PNW blue carbon database and the ecological effects of sea-level rise

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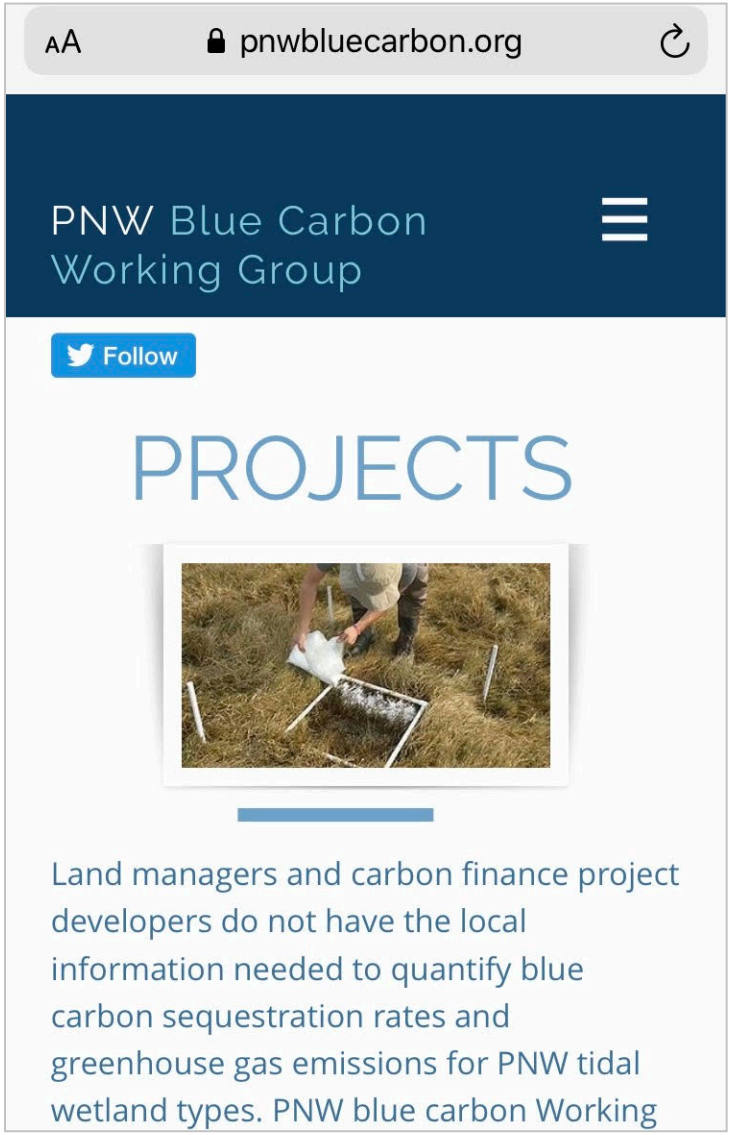
LCEP Science Work Group, May 2021

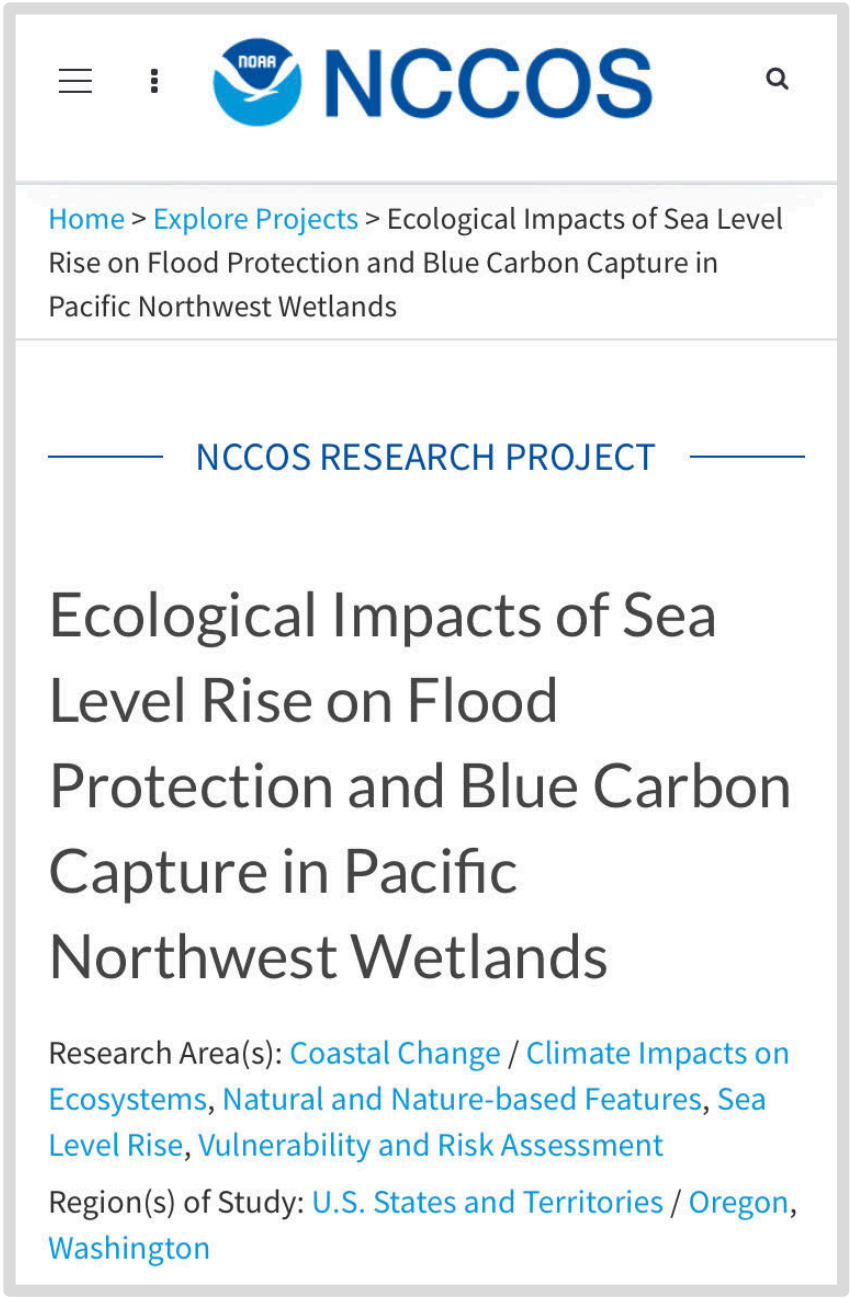
PNW Blue Carbon Working Group

- Established in 2014
- Brings together natural scientists, social scientists, managers, & policy makers to advance BC science & data sharing
- Informal membership and structure, mainly operates in sub-groups around specific funded projects
- Efforts mostly based from northern CA to British Columbia

