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Abstracts (rev. as of 31 Dec 2002)

Marine Parasites of Juvenile Salmon in the Northern California Current System: Differences in Regional Trophic Interactions? (Poster)

Rebecca Baldwin, Cooperative Institute for Marine Resources Studies, Oregon State University, Hatfield Marine Science Center, Newport, OR. Kym C. Jacobson, National Marine Fisheries Service, Northwest Fisheries Science Center, Hatfield Marine Science Center, Newport, OR.

Parasites obtained through trophic interactions are being examined in juvenile coho salmon (*Oncorhynchus kisutch*) and chinook salmon (*O. tshawytscha*) to determine if habitat influences salmon diet, and if habitat differences are reflected in parasite communities. Juvenile salmon were collected between Crescent City, California and Newport, Oregon during the 2000 U.S. GLOBEC cruise. Juvenile salmon were also collected between Newport, Oregon and La Push, Washington in 1998 and 1999 as part of a project funded by the Bonneville Power Administration (BPA), to examine the potential effect of the Columbia River on juvenile salmon. Both studies were carried out in early and late summer using a 30 m - 20 m rope trawl fished near the surface. Chi-square analyses were used to determine differences in parasite prevalences, and intensities were tested using an ANOVA. The common parasite species (three trematodes and one nematode) found in the stomach were used in these analyses. The trematode, *Genolinea* sp. was most abundant south of Newport. *Hemiurus* sp. was consistent throughout the nearshore. *Brachyphallus* sp. and the nematode *Anisakis simplex* had low prevalences in salmon caught directly off of the Columbia River, but *Brachyphallus* sp. was not recovered south of Newport. We found no difference in prevalences and intensities between juvenile chinook and coho salmon. Parasite prevalences in the GLOBEC region were more similar to the Washington region than the Columbia River region, although species diversity was not identical. Low prevalences of some marine parasites in the juvenile salmon caught in the Columbia River region could be a result of habitat (salinity or turbidity) effects on salmon trophic interactions, or a result of the timing of their ocean entry. Too few fish were collected south of Cape Blanco to determine any potential effects this feature had on parasite community structure.

Temperature, salinity and fluorescence over Heceta Bank (Talk)

Jack Barth, Tim Cowles and Steve Pierce

The Heceta Bank region has been sampled each year from 1999 through 2002 through a combination of NOPP (1999), GLOBEC NEP (2000 and 2002) and CoOP (2001) field programs. Heceta Bank widens the continental shelf off central Oregon (43.8-45.0N) to about 60 km from a narrower (25 km) shelf to the north and south. Towed undulating vehicle and shipboard ADCP measurements have been made along several E-W lines on the Bank over these years: 44.652N (GLOBEC Mesoscale Line 1 = Newport Hydrographic Line) ; 44.475N (Line 2), 44.25N (Line 3; near PISCO Strawberry Hill nearshore site) and 44.0N (Line 4 = Heceta Head Hydrographic Line). Vertical sections of temperature, salinity, chlorophyll fluorescence and velocity along these lines over the years will be presented. The deflection of the equatorward upwelling jet around the Bank and the formation of a high-chlorophyll, sometimes warm, pool inshore on the Bank will be demonstrated. T/S diagrams will be used to examine year-to-year variability and to highlight the anomalous conditions (low temperature halocline) during 2002. In addition to vertical sections made with SeaSoar, a few vertical profiles made with a CTD/rosette equipped with an oxygen sensor were made in this region during these same years. The hypoxic conditions observed in the lower water column over the Bank during 2002 are related to the hydrographic and chlorophyll fluorescence fields and are contrasted to normal oxygen levels of previous years.

Coupled biophysical models of transport and demography of plankton and fish in a dynamic coastal upwelling environment (Talk/Poster)

Batchelder, H. P., C. A. Edwards, E. Curchitser, T. M. Powell and D. B. Haidvogel

Coupled biophysical models that link 1) physical circulation and mixing, 2) lower trophic level ecosystems, and 3) higher trophic levels are being used to explore spatial and temporal distributions of animals in wind-driven upwelling systems. While the specific applications described are focused on macrozooplankton (copepods), the techniques used apply equally well to fish larvae. Results of both two- and three-dimensional simulations using idealized and realistic coastal geometry and bathymetry, simple physical forcing, and relatively well understood lower trophic (NPZD)

ecosystem models will be shown. Individual based models (IBMs) that account for the physiological condition and behavior of individual organisms are modeled in a Lagrangian particle tracking model (PTM). Advection, diffusion and food fields from separate Eulerian simulations of the physics-NPZD model are used to force the IBM-PTM model. Some of the simulations incorporate a full bioenergetics-based model of individual's vital rates (growth, birth, death) and behavior, while other applications ignore vital rates and consider only behavioral effects interacting with the physics. Approaches that use both forward time and backwards-in-time trajectory (BITT) approaches for linking the Eulerian and Lagrangian models are described. The specific question of interest determines the more appropriate approach to use. When the source locations and times of particle release are known, forward time PTMs are the obvious and simplest choice. Conversely, in applications in which the destinations of particles are known and information on the source is desired, BITT PTMs may be useful, despite some of their limitations. Examples of both approaches will be shown.

Hydrographic Conditions in the Southern California Current System and Large-Scale Forcing Conditions in Summer 2002 (Talk)
Steven J. Bograd, Franklin B. Schwing, Tom Murphree, Ronald J. Lynn

We describe anomalous water property observations from the southern California Current System (CCS) during summer 2002 based on CalCOFI hydrography. An unusual feature characterized by low spiciness and high oxygen was confined to a narrow ribbon within the core of the California Current in the July 2002 CalCOFI survey. This appears to be the same feature observed in the northern CCS during the concomitant LTOP and Line P surveys. The feature off California was approximately 100 km wide and 50 m thick, and centered a few hundred km offshore within the 60-110 m depth range. Some stations recorded the lowest summer temperatures and salinities observed at this depth in the 50-year CalCOFI record. We use *in situ* and satellite data to record the biological response to this feature. The large-scale atmospheric and oceanic conditions in the northeast Pacific prior to and during summer 2002 were similar to those from the previous three years. Coastal upwelling was anomalously strong, particularly off northern California and Oregon, and SSTs were 2-4°C below normal. In addition, an offshore region of unusually warm SST expanded toward the coast during summer 2002, confining the cool anomalies nearshore. A possible result of these conditions may have been greatly enhanced primary production that was contained over the continental shelf and slope. These patterns also imply an enhanced equatorward transport, displacing low spiciness water throughout the CCS.

Comparative Analysis of How Coho and Chinook Salmon Populations Respond to Environmental Variability (Poster)
L.W. Botsford, F. Hill, A. Hastings, and C. Lawrence

Our retrospective analyses of salmon in the California Current include examination of catch data up to 1990, and escapement data up to 2000. Both CCS species appear to be driven by conditions associated with a combination of sea level, temperature and upwelling index, in a way that reflects El Nino/La Nina variability. However, they respond in different ways. The poster will assess the various differences and possible explanations for them.

Progress in the Effects of Ocean Conditions on Salmon Populations in the CCS (Talk)
LW Botsford, MF Hill, AM Hastings

I will review where we stand with regard to our GLOBEC NEP work on understanding the changes in populations in the CCS over the past 40 years. Chinook and coho salmon respond to ocean conditions differently in terms of time scales, spatial scales and behavior in the mid-1970s. The explanation(s) for these differences are either in 1) differences in early ocean life or 2) other life history differences. Our work on the latter thus far has shown that differences in spawning age distribution are not the explanation, and that straying and metapopulation behavior can have a significant effect on population behavior. It is still quite possible that the explanation lies in 1) and may be seen in the NEP field observations.

Community Structure of Surface Nekton and Plankton in the Northern California Current in Relation to Oceanographic Conditions (Poster)
Ric Brodeur, Todd Miller, Doug Reese, Bob Emmett

No abstract submitted.

Mesoscale Distribution of Salmon and Nekton (Talk)
Brodeur, Emmett, Pool, Miller, Reese

This talk will summarize work done examining the mesoscale distribution patterns of juvenile salmon and co-occurring nekton in the California Current system. We will present results from the 2002 mesoscale and fine scale cruises, compare these to the 2000 surveys, and relate the distributions to environmental variables measured during the sampling. We also examine the 2000 cruises in detail, giving examples of community and spatial analyses, as well as discuss long-term trends as part of our ongoing retrospective analysis of the nekton of the California Current system.

