Contaminants in Hudson Bay & Estuaries

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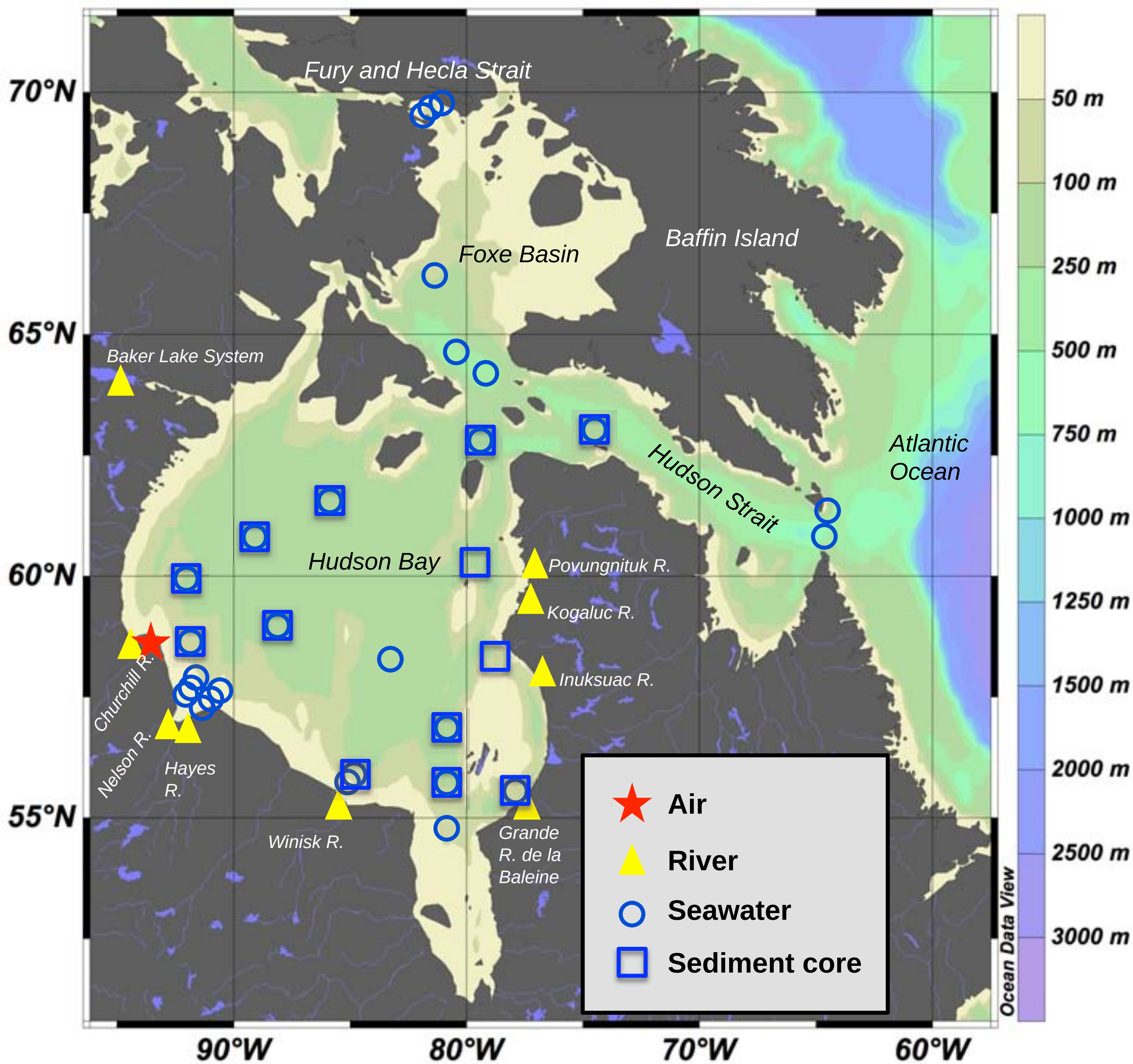
Why Contaminants?

- Long range transport (via air, river, ocean) to the Bay
- Biomagnifying contaminants tend to be heavily enriched in marine mammals, impacting their health as well as the health of Northern People
- Two types of contaminants studied:

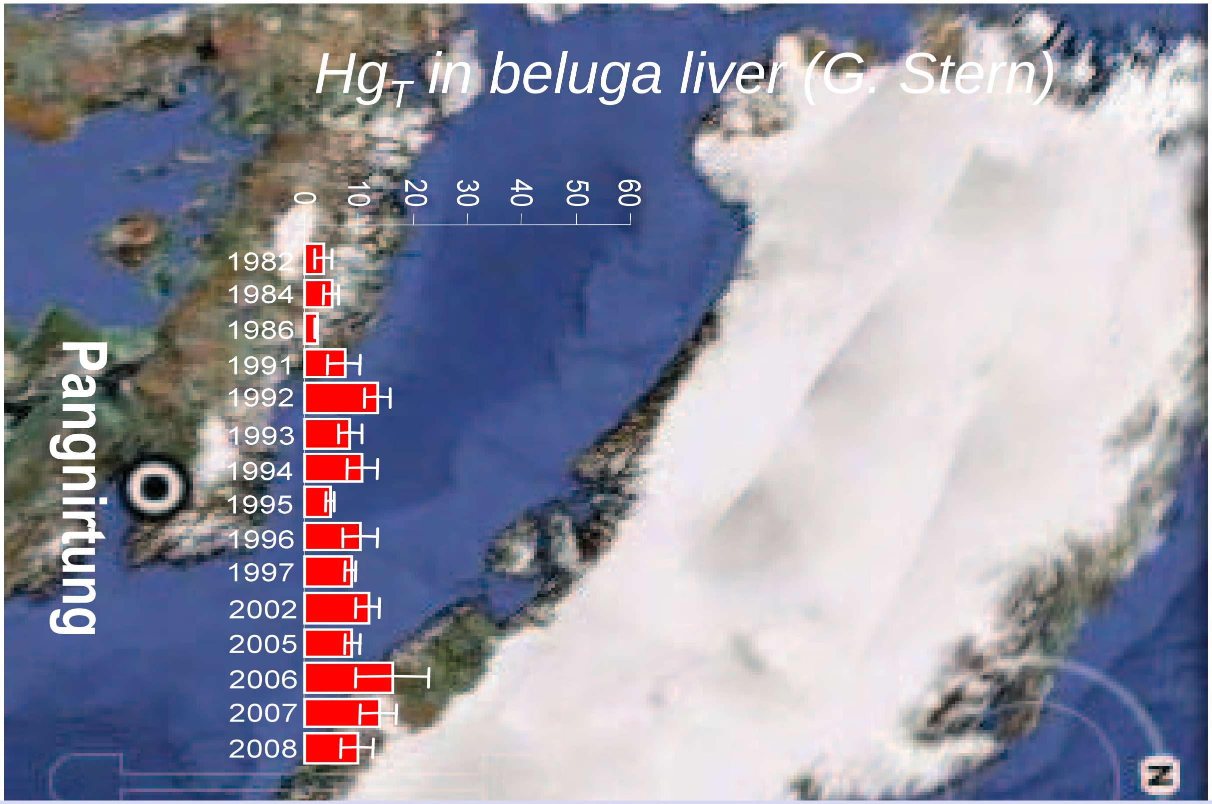
  - **PCBs**
  - **Mercury**

Both are developmental neurotoxins

Photo by Michelle Watts

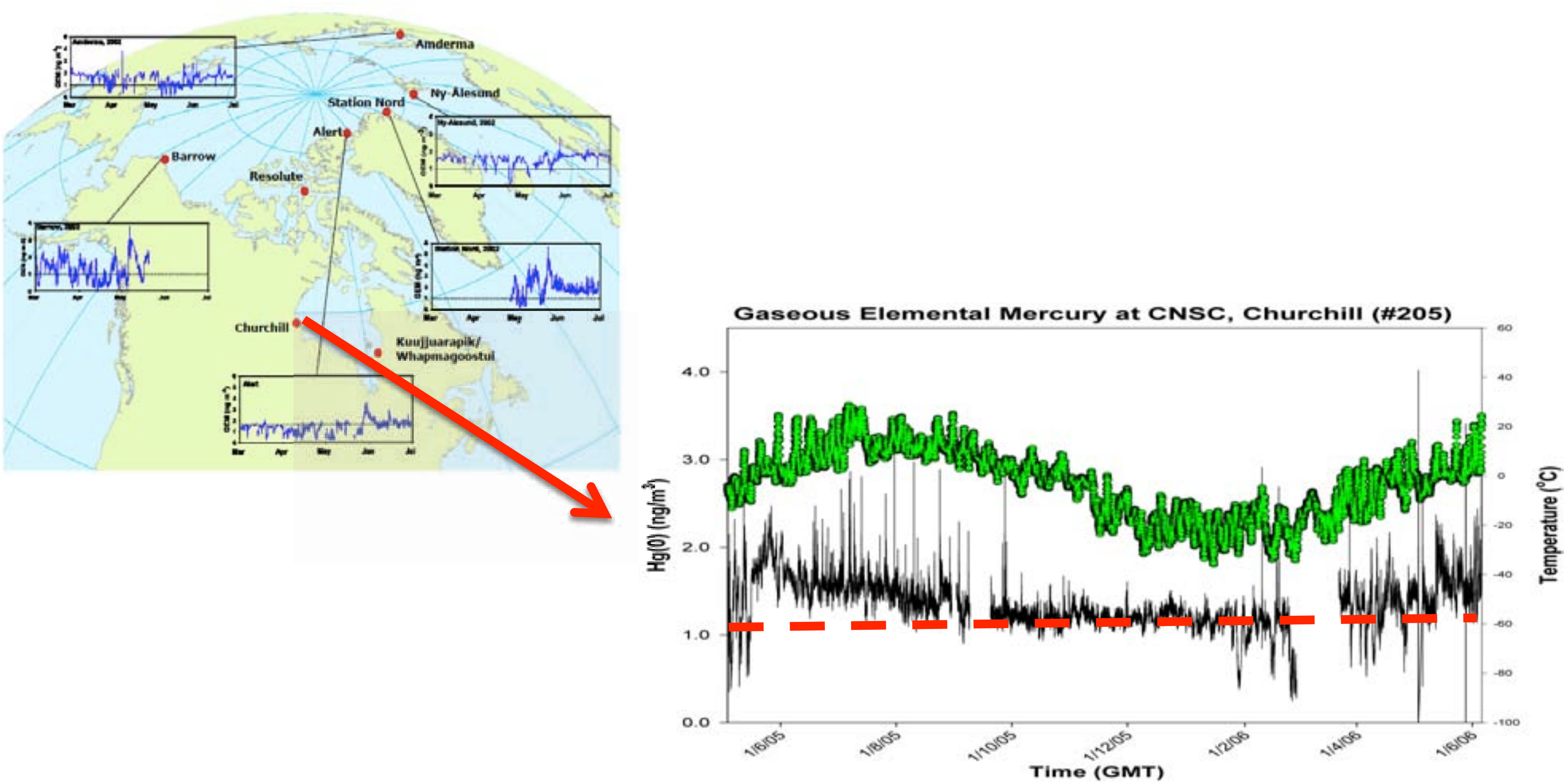

Fury and Hecla Strait
Foxe Basin
Baffin Island
Baker Lake System
Hudson Strait
Atlantic Ocean
Hudson Bay
Povungnituk R.
Kogaluc R.
Inuksuac R.
Churchill R.
Nelson R.
Hayes R.
Winisk R.
Grande R. de la Baleine
70°N
65°N
60°N
55°N
90°W
80°W
70°W
60°W
50 m
100 m
250 m
500 m
750 m
1000 m
1250 m
1500 m
2000 m
2500 m
3000 m
Ocean Data View
Air
River
Seawater
Sediment core

