Ian McIvor:  
A comparison of zooplankton communities in Trevor Channel to those over the continental shelf

Zooplankton form an important trophic link between producers (phytoplankton) and the upper trophic levels, therefore understanding zooplankton communities and the way in which they function is an important component of biological oceanography. Acoustics are particularly attractive in the study of zooplankton communities as they provide rapid surveys of zooplankton scattering layers and provide a powerful tool for assessing small scale patchiness. The aim of this study was to gain insight into the major differences between two neritic ecological communities: Station 1 representing a continental shelf community and Station 2 (Trevor Channel) representing a river fed fjord community. Samples were collected at both stations from 90-0, 60-0 and 30-0m both at day and at night. It was found that small copepods were the most abundant zooplankton in all samples; however large copepods were found to be much more prevalent on the shelf compared to the Channel community. Fluorescents data collected at both stations indicated that the shelf community contained relatively higher concentrations of chlorophyll; however peak zooplankton biomasses were obtained in Trevor Channel. During night tows the biomass of zooplankton in Trevor Channel increased significantly however little variation vertically through the water column suggests that diel vertical migrations are not a major component of the channel community. Zooplankton biomasses obtained from the shelf community did not show significant differences between night and day however acoustics data indicating a near surface congregation of zooplankton at night suggests that strong currents and failures in the net opening-closing system may have contributed to inaccuracies in this study.

Andrew M. Snauffer:  
Comparison of Zooplankton Biomass Distribution and Echosounder Data

A study of zooplankton distributions at the Folger Passage Node of Canada's NorthEast Pacific Time-series Undersea Networked Experiments (NEPTUNE) project has been conducted. A series of day and nighttime vertical net tows from 30, 60 and 90 meters was performed using a 250m plankton net. Shallow tows were subtracted from deeper ones in order to determine the vertical biomass density distribution. This distribution was subsequently compared to data from the 3-frequency echosounder installed at the node. Daytime biomass densities generally agree with high-frequency volume backscatter intensities except for a backscatter peak in the bottom 10 meters of the water column, which was likely not sampled in the challenging weather conditions experienced. Nighttime biomass densities showed lack of reproducibility and significant deviations from backscatter in the bottom one-third of the water column. A nighttime CTD profile was taken using a Sea-Bird SEACAT Profiler SBE 19plus outfitted with a fluorometer and oxygen sensor. The profile revealed steady increases in temperature and salinity and declines in oxygen and fluorescence throughout the column. A spike in temperature and less dramatic increase in salinity at 55 meters depth is suggestive of a water mass change, though no effect is seen in zooplankton distribution. Finally data from the M/V Alta’s own echosounder was digitally photographed and compared. Few correlations could be made from this data owing to the limitations of the instrument and data acquisition technique.
11:25 **Nari Sim:**

**Preformed Nutrients, NO, and PO as Water-Mass Tracers in Barkley Sound**

Preformed nutrients, NO, and PO are used as geochemical tracers to determine the water-mass composition and mixing along the Junction passage around Tzartus Island in Barkley Sound in 2011. Each of these tracers has been calculated using concentration of nitrate and phosphate, as well as temperature, salinity, and concentration of dissolved oxygen measured by CTD. Preformed nutrients, NO, and PO showed that there are at least three different water masses in this study area mainly due to the presence of sill at the mouth of Barkley Sound and deep bottom depths of stations. In addition to the water-mass determination, uncertainties involved with preformed nutrients, NO, and PO tracers and the superiority of PO among other tracers are explored by comparing these geochemical tracers with salinity and temperature data obtained by CTD which have higher sampling resolution than nitrate and phosphate data. Lastly, this project also alluded the modified analytical method for determining the level of dissolved nitrate in the seawater. This method solved the problems with the narrow detection range of spectrophotometer for the nitrate measurement.

