

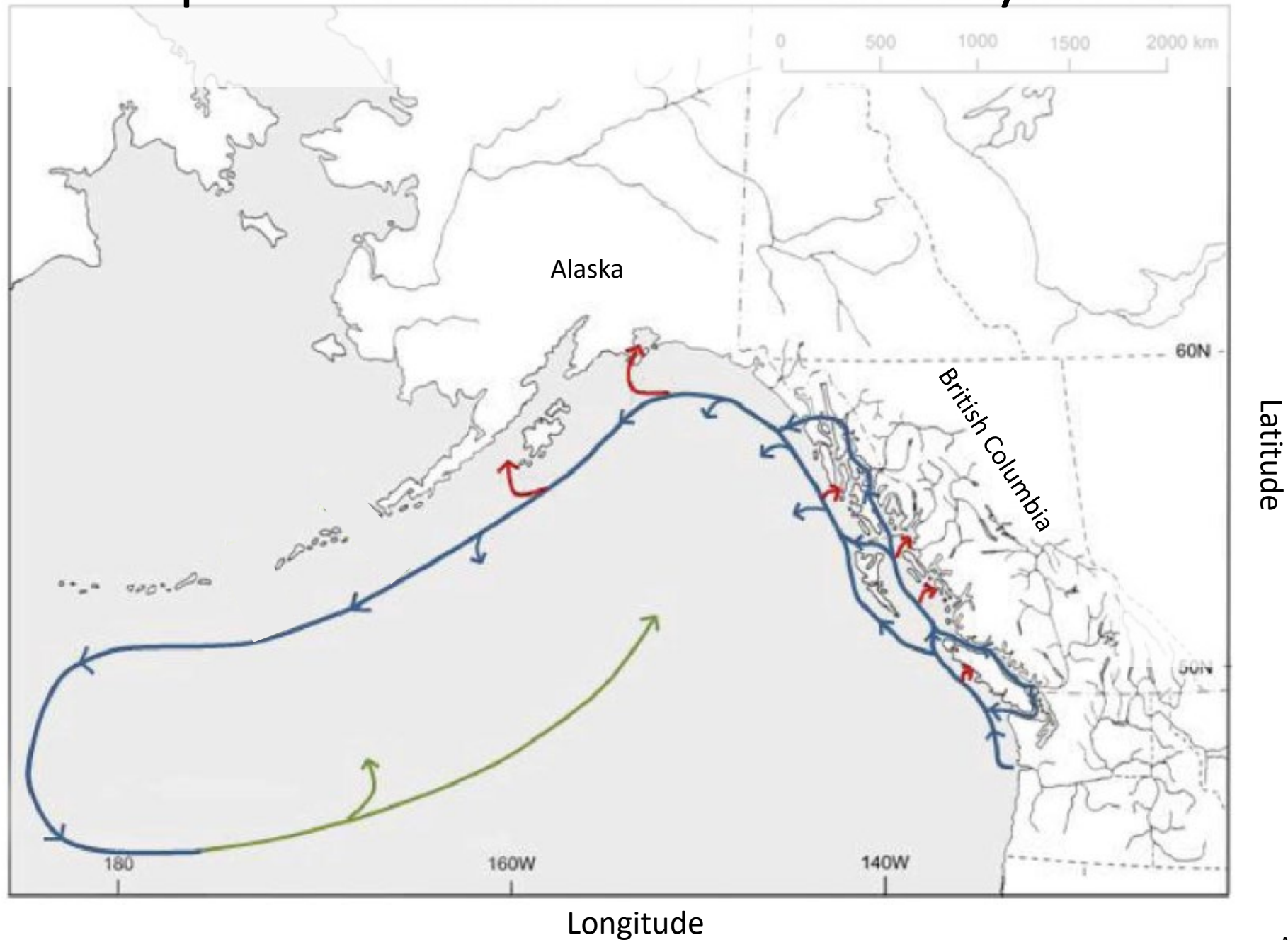
Co-variability of Fraser River sockeye salmon productivity and phytoplankton biomass in the Gulf of Alaska



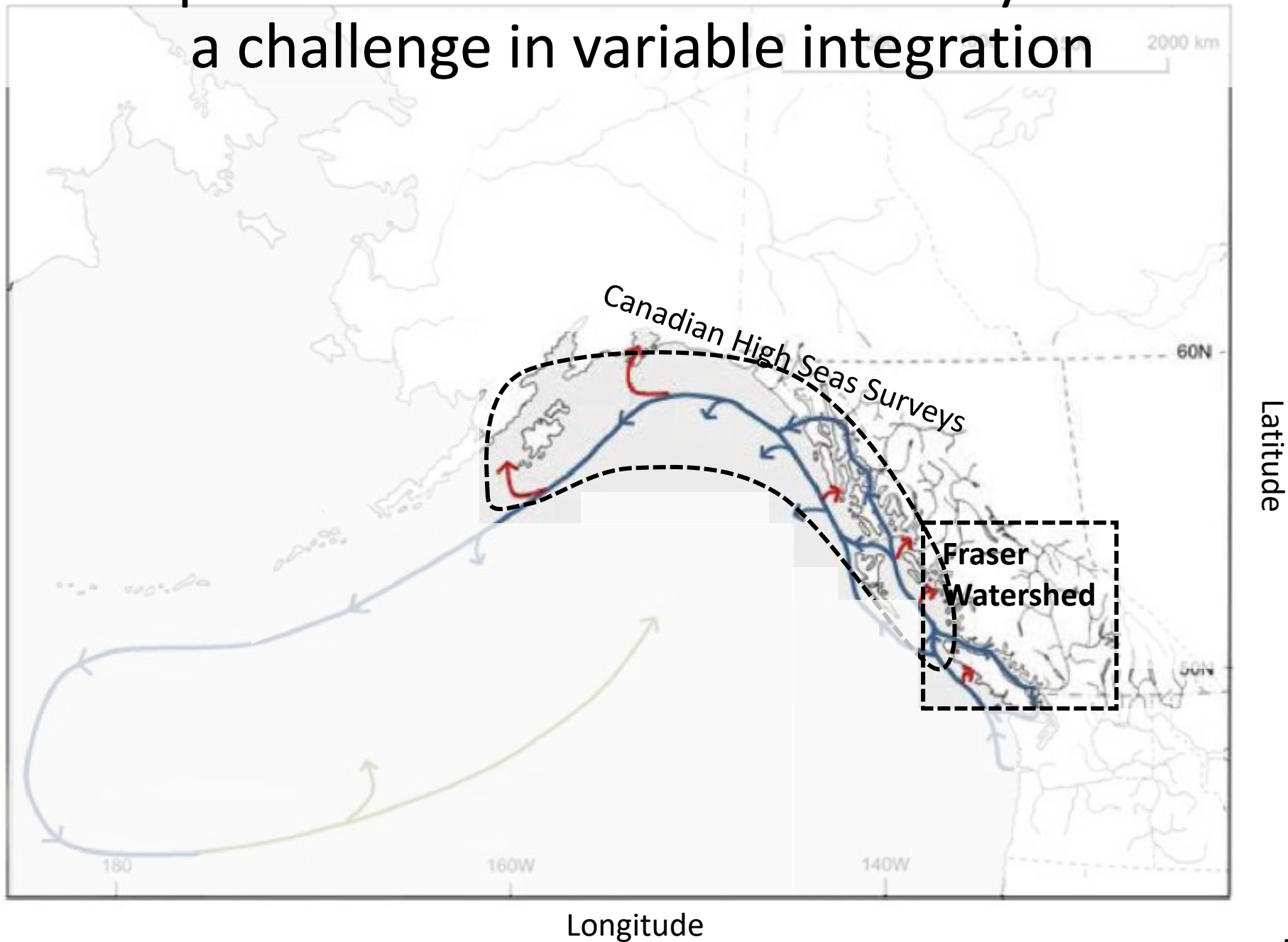
Sarah Z. Rosengard¹, Cameron Freshwater², Yi Xu³, Philippe Tortell^{1,4}
srosengard@eoas.ubc.ca

1. University of British Columbia, Department of Earth, Ocean and Atmospheric Sciences
2. Pacific Biological Station, Fisheries and Oceans Canada
3. Stock Assessment Division, Fraser and Interior Area, Fisheries and Oceans Canada
4. University of British Columbia, Department of Botany

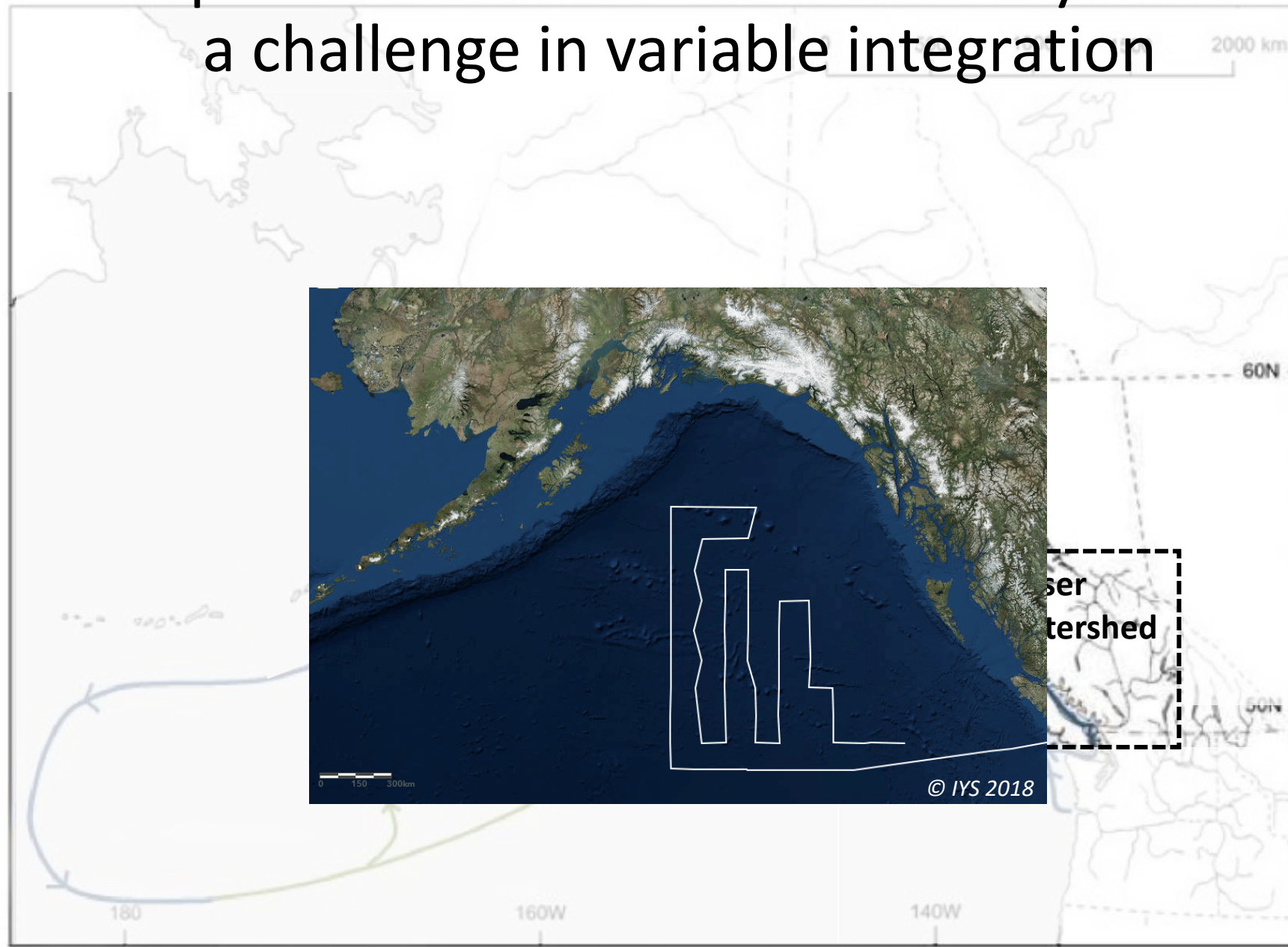
Ocean processes that influence sockeye survival:



Ocean processes that influence sockeye survival: a challenge in variable integration