What We Know (I)



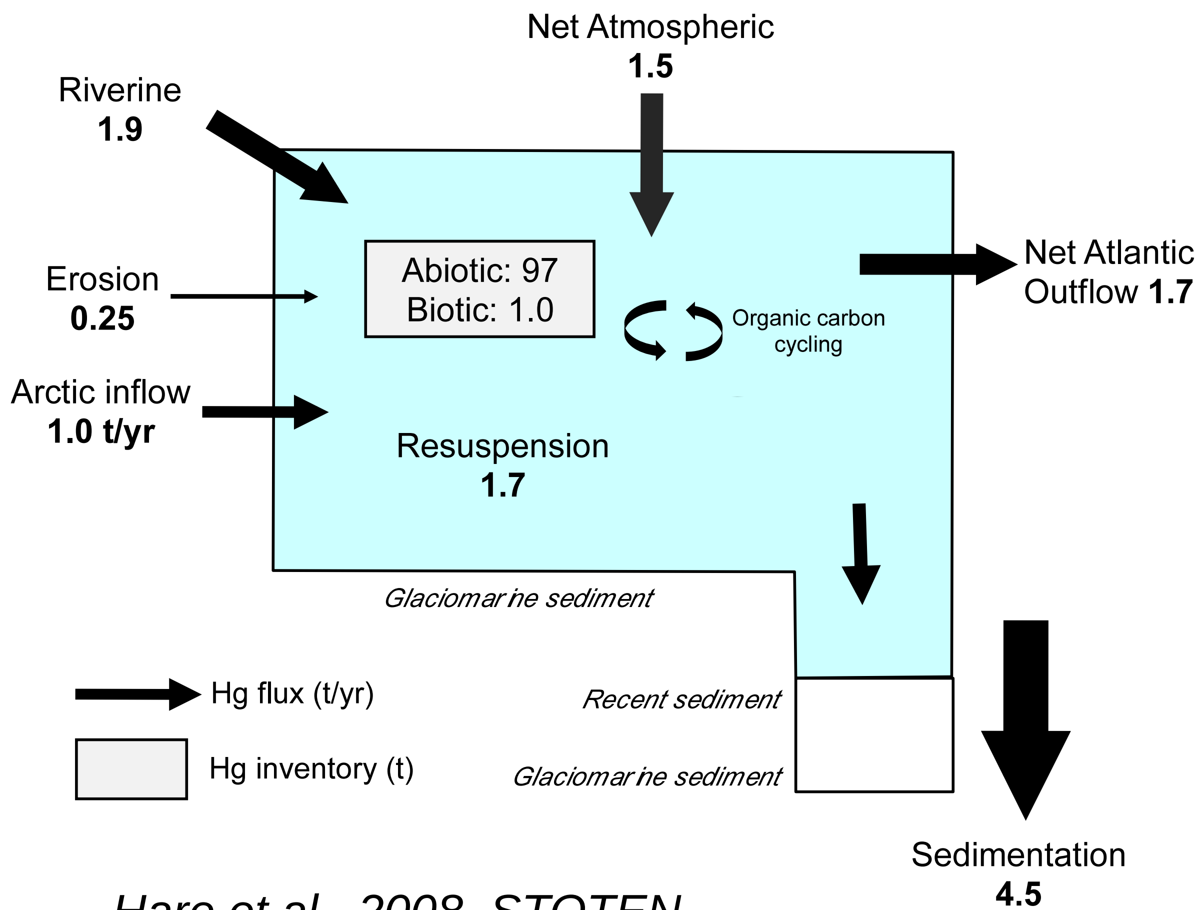
- $[Hg]_T$ in Hudson Bay marine mammals remain high
- Decreasing trend detected in $[Hg_T]$ in female Arviat beluga muscle tissue from the early 1980s to 2008, probably due to behavioral changes (foraging more in offshore areas due to sea ice recede) (Gaden and Stern, 2010)

What We Know (II)



- Mercury depletion events occur during springtime in Churchill, providing a possibility of enhanced atmospheric Hg transport to the marine system, particularly during melting season.

What We Know (III)



Hare et al., 2008, STOTEN

- Riverine and atmospheric are the major sources of Hg to the Bay
- There exists a unique and powerful particle re-suspension “pump”!

Table 2 – Water and sediment fluxes of the Hudson Bay System

Constituents	Flux		
	Low	High	Best estimate
Water (km^3/yr)[a]			
Riverine	892	948[b]	940
Precipitation–Evaporation	10	50	30
Oceanic			
Arctic (Fury and Hecla Strait)	1300	3200	2200
Net Atlantic (Hudson Strait)	−3170	−6300	−3170
Water inputs–outputs			0
Sediment (10^6 t/yr)			
Riverine[c]	8.2	11.4	10.2
Atmospheric[d]	0.71	0.77	0.74
Coastal erosion	18[e]	27.5[f]	18[e]
Net oceanic[g]			<−1
Resuspension[h]			120
Sedimentation[i]	−78	−216	−147
Sediment inputs–outputs			~0

Hare et al., 2008, STOTEN

What We Know (IV)

