

Long-term monitoring of pelagic biodiversity in the NE-Pacific: a new program based on vertical ROV video surveys during NEPTUNE observatory maintenance expeditions.



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Summary

Ocean Networks Canada (ONC) operates large seafloor cabled observatory networks in the Arctic and NE Pacific, with some of its long-term observations nearly approaching 15 years of archived data. The seafloor network of 850+ km of backbone cables connects > 50 instrumented sites (>400 oceanographic instruments, >5,000 sensors), in habitats ranging from temperate coastal fjords and rocky subtidal reefs, ice-covered Arctic bays, to deep-sea canyons, cold seeps, abyssal plains and hydrothermal vents. Since 2015 ONC initiated a new long-term monitoring program with the overall goal of adding pelagic biodiversity monitoring to an otherwise benthic-focused observatory infrastructure. Remotely Operated Vehicle (ROV) dives conducted yearly to maintain the regional offshore NEPTUNE observatory have been collecting high-definition video to assess the vertical distribution of gelatinous plankton and nekton in **Barkley Canyon (1000 m)**, **Clayoquot Slope (1200 m)**, **Cascadia Abyssal Plain (2600 m)** and **Endeavour Hydrothermal Vent (2300 m)**. Here we present preliminary results based on 4 years of observations, of abundance and diversity linked to oceanographic drivers of community structure such as temperature and dissolved oxygen. This new time-series overlapped with the onset and demise of a strong positive temperature anomaly in the upper NE Pacific Ocean ('Warm Blob'), which brought major ecosystem reorganization that ranged from reduced offshore primary productivity to the appearance of non-indigenous species, most notably the dominance by picoplanktonic *Prochlorococcus*, and a massive bloom of pelagic tunicates, *Pyrosoma atlaticum*. We also discuss the challenges and new collaboration opportunities for this new long-term monitoring program of pelagic biodiversity in an otherwise poorly studied area of the Pacific Ocean.

A range of species found at the 4 NEPTUNE observatory locations



Methods

- Opportunistic surveys, currently under consideration for implementation as a long-term monitoring program;
- Initiated in 2015 and ongoing (5 years of data);
- Initial challenges: (1) ONC funding model focused on operation and maintenance of observatory infrastructures (i.e. need for additional \$\$ for ship and ROV time); (2) use of multiple ROV platforms (e.g., 10 ROV providers since 2009). This means different video camera and lighting set-ups, sampling capabilities and variable ancillary oceanographic instruments among platforms (CTDs, dissolv. O₂, etc – i.e., need for careful sensor quality control and calibration protocols);
- Minimum required video survey protocols (adding ~45-60 min per dive);
- ROV descends at 10 m/min. for at least the upper 1000 m of the water column (video quality for faunal identifications);
- Vertical video transects in all NEPTUNE observatory stations (during descent, ascent or both)
- ROV moving vertically slightly forward and towards incoming current; video in near-field focus (maximizing good visual observations of gelatinous plankton);
- 20 vertical video transects from 18 dives were analyzed, approximately ~26 hr of video.



