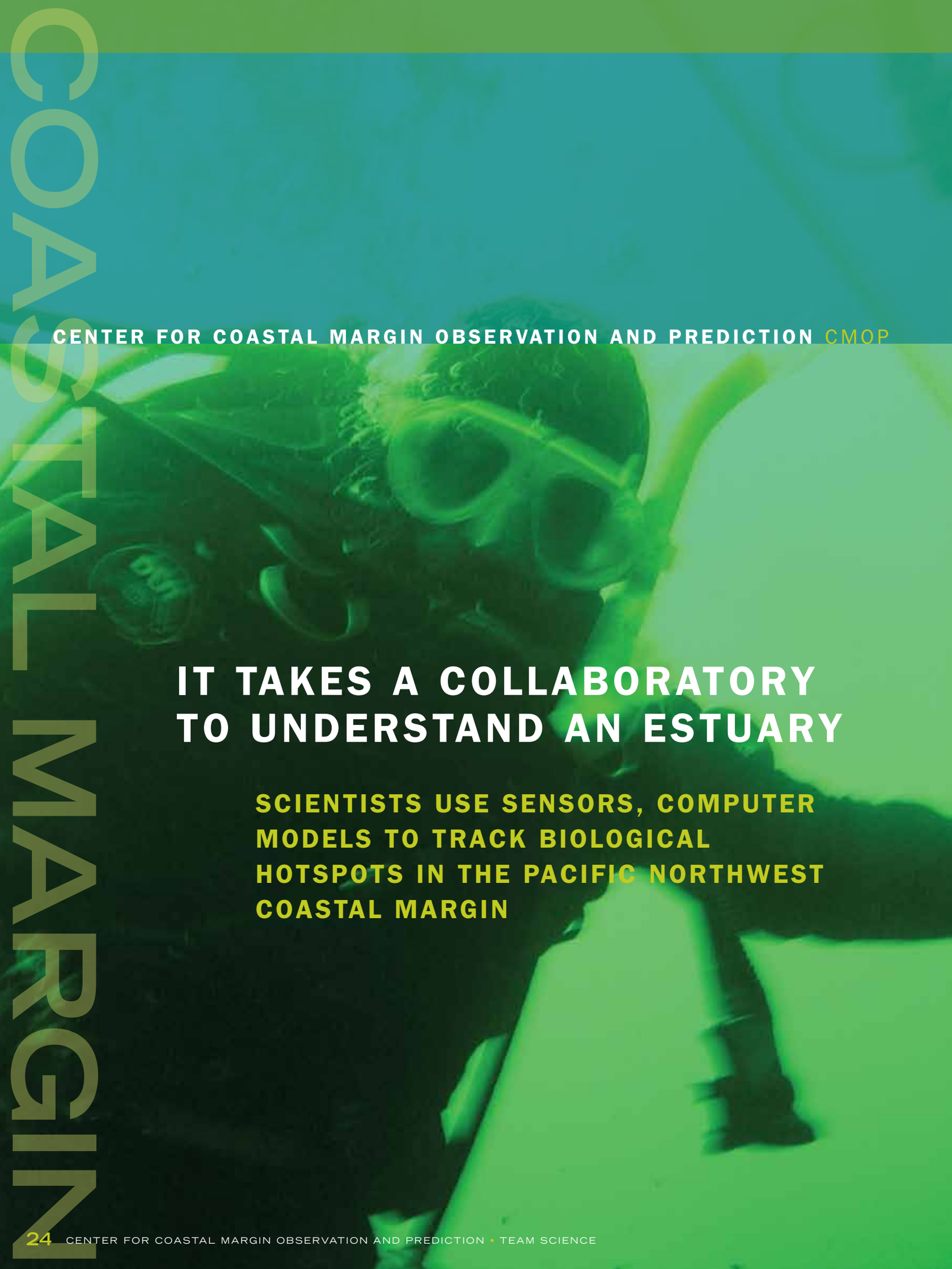
COASTAL MARGIN

CENTER FOR COASTAL MARGIN OBSERVATION AND PREDICTION CMOP



IT TAKES A COLLABORATORY TO UNDERSTAND AN ESTUARY

SCIENTISTS USE SENSORS, COMPUTER MODELS TO TRACK BIOLOGICAL HOTSPOTS IN THE PACIFIC NORTHWEST COASTAL MARGIN

Like canaries in coal mines, biological hotspots in coastal margins are sensitive to the changing environment, such as changes in climate and increased demands on freshwater supplies. Scientists and engineers at the Center for Coastal Margin Observation and Prediction (CMOP) are improving the ability to monitor, understand, and anticipate changes in these hotspots, using the Columbia River as a natural laboratory. An expected outcome is to develop approaches and tools necessary to sustainably manage one of the largest rivers in the world.