Table 3 – Riverine Hg fluxes to the Hudson Bay System

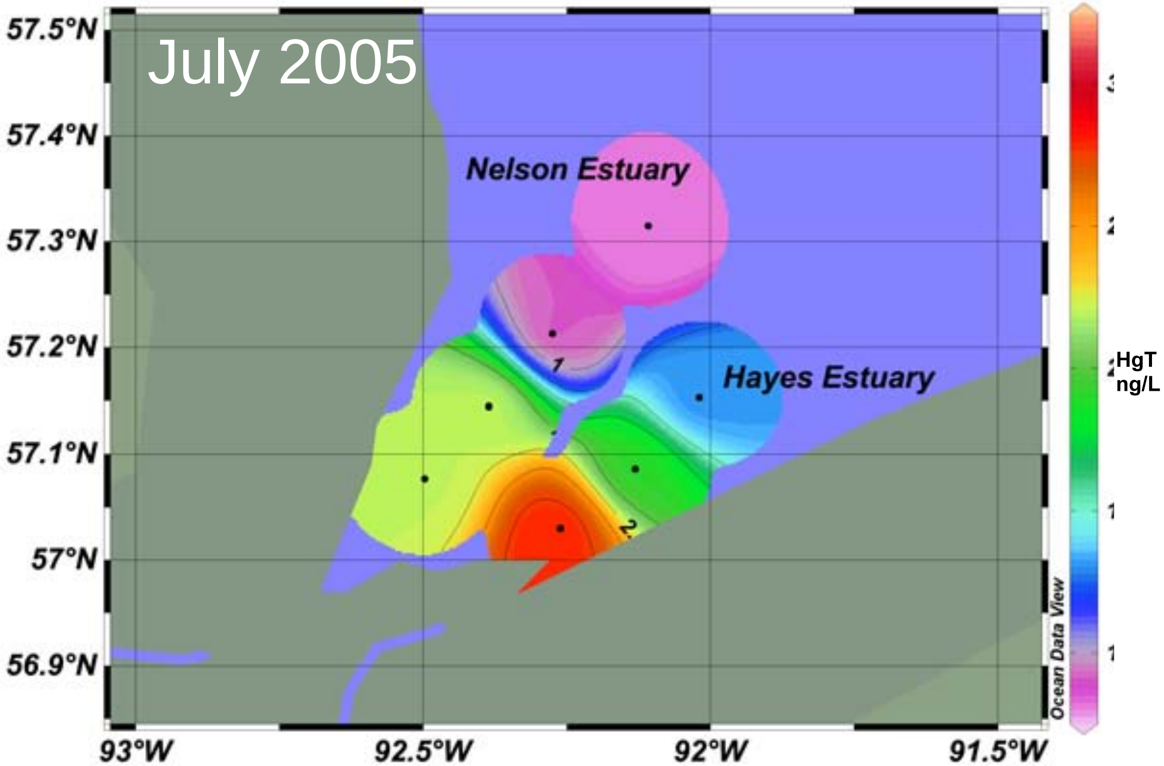
Rivers	Water discharge[a]	Sediment discharge[b]	Hg concentration (ng/L)			Hg flux (kg/yr)		
	(km^3/yr)	(10^6 t/yr)	Hg_D	Hg_P[c]	Hg_T	Hg_D	Hg_P[c]	Hg_T
HBS Rivers:								
Povungnituq	11.6	–	1.13	0.47	1.6	13	5.5	19
Kogaluc	4.9	–	1.05	0.22	1.27	5	1.1	6.2
Nastapoca	7.9	–	–	–	1.23	–	–	10
Grande Baleine	19.8	0.1[d]	2.28	0.59	2.87	45	11	57
Winisk	16.5	0.2[d]	–	–	2.38	–	–	39
Hayes	18.6	–	1.83	1.07	2.9	34	20	54
Nelson	94.2	0.74	1.9	0.33	2.23	179	31	210
Churchill	20.6	0.18	3.34	0.13	3.47	69	2.7	71
Baker Lake Outflow	48.5	–	–	–	0.72	–	–	35
Sub-total	243							501
All HBS rivers[e]	940							1940
Other Arctic Rivers:								
Mackenzie[f]	330	125	2.77	3.68	7.18	530	1640	2170
Ob[g]	405	16.5	0.56	–	–	530	820	1350
Lena[g]	525	17.6	1	–	–	1150	2900	4050
Yenisei[g]	626	5.9	0.3	–	–	410	310	720

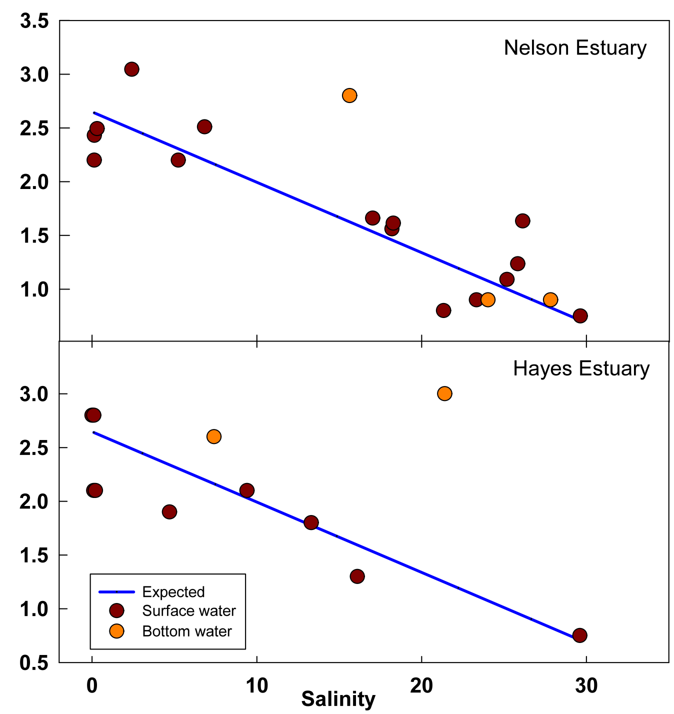
(Hg_D: dissolved Hg; Hg_P: Particulate Hg; Hg_T: total Hg).

Hare et al., 2008, STOTEN

- Nelson and Churchill Rivers are the largest riverine source of Hg to the bay (15% of the riverine total).

