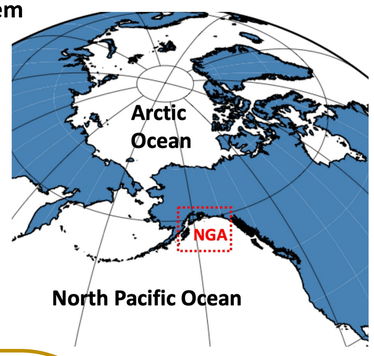
Ecological Structure from a Variable River Plume in a Productive Marine Setting

Suzanne Strom[1], Seth Danielson[2], and the NGA Team

[1]Western Washington University (stroms@wwu.edu); [2]University of Alaska Fairbanks (sldanielson@alaska.edu)

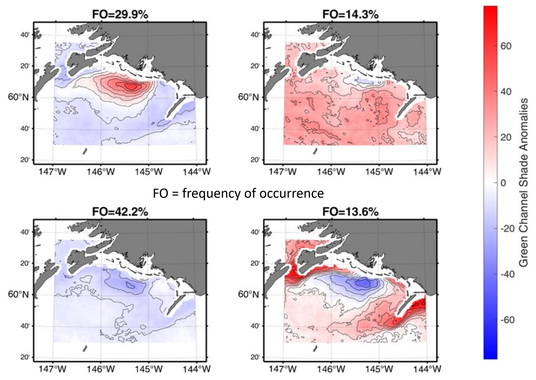
Freshwater plays multiple important roles in the Northern Gulf of Alaska (NGA) ecosystem

- Terrestrial runoff contains iron and other micronutrients
- Low-density surface water vertically structures habitat and mediates nutrient fluxes into the euphotic zone
- Spreading of the plume edges entrains nutrients into surface waters, stimulating production
- Fresher waters support distinct planktonic assemblages

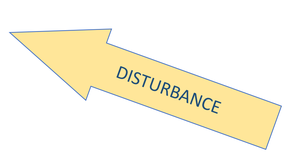


With a mean discharge of ~1800 m^3 s^{-1}, the Copper River is the largest point source of fresh water to the NGA (NASA image).

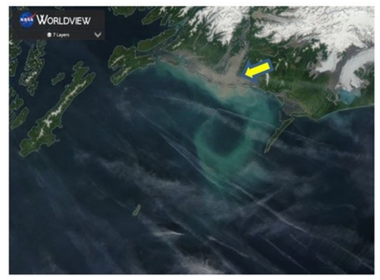
Plume inputs are variable but quasi-predictable

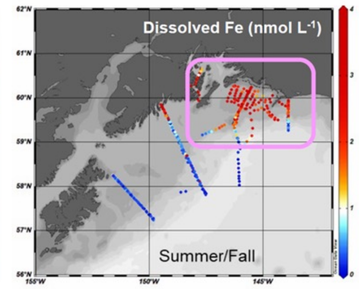


Self-organizing map analysis shows the plume exhibits 4 primary modes of freshwater spatial distribution (mediated by wind and discharge rate) with varying frequencies of occurrence (*see Reister on-line NGA poster*). Freshwater inputs also show a pronounced seasonal cycle, peaking in late summer (Beamer et al. 2016).

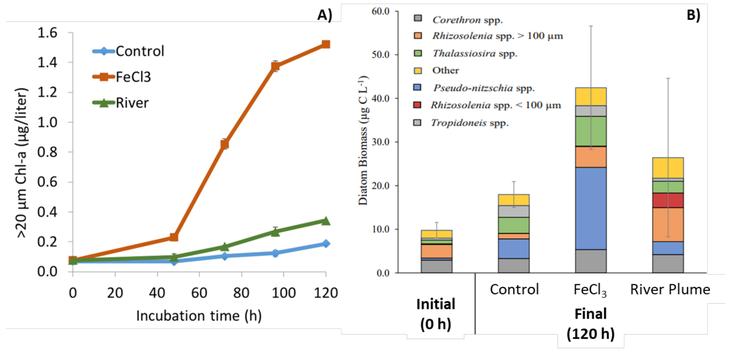


Coastal freshwater supplies iron, a limiting micro-nutrient in the NGA



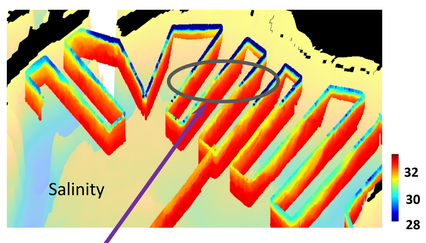


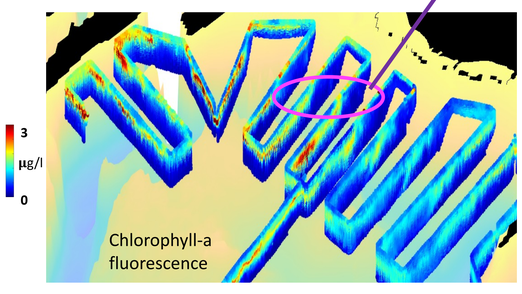
Dissolved iron, a limiting micronutrient in the NGA, is provided by river plume and non-point-source freshwater inputs, especially in summer/fall (*see Ortega on-line NGA poster*)



Adding river plume water to iron-limited offshore waters stimulates growth of large phytoplankton (diatoms) and alters community composition, as shown in at-sea incubation experiments (Mazur 2020).