Headquartered at Oregon Health & Science University (OHSU) in Beaverton, Ore., CMOP is one of three NSF supported Science and Technology Centers (STCs) that focus on the ocean. It is the first STC dedicated to studying coastal margins, the complex, productive and sensitive regions where rivers meet the sea. Participants include researchers at Oregon State University (OSU), University of Washington (UW), and several other academic, industrial, state, federal and tribal partners. CMOP's research is regionally focused on the Columbia River, but has global relevance for all coastal margins.

Famous for providing Lewis and Clark with a gateway to the Pacific, the "mighty Columbia" ranks first in freshwater input to the Pacific Ocean in the Western Hemisphere. It is the lifeblood for a dense population founded on a rich economy of trade, fishing, logging, recreation, and hydroelectric power industries in the Northwest. Of particular importance to the region is the balance between protection and recovery of species listed under the Endangered Species Act, and the economically vital activities of energy production and of fluvial and marine transportation.

Although Columbia River issues are specific to the region, the need to understand and manage coastal margins is not. Natural features such as estuaries, freshwater and sediment plumes, continental shelves, watersheds, and rivers are all part of coastal margins. These zones are found all over the world and mark unique and ever-changing environments where fluctuations in temperature and salinity–and human activity–affect populations at every level of the food chain.

Because of the importance of coastal margins, oceanographers have long studied the physical and chemical conditions within these dynamic environments. They have sought to quantify seasonal fluxes of sediment discharged by the river to the sea, changes in salinity as a result of melting snow, trends in ocean temperature as a result of El Niño events, and effects of these changes on seasonal salmon runs. They have also started realizing that microorganisms may hold clues to understanding and even predicting natural variability and trends. CMOP is using a systems approach to answer these complicated questions, and to place them in a context of evolving climate and human activities.

Central to CMOP's approach is a "collaboratory," a network designed to transcend disciplinary, logistical, institutional and societal barriers, allowing diverse user communities to interact freely and to have shared access to objective information.

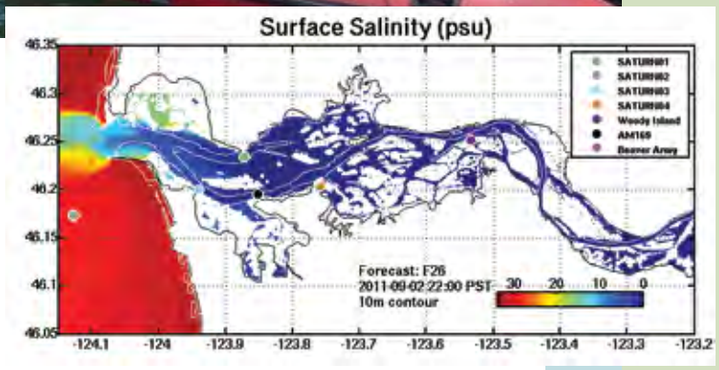
"In the first five years of CMOP we laid the foundation by building SATURN, from the sensors and models to the scientific and broad-impact partnerships," says CMOP director António Baptista. "We are now ready to advance the science in a very systematic way. Our immediate focus is understanding the estuary as a 'bioreactor' that integrates and transforms land, ocean and atmospheric influences."