What We Know (V)





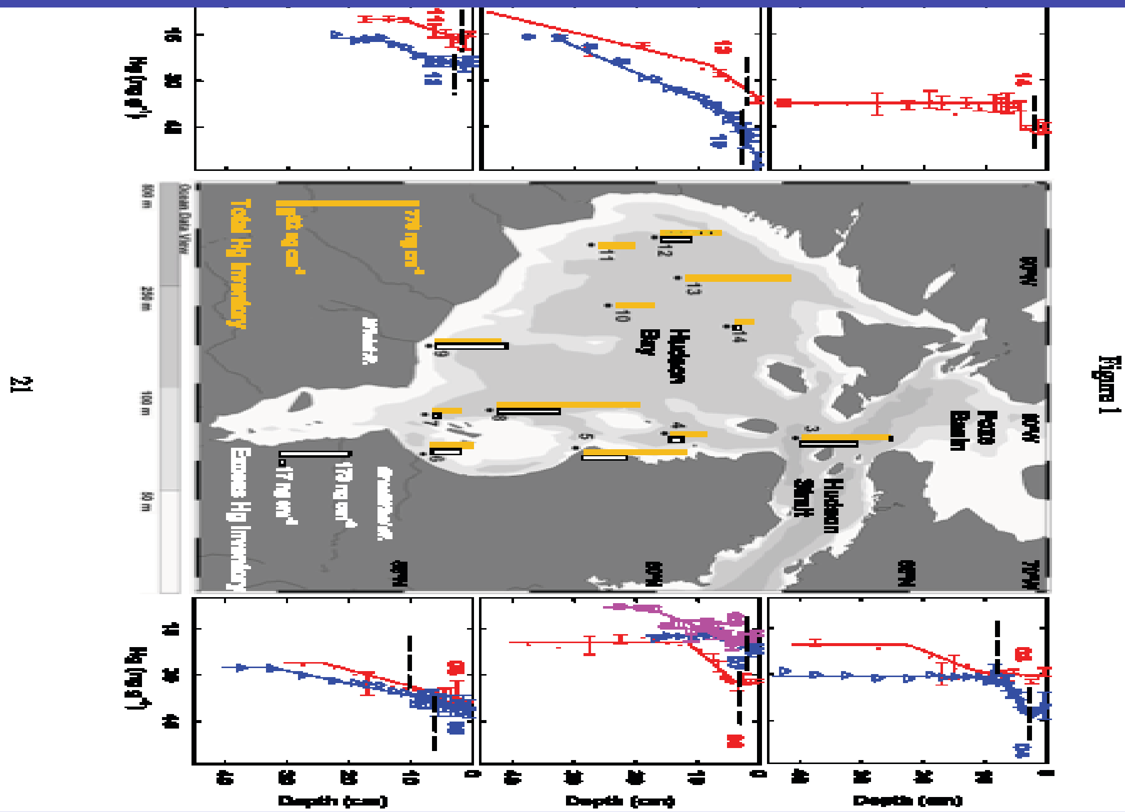
Surface water Hg_T concentrations in the Nelson and Hayes River estuaries

Conservative behavior of Hg_T

See Poster by Hare et al.!

- Very little removal or remobilization of riverine Hg in the estuaries

What We Know (VI)

