SALMON AND WETLAND INFLUENCES ON CARBON AND NUTRIENT CYCLING IN FORESTED WATERSHEDS

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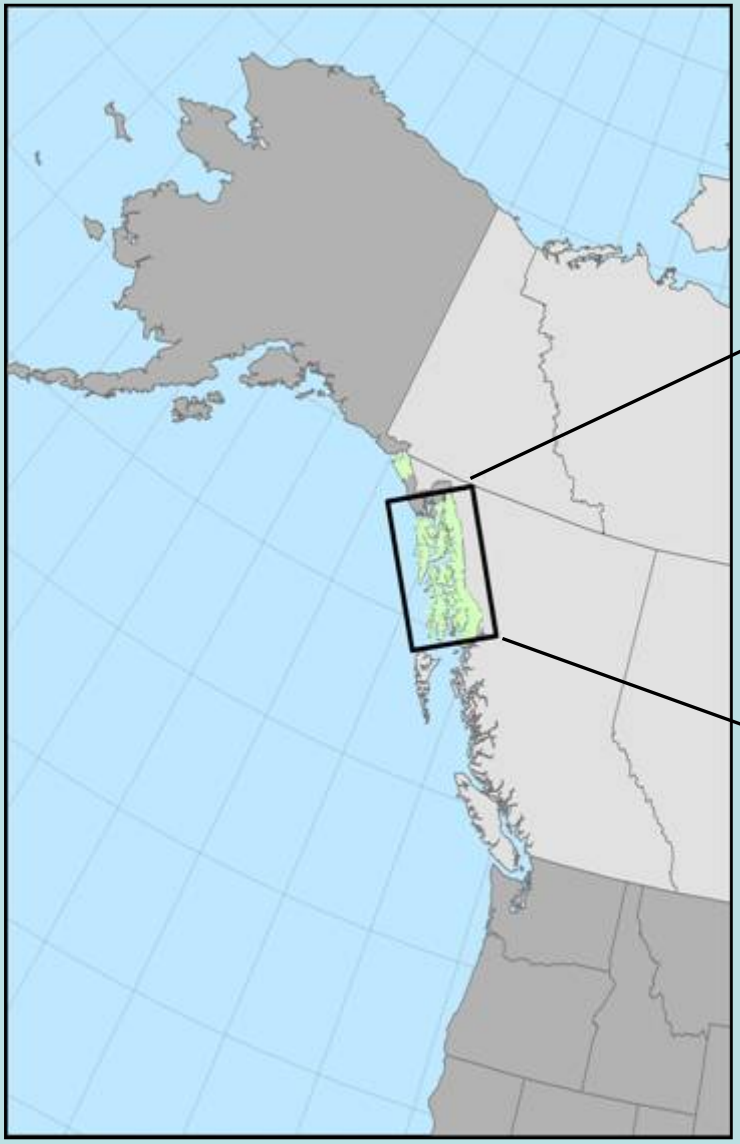
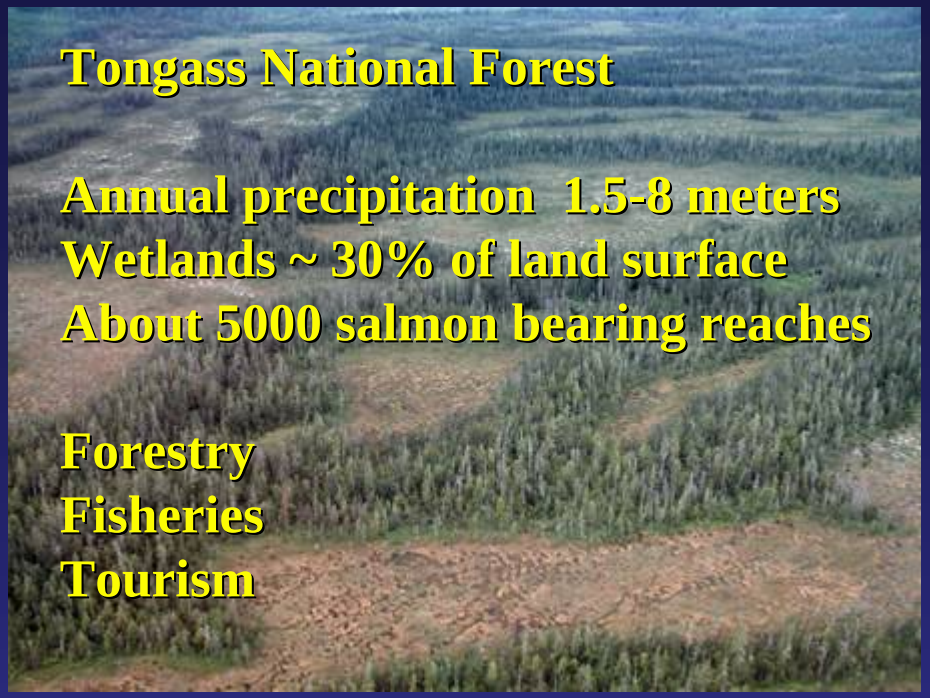


CANADA
BRITISH COLUMBIA
Juneau
Hoonah
Pelican
Tenakee Springs
Admiralty I
Angoon
Chichagof I
ALEXANDER ARCHIPELAGO
Sitka
Baranof I
Kake
Kupreanof Island
Petersburg
Wrangell
Kuiu I
Chatham Strait
Hyder
Revillagigedo Island
Ketchikan
Prince of Wales I
Craig
Thorne
Metlakatla
Dixon Entrance