ONC Sea Tube V2 annotation tool

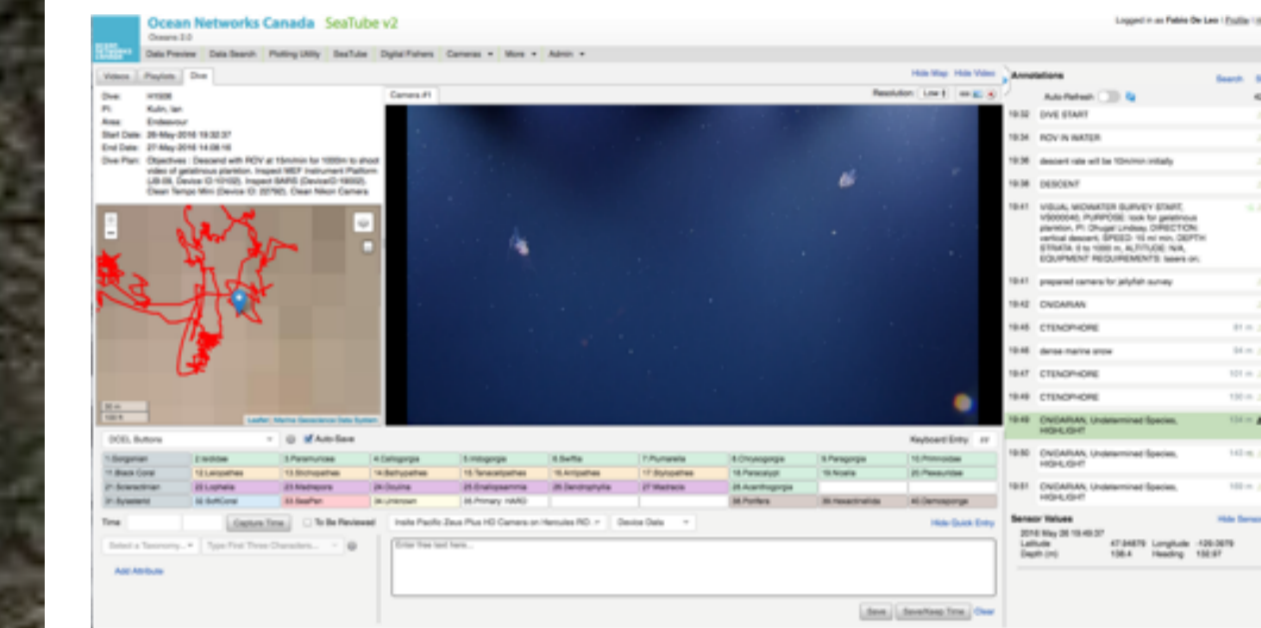
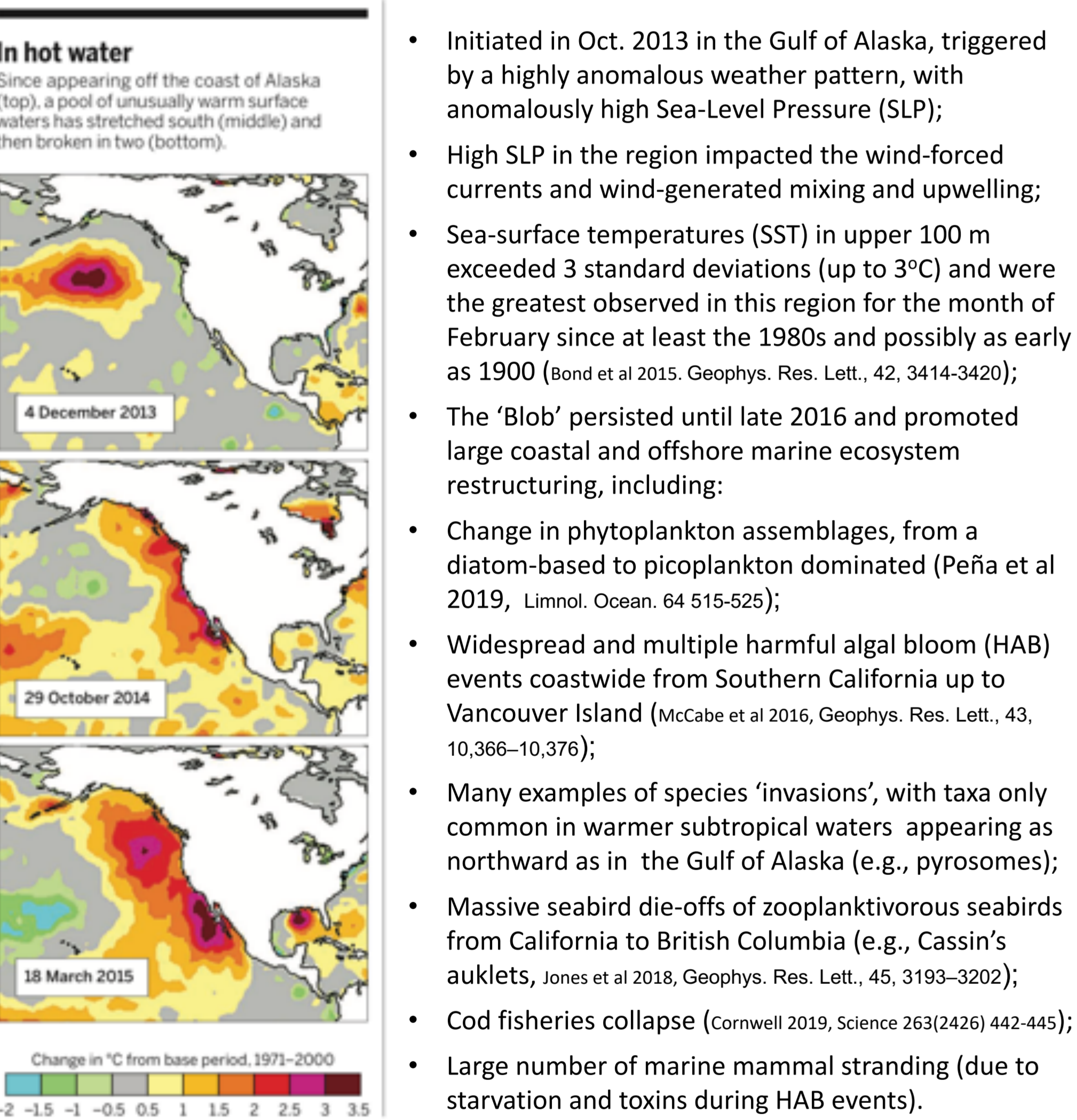


