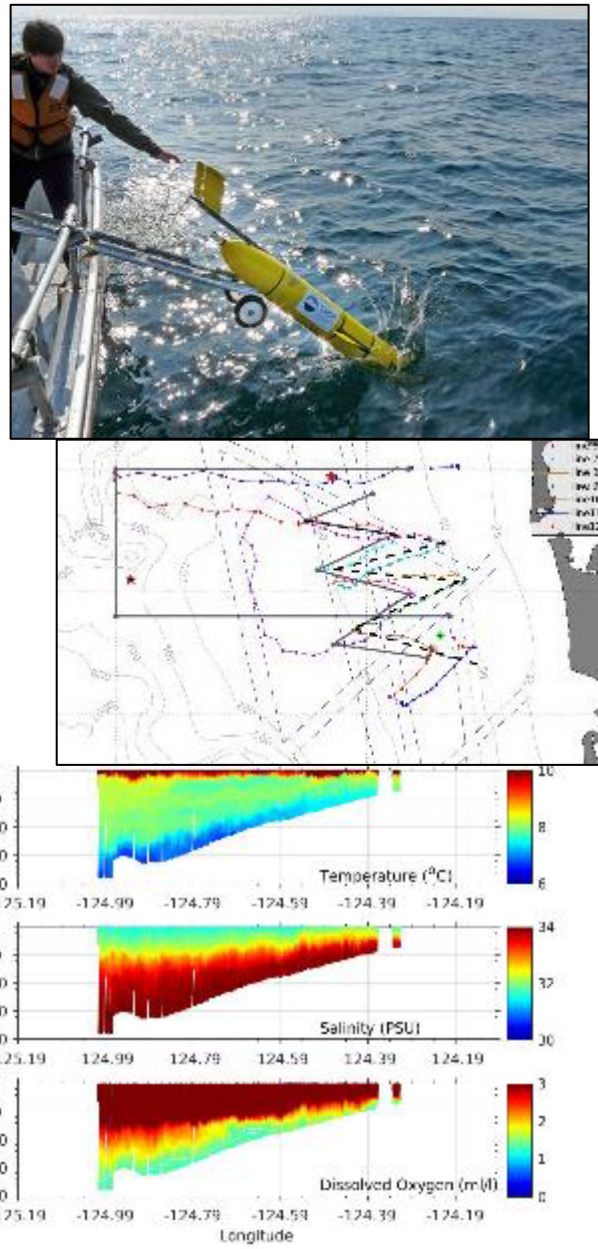
What we measure (2021)



Cbnc3: salinity, temperature
Woody: temperature

Observations: Glider Program

- Glider runs along Washington coast, offshore of Grays Harbor
- Focused on detection of hypoxia/anoxia during summer
- Test deployment in October 2020
- Operational deployments started in April 2021
- CRITFC-owned gliders
- Operated by Jack Barth's glider research group at Oregon State
- In collaboration with Quinault Indian Nation
- Potential to be used for detection of acoustic tagged salmon