IndexMap

NF



Tongass National Forest

Annual precipitation 1.5-8 meters
Wetlands ~ 30% of land surface
About 5000 salmon bearing reaches

Forestry
Fisheries
Tourism

Coastal Temperate Rainforest

- Streams nutrient limited and oligotrophic
- Annual salmon returns fertilize streams, increasing production (MDN)
- Logging reduced physical habitat altering species distributions and reducing salmonid abundance
- Warming climate is altering fundamental biogeochemistry with unknown impacts on habitats productivity and nutrient export to coastal waters

Objectives

1) Characterize major sources of organic and inorganic C, N, and P in salmon spawning streams (watershed vs MDN)

2) Quantify nutrient inputs into streams from wetland soils

3) Evaluate the seasonal patterns of nutrient inputs to develop watershed models of nutrient cycling across the region

Organic and Inorganic C, N, and P Inputs to Aquatic Ecosystems

Experimental Design

Soils

Tributary Streams

Coastal Watersheds

Key Findings

1) Salmon-Derived Nutrients

2) Wetlands Nutrient Fluxes

3) Wetlands and Mercury

Salmon Nutrients

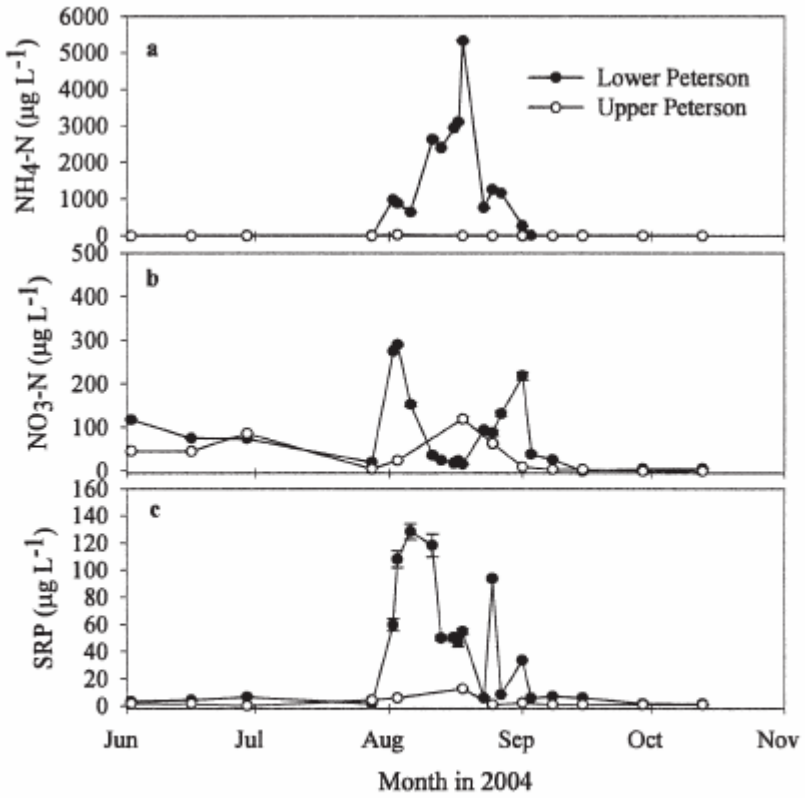


Fig. 2. Mean surface water concentrations (±1 SE) of (a) NH_4-N, (b) NO_3-N, and (c) SRP during the period June–October, 2004. Note the difference in scale between panels.

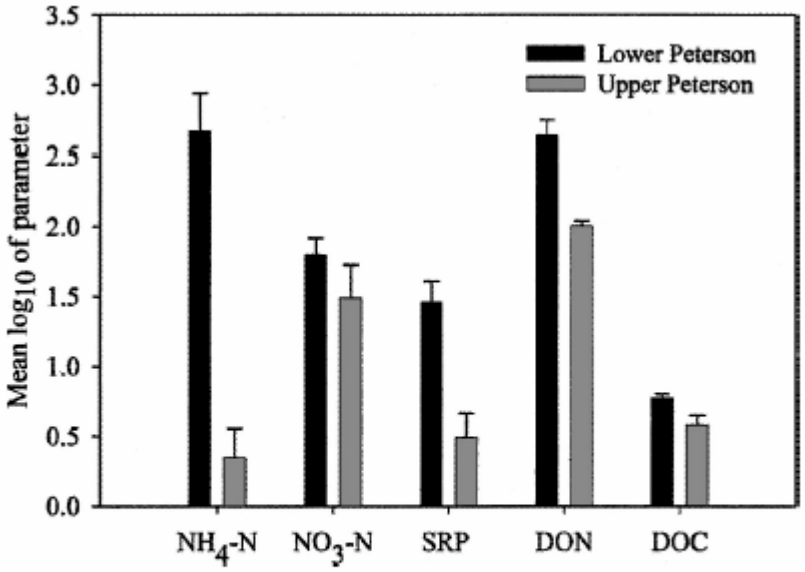


Fig. 3. Mean $\log_{10}$ concentrations (±1 SE) of NH_4-N, NO_3-N, SRP, DON, and DOC during salmon spawning above (Upper Peterson) and below (Lower Peterson) the barrier waterfall. All concentrations are in micrograms per liter except DOC, which is in milligrams per liter.

