Marine Ecological Studies in the Subarctic to Subtropical North Pacific

A mini-symposium to mark the 2005 port call of the T/S *Oshoro Maru* to Honolulu

Program and Abstracts

8 August 2005
University of Hawai'i
Marine Science Building

PROGRAM

09:00-09:05 Opening remarks
Chris Helm, Office of International Education, University of Hawaii

09:05-09:15 Welcoming remarks
Lorenz Maagard, Chairman, Department of Oceanography, University of Hawai'i at Manoa

Samuel Pooley, Science Center Director, Pacific Islands Fisheries Center, NOAA

09:15-09:20 Symposium logisitics
Evan Howell (Pacific Islands Fisheries Science Center, NOAA)

09:20-09:32 **John Bower** (Hokkaido University)
A short history of the *Oshoro Maru* in the North Pacific

SESSION 1: Iron and Aerosols (Chair: Atsushi Yamaguchi)

09:32-09:44 **Kenshi Kuma** (Hokkaido University)
Iron in the northwestern North Pacific Ocean

09:44-09:56 **Chris Measures** (University of Hawai'i at Manoa)
Dust deposition to the surface waters of the North Pacific Ocean inferred from surface water dissolved Al concentrations

09:56-10:08 **Eriko Shimizu, J. Zhang, M. Arisawa and W. Yuan** (Toyama University)
Aerosol geochemistry and nutrient deposition in the North Pacific

10:08-10:20 **Yohei Shinozuka** (University of Hawai'i at Manoa)
Can new satellite capabilities be used to infer cloud condensation nuclei?
-- An empirical assessment based on in-situ airborne data

10:20-10:40 **BREAK**

SESSION 2: Nekton (Chair: Keiko Sekiguchi)

10:40-10:52 **Jeff Polovina, Itaru Uchida, George Balazs, Evan A. Howell, Denise Parker and Peter Dutton (**Pacific Islands Fisheries Science Center, NOAA)
The Kuroshio Extension Bifurcation Region: A pelagic hotspot for juvenile loggerhead sea turtles

10:52-11:04 **Lareina Yee and Keiko Sekiguchi** (University of Hawai'i at Hilo)
Results of a cetacean sighting survey during the T/S *Oshoro Maru* North Pacific cruise in 2005

11:04-11:16 **Evan Howell, Donald R. Hawn and Jeffrey J. Polovina (**Pacific Islands Fisheries Science Center, NOAA)
Vertical and horizontal distribution of bigeye tuna (*Thunnus obesus*) in the northeastern subtropical gyre during summer

11:16-11:28 **John Bower** (Hokkaido University)
Squid studies aboard the *Oshoro Maru*

SESSION 3: Self-introduction of students (Chair: John Bower)

11:28-11:45 **1. Yujiro Aota**
2. Mitsuru Chigira
3. Ryohei Fukui
4. Kei Hirose
5. Shinichi Kado
6. Hitoshi Kaneko
7. Saori Kitayama
8. Eri Manabe
9. Yosuke Sagawa
10. Kenichi Sato
11. Meguru Takashima

11:45-13:00 **LUNCH**

SESSION 4: Plankton (Chair: Hiroji Onishi)

13:00-13:12 **Bob Bidigare** (University of Hawai'i at Manoa)
Influence of climate forcing on plankton community structure in the subtropical North Pacific Ocean

13:12-13:24 **Saho Kitatsuji and Tsutomu Ikeda** (Hokkaido University)
Long-term changes (1984-1994) in phytoplankton communities in Oshoro Bay, northeastern Japan Sea

13:24-13:36 **Cecilia C.S. Hannides* and Michael Landry** (*University of Hawai'i at Manoa)
Spatial and temporal variability in mesozooplankton community structure in the subtropical North Pacific

13:36-13:48 **Atsushi Yamaguchi** (Hokkaido University)
East-west comparison in zooplankton community structures along 165°E and 165°W in the North Pacific Ocean

13:48-14:00 **Ken Kato and Naonobu Shiga** (Hokkaido University)
Summer distribution and community structure of appendicularia in the northwestern North Pacific

SESSION 5: Remote Sensing (Chair: Evan Howell)

14:00-14:12 **Takahiro Iida**[*], Jia Wang, Meibing Jin and Seiichi Saitoh ([*]Hokkaido University)
The springtime plankton dynamics affected by wind forcing and solar radiation on the Bering Sea shelf