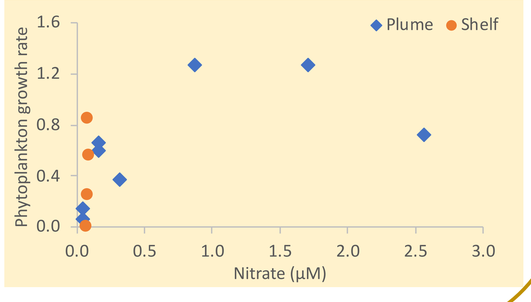
Plume edge processes supply growth-promoting nutrients



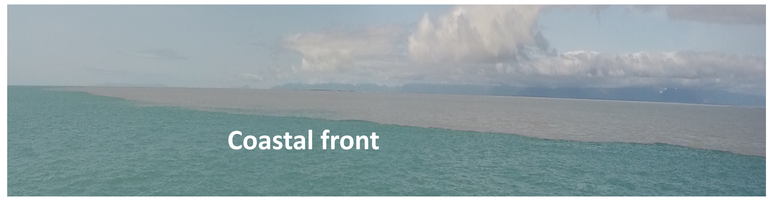


Fine-scale mapping shows 3-D plume structure. Spreading mid-shelf plume fronts generate turbulent shear as they flow over saline shelf waters; shear mixes macronutrients from below, leading to small-scale phytoplankton blooms at the sea surface.

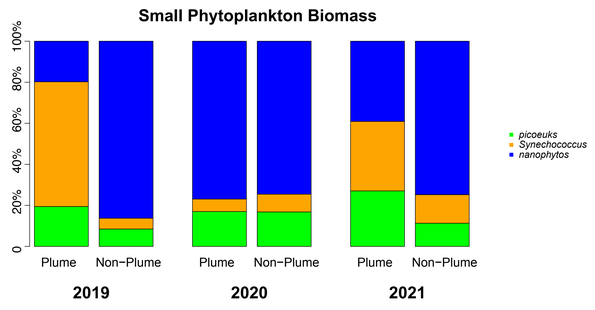
Phytoplankton growth rates (d^{-1}) during two summers (2019, 2020) were higher in nitrate-rich plume frontal zones. Data from seawater dilution experiments.



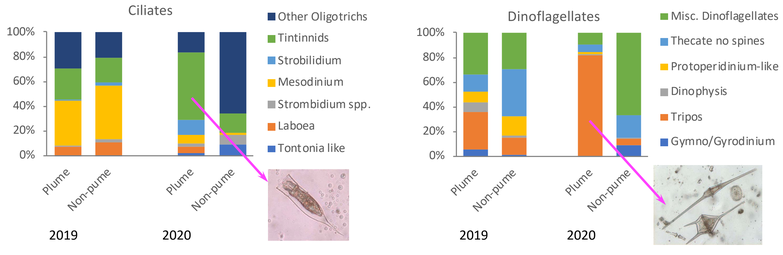
NGA river plumes promote higher ecosystem production and biodiversity through multiple habitat types and temporally evolving physical disturbances



Plume creates distinct habitats that increase ecosystem-wide diversity



Plume phytoplankton communities tended to be higher in *Synechococcus* cyano-bacteria, lower in larger phytoflagellates (*see Cohen and O'Hara on-line NGA posters*)



Microzooplankton (primary consumers in the NGA) showed different community biomass composition in the river plume. Tintinnids (shelled ciliates) and large mixotrophic dinoflagellates (*Tripos* spp.) were dominant plume members. Plume communities were less distinct in the 2019 marine heatwave year.

Additional support from:

We acknowledge that we work on the ancestral lands and waters of the Eyak and Sugpiaq-Alutiiq peoples. We recognize their unique relationships with and knowledge of this place and are grateful for their stewardship past, present, and future. We strive to be in good relations with the original peoples and with this place.

References Cited:
Beamer et al. 2016. Water Resour. Res., 52, doi:10.1002/2015WR018457
Mazur 2020. M.S. Thesis, Western Washington Univ.