Hood et al., *Limnol. Ocean.*, 2007

Salmon Nutrients

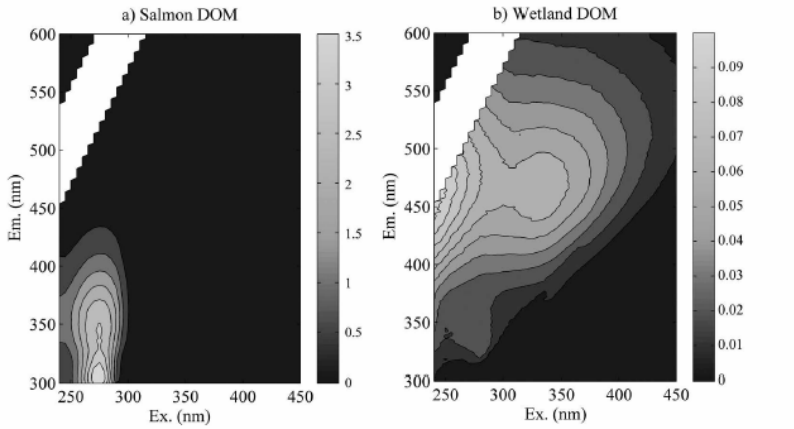


Fig. 5. Fluorescence EEMs for DOM derived from two individual catchment sources: (a) salmon carcasses and (b) wetland soils. Excitation (Ex.) wavelengths range from 250 to 450 nm and emission (Em.) wavelengths range from 300 to 600 nm. Fluorescence intensities are in Raman units.

Hood et al.,
Limnol. Ocean., 2007

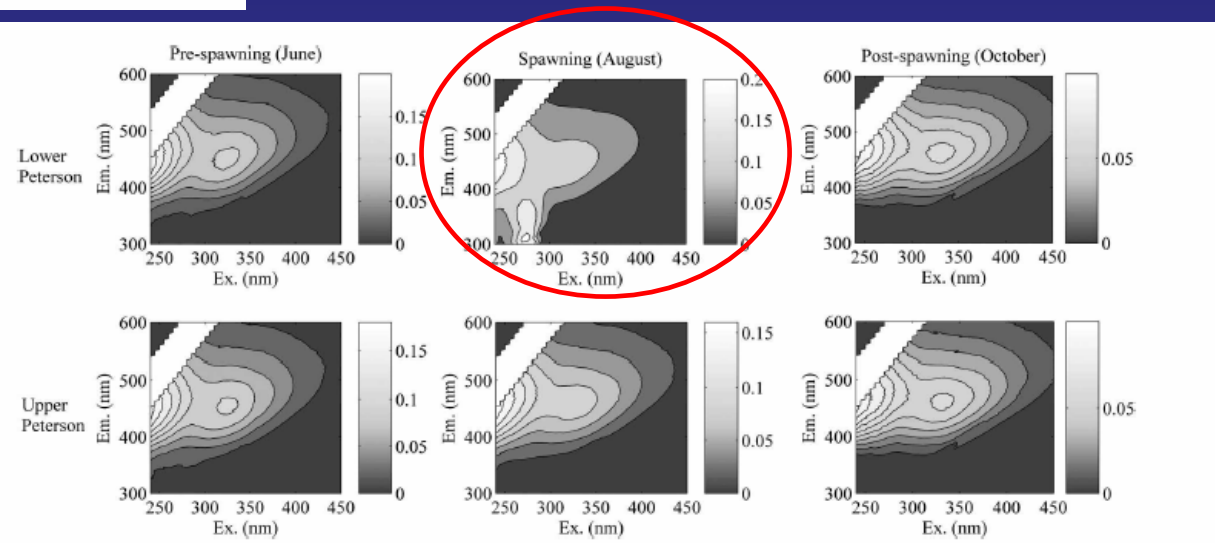
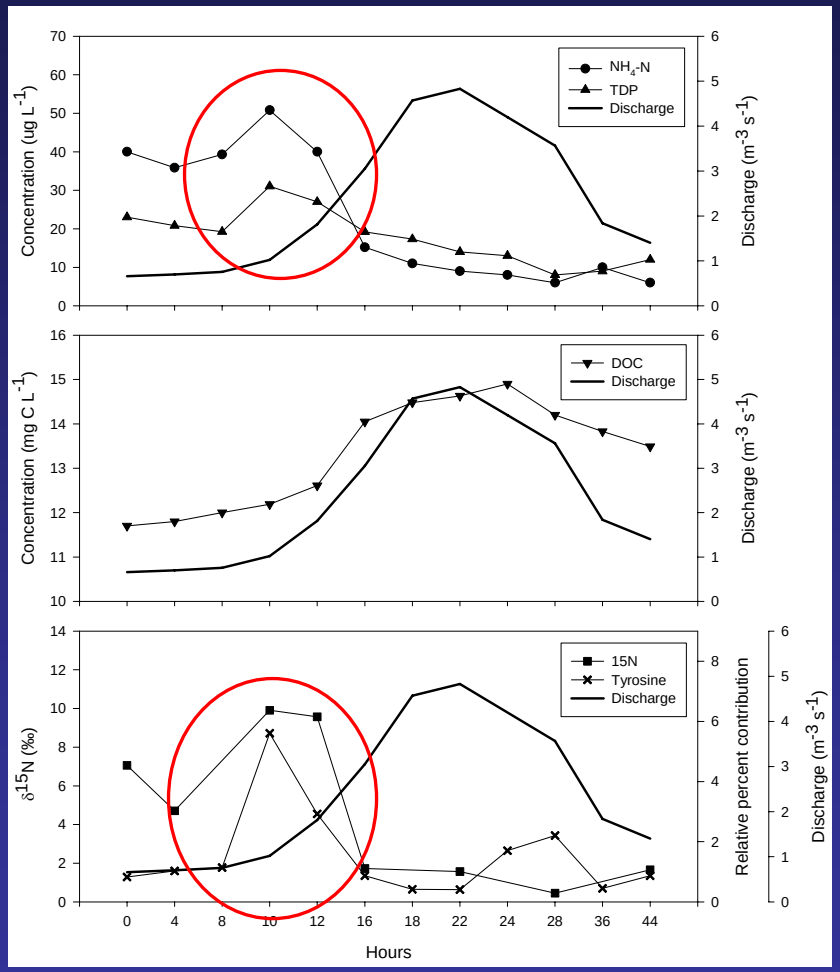