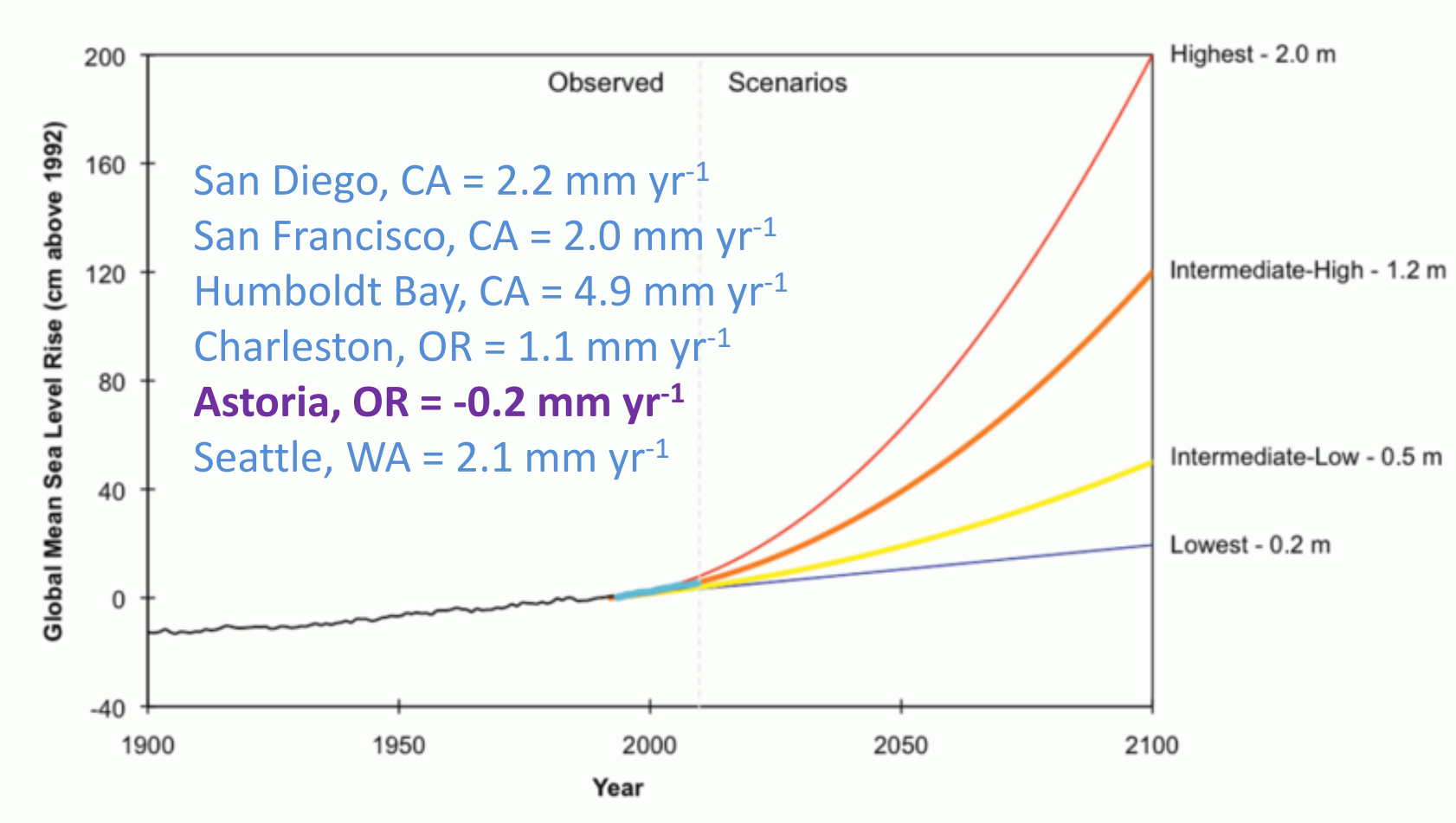


PNW Blue Carbon Working Group projects

- PNW stocks project (2016-2019) to quantify blue carbon stocks & start a regional database
- Assessment of blue carbon finance project feasibility in the PNW (2018-2019)
- Two current (2019-2023) carbon sequestration & GHG emissions projects (NOAA and NERRS Science Collaborative)
- Other recent and pending projects by UO, USGS, OSU, WWU, others


NCCOS
Home > Explore Projects > Ecological Impacts of Sea Level Rise on Flood Protection and Blue Carbon Capture in Pacific Northwest Wetlands
NCCOS RESEARCH PROJECT
Ecological Impacts of Sea Level Rise on Flood Protection and Blue Carbon Capture in Pacific Northwest Wetlands
Research Area(s): Coastal Change / Climate Impacts on Ecosystems, Natural and Nature-based Features, Sea Level Rise, Vulnerability and Risk Assessment
Region(s) of Study: U.S. States and Territories / Oregon, Washington

Regional variation in SLR



- Sea-level rise may also lead to increased salinity in coastal estuaries

Parris et al (2012), Cloern et al. (2011); NOAA (tidesandcurrents)

