Disentangling human-induced X natural sediment resuspension events in Barkley Canyon, NE Pacific, using cabled observatory, mooring and vessel AIS data

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Background

In 2016, Ocean Networks Canada (ONC) initiated a new monitoring program aiming at studying sediment transport processes off the shelf and slope of Vancouver Island, British Columbia. This area is subject to an intense bottom trawling fishery targeting predominantly rockfish, flatfish, Pacific cod and Lingcod, with landings ranging between 100-115 tones from 2016 to 2018 (DFO Pacific Groundfish Reports).

Bottom trawling is a pervasive activity along the world's continental margins, known for triggering sediment resuspension due to the physical contact of heavy fishing gear to the seafloor.

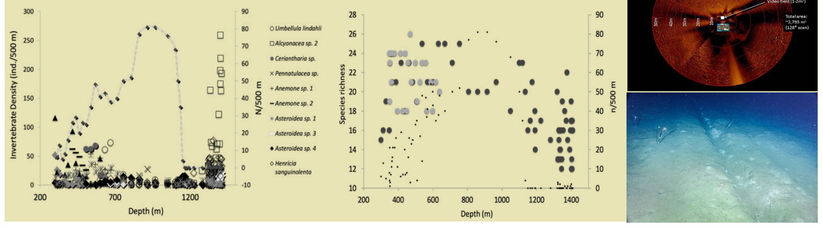
A recent study (De Leo et al., 2017) showed that the number of seafloor bottom trawling tracks offshore Vancouver Island had a significant negative impact on slope megabenthic biodiversity and abundance.

We are now seeking to understand if the bottom trawling fishery also exerts significant influence on sediment resuspension in Barkley Canyon and nearby slope, affecting yet another aspect of water column and seafloor ecosystem dynamics.

We present here preliminary results based on data from multiple ocean monitoring assets (two autonomous moorings, a meteorological buoy, a cabled observatory, and AIS data) to investigate the main triggering mechanisms of sediment resuspension events in and around **Barkley Submarine Canyon**, off Vancouver Island, Canada's Pacific Coast.

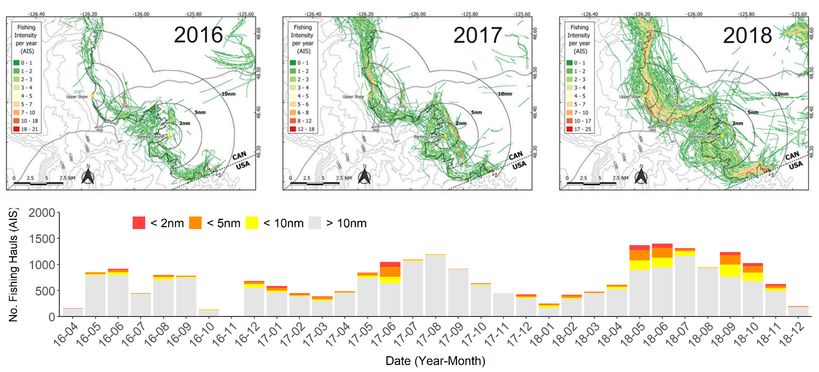
Our work hypothesis was that the bottom trawling fishery had the potential of causing substantial sediment resuspension at Barkley Canyon Head and adjacent Upper Slope.

