



Effects of local and global change on an inland sea The Strait of Georgia, Canada

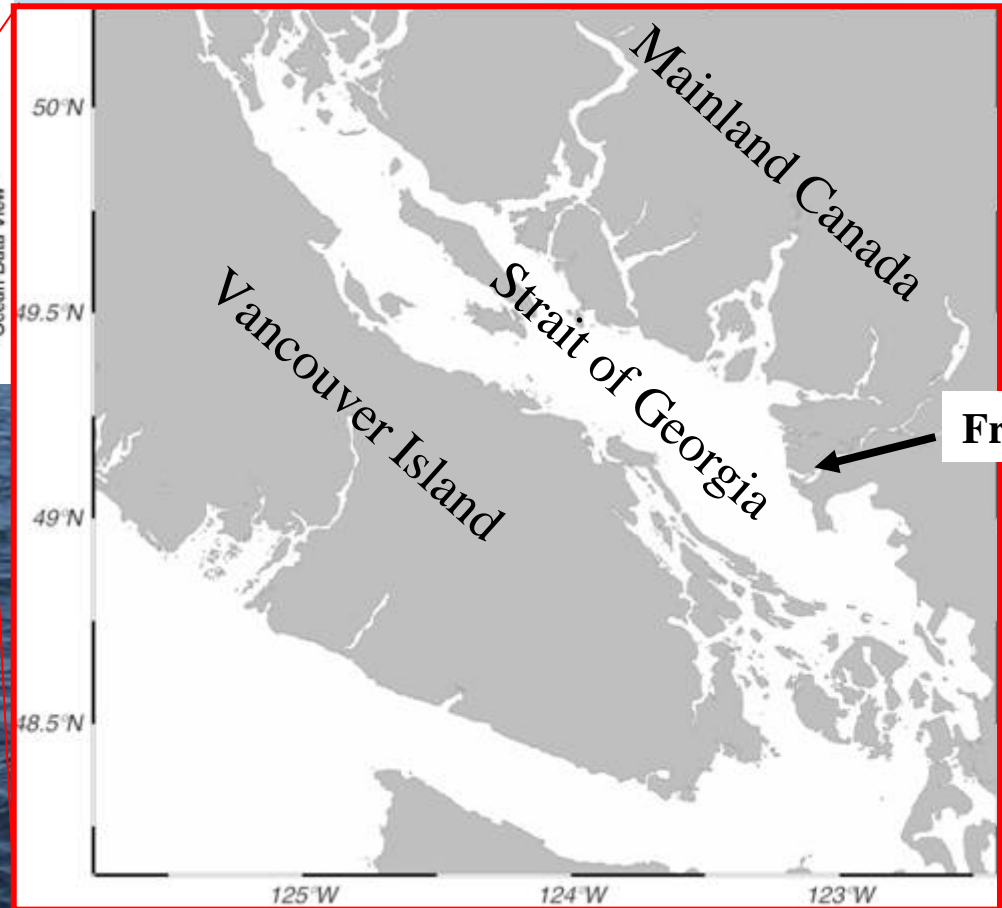
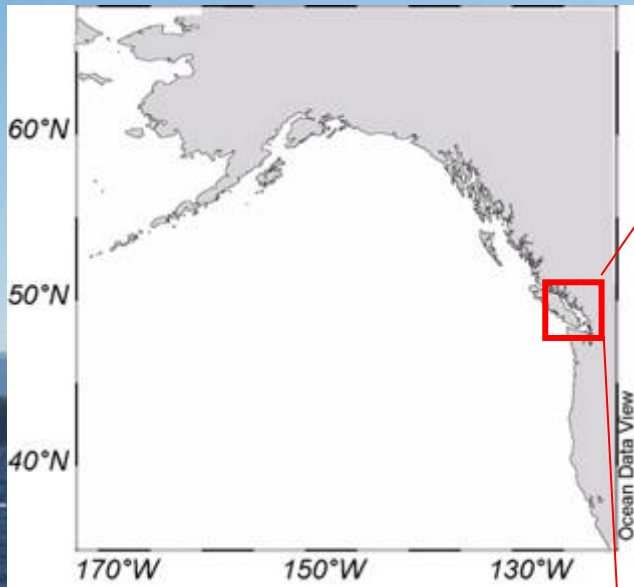
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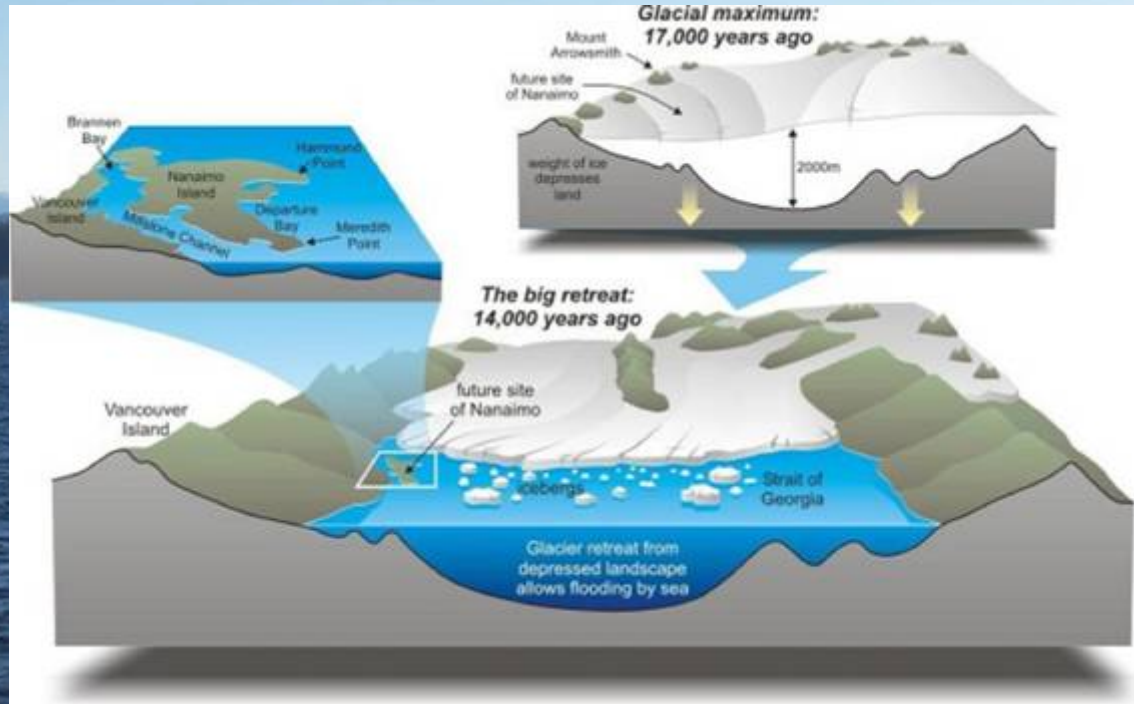
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The Strait of Georgia



