# PICES 2013 Summer School on "*Ocean Observing Systems and Ecosystem Monitoring*"

*by Jack Barth and Craig Risien*

A 5-day PICES 2013 Summer School on "*Ocean Observing Systems and Ecosystem Monitoring*" was held from August 19–23, 2013, at Oregon State University's (OSU) Hatfield Marine Science Center, Newport, Oregon, U.S.A. The goals of the summer school were to 1) learn about in-water ocean observing, 2) work with multi-disciplinary sensors and analyzers in the laboratory, 3) make interdisciplinary measurements during an oceanographic cruise, 4) process and analyze in-water data, 5) answer some interdisciplinary questions about local ocean and estuarine dynamics, and 6) meet new people and have fun.

Thirty-three early career scientists representing all the PICES member countries attended the Summer School (Photo 1). Included in this number were students from Argentina, Australia, India, and the Philippines. Professor Jack Barth (OSU, MONITOR member) was the Principal Organizer and was assisted by the School Coordinator, Mr. Craig Risien (OSU). Instructors included Barth and Risien, as well as Francis Chan (OSU), Burke Hales (OSU), Waldo Wakefield (U.S. National Oceanic and Atmospheric Administration), Steven Rumrill (Oregon Department of Fish and Wildlife), Alicia Helms (South Slough National Estuarine Research Reserve), Cheryl Brown (U.S. Environmental Protection Agency), and R. Kipp Shearman (OSU). Much of the laboratory and field work was led by OSU Teaching Assistants Ata Suanda, Piero Mazzini and Colleen Wall.

The Summer School consisted of a series of classroom lectures, laboratory demonstrations of inter-disciplinary ocean sensors, an introduction to ocean observing platforms, and fieldwork on a research vessel to deploy ocean observing equipment at sea. We covered a range of sensors and equipment used to measure physical, biological and chemical properties of the ocean. Particular emphasis was placed on the measurement of temperature, salinity, dissolved oxygen and the partial pressure of carbon dioxide ($pCO_2$). Students received practical experience with the programming, calibration, deployment, recovery, data file formats, and QA/QC protocols for time-series data. Each student took part in a half-day oceanographic cruise aboard OSU's R/V *Elakha*, conducting sampling along the estuary adjacent to the Marine Center. Students also gained an understanding of the ecological processes that contribute to marine ecosystem metabolism and how to estimate the relative importance of physical and biological contributions.

In preparation for the Summer School, the participants were asked to read about a dozen papers from a list that included detailed descriptions of analytical techniques for measuring oxygen and carbonate species, and a review of physical oceanographic sensors and their use on various platforms, including Argo floats and gliders.

The Summer School started with an introductory lecture about ocean and estuarine observing delivered by Dr. Barth.

*Photo 1 Participants in the PICES 2013 Summer School on "Ocean Observing Systems and Ecosystem Monitoring" (August 19–23, 2013, Newport, Oregon. Photo by David Reinert (OSU).*

He highlighted the importance of knowing the time and space scales of the phenomena of interest in order to design an effective ocean observing system. Dr. Barth also covered the many types of in-water oceanographic instruments and measurement platforms, and the challenges to their use such as keeping them in calibration, bio-fouling, energy demands, *etc*. After an introduction to the oceanography and biogeochemistry of Pacific Northwest waters, his lecture concluded with a description of the near real-time Ocean Observatories Initiative array being installed off Oregon and Washington. A series of lectures then followed, describing the scientific goals and relevant in-water sensors for studying physical oceanography (Dr. Shearman), ocean chemistry (Dr. Hales), ecosystem monitoring and metabolism (Dr. Chan) and fisheries oceanography (Dr. Wakefield).

After learning about physical, biological and chemical sampling techniques in the class lectures, the students broke up into groups of about eight and cycled through half-day laboratory sessions where they obtained "hands on" experience with various oceanographic sensors. In the physical oceanography laboratory, they learned how to operate a conductivity-temperature-depth (CTD) profiler, how to keep the individual sensors in calibration, and how to process data obtained with the CTD at sea. Students also learned how Acoustic Doppler Current Profilers (ADCP) operate, how to calibrate the internal compass inside the ADCP so that the raw velocities can be accurately converted to east-west and north-south currents, and how to interpret velocity time series. The physical oceanography session finished with a demonstration of how autonomous underwater gliders work and how CTD data can be obtained with this new oceanographic platform.

In the biological laboratory, students learned about measuring dissolved oxygen and using it to understand respiration and net community metabolism. They found out about both Clark electrode-type and fluorescence quenching-type dissolved oxygen sensors. Students learned about and completed Winkler titrations for measuring dissolved oxygen concentrations in samples obtained during the Summer School cruises. In the chemistry laboratory, students studied carbonate species in seawater and how to measure them accurately, and how to use an instrument to measure both the partial pressure of carbon dioxide ($pCO_2$) and the total carbon dioxide ($TCO_2$) from seawater samples and how to keep that instrument in calibration using reference samples (Photo 2). A similar system to this is presently being used to estimate ocean acidification in waters entering Oregon oyster hatcheries.