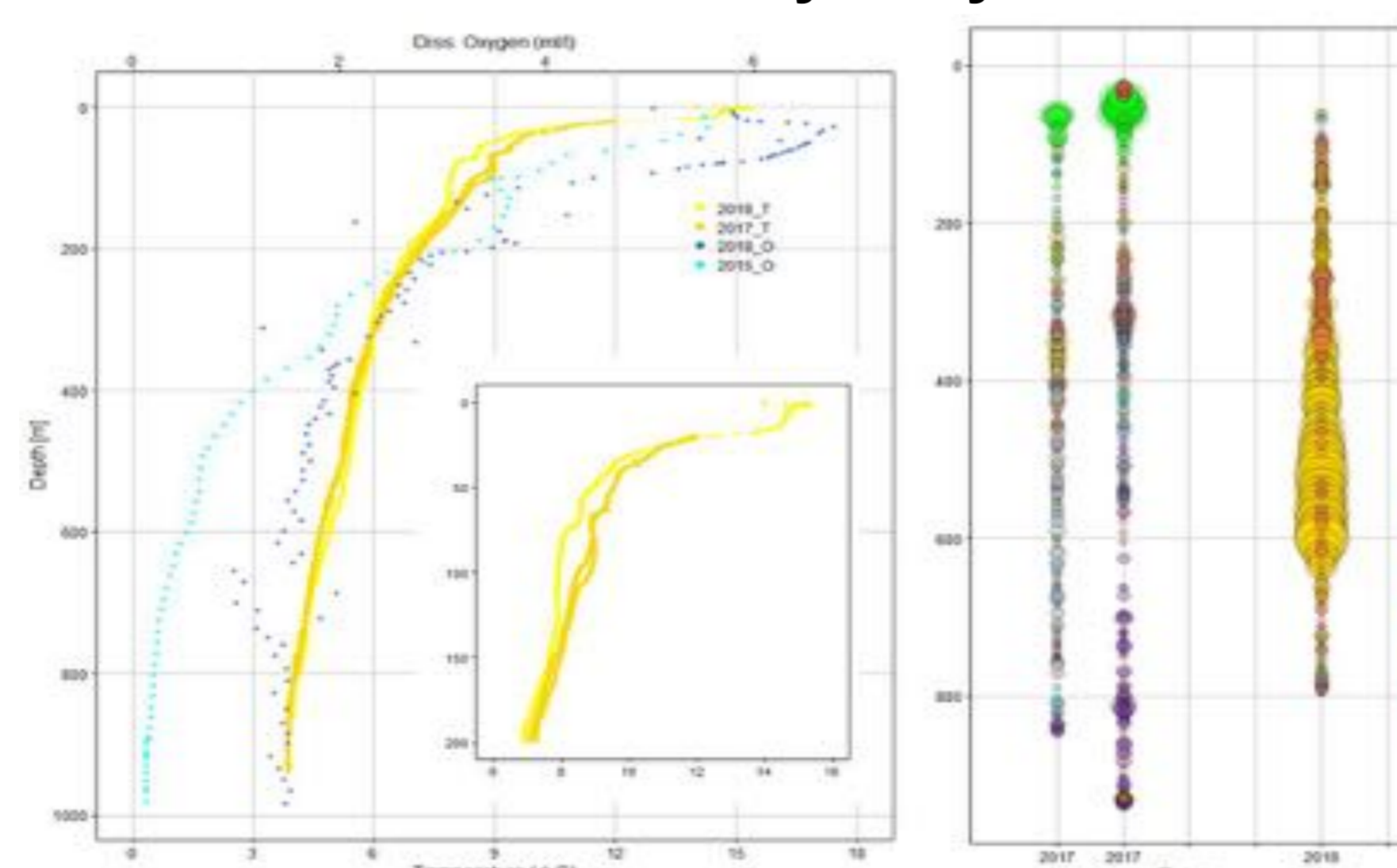
Image and Data Analysis

- Manual annotations performed on the high-resolution video;
- A single person analyzed the entire video dataset, minimizing intrinsic biases in faunal identifications and abundance estimations;
- Taxa annotations matched with timestamp and depth data from video close captioning based on ROV positioning and pressure (CTD) sensors;
- ONC's 'Marine Species Field Guide' was used as a base reference for the more abundant and representative taxa;
- Non-metric multidimensional scaling (MDS) analysis was performed based on square-root transformed taxa abundance data, and using Bray-Curtis similarity matrix. Data was also binned in 100-m depth strata to allow comparisons with previous studies;
- Total abundance and species richness were calculated from individual video transects;
- * Due to the initial opportunistic character of this program, the 4-year time series is only complete for Endeavour. Barkley Canyon was surveyed only in 2017 and 2018, and Clayoquot Slope and Cascadia Basin in 2015, 2017, 2018.
- ROV dissolved oxygen data is not available for 2016 and 2017.