Fraser River

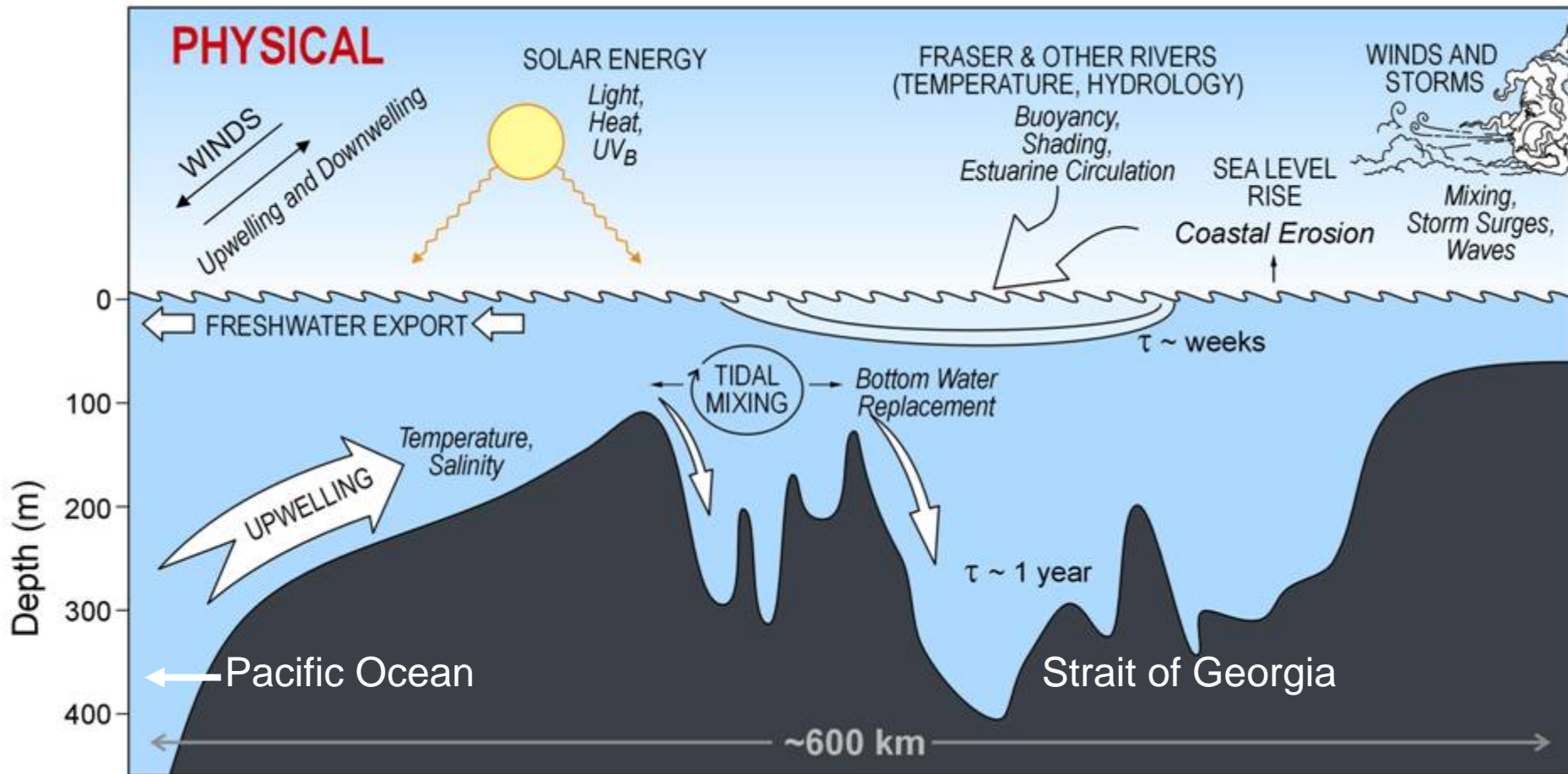
Climate change is nothing new...



http://web.viu.ca/geoscape/images/Ice_Age.jpg

But this time unprecedented interaction with local human activity.

How water (and other things) move around the Strait



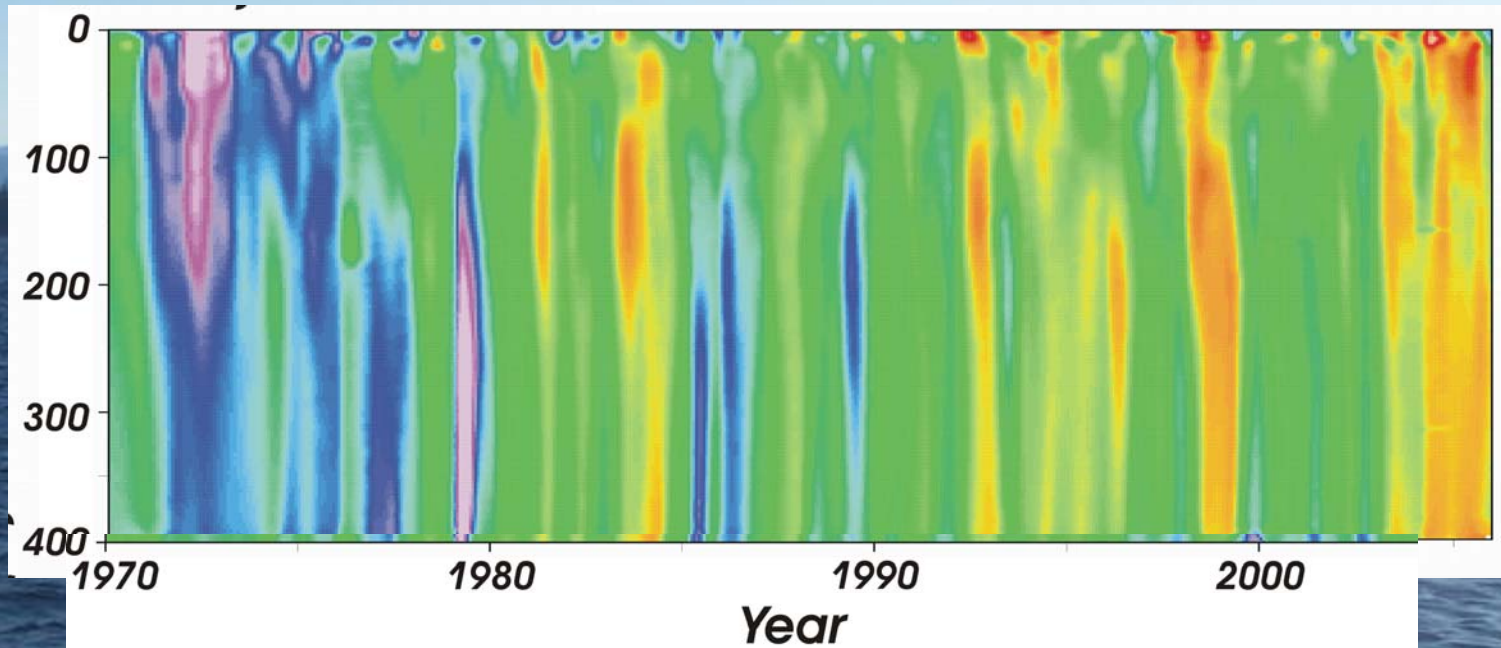
Johannessen & Macdonald, 2009. Climate Research 40:1-21