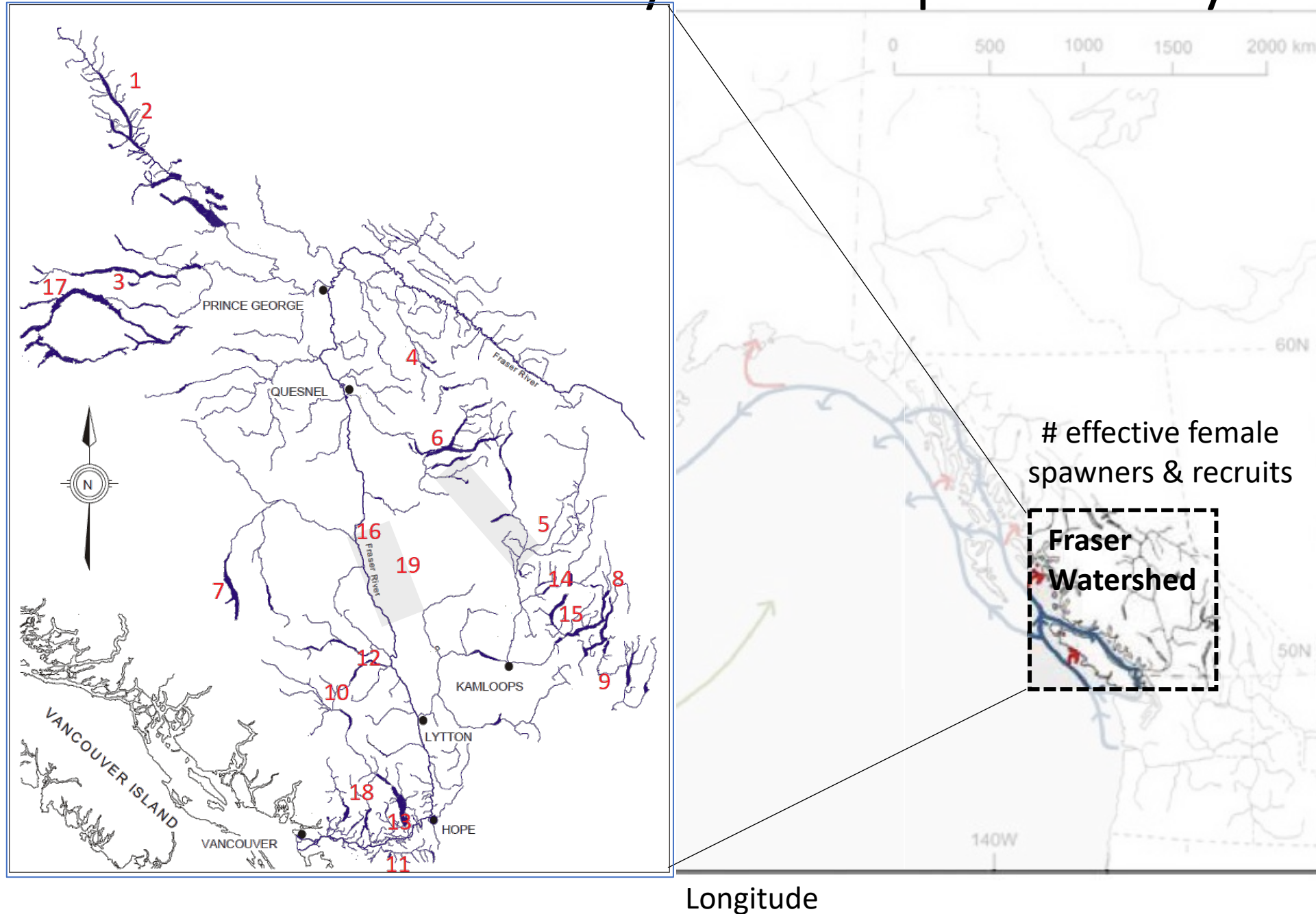
Ocean processes that influence sockeye survival: a challenge in variable integration



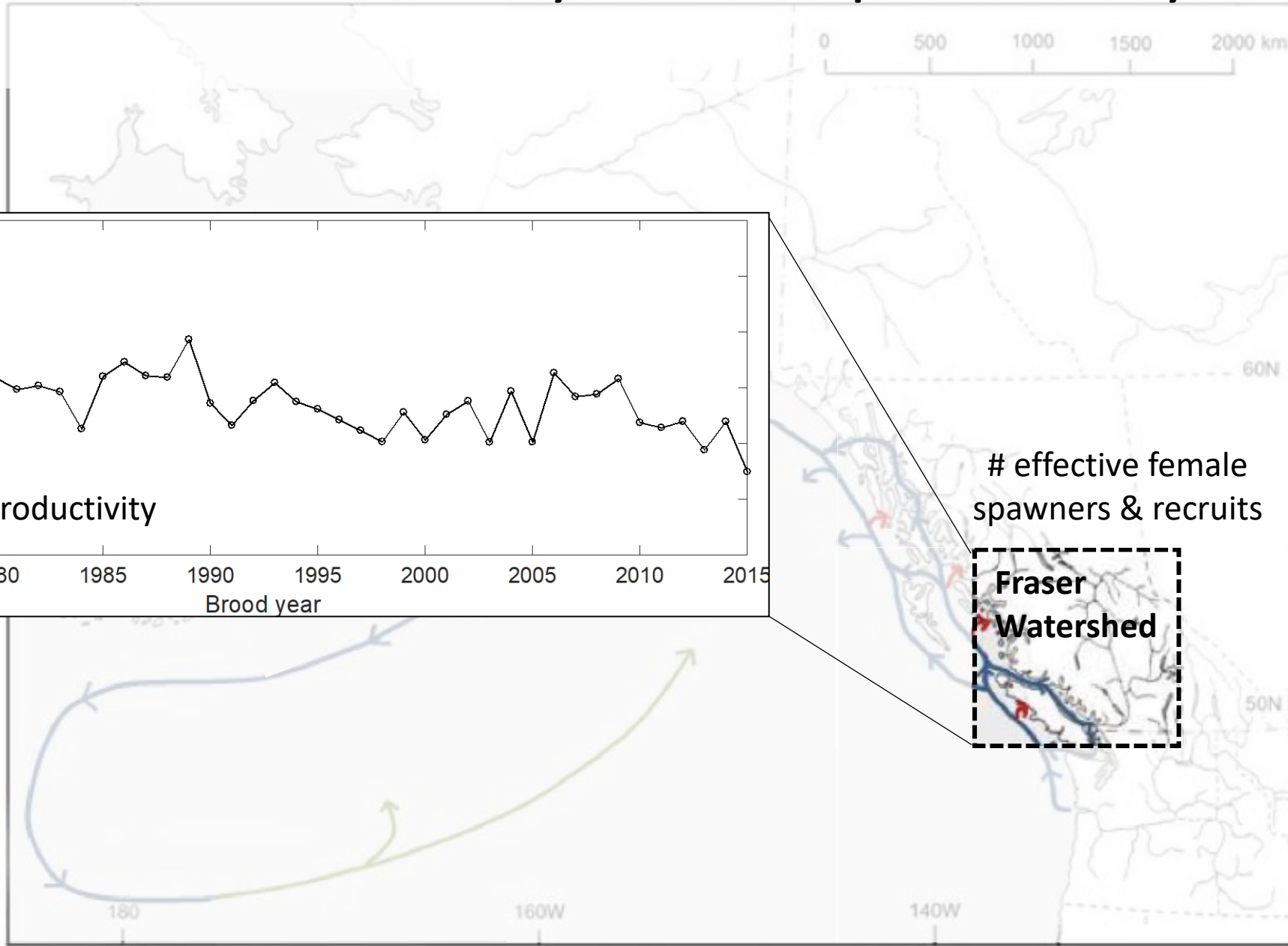
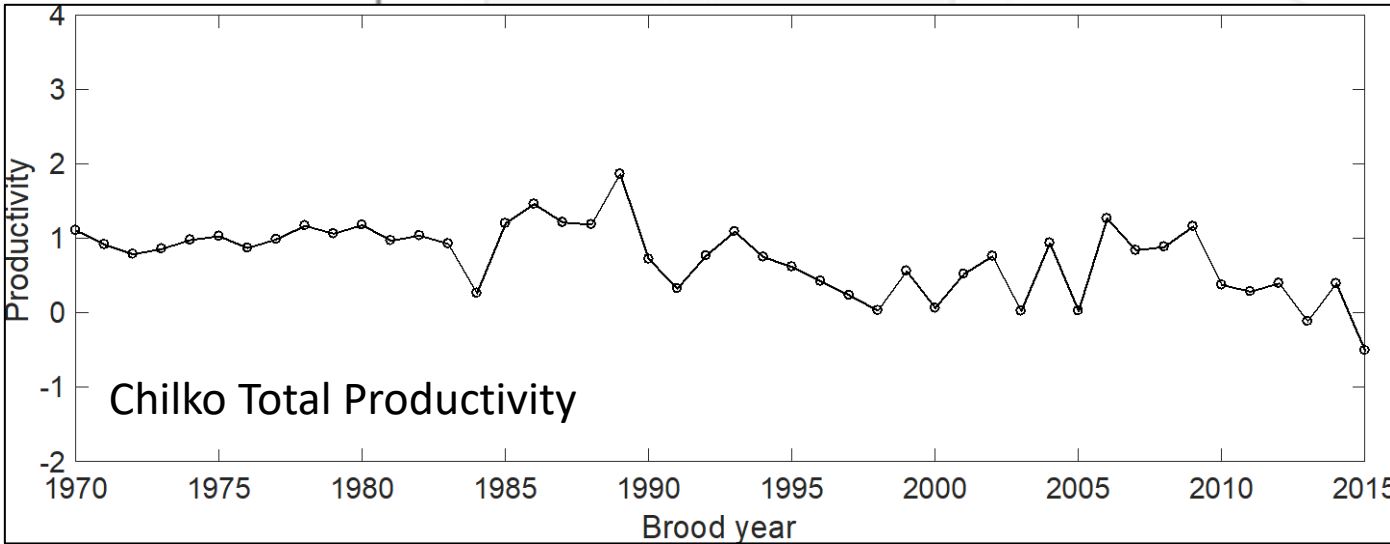
Latitude

Longitude

Estimates of sockeye salmon productivity



Estimates of sockeye salmon productivity



effective female
spawners & recruits

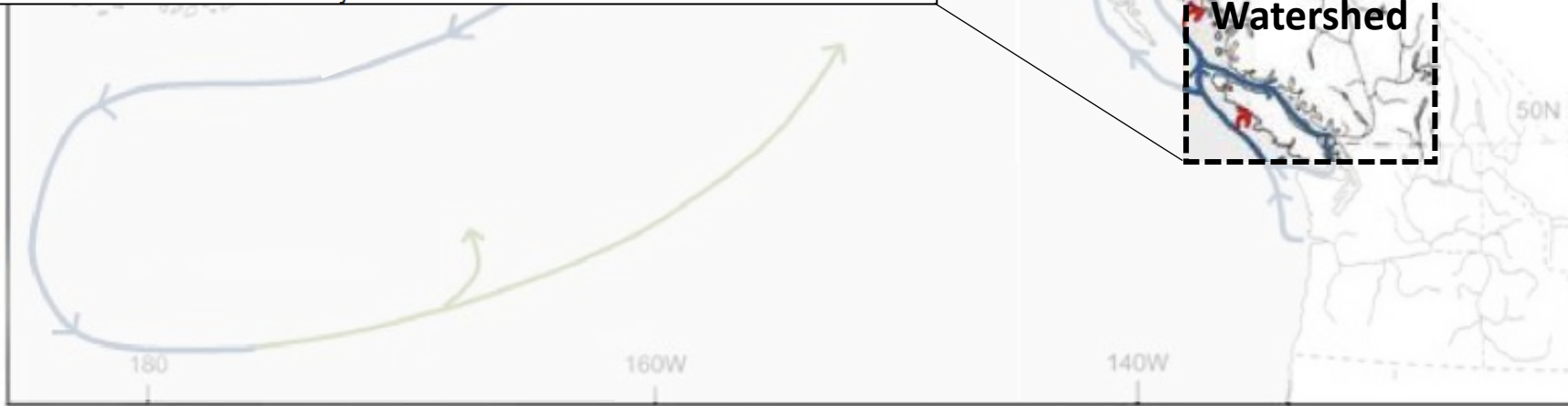
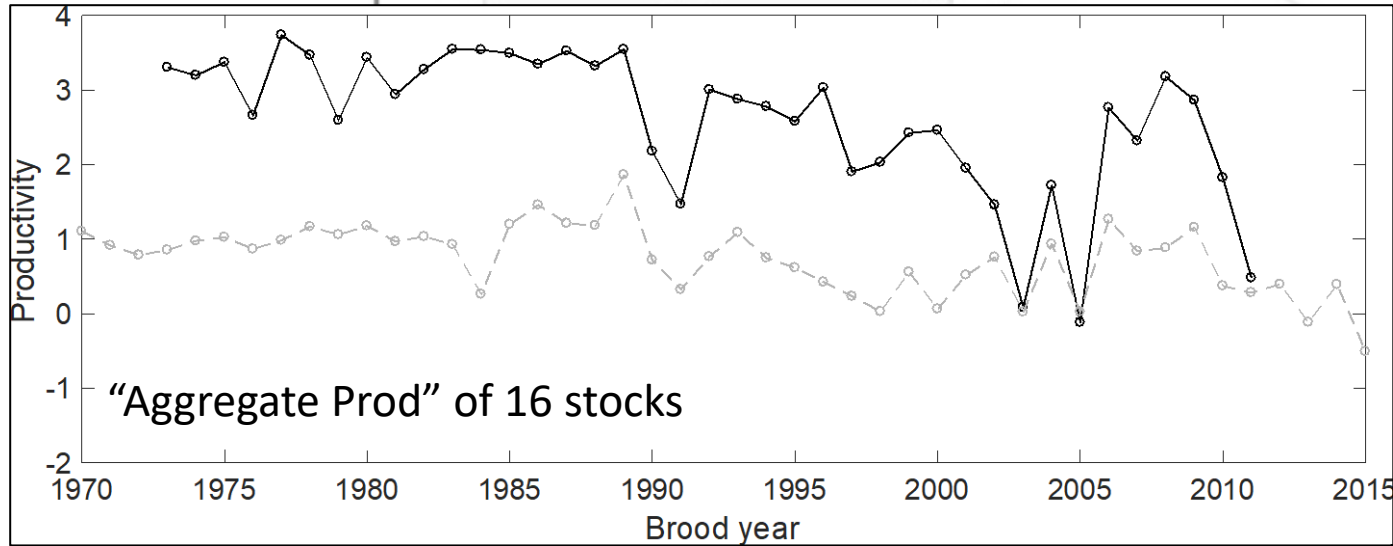
**Fraser
Watershed**