11:35 **Ania Posacka:**

**Tracing the sources and sinks of nitrogen in the Barkley Sound using the N* tracer.**

The nitrogen cycle controls the availability of nitrogenous nutrients (N-cycle) and biological productivity in marine systems. Study of the N-cycle is therefore of great interest in terms of the global fixation and export of the CO2 but it is also important with regard to coastal areas which might be affected by anthropogenic inputs of nutrients, and possibly resulting in harmful events such as eutrophication. In this study a quasi-conservative tracer N*, the deviation from the stoichiometric relationship between nitrogenous nutrients and phosphorous was used to characterise the N cycle in the Barkley Sound, Vancouver Island, BC. The tracer was estimated from the nutrient data (NO3 and PO43-) obtained at different depths of the four selected stations within the sound during a winter month of February 2011. The observed N:P ratios at stations sampled deviated strongly from the Redfield ratio of 16:1, thus N* tracer calculations in this study were adjusted to account for this deviation. The adjusted N* suggest that all stations with the exception of Pill Point were characterised by signatures of nitrification processes during the time of sampling, indicating that they may be sources of N into the Barkley Sound. The results of this work are discussed in the context of different sources and sinks of N in this coastal system, but also in the context of application of the N* tracer to the coastal environment.

11:45 **Julie Elsliger:**

**Fluorescence compared against salinity, temperature and depth Transect: Grappler Inlet to Imperial Eagle Channel**

Research was conducted within the oceanic area and Grappler inlet outside Bamfield Research center. The aim was to determine how water regimes affect the salinity, temperature and how these variations affect phytoplankton fluorescence of regions on the West Coast of Vancouver Island. The data was collected using a CTD and was analyzed using excel and Ocean Sneaker to determine whether changes in fluorescence correlated with temperature, salinity and/or depth. Firstly, salinity increases with depth in both regions and salinity is overall higher in coastal inlets. The water at the surface (0-10m) appears to be much fresher and at deeper regions in the water column there is extremely uniform, saline water. Temperature increases with depth, however it appears to be more variable in Grappler. As well the average temperature in Grappler is higher when compared with Trevor Channel. Lastly, fluorescence appears to be greater and decrease more sharply in Trevor Channel than in Grappler Inlet. Fluorescence decreases with increasing salinity and increasing temperature. Deeper water is more saline and thus dense, and so is likely to be older, oceanic water mass. Salinity which is higher in the coastal inlet may be caused from tidal mixing. Less saline surface water is likely to be fresh water mass on the surface caused by runoff from land and remains at the surface due to a lower density. Water temperatures are more variable in Grappler, this may be due to the shallower depth which would result in higher tidal mixing. Fluorescence decreases with increasing salinity, temperature and depth. Since both salinity and temperature increase with depth it is difficult to determine whether fluorescence is in fact changing due to salinity or temperature or if it is decreasing due to other variables such as nutrient depletion or light attenuation which would also occur with depth. Further data manipulation is required to further investigate these correlations.
Tuesday April 5

11:05 Mariko Ikehata:
Trace metal (As, Cd, Pb) Concentrations and Distributions in Sediments from Barkley Sound, British Columbia

Metal (As, Cd, Pb) concentrations were determined for sediment sample from Barkley Sound, located on the west coast of Vancouver Island, British Columbia. Sediment samples were collected from transects along Imperial Eagle Channel, and Trevor Channel, and from Junction Passage, which links the two channels. Alberni Inlet supplies freshwater to Barkley Sound and the headwaters are proximal to Port Alberni. Port Alberni is home to several industries (e.g., pulp and paper mills), responsible for releasing significant amounts of heavy metals (e.g., As, Cd, Pb and Hg) into Alberni Inlet every year.

Sediment samples were used to assess metal contamination associated with local industries. Metal concentrations for sediments from Imperial Eagle Channel, Junction Passage and Trevor Channel were determined by ICP-MS. Concentrations ranged from 3.01 to 5.39 ppm for As, from 0.282 to 0.521 ppm for Cd, and from 2.92 to 16.7 ppm for Pb.

The highest concentrations of As and Cd were observed in sediments from Junction Passage. In general, a decrease was observed in As and Cd sediment concentrations along the transects from the north-west ends to the south-west ends of Trevor Channel and Imperial Eagle Channel. These results suggest industrial inputs to Alberni Inlet headwaters are an important source of contamination. Lead concentration results for the sediments indicate contributions from additional source, e.g., emissions associated with boat traffic. Lead isotopic compositions may be used to identify important sources of anthropogenic and natural Pb to Barkley Sound.