What is expected to change physically?

- Global temperature rise (1 – 6 °C by 2100)
- Global sea-level rise (0.2 – 0.6m by 2100 – and maybe more)
- Precipitation patterns (drier summer, wetter winter)
- More short-term variability

Basin Water Temperature Already on the Rise

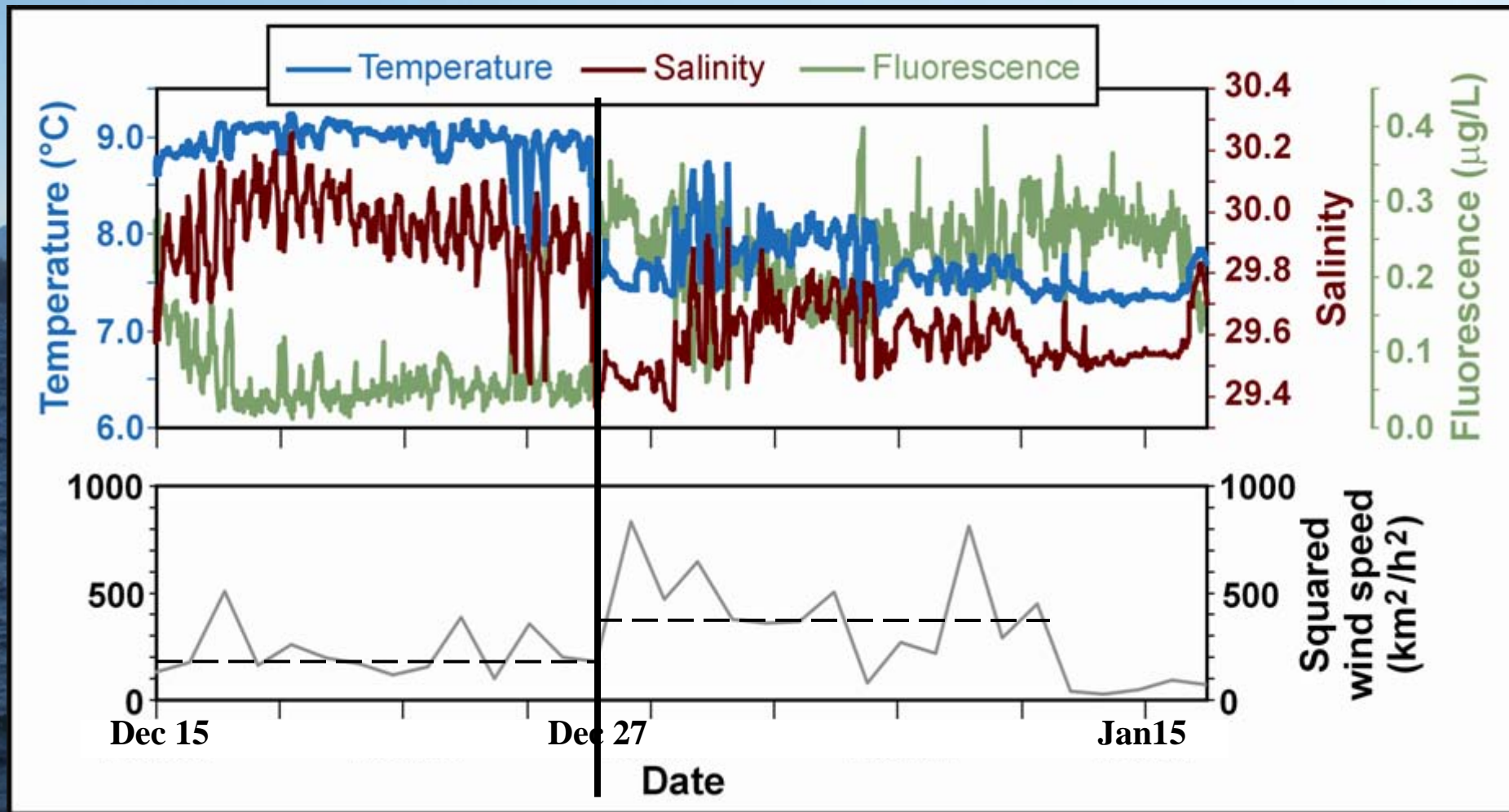


Masson and Cummins, 2007. Cont Shelf Res 27:634-649

(data collected in the central Strait)