One of the highlights of the Summer School was the chance for students to participate in an oceanographic cruise to carry out a sampling program using the instruments and sensors they learned about in the classroom and laboratories. The students were split up into four groups and each group embarked on the R/V *Elakha* for a half-day cruise on the Yaquina Bay estuary. The cruises were designed to sample changes over two days, hence multiple tidal cycles, and to make measurements spanning from near the ocean upstream to the more freshwater-dominated end of the estuary.

*Photo 2 PICES Summer School instructor Burke Hales (OSU) supervises PICES students, from left to right, Jianbo Luo (China), Renyan Liu (China), Ellen Tyler (USA), Chuning Wang (China), Tetsuichiro Funamoto (Japan), and Bo-ram Shim (Korea) as they operate a combined $pCO_2/TCO_2$ analysis system. Students analyzed samples they collected from various stations in Yaquina Bay while onboard the R/V Elakha in order to better understand the complex biogeochemistry of this estuary. Photo by Steve Rumrill (ODFW).*

The students used the R/V *Elakha*'s flow-through surface seawater instruments for measuring salinity, temperature and chlorophyll fluorescence. They deployed a profiling CTD at several stations to reveal along-estuary gradients in salinity and evidence for vigorous tidal mixing (Photo 3).

*Photo 3 Hiromu Ishiyama (Japan) and Sung Yong Kim (Korea) deploy a CTD rosette from the R/V Elakha. Photo by Jack Barth (OSU).*

Students studied how to take uncontaminated water samples from a rosette bottom system and to prepare them for measuring dissolved oxygen, $pCO_2$ and nutrients (Photo 4). They were thrilled to learn that water samples for $pCO_2$ really are collected using beer bottles and a beer bottle capping device! On one of the half-day cruises, the students helped collect animals in the bay using a beam

trawl towed on the sea floor in order to see the associations of various species with the along-estuary gradients in water properties (Photo 5).

*Photo 4 PICES Summer School students sampling for dissolved oxygen onboard the R/V Elakha. Dubrava Krievskaya (Russia) adds chemical reagents to a dissolved oxygen sample taken with the ship's rosette with assistance of, from left to right, Sung Yong Kim (Korea), Anna Malek (USA) and Christine Cass (USA). Photo by Jack Barth (OSU).*

*Photo 5 PICES Summer School instructor Waldo Wakefield (NOAA) assists students, from left to right, Ellen Tyler (USA), Chuning Wang (China), Tetsuichiro Funamoto (Japan), Jianbo Luo (China) and Christina Frieder (USA) sort a beam trawl sample onboard the R/V Elakha. This particular sample taken from Yaquina Bay included a number of juvenile Dungeness crab. Photo by David Reinert (OSU).*

In addition to the ship-based measurements, students learned how to deploy and recover an oceanographic mooring that sampled water velocity using an ADCP and water properties (temperature, salinity, dissolved oxygen) at the sea floor and at the sea surface. All of these data and water samples were used in the laboratory analyses and in learning about the Newport ocean-estuary system.

Because many of the Summer School students are interested in fisheries oceanography, Dr. Waldo Wakefield provided two very interesting tours of local fisheries research activities. The first was a tour of a Hatfield Marine Science Center laboratory where the effects of hypoxia and temperature on the growth of juvenile English sole and Dungeness crab are being studied. This work, led by OSU graduate student, Morgan Bancroft, involves the use of 21 fish tanks simulating a range of temperatures and dissolved oxygen levels found during the spring and summer months in Oregon coastal waters. The second tour was of the F/V *Excalibur*, docked in Newport and being prepared for a NOAA survey of groundfish along the U.S. west coast (Photo 6). Students were able to see both how fish are sampled and enumerated, and how ruggedized oceanographic instruments are used in the fish trawls.