PNW ESLR objectives

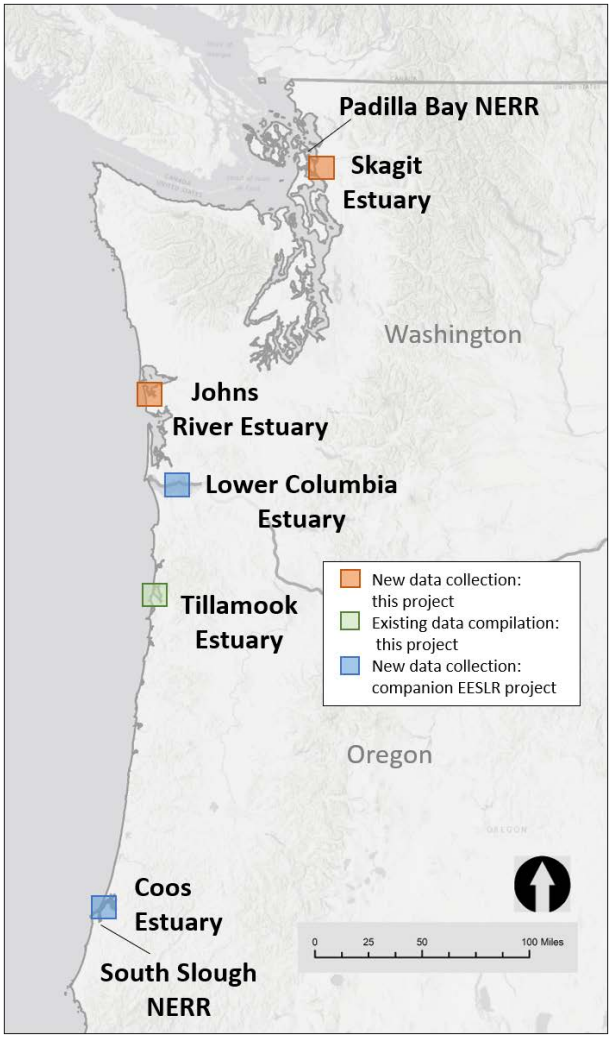
- Model how tidal wetlands protect coastlines from flooding under a range of restoration and sea-level rise scenarios.
  - FVCOM model (PNNL)
  - Coos Bay Estuary
  - Gray's Bay region of the Lower Columbia River Estuary
- Measure greenhouse gas (GHG) emissions and C sequestration in natural, restored, and former tidal wetlands along salinity gradients.
  - What are the blue carbon benefits of wetland restoration?
  - How may sequestration and GHG emissions change with SLR and salinity change?
  - This component of the ESLR project is closely aligned with a NERRS Science Collaborative project based in several WA estuaries; that project includes an additional 15 sites.

ESLR blue carbon sites

- 12 sites in Coos Bay Estuary; 7 in Lower Columbia River Estuary

Salinity and wetland class	Emergent marsh	Forested tidal wetland	Disturbed wetlands/ pastures
Freshwater	SEC*, KAN*	SEC*, SEA*	WAS, WAS2, ALD*
Oligohaline	MLC*, SCS*	WIN	SAU
Mesohaline	FSM, DAN, KZL, KZH, FRE		
Polyhaline	MIL, MET, MIL		

Least-disturbed sites; restored sites; disturbed/non-tidal sites



Map by Craig Cornu

ESLR blue carbon measurements

- 1. Soil carbon stocks
  - Sampled to 50 cm and every 2 cm bulk density, carbon and nitrogen content determined
- 2. Soil accretion rate
  - ^{210}Pb, ^{137}Cs profiles (least-disturbed sites)
  - Soil density change (restored sites; Drexler et al. 2019).
  - From C density and accretion rate, can estimate carbon sequestration rate

Soil cores

ESLR blue carbon measurements

- Also determining short-term soil accretion rates with feldspar marker horizons

Marker horizons

ESLR blue carbon measurements

- 3. Greenhouse gas emissions
  - Methane, carbon dioxide, nitrous oxide
  - Light and dark fluxes
  - ~8 measurements over the course of a year
  - First measurements spring 2021