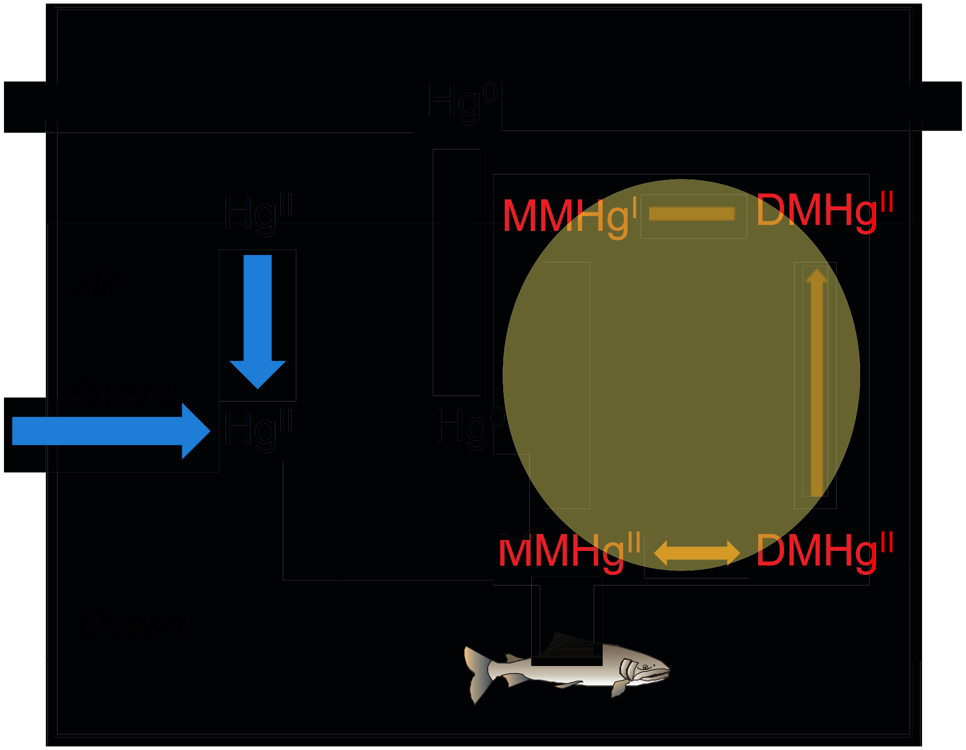


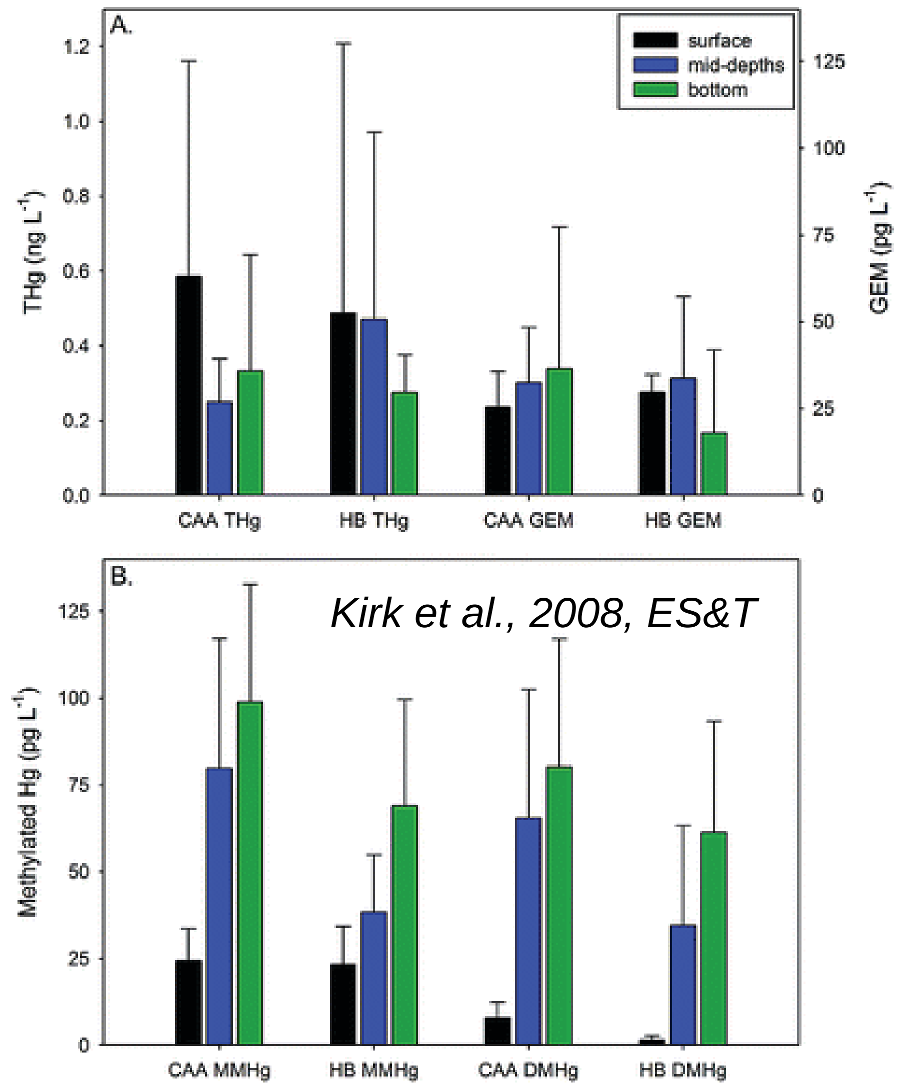
Hare et al.,

2010, ES&T

- Atmospheric deposition of Hg is largely controlled by the particle flux;
- Natural changes in OM composition and dynamics can cause variation in sedimentary [Hg] at least to the same extent as those caused by increasing anthropogenic Hg emissions

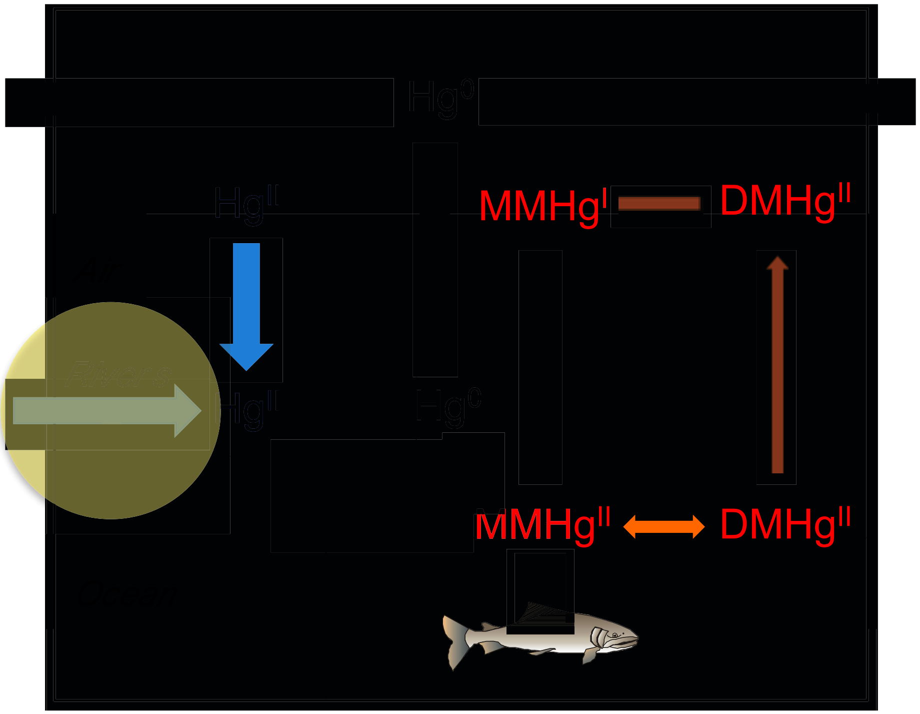
Major Gaps (I)