Bottom trawling impacts on deep-sea benthos

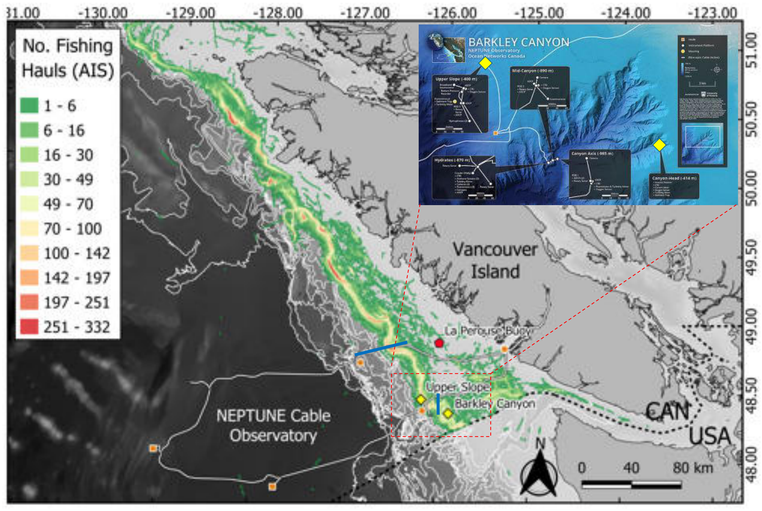


Reduced benthic megafauna density and species richness across a depth gradient obtained from two 12-30 km long ROV video transects near Barkley Canyon and Clayoquot Slope (De Leo et al., 2017, large map).

Results – Rockfish bottom trawling fishery

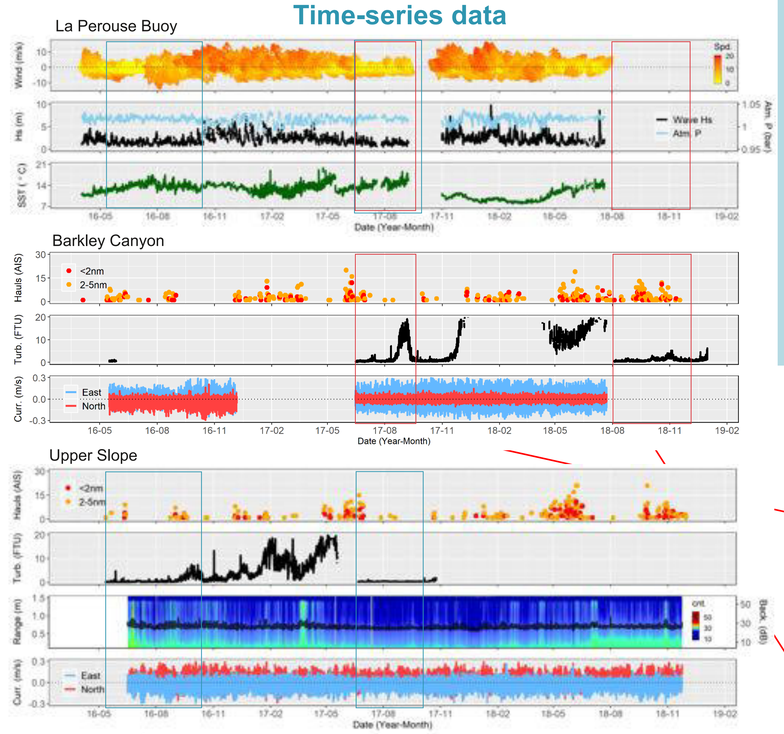


- 47 vessels operated offshore Vancouver Island between May 2016 and December 2018, representing 20,759 fishing hauls or 29,669 fishing hours;
- Fishing effort is clearly seasonal with highest number of hauls occurring during late Spring, Summer and Fall. Fishing intensity also significantly increased from 2016 towards 2018;
- 35 vessels operated in the same period upstream from our deployed moorings/turbidity sensors (< 420 m depth) and within a 10 nm boundary, (= 2,563 hauls or 2,548 fishing hours).



Study area depicting the spatial footprint of the bottom trawl fishery off Vancouver Island (AIS data, 2016-2018), and the ocean monitoring assets used in this study (2 moorings, a meteorological buoy and the NEPTUNE observatory). Blue lines show ROV transects studied in De Leo et al, 2017.