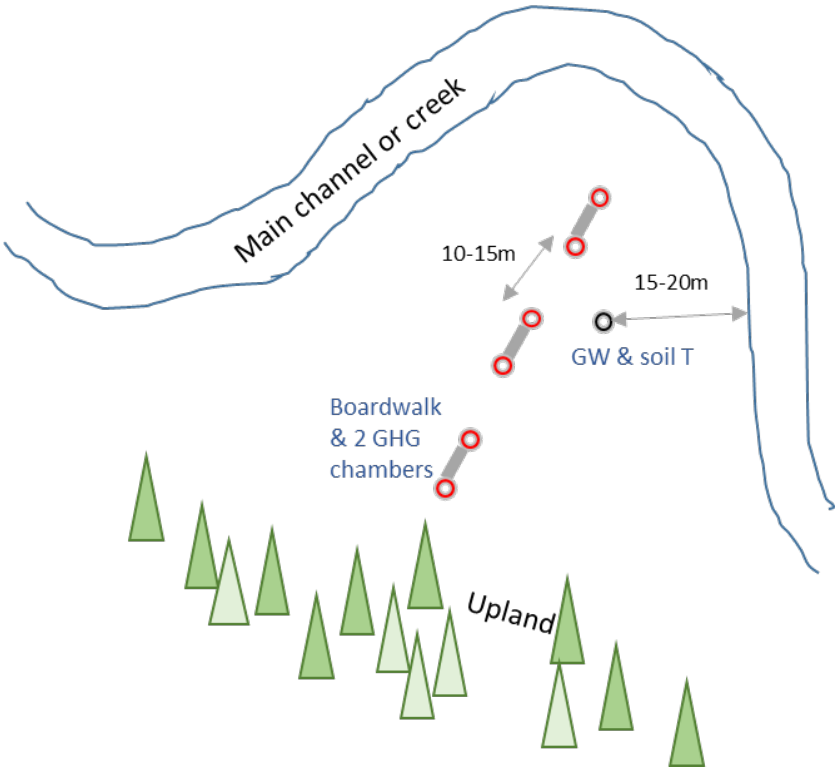
Environmental drivers of blue carbon

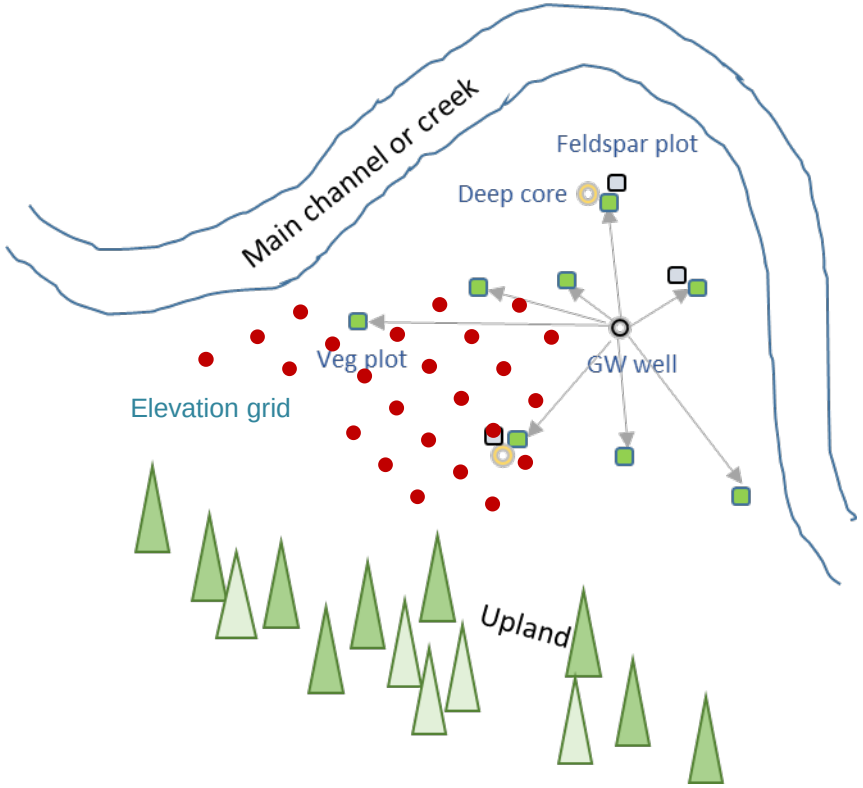
Groundwater conditions

- Groundwater level*
- Groundwater salinity*
- Groundwater temperature*
- Soil temperature*
- Light flux*
- Barometric pressure*
- pH
- Elevation
- Plant cover & composition

** High frequency time series*

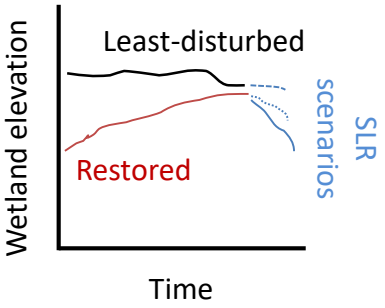
Sampling layout at each blue carbon site





Synthesizing components of ESLR project

PNW wetland succession model



Wetland elevation change model

SLR scenarios
Restoration scenarios

Future wetland elevation

Field data on blue carbon and GHG fluxes by wetland type, elevation, & salinity regime

Estimate future soil carbon sequestration and GHG fluxes

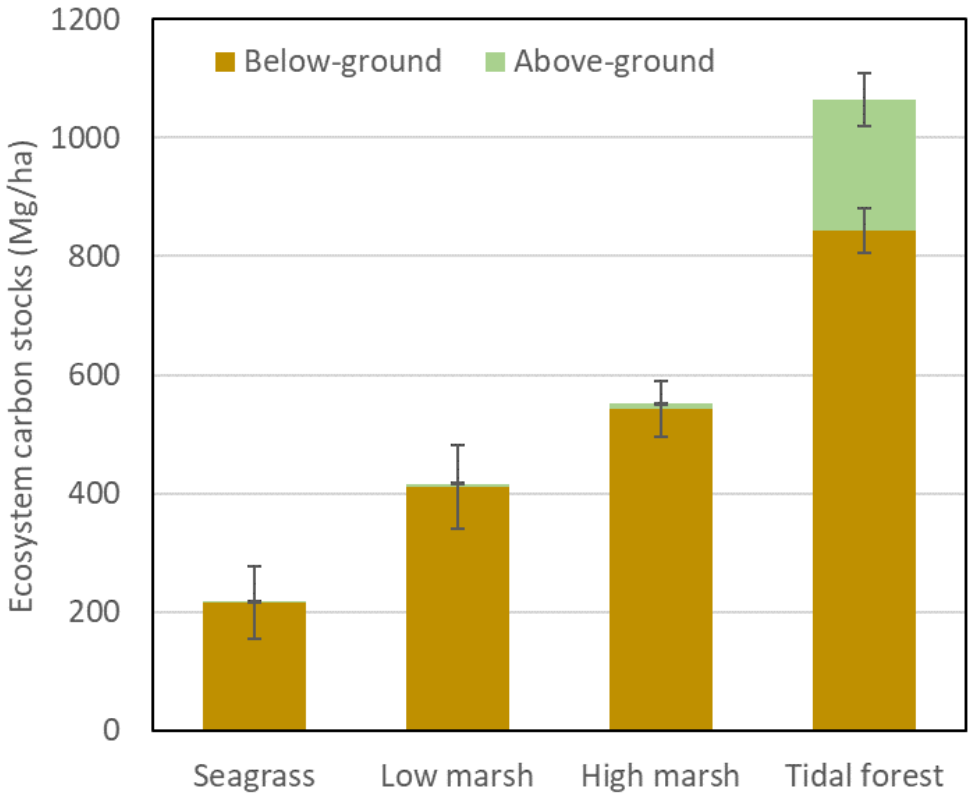
Blue carbon database

- Started in ~2018 as part of PNW stocks project, with a focus on soil carbon data from Northern California to Washington

PNW stocks project (9 estuaries)