CMOP scientists are focusing on three biological hotspots – high-turbidity events in rivers, lateral bays, and plankton blooms–which they believe are key. "If CMOP researchers can correlate microbial hotspots in the estuary to the response of the broader coastal margin relative to large-scale forcing, they will greatly advance the ability to anticipate future changes in the ecosystem," says Baptista. "CMOP stakeholders, including state, federal and tribal agencies, would then have a very powerful tool to steer ecosystem performance and sustainability accounting for climate changes and increasing pressures on natural resources. "

This integrated research program and broad societal impact would not be possible without an STC, says CMOP co-director David Martin of UW-APL. In the coastal zone, "everything is interconnected–the hydrosphere, the lithosphere, the chemosphere, the biosphere, the atmosphere," he observes. Trying to understand the entire ecosystem, and the diverse human influences on it, would be impossible through the narrow view of any one discipline. Equally important, the effective integration of scientific findings in regional management is uniquely facilitated by the broad view that the STC program takes of science as a catalyst for societal transformation.□

At top: The Pacific Ocean and Oregon Coast from Cape Lookout State Park. *Photo: Jeff Schilling, CMOP*

At left: Ninety feet below the surface of the Pacific, OHSU diver Michael Wilkin grasps a mooring cable that anchors an ocean observing buoy to the seafloor. *Photo: Jon Graves, OHSU*



Above: OHSU field staff members Michael Wilkin and Jon Graves rewire an ocean observing buoy on a calm day in the Pacific Ocean west of Seaside, Oregon. *Photo: Courtesy of CMOP*

At right: Model of surface salinity in the Columbia River estuary and near plume.

THE SATURN COLLABORATORY

http://www.stccmop.org/saturn

Central to CMOP's approach is the SATURN collaboratory, a network for interaction and data sharing. "SATURN offers a data-rich and model-supported environment, where information, tools and ideas flow freely, enabling team science to flourish," says center director António Baptista.

The SATURN collaboratory is anchored on an interdisciplinary, river-to-shelf observational network. The network includes endurance stations measuring everything from salinity and temperature to biogeochemistry and bacterial diversity on a 24/7 basis. Adding spatial coverage is an array of ocean gliders that roam the Washington shelf and autonomous underwater vehicles (AUVs) that capture the small-scale details of the structure of the Columbia River estuary and plume.

The data collected from the observation network are essential to assessing the skill of SATURN's modern modeling system, the Virtual Columbia River. At the heart of the system are various types of numerical models, each run with realistic bathymetry and river, ocean, and atmospheric forcing to produce daily forecasts, decade-scale historical simulations, and scenarios of change in the future due to climate or anthropogenic activity.

SATURN's observations and the simulations are products used and influenced by a number of communities of practice: individuals and groups who conduct science or make decisions incorporating the information and insight generated by these collaboratory components.

The observations, models, and communities of practice are all producers and consumers of information, a demand that requires a powerful infrastructure to manage. "CMOP's cyber-infrastructure enables the free and timely flow of vast quantities of information among all producers and consumers, while also adding value to the information through QC and analysis tools," says Baptista. "As a complete system, SATURN allows for transformative advances in the scientific understanding of coastal-margins, while simultaneously helping integrate science in regional management and enabling the training of a scientifically and technologically savvy workforce."

NEWS WATCH

COLUMBIA RIVER TREATY

CMOP is working with the Columbia River Inter-Tribal Fish Commission and other organizations to study the impact of the changes in hydropower regulation anticipated as a consequence of the renegotiation of the 1964 Columbia River Treaty between Canada and the US. Since 1964, the Columbia River Treaty has offered significant flood control and power generation benefits for both the U.S. and Canada. In 2024, the 60-year treaty is scheduled to end, opening the opportunity to renegotiate the terms and potential impacts of the treaty. The SATURN collaboratory and CMOP's current research efforts will help characterize the current state of the Columbia River coastal margin, and anticipate future effects on ecosystem health and fisheries. The goal is to provide negotiators with objective information to facilitate science-based decisions.

A WINDOW ON THE MICROBIAL ENVIRONMENT

CMOP is scheduled to take delivery in fall 2011 of an Environmental Sample Processor (ESP) which can be pre-programmed or triggered remotely to collect samples. Purchased from Spyglass Biosecurity, Inc, thanks to a grant from the M.J. Murdock Charitable Trust, the ESP will allow autonomous, on-site collection and near real-time analysis of water samples from the estuary. Addition of the ESP to the SATURN observation network will facilitate comprehensive testing of hypotheses about microbial roles in estuarine processes. The sampling capabilities of the ESP will be particularly useful for understanding the roles of microbial communities in oxygen dynamics in the South Columbia River channel, and for monitoring algal bloom populations and their effects.