14:12-14:24 **Kazushige Oishi** (Hokkaido University)
Temporal and spatial variability of chlorophyll *a* concentration around Futaoi Island in the Sea of Japan - A comparison of satellite ocean color data and in-situ ship observation data

14:24-14:36 **Cedric Chavanne** (University of Hawai'i at Manoa)
HF-radar remote sensing of the ocean surface currents in the lee of Oahu, Hawaii

14:36-14:48 **Toshiyuki Konishi** (Hokkaido University)
Prediction of Pacific saury fishing grounds based on SST and SSC variability derived from satellite remote sensing data

14:48-15:10 **BREAK**

SESSION 6: Acoustics, Nutrients and Hydrography (Chair: Kenshi Kuma)

15:10-15:22 **Reka Domokos** (Pacific Islands Fisheries Science Center)
Distribution and abundance estimates of micronekton and tuna using two frequency echosounder in the tropical and subtropical Pacific

15:22-15:34 **Takaaki Tatsuta, Kouji Iida and Toru Mukai** (Hokkaido University)
Relationship between SV and zooplankton in the North Pacific

15:34-15:46 **TaeKeun Rho** (Hokkaido University)
Nutrient dynamics and productivity in the Bering Sea during 1997-2001

15:46-15:58 **Fernando Santiago-Mandujano** (University of Hawai'i at Manoa)
Long-term hydrographic observations in the subtropical North Pacific during the Hawaii Ocean Times-series

15:58-16:10 **Hiroji Onishi** (Hokkaido University)
Temperature inversion in the Gulf of Alaska

16:10-16:15 Closing remarks
Kenshi Kuma

ABSTRACTS

Influence of climate forcing on plankton community structure in the subtropical North Pacific Ocean

Bob **Bidigare**

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Potential biological responses to basin-scale climate forcing in the Subtropical North Pacific Ocean are assessed based on temporal variations in phytoplankton community structure observed at Station ALOHA (1990-2004) and the output of a Regional Ocean Modeling System (ROMS) model. Phytoplankton populations were monitored monthly during this period using taxon-specific pigment analyses. These analyses revealed distinct temporal patterns, with highest pelagophyte abundance during the periods 1990-1995 and 1998-2004. For other key groups, such as the haptophytes and cyanobacteria, there appears to be a recent post-1998 enhancement in their biomass relative to the previous period of observation. An Ocean General Circulation Model, based on the terrain-following vertical coordinate primitive equation ROMS model, was used to simulate hydrographic dynamics at Station ALOHA. A comparison of model simulation with TAO observations has shown that the model can realistically reproduce the low-frequency (seasonal-to-interannual) variability. The ROMS simulation during 1990-2004 will be first compared against the HOT physical measurements and then used to help interpret the observed changes in phytoplankton community structure at Station ALOHA.

Squid studies aboard the *Oshoro Maru*

John **Bower**

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The cephalopods, commonly the octopuses, squids and cuttlefishes, comprise a well-defined class of Mollusca. Much of what we know about these animals comes from inshore species, which are those most available to study and easiest to maintain in tanks. The offshore fauna, which comprises both epipelagic and deep-sea species, is far less well known. My talk will briefly describe some of our research aboard the *Oshoro Maru* on the offshore fauna, including the red flying squid (*Ommastrephes bartramii*) and several gonatid species.

HF-radar remote sensing of the ocean surface currents in the lee of Oahu, Hawaii

Cedric **Chavanne**

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Two high-frequency radars were deployed on the west shore of Oahu, Hawaii, from September 2002 to May 2003, as a component of the Hawaii Ocean Mixing Experiment (HOME). Surface currents were obtained every 20 to 30 minutes during the 9-month period, up to 100 km offshore with a spatial resolution of 2 km.

The 9-month average circulation reveals the Hawaiian Lee Current, flowing northwestward along the western side of the Hawaiian archipelago. The variability is dominated by 10-day oscillations of 50 cm/s amplitude, mesoscale eddies spun-up at Barbers Point, and semi-diurnal tidal currents of 10-20 cm/s amplitude. A study of island retention vs. dispersal of reef larvae is on-going.