Time-series data



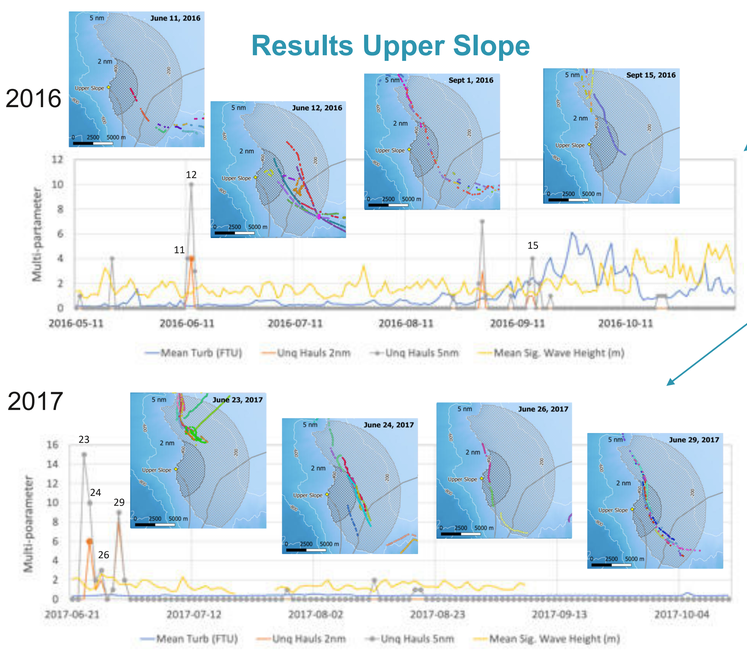
Upper Slope

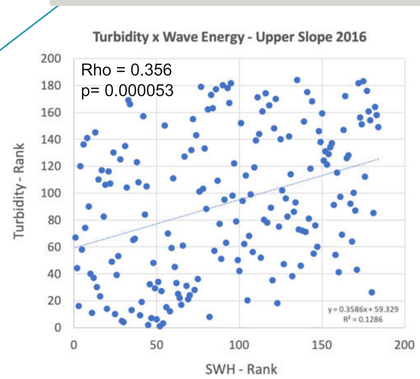
- There was no significant positive correlation between bottom trawling activity and turbidity in **Barkley Upper Slope;**
- There was significant positive correlation between wave activity (SWH) and turbidity signals at Barkley Upper Slope (below).
- Doppler current meter data (current speeds and backscatter) from the NEPTUNE observatory did not show any correlation with the turbidity data (15 mab) from the mooring located tens of meters away.

Barkley Canyon

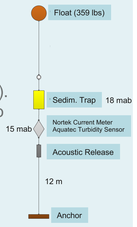
- There was no significant positive correlation between bottom trawling activity and turbidity signals at **Barkley Canyon Head**;
- Daily AIS fishing intensity maps (right) show that despite intense fishing activity occurred in Fall of 2018, no turbidity signals reached our sensors at the Canyon Head mooring;
- ADCP data from both NEPTUNE stations at 420 and 987 m (not shown) show sluggish currents incompatible with turbidity currents generated by storms events over the shelf.

Results Upper Slope

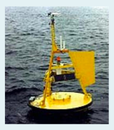




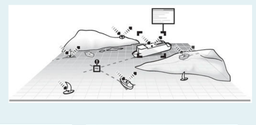
Materials and Methods



- Two **autonomous moorings** were deployed in the vicinity of the NEPTUNE cable observatory, at the head of Barkley Canyon (BC), and on the adjacent slope (center map). The moorings were equipped with turbidity sensors, current meters and sediment traps to quantitatively and qualitatively assess the suspended particle load. Instruments used:
  - Aquatec Turbidity logger (FTU, 1Hz)
  - Nortek Aquadopp single point ADCP (1 Hz)
  - McLane Sediment trap (78H-21, 21-d interval sampling)
- Sea surface data obtained from the **La Perouse buoy station**, maintained by Canada's Department of Fisheries (DFO), were used to assess temporal variability in wave energy potentially capable in resuspending sediments over the shelf and slope. Parameters used:
  - Atmospheric pressure (dbar)
  - Wind speed (m/s) and direction (deg.)
  - Significant wave height (m)

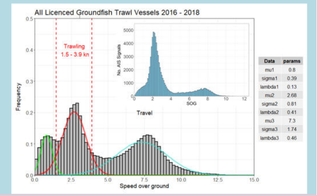


- **Automatic Information System (AIS) vessel tracking data** co-owned by ONC and the Canadian Coast Guard were used to determine the extent of the 'fishing ground footprint' near BC.