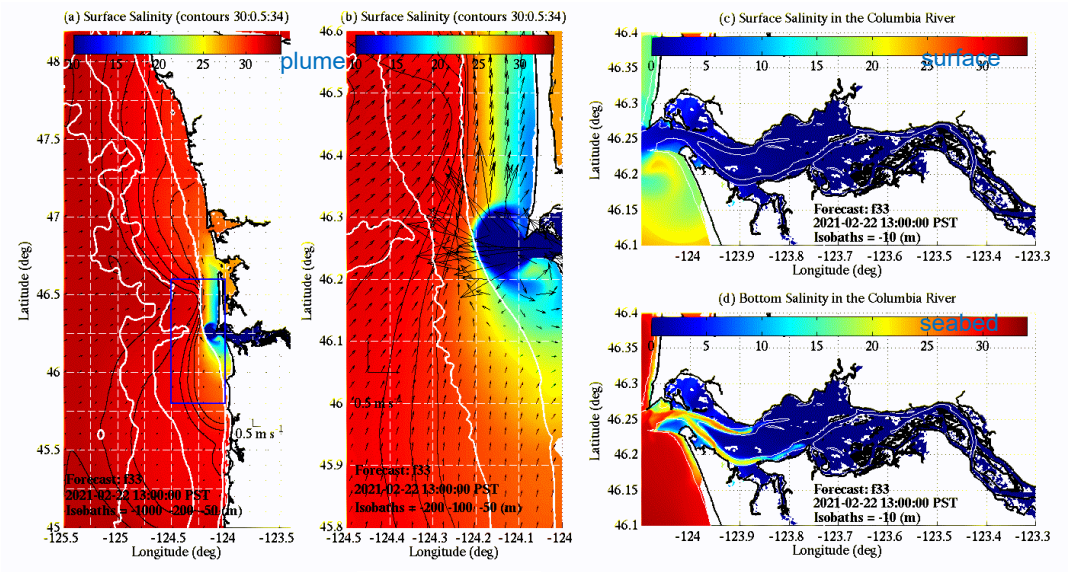
Figures from GRG web site

Potential future of observations

- Maintain long-term observation network
- Restoration of nitrate and ocean acidification monitoring
- Contaminant monitoring
- Acoustic tag monitoring
- CMOP stations as platforms of opportunity

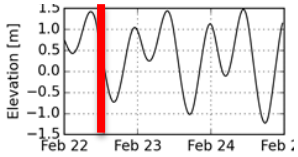
Modeling: The Virtual Columbia River

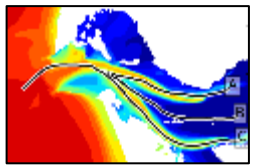
- Focus of the Virtual Columbia River is the lower estuary
- Core of the model is elevation, velocity, salinity, temperature
- Forecasts, hindcasts, scenarios