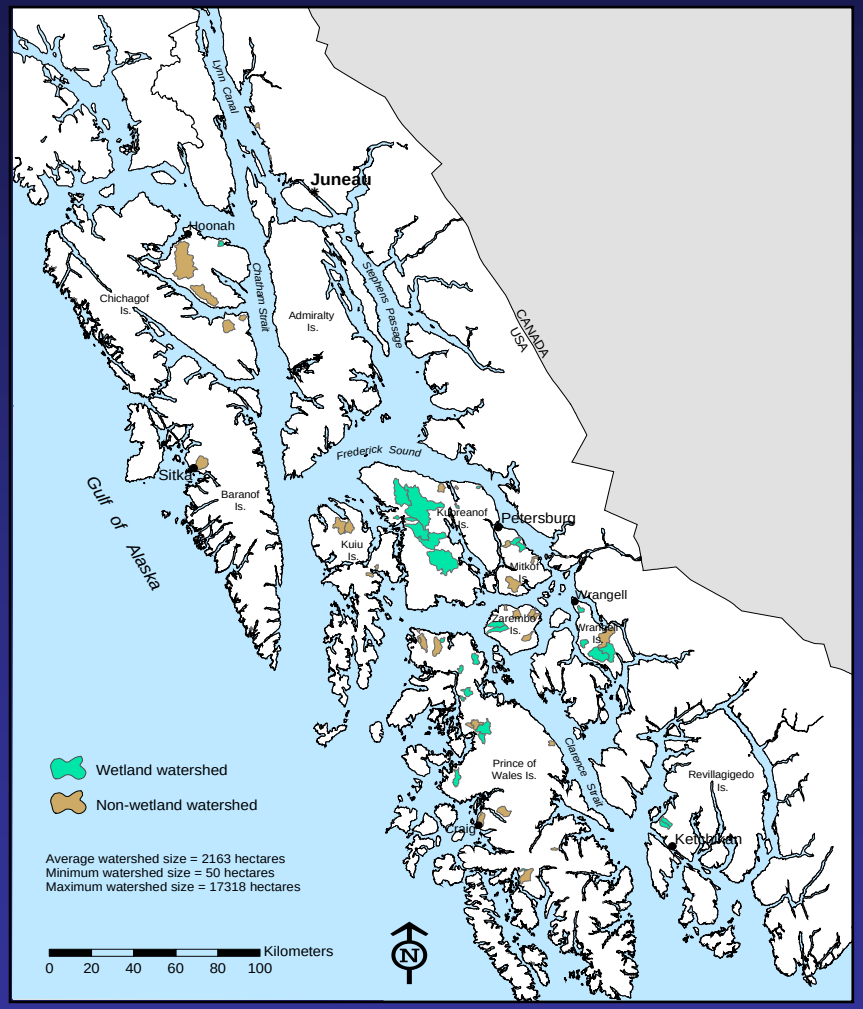
Fig. 6. Fluorescence EEMs for DOM before, during, and after the salmon spawning period at the Upper and Lower Peterson sites. Fluorescence intensities are in Raman units. Excitation (Ex.) wavelengths range from 250 to 450 nm and emission (Em.) wavelengths range from 300 to 600 nm. Fluorescence intensities are in Raman units.