2013-2016 NE Pacific Sea-Surface Warm Temperature Anomaly

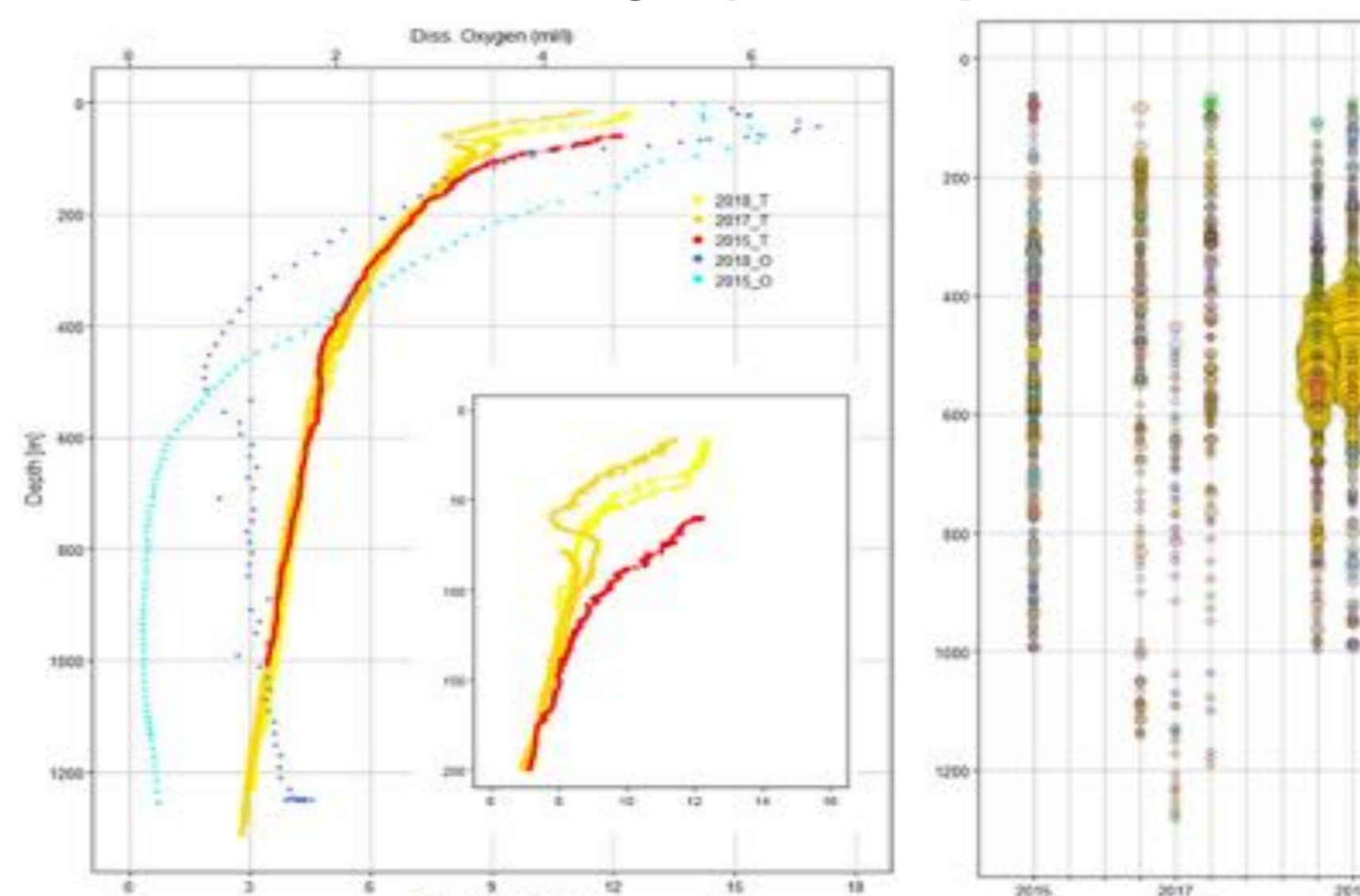


Barkley Canyon



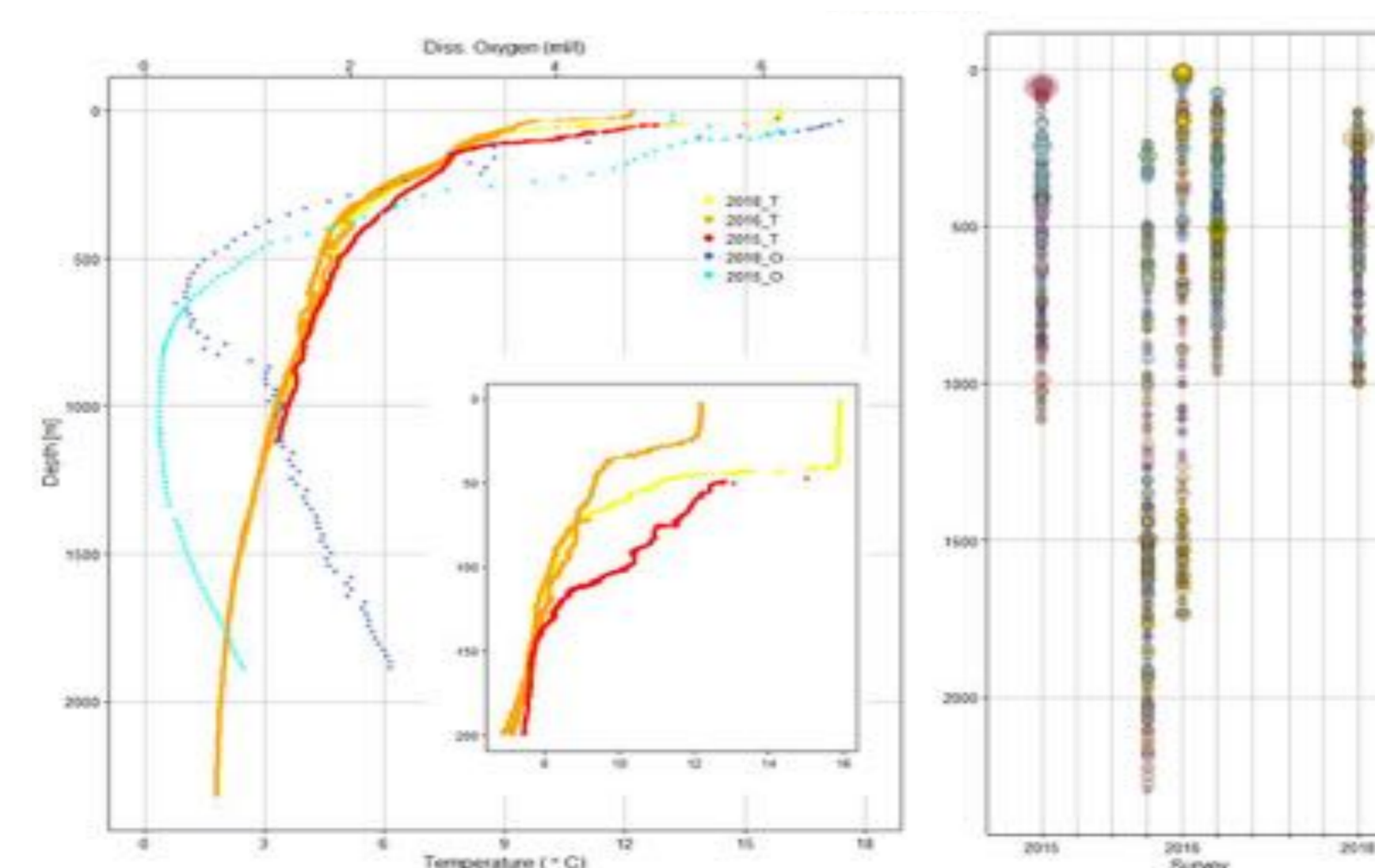
- 34 taxa identified from 2 years of observations in Barkley Canyon;
- Pyrosomes dominated the upper 100 m of the water column in 2017;
- *Poralia rufescens* distinctly dominated from 700-900 m in 2017;
- In 2018, a dense layer of myctophids is visible between 400 and 650 m;