Distribution and abundance estimates of micronekton and tuna using two frequency echosounder in the tropical and subtropical Pacific

Reka **Domokos**

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Active acoustics measurements at 38kHz and 120kHz frequencies were used as part of an effort to advance our knowledge regarding the oceanographic characteristics of the American Samoa fishing grounds and to better understand how these characteristics affect the local longline fishery and their target species, albacore tuna. For this project, shipboard acoustics data were collected March-April, 2004, on board the *Oscar Sette* to study the spatial and temporal distribution and relative abundance of forage for albacore, the micronekton scattering layer. Results were compared with depth records from tagged tuna, satellite altimetry data, and CTD profiles. Tagged albacore spend most of their time between 150-250 m depth --- with depths between 150-300m during the day and 0-200m during the night --- corresponding to relatively high biomass as estimated from acoustic backscatter and to strong temperature and salinity gradients. Further, horizontal distribution of relatively high biomass corresponds to that of lower dissolved oxygen and higher chloropigments.

Another project involving active acoustics is designed to develop an efficient method for long-term monitoring of tuna biomass at Cross Seamount within the Hawaiian EEZ, as well as to study the effects of the physical environment of seamounts on bigeye and its forage, the micronekton scattering layer. Shipboard active acoustic measurements at 38kHz and 120kHz frequencies were collected over Cross and Finch seamounts during the month of April, 2005, as part of a

preliminary investigation. Future plans include a cruise back to Cross Seamount in the spring of 2007 to complete the first acoustic survey for bigeye tuna biomass estimation.

Spatial and temporal variability in mesozooplankton community structure in the subtropical North Pacific

Cecilia C.S. **Hannides**[1] and Michael Landry[2]

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Recent evidence from the Hawaii Ocean Time-series (HOT) program indicates that mesozooplankton biomass has increased in the North Pacific over the past decade. This observation challenges the classic view of a time-invariant, "climax state" zooplankton community in the region. To understand this shift in perspective we explore differences between current (HOT) and early (CLIMAX) long-term sampling studies in the subtropical gyre. We focus on change in zooplankton species composition over space and time. Decadal change in the zooplankton community is finally linked to physical changes in the upper water column of the subtropical North Pacific.

Vertical and horizontal distribution of bigeye tuna (*Thunnus obesus*) in the northeastern subtropical gyre during summer

Evan **Howell**, Donald R. Hawn and Jeffrey J. Polovina

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Popup satellite archival tags were deployed on 6 bigeye tuna (*Thunnus obesus*) in August of 2003. These tags were deployed from a commercial vessel operating as part of the Hawaii Longline fishery during normal fishing conditions at 150ºW, 30ºN. These tags had times at liberty ranging from 19 to 74 days before release from the animal and surface transmission of data to Service ARGOS satellites. Vertical depth and temperature data from these tags show a strong diurnal pattern with a bimodal surface/depth distribution during the daytime while over 80% of the nighttime was spent at the surface. Geolocations were estimated using a Kalman Filter state-space model and light and surface temperature values measured by the archival tag. The horizontal distributions of these 6 bigeye tunas show a highly resident pattern, with over 71% of the total time at liberty spent in the box 145ºW-154ºW, 27ºN-32ºN. Fishery data from the Hawaii Longline Logbook program shows that this region is an area of high historical bigeye catch and effort in the summer months of recent years. Satellite altimetry and sea surface temperature data show that this region is situated on the northeastern gradient of the subtropical gyre, a region with high eddy activity. These

temporal and spatial conditions appear to creating a preferential habitat for bigeye tuna, resulting in a shift from migratory to residential behavior in summer months in this region resulting in high interaction with the Hawaii Longline fishery

The springtime plankton dynamics affected by wind forcing and solar radiation on the Bering Sea shelf

Takahiro **Iida**[1], Jia Wang[2], Meibing Jin[2] and Seiichi Saitoh[1]

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2- International Arctic Research Center, 930 Koyukuk Drive, PO Box 757335, University of Alaska Fairbanks, Fairbanks, Alaska 99775-7335

Interannual and seasonal variability of surface phytoplankton are examined in the Bering Sea using Empirical Orthogonal Function (EOF) analysis of Sea-viewing Wide Field-of-view Sensor (SeaWiFS) datasets from 1998 to 2002. The results of EOF analysis on normalized monthly fields in spring (April-June) after temporal and spatial monthly means were removed showed that phytoplankton concentrations varied in spring. The spatial EOF showed different phases occurred on the eastern shelf and the western Bering Sea shelf. This suggests the timing and magnitude of the spring bloom has an east–west dipole mode in the Bering Sea. The east-west dipole of the spring bloom is linked by ocean surface wind and solar radiation in connection with the position and strength of the Aleutian low. The Aleutian low located in the western Bering Sea, winds blow in the western Bering Sea, the solar radiation is stronger in the eastern Bering Sea.