References

Environmental Canada (2009) National Pollutant Release Inventory Facility (NPRI) Data Search: Release reports:

11:15 Adrian Jones:
Observations of Internal Tides at Trevor Channel, British Columbia

The purpose of this project is to measure internal tides in Trevor Channel by observing changes in the relationship between depth, temperature and salinity though multiple measurements at one location on the landward side of the fiord’s sill.

In total eight casts of conductivity, temperature and pressure were taken. Five casts (those on the 14th, 15th and two on the 17th) also included dissolved oxygen and fluorescence measurements. The five casts on the 17th cover one tidal cycle with three measurements at the end of the flood and two at the end of the ebb.

Data were processed with the instrument manufacturer’s software, using provided calibration curves, smoothed and time shifted to account for different equilibration rates and position in the flow. MATLAB generated plots for visualizing differences in the depth of salinity and temperature features compared with the height of the tide.

The casts on the 14th exhibit a different structure and have been left out of the first analyses. The remaining six casts were plotted together for both salinity and potential temperature. There is a clear gap between casts taken at high tide and lower tide, with the high tide points shifted 10m deeper relative to the low tide. This gap occurred during a 3m tide so the true internal tide is closer to 13m.

Further analysis will correct depth for tidal variation and determine how actual tide height and flow direction change the temperature-salinity-depth relationship. Finally, dissolved oxygen will be assessed to see if that helps identify a sub-sill water mass.

11:25 Katy Ramsden:
Understanding circulation in Imperial Eagle Channel: analysis of water column profiles taken in Barkley Sound using a conductivity-temperature-depth sensor.

An understanding of circulation patterns and water masses within Imperial Eagle Channel is a necessary component to gaining an understanding of the broader circulation of Barkley Sound. CTD casts were taken both across and up the channel in order to identify the location and movement of water masses. Profiles of temperature, salinity and oxygen were constructed for each station. Preliminary analysis of these profiles suggests that there is a large mass of cold fresh water at the surface. This mass is most pronounced in the north of the channel, near significant fresh-water sources, suggesting that this mass is moving south toward the mouth of the channel. At depth, there is another water mass which is both warmer and saltier than the water above.

The vertical structure of this water mass and temperature and density gradients within it suggest that this mass originates outside of the channel and is flowing northward up it. These masses and the directions of their movement suggest that water flow within the channel is dominated by estuarine circulation, in which cool, fresh water is flowing seaward at the surface, while warmer, saltier water is entering the channel at depth.
11:35 **Marianne Williams:**  
**Geostrophic method applied to data from Imperial Eagle Channel, Barkley Sound, BC**

Geostrophic currents occur when the pressure gradient is equal and opposite to the Coriolis effect and the geostrophic current is perpendicular to these forces with high pressure to the right of the flow. The geostrophic method for calculating currents was applied to data from Imperial Eagle Channel in Barkley Sound, British Columbia. CTD casts were taken on February 17th and 18th, 2011 in two cross sections of the channel each consisting of four stations. The rectangular formation of the stations spanning the channel, with casts taken to depths near the bottom makes for a three dimensional rectangle across the channel for which salinity, temperature and pressure data are known. This information was used to generate profiles of density, which was used to calculate the specific volume anomaly. This anomaly was integrated to determine the geopotential anomaly at all depths relative to some isobaric surface, which was assumed to be level. The relative geopotential anomaly in turn was used to generate profiles of relative geostrophic velocity. These calculations were done using functions from the SeaWater Matlab library. This method applied to the obtained data suggests low magnitude velocities moving fresh water out of Imperial Eagle Channel at the surface. Further analysis of the relative geostrophic velocities in Imperial Eagle Channel can be carried out to determine the influence of geostrophy on the circulation in the channel.