Clayoquot Slope



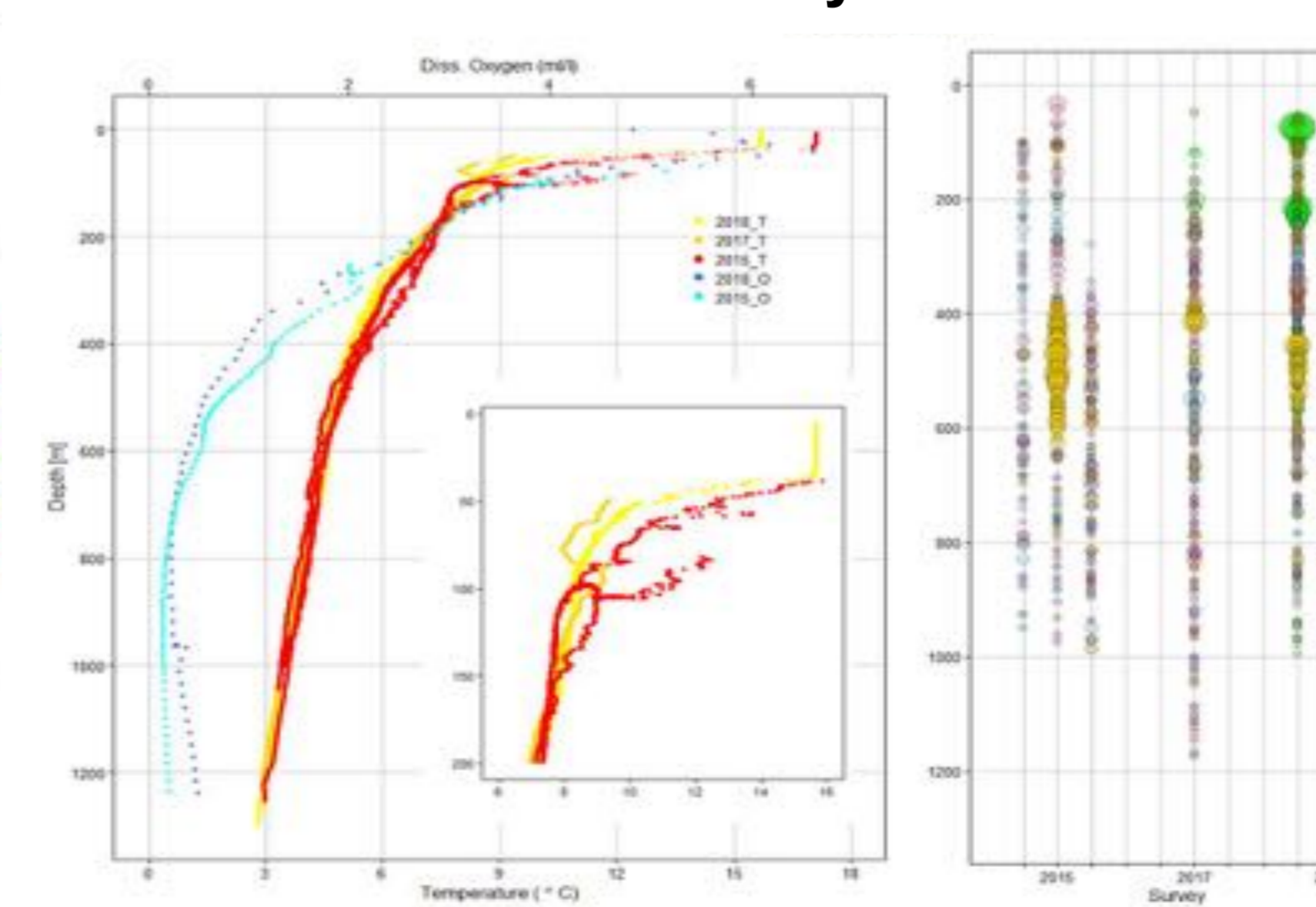
- 45 taxa identified based on the 3 years of video transects performed in Clayoquot Slope;
- No taxa dominated the pelagic community through the entire 1200 m of the water column in 2015 and 2017; with 5 species of jellies and two siphonophores being the most representative;
- In 2018, however, like for Barkley Canyon, a dense layer of myctophids between 400-600 also in 2018;