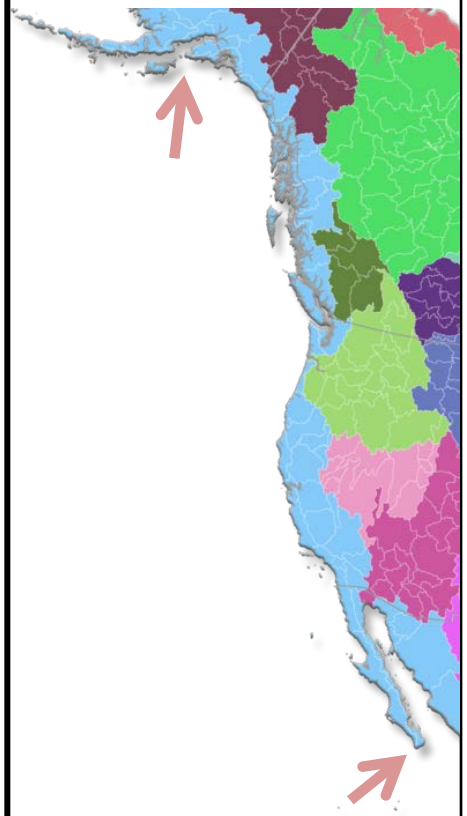
9 estuaries

213 cores collected in the study



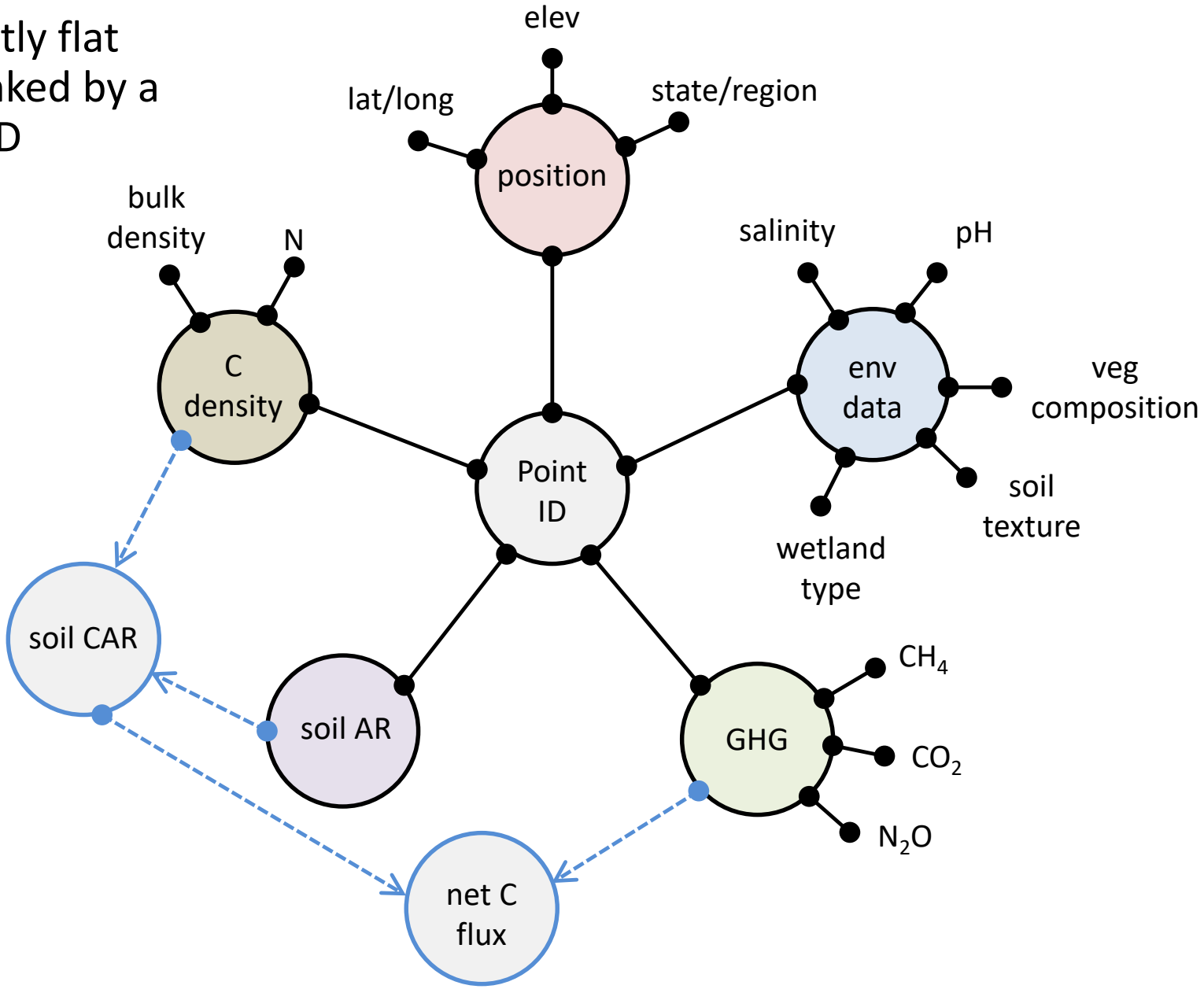
Kauffman et al. (2020) *Global Change Biology*

Blue carbon database

Geographic scope	Wetland types	Data types
Baja California to Alaska 	• Seagrass meadows • Tide flats • Emergent tidal marsh (freshwater to salt marsh) • Mangroves • Temperate scrub-shrub wetlands • Temperate forested tidal swamps • Pastures (former tidal wetlands)	• Soil carbon content and density • Soil accretion and carbon accumulation rates • Environmental drivers (e.g., elevation, plant species) • Greenhouse gas emissions (chambers)