To quantify phytoplankton variability in relation to wind and solar radiance, we simulated the phytoplankton dynamics using a vertical one-dimensional NPZD ecosystem model. The phytoplankton bloom period varied from late April to late May in relation to wind-driven water column convection in the eastern and western Bering Sea. Large phytoplankton blooms occurred when the mixing layer depth was shallow, the winds were weak, and the solar radiance was strong. These results show that the timing and distribution of the phytoplankton bloom changed with the Aleutian low system.

Summer distribution and community structure of appendicularians in the northwestern North Pacific

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Appendicularians live within a complex mucus structure known as ‘house’. They feed efficiently on food ranging from nanoplankton to bacteria by filtering ambient water with mucus filters, and transfer energy directly to higher trophic levels in the marine ecosystem. Since appendicularians are fragile organisms, there have been few studies on their distribution compared with other zooplankton taxa. In the present study, we examined the horizontal and vertical distribution of appendicularians in the northwestern North Pacific.

Samplings were conducted by vertical hauls (0-150 m depth) with a NORPAC net (mesh size 0.33 mm) along 155°E (35°− 44°N) in the northwestern North Pacific during May− July of 2001, 2002 and 2003. Based on hydrographic conditions, this region can be divided into three domains (subarctic domain: SA, transition domain: TD, subtropical domain: ST). The number of sampling stations ranged from 6 to 14 each year. To determine the vertical distribution, simultaneous horizontal tows with MTD (Motoda) nets (mesh size 0.33 mm) were made at 20- to 50-m depth intervals between 0 and 200 m depth at 44°N, 42°30’N, 39°30’N and 38°N in 2003. All the samples were preserved with borax-buffered formalin, and appendicularians were identified under a stereomicroscope.

A total of 15 species were identified. Species number was greater in the southern region (SA: 4, TD: 12, ST: 14 species). In the SA (north of ca. 42°N), the cold-water species *Oikopleura labradoriensis* was most abundant, followed by *Fritillaria borealis* f. *typica*. *O. labradoriensis* showed a bimodal vertical distribution with peaks at 0 and 50 m depth. In the TD (ca. 40− 42°N), *O. labradoriensis* and *O. longicauda* (warm water species) were dominant. The vertical distributions of the two species differed slightly; *O. longicauda* dominated near the surface, while *O. labradoriensis* dominated below 50 m depth. The neritic species *O. dioica* was also collected at a few stations in the TD, presumably due to transport by the Kuroshio. In the ST (south of ca. 40°N), many warm water appendicularians were collected. *O. longicauda* was dominant at most stations, followed by *O. fusiformis*. Smaller *F. pellucida* predominated (79.6 inds. m^{-3}) at the surface in the ST. The horizontal and vertical distributions of appendicularians are primarily governed by surface currents and will reflect the difference in their optimum temperature ranges, even within the same hydrographic domain in the oceanic North Pacific.

Long-term changes (1984-1994) in phytoplankton communities in Oshoro Bay, northeastern Japan Sea

Saho **Kitatsuji** and Tsutomu Ikeda

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Phytoplankton samples collected at bi-weekly or monthly intervals in 1984-1994 (11 years) in Oshoro Bay, northeastern Japan Sea, were analyzed to look for a signal from the 1989/1990 regime shift, which caused a sudden increase of sea surface temperature

(SST) throughout the Sea of Japan. Phytoplankton were collected with a conical net (110 μm mesh aperture) towed through the surface layer from the center of the semi-closed bay to its mouth and preserved in 10% neutralized formalin-seawater. As environmental parameters, SST, transparency and specific gravity (a measure of salinity) were measured at each sampling station. Day-length data were obtained from the Japan Meteorological Agency homepage. In the laboratory, phytoplankton cells larger than 100 μm were counted and identified to species. Of the time-series data of 1984-1994, a signal of the 1989/1990 regime shift was detected in monthly SST anomalies, but not in monthly specific gravity and transparency anomalies. During the 11 years, phytoplankton abundance (cells ml-1) was high during the late 1980's and the 1990's, and was negatively correlated with SST. It is interpreted that low phytoplankton (cell size >100 μm) abundance during high SST years was due to possible nutrient depletion caused by an earlier bloom of smaller phytoplankton. It has been observed that small phytoplankton blooms occur in early summer during years of high SST. Phytoplankton community structure (species composition) was not affected by the 1989/1990 regime shift. An anomalous feature seen in phytoplankton community structure was the predominance of *Pseudo-nitzschia* sp. in the summer 1992 since centric diatoms were the dominant phytoplankton component in the summer of all other years. A combination of low nutrients and short day-length in spring-summer 1992 is considered to be a special condition to which *Pseudo-nitzschia* sp. is better adapted than the other diatoms.