Latitude

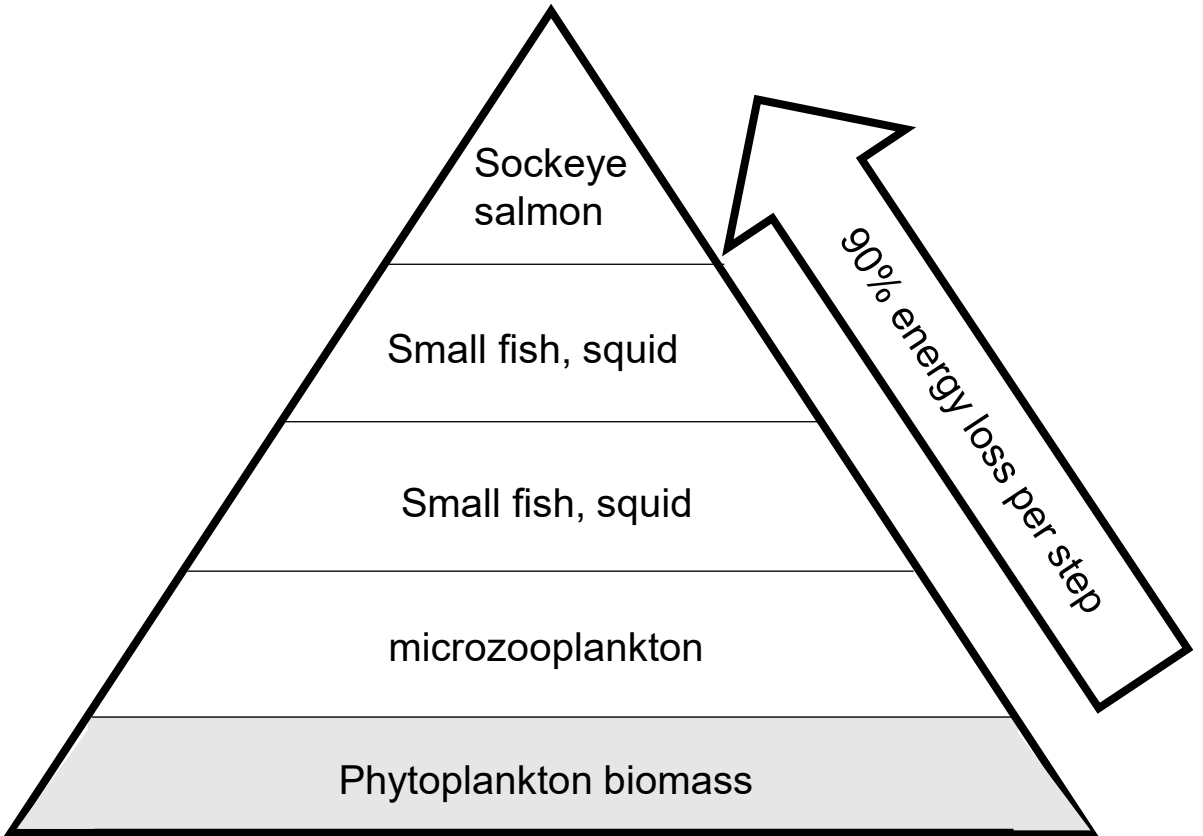
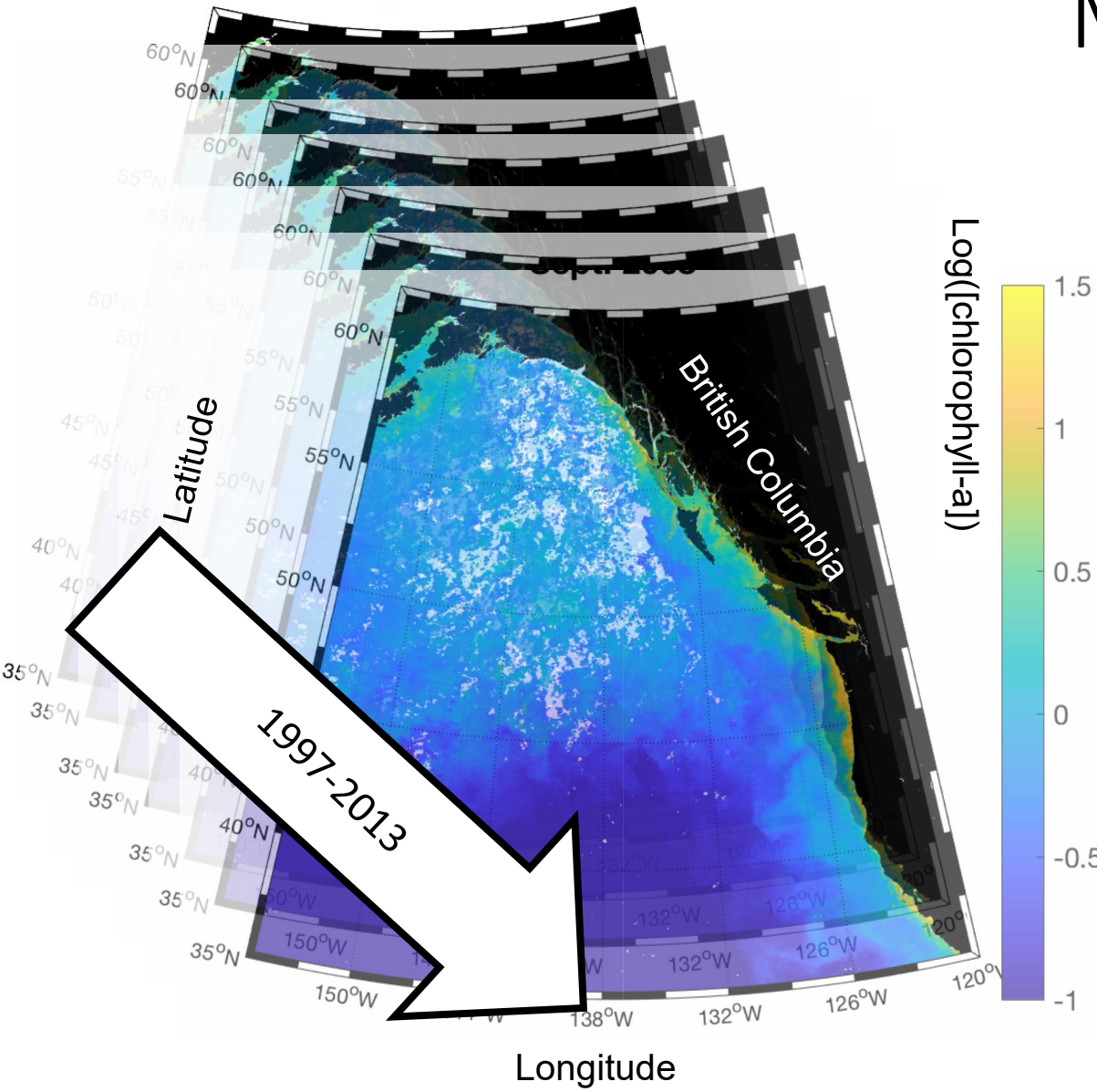
Longitude

Estimates of sockeye salmon productivity

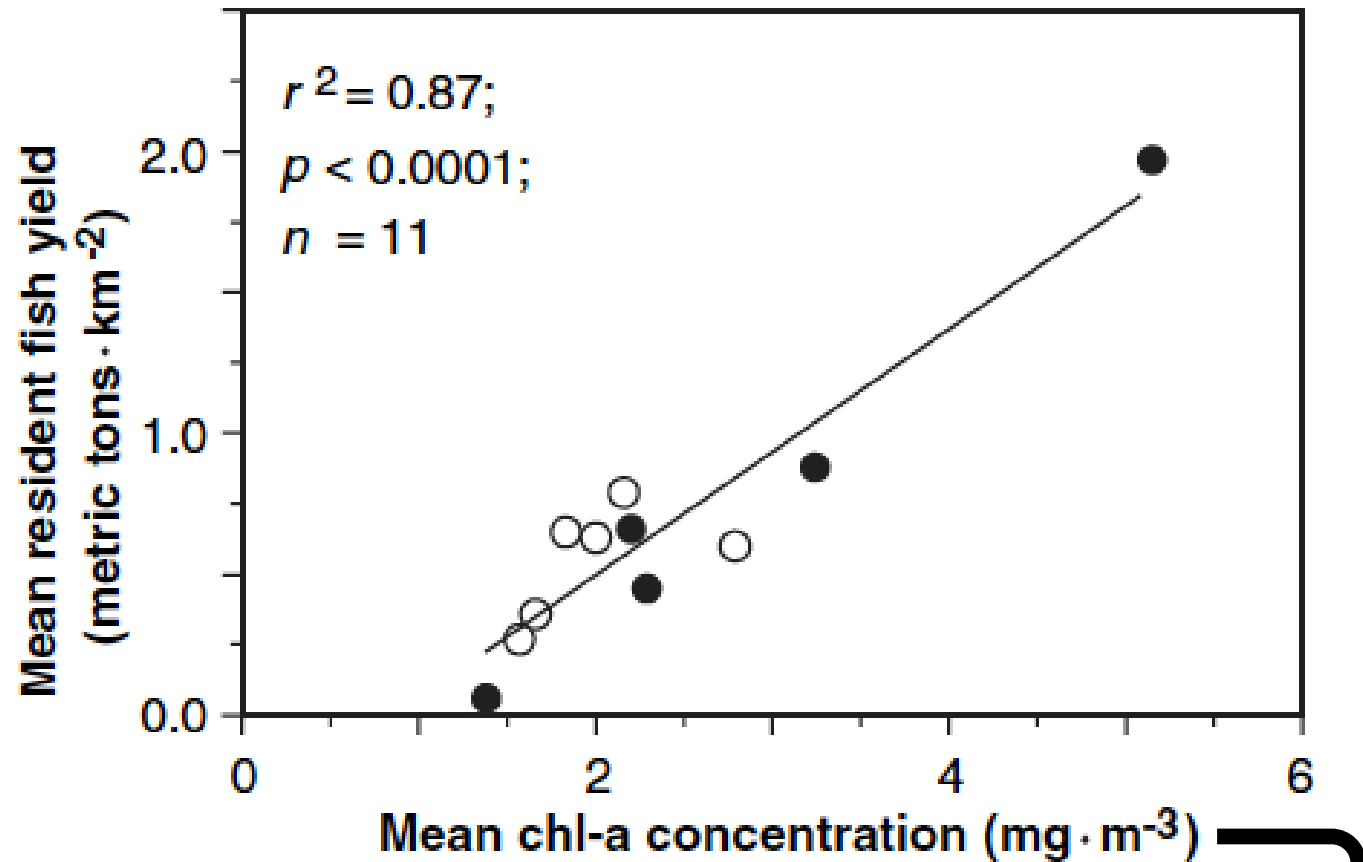
What are the shared conditions that impact salmon at sea?



MODIS chlorophyll-a ([Chl-a]) and fish productivity



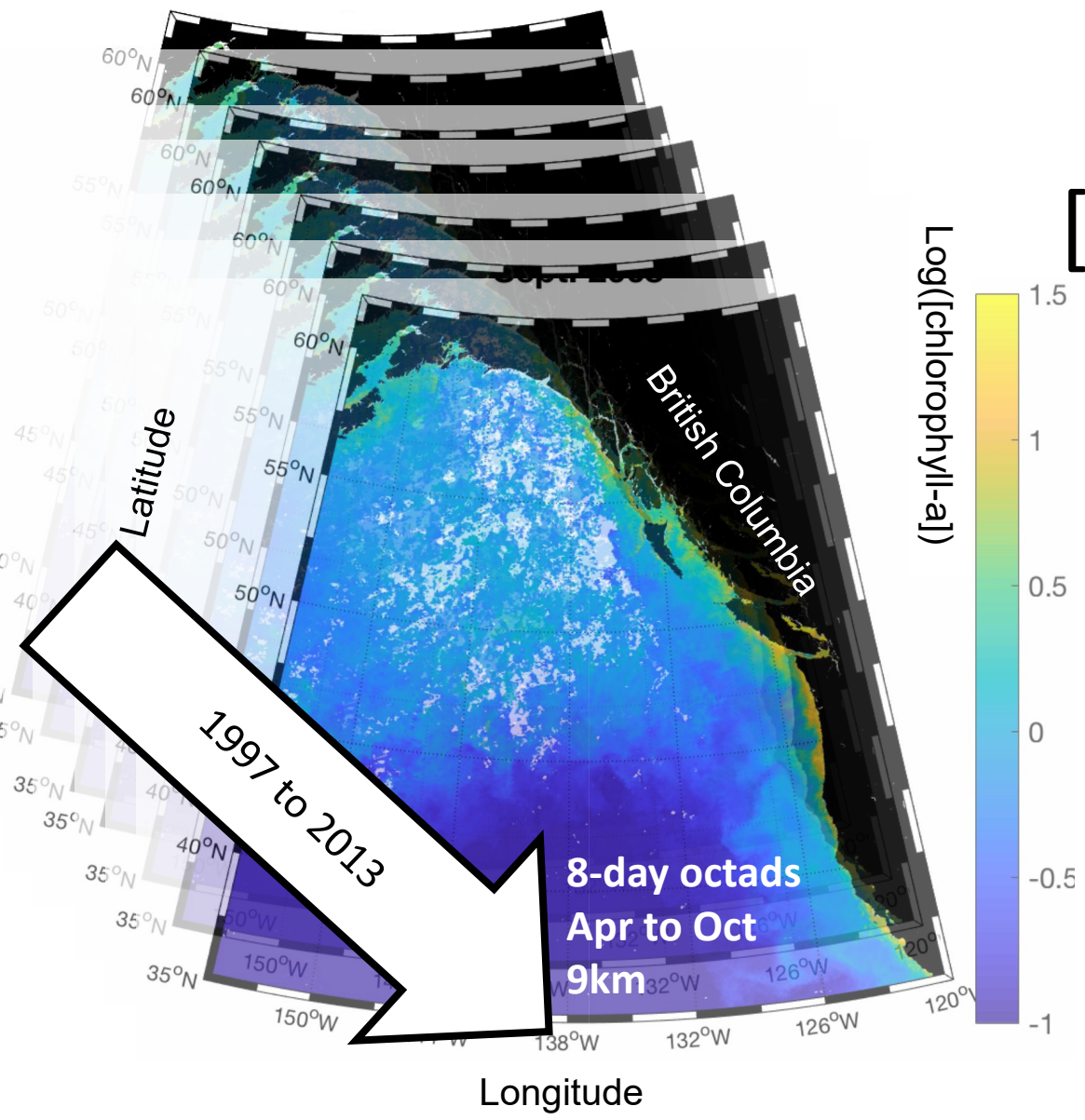
MODIS chlorophyll-a ([Chl-a]) and fish productivity