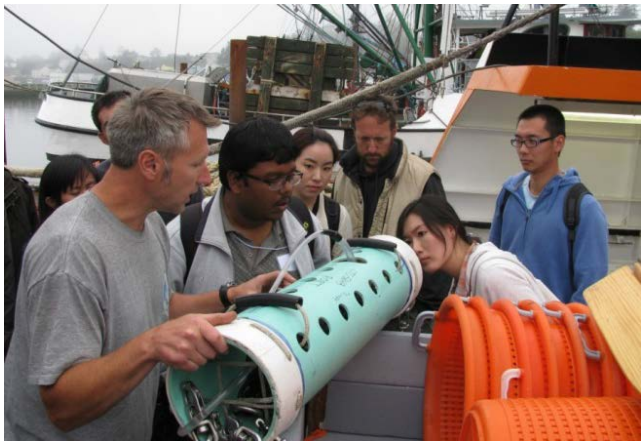

*Photo 6 Victor Simon (NOAA Marine Biologist) onboard the chartered NOAA F/V Excalibur shows Irene Alabia (Philippines), Zhankun Wang (China), Sourav Maity (India), Hanna Na (Korea), Henry Potter (USA), Bo-ram Shim (Korea) and Chuning Wang (China) one of the ruggedized CTD instruments that are attached to the survey bottom trawl for profiling conductivity, temperature, depth, dissolved oxygen, turbidity, and fluorescence. Photo by Jack Barth (OSU).*

The Summer School featured a lecture and tutorial about the global Argo float program delivered by Dr. Howard Freeland. After describing this amazing global program and showing off an Argo float, he demonstrated how to easily access the Argo data so that the students can use it in their own research. We also enjoyed an evening lecture by Dr. Robert Cowen, the new Director of the Hatfield Marine Science Center, who talked about his very exciting optical line scanner for making very detailed *in situ* images of zooplankton and small fish.

On the evening before the final day of the course, the students were challenged to synthesize what they had learned and measured in the field and laboratory to answer some fundamental questions about Newport's ocean-estuary system:

- What is the along-estuary *spatial variability* in physical, biological and chemical properties and what are the driving forces that create these variations?
- What is the *temporal variability* in physical, biological and chemical properties and what are the processes that create these variations across the observed range of time scales?
- What are the relative roles of the coastal ocean and local environmental factors in driving dissolved oxygen dynamics in the estuary, and which dominates at each of the stations we sampled along the estuary?

- Are there departures from conservative mixing predictions as revealed by generating plots of total carbon dioxide, alkalinity, nutrients, partial pressure of carbon dioxide and pH versus salinity from stations along the estuary?

One question was assigned to each group and the students rose to the challenge by doing their homework that evening and then presenting summaries on the final morning of the Summer School. The summaries reflected the students' greater understanding of interdisciplinary ocean observing and were a delight to hear.

The Summer School participants enjoyed meeting and collaborating with other young scientists from around the world. The working groups of about eight enabled close relationships to develop among participants. Discussion and camaraderie continued beyond the classroom and laboratory, with several evenings filled by informal gatherings and friendship. As one student put it, "the opportunity to interact with international students has been not only an excellent occasion to exchange views on each other's work, but also a perfect time to create new relations for future collaborations."


*Photo 7 A way to say "Thank you for the wonderful experience" from our next generation of oceanographers. Photo by Steven Rumrill (ODFW).*

To cap off the Summer School, we took a field trip along the Oregon coast, including walking in the frigid upwelled ocean waters, gazing out across the Pacific from high cliffs as banks of fog drifted by, and watching whales spout just offshore. Judging by student comments, the Summer School was a success: "It was an incredible experience and I am very grateful that I was chosen to participate in it;" "Nicely planned and efficiently managed; entire knowledge and expertise I received is really relevant to my field;" "The week was overall wonderful. The thought put into every detail was apparent (from science to food to field trips);" "Thank you for a wonderful experience." (Photo 7).

We appreciate the assistance of the PICES Secretariat and the Summer School Steering/Selection Committee who helped identify the 33 Summer School attendees from among a pool of 90 applicants. Main funding was from the U.S. National Science Foundation, with travel support from various U.S. and international programs, including the Ocean Observatories Initiative (OOI), the North Pacific Research Board (NPRB), the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project, the Surface Ocean – Lower Atmosphere Study (SOLAS) project, and the Scientific Committee on Oceanic Research (SCOR). In addition, Oregon State University's College of Earth, Ocean, and Atmospheric Sciences (CEOAS) and Hatfield Marine Science Center provided substantial local support.

*Dr. Jack Barth (barth@coas.oregonstate.edu) is a Professor of Oceanography and Associate Dean for Research in the College of Earth, Ocean, and Atmospheric Sciences (CEOAS) at Oregon State University. His research seeks to understand the spatially and temporally variable ocean circulation, water mass structure and ecosystem response in coastal waters including a focus on low-oxygen zones off Oregon. Within PICES, Dr. Barth is a member of the Technical Committee on Monitoring (MONITOR).*

*Mr. Craig Risien (crisien@coas.oregonstate.edu) is a Senior Faculty Research Assistant in the College of Earth, Ocean, and Atmospheric Sciences (CEOAS) at Oregon State University. He has conducted research using satellite-derived winds in relation to oceanographic features and is now actively involved in several ocean observing efforts off Oregon including the Northwest Association of Networked Ocean Observing Systems (NANOOS) and the Ocean Observatories Initiative (OOI).*