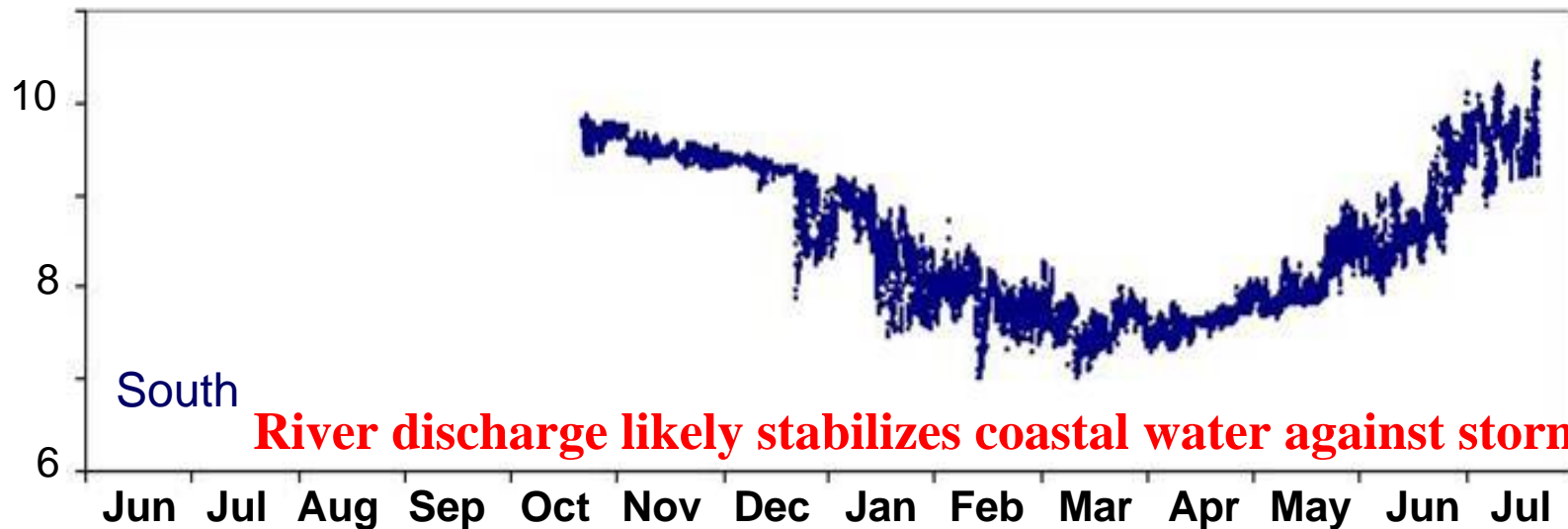
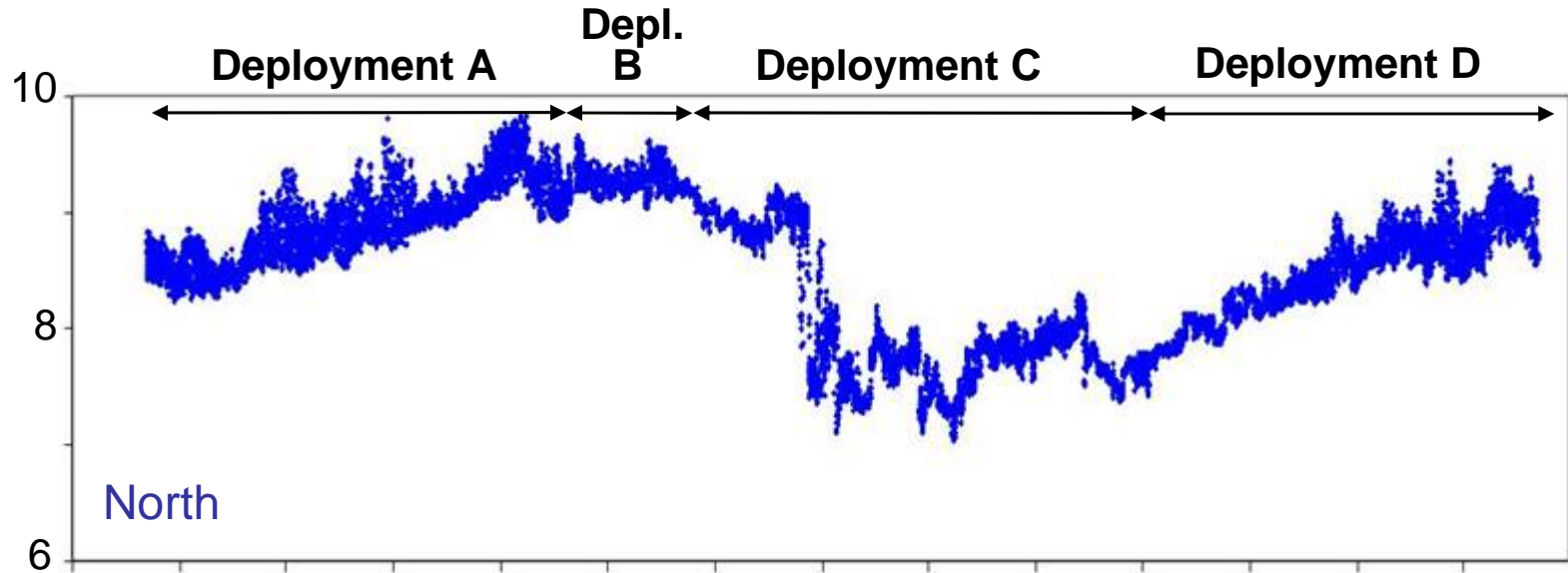
Fraser River temperature also increasing

New Year's wind storm (Dec. 2008 / Jan. 2009) Effect at 50 m



Minham Dai: typhoon mixed DIC and fresh water to 1000m!

Temperature records are different in the north and south.

