Hydrographical Variations at James Bay Eelgrass Beds in Relation to an Under-Ice River

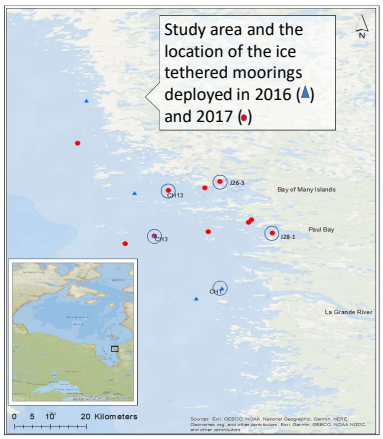
Christopher J. Peck[1], Zou Zou A. Kuzyk[1], Joel P. Heath[2], Fredrick T. Short[3], Misha L. Warbanski[2], Kaushik Gupta[1], Alessia Guzzi[1], Jens K. Ehn[1]
1. University of Manitoba, 2. Arctic Eider Society, 3.University of New Hampshire

Background

- Eelgrass (*Zostera marina)* in James Bay declined in the 1990s and today remains far depleted from its historic extent. Eelgrass is globally recognized as an important habitat for juvenile fish and birds and provides a number of ecosystem services such as nutrient recycling, sediment trapping and carbon sequestration (1). It is known that extended exposure to low salinity can reduce growth and abundance of eelgrass (1).
- In the Chisasibi region of northeast James Bay (Figure 1), a possible contributor to reduced salinity at eelgrass beds is the enlarged under-ice freshwater plume of the La Grande River (2).
- Hydroelectric developments have reportedly more than doubled the average annual discharge of the La Grande River and shifted the peak discharge from spring (June) to the winter months (3).
- The under-ice freshwater plume of the La Grande deflects northwards as it enters James Bay (4) and then flows towards southeast Hudson Bay (5), consistent with the coastal circulation of Hudson Bay.

Objectives

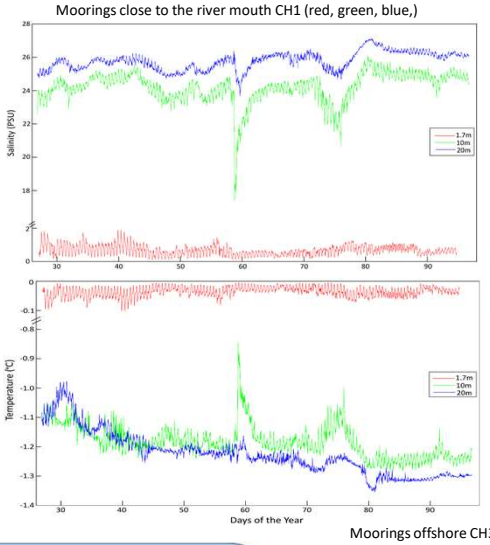
- Characterize the La Grande under-ice river plume.
- Investigate the inshore – offshore differences between two bays that historically contained eelgrass. Bay of Many Islands with eelgrass beds persist, and Paul Bay where eelgrass is now absent.



Methods

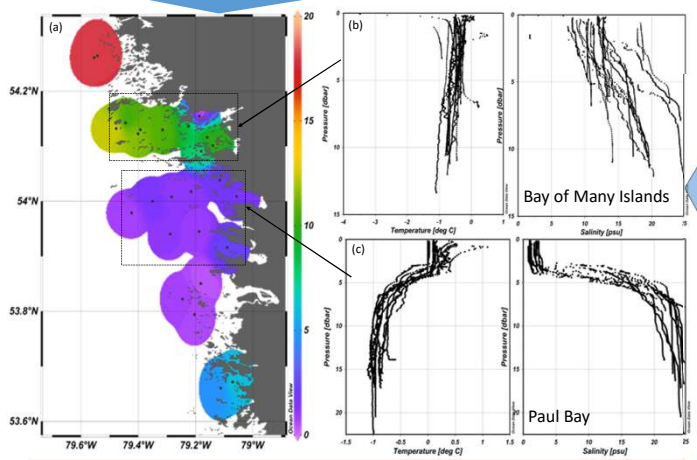
- Conductivity, temperature and depth (CTD) measurements were collected at various locations extending northwards from the La Grande River.
- Moorings were deployed in both nearshore and offshore environments to monitor current direction and speed, tidal amplitude and temperature and salinity.
- Data were collected in both the summer and winter months of 2016 and 2017.

Moorings close to the river mouth CH1 (red, green, blue,)



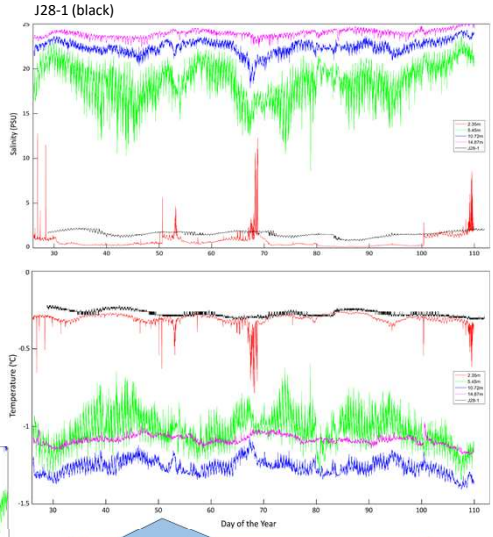
- Close to the La Grande River mouth and in Paul Bay the water column was strongly stratified with a 5m thick freshwater layer.
- Both greater river discharge during the winter and reduced wind mixing under the landfast ice explain these differences.