Endeavour Vent Field



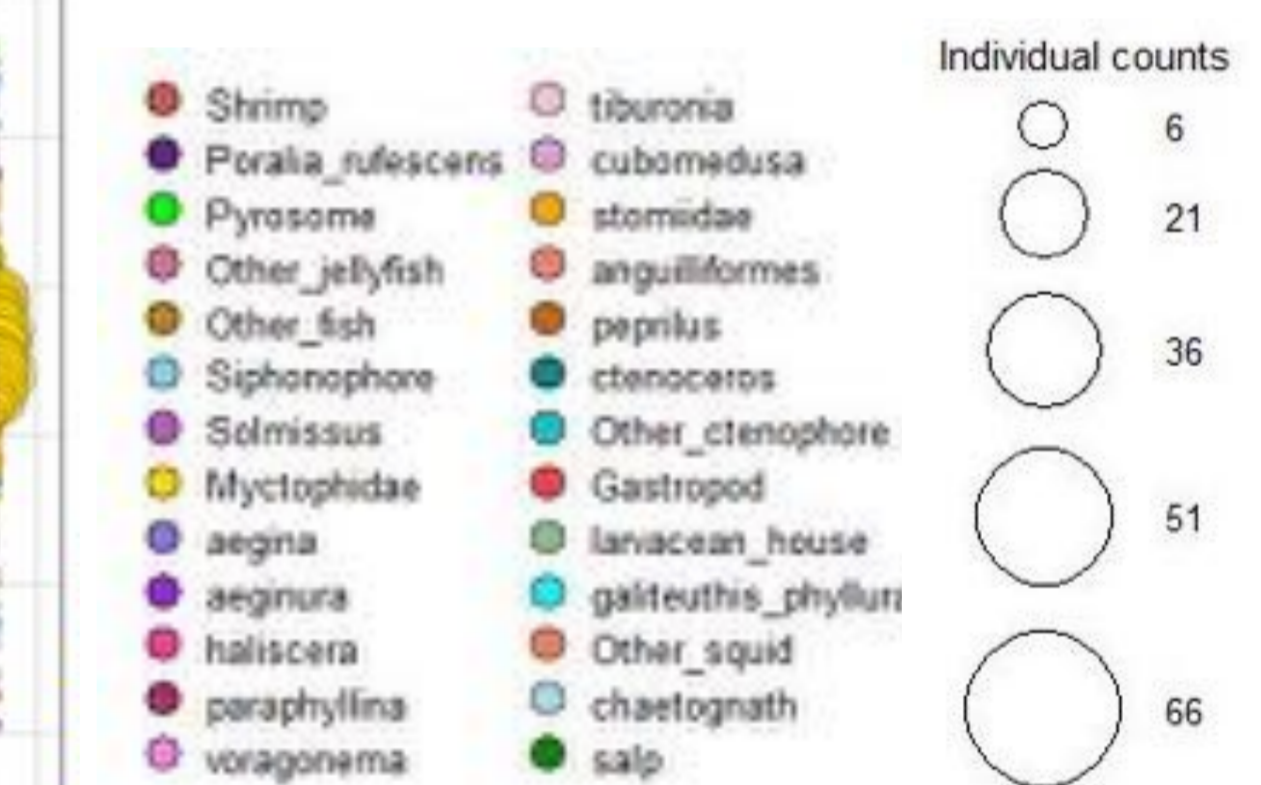
- 47 taxa identified from 3 years of observations at Endeavour;
- The Blood-belly ctenophore *Lampocteis cruentiventris* and jelly *Poralia rufescens* dominated the gelatinous plankton, each with 24% of the total abundance (3 years combined);
- An unidentified shrimp species accounted for 17% of the total abundance; an unidentified squid for 14%, chaetognaths 9%, pyrosomes 6%, siphonophores 5%.