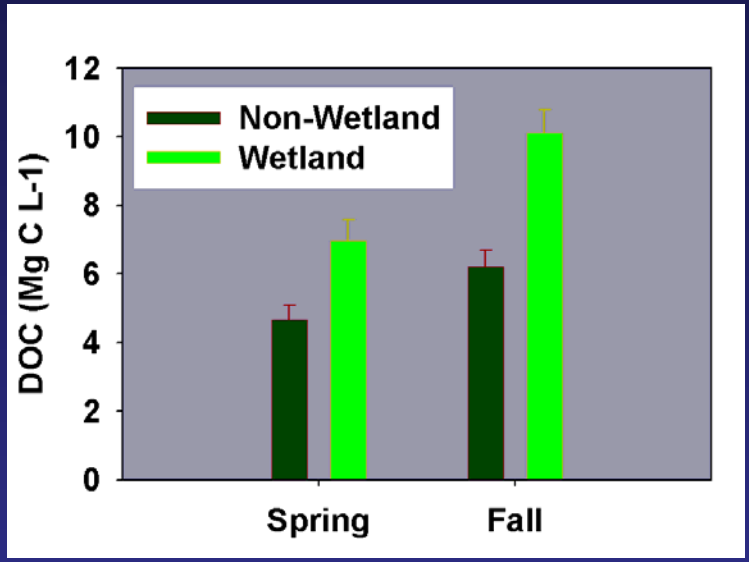
Salmon Nutrients

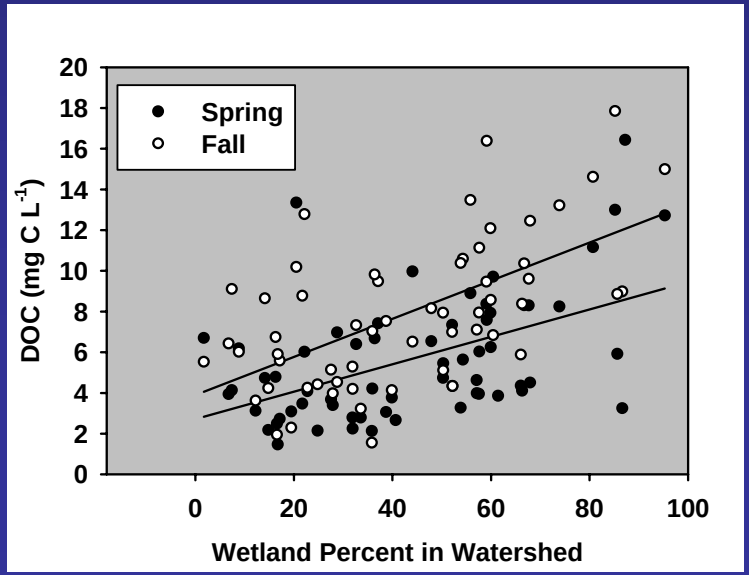


Fellman et al., *Ecosystems,* in revision

Wetland Nutrients

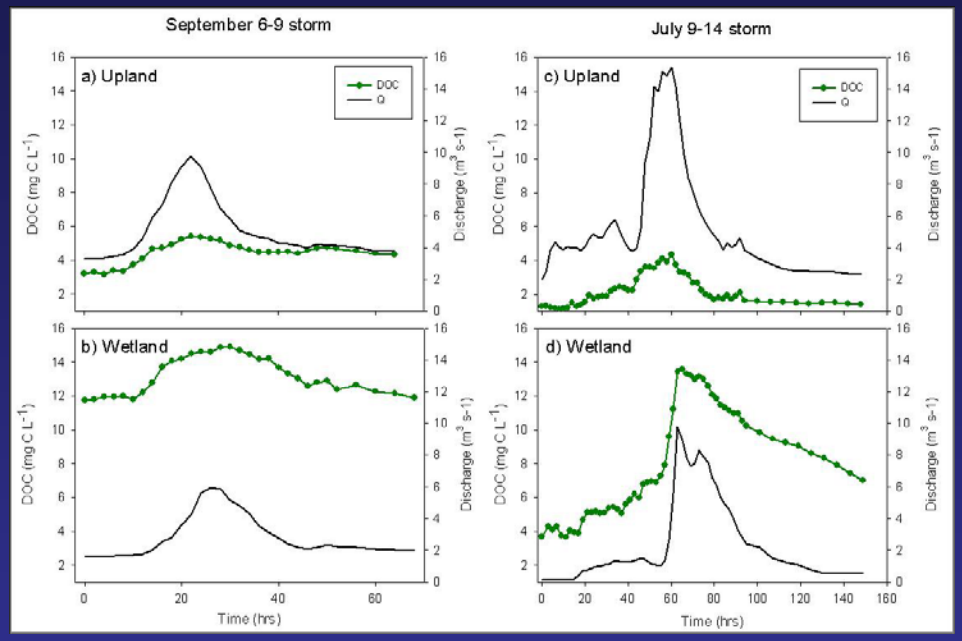




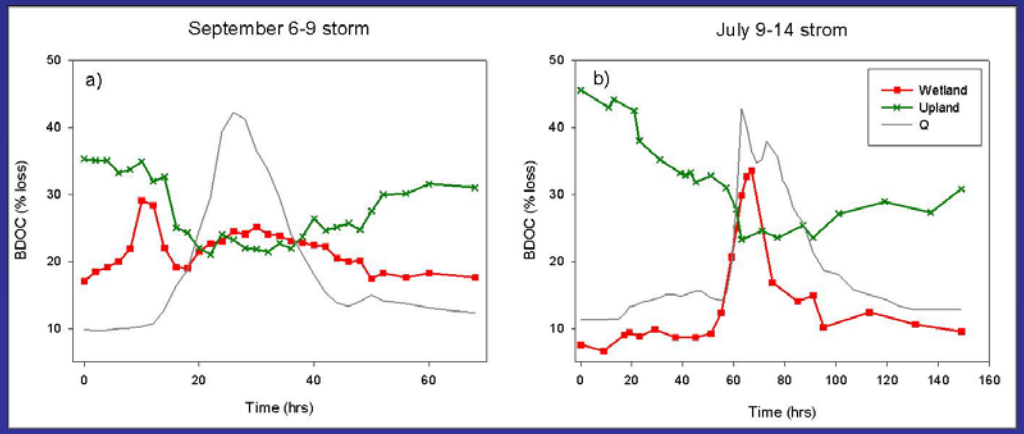


D'Amore et al., *Ecosystems,* in prep