11:55 **Tara Howatt:**  
**Tidal Advection in Grappler Inlet**

The basis of this project is to study the advection of the semidiurnal tides in Grappler Inlet. As the tide comes in, new water displaces the existing water; while during the ebbing tide water leaves the inlet, lowering the surface level. Due to this advection, spatial and temporal changes in physical properties such as temperature, salinity, density, oxygen, and fluorescence are expected. CTD casts along with surface temperature and salinity measurements using the YSI instrument were taken at seven different stations along Grappler Inlet at both high and low tides on February 16 and 17 2011. Data was processed using Seabird and MATLAB, creating depth profiles and contour plots with which changes in physical properties were observed. Grappler Inlet was chosen to be the point of interest as it is fairly shallow, which resulted in more pronounced water displacement and changes; furthermore, it has a freshwater source, Sugsaw Creek, at the head.

11:45 **Evgeniya Snauffer:**  
**Measuring Currents in Bamfield Inlet**

A study has been conducted in Bamfield Inlet, located on the West Coast of Vancouver Island to determine the current velocities at the mouth of the inlet. Knowing more about the flow movement in the area provides a better understanding of the chemical and biological processes. Currents are also important for marine navigation purposes. The survey was done over the course of 4 days. Continuous measurements of current velocities were taken with an Acoustic Doppler Current Profiler (ADCP) off the dock of Bamfield Marine Sciences Centre. Apart from the ADPC measurements, direct observations were made by tracking drifters off the same dock. The results from the observations are in good agreement with the profiler data. Data from the ADCP was processed with Matlab to illustrate that the currents are clearly induced by tides. The tidal depth changes determined by the ADCP show good correlation with the sea water levels measured in Bamfield by the Canadian Hydrographic Service (CHS) for that period. Depth profiles of the current velocities are also presented.
11:05 **Jonathan Heinz:**  
**Effects of Chaetognath Predation on a Barkley Sound Copepod Community**

An assortment of live copepods along with fifteen individual chaetognaths were collected and isolated from a single water sample taken from Barkley Sound on February 17, 2011. Individual chaetognaths and copepods were not identified to the species level nor were they selected by size. Incubation took place in 6 1L jars, each with 100 live copepods added. Three control jars did not have predators introduced while three experimental jars had five copepods added immediately after the copepods. Final remaining copepod numbers in each jar were counted after an 18 hour incubation period and the data were extrapolated to find a 24 hour feeding rate for the copepods. The final average predation rate from the three experimental jars was found to be 0.53 copepods/18 hour period or 0.70 copepods/day. Copepod mortality was also measured in both the control and experimental jars. Mortality was found to be markedly higher in the experimental case, apparently due to the stress placed on the copepods due to the presence of predators.

11:15 **Lena Clayton:**  
**A comparison of the effects of grazing by migrating and non-migrating Copepod species on phytoplankton community structure.**

The diel vertical migration of zooplankton; in particular that of the dominant group, Copepoda; that occurs in Barkley Sound may in fact alter the phytoplankton community structure upon which it feeds. In turn this may result in major changes on the ecosystem as a whole. Differential grazing by migrating and non-migrating Copepod species are analyzed in order to decipher if the diel vertical migration of Copepods has an effect on the species composition of a given phytoplankton community. Two consecutive classic grazing experiments are run with plankton from the surface waters of one location in the Trevors Channel following and prior to sunset. Initial, control and experimental samples (each containing exactly 40 Copepods) were set up and replicated twice for both night and day experiments. Chlorophyll a biomass is measured by means of fluorometry and particular organic carbon is measured in all these samples by UV spectrometry to determine grazing rates. Subsequently 10 or 25mL of each different fixed sample is settled in individual settling chambers and observed under light microscope. Phytoplankton are indentified and counted in order to interpret if there are any changes in phytoplankton community structure. Following grazing there is no notable change in diversity as per the Simpson Reciprocal Index and the Shannon Diversity Index however there is a notable variation in the proportion of various size classes of phytoplankton found following grazing. The dominant group of each size class of phytoplankton was used to characterize changes in its own size class and is as follows: < 10µm Unidentified pennate diatoms, 10-49µm Thalassionema, 50-100µm Thalassiosira, and > 100µm Coscinodiscus. In the night time grazing experiment the less than 10µm size class is the only class to increase in overall dominance (as calculated by the Berger-Parker Dominance Index to be an increase of 26% in dominance), all larger size classes of phytoplankton became subsequently less dominant (decreases ranging from as little as 1% to 38%) following Copepod grazing. However in the day time grazing experiment all phytoplankton under 50µm decreased in dominance (by 29% for those < 10µm and 6% for those 10-49um) while larger phytoplankton increased in dominance (by 7% for those > 50um and < 100um), most notably those larger than 100um which nearly doubled their dominance index. One can conclude that the migrating Copepods found at the surface at night are more capable of feeding on larger phytoplankton due to their size than those non-migrating species. The presence of large, vertically migrating Copepods controls the dominance of phytoplankton species larger than 50um. Following night time grazing these large Copepods migrate back down to depth and leave the surface waters with much fewer large phytoplankton. It is possible that due to the diel vertical migration of certain species of Copepoda that the number of trophic levels may need to increase in order to satisfy the needs of the larger organisms that reside in the surface and feed during the day.