Salinity maps

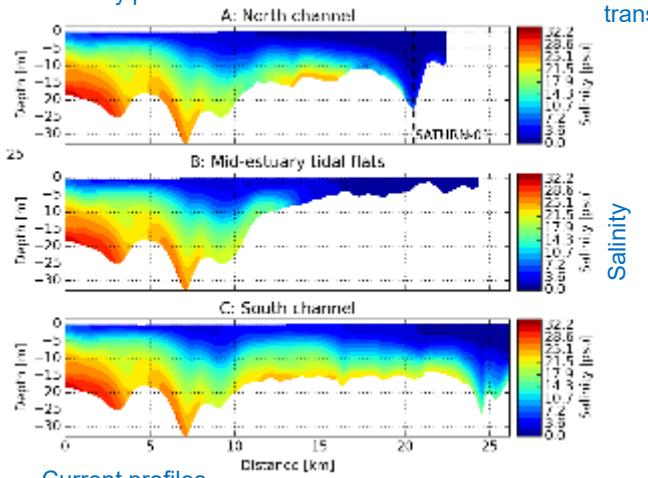
Feb 22, 2021
strong ebb tide



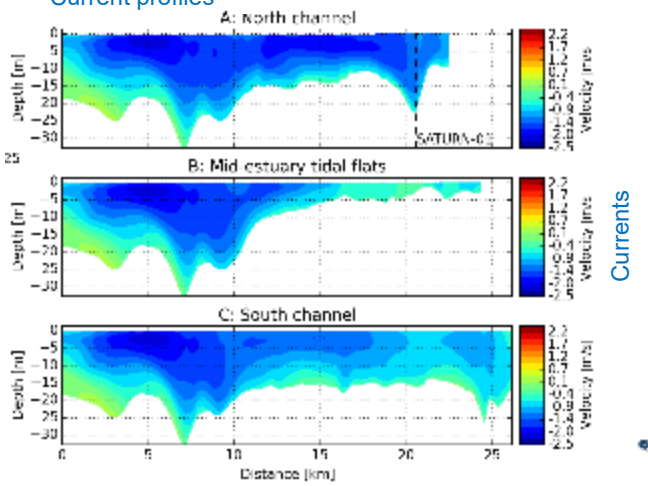


Vertical profiles along three transect lines

Salinity profiles



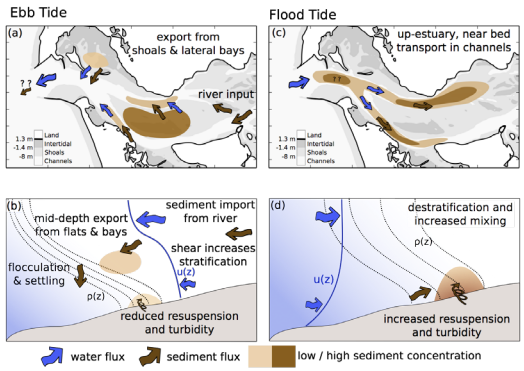
Current profiles

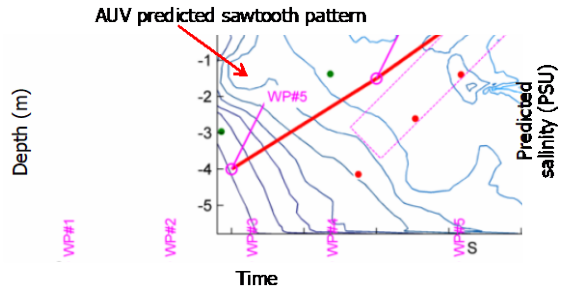


Why we model

- To understand processes
- To characterize variability
- To inform field campaigns
- To predict change