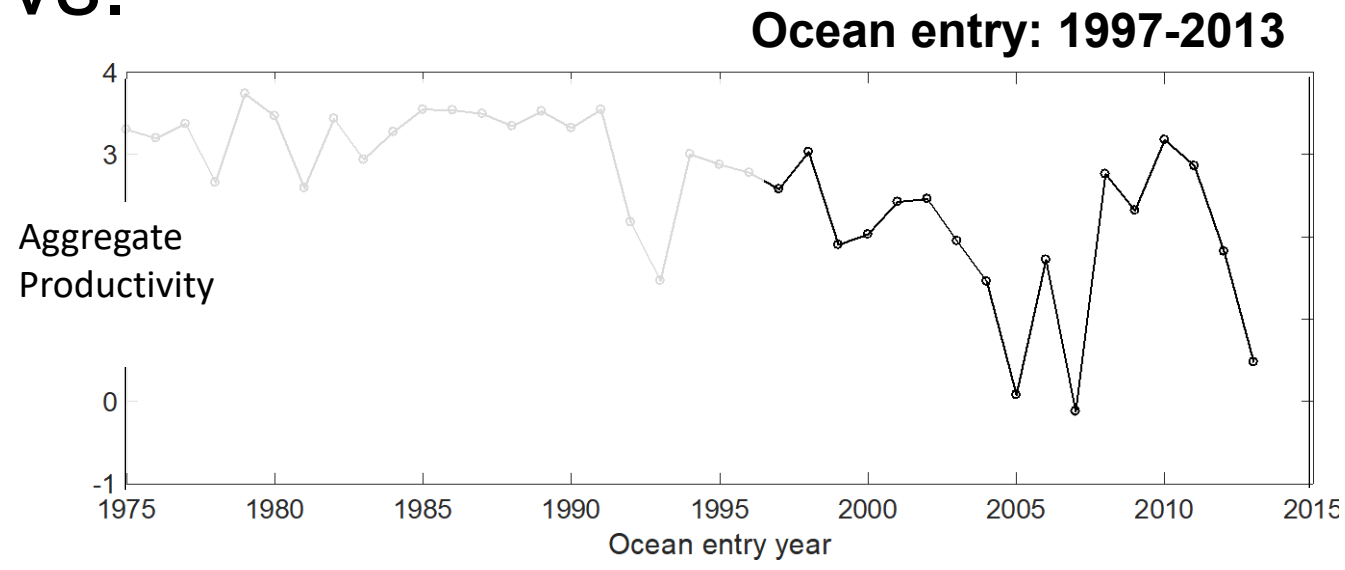
*Average values over 1998-2003
within 11 NPAFC areas*

~Phytoplankton biomass

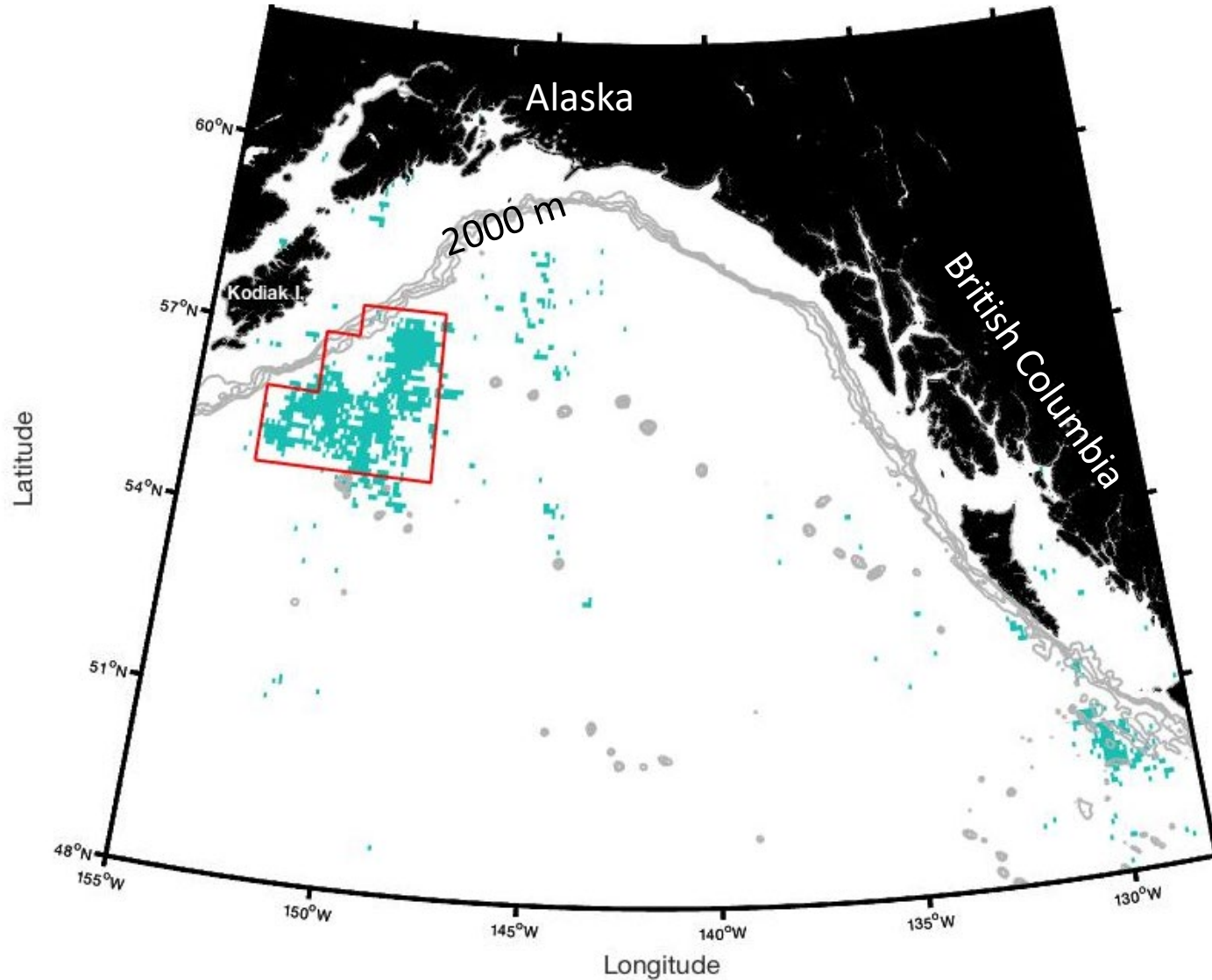
Objective: Spatial & temporal relationships between MODIS [Chl-a] and sockeye productivity

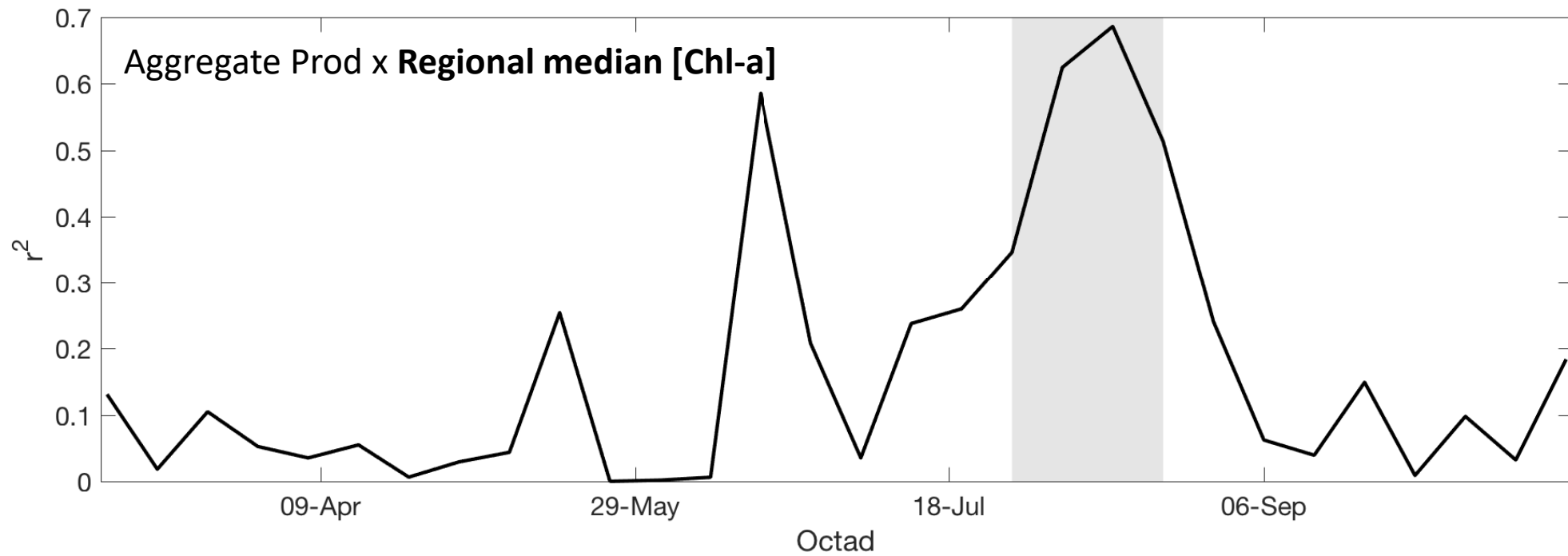


VS.

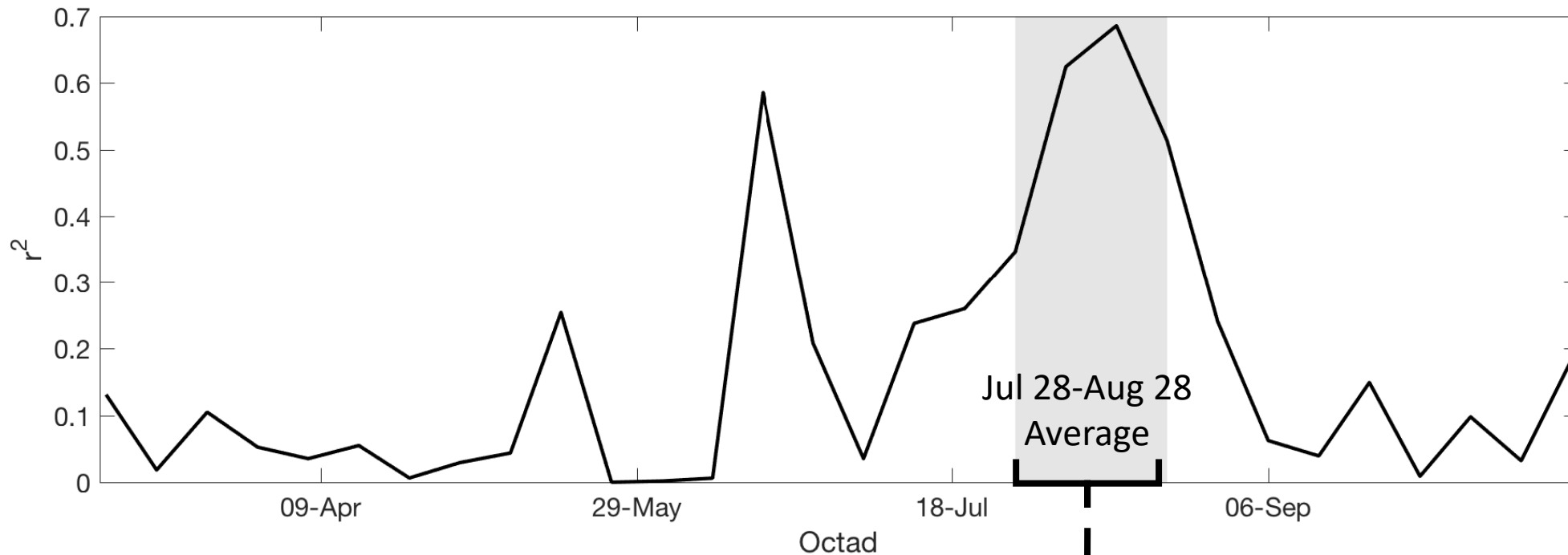


Strong correlation ($r^2 > 0.4$) in the Northwest Gulf of Alaska (GoA)