Comparison of Growth and Condition of Juvenile Salmon in the Northern California Current in 2000 and 2002 (Talk)
E. Casillas (NMFS, Seattle), J. Fisher (OSU, Corvallis), K.C. Jacobson (NMFS, Newport), and G.H. Rau (UCSC, Santa Cruz)

Salmon captured from the NEP GLOBEC Mesoscale Surveys in June and August 2002 were sub sampled in October (in Newport, OR) 2002, respectively. One of the NEP GLOBEC study goals is to characterize and compare the biological condition of salmon from coastal waters in the California Current off of southern Oregon and northern California. The length of the fish indicated that substantial growth occurred in juvenile salmon during the study period as observed in 2000. Growth of juvenile salmon also appeared to be greater in 2002 compared to growth observed in juvenile salmon in 2000, indicating more favorable ocean conditions in 2002. Juvenile coho and yearling chinook salmon were 15 and 17% larger in 2002, respectively, compared to juveniles in 2000. Juvenile subyearling chinook salmon were, however, not significantly different in length between years. Growth and condition of juvenile chinook and coho salmon north and south of Cape Blanco, Oregon could not be compared as done in 2000, as few juvenile salmon were captured south of Cape Blanco. Significant differences in growth and condition of juvenile salmon indicate different The information collected to date support the contention that oceanographic environments north and south of Cape Blanco, OR and interannual variation can affect the growth and condition of juvenile salmon. Upon completion of the all analyses, all information will be integrated and evaluated to determine how our findings relate to the ocean conditions.

Mesoscale bio-optical patterns: 2000 and 2002 (Talk/Poster)
Tim Cowles, Chris Wingard, Russ Desiderio, Jack Barth, Amanda Briggs, Cidney Howard

Mesoscale patterns in physical/biological distributions were examined in June and August of 2000 and 2002 using SeaSoar surveys and surface mapping along onshore-offshore transect lines off the Oregon coast. Optical instrumentation on the SeaSoar included two fluorometers and an ac-9 (9 wavelengths of absorption and beam attenuation) while surface maps of bio-optical properties were made with a more extensive array of optical instruments. We will present a preliminary comparison of the two years of field work off the Oregon coast, focusing on the spatial scales of variability in optical properties and their relationship to topography, hydrography and velocity fields.

Nested Modeling in the Northeast Pacific: First Results in the California Current System (Talk/Poster)
E. N. Curchitser, Lamont-Doherty Earth Observatory, D. B. Haidvogel, Rutgers University, A. J. Hermann and E. L. Dobbins, PMEL, K. Hedstrom and D. Musgrave, UAF

The first implementation of a nested suite of circulation models for the GLOBEC Northeast Pacific regions is complete. System components include a basin-scale domain at approximately 40 km horizontal resolution, a regional window covering the Northeast Pacific (NEP, ~10 km), and higher-resolution (~2 km) models in the California Current System (CCS) and the Coastal Gulf of Alaska. One-way nesting is used; that is, tracer, velocity and surface height fields are passed from the larger to the next smaller domain.

A non-assimilative simulation of the summer 2000 circulation in the CCS region has been conducted. Daily surface forcing fields (winds, heat fluxes, etc.) are obtained from the NCEP reanalysis, and initial and sidewall boundary conditions from the NEP model. Phenomenological behaviors qualitatively similar to those observed in the region are produced in the model including energetic mesoscale variability, offshore-directed jets and filaments, trapping of fluid over Heceta Bank, and others. A more quantitative analysis of the statistical properties of these processes is underway. Assimilative hindcasts of these features for summer 2000 are planned for the future.

Comparison of physical-biological models of the California Current System and the Coastal Gulf of Alaska (Poster)
Elizabeth L Dobbins (JISAO, University of Washington, Seattle, WA) Craig V. W. Lewis (University of California, Berkeley, CA) Sarah Hinckley (Alaska Fisheries Science Center, NOAA, Seattle, WA) Albert J. Hermann (JISAO, University of Washington, Seattle, WA).

The California Current System (CCS) and the Coastal Gulf of Alaska (CGOA) are both regions of high biological productivity. While the dynamics governing the CCS's upwelling system are fairly well understood, the reasons for high productivity on the CGOA's downwelling shelf are more mysterious. Two biological models, each embedded within the Regional Ocean Modeling System (ROMS), are being used to investigate the differences between these systems; a simple NPZD model is used for the CCS, but for the CGOA, a specialized, 10-compartment model, called GLNPZ, has been developed and tuned to conditions in the Gulf. In order to compare the biological models, independent from the different physical conditions of the regions, a pseudo 1-D test case of ROMS was developed to run with both. We compare the biological results produced by several implementations of this test case.

Enhanced Fluorescence in the Northern California Current System, July 2002 (Poster)
Jane Fleischbein, Adriana Huyer and Robert L. Smith

Underway measurements of fluorescence, temperature and salinity data from the ship's 5-m intake during GLOBEC LTOP surveys off central and southern Oregon show much higher values of fluorescence in July 2002 than in July 2001 and July 2000, though both of these were also La Nina years during a cold phase of the Pacific Decadal Index. Salinity values were higher in July 2001 than the preceding and following years, presumably because of the drought in the winter of 2000-01. Temperature differences among the three years are relatively subtle.

Fish-kills and hypoxia of inshore waters at 44.3N (Talk)
Dave Fox

No abstract submitted.

Hydrography on Line P (48-50N), summer 2002 (Talk)
Germaine Gatien, Howard Freeland, Frank Whitney

No abstract submitted.

Hatching mechanism, early and delayed hatching of the eggs of broadcast and brood-sac spawning euphausiids under laboratory conditions (Poster)
Jaime Gómez-Gutiérrez

Four different egg hatching mechanisms were observed under laboratory conditions in *Euphausia pacifica* Hansen, *Thysanoessa spinifera* Holmes, *Thysanoessa inspinata* Nemoto, and *Nematoscelis difficilis* Hansen: backward, forward, flipping, and swimming. It is well known that broadcast spawning euphausiids hatch as nauplius 1 (N1) and brood-spawning species as pseudometanauplius (PMN) or metanauplius (MN). In broadcast spawning species when ready to hatch, the N1 pushes against the chorion with the posterior part of the abdomen producing a protuberance. No spine or egg tooth is present to break the chorion. The pressure breaks the chorion, and the nauplius pushes itself backward with the first and second antennae and mandible to slide from the chorion. After about ¾ of the body is outside, the nauplius brings all the appendages together to move backward without becoming stuck in the chorion. This is the backward hatching mechanism. Normal hatching of *N. difficilis*, a brood-sac spawner, show different hatching mechanism the PMN or MN embryos extended and contracted their pairs of first and second antennae in a swimming movement, breaking the chorion in almost two equal halves joined by one small section in the anterior part of the chorion. This is the swimming hatching mechanism. Hatching time of the of the N1 in broadcast species at 10°C was about 35-40 h, and for brood-sac species was about 55-60 h as PMN and about 84 h as MN after spawning. Several eggs of *E. pacifica* hatched as metanauplii (MN) (>200 h after spawning) or as calyptopis 1 (C1) stage (>232 h), rather than as N1. Delayed hatching of embryos also was observed in *T. spinifera* as nauplius 2 (N2) (>120 h) or as MN stage (>180 h), and in *T. inspinata* as N2 (106 h) after spawning. Eggs with larvae in stages of development beyond N1 have not been observed from preserved zooplankton samples. However, eggs spawned in the field and incubated in the laboratory also had extended development and late hatching but with low frequency (< 0.06%). Several broods of *N. difficilis* hatched backward as nauplius 2 (N2), rather than as PMN or MN (47 h). This is considered an earlier hatching schedule for this

species. The N2 and MN in broadcast spawning species break the chorion with the first and second antennae, hatching forward, and the C1 breaks it with the telson spines and by flipping of the abdomen, resembling the decapod hatching mechanism. Both, brood-sac and broadcast spawning strategy in euphausiids have shown very high flexibility in the hatching time schedule. It is proposed that, if the backward hatching mechanism fails in broadcast spawning species and swimming hatching mechanism fail in brood sac spawning species, alternate hatching mechanisms can be used by the euphausiid. However, early hatching in brood-sac spawning strategy and late hatching in broadcast spawning strategy are usually associated with low embryo hatching success and considered as optional hatching modes for euphausiids.