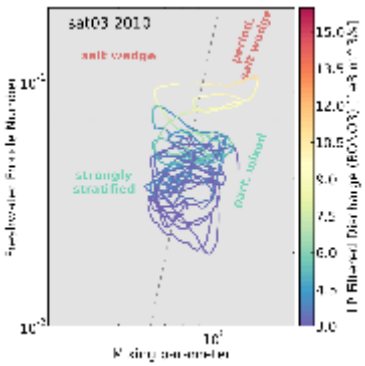
ETM

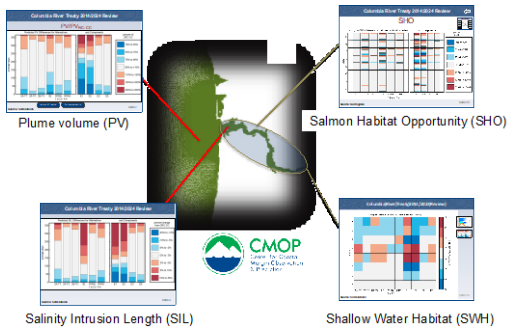




mission planning

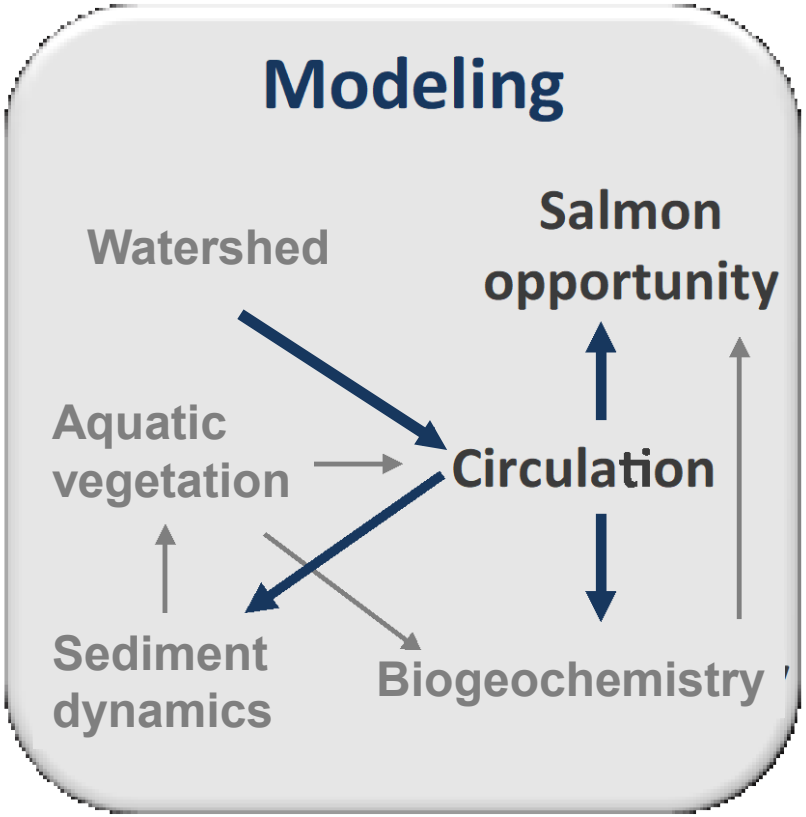
Regimes





Columbia River Treaty Review

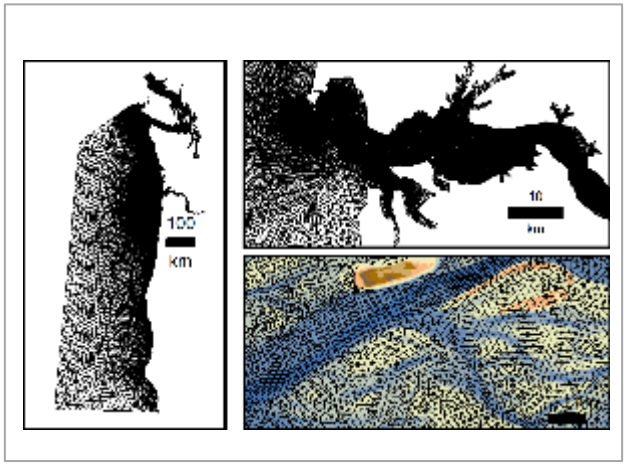
What we model



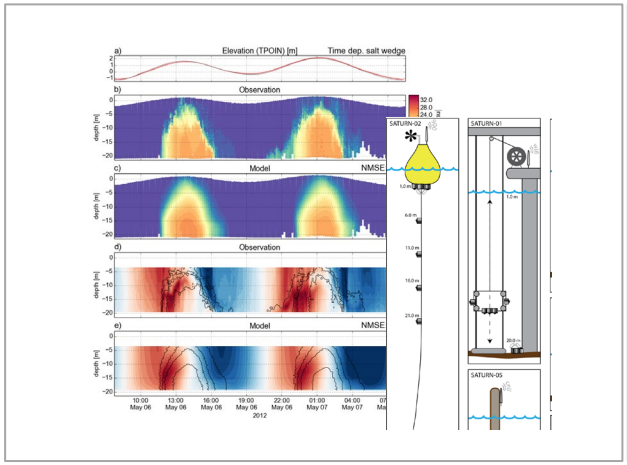
- 3D Circulation: water levels, velocities, salinity, temperature
- Salmon habitat opportunity
- Biogeochemistry