Prediction of Pacific saury fishing grounds based on SST and SSC variability derived from satellite remote sensing data

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Pacific saury, *Cololabis saria*, is one of most important commercial fishes exploited in the Northwest Pacific Ocean, especially in the waters around the central Kurile Islands, southeastern Hokkaido Island and northeastern Honshu Island. We investigated the temporal and spatial variability of sea surface temperature (SST) and chlorophyll-*a* concentration on the formation of saury fishing grounds, and estimated the daily saury fishing grounds. During 2000-2002, we analyzed these fishing grounds based on the distribution of fishing fleet lights from Defense Meteorological Satellite Program/Operational Linescan System (DMSP/OLS) night time images, sea surface temperature (SST) from NOAA/AVHRR data, and chlorophyll-*a* from Orbview2/SeaWiFS images. We found that the fishing grounds formed on the range of 11.8-18.0^{o}C and 0.4-2.4 mg chl-a/m^{3} off southeastern Hokkaido, 12.5-18.8^{o}C and 0.2-1.4mg/m^{3} off the Sanriku coast and 16.0-19.8^{o}C and 0.3-0.8mg/m^{3} off the Jyoban coast. These results show a relatively good agreement with the daily saury fishing grounds detected by DMSP/OLS. In this study, we estimated the optimal environmental

conditions for the formation of saury fishing grounds, which may help fisherman to find good fishing grounds in the future.

Iron in the northwestern North Pacific Ocean

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Iron is an essential micronutrient for phytoplankton growth, as an important component of such biochemical processes as photosynthetic and respiratory electron transport, nitrate and nitrite reduction and chlorophyll synthesis. Although iron is an element of great biological and geochemical importance, its oceanic chemistry, such as inorganic speciation and organic complexes, is very complex and not yet fully understood. Recently, a number of studies pointed out that the Fe(III) complexation with natural organic ligands is possible in oceanic waters, but the detailed distribution, origin and chemical identity of organic ligands are largely unknown. Here I present the basic concept of bioavailable iron species in seawater and iron chemistry in seawater such as ferric iron hydroxide solubility and iron-organic complexation in seawater. Finally, I present the detailed vertical distributions of iron (Fe(III) hydroxide solubility, dissolved and dissolvable Fe concentrations) which are strongly related to the concentration and affinity of natural Fe(III)-complexing organic ligands in seawater in the northwestern North Pacific Ocean showing the iron source such as upwelling, vertical water mixing during winter and atmospheric input.

Dust deposition to the surface waters of the North Pacific Ocean inferred from surface water dissolved Al concentrations

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Surface water dissolved Al concentrations determined during two cruises in the north western and central Pacific have been used to calculate mineral dust deposition to the surface waters of these regions. Along 30˚N, calculated mean mineral deposition rates range from ~ 1 gm m^{-2} yr^{-1} in the subtropical gyre near Japan to less than 0.1 gm m^{-2} yr^{-1} near the US west coast. A region of relatively enhanced deposition was seen to the north west of the Hawaiian Islands, between 155 and 145˚W. In the north west Pacific, the mixed water region and the sub-arctic gyre west of 170˚E show deposition values that range from <0.1 to 0.6 gm m^{-2} yr^{-1}. These values are more than one order of magnitude lower than those predicted for this region by the GESAMP model (Duce *et al.*, 1991) and are surprisingly low given the very large transport of dust from the Gobi desert over this part of the ocean. The high altitude of the dust transport across this region, above

the marine boundary layer, is thought to be responsible for the relatively low mineral deposition rate. However, the low deposition rate of mineral aerosol material to the surface waters of this region is consistent with their High Nutrient Low Chlorophyll status, since this would suggest that only small amounts of Fe are added to the nutrient-rich surface waters by aerosol deposition.

[Duce *et al*. Global Biogeochemical Cycles, 5, 193-259, 1991.]