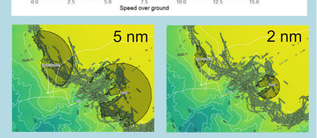


- **ONC's NEPTUNE cable observatory** provided complementary data on bottom currents, backscatter and turbidity at nearby locations (Barkley Upper Slope, 420 m, and Barkley Axis, 987 m depth). Instruments used:
  - WETLabs FLNTU – 1.8 mab (1 Hz)
  - Aquadopp 2 MHz ADCP 1.8 mab (1 Hz)

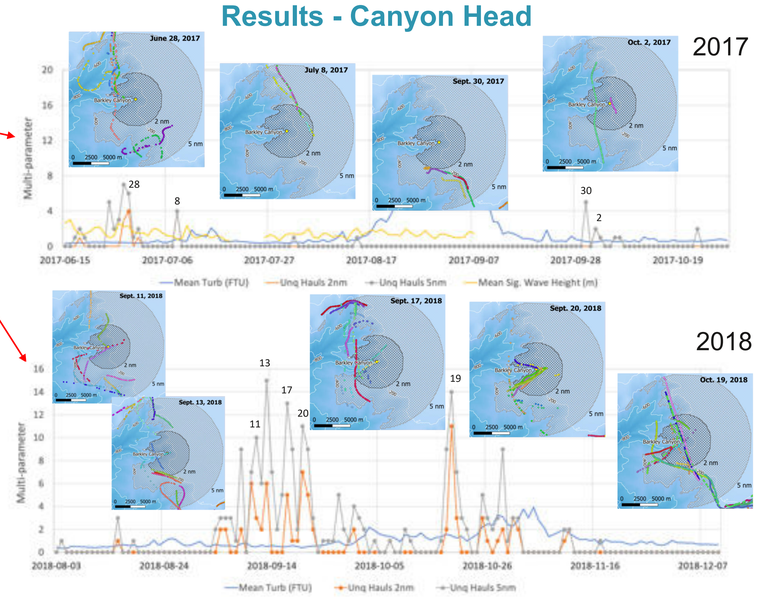
Data Processing and Analysis



- Due primarily to biofouling, 50% of turbidity logger data from the two moorings were discarded from our analysis. Data post-processing also included the removal of artificial outliers by resampling the data at 30 min. intervals;
- AIS data (2016-2018) were post-processed using two major selection criteria: 1) vessel 'ids' matching DFO's operating fishing license category 'groundfish trawler'; 2) speed over ground between 1.5 to 3.9 knots, defining the range of trawling speeds, after Natale et al., 2016 and Oberle et al., 2016;
- Fishing intensity metrics were derived for AIS tracks upstream from the moorings (< 420 m) and distant 2 and 5 nm away;
- Non-parametric regression was used to assess if turbidity signals were correlated to fishing intensity or with other physical forcing such as significant wave height, current speed.



Results - Canyon Head



Conclusions and Future Directions

- The bottom trawling fishery off Vancouver Island is highly seasonal concentrating around spring, summer and fall, but also somewhat variable between the years studied;
- Our preliminary results did not support our hypothesis that bottom trawling is a triggering mechanism of sediment resuspension near the head of Barkley Canyon and adjacent slope;
- At Barkley Upper Slope it appears that the suspended particle load is controlled primarily by advection from shelf-resuspension due to wave activity. However, the somewhat week current velocities measured, never above 30 cm/s (both at the Canyon Head and Slope, and further down the Canyon Axis at 987 m – data not shown) rule out any possible turbidity currents triggered by large storm events over the shelf;
- The temporal and spatial analysis of AIS reveals that our moorings equipped with turbidity sensors were not placed in 'hotspots' of bottom trawling activity. In 2018, however, when intense fishing developed near our slope mooring, the turbidity sensor failed soon after deployment (mid May) and we lost the opportunity to potentially identify trawling-induced turbidity signals;
- In a future attempt to assess the potential effects of bottom trawling on sediment transport processes in Barkley Canyon we plan the following strategies: 1) utilize turbidity sensors that resist biofouling for longer (with a wiper system), 2) chose a different location for a mooring deployment, e.g., near the northern flank of Barkley Canyon where fishing intensity is higher; 3) rely on gliders (ONC's recently acquired monitoring assets) allowing larger spatial coverage over the canyon head and adjacent slope);