- Aquatic vegetation
- Stream to ocean watershed modeling

How we model

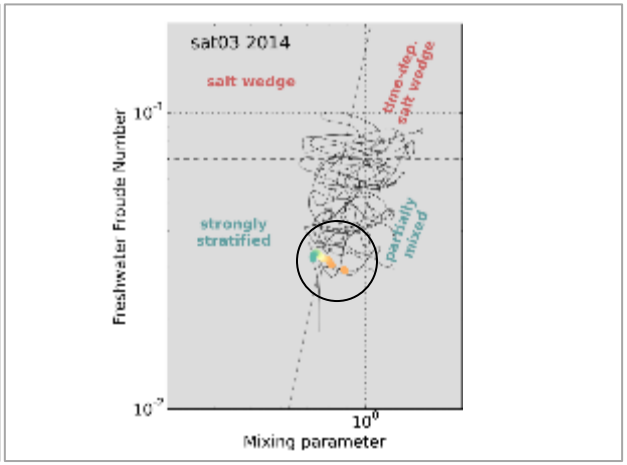
- River-to-ocean, unstructured grids
- SELFE and SCHISM are the base models to which we add
  - Formal modules (water age, aquatic vegetation, water quality)
  - Biological filters: salmon habitat
  - Empirical correlations: hypoxia
- Extensive skill assessment
- Models are “socialized”