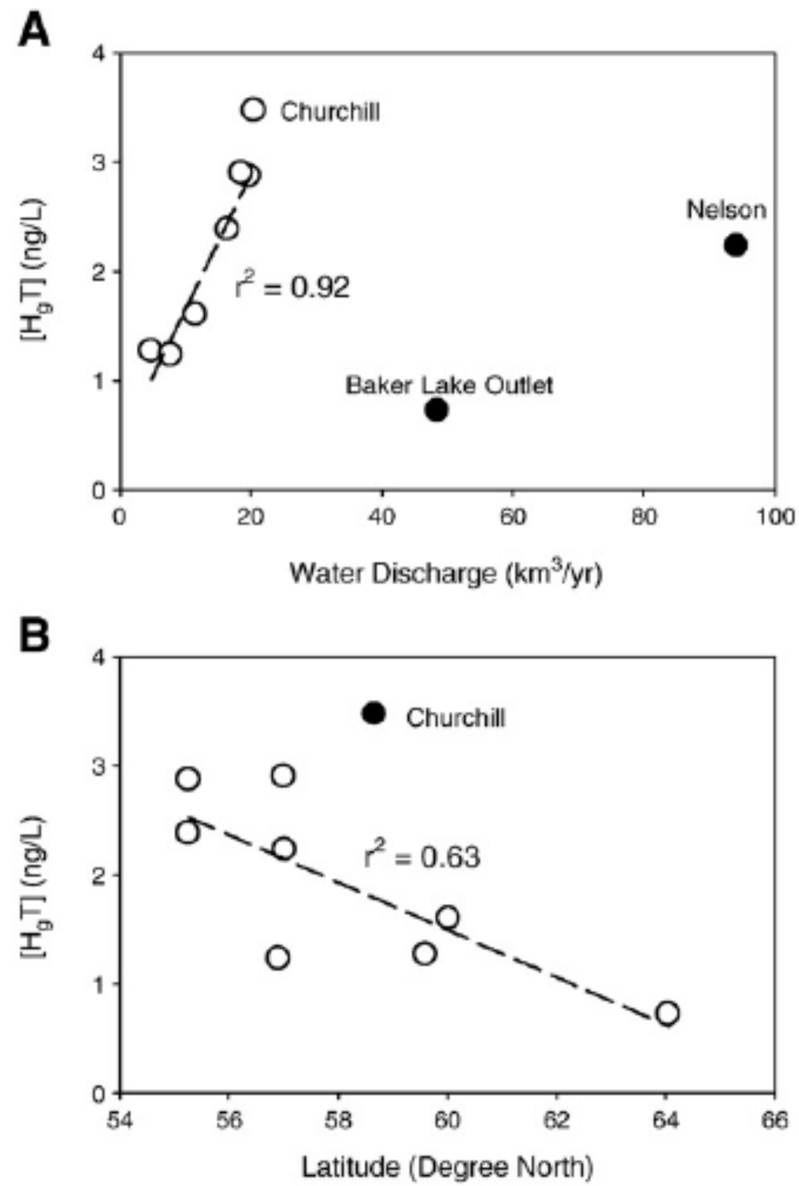




- Methylmercury: sources, sinks, dynamics

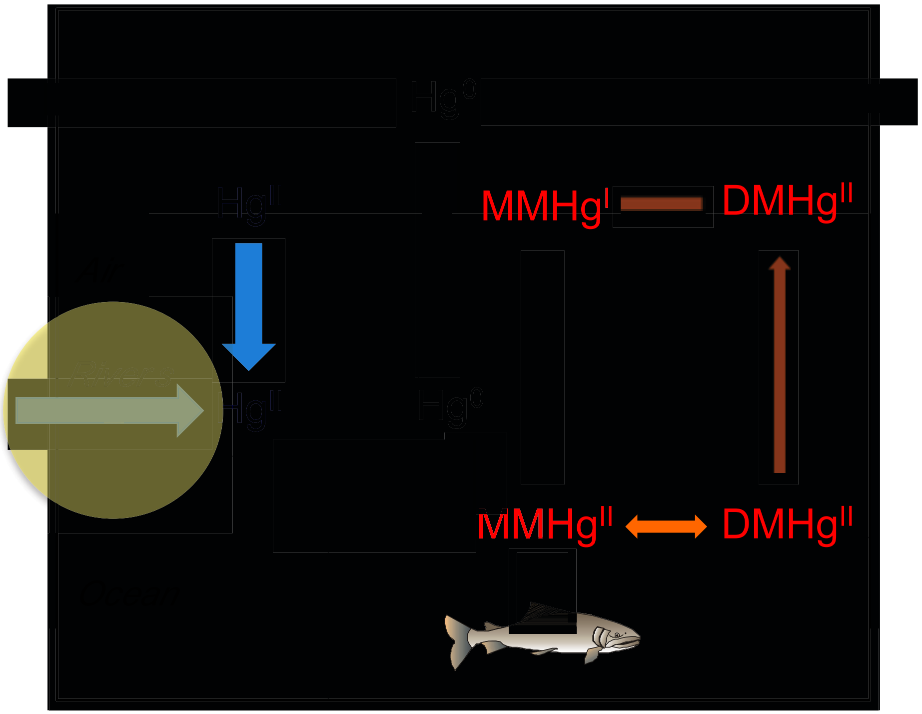
Major Gaps (II)