Database structure

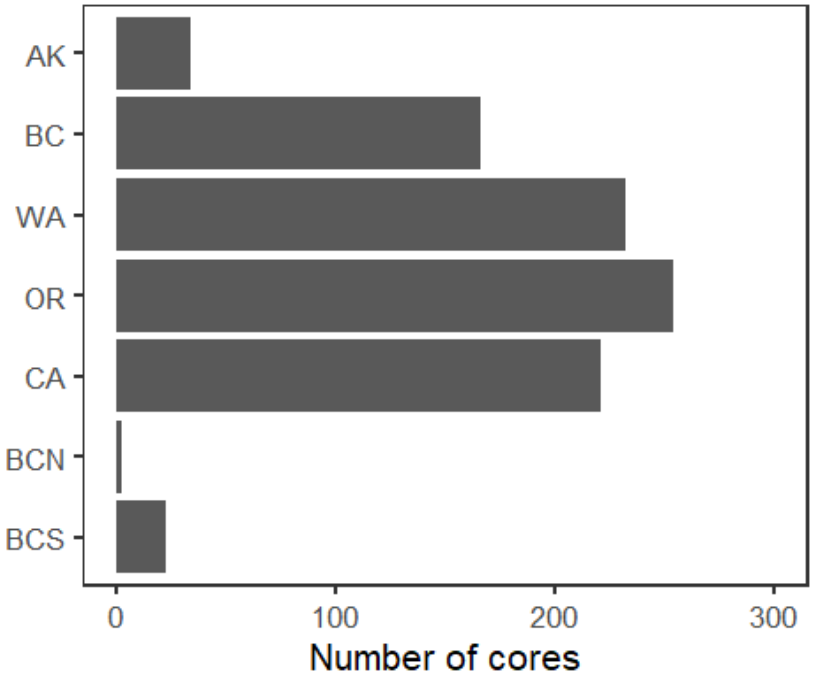
- Currently flat files linked by a point ID



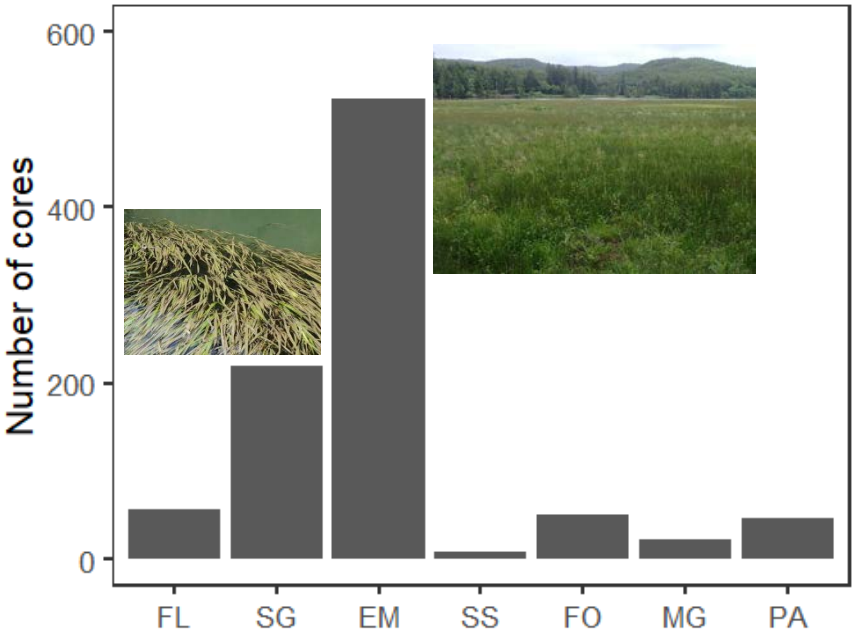
Some summary statistics

- ~930 cores in the database (as of Jan 2021) from ~33 studies
- ~850 cores with depth-specific carbon density values
- ~240 some measure of accretion rate (usually ^{210}Pb or ^{137}Cs)