Grids

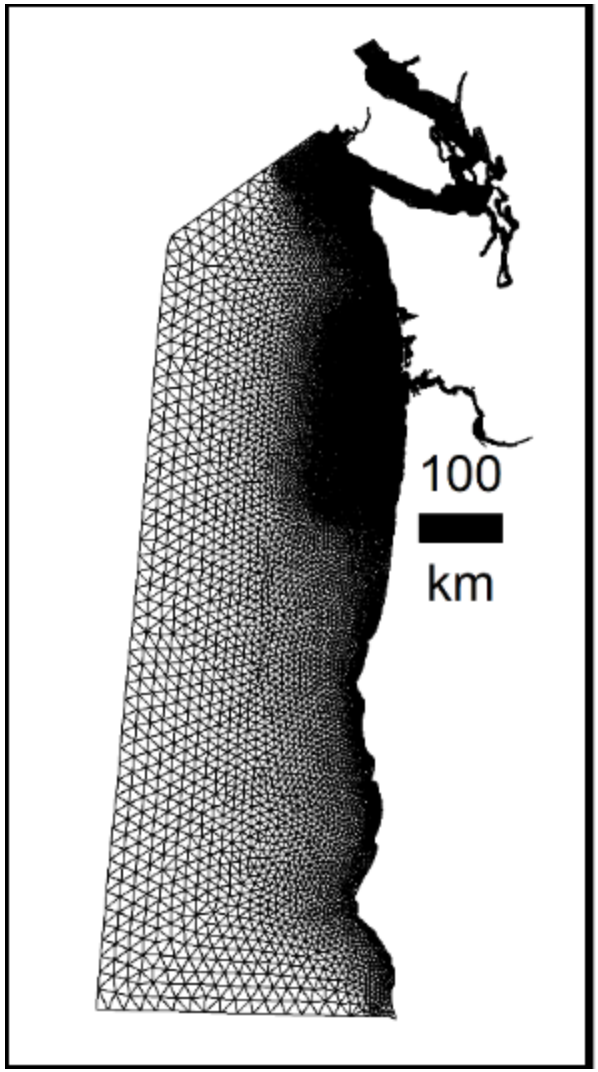


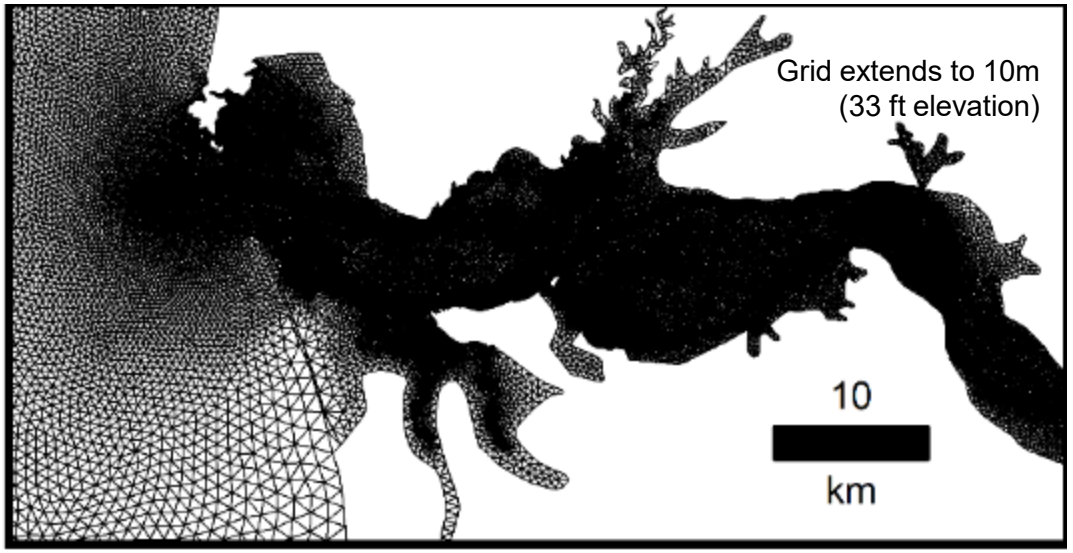
Skill assessment

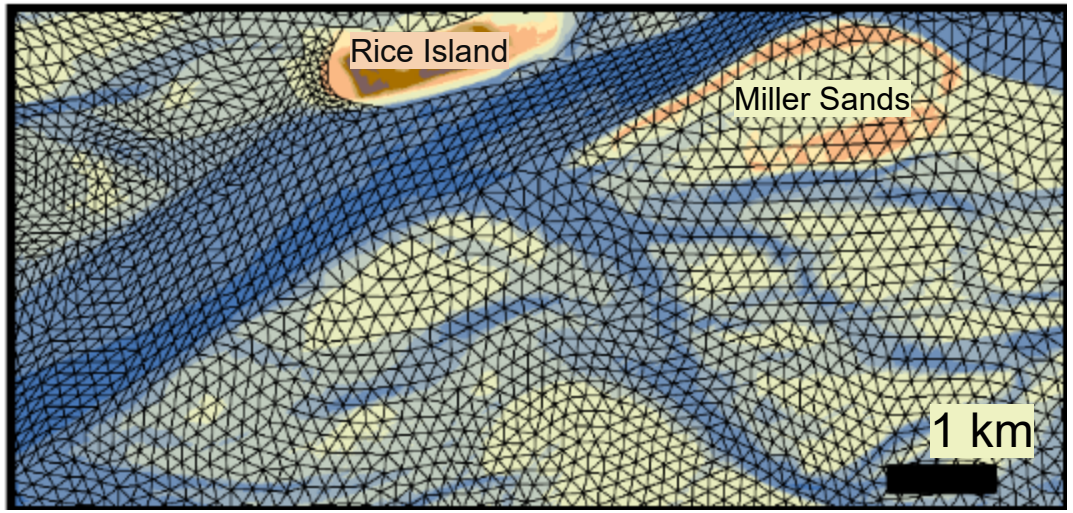


Socializing models

How we model: Model grids