Temporal and spatial variability of chlorophyll *a* concentration around Futaoi Island in the Sea of Japan - A comparison of satellite ocean color data and in-situ ship observation data

Kazushige **Oishi**

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A large fishing ground for chub mackerel and Japanese sardine occurs in the Sea of Japan around Futaoi Island, where the Tsushima Current, which is high in nutrients and chlorophyll, flows eastward and mixes with coastal water. To better understand the spatial and temporal variations of chlorophyll distribution in this area, we observed chlorophyll concentrations using satellite ocean color data and in-situ ship observation data. We measured in situ chlorophyll concentration during 29 July 29, 4-5 August, 8 October, and 25 November 2004 using a MODIS (Moderate Resolution Image Spectroradiometer) for satellite chlorophyll estimation. Chlorophyll concentrations were generally higher near the coast than in offshore waters. This difference was larger in autumn and winter than in summer. In situ chlorophyll concentrations showed a peak at 20-25 m depths. The correlation coefficient between satellite and in situ observations was 0.82, and the slope was 0.58. During autumn, a chlorophyll front occurred in the coastal area and may have resulted from nutrients supplied by the Tsushima Current.

Temperature inversion in the Gulf of Alaska

Hiroji **Onishi**

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Temperature inversions are generally observed in the subarctic North Pacific (e.g., Favorite et al., 1976). They are thought to be formed mainly by wintertime cooling from the surface, preserving the memory of wintertime atmospheric conditions. After the formation, temperature inversions gradually weaken as the season progresses due to surface heating and vertical mixing.

Using hydrographic data from the *Oshoro Maru* monitoring along 145°W every summer during 1994-2002 and Argo profiling floats during 2001-2004, I will study the formation and fluctuation of temperature inversions in the Gulf of Alaska focusing on their distributions and interannual variation. The Argo project started in 2000 to monitor the temperature and salinity in the world oceans in 10-day cycles using 3000 profiling floats (The Argo Science Team, 2001).

A distribution map of temperature inversions of all Argo data indicates a distinctive feature separating three areas in the Gulf of Alaska. In the central area of the Alaskan gyre centered at about 53°N, 152°W, large temperature inversions were seldom recorded in all years. Contrarily, in the Alaskan Stream area north of the Alaskan gyre, large (>0.3°C) temperature inversions were often observed. In the Alaska Current east of the Alaskan gyre, small temperature inversions including non-inversions and large temperature inversions were observed together side by side at the same time. In this area, warm mesoscale eddies generated from coastal areas in the eastern Gulf of Alaska are often observed (e.g., Crawford 2002). These eddies carry mesothermal structures in this area. From *Oshoro Maru* data along 145°W, which is just east of the center of the Alaskan gyre, the frequency of temperature inversions and degree of temperature minimum also showed large interannual variations.

The Kuroshio Extension Bifurcation Region: A pelagic hotspot for juvenile loggerhead sea turtles

Jeffrey J. **Polovina**[1], Itaru Uchida[2], George Balazs[1], Evan A. Howell[1], Denise Parker[3] and Peter Dutton[4]

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Satellite telemetry of 43 juvenile loggerhead sea turtles (*Caretta caretta*) in the western North Pacific together with satellite-remotely sensed oceanographic data identified the Kuroshio Extension Bifurcation Region (KEBR) as a forage hotspot for these turtles. In the KEBR juvenile loggerheads resided in Kuroshio Extension Current (KEC) meanders and the associated anti-cyclonic (warm core) and cyclonic (cold core) eddies during the fall, winter, and spring when the KEC water contains high surface chlorophyll. Turtles often remained at a specific feature for several months. However, in the summer when the KEC waters become vertically stratified and surface chlorophyll levels are low, the turtles moved north up to 600 km from the main axis of KEC to the Transition Zone Chlorophyll Front (TZCF).

In some instances, the loggerheads swam against geostrophic currents, and seasonally all turtles moved north and south across the strong zonal flow. Loggerhead turtles traveling westward in the KEBR had their directed westward movement reduced 50% by the opposing current, while those traveling eastward exhibited an increase in directed

zonal movement. It appears, therefore, that these relatively weak-swimming juvenile loggerheads are not passive drifters in a major ocean current but are able to move east, west, north, and south through this very energetic and complex habitat.