Cascadia Basin Abyssal Plain

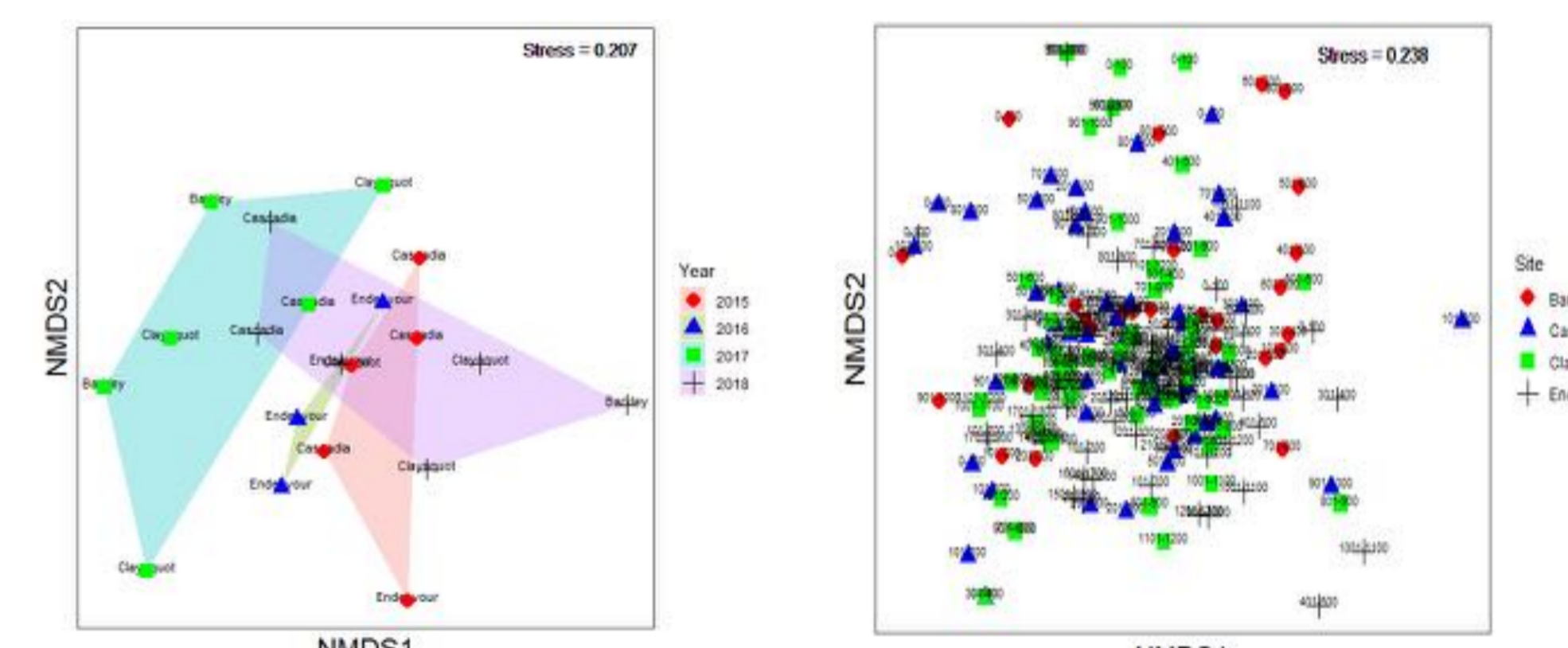


- 42 taxa identified from the 3 years of observations at Cascadia Basin;
- 5 species of jellies accounted for ~22% of the total abundance, while myctophids accounted for 18%; an unidentified species of shrimp 5%;
- While pyrosomes appeared in modest numbers at the upper 200 m of the water column in 2016; in the following year they were very abundant at 50-100 m and also at 200-250 depth horizons;