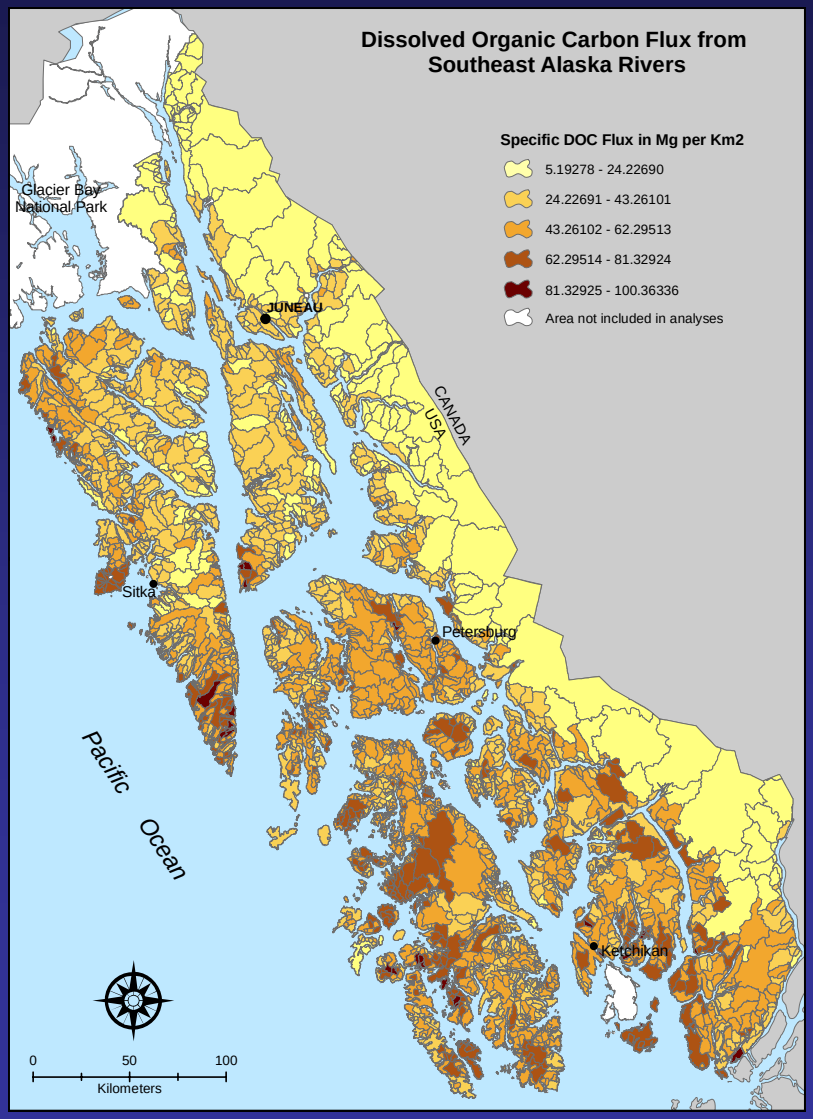
Wetland Nutrients



Fellman et al., *Biogeochemistry,* in review



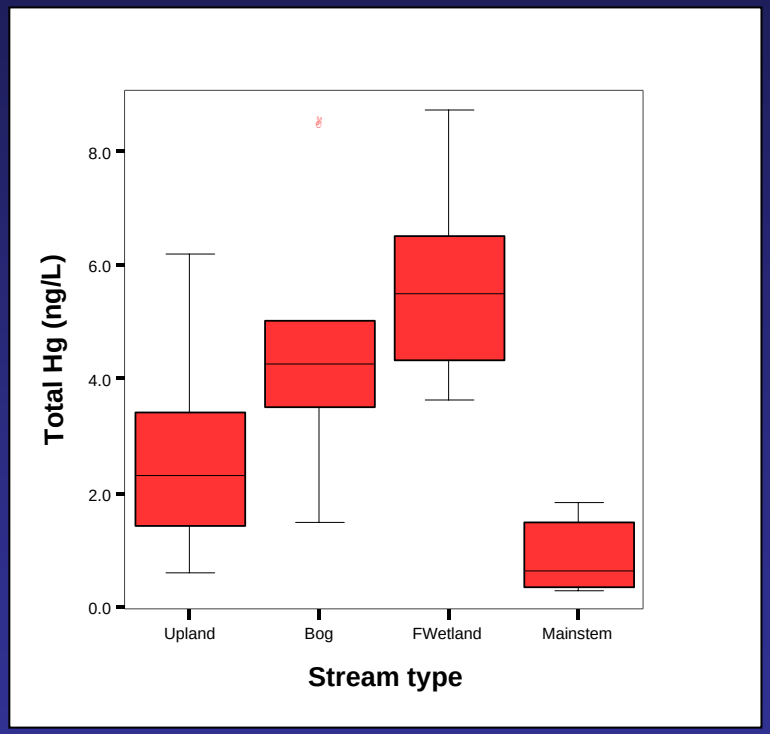
Watershed Nutrient Fluxes

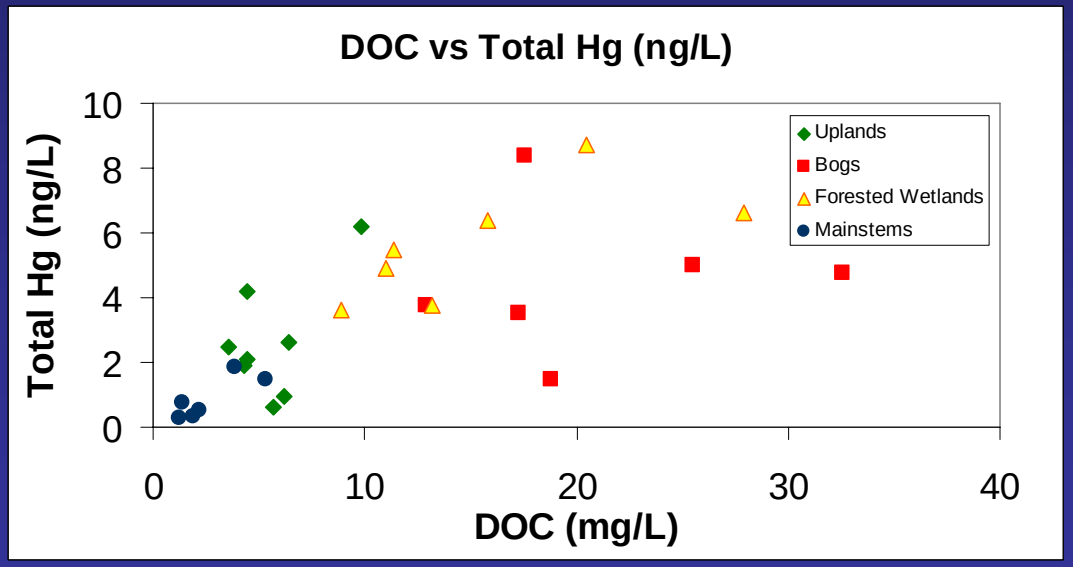


Location	Area (km^2)	Mean Annual Discharge (km^3)	Annual DOC Flux ($Tg\ yr^{-1}$)	