Massive mortality of euphausiids caused by endoparasitic apostomatic ciliates (Poster)
Jaime Gómez-Gutiérrez, William T. Peterson, Richard D. Brodeur, Alex De Robertis

During June 2001 a deployment of a ROV video-system in the bottom off Astoria Canyon, Oregon USA recorded thousands of carcasses of the euphausiid *Euphausia pacifica* laying on the seafloor. This massive mortality event was caused by the highly virulent endoparasitic apostomatid ciliate *Collinia beringensis* Capriulo and Small. The parasite was originally reported infecting to *Thysanoessa inermis* in the Gulf of Alaska, but this is the first large-scale epidemic infestation reported in euphausiids that resulted in a massive mortality. During several oceanographic cruises conducted between 2000 and 2002, 70 infected euphausiids (*E. pacifica*, *Thysanoessa spinifera*, and *T. gregaria*) were collected alive and observed the evolution of the infestation. These obligate killing parasites grow inside the euphausiid and convert host biomass into parasite transmission stages. Adults infected with the ciliates have a swollen cephalothorax of with bright red/orange coloration. The ciliates feed osmotrophicaly on the organs and muscles of the euphausiids and increases their biovolume due growth and reproduction to such a point that in 85% of the infected euphausiids are torn in half as the body cavity ruptures in a dramatic burst, releasing millions of ciliates into the surrounding water. The rest of the infested animals did not burst, but died due to the heavy ciliate infestation eating completely the host body. The carcasses on the seafloor of Astoria Canyon and animals killed by the ciliates in the ship-board incubations exhibit the same symptoms having ciliates within their body cavity and the analysis of the ROV video showed sinking dead or weak euphausiids close the bottom of the canyon. The ciliate have an age and sex-specific rate infesting mostly adult females. This ciliate infestation is a hitherto unknown source of mortality that affects negatively the euphausiid secondary productivity in coastal upwelling regions of the California Current System.

Brood size and egg production rates for *Euphausia pacifica* with a comparison of laboratory and field estimations of fecundity (Poster)
Jaime Gómez-Gutiérrez, Leah Feinberg, Tracy Shaw, William T. Peterson

The most difficult variable in estimating the fecundity of euphausiids is the interbrood period. Previous estimations of fecundity using the oöcite number inside the female underestimate it because they assume the females spawn one or two times per year. Few direct observations have been made of live euphausiids to estimate mean brood size and interbrood period (Stuart 1992). Previous studies concluded that euphausiids spawn several times within a reproductive season (Ross et al. 1982). We measured the fecundity of *Euphausia pacifica* from specimens reared in the laboratory (from eggs to adulthood) and females collected from the field. For the animals reared in the laboratory, the average brood size and interbrood period were 42 eggs fem-1 and 6.3 days. Females collected in the field and maintained in the laboratory had an average brood size and interbrood period of 85 eggs fem-1 and 5.2 days. Assuming that these animals would be reproductively active for the entire spawning season (231 days), these experiments indicate that fecundity would be on the order of 1551 to 3,784 eggs fem-1 for the reproductive season. We compared the laboratory measurements with estimates of fecundity for *E. pacifica* from more than 30 oceanographic cruises (July 1999 to July 2002) in the coastal upwelling zone off central Oregon. Brood sizes of females incubated for 48 hours had an overall average of 141 eggs fem-1. This value represents 17.3% of the female's body weight per brood. Using the proportion of purple females (stage IV) along the Newport Hydrographic line (during 1971) and the average brood sizes (2000-2002), we were able to estimate fecundity of *E. pacifica* using the method and assumptions proposed by Ross (1982). The average proportion of purple females during the reproductive season (March-October sampled biweekly) was p=0.223, which indicates an interbrood period of 4.5 days. Therefore, the fecundity was estimated to be 7,238 eggs per female per reproductive season. Though both methods support multiple spawning hypothesis, euphausiids showed high female-to-female variability in spawning frequency and brood size.

Hypoxia and enrichment of inshore waters at 44.3N (Talk)
Brian A. Grantham, Karina J. Nielsen, and Francis Chan (all at Oregon State University)

On July 10, 2002 Oregon Department of Fish and Wildlife (ODFW) scientists conducting an annual ROV survey of rockfish and rockfish habitat found only dead fish and invertebrates on a previously well- populated rocky reef near Cape Perpetua. Shortly thereafter, commercial crab fishermen began pulling up crab pots filled with dead rockfish, crabs and other invertebrates and dead fish washed up on local beaches. During the same period scientists from the College of Oceanic and Atmospheric Sciences at Oregon State University measured unusually low oxygen water within 10 km of shore on the Newport and Cape Perpetua survey lines. Based on these observations, the hypoxic zone was estimated to cover more than 700 km2. Following these reports, researchers from the Partner- ship for Interdisciplinary Studies of Coastal Oceans (PISCO) at OSU began repeated sampling of temperatures, conductivity, nutrients, chl-a, and dissolved oxygen along a cross-shore transect near the site of the ODFW observations (34.3N). Four transects extending from depths of 8-65 meters were occupied between July 19 and September 5, 2002. On all transects a layer of hypoxic (<1.4 ml O_2/l) water 10-20 meters thick was observed along the bottom. This hypoxic water extended into water as shallow as 8 meters. Elevated nitrate concentrations (30-35 μM) were coincident with this layer. Bottle samples revealed the presence of extremely high chlorophyll a levels, with our most nearshore samples exceeding 220 μg/l on the August 12 transect. Further data from PISCO moorings deployed from April-September and located along the transect lines indicate the persistent presence of very cold, saline water bottom layer and high chlorophyll a concentrations beginning near the estimated start time of this event. These temperatures were colder and the salinities and fluorescence measurements from these moorings were among the highest observed at this location over the past five years. It is hypothesized that an influx of anomalously cold, saline water with high nutrient concentrations, and perhaps lower-than-normal dissolved oxygen levels, fueled extremely high productivity on the inner shelf, leading to increased decomposition rates that depleted oxygen concentrations to hypoxic levels. It is estimated that these conditions persisted for at least 2 months. This is the first documentation of a hypoxic zone and associated die-off in shallow waters off the Oregon coast.

Nutrients and pCO2 off central Oregon (Talk)
Burke Hales

No abstract submitted.

The Application of Multiple Lipid Markers to Track the Diet History and Nutritional Status of Euphausiids in the NEP (Talk/Poster)
H. Rodger Harvey and Se-Jong Ju

Our primary goal in the NEP-GLOBEC program is to better understand the relationship between age structure, diet history and nutritional status of euphausiids. We are using a suite of lipid biomarkers (including pigments, fatty acids and sterols and alcohols) in animals and seston to allow us to examine food resources and its consumption and trophic transfer in this spatially complex coastal zone. Results to date show substantial changes in many of these markers in animals and seston along physico-chemical features and coastal topography, most notable in upwelling regions where diatoms are important. Pigment distributions show strong gradients and temporal variability, reflecting the complex physical environments and dynamic nature of food resources. Pigment analysis in seston often finds fucoxanthin (mainly from diatoms) the most abundant secondary pigment (up to 49 % of the total Chl-a) in upwelling, nearshore regions while 19'-butanoyl-oxyfucoxanthin (chrysophytes), lutein (chlorophytes), and chlorophyll-b (chlorophytes and prasinophytes) were dominant at offshore stations and in warm currents and eddies. Other lipid biomarkers are well correlated with pigment signatures including the distribution of diatom specific lipids such as the polyunsaturated fatty acid-20:5 and sterols which were significantly correlated with fucoxanthin (r=0.90 and 0.82 at p=0.01, respectively). The lipid composition of euphausiids collected in across shelf transects in several areas often reflect the varied food resources available in the water column, but also suggest selective feeding. For example, the fatty acids 18:1(n-9), 20:5, and 22:6 were major components in adult animals with only minor shifts between seasons and over spatial scales, reflecting the importance of diatoms as a food resource. Furcilia, however, contained a number of additional algal markers compared to adult animals or seston, suggesting that either juveniles feed on alternate phytoplankton in the water column or were advected from areas of feeding prior to collection. Through integration of such chemical tracers with biological rate measures and physical transport, a more complete picture of carbon cycling in this complex coastal zone may be possible.

Interannual variability of SST and cross-shelf transport in the coastal Northeast Pacific (Poster)
A. J. Hermann (JISAO/University of Washington), D. B. Haidvogel (Rutgers University), E. L. Dobbins (JISAO/University of Washington), P. B. Stabeno (NOAA/Pacific Marine Environmental Laboratory)

The winter SST of the coastal Northeast Pacific exhibits strong interannual variability, and contributes to large-scale indices of climate variability such as the Pacific Decadal Oscillation (PDO). Spatially nested primitive equation model hindcasts, forced with NCEP winds and heat fluxes for the years 1997-2001, have been used to diagnose this interannual variation. Patterns generated by the model for those years (e.g. warming around the coastal Gulf of Alaska and cooling in the deeper basin) relate directly to ENSO and PDO modes, compare favorably with observed SST from satellite data, and exhibit especially pronounced interannual differences between 1998 and 1999. Through float tracking and EOF analysis of model output, we explore the mechanisms for spatial downscaling of the regional circulation in different years, the interannual variability of cross-shelf transport, and how these effects might produce observed biophysical correlations in the region.