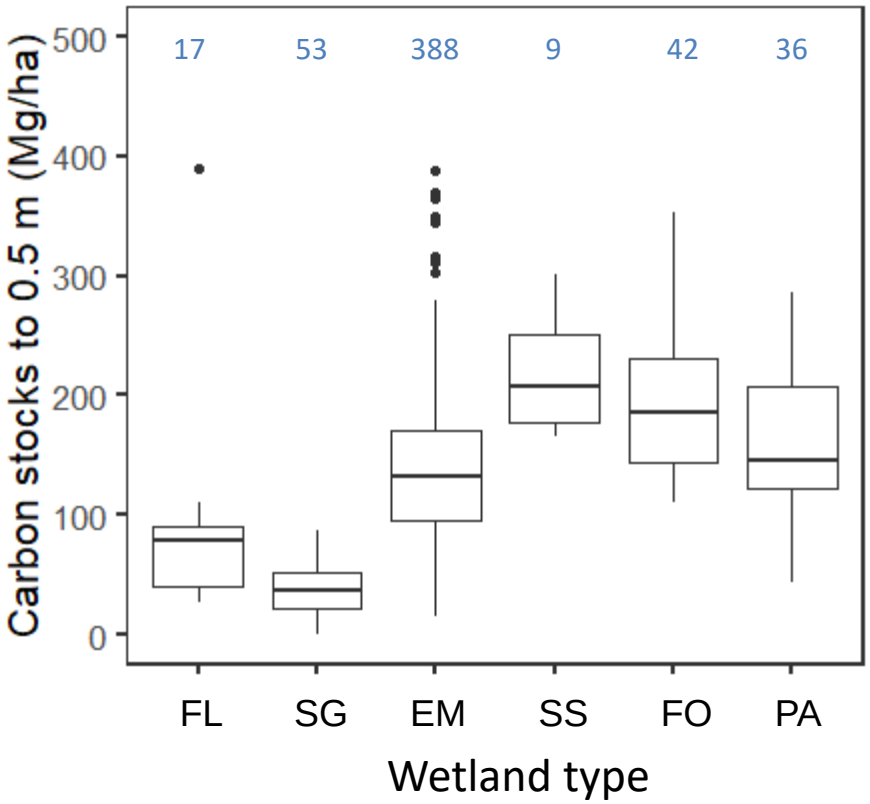
States/provinces



Wetland type



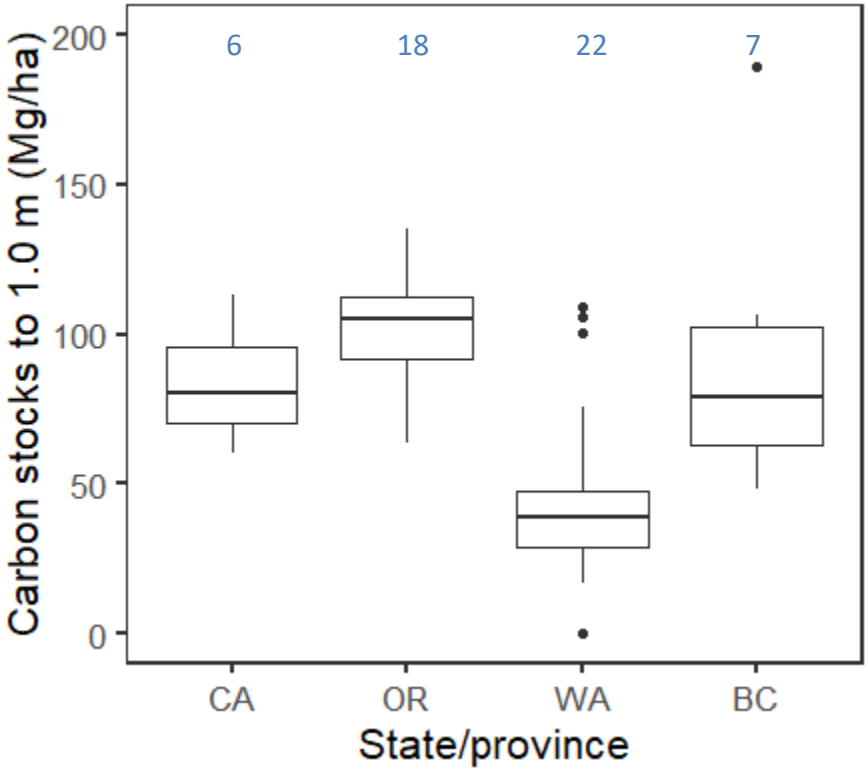
Soil carbon stocks by wetland type (preliminary)



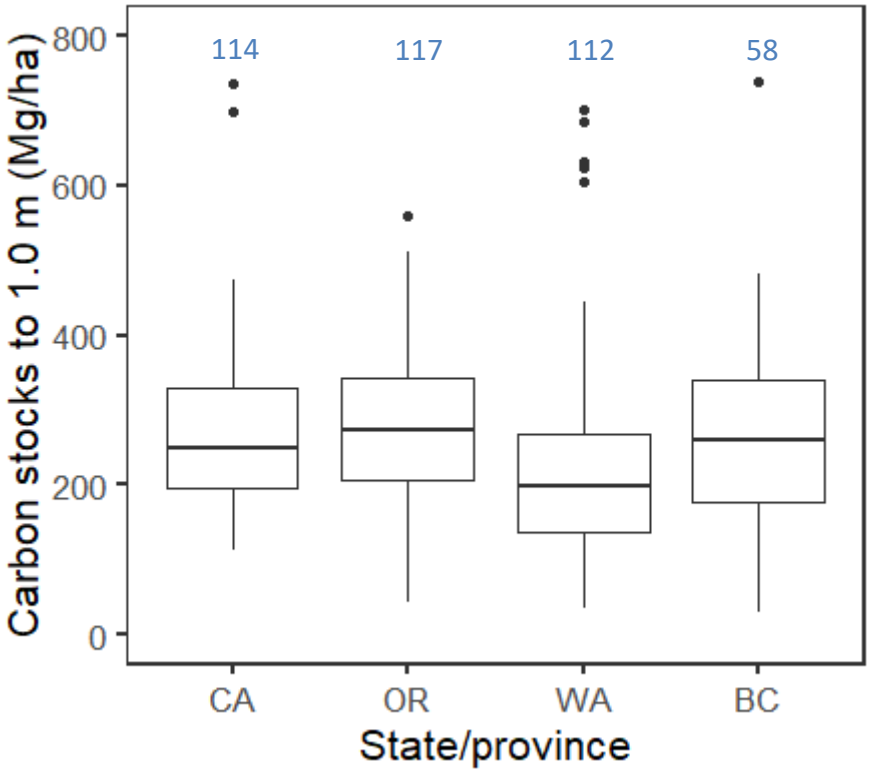
- Tidal marshes have high, but quite variable, soil carbon stocks
- Stocks are lower in tide flat (FL) and seagrass meadows (SG)
- Median stocks are highest in temperate woody wetlands such as Sitka spruce swamps (see also Kauffman et al. 2020)

Soil carbon stocks by geographic region (preliminary)