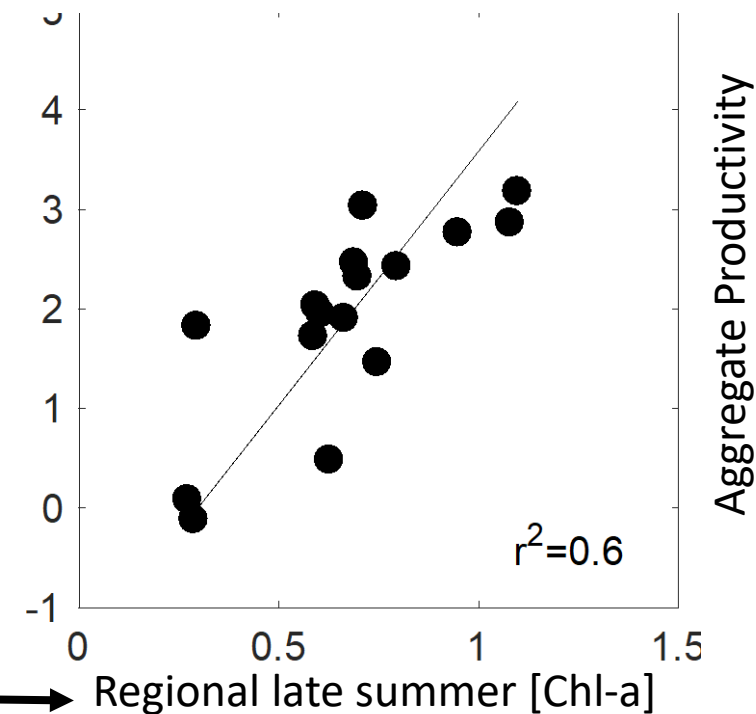




Strongest in the late
summertime



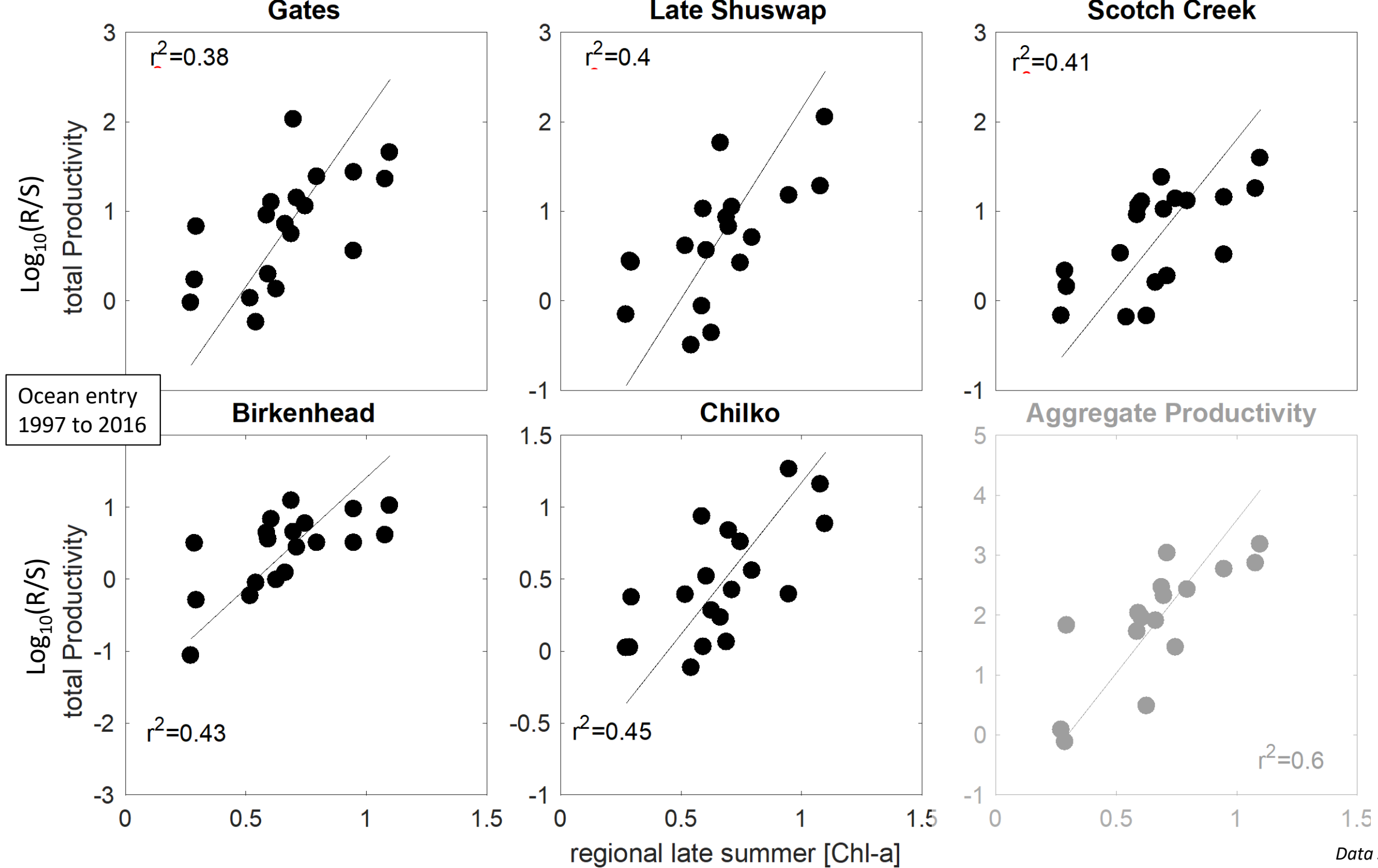
Strongest in the late summertime

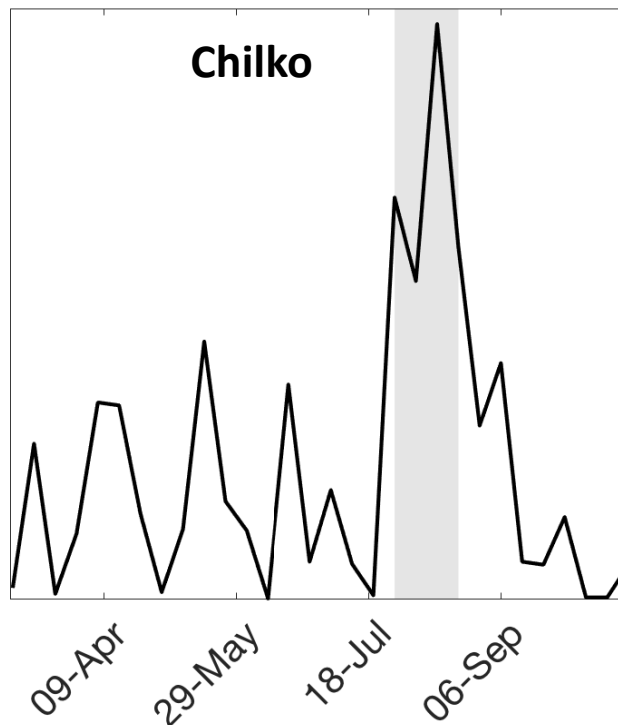
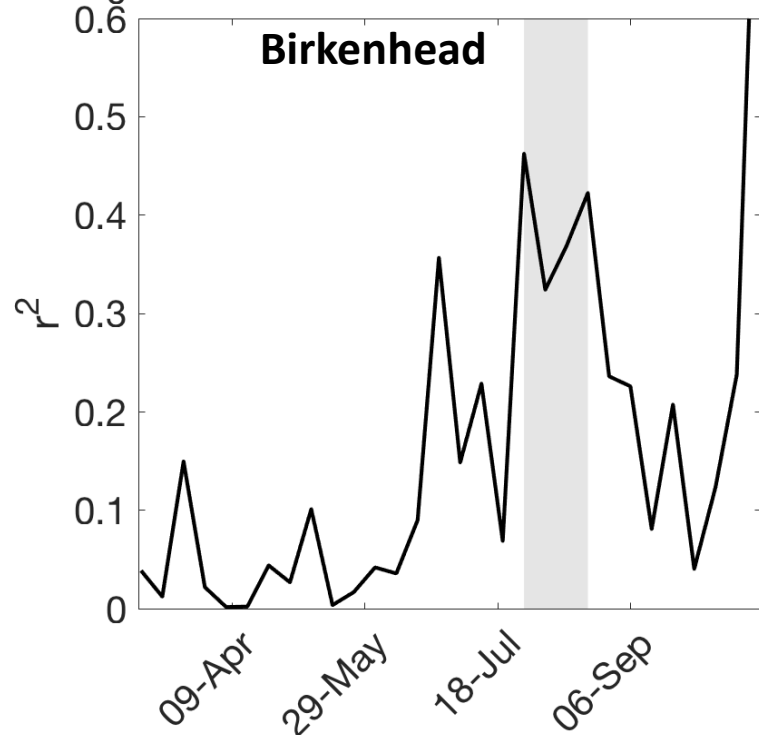
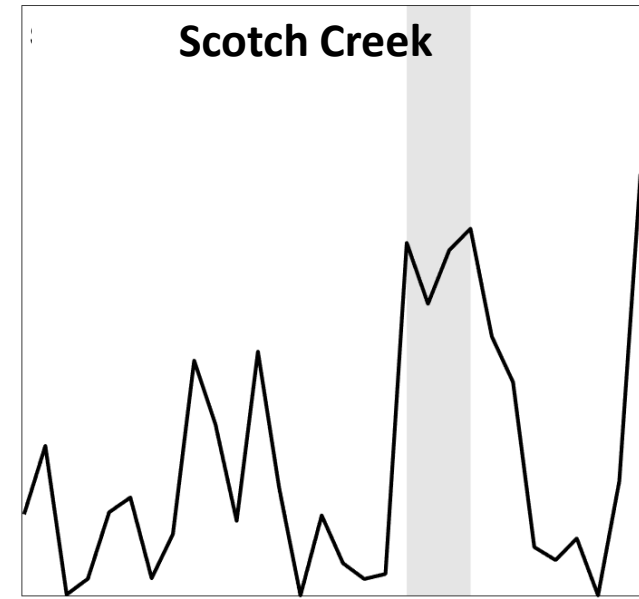
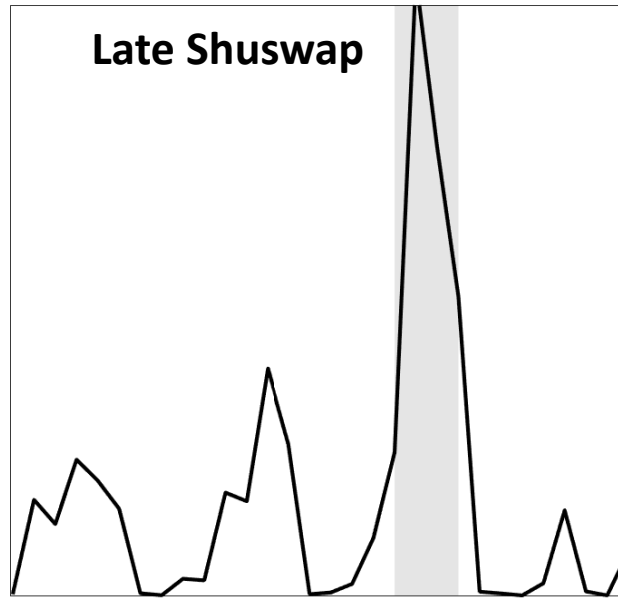
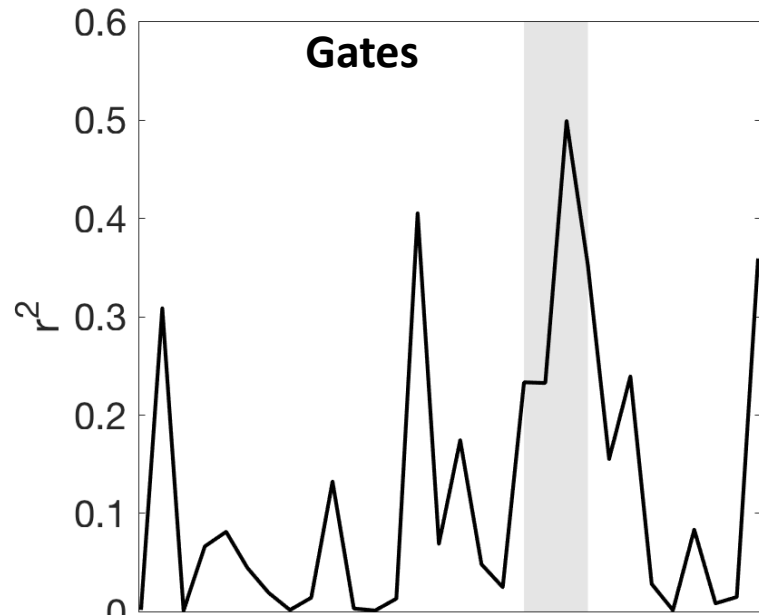


Integrated in both space AND time:

Regional late summer [Chl-a]