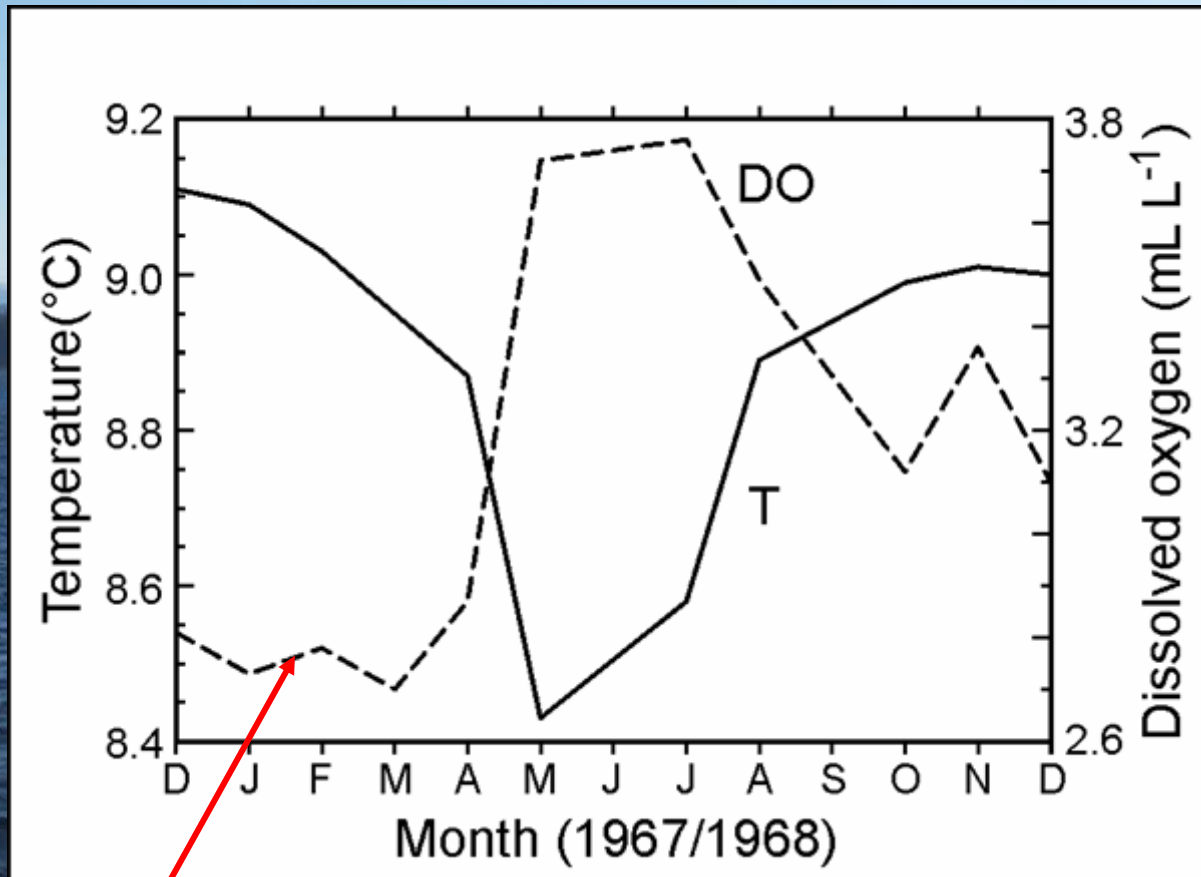


River discharge likely stabilizes coastal water against storms.

What is expected to change chemically?

- Timing and type of organic carbon and particle cycling
- Decreasing oxygen concentration in deep water
- Declining ocean pH
- Contaminants

Seasonal cycles of O₂ and T in Bottom Waters of the Strait of Georgia



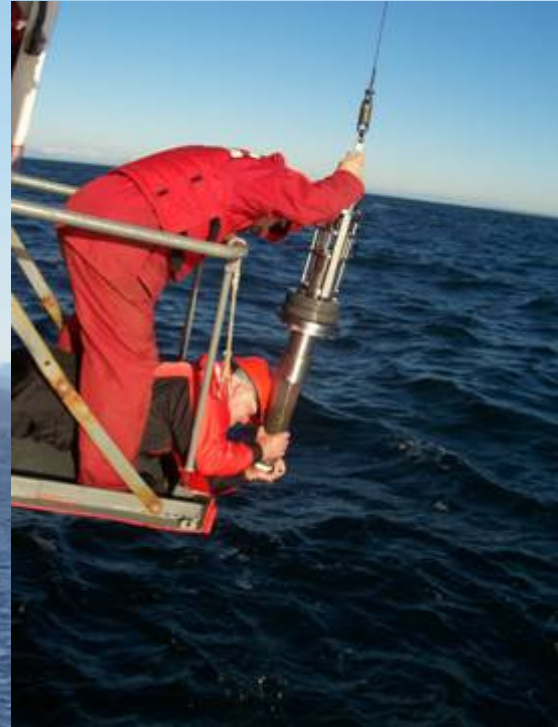
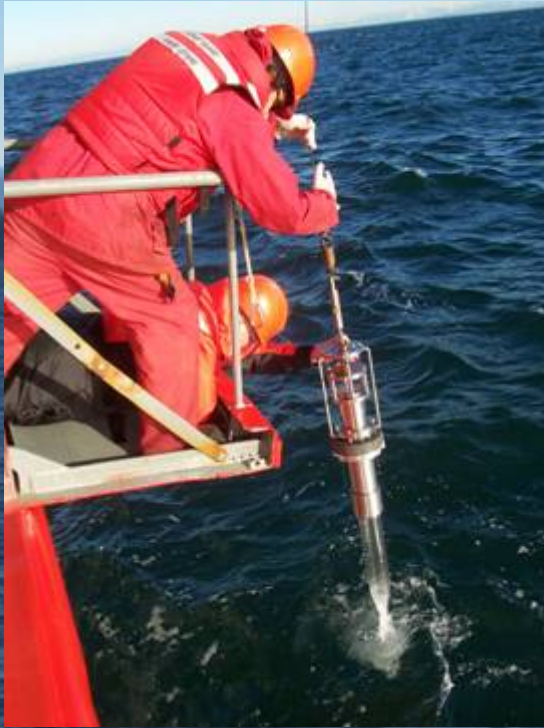
In some years O₂ has dropped to 2 mL L⁻¹ (Masson, unpubl.)