These results indicate that oceanic regions, specifically the KEBR, represent an important juvenile forage habitat for this threatened species. Interannual and decadal changes in productivity of the KEBR may be important to the species' population dynamics. Further, conservation efforts should focus on identifying and reducing threats to the survival of loggerhead turtles in the KEBR.

Nutrient dynamics and productivity in the Bering Sea during 1997-2001

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During the late 1990s and early 2000s, the southeastern Bering Sea experienced large physical and biological changes. In this region, there were also changes in the nutrient dynamics, and high ammonium concentrations were observed over the southeastern Bering Sea shelf in early spring. In this study, we investigated interactions between ammonium and nitrate, especially ammonium inhibition of nitrate uptake rates during the early summer of 2000. Ambient nitrate concentrations in the ammonium treatment were not utilized until the ambient ammonium concentration fell below 7 μM. Absolute nitrate uptake rates in the ammonium treatments decreased when ammonium concentrations were greater than 7 μM. Carbon uptake rates increased both in the nitrate and ammonium addition bottles. During 1997-2001, high summer production over the inner shelf may have been supported by the supply of ammonium during 1997-2001.

Long-term hydrographic observations in the subtropical North Pacific during the Hawaii Ocean Times-series

Fernando **Santiago-Mandujano**

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Aerosol geochemistry and nutrient deposition in the North Pacific

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In the present study, we measured the phytoplankton cell-number, chlorophyll *a*, and nutrients in sea surface water between 35-50^{o}N along 165^{o}E in July 2003. In the subarctic and transition regions, the surface water was characterized by high nutrients and low chlorophyll *a* concentration, which suggests that these regions were iron limited. Estimations of nutrient consumption showed that the consumption of silicon and phosphorus were high in these regions. Near 40^{o}N, the sea surface water was characterized by low nutrients and high chlorophyll *a* concentration, which suggests that sufficient iron was supplied to this area. To clarify the origin of iron near 40^{o}N, we calculated the back trajectories of air currents 3000 m above 40^{o}N, 165^{o}E using a model. The model showed that more than half of back trajectories at 40^{o}N, 165^{o}E originated in the Gobi desert. Thus we hypothesize that iron was supplied to the North Pacific by aerosol deposition. We also found that aluminum and opal fluxes measured in a sediment trap at St. KNOT (44^{o}N, 155^{o}E) were highly correlated with dust events in the desert. To determine the effect of continental dust, in August 2004, we collected both aerosols and sea surface water samples over the North Pacific and measured the major water-soluble ions and nutrients in each. NO_3^- concentrations at the sea surface showed that the Japanese coast was a nitrate-limited area. Our estimation showed that the aerosols supplied 24 μmol m^{-2} day^{-1} NO_3^- flux to the Japanese coast. We are now measuring major nutrients, microelement nutrients and acidity in aerosols to clarify the importance of aerosols as a source of iron to the ocean.

Can new satellite capabilities be used to infer cloud condensation nuclei? -- An empirical assessment based on in-situ airborne data

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The goal of this proposed research is to identify the satellite capabilities needed to infer cloud condensation nuclei (CCN). The current satellite algorithms (e.g., Kaufman et al., [1997]) derive the concentration of small particles, which contribute little to the observed radiances, based on their association with larger optically effective particles defined in several aerosol models. It is, however, not clear how well these models reflect the actual aerosol physical, chemical and optical properties. During extensive airborne campaigns in diverse regions over the globe, we measured aerosols deriving from urban pollution, biomass burning, desert outflow and ocean surface. By evaluating their properties, we will constrain the degree to which satellites will be able to effectively retrieve the CCN concentration in various air masses. We expect this effort to provide guidance as to when, where and how satellite platforms might best be used to address this objective.

Relationship between SV and zooplankton in the North Pacific

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In recent years, acoustic technology has been extensively used to estimate zooplankton abundance. Zooplankton generally form a sound scattering layer and aggregate near the surface at night by diel vertical migration. In this study, we compared the volume backscattering strength (SV) measured using a scientific echo sounder (actual SV) with the SV calculated from an acoustic scattering model (calculated SV) and verified the acoustic characteristics of the zooplankton sound scattering layer (SSL). We carried out surveys along 165°E and 165°W during June-August of 2003 and 2004. Acoustic data were collected with a scientific echo sounder (Simrad EK60), and zooplankton samples were collected at night with oblique hauls of bongo nets (2003) and horizontal hauls of an ORI net (2004). We sorted the zooplankton and measured the live body density, sound speed, number of individuals, wet weight, and body length of each zooplankton. On the basis of these data, we determined the calculated SV using the high-pass fluid sphere model described by Johnson (1977). Echograms and the SV were greatest at low frequencies in low latitude areas. The zooplankton samples comprised mainly copepods, so only copepods were used in the acoustic scattering model. Comparison of the actual SV with the calculated SV showed a weak correlation at high frequencies in high latitude areas, and no correlation in low latitude areas. This was thought to be due to the low efficiency of the nets used to collect zooplankton and micronekton and the low accuracy of the acoustic scattering model.