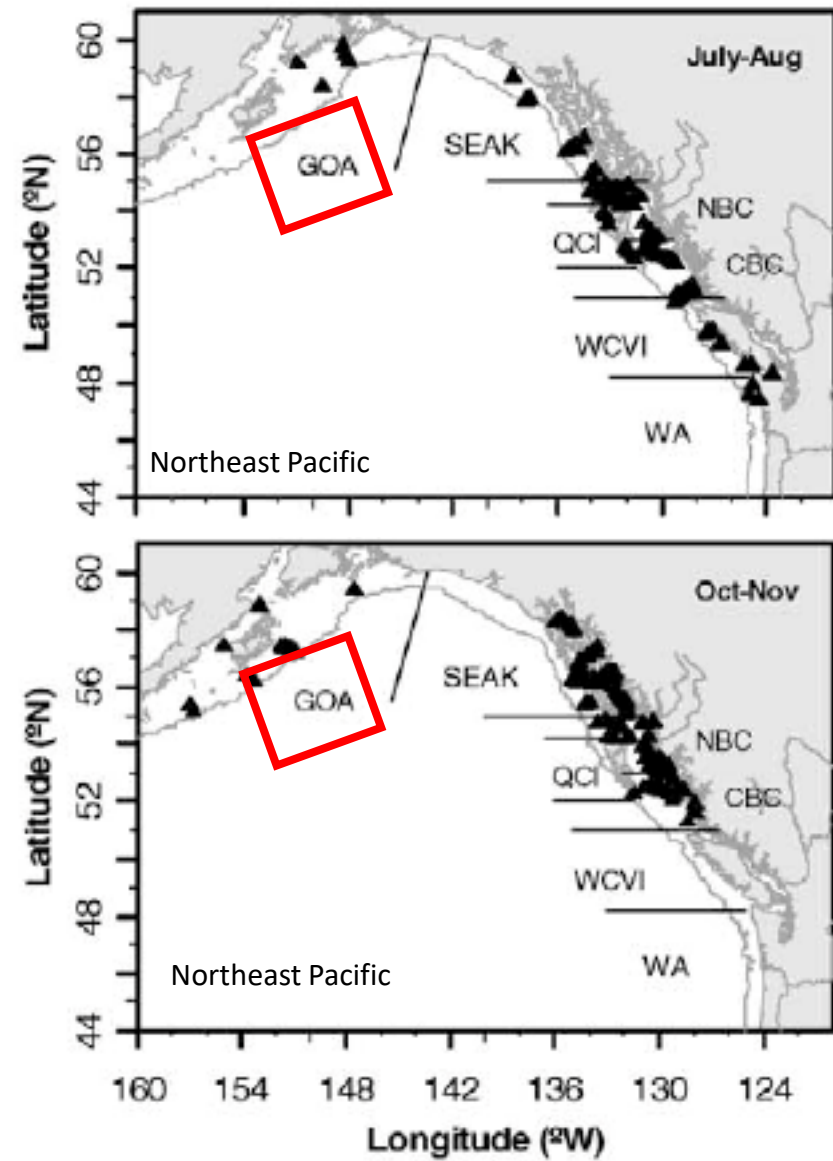
Aggregate Productivity



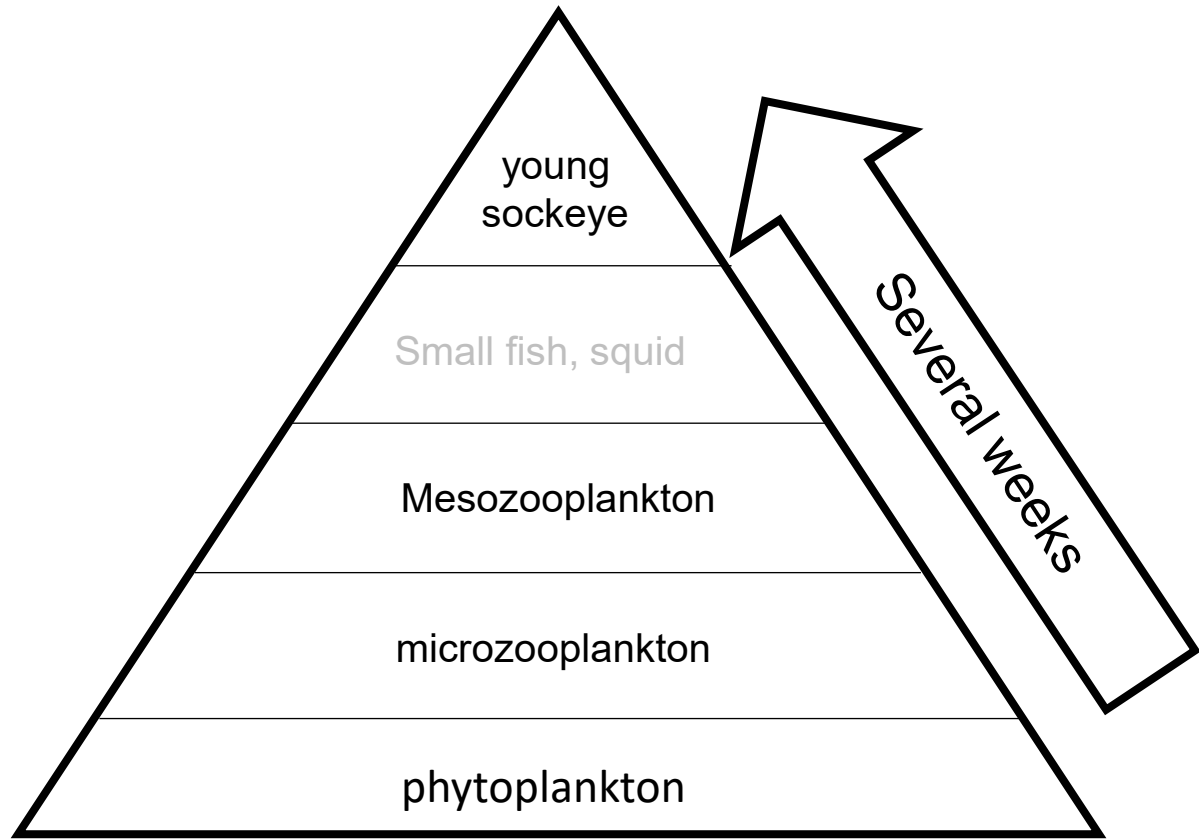


Coherent temporal pattern
of regression statistics
across multiple stocks

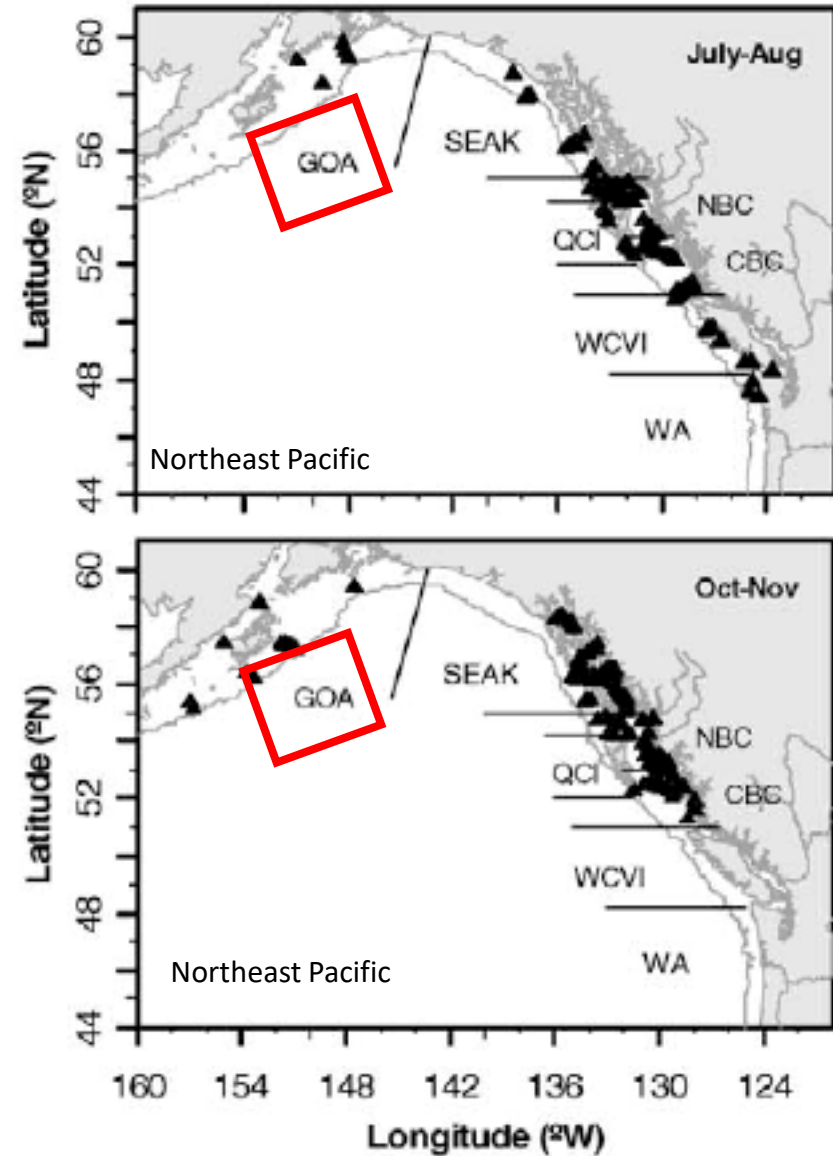
Sampling surveys ('97-'07)
of Fraser R sockeye salmon



A food web mechanism requires overlap between juvenile sockeye salmon and their prey

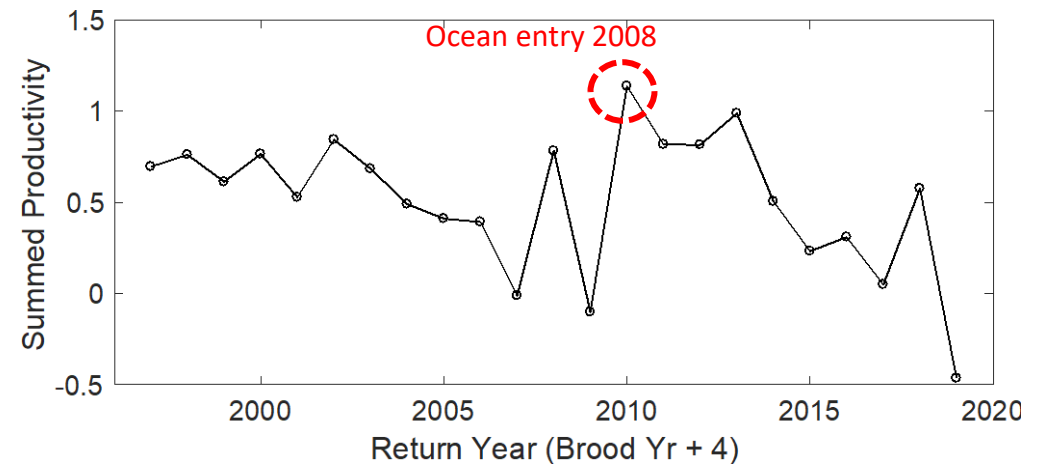
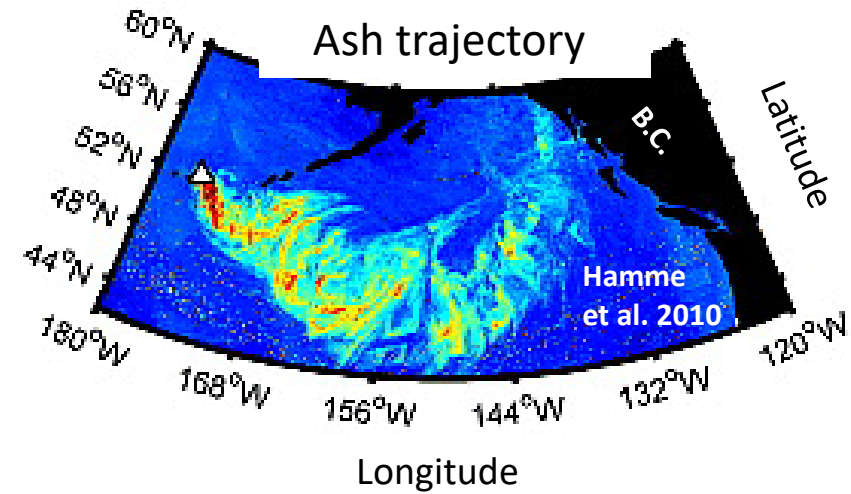


Sampling surveys ('97-'07) of Fraser R sockeye salmon

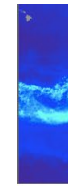


McKinnell (2013): the 2008 phytoplankton bloom did not augment the 2010 sockeye salmon return

Kasatochi Volcano Eruption of 2008



Weaker correlation with net primary productivity



OCEAN

PRODUCTIVITY

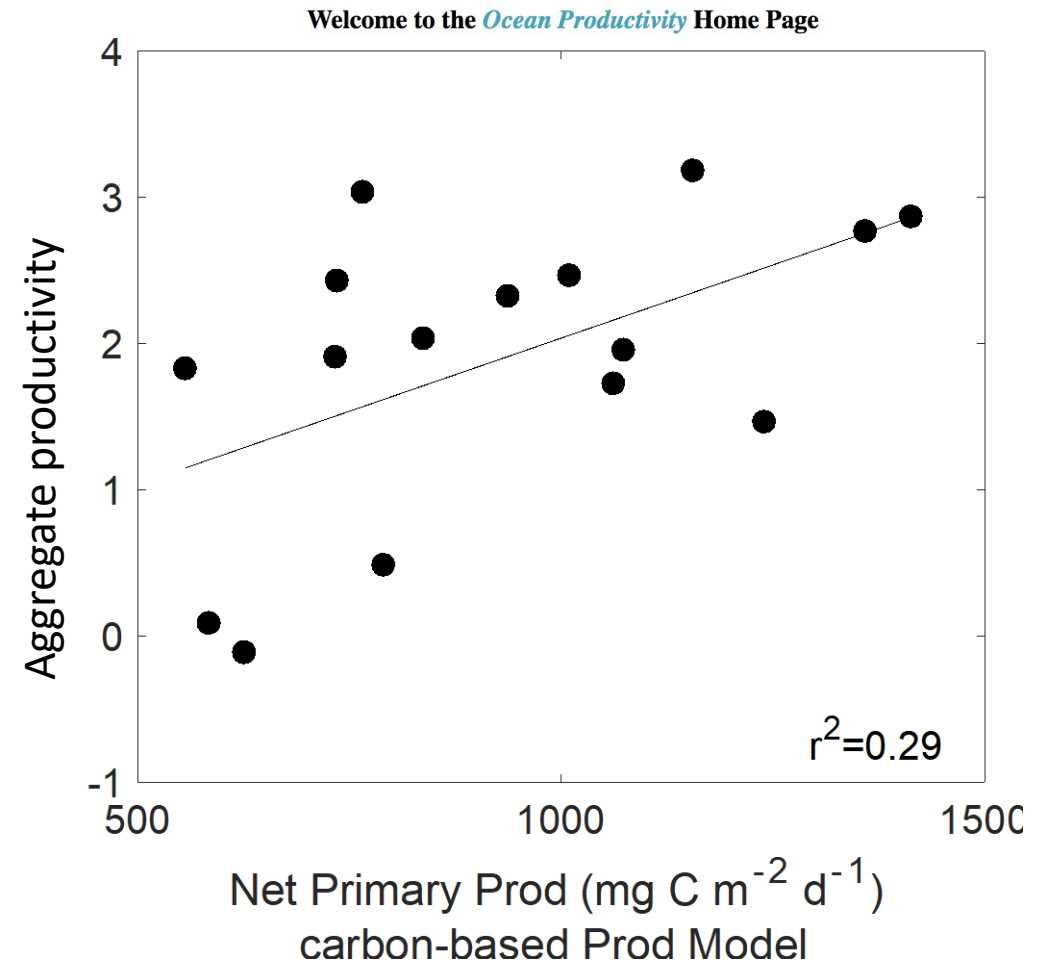
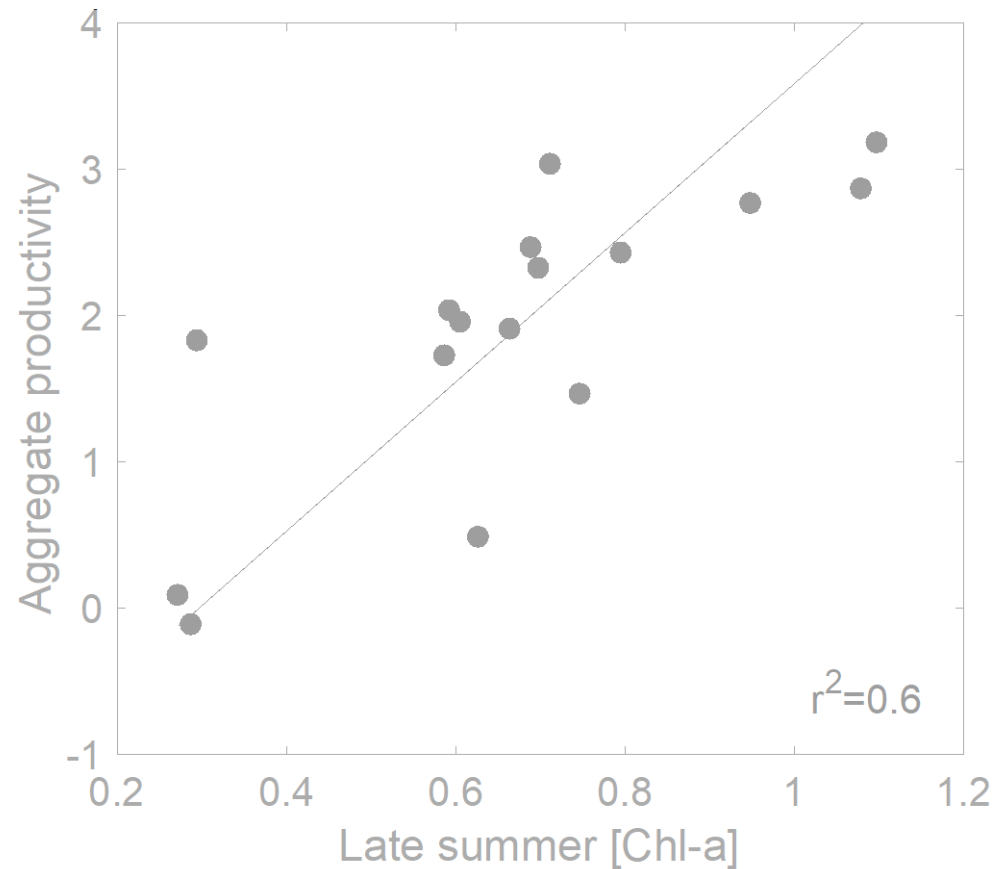
NPP Data source: Westberry et al. 2008