Water Properties and Currents off mid Washington (~47˚N, Grays Harbor) and mid Oregon (~43˚N, Coos Bay) during 2000-2002 (Talk)
B. Hickey, S. Geier, N. Kachel and A. Macfadyen; (University of Washington; bhickey@u.washington.edu)

Significant changes in shelf water properties between 2000 and 2002 are addressed using available hydrographic survey data as well as data from moored sensors. Hydrographic sections across the WA shelf in May 2001 and 2002 and late June 2002 are compared with each other and, to the extent possible, with historical data from the WA coast (1950-1984). In general, section and T/S profiles indicate colder water on the mid to outer shelf in May and June 2002 in comparison with 2001. T/S profiles in ~100-m bottom depth indicate colder, fresher water at mid depth in May-June 2002, similar (although more extreme) to profiles from 1972, 1979 and 1982, and colder and fresher than profiles from 1983, 1995, 1997, 1998 and 2001. Oxygen data from late June 2002 indicate near bottom values less than 2 ml/l, comparable to historical values for that month and higher than historical average values in the upper and mid water column. Monthly mean temperatures and salinities were evaluated at 35-m off the central WA coast in a 41-m bottom depth and at 35 and 95-m in a 100-m water depth off central OR. Velocities were primarily evaluated near surface (~10-m) and near bottom. Spring and summer temperatures were coldest in 2002 at 35-m at both sites (except June off OR). However, near bottom (~95-m) temperatures off central OR were not anomalously cold in 2002. Salinity data do not provide as clear a pattern. Water at 35-m was fresher in May and June off WA, and in June and September off mid OR. In other spring and summer months at both sites the water at 35-m was saltier in 2002 than in the prior two years. However, near bottom water (~95-m) off OR was fresher throughout summer. In general, spring-summer water conditions at both sites and at both depths off OR are on the cold, fresh side of T/S curves. In the preceding winter (Jan-Mar), the same is true in the upper water column at both OR and WA sites. Alongshelf advection off both WA and OR also displayed anomalies in 2002 relative to the two previous years in the upper water column (<10-m) and near bottom (~90-m) off OR, but not in the mid water column. Southward flow was strong and continuous at the WA site from April to May and off OR from April to June. Anomalous southward flow also occurred near bottom off OR in June (only). In winter and early spring near bottom (~90-m) flow off OR was anomalously northward relative to the previous year. Last, to provide long term perspective, temperature and velocity data were compared with historical time series data obtained at the same OR site by Bob Smith in 1981-1984 and 1986-1991. The comparison to date suggests that the 2002 anomalies may not be highly unique.

Summer 2002 conditions off Washington and southern Oregon (Talk)
Barbara Hickey

No abstract submitted.

Cold halocline in the northern California Current (Talk)
Adriana Huyer, Robert L. Smith (College of Oceanic and Atmospheric Sciences, Oregon State University)

Subsurface upper ocean waters off Oregon were about 1ºC cooler in July 2002 than in July 2001 when temperatures and salinity values were near normal. The anomalously cool layer coincides with the permanent halocline which has salinities of 32.2 to 33.8, and this suggests an invasion of nutrient-rich subarctic waters. The anomalously cool halocline lies at 50-180 m deep offshore, and intersects the sea surface in the seasonal coastal upwelling front. The cool anomaly is likely caused by stronger southward flow in the California Current and weaker northward flow in the Alaska and Davidson Currents during spring 2002. Other contributing factors may include reduced coastal

downwelling in late winter and early spring 2002, enhanced eastward flow in the subarctic Current, and enhanced winter mixing

Oregon Ocean Climate Update, Nov 2002 (Poster)
Adriana Huyer, Robert L. Smith, Jane Fleischbein (COAS, Oregon State University)

As part of the GLOBEC NEP Long Term Observation Program (LTOP) in the northern California Current system, the Newport Hydrographic (NH-Line) has been sampled five times per year since July 1997. This poster shows 26 vertical sections of temperature, salinity and geostrophic velocity. Also shown are the normalized temperature anomaly (difference from 1961-71 seasonal average divided by 1961-71 seasonal standard deviation) for each section, and T-S curves at NH-25 (over the shelf-break). Striking features in the 2002 sections are: 1) very cool subsurface waters over the shelf and shelf-break in summer; a cool anomaly in the upper halocline in spring and summer (April, July and September), 2) a cool surface layer in late winter (February) and early fall (September); and 3) warm near-bottom water at the shelf-break in September. The cool halocline waters are likely advected from the Subarctic Pacific. The warm anomaly at the shelf-break is likely an early signal from El Niño 2002-3 in the Equatorial Pacific Ocean.

Trophic interactions and migration of juvenile salmonids in the California Current System: conclusions from parasitology and genetics (Poster)
K.C. Jacobson, NOAA/NMFS/NWFSC/Fish Ecology Division, Hatfield Marine Science Center, Newport, OR R.E. Baldwin, Cooperative Institute for Marine Resources Studies, Oregon State University, Hatfield Marine Science Center, Newport, OR D.Teel, NOAA/NMFS/NWFSC/Conservation Biology Division, Manchester, WA.

Among our objectives in the U.S. GLOBEC Northeast Pacific Program is the use of parasite community analyses to help characterize trophic interactions, migrations, and salmon population origins. The present analyses focuses on four species of parasites found in juvenile chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) caught between Newport, Oregon, and Crescent City, California, in June and August of 2000. Juvenile salmon were frozen whole, muscle, stomach, and intestine were examined for macroparasites at a later date. Chi-square analyses were used to determine differences in parasite prevalences. Parasite intensities were tested using an ANOVA. The prevalences of three trematode species declined from June to August. By August, *Podocotyle* sp. was absent from yearling chinook salmon and the intensities had decreased in coho salmon. Intensities for *Genolinea* sp. and *Hemiurus* sp. were higher in coho than chinook salmon. Stock composition of salmon also changed during the summer. Allozyme data indicate that the chinook salmon caught in June were mainly from rivers north of Cape Blanco, Oregon, but by August over 90% of the juvenile chinook salmon were from stock groups south of Cape Blanco. Allozyme data for juvenile coho salmon indicate similar proportions of southern and northern Oregon stocks in June and August, but with a 24% increase of Lower Columbia River stocks in the August samples. The parasite data suggest differences in salmon trophic interactions and together with the genetics study suggest a temporal shift in stock compositions.

Relationships between zooplankton communities and mesoscale physical features during the 2000 Mesoscale cruises (Poster)
Julie E. Keister and William T. Peterson

We studied mesoscale variability in zooplankton communities during early (June) and late (August) summer 2000 as part of the U.S. GLOBEC Northeast Pacific program. These cruises were conducted in conjunction with two other vessels studying the physical oceanography and distribution of juvenile salmon. We sampled zooplankton using a 202mm mesh, ½ m diameter plankton net lifted vertically from near-bottom (max. depth of 100m) to surface. Zooplankton were counted and identified to species when possible (most copepods) or to genus or larger taxonomic groups such as chaetognaths, echinoderms, or medusae. We used cluster analysis and Non-Metric Multidimensional Scaling (an ordination technique) to examine similarities in zooplankton communities among sampling sites. Satellite images of SST and CTD and SeaSoar data collected during the cruises show that mesoscale physical activity was minimal during the early-summer cruise, but mesoscale features (e.g.-eddies and filaments) were well developed during the late-summer cruise. Strong differences in the zooplankton communities that appear related to mesoscale physical activity were apparent both between cruises and within each cruise. At the highest cluster level, the zooplankton communities present during the early-summer cruise separated completely from that found during the late-summer cruise. Within each cruise, communities north of Cape Blanco separated from communities south of Cape Blanco. The relative complexity of the physical system during the two cruises was reflected in zooplankton distributions: during early summer, cross-shelf differences were slight, whereas in late summer, cross-shelf differences in the zooplankton

communities were strong and the pattern of community structure matched well with the complex physical features (primarily a large eddy) seen in the physical data and satellite images.

GLOBEC Mooring: Newport, Oregon (Poster)
Mike Kosro

No abstract submitted.

Shore-Based Mapping of Ocean Surface Currents at Long Range Using 5 MHz HF Backscatter (Poster)
Mike Kosro and Jeffrey Paduan

No abstract submitted.

Temperature, salinity and advection from time-series measurements off Oregon (Talk)
Mike Kosro and Walt Waldorf

No abstract submitted.