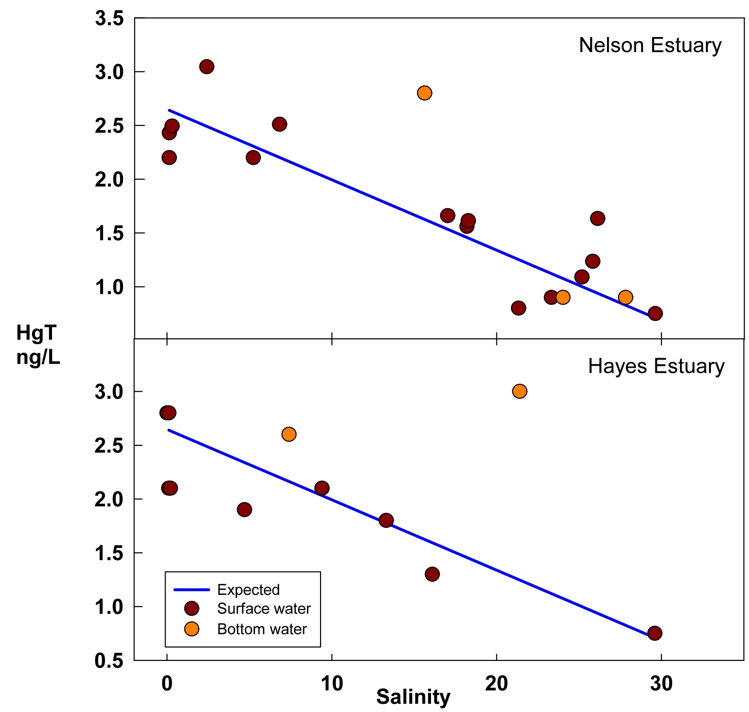




- ➢ Why the Churchill and Nelson Rivers behave differently from other rivers in the region?

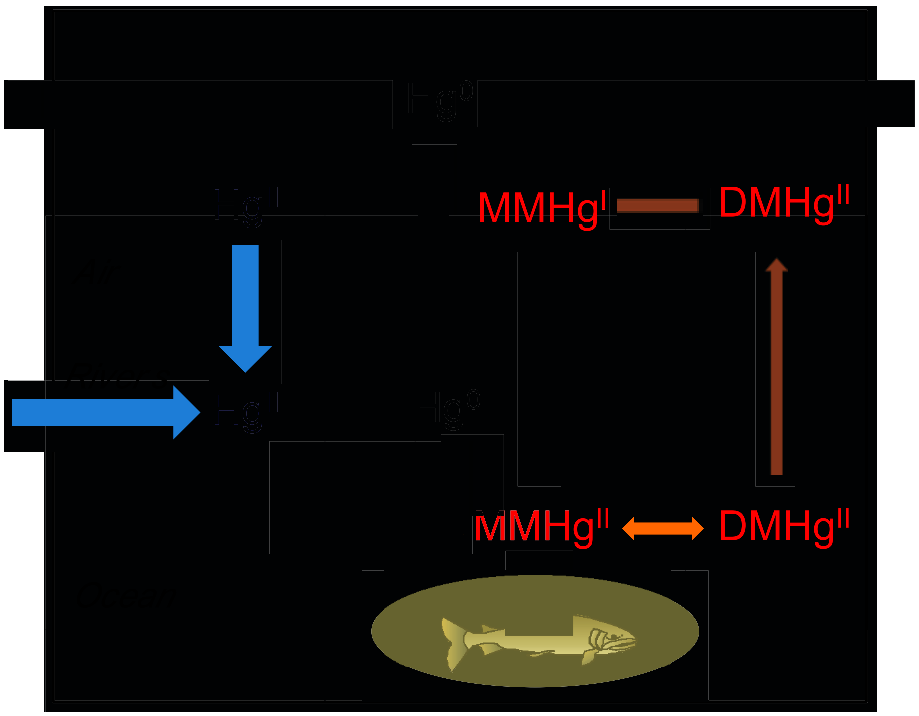
Major Gaps (III)

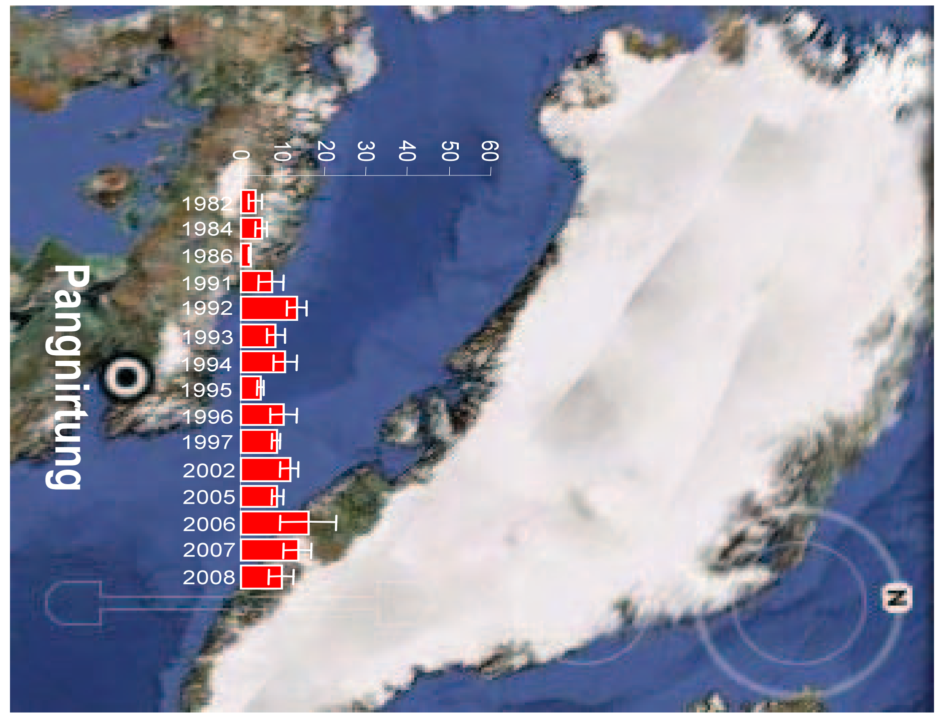




➢ Why do the Churchill and Nelson estuaries not modify riverine Hg input?

Major Gaps (IV)





- How will biotic Hg respond to changes in emissions and hydropower development under a changing climate (in the presence of a powerful particle resuspension pump)?

What can we do better?

- Year-round time-series at fixed stations
- Seasonal transects along the estuaries
- Monitoring vs hypothesis-driven research

New Opportunity: Sea-ice Environmental Research Facility (SERF)