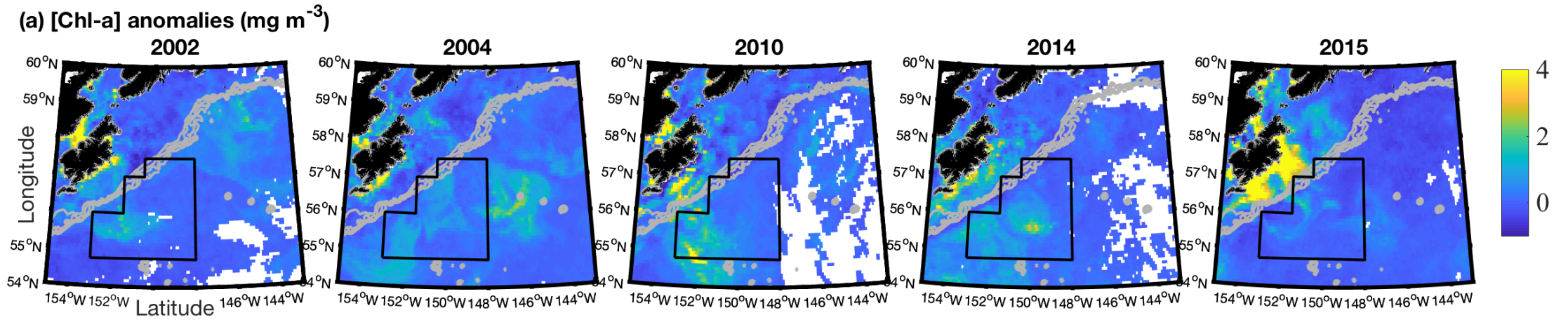
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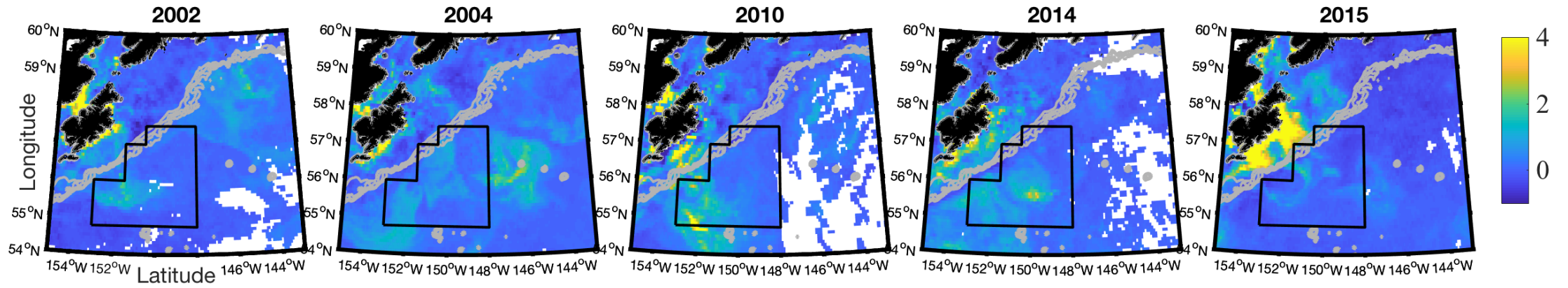
[Frequently Asked Questions](#)
[Highlights / Results](#)



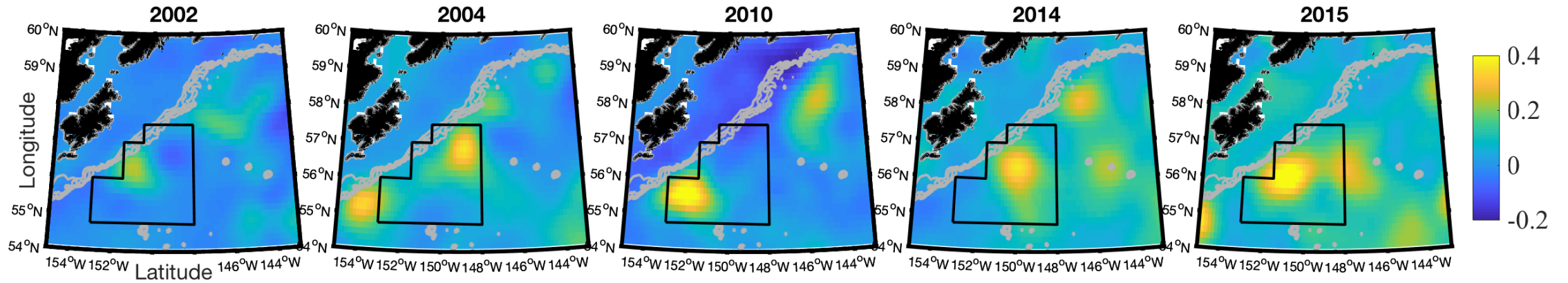


So what controls [Chl-a] variability in this section of the GoA?

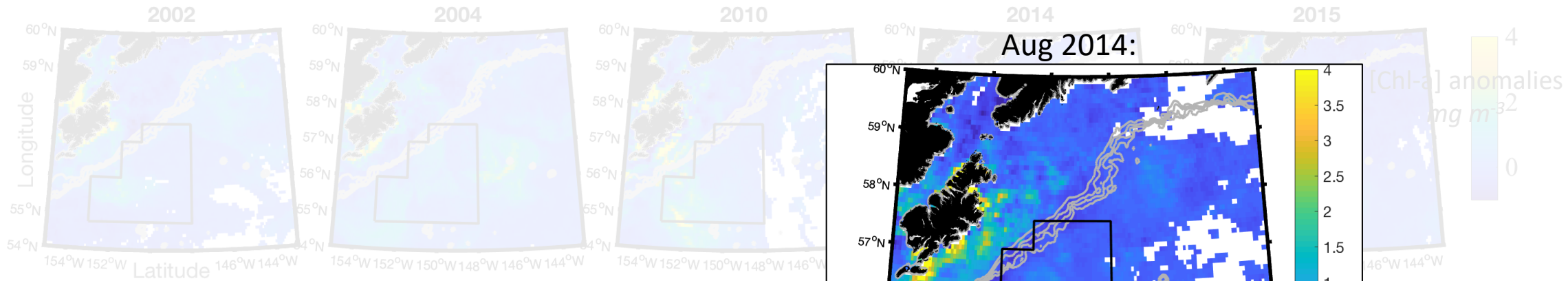
(a) [Chl-a] anomalies (mg m^{-3})



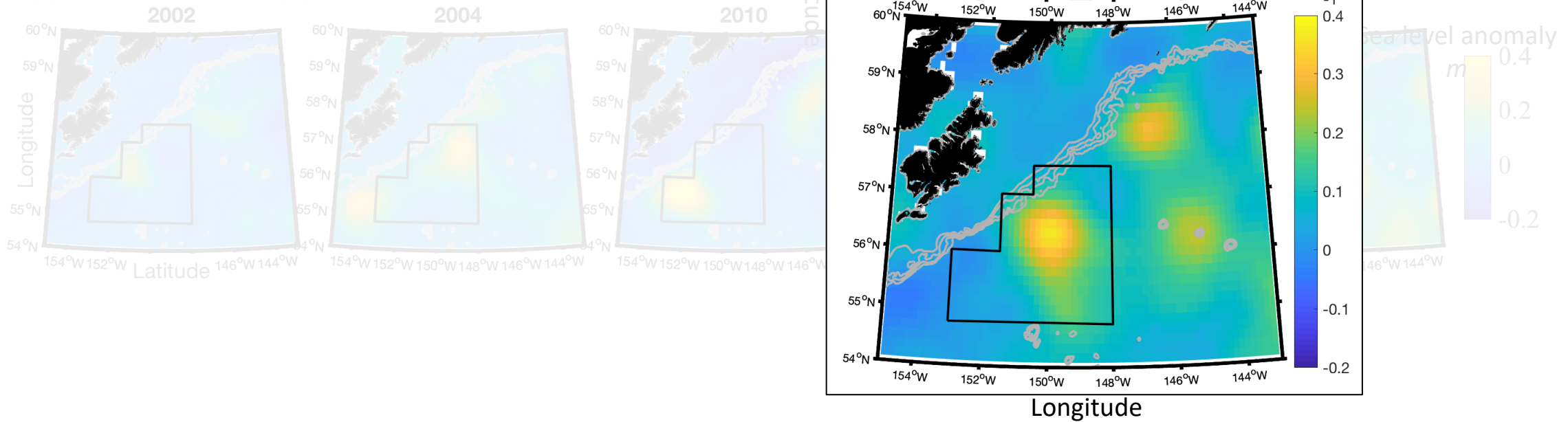
(b) Sea Level Anomalies (m)



(a) [Chl-a] anomalies (mg m^{-3})

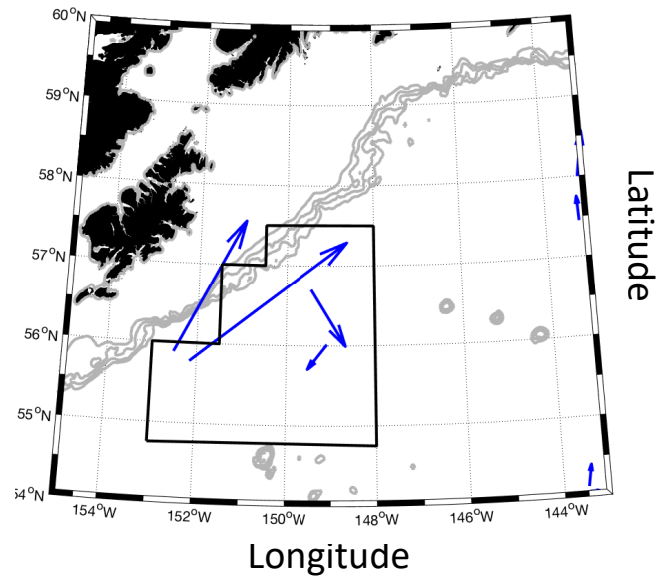


(b) Sea Level Anomalies (m)