Humpback whale sightings off the Oregon and northern California coast, during summer 2002 (Poster)
Barbara A. Lagerquist and Bruce M. Mate

As part of a collaborative project with the 2002 GLOBEC study, OSU's Marine Mammal Program attempted to attach satellite-monitored radio tags to humpback whales off the Oregon coast. The purpose of the study was to track the movements of humpback whales during their summer feeding season and to compare these movements with the summer 2002 GLOBEC cruise data. Additionally we had hoped to identify humpback migration routes to their wintering grounds. It was hypothesized that humpback whale movements during the feeding season would coincide well with areas of high prey abundance and nearby high primary productivity.

Chlorophyll, fluorescence and MODIS, summer 2002 (Talk)
Ricardo Letelier

No abstract submitted.

Large Scale Climate Variations in the Northeast Pacific (Talk)
Tom Murphree and Frank Schwing

Large-scale climate variations occurring on intraseasonal to decadal scales can have major impacts on ecosystems in the northeast Pacific (NEP). These variations include Madden-Julian oscillations, El Nino and La Nina events, and decadal events. The characteristic atmospheric and oceanic anomaly patterns in the NEP associated with these variations are strikingly similar to each other, indicating that: (1) the mechanisms that produce these patterns are dynamically similar; and/or (2) the longer term events represent a superposition of shorter term events. Determining how an individual climate variation has impacted the NEP is complicated by pre-existing oceanic anomalies. The 1995-2002 period in the NEP provides some clear examples of the importance of tracking the temporal evolution of oceanic anomalies when attempting to attribute specific anomalies to an individual climate event (e.g., an individual El Nino event). In the coastal NEP, oceanic anomalies are especially sensitive to relatively small changes in large-scale climate variations. This includes small changes in the location, orientation, and intensity of anomalous atmospheric wave trains from one month to the next during an individual event. This also includes differences between two similar events (e.g., differences between two El Nino events in the orientation and strength of surface wind anomalies). The resulting complexities in coastal responses to climate variations can be resolved, at least partially, through analyses of the larger scale (e.g., basin-scale) responses.

Comparison of the Coastal Gulf of Alaska Circulation Model (3-km grid) to GLOBEC Data (Poster)
Dave Musgrave, Kate Hedstrom, Al Hermann and Dale Haidvogel

No abstract submitted.

Interannual variations in the seasonal cycles of temperature, salinity, nutrients, chlorophyll and zooplankton biomass and species composition on the Newport Line, 1996-2002: was summer 2002 different from the other years? (Talk)
Bill Peterson and Leah Feinberg

We have been sampling the Newport Line since May 1996 on cruises conducted biweekly at several shelf stations. We will present our data on seasonal cycles of temperature, salinity, nutrients, chlorophyll and zooplankton for the seven years. The main purpose of this is to compare conditions on the shelf observed during the (apparently) anomalous summer of 2002 to the other six years. We know from our CTD observations that there were several dates in May, July and August that had relatively fresh water on the shelf but most cruises found cool salty water, normal for this time of year. As for chlorophyll, at this point we do not have all of the data worked up so do not know if it was higher this summer (as has been found by Wheeler). Copepod densities were 'average' - in fact, this was the most 'average' year ever sampled. Our preliminary conclusion is that although anomalies in water mass properties were certainly seen at and offshore of the shelf break, the shelf waters were only slightly fresher and zooplankton were certainly not different either in terms of species composition or total biomass. The only really odd thing that we observed were high numbers of galatheid crab megalopae in MOCNESS samples collected in the poleward undercurrent. We think these may be the larvae of the 'pelagic red crab', a species that ordinarily lives far to the south of us, off Baja, but at this point we have not had the time to work on their identification. We just received specimens from colleagues at La Paz, MX so we will have the answer by November. If the larvae are pelagic red crabs, this will suggest that the undercurrent ran exceptionally strong this summer, a fact that might bear on the anomalous hydrographic conditions observed off Oregon.

Recent changes in climate and carrying capacity in the California Current, a positive sign for recovery of salmon (Talk)
Bill Peterson and Frank Schwing

In July 1998, a large La Niña event occurred, weakening winds in the Gulf of Alaska and strengthening upwelling winds over the California Current. This event led to a cooling of the coastal waters of the Gulf of Alaska and California Current by several degrees. Since 1998, fundamental changes in the productivity of the northern California Current have increased the carrying capacity of the ecosystem: zooplankton biomass has doubled and coho salmon survival has increased by 500%. It has now been four years since the La Niña was initiated, an unusually long period for such events. Based on persistent changes in the Pacific Decadal Oscillation and in ecosystem structure, we suggest that the La Niña conditions have given way to a climate regime shift, similar to regime shifts that occurred in 1925, 1947 and 1976.

Mesoscale Bio-acoustic Surveys in the Northern California Current System (Poster)
Stephen D Pierce, Jack A Barth, William T Peterson, Timothy J Cowles, and Meng Zhou

During spring and summer 2000, two mesoscale mapping cruises surveyed the northern California Current system from 41.9-44.6N and about 150 km offshore. Concurrent with the physical and bio-optical measurements made from a towed undulating vehicle (SeaSoar), a multi-frequency (38, 120, 200, and 420 kHz) towed bio-acoustics instrument collected backscatter data. The bio-acoustics were collected in 12 s ensembles (about 50 m horizontal resolution) and 1 m vertical bins, comparable to the resolution of the SeaSoar measurements, allowing for close evaluation of the physical control of biological distributions on these scales. The acoustics were sea-truthed using nearby MOCNESS samples. Predicted scattering was computed for each net sample using body lengths in a randomly-oriented bent cylinder scattering model, a reasonable approximation for both copepods and euphausiids. Predicted volume backscattering for the MOCNESS samples explained 44% of the variance of the nearby acoustics backscatter. A non-negative least squares inverse method is applied in conjunction with the scattering model, yielding estimates of biomass in four zooplankton size classes plus a "fish" class over the entire survey region. For the spring 2000 case, we also compare our bio-acoustic results with zooplankton measurements made with an Optical Plankton Counter (OPC) mounted on the SeaSoar vehicle. The overall mean OPC and acoustic zooplankton estimates agree moderately well for the 5-9 mm and 9-17 mm size classes, with biovolumes within factors of two. For the 1-5 mm size class, the mean OPC value is an order of magnitude larger than the acoustic estimate. On the other hand, the 1-5 mm bio-acoustic map reveals some mesoscale spatial structure over a submarine bank which the OPC does not show. The different methods of observing zooplankton will be discussed in more detail. Preliminary bio-acoustic results from other years (2001 and 2002) off the Oregon coast will also be shown.

Abundance and Distribution of Pelagic Nekton from GLOBEC 2002 Surface Trawl Surveys (Poster)
Pool, S.S., R. Emmett, R. Brodeur

The abundance and distribution patterns of pelagic nekton in the northern California Current System offshore of Newport, OR to Crescent City, CA are poorly known. These nekton may be prey, predators, and potential competitors of juvenile salmon. Therefore, gathering baseline data to increase our knowledge of pelagic nekton may lead to a better understanding of juvenile salmon in their ocean habitat. To examine the nekton community, a surface trawl was conducted at meso- and finescale stations in June (104 tows) and August (101 tows) 2002. In addition, a 24-hour diel study was done at one mesoscale station with a large number of salmonids caught during the regular mesoscale surveys in June and August. Trawl catches showed that few chinook and coho salmon were present south of Cape Blanco whereas they were abundant on the shelf north of Cape Blanco. Common non-salmonid nekton caught included jack mackerel, Pacific herring, Pacific sardine, whitebait smelt, surf smelt, Pacific saury, Pacific hake, juvenile rockfish, and market squid. The diel study in June showed a shift from market squid during the day to smelt and herring at night whereas in August, more herring and sardine than market squid and Pacific hake were caught. The spatial and temporal patterns of the pelagic nekton and trophic relationships are currently being analyzed for further understanding of interactions between the nekton community and salmonids.

Cold, Fresh Halocline South of Cape Blanco? (Talk)
Steve Ramp and Fred Bahr (Department of Oceanography, Naval Postgraduate School, Monterey, CA 93943)

The currents, temperature, and salinity at the Rogue River mooring site were compared for the "summer" period (May to October) 2000, 2001, and 2002 to examine the regional extent of the anomalous conditions off the Oregon coast. The overlaid low-passed temperature time series appear event-driven and don't exhibit any particular long term trend. Temperatures did appear lower during most of July 2002 by about 0.5°C (eyeball estimate) than July 2000 or 2001. The corresponding salinities were not anomalously fresh except during two events which can clearly be identified as across-shore excursions of warm, fresh water from offshore (see poster). Monthly averages were computed to reduce the event-by-event character of the records. The monthly mean temperatures were cooler than previous years during May, June, and July at all depths but returned to near-normal in August and September. The deltas at 22, 35, and 66 m were 0.8, 0.6, and 0.4°C respectively. The alongshore near-surface currents were anomalously equatorward in 2002 by about 5 cm s^{-1} (-15 vs. –10 cm s^{-1}) during May, June, and July but poleward by a similar value during August. The deeper currents were not significantly different from year to year. The T-S plots for the three years formed overlapping envelopes at 22 and 35 m. At 66 m, the water colder than 7.5°C was saltier during 2002 by about 0.1 psu. As an aside, we note that solitons observed at 22 m provide an indication of the true surface temperature and salinity above, allowing the extremes during the "fresh events" to be observed. These are waves of depression at this site off Oregon and push the surface water down to the 22 m depth as they pass by.