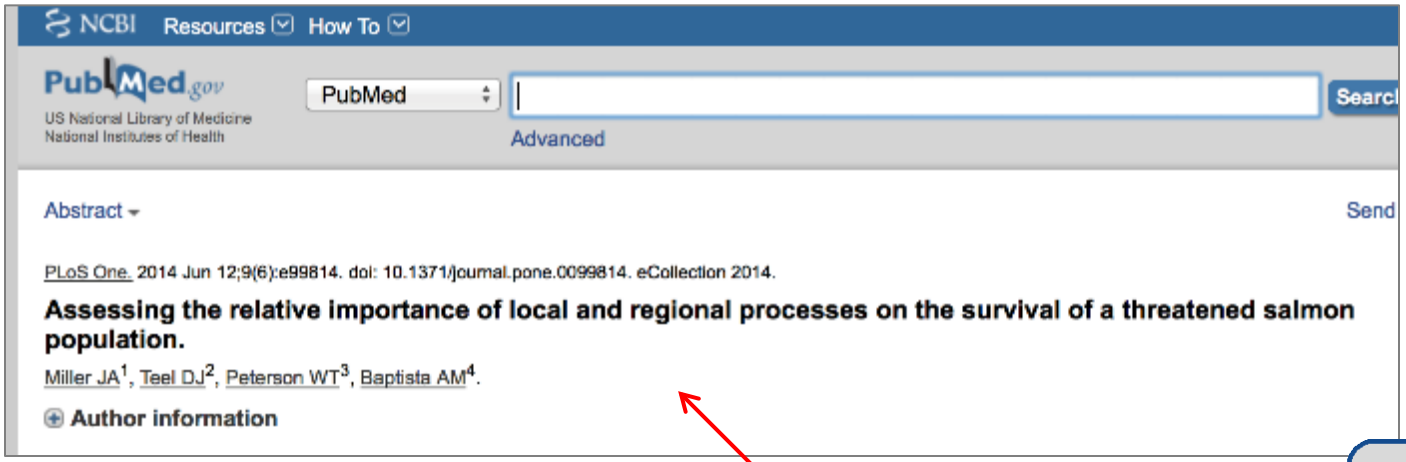






Highest resolution triangles ~ 50m side length

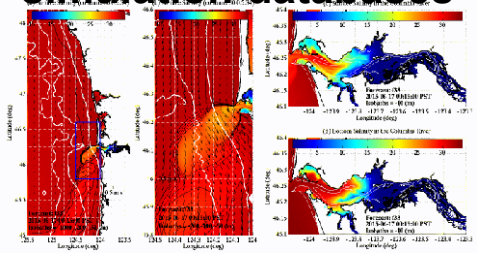
What we learn: metrics



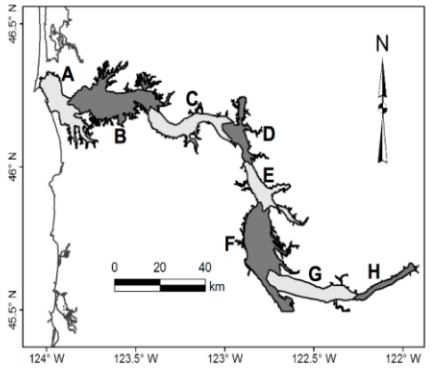
Plume volume (PV)

Salmon Habitat (SH)