DOC Flux per unit area ($Mg\ km^{-2}\ yr^{-1}$)
Tongass	66,239	207	2.32	35
Yukon	832,681	212	0.53	1.7
Mackenzie	1,800.000	330	1.3	0.72
Amazon	7,000,000	6,590	27	3.9
England and Wales	150,000	~127	0.53	4.0

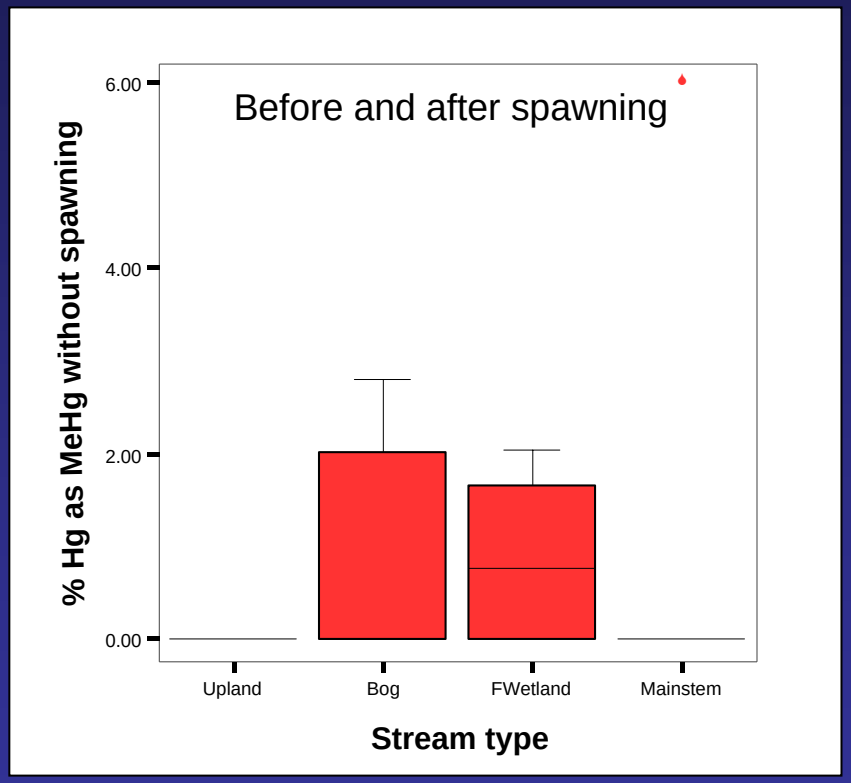
Edwards et al., *Nature Geoscience*, in prep