Seasonal Evolution of the Upwelling Process South of Cape Blanco (Poster)
Steve Ramp and Fred Bahr (Department of Oceanography, Naval Postgraduate School, Monterey, CA 93943),Mike Kosro, Ted Strub, and Jane Huyer (COAS, Oregon State University, Corvallis, OR 97331)

Bursts of upwelling favorable winds lasting 4-20 days occur year-round south of Cape Blanco. While they are decidedly more common during the spring and summer, strong upwelling favorable wind events with magnitude exceeding 28 knots also occurred during 12-20 January, 24 February to 3 March, and 24-31 March 2002. The ocean's response to these events south of a major headland, Cape Blanco, was studied using moored current, temperature, and salinity data, satellite SST data, and a few across-sections along the Rogue River line. The mooring site at 42°26.49'N, 124°34.47'W was initiated 6 nm off the mouth of the Rogue River during May 2000 and continues to the present. The goal of the site is to be able to compare and contrast conditions, particularly the response to upwelling and its impacts on biological productivity, north and south of Cape Blanco via comparison with data being collected north of the Cape by other investigators. The response to upwelling was quite different in the different seasons and can be summarized briefly as follows: **Winter:** The normal condition is unstratified with little variation in SST across the shelf. Upwelling restratifies the water column from the bottom up, by drawing cold, salty water onshore along the bottom, with little or no change in SST. **Spring and early summer:** Steady equatorward wind stress does not produce steady equatorward and offshore flow, but rather a much more variable current consisting of a series of equatorward jets that evolve and move offshore across the mooring. This results in a series of currents that are alternately strong and then weak with a shorter time scale than the wind stress forcing. **Late summer and fall:** Comparable or greater wind stress

than during spring and summer produces little equatorward flow, as the equatorward jet separates well north of Cape Blanco and remains far offshore south of the Cape even during the relaxation events. Thus, currents south of Cape Blanco in August and September were weak or even poleward during upwelling favorable winds. These currents and water properties are quite different than the responses north of the Cape or at other sites along the straight sections of the Oregon coast.

Linking Climate Variability to Nitrogen Dynamics off Central California: A 50 year Record Based on $^{15}N/^{14}N$ in CalCOFI Zooplankton (Poster)
Greg H. Rau, Mark D. Ohman, Annelies Pierrot-Bults

Long term variability in zooplankton $^{15}N/^{14}N$ was investigated in two species of calanoid copepods (*Calanus pacificus* and *Eucalanus californicus*) and two chaetognaths (*Sagitta bierii* and *Sagitta euneritica*) sampled in the spring of selected years from 1951 to 2001 off the central California coast. No statistically significant, linear trend was detected for any of the four species, with isotopic ratios in 2001 resembling those in copepods and chaetognaths sampled 50 years earlier. Zooplankton body lengths also showed no long term trends. With respect to proposed regime shifts in this region, heterogeneity in $^{15}N/^{14}N$ was detected only for the two chaetognath species when comparing means from the periods 1951-1972, 1979-1998, and 1999-2001. Chaetognath $^{15}N/^{14}N$ in the most recent, brief period (1999-2001) was slightly lower than in the previous period. Three of the four species (*C. pacificus*, *S. bierii*, and *S. euneritica*) showed significant increases in $^{15}N/^{14}N$ during major El Niños. El Niño-related enrichment in ^{15}N could arise as a consequence of increased nitrate demand:supply at the base of the food web or advection of ^{15}N-enriched nitrate from more southerly waters. While a range of physical and climate indices were evaluated, anomalies of $^{15}N/^{14}N$ from the long term mean were found to be significantly related only to; i) the Southern Oscillation Index in the case of the two chaetognath species, ii) an index of wind-driven coastal upwelling for the surface-dwelling *C. pacificus*, and iii) variability in the Pacific Decadal Oscillation for the somewhat deeper-dwelling *E. californicus*. The relationships among each species' $^{15}N/^{14}N$ averaged over the total sampling period was: *E. californicus* $\approx$ *C. pacificus* $<<$ *S. euneritica* $<$ *S. bierii*, consistent with trophic ^{15}N biomagnification and the predatory nature of *Sagitta*.

Mesoscale physical features and the patchiness of zooplankton and nekton in the northern California Current System (Poster)
P.H. Ressler, R.D. Brodeur, W.T. Peterson, S.D. Pierce

Zooplankton and nekton populations were surveyed using both nets and acoustics during multidisciplinary GLOBEC (Global Ocean Ecosystems Dynamics) fieldwork in the northern California Current System (CCS) during August 2000. The interaction of seasonal upwelling and mesoscale eddies clearly influenced spatial patterns: chlorophyll concentrations, zooplankton biomass, seabird biomass, and the densities of fish and marine mammals were all elevated in meanders of the California Current off of Heceta Head and Cape Blanco, Oregon, relative to other parts of the study area. To test the hypothesis that aggregations of zooplankton and nekton were larger and more numerous in these apparently productive waters than in other parts of the study area, patch definition methods based on image analysis techniques were applied to multifrequency acoustic backscatter data. This poster shows preliminary results of those analyses.

Longitudinal scales of variability of phytoplankton biomass and maximum photosynthetic quantum yield during the 2000 GLOBEC NEP process cruises. (Poster)
Rachel Sanders, Ricardo Letelier, and Mark Abbott

The upwelling region off the Oregon Coast is dominated by strong mesoscale variability which creates structure in both physical (temperature, salinity) and biological (biomass, physiological) parameters. Primary production models are based on estimates of algal biomass (chl or fluorescence) and physiological status (a, PB_{max}, fp). However, when using remote sensing data to derive phytoplankton production rates, SST is often used as a proxy for physiological status (Behrenfeld and Falkowski, 1997). Hence, these derivations are based on the assumption that temperature, biomass, and physiological parameters all vary on the same scale. In the present study we use continuous near surface records of temperature, fluorescence, and the maximum quantum yield of fluorescence (Fv/Fm) from the June and August 2000 NEP GLOBEC cruises to estimate the scales of variability of these parameters off the Oregon coast. We compare the scales of variability between seasons and regions to determine if physiology always varies with temperature or biomass.

Moulting and Growth of *Euphausia pacifica* and *Thysanoessa spinifera* in the Northern California Current (Poster)
Tracy Shaw, Leah Feinberg, Jaime Gomez-Gutierrez, William T. Peterson

The euphausiids *Euphausia pacifica* and *Thysanoessa spinifera* are target organisms of Pacific Ocean GLOBEC research in the northern California Current. They occupy a key role in this ecosystem, both as grazers and as prey items for many vertebrates, including salmon. Determining vital rates of these organisms is a goal of this research project. Molting rates of juvenile and adult euphausiids were measured off the Oregon Coast from 2000-2002. Molting rates were fairly consistent regardless of species, life stage or body length. Negative and positive growth occurred at all times of year and at low and high chl a concentrations. Negative growth among reproductively active adults may be due to channeling energy into reproduction instead of growth.

Distribution in relation to phytoplankton, and potential grazing impact, of microzooplankton in the California Current System (Poster)
Barry F. Sherr, Evelyn B. Sherr (COAS, Oregon State University)

We are analyzing the distribution of microzooplankton (ciliates and heterotrophic dinoflagellates) in the California Current System (CCS) during 2001-2003 as part of the Long Term Observation Program (LTOP) off the Oregon and Northern Californian coasts. In addition, we are also evaluating, via flow cytometry, the abundance distributions of large phytoplankton (diatoms and autotrophic dinoflagellates) and of small phytoplankton (coccoid cyanobacteria, and pico- to nano-eukaryotic algae) in the CCS. This data set should allow us to test the idea that microzooplankton, and particularly ciliates, tend to feed on, and thus be associated with, smaller-sized prey cells. In the 2002 field year, we found that ciliate abundance and biomass was high both in inshore regions with high diatom abundance (but low abundance of smaller phytoplankton), and in offshore regions where the phytoplankton assemblage was dominated by small phytoplankton. This does not support the hypothesis of ciliates mainly feeding on small-sized phytoplankton. Along the Newport Hydroline, ciliate abundance was lower at slope stations, even in the presence of high abundances of small phytoplankton; we speculate that top-down control of microzooplankton by mesozooplankton accounts for this observation. Dinoflagellate abundance tended to be more uniformly distributed in the CCS. Estimates of potential grazing impact of microzooplankton, based on our data for cell abundances and literature values for cell-specific grazing rates, indicated that microzooplankton could clear phytoplankton from, on average, 67% of the water column per day during summer in regions dominated by smaller-sized cells.

