Warming from recent marine heatwave lingers in deep British Columbia fjord

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Jackson, et al., Geophysical Research Letters, 2018; jennifer.jackson@hakai.org
Outline

• Introduction to study area
• Description of the four datasets
• Evolution of 2014 – 2017 marine heatwave in the Gulf of Alaska
• Tracing the marine heatwave to BC central coast
• Possible influence on coastal ecosystem
• Correlation between offshore and coastal conditions – can coastal waters be predicted from open ocean data?
• Summary
Introduction to British Columbia

Jackson et al., JGR Oceans, 2015
Study region and datasets

- 4 different datasets were used:
  1. Argo data interpolated to Queen Charlotte Sound shelf break from 2004 to 2018
  2. DFO Line P data from 1959 to 2018
  3. DFO CS line data from 1998 to 2017
  4. DFO/Hakai Rivers Inlet data from 1998 to 2018
Introduction to Rivers Inlet

- Rivers Inlet is a fjord on British Columbia’s central coast
- It is about 45 km long and 3 km wide
- The maximum depth is 340m and the sill depth is about 140m (Pickard, 1961)
- The mouth of Rivers Inlet is exposed to Queen Charlotte Sound
- There are approximately 53 inlets at least 18.5 km long in British Columbia

Image by Keith Holmes
Rivers Inlet sockeye salmon 1948 - 2012

NUMBER OF INDIVIDUALS


University of British Columbia collected data from 1951-1987 and 2008-2010
Fisheries and Oceans Canada collected data from 1990-2018
Hakai Institute collected data from 2013-2018
This is the first time that the data have been brought together for analysis
Deepening of heat in the NE Pacific

Surface >0.25°C warmer than average

Surface and 140 m >0.25°C warmer than average

140 m >0.25°C warmer than average

*Results shown here are from Argo data*
Tracing heat from the NE Pacific to the coast – Argo data

- Surface anomaly first observed spring 2014
- Subsurface anomaly observed fall 2014
- El Niño is clear in 2016
- Subsurface anomaly persists between 1025.6 kg m\(^{-3}\) and 1026.1 kg m\(^{-3}\) until at least March 2018
Tracing heat from the NE Pacific to the coast – Queen Charlotte Sound

- These data only sampled twice a year so low temporal resolution
- El Niño is clear in 2016
- Subsurface anomaly persists between 1025.6 kg m\(^{-3}\) and 1026.1 kg m\(^{-3}\) until at least September 2017
Tracing heat from the NE Pacific to the coast – Rivers Inlet

- Surface anomaly first observed spring 2015
- Subsurface anomaly observed fall 2015
- El Niño is clear in 2016
- Subsurface anomaly persists below 140 m until at least August 2018
Extending the time series at Line P

The surface and subsurface anomalies were also observed at Line P.
Extending the time series shows that there have been other prolonged warm periods along 1026.1 kg m\(^{-3}\).
Mid-1980s and 1993 to 1998 were times when water warmer
Possible consequences to ecosystem

- Decline of Rivers Inlet sockeye salmon occurred at the same time when there was a warm anomaly at 140 m along Line P (1993 to 1998)
- Warm waters favour smaller, less lipid-rich zooplankton on the BC coast
- Is it possible that open ocean subsurface warm anomalies influence salmon?
Correlation between open ocean and shelf break

- Lagged maximum correlations at 140 m between Argo data and Argo interpolation point at Queen Charlotte Sound shelf break
- Points with correlation less than square root of 0.2 not shown
- Suggests a lag of 1 to 3 years from Blob’s deep manifestation to warming at the coast
Correlation between shelf break and Rivers Inlet

- Temperature anomaly at Argo Interpolation point and Rivers Inlet are very well correlated, with a 0 to 2 month time lag.
Summary

• Four datasets (Argo, Line P, DFO CS line and Rivers Inlet) were used to trace the subsurface marine heatwave from the open ocean to Rivers Inlet
• The marine heatwave persisted at 140 m in the open ocean until at least March 2018
• As of August 2018, deep water in Rivers Inlet was still 0.6°C warmer than the monthly average
• This subsurface warm anomaly could influence River Inlet ecosystem, including sockeye salmon
• The strong correlation between open ocean and BC coast suggest that bottom water in Rivers Inlet can be predicted