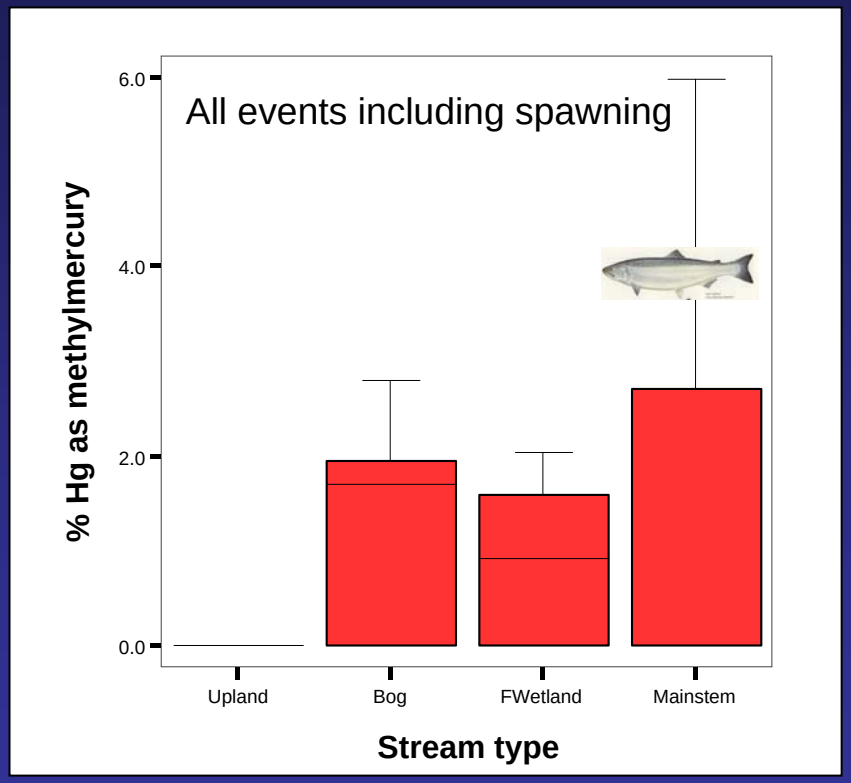
Wetlands and Mercury

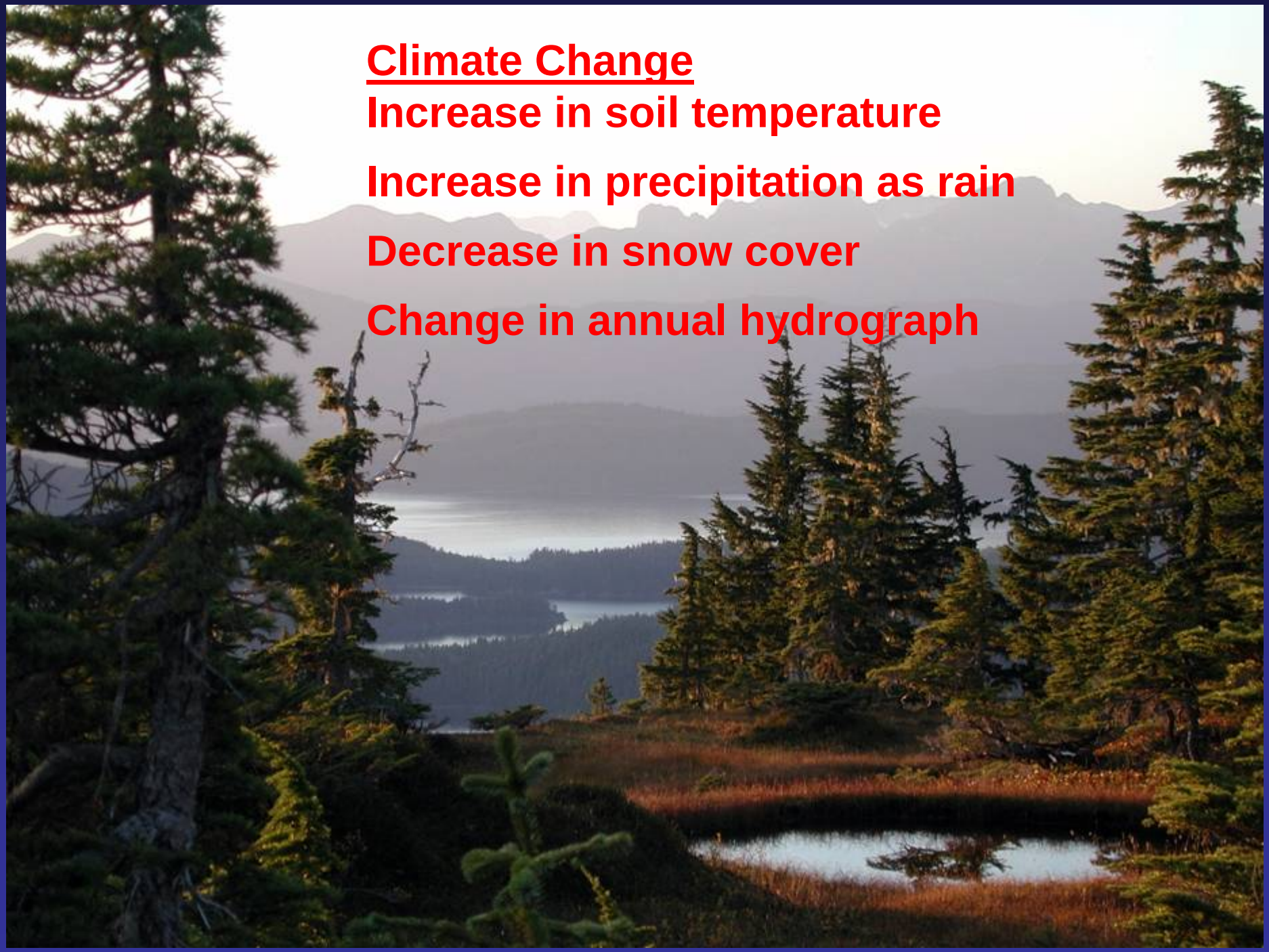




Salmon and Mercury







Climate Change

Increase in soil temperature

Increase in precipitation as rain

Decrease in snow cover

Change in annual hydrograph

Climate change influences forest structure

200,000 ha of yellow cedar declining

Project Outputs

PUBLICATIONS

- **Fellman, J., E. Hood, R.T. Edwards, and D. D'Amore (in review) Fluorescence characteristics and biodegradability of DOM in forest and wetland soils from coastal temperate watersheds . *Biogeochemistry*.**
- **Fellman, J., E. Hood, R.T. Edwards, and D. D'Amore (in revision) Return of salmon-derived nutrients from the riparian zone to the stream during a storm in southeastern Alaska. *Ecosystems*.**
- **Fellman, J., D. D'Amore, and E. Hood (2008) An evaluation of freezing as a preservation technique for analyzing dissolved organic C, N and P in surface water samples. *Science of the Total Environment*.**
- **Hood, E., J. Fellman, and R.T. Edwards (2007) Salmon influences on dissolved organic matter in a coastal temperate brownwater stream: An application of fluorescence spectroscopy. *Limnology and Oceanography* 52: 1580-1587.**
- **Fellman, J.B. and D.V. D'Amore (2007) Nitrogen and phosphorus mineralization in three wetland types in southeast Alaska. *Wetlands* 27:44-53.**

PRESENTATIONS

15 Total at National Meetings : AGU, ASLO, NABS, SSSA, SWS

Acknowledgements

- **Funding from USDA NRI CSREES Grant # 2005-35102-16289 and USDA Forest Service PNW Research Station**

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