¼ of decline due to solubility

Masson, 2002. ECSS 54:115-126

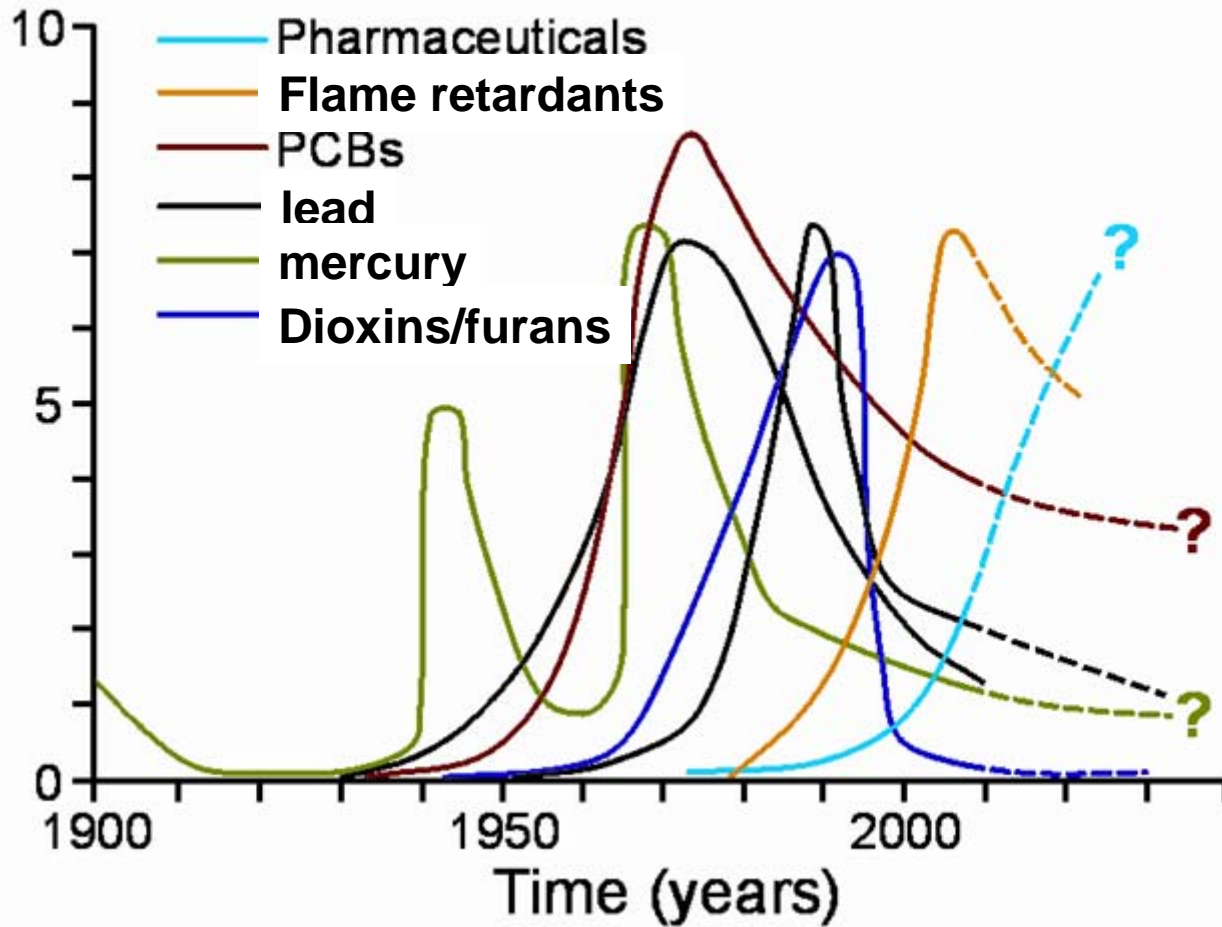
Shelf seawater likely responsible for decline
John Barth: hypoxia off Oregon

Collecting sediment cores for contaminant analysis



**New sediment falls on top of old sediment,
preserving history in the mud.**

Trends in Contaminant Loadings



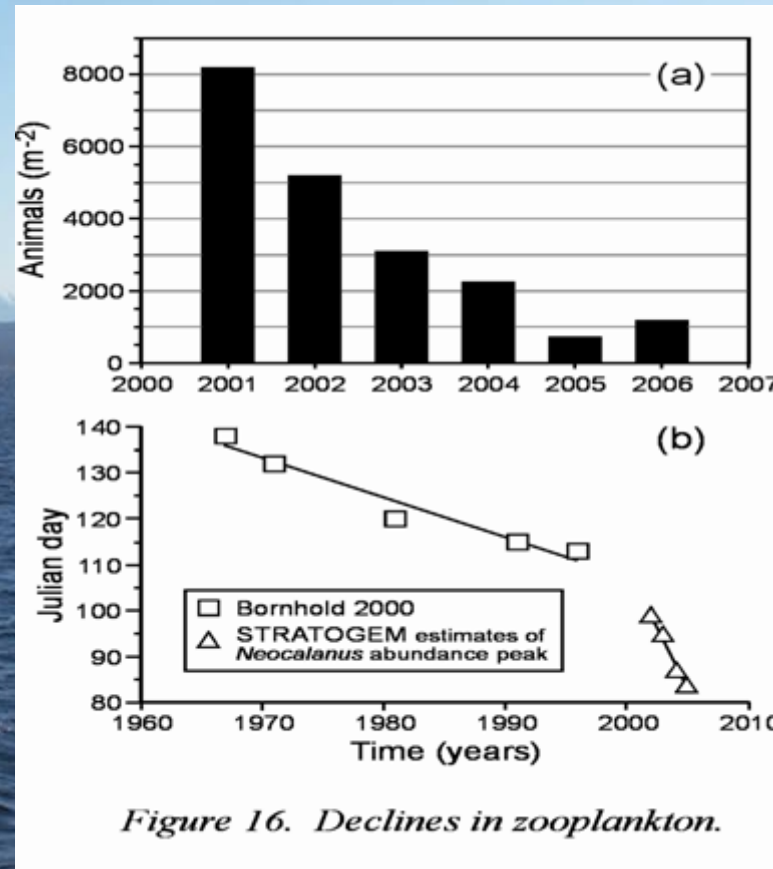
Johannessen & Macdonald, 2009. Climate Research 40:1-21

Effects on biota...