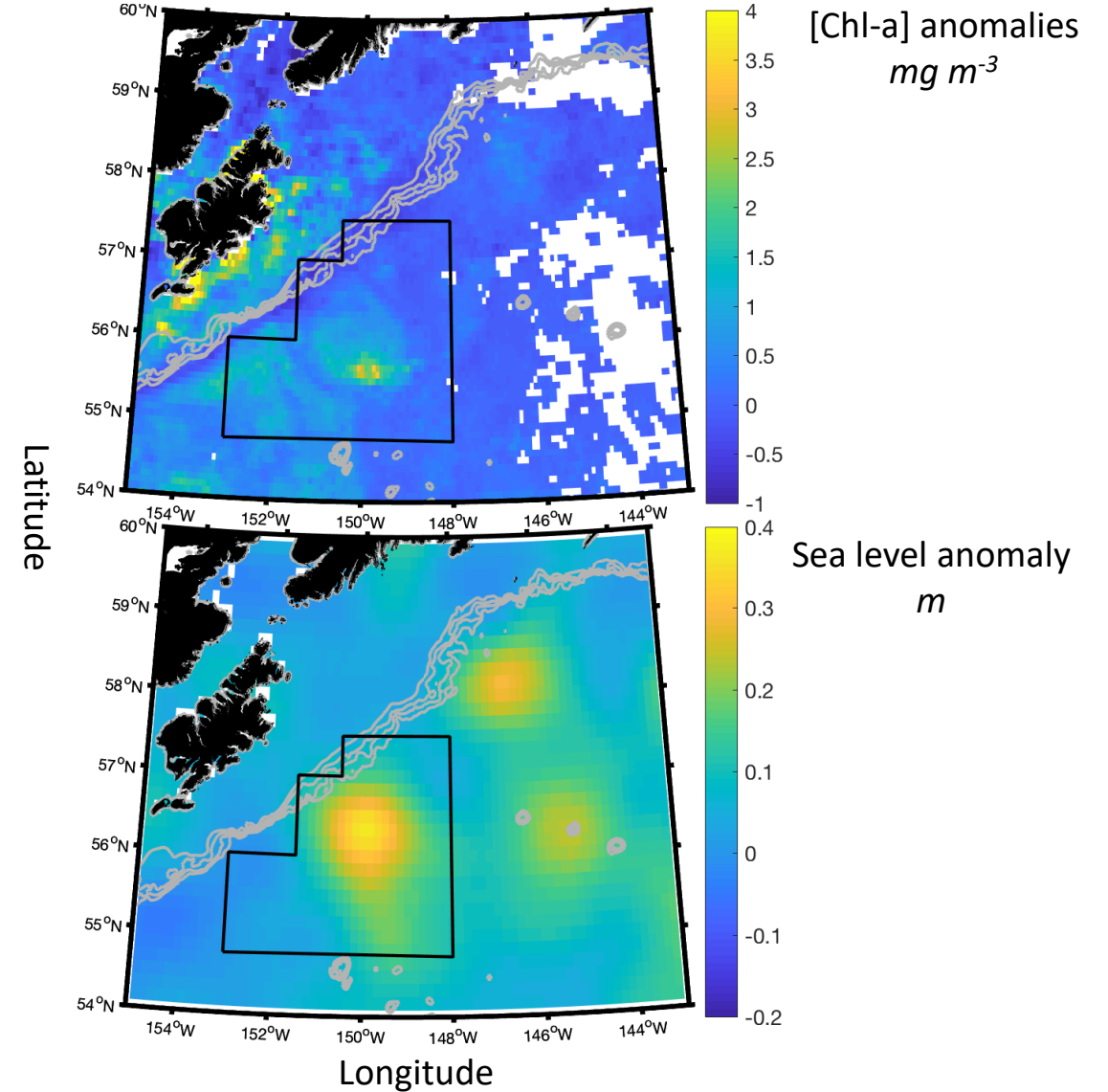
Cross-shelf exchange

2014 - surface argo velocity vectors

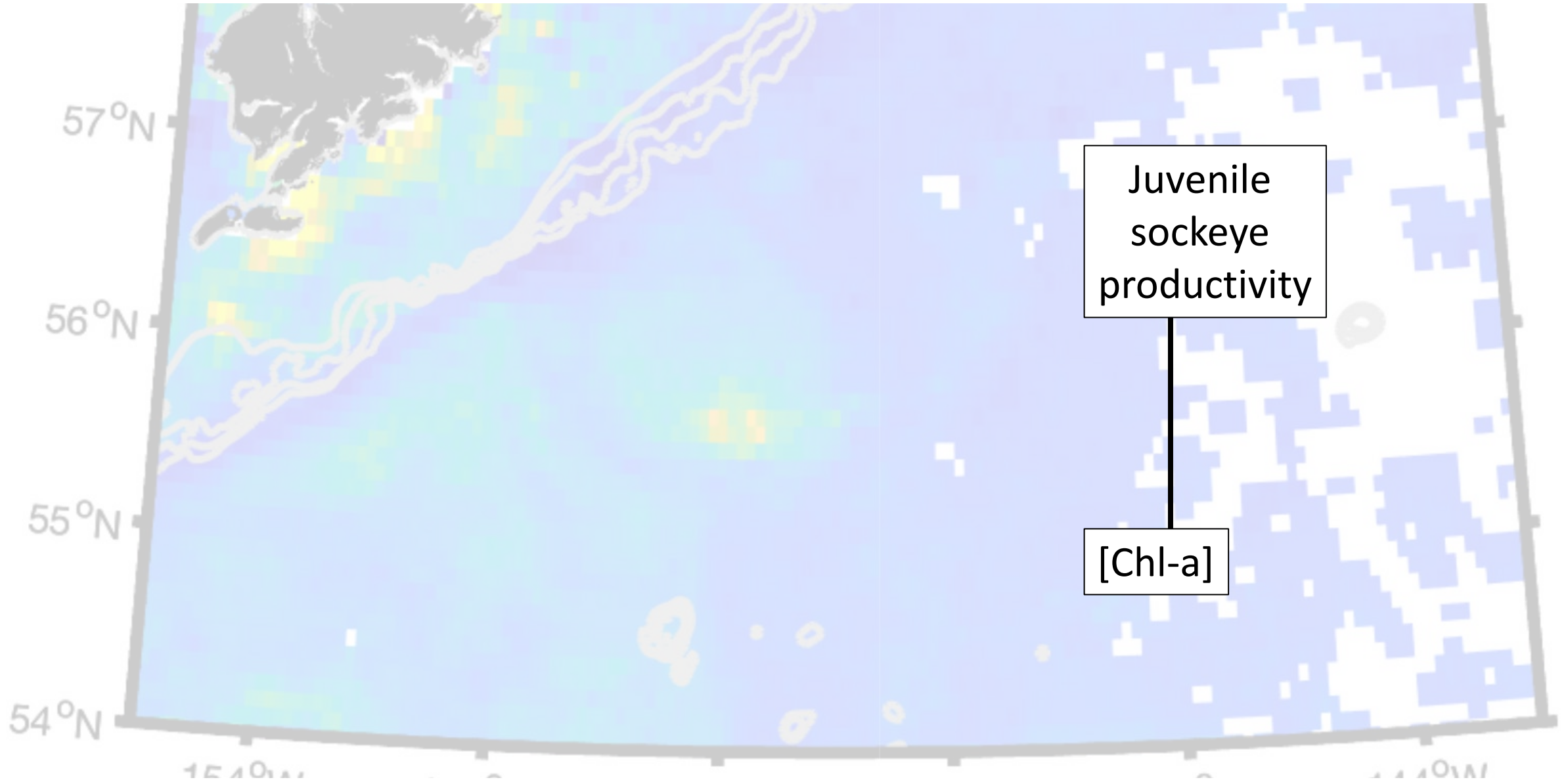


© Ifremer - 2009 - Mamaca/Dugornay

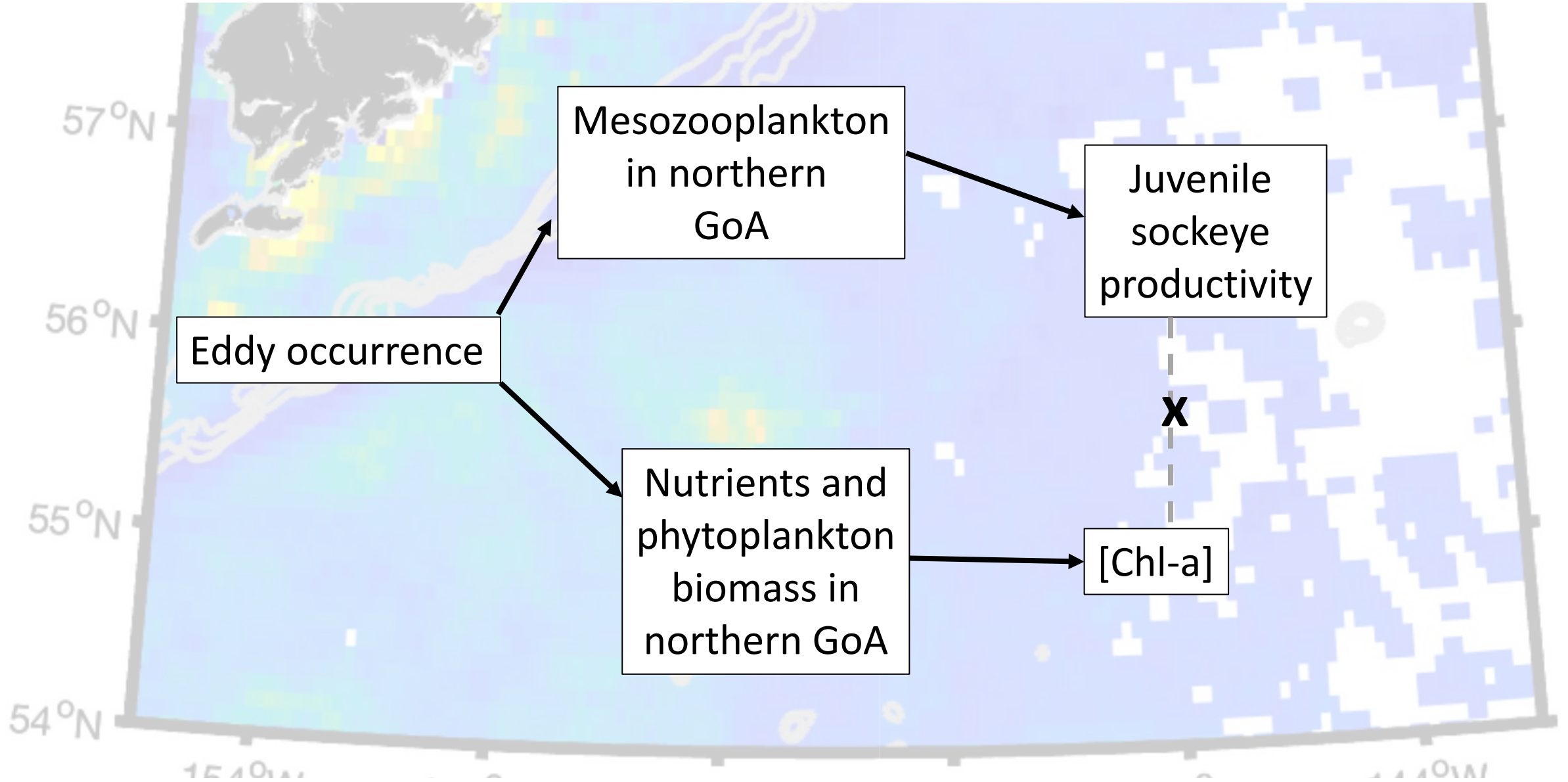
Aug 2014:



Conclusion I: Higher eddy activity deliver prey to sockeye salmon foraging near Kodiak Island



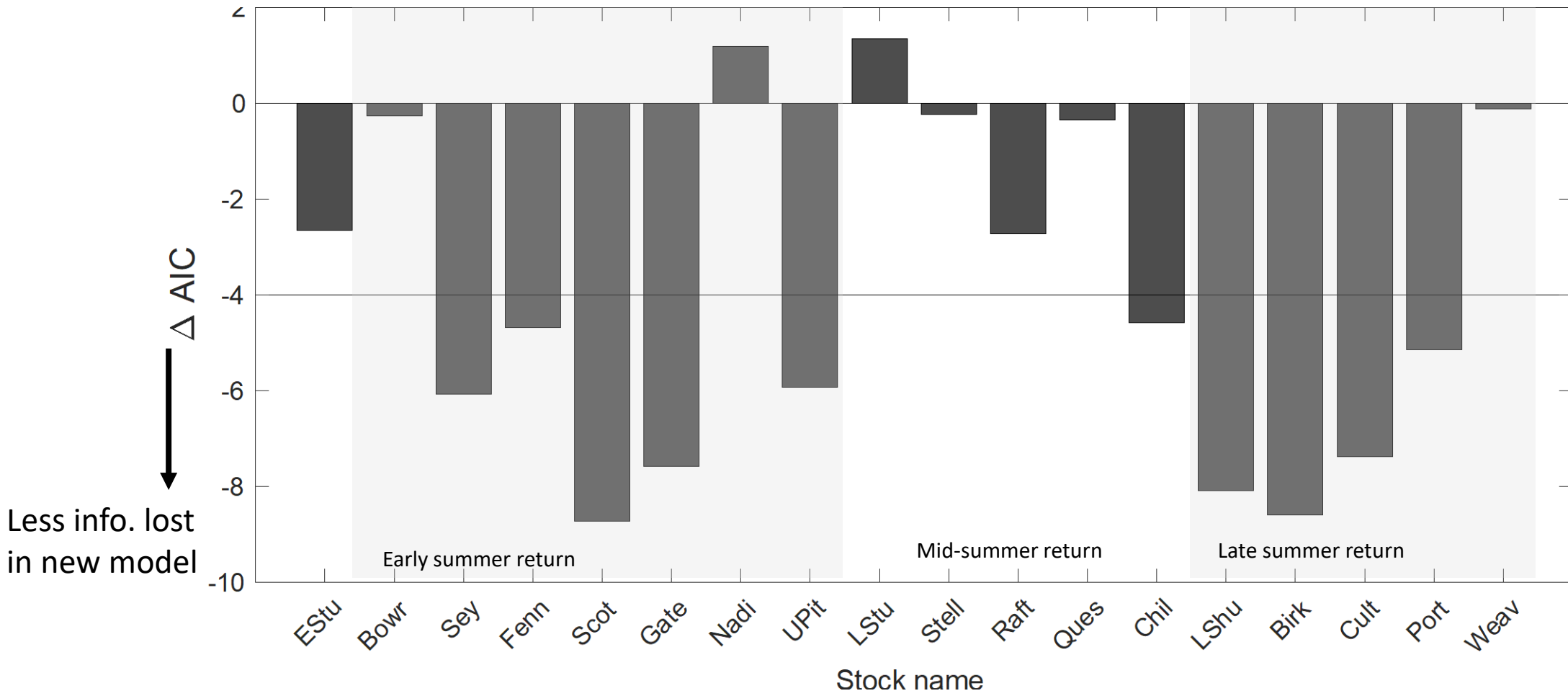
Conclusion I: Higher eddy activity deliver prey to sockeye salmon foraging near Kodiak Island



Conclusion II: contribute to stock recruitment models?

$$\text{Log} \frac{R}{S} = \alpha + \beta_1 S + \beta_2 x_2$$

Pop-independent
Pop-dependent
Integrated [Chl-a] variable



Conclusion III: methodology informs new hypothesis testing in the future

Requires few *a priori* assumptions

Coupled with multiple-stock productivity indicator – a useful approach to search for regions/times of focus for future field work?

Questions?

Contact: srosengard@eoas.ubc.ca