At top: OHSU diver Michael Wilkin prepares sensors for deployment at the Marsh Island station of the CORIE observation network in the Columbia River estuary. *Photo: Courtesy of CMOP*

CMOP IN THE CLASSROOM

CONNECTING STUDENTS WITH THE SEA

To establish a "pathway" leading to scientists, engineers, and citizens capable of using a systems approach to addressing complex problems, CMOP is creating education and outreach programs for students and teachers at the K-12 and university levels. Close integration of CMOP's science and technology with the educational activities ensures students' exposure to leading-edge research and its application to coastal margin challenges. Through each educational effort, CMOP strives to broaden participation of traditionally underrepresented groups, in particular Native Americans, the traditional stewards of the environment.

CMOP graduate students receive hands-on training and experience in the laboratory and the field, with access to research cruises, advanced sensors and instruments, and extensive physical and biogeochemical observational data. Students are trained throughout their program in a highly interdisciplinary manner, providing them the skills to understand and solve complex environmental problems through integrative studies across multiple scales, from molecular to global. Additionally, CMOP students regularly attend and present at national and international conferences, co-author publications, mentor high school and undergraduate research interns, teach K-12 science classes and camps, and pursue their own passions as co-PIs, adjunct instructors, fellows, and student government leaders.

During the summer, CMOP's labs swell with high school and undergraduate interns eager to participate in ground-breaking research. The interns, with guidance from frontline mentors and senior scientists, are immersed in the scientific environment through their own research projects designed to contribute to CMOP's research initiatives. Interaction doesn't stop when the summer is over, with many interns joining their CMOP mentors and educators in giving presentations at national conferences or co-authoring their contribution to CMOP publications.

CMOP also offers science enrichment opportunities for middle and high school students through key partnerships in the Pacific Northwest. Working with one of our founding partners, Saturday Academy, CMOP graduate students, staff and investigators develop and teach short-term classes and week-long summer camps to introduce CMOP science to middle and early high school students through interactive, memorable activities to spark long-term science interest.

CMOP is developing a rigorous curriculum that engages primarily Native American high school students in a culturally relevant, place-based learning experience. Designed as a three-year progressive program, the curriculum combines Western environmental science, traditional ecological knowledge from the mid-Columbia River tribes, and a respect for water and cycles of the Sacred Foods to teach students the relevance of ecological sustainability through a meaningful personal experience. Recognizing that true sustainability in K-12 education lies with the teachers, CMOP offers a number of teacher professional development opportunities to inspire and enable inquiry-based ocean science activities in the classroom.

At top: OHSU divers Michael Wilkin and Jon Graves. *Photo: Courtesy of CMOP*

MEET THE DIRECTOR

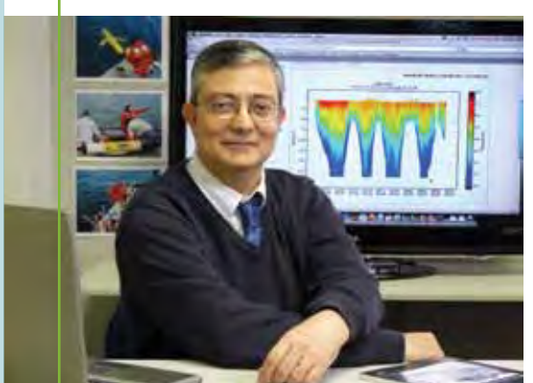
António Baptista

CMOP director António Baptista sees the Columbia River and the Pacific Northwest as an ideal laboratory for studying the impact of climate change and resource management on coastal margins. This is a complex problem requiring contributions from many disciplines, and Baptista is no stranger to establishing collaborative science programs.

Fifteen years ago, he began work on CORIE, a multi-purpose observation and prediction system and the precursor to CMOP's SATURN collaboratory. Ten years ago, he was the founding head of OHSU's Division of Environmental and Biomolecular Systems, which merged environmental science and engineering with biochemistry and molecular biology. For Baptista, creating CMOP seemed to be the logical next step to advance the concept of team science with societal relevance.

"