Anomalous Transports into the California Current as Seen in Cross-Track Altimeter Surface Velocities (Talk)
Ted Strub, Andrew Thomas and Corinne James

After the 1997-1998 El Niño, oceanic conditions along the Pacific Northwest (PNW) changed in a number of ways: oceanic temperatures were generally cooler and sea surface heights (SSH) were lower, while zooplankton distributions revealed an increase in boreal species. However, calculations of surface transports, made using altimeter SSH data, did not reveal a simple increase in equatorward flow along the coasts of BC and the PNW that would indicate equatorward transport of cooler water and boreal zooplankton species. While surface water was cooler, the water mass properties in the pycnocline (approximately 100m deep) during 1999-2001 were similar to historical values during non-El Niño periods (Jane Huyer, personal communication). During July 2002, however, temperatures in the pycnocline off Oregon became anomalously cold and fresh, while nutrients became anomalously high (Jane Huyer, Pat Wheeler, personal communication). Colder pycnocline temperatures were also observed along Line P, off Vancouver Island (Howard Freeland and Frank Whitney, personal communication), implying a source farther north for the pycnocline anomalies. In this presentation, we extend the analysis of altimeter-derived surface transports and satellite estimates of surface chlorophyll concentrations to determine whether these satellite-derived fields can detect an increase in equatorward flow into the PNW during the first half of 2002, or an anomalous increase in chlorophyll concentrations in the PNW by summer.

Seasonal Development of Mesoscale Satellite Fields Along the Pacific Northwest (Poster)
Ted Strub, Corinne James, Andrew Thomas, and Roberto Venegas

No abstract submitted.

GLOBEC: Abundance, distribution, and feeding ecology of large medusae in the California Current upwelling system (Poster)
CL Suchman and RD Brodeur

Gelatinous zooplankton are often conspicuous predators, appearing seasonally in coastal areas and estuaries. In recent years some researchers have also become concerned that numbers of jellyfish are increasing, indicating a fundamental change in or degradation of coastal food webs. Unfortunately, relatively little quantitative data have yet been presented regarding the spatial and temporal distribution of these predators. Here we describe the abundance and distribution of four large medusae (*Chrysaora fuscescens*, *Aurelia labiata*, *Aequorea* spp., and *Phacellophora camtschatica*) in the California Current upwelling system. During June and August 2000 and 2002, as part of the GLOBEC Northeast Pacific program, gelatinous zooplankton were quantified during trawls deployed from chartered fishing vessels along onshore- offshore transects from Newport, Oregon to Crescent City, California. In general, all four species were more abundant inshore of the shelf-break, yet some retained geographic separation (e.g. peaks of *A. labiata* were further south than those of *C. fuscescens*). Abundances were higher, and distribution more widespread, in 2002 than 2000. We also report preliminary results of gastric content analysis of *C. fuscescens* collected along the Newport Line during summer 2002. Euphausiid eggs can comprise 80 to 98% of the prey ingested by *C. fuscescens*. Thus, the factors that govern interannual variability in medusan abundance also influence predation pressure on other dominant zooplankton taxa off the Oregon coast.

Biological response to the 1997 – 1998 regime shift in the North Pacific Eastern Boundary Current (Talk/Poster)
Gordon Swartzman

The Pacific Decadal Oscillation has been consistently negative since the El Niño of 1997-1998 after a period of about 20 years of positive temperature anomalies, and this change appears to be associated with a regime shift. This paper explores its effects on the biota in the Pacific Eastern Boundary Current ecosystem. Predictions of changes in abiotic and biotic components from the recent regime shift to a cooler regime in the California Current Ecosystem: precipitation—higher; California current—stronger; California undercurrent—weaker; upwelling—more; thermocline/stratification—deeper/weaker; salinity—higher; nutrients—higher.

Lower trophic levels: primary production—higher; euphausiids—higher south of Cape Blanco, more nearshore north of Cape Blanco; copepods: more boreal copepods and fewer temperate copepods

Higher trophic levels: salmon—higher; rockfish—higher; anchovy—higher; sardine—lower; and more southward; Pacific hake—lower and more southward; other small pelagic fish (herring, eulachon) —higher; seabirds—higher. In this paper we provide evidence for the above predictions. We also briefly touch on changes in euphausiid species composition from net samples taken throughout the CCE in 1995 and 2001. Finally, a conundrum on the nature of unidentified 'zooplankton' acoustic sign during night samples is posed.

Copepods feeding behavior and potential impact on the food web (Talk/Poster)
Delphine Thibault Mark E. Huntley

Feeding rates were measured on *Calanus marshallae* and *Pseudocalanus* sp. during the 2000 and 2002 cruises in the NEP Ocean. Strong annual and seasonal variation in the abundance of these two species of copepods have been observed. Their potential impact on the available food in term of phytoplankton has been measure using gut evacuation rates and gut contents. Highly variable rates have been observed. High feeding rates have been in some cases directly associated with higher chlorophyll a concentration, but often a spatial discrepancy appear between the area with high chlorophyll a concentration and that of high feeding rates. Low feeding rates were related to low productivity stations. Potential importance of these copepods in this oceanic system is given here.

NEP Ocean, have we been overlooking the most important component of the local system (Poster)
Delphine Thibault

During the August 2002 cruise of the NEP GLOBEC, large numbers of gelatinous zooplankton have been observed, often exceeded the number of large copepods available as food for the salmon population. Siphonophores and ctenophores were the most conspicuous member of the gelatinous world. Measurement on the size, abundance, and species composition as well as on gut contents, feeding rates and excretion rates have been measured at different sites over the whole area. These different species might play an indirect role in the decline of the salmon population by

feeding on small/medium size copepods competing then with the fish larvae. Further studies on their potential role in this ecosystem should be done, in order to access their real importance.

Interannual variability of surface chlorophyll concentrations in the California Current (1997-2002): the broad-scale satellite view (Talk/Poster)
Andrew Thomas and Peter Brickley

A five year time series of monthly composite SeaWiFS images over the California Current (Sept 1997 - Aug 2002) shows the large-scale patterns of interannual variability in surface chlorophyll concentrations. Inspection of the time series of concentrations as well as cross-shelf distributions show that seasonal cycles were relatively regular and similar over the period 1999 - 2001, with differences apparent in both 1997-98 and in 2002. A 12 month climatological seasonal cycle was formed using the 3-year period 1999-01 and anomalies of the entire time series calculated from these. The anomaly time series is dominated by maxima during two periods. Low anomalies through most of the California Current were present during the first year, strongest off Oregon and Central California, weakest and actually positive off Baja. These are associated with the end of the 1997-98 El Nino event. Strong positive anomalies off the Pacific Northwest are present in the time series beginning in May 2002. An EOF decomposition of the dominant patterns shows these elevated concentrations extend from at least northern Vancouver Island (50N) to Point Conception, strongest in the Pacific Northwest. Cross shelf profiles highlight these anomalous concentrations at specific latitudes.

New (2002) SeaWiFS chlorophyll imagery of the California Current (Poster)
Andrew Thomas, Pat Wheeler, Lee Karp-Boss and Peter Brickley

In the summer of 2002, the NASA SeaWiFS community implemented a re-processing of the entire SeaWiFS data set which resulted in a modified time series of chlorophyll concentrations (Version 4) for the global ocean (and GLOBEC). The main results of this re-processing can be summarized as 1) reduced concentrations in more oligotrophic regions, 2) increased concentrations in more eutrophic regions 3) elimination of suspect pixels very near shore (~ 1-2 km) and 4) a slight increase in noise due to a modified cloud masking scheme. Here we present a quantitative comparison of the previously available California Current SeaWiFS data used by the GLOBEC program (Version 3: circa 1998-2002) with the new data (Version 4: circa August 2002). Difference images and regressions highlight the spatial patterns and quantitative chlorophyll differences. Preliminary comparisons of both Version 3 and Version 4 are made to in situ surface chlorophyll measurements from the west coast GLOBEC region. Severe difficulties in making comparisons to field data are highlighted by the strong temporal variability in chlorophyll concentrations on the Oregon shelf evident in the in situ data over 7 day periods.