Pelagic taxa

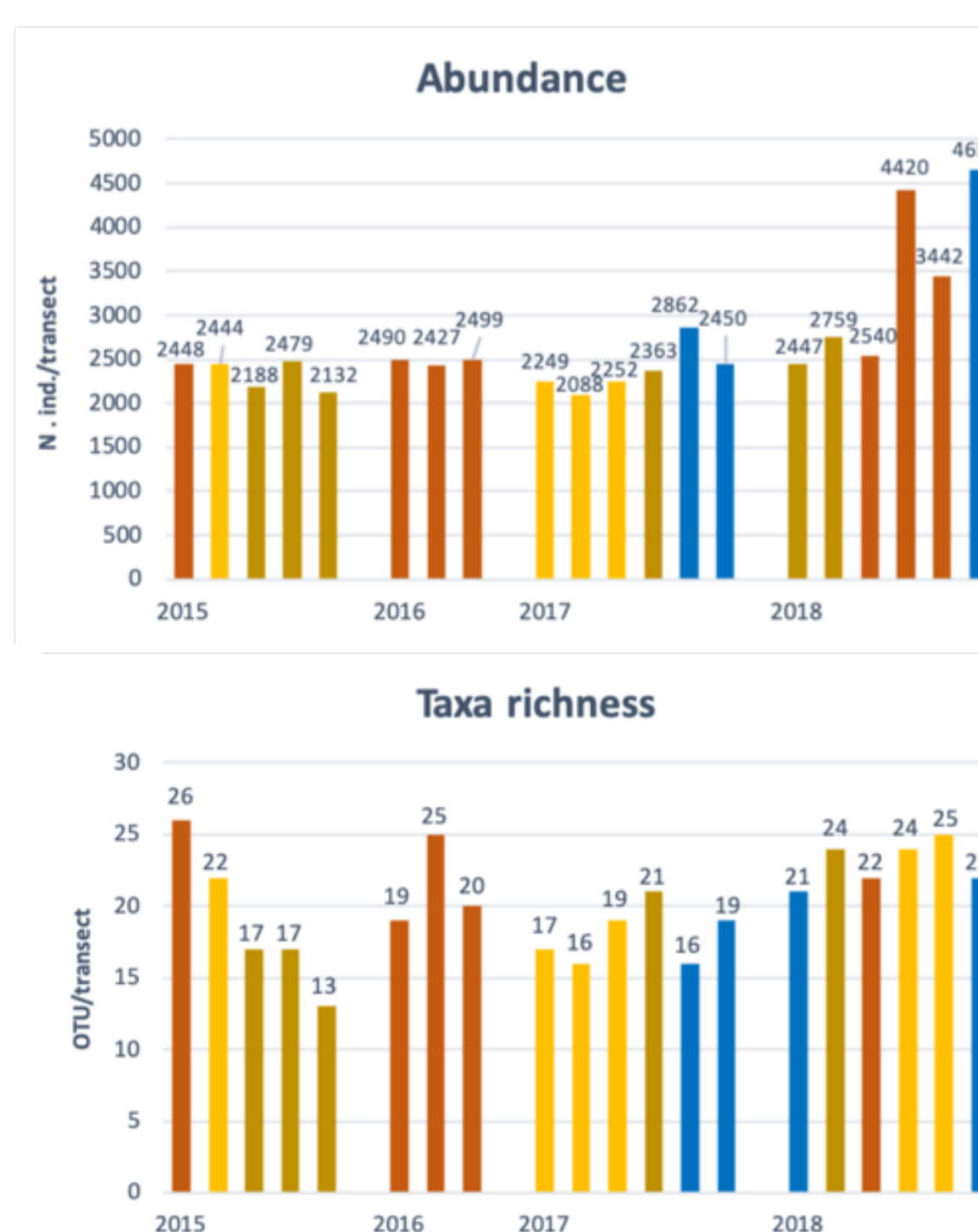


Community Structure

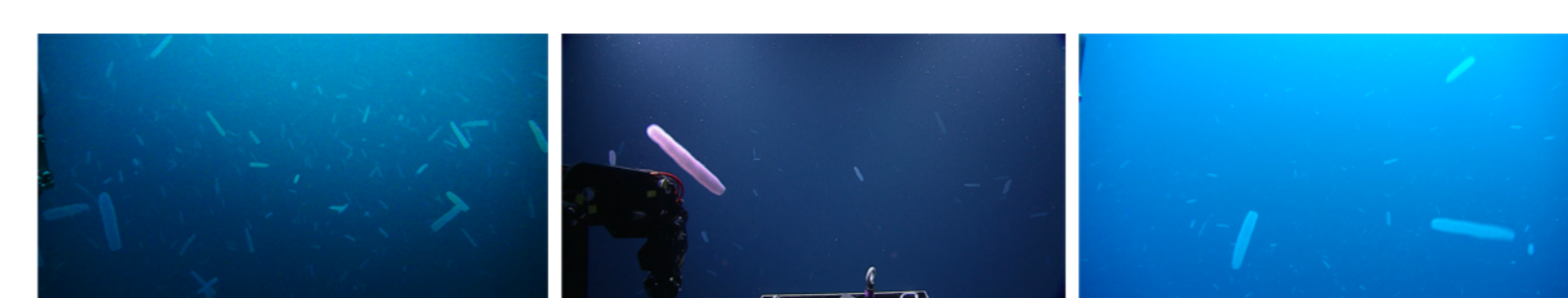


- Considering entire vertical transects as individual samples, the combined gelatinous plankton and nekton communities appeared to be primarily structured by the temporal variability in the environmental conditions (MDS plot 1 - left);
- When data is binned in 100 m depth intervals spatial structuring is also not evident (MDS plot - right).

Total Abundance and Taxa Richness



- Combined abundances of gelatinous plankton and nekton ranged from 2,088 to 4,657 indiv. per video transect;
- No significant spatial differences in faunal abundance were observed between all four NEPTUNE sampling stations;
- 2018 was the year with higher total pelagic abundances in particular due to the high myctophid abundances both in Barkley Canyon and at Clayoquot Slope;
- While the average in taxa richness was the lowest in 2015 (15 sp./transect), it reached its highest values in 2018 (23 sp./transect).



Future directions

- Fine-tune taxonomic identity of gelatinous plankton species;
- Further explore data by depth-strata (100 m bins);
- Quantify role of environmental variables (temp., dissolved O₂, and surface productivity);
- Implement artificial intelligence in automating the detection and classification of species;
- Seek additional funding for dedicated research program on pelagic biodiversity;
- Improve on survey protocols (oblique transects?) as we implement a permanent monitoring program.