11:25 **Rachel Boardman:**  
**Phytoplankton Biomass and Diversity in Barkley Sound: The Role of Limiting Nutrients**

In phytoplankton ecology, nutrients are considered one of the primary variables controlling phytoplankton community structure and biomass. In Barkley Sound, surface phytoplankton abundance and size classes were determined for five stations with varying Nitrate:Phosphate ratios. In this talk, we will look at which species thrive in nutrient limited zones and the relationship between nutrient availability and phytoplankton size. The flagellate cryptomonad was abundant at all Barkley Sound stations and small dinoflagellates were much greater in abundance than diatoms. The correlation between nutrients and phytoplankton abundance will be examined both by looking at biomass determined by counting and by looking at fluorescence values read from a fluorometer. Disadvantages of only sampling during the winter, when phytoplankton are light-limited, will be discussed.
11:35 Angela Finfrock:
Interpreting Chlorophyll and Nutrient Concentrations Using Oxygen Measurements in Barkely Sound

Abstract: Phytoplankton and nutrient concentrations are important indicators of the health of marine ecosystems. Oxygen levels in the water column can be used to interpret these indicators. This research uses oxygen levels to determine differences in chlorophyll and nutrient concentration between Trevor Channel and Imperial Eagle Channel of the Barkely Sound, Vancouver Island, BC. The study region is comprised of six stations, three in each channel. Oxygen measurements are compared with fluorescence, temperature, salinity, nitrate and phosphate levels. This research was conducted using CTD casts to depth that were analyzed using the program Matlab. In addition, oxygen, phytoplankton, and nutrient bottle samples were collected at one station in each channel and were analyzed using biomass techniques and the Winkler method. The research shows that there are significant differences in fluorescence and oxygen levels between Trevor Channel and Imperial Eagle Channel.

11:45 Ben Moore-Maley:
Carbonate Equilibrium and Dissolved Carbon Dioxide in Barkley Sound

The coastal upwelling areas of the world oceans are important sites of biological carbon cycling. However, the pathways and abundance of carbon in many of these ecosystems have yet to be fully characterized. Barkley Sound is an estuarine fjord located on the west coast of Vancouver Island, British Columbia at the inner shelf. Two channels into the sound are studied here, Trevor Channel situated behind a 30 meter sill and Imperial Eagle Channel which is not blocked by a sill. CTD casts and Niskin bottle samples were obtained at three stations spanning Imperial Eagle Channel and at one station in Trevor Channel. Alkalinity Gran Titrations and pH measurements were performed and used in conjunction with CTD data to produce carbonic acid, bicarbonate, carbonate, and fugacity profiles at each station. Bicarbonate was found to be the most abundant form of carbon in both channels and increased at all stations with depth down to 10 meters. Carbonic acid and fugacity were found to be higher along the northern edge of Imperial Eagle Channel in the top 30 meters indicating increased dissolved carbon dioxide. Overall, carbon dioxide fugacity profiles at all stations suggest highly elevated dissolved carbon dioxide in Barkley Sound compared to the open ocean, which is consistent with previous carbon system studies on the west coast of Vancouver Island.