Monitoring the Variability of the Mid-latitude North Pacific Ocean (Poster)
Robin Tokmakian (Naval Postgraduate School, Monterey CA robint@ucar.edu)

The low frequency variability of the ocean's circulation and its relationship to the variability of marine populations has been explored to first order (McGowan et. Al. and Schwing et. al.). In these papers, the authors explored the relationship between the low frequency changes in sea surface temperature (SST) with disturbances in the coastal ecosystems. Large scale interdecadal shifts of SST and atmospheric pressure are associated with a southward shift and intensification of the Aleutian Low. With the atmospheric pressure shift is a shift in the location of the prevailing westerlies over the midlatitude central and eastern North Pacific. These changes also cause changes in the sea surface height (SSH) field reflecting cooler and denser water below the surface and which also may reflect an increase in mixing of nutrient rich waters. This paper gives an example of how a space-based monitoring system might be developed to help in the prediction of changes to various fish stocks.

Through the use of satellite data (altimeter and infrared) and WOCE repeat section PR06, the model's realism is quantified. Once quantified, fields of 20 years of modeled (0.25 resolution Parallel Ocean Climate Model 1979-1998) sea surface heights and temperatures are used to develop an algorithm to monitor the low frequency variability in the heat content of the North Pacific's mid-latitudes associated with regime shifts in the coastal circulation patterns of the Alaskan currents and the California currents. The model shows that the mid latitude Pacific circulation subsurface variability is primarily due to the large, low frequency horizontal N/S movement. During some years, changes may also be due to large scale atmospheric changes in wind patterns. It is proposed that this type of monitoring might be useful to help with understanding the basin's variability and its relationship to the variability in our fisheries. Initial related results from an on-going 40 year 0.2 degree resolution ocean simulation will also be given.

Distributions of upper-trophics in 2002 compared to 2000 (Talk)
Cynthia Tynan, David Ainley

No abstract submitted.

Diel Vertical Migration of Life History Stages of *Euphausia pacifica* (Poster)
Mitch Vance, Julie Keister, Bill Peterson

The diel vertical migration (DVM) movements of marine zooplankton are thought to be an adaptation which balances feeding behavior with predator avoidance. Many species of euphausiids, as well as other zooplankton, spend their days at depths which decreases their chances of becoming prey to visual predators and then ascend to shallower depths at night to feed in relative safety. The dynamic system of seasonal current patterns along the continental shelf and slope off the Oregon coast likely plays an important role in controlling the spatial distribution of euphausiid populations. To study the linkages between behavior patterns and population retention within the coastal upwelling zone, vertically stratified samples were collected during the daytime and again at the same station at night. We used a MOCNESS (Multiple Opening and Closing Nets and Environmental Sensing System) to collect day/night sample pairs at five stations. Three stations were in relatively shallow water (100 - 200 m) on the shelf and two stations were in deeper water (500 - 1000 m) over the slope. Euphausiids from all nets were identified to species and life history stage. We found that the densities of *E. pacifica* were higher over the slope than on the shelf. There is evidence of diel vertical migration by *Euphausia pacifica* as young as the calyptopis stage. The magnitude of DVM is 10 - 20 m for small furcilia. Similar findings have been reported by Taki (1998) and Iguchi (1995) in areas of the NW Pacific. The migrations increase in magnitude with ontogeny to a range of at least 100 meters with adults.

Marine Trophodynamics off Oregon and California (Talk)
Tom Wainwright, Ric Brodeur, Kym Jacobson, and others

This year we focused on three areas: diet analysis, parasite analysis, and modeling. Stomach contents of all salmon and common species of fish collected from GLOBEC 2000 June and August cruises have been processed. Diet analysis of fish collected from the GLOBEC 2002 sampling events (May-June and July-Aug.) is continuing. Size measurements and identification of predators and corresponding prey from these analyses are being used to establish size and species-specific guilds for trophic analysis. Additional trophic work has focused on obtaining tissue samples of fish and zooplankton for measuring natural levels of stable isotopes $\delta^{15}N$ and $\delta^{13}C$. Isotope tissues were taken from all fish species and are being processed for isotope analysis. Laboratory studies have been conducted to examine the turnover rates of stable isotopes in different body tissues of zooplankton and fish. Fourteen of the fish species collected in 2000 are being examined for parasites. Of the ten fish species processed to date the juvenile salmonids have the most diverse parasite communities suggesting a more diverse diet. Although both juvenile chinook salmon and juvenile coho salmon have similar parasite diversities, differences in intensities of core species suggest differences in diet between the two juvenile salmonids. Design and implementation of a spatially-explicit trophic model of the pelagic zone continued. In previous work periods we had developed two distinct prototype models: a single-point model of the lower trophic levels, with 11 trophic components, and a 2-dimensional cross-shelf upwelling hydrodynamic model with a simpler (5-component) lower-trophic representation. Work this period focused on re-implementing these models in a single, more efficient framework, extending the models to three dimensions, and incorporating fish into the trophic web. Preliminary analyses of food-web structure have been completed based on the 2000 cruise data.

Pelagic Food Web Structure in The California Current System (Poster)
Tom Wainwright & Todd Miller

From the June and August 2000 GLOBEC cruises, we analyzed the diets of major nekton species including coho (*Oncorhynchus kisutch*) and chinook (*O. tshawytscha*) salmon, steelhead trout (*O. mykiss*), smelts (*Hypomesus pretiosus* and *Allosmerus elongates*), clupeoids (*Clupea pallasii* and *Sardinops sagax*), juvenile rockfish (*Sebastes crameri* and *S. flavidus*), Pacific saury (*Cololabis sauria*) and Pacific jackmackerel (*Trachurus symmetricus*). Euphausiids, hyperiid amphipods, decapod larvae, copepods and fish were the dominant prey categories for most species mentioned. Jackmackerel, Pacific saury and steelhead consumed high proportions of euphusiids. Chinook and coho salmon consumed primarily fish and hyperiid amphipods. Surf smelt, whitebait smelt and herring consumed copepods, larval decapods, and to a lesser extent, euphausiids. These data were used (in combination with literature data for invertebrate, bird, and mammal diets) to construct a pelagic food web for the California Current off northern

California and Oregon. Preliminary cluster analyses based on prey and predator similarities were conducted; results show some potential simplifications of the food web based on predator/prey guild structure.

Nutrient enrichment and high fluorescence off Newport (44.65N) (Talk)
Pat Wheeler

Hydrographic, chemical and biological sampling off Oregon has been carried out since 1997 as part of the NEP-GLOBEC Long-term Observation Program (LTOP). In 2002 the halocline water was about 1^{o} C colder than usual and somewhat fresher. This talk will present some of the hydrographic data documenting the changes in temperature and then present the concentrations of the major nutrients in the halocline along the Newport line 44.65^{o} N and along the Heceta Head line 44.00^{o} N. Both transect lines show a substantial increase in nitrate, phosphate and silicate at 33 psu in 2002 compared to 1998-2001. Along the Newport line the increase in nutrients is greatest between 47 and 65 km offshore while along the Heceta Head line the greatest increases are between 37 and 53 km offshore with another increase at 100 km offshore. The halocline water is the source of upwelled nutrients and increases in nutrients are also seen closer inshore but appear to be more transient due to utilization by phytoplankton. Underway fluorescence levels during the summer of 2002 are higher inshore than observed in the preceding three years.

The halocline waters are derived from the subarctic and significant temperature anomalies were also observed in 2002 along the Canadian P-transect. The cooler waters off Canada were also accompanied with increased nitrate levels. Estimates of primary production based on nutrient supply need to take into consideration the increased nutrient level in the upwelled water, any differences in intensity and frequency of upwelling, as well as diffusive fluxes across the nutricline between upwelling events. Our initial estimates indicate that productivity is at least four times greater during the summer of 2002 compared with the preceding five years. This change may be related to a weakening of the Alaska coastal current and a strengthening of the California Current.

Mesoscale variability in zooplankton distributions: 2000 and 2002 (Talk)
Meng Zhou, Di Wu, Yiwu Zhu, Jay Peterson (University of Massachusetts, Boston), Tim Cowles and Jack Barth (Oregon State University)

Mesoscale distributions of zooplankton were measured in June and August 2000 and 2002 using an Optical Plankton Counter (OPC) mounted on the SeaSoar. The results revealed the correlation between maxima of zooplankton abundance and areas of coastal upwelling and mesoscale eddies, and seasonal variability in spatial distributions of zooplankton abundance and size structure. We also investigate the temporal variation in zooplankton size structure in term of population dynamics.