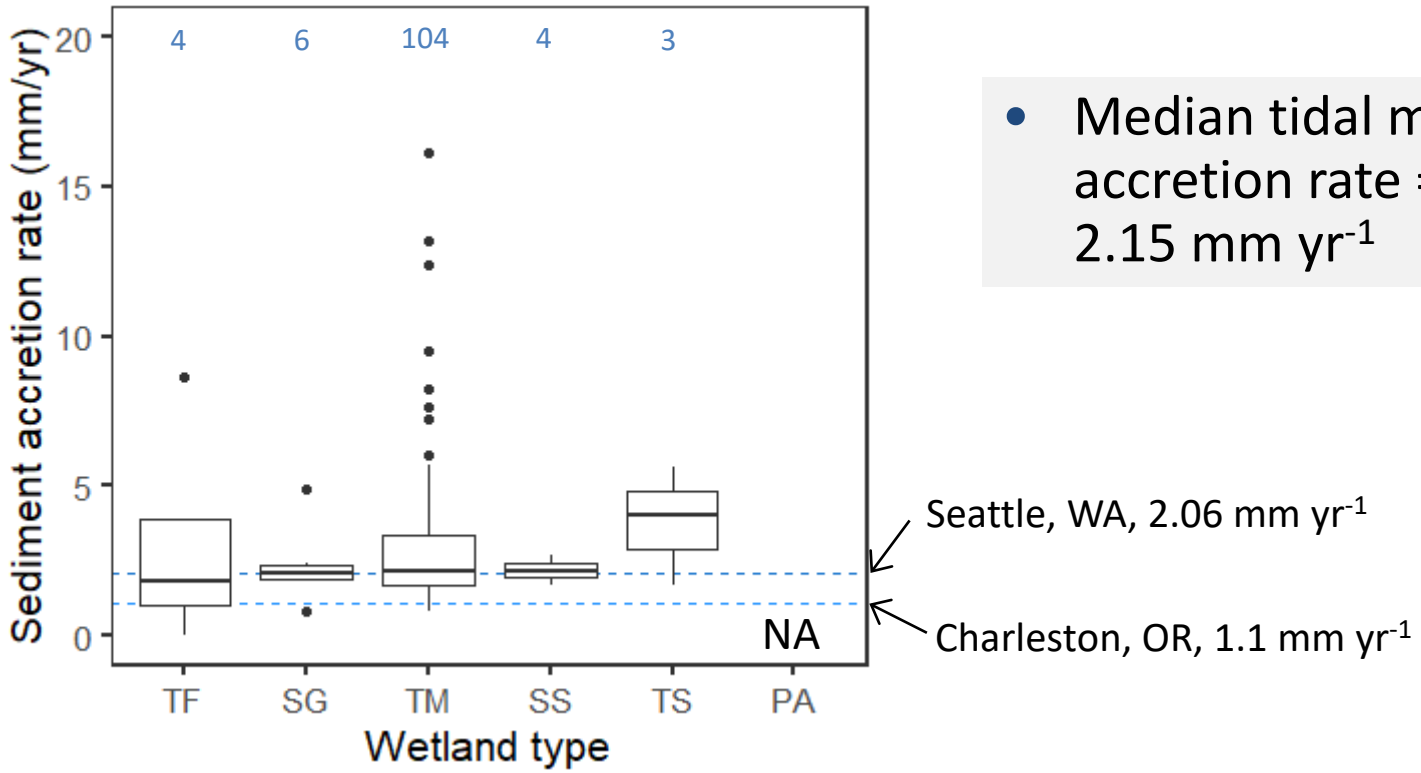
Seagrass meadows



Emergent marshes



Accretion rates by wetland type (^{210}Pb only) (preliminary)

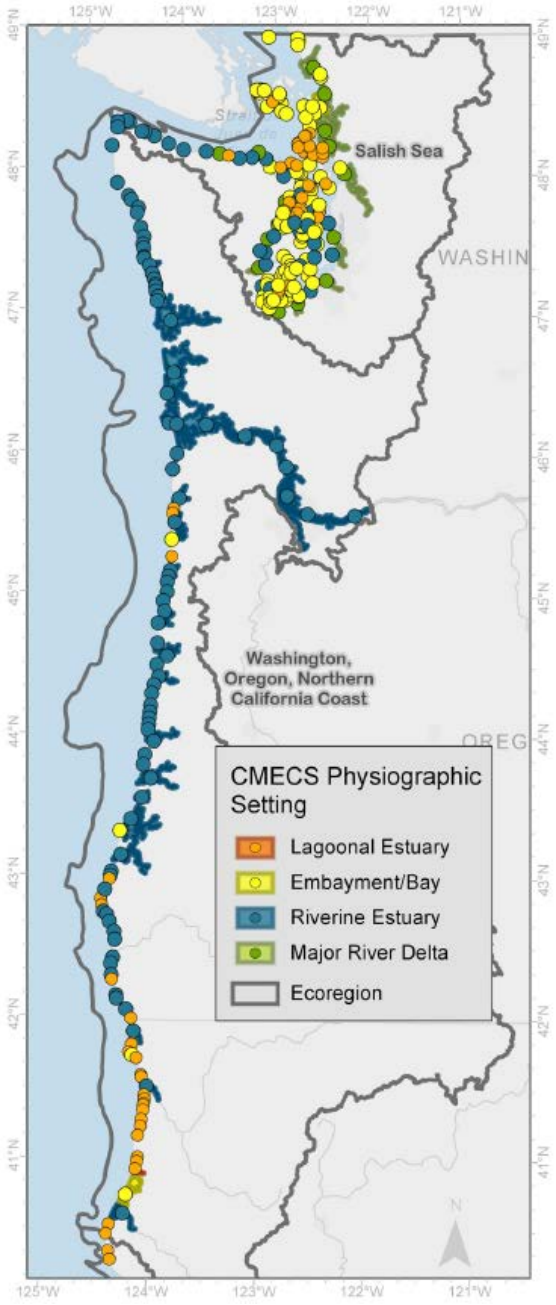


- Median tidal marsh accretion rate = 2.15 mm yr^{-1}

- Recent accretion rates across wetland types are generally keeping up with recent rates of SLR in the PNW

Final points about the database

1. The database has been valuable for identifying **data gaps** regionally (wetland types, estuaries).
2. We are seeking any **new data** you may have and wish to share.
3. Two **synthesis publications** are planned for the database (funding from NERRS Science Collaborative, Pew Charitable Trusts).
4. Many of the data sets are **available** on the CCRCN's Coastal Carbon Atlas and Figshare.



Brophy et al. 2019 Plos 1, public domain

Lower Columbia River Estuary

- Several data sources for marshes, tidal swamps, tideflats
  - Kauffman et al. (2020; unpublished)
  - Diefenderfer and Borde (unpublished)
  - Peck et al. (2020)
  - Peterson et al. (2014)
  - Petersen et al. (2003)
  - ESLR project team (analyses in progress)

- Given the very large size of the estuary, more data are needed on blue carbon stocks and rates of sequestration

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PNW Blue carbon working group social media: @PNWBlueCarbon

REFERENCES

Brophy LS, Greene CM, Hare VC, Holycross B, Lanier A, Heady WN, O'Connor K, Imaki H, Haddad T, Dana R. 2019. Insights into estuary habitat loss in the western United States using a new method for mapping maximum extent of tidal wetlands. PLoS ONE 14:e0218558.

Kauffman JB, Giovanonni L, Kelly J, Dunstan N, Borde A, Diefenderfer H, Cornu C, Janousek C, Apple J, Brophy L. 2020. Total ecosystem carbon stocks at the marine-terrestrial interface: Blue carbon of the Pacific Northwest coast, United States. Global Change Biology 26:5679-5692.

FUNDING

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- NOAA EESLR grants NA15NOS4780171 and NA19NOS4780176
- OWEB 219-923-17145
- Pew Charitable Trusts

DATA LINKS

- Link to CCRCN's international Coastal Carbon Atlas
- Figshare data releases for Kauffman et al. 2020 *Global Change Biology*