Winter Conditions

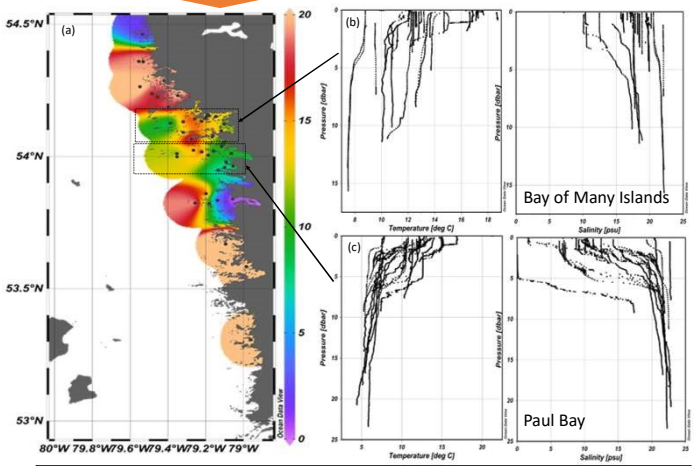


- Overall the water column was fresher during the winter and the ice covered conditions allowed the plume to extend much further than during the summer.
- The unmixed river plume is able to freely enter Paul Bay and reduce the salinity.
- In Bay of Many Islands, the water column was more mixed and had a higher salinity.
- Our interpretation is that the plume is mixed with underlying salty waters as it flows amongst the islands that surround the bay, thus arriving at the eelgrass beds with a higher salinity.
- Deep saline water may enter the bay from some of the channels between the islands.

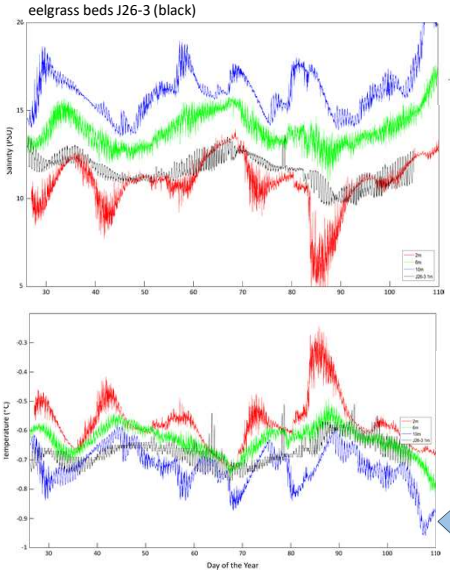
Moorings offshore CH3 (red, green, blue, magenta) and in Paul Bay J28-1 (black)



Summer Conditions



Moorings in Bay of Many Islands CH13 (red, green, blue) and in eelgrass beds J26-3 (black)



- Storm events in the winter were associated with increases in the salinity of the surface layer and decreases in the salinity of the deeper layer in the offshore plume, implying enhanced vertical mixing during those periods.
- While the storm did not break up the landfast ice, the mixing that occurred offshore influenced the water column under the landfast ice.

- The temperature and salinity varied less at the eelgrass bed than outside in Bay of Many Islands.
- Tidal variations in temperature and salinity at in-shore locations were larger than further offshore.
- Tidal forcing drives the vertical mixing and exchange of waters at the inshore locations.
- Waters in Bay of Many Islands take longer to exchange with the offshore waters, leading to longer residence times.

Acknowledgements

We would like to acknowledge the Cree Nation of Chisasibi, Arctic Eider Society, NSERC and NCE.
ArcticNet for helping to fund the project. We would like to thank Mairie Fenton, Michelle Kamula, the Cree Nation of Chisasibi and the Arctic Eider Society for their help collecting the data during the field campaign.

References:
1. Short, F.T. 2008. *Report to The Cree Nation of Chisasibi on The status of eelgrass in James Bay*. An assessment of Hydro-Quebec data regarding eelgrass in James Bay, experimental studies on the effects of reduced salinity on eelgrass, and establishment of James Bay environmental monitoring by the Cree nation. University of New Hampshire. 24 p.
2. *Dickey*, M-H. 2015. Status of eelgrass beds on the east coast of James Bay, Internal Environment Canada Report, Québec, QC, 76pp.
3. Messier, D. 2002. *Suivi environnemental des projets La Grande-2A et La Grande-1. Le panache de La Grande Rivière*. Rapport synthèse pour la période 1987-2000. Direction Barrages et Environnement, Hydro-Québec Production. 73 p.
4. Ingram, R.G. and P. Larouche. 1987. *Changes in the under-ice characteristics of La Grande Rivière plume due to discharge variations*. Atmosphere-Ocean 25(3):242-250.
5. McDonald, M., L. Arragutainaq and Z. Novalinga. 1997. *Voices from the bay: traditional ecological knowledge of Inuit and Cree in the Hudson Bay bioregion*. Canadian Arctic Resources Committee et Environmental Committee of Municipality of Sanikiluaq.