CMOP circulation simulation databases



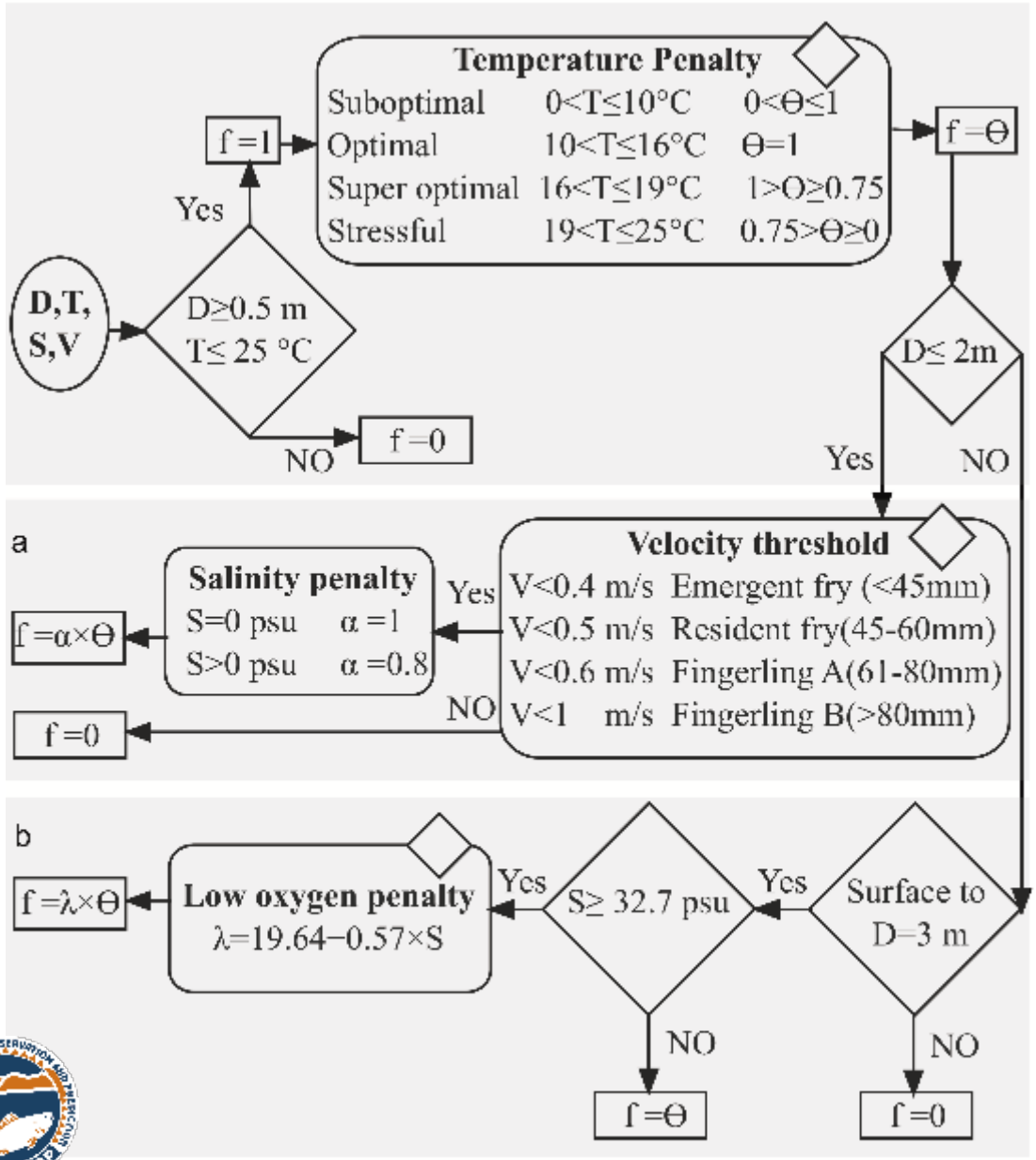
Filters



Salinity Intrusion Length (SIL)

Shallow Water Habitat (SWH)

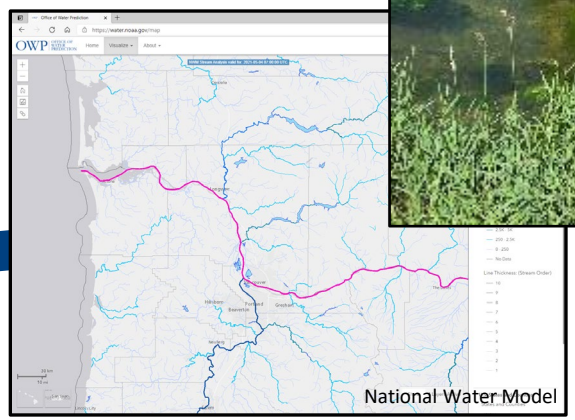
What we learn: “Salmon Habitat”



- Defined in collaboration with fisheries biologists
- Fill a gap: used in the region in support of major decisions (CRCIP, CRTR)
- Responsive to new modeling capabilities
- References: Bottom et al. 2005, Burla 2010, Rostaminia et al., 2017

Potential Future of CMOP modeling

- Integrate outputs of NOAA National Water Model to incorporate minor tributaries
- Increase resolution in wetland areas
- Aquatic vegetation, sediment transport, water quality models
- Climate change scenarios: sea level rise, river temperature, river discharge
- Invertebrate flux from wetlands?



CC: Robert Flogaus-Faust

Integrating the NOAA National Water Model

- High resolution watershed model for full US
- Integratable into SCHISM model
- Provides tributary flows to SCHISM model
- Will greatly improve model capability in wetlands and lateral bays

Office of Water Prediction (noaa.gov)