East-west comparison in zooplankton community structure in the subarctic Pacific during summers of 2003 and 2004

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Recently, east-west differences in phytoplankton community in the subarctic Pacific have been well reported; they show that a large spring phytoplankton bloom occurs in the west, while little or no bloom occurs in the east. However, little information is available on east-west differences in zooplankton community structure. In the present study, we evaluated east-west differences in zooplankton community structure and body size in the subarctic Pacific. Zooplankton samples were collected with vertical hauls of a NORPAC net at 0-150 m depth at 7 stations (2003) and 9 stations (2004) between 36°N to 50°N along 165°E, and 7 (2003) and 11 stations (2004) along 165˚W during June-August of 2003 and 2004. After wet-weight measurement, zooplankton were sorted, counted with major taxa and species identification were done for the dominant copepod *Neocalanus cristatus* copepodid 5 stage (C5), *N. plumchrus* C5, *Eucalanus bungii* C4 to C6F, *Metridia pacifica* C6F, the hydrozoa *Aglantha digitale*, and the

chaetognatha *Sagitta elegans*. Body size measurements were also made for each specimen. Integrated mean temperature between 0 and 150 m was lower in the west (165˚E) than at the same latitude in the east (165˚W). In both 2003 and 2004, the abundance of *A. digitale* was greater in the east; in 2004, its abundance was 60 times greater in the east (U-test: $p<0.001$). The copepod *E. bungii* showed the opposite pattern; its abundance was 3 times greater in the west ($p<0.05$). Body sizes of *A. digitale* and *S. elegans* showed a bimodal distribution throughout the region in both years, which suggests the presence of several generations in the study period. Body sizes of most copepod species were larger in the west, which reflect the lower temperature in this region. Differences in marine ecosystem structure and generation length will be discussed as possible causes of the dominance of *A. digitale* in the east and *E. bungii* in the west.

Results of a cetacean sighting survey during the T/S *Oshoro Maru* North Pacific cruise in 2005

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The cetacean sighting survey was conducted along the second and third legs of the T/S *Oshoro Maru* North Pacific cruise 2005. Leg 2 was in the eastern Bering Sea above the Aleutians Islands and Leg 3 was en route from Dutch Harbor to Honolulu, Hawaii along the 165°W longitude line. One or two observers scanned the sea on the upper bridge during full effort surveys using a 7x50 Fujinon binocular while communicated with another who had the responsibility of recording data gathered on the bridge. The survey was conducted daily for 12 days beginning about 1 hour after sunrise weather permitting alongside with other marine research conducted on the vessel. A total of 79 hours and 29 minutes was performed during full effort status during Leg 2 covering a distance of 549.7 nautical miles. On Leg 3, a duration of 172 hours and 45 minutes was used during full effort surveying covering a distance of 1312.75 nautical miles. In total, full effort cetacean sighting survey had covered a distance of 1862.45 nautical miles in 252 hours and 14 minutes. On the Bering Sea voyage, a total of 170 cetaceans was sighted in 63 schools: 3 harbor porpoise in 2 groups, 88 Dall's porpoise in 19 groups, 19 fin whales in 12 groups, 4 sei whales in 2 groups, 24 humpback whales in 11 groups, 13 killer whales in two groups, 3 minke whales and 1 sperm whale and 15 unidentified cetaceans in 10 groups. On Leg 3, a total of 232 cetaceans in 40 groups was sighted: 109 Pacific white-sided dolphin in 5 groups, 56 Dall's porpoise in 14 groups, 16 humpback whales in 6 groups, 8 killer whales in 1 group, 1 northern right whale dolphin, 1 fin whale, 1 sei whale, 1 Ziphiidae and 31 unidentified cetaceans in 2 groups. Most sightings were associated near the edge of the continental shelf in the Bering Sea and in colder waters along the 165°W longitude line.

List of speakers

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