**Biological changes already observed
(though not explained)**



Declines in zooplankton populations and changes in timing

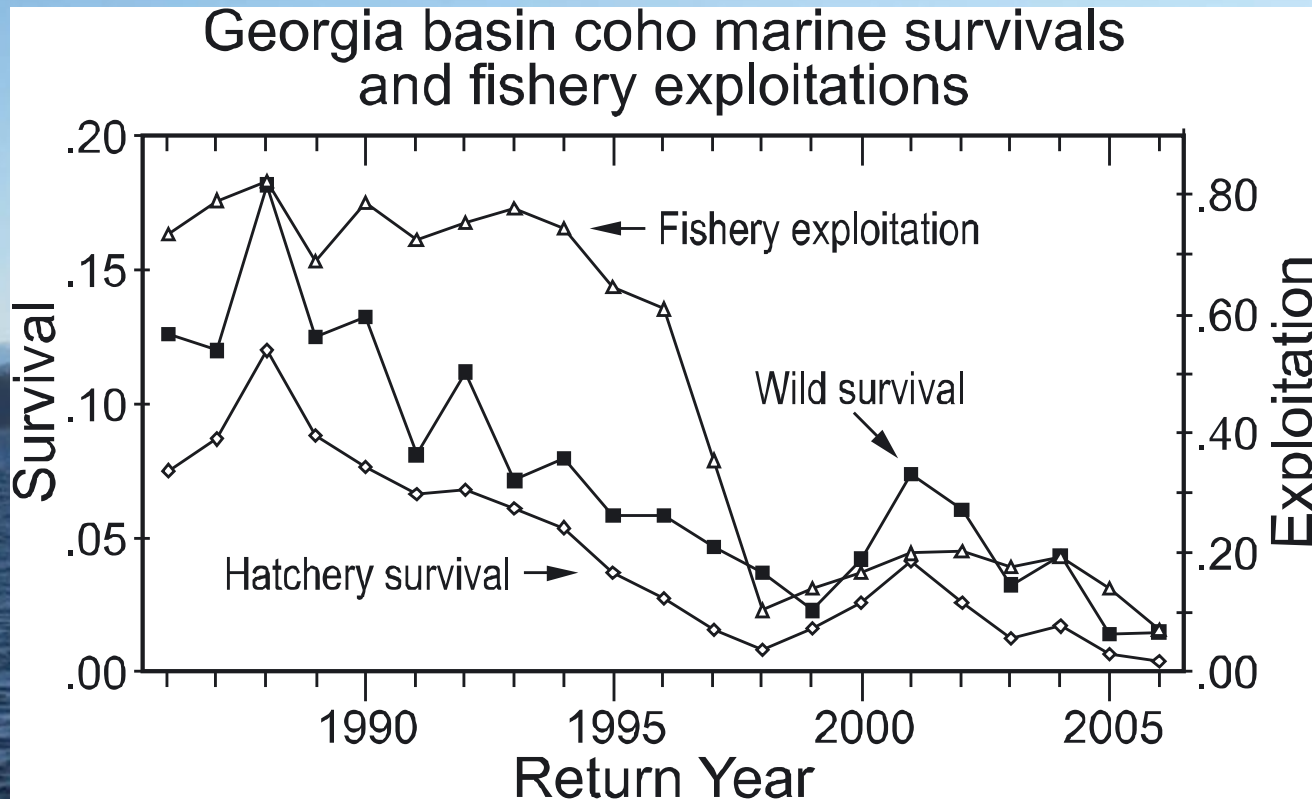


El-Sabaawi et al., 2009.
MEPS 382, 151-161

Potential mismatch with juvenile fish c.f. Yuri Zuenko's result for saffron cod in Japan Sea

Some salmon populations declining; others OK

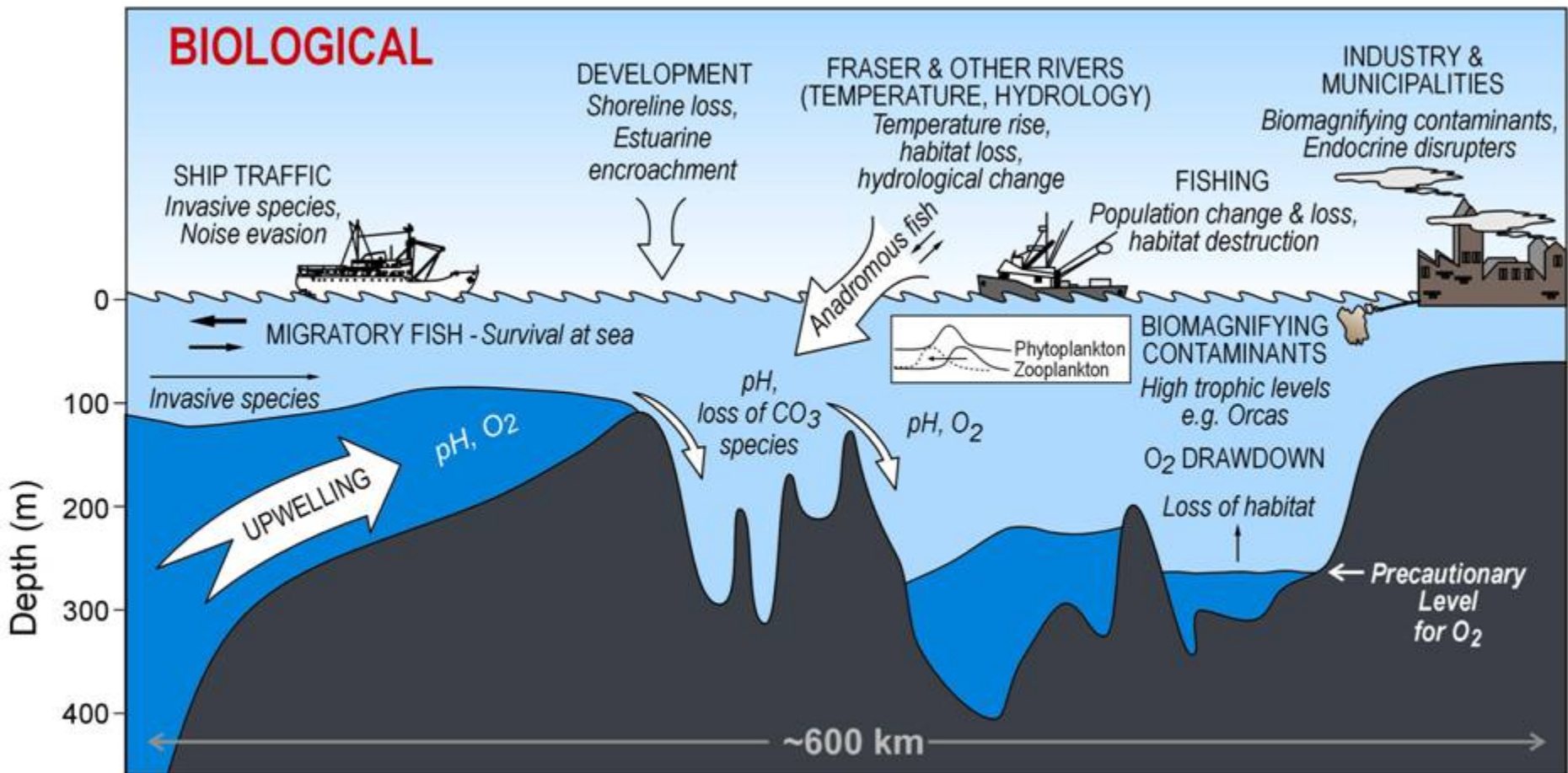
Coho and Chinook declining, sockeye fluctuating wildly



modified from Simpson et al. (2001) DFO report

Pink and chum stable or increasing – not fished heavily.

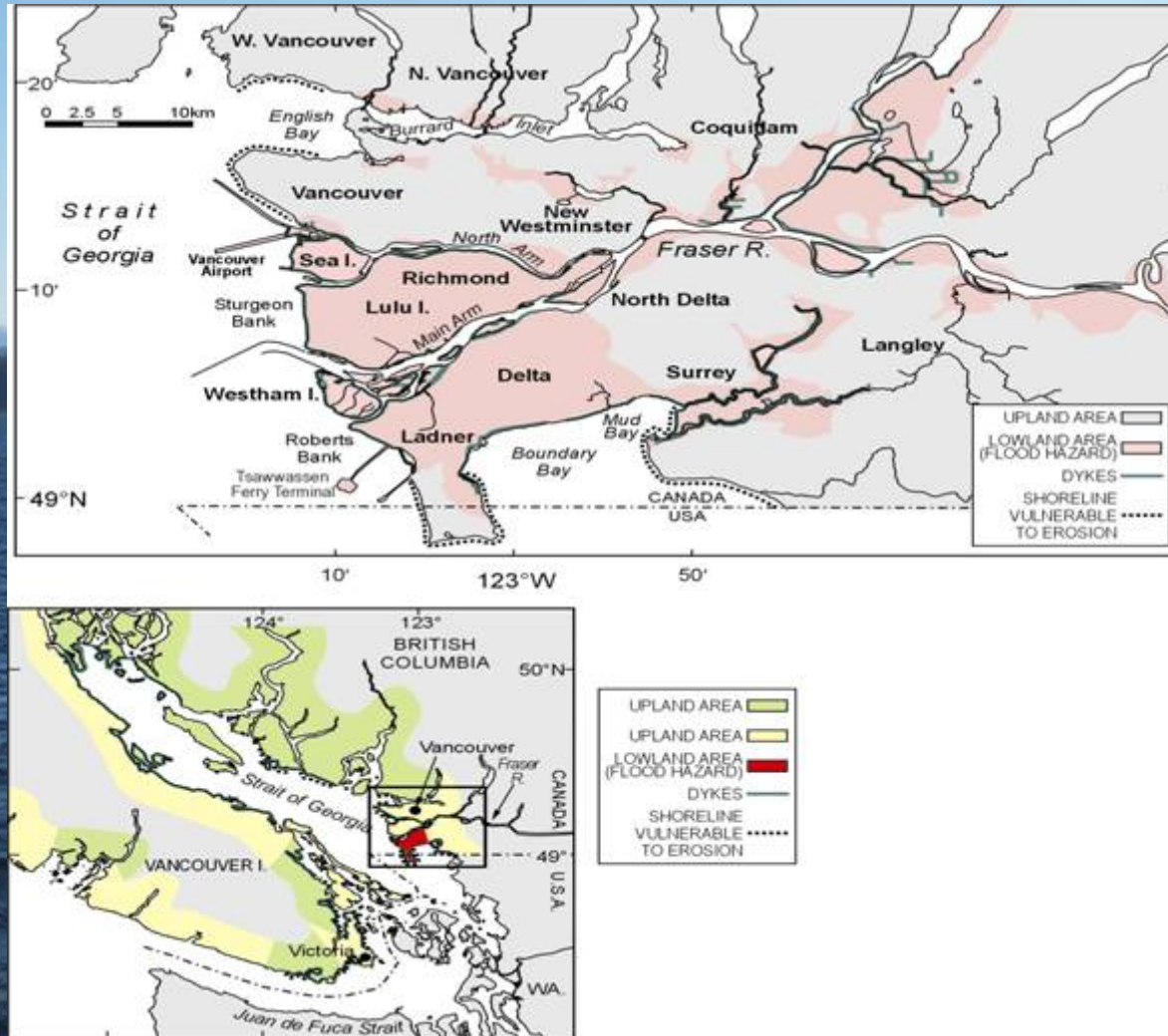
Local and global stressors combine



Johannessen & Macdonald, 2009. Climate Research 40:1-21

Interaction of human activities and climate change

1. Sea level rise and hard edges



Shaw et al., 1998; NRCan Report #505.

Interaction of human activities and climate change

2. Oxygen, temperature and organic carbon flux

Not a good time to add more organic carbon



Oxygen declining
0.2-0.3 mL/L/decade (Masson unpubl.)

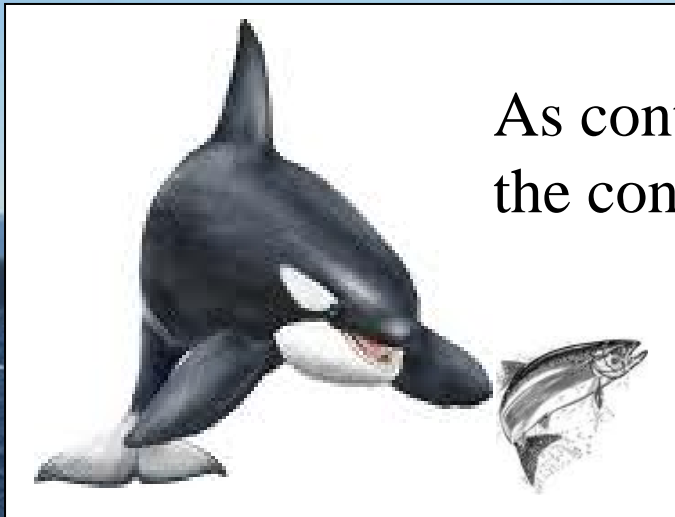


Temperature rising
0.24°C/decade (Masson&Cummins, 2007)

Hans Pörtner: O₂ and capacity-limited thermal tolerance

Interaction of human activities and climate change

3. Marine mammals: food, traffic and contaminants



As contaminated animals burn fat,
the concentration of contaminants increases.
(Peter Ross, PICES, Tuesday)

Killer whales already stressed by climate and declining food.
Contaminants and traffic add to stress.

“Tackling the old familiar problems of pollution, habitat alteration and overfishing will help with adapting to climate change.”

Brander K (2008) Mar.Poll.Bull. 56:1957–1958.

- Habitat destruction / protection and restoration
- Fishing
- Contaminants
- River flow/temperature (partially)
- Traffic
- Response to sea level rise

Bad news... Good news.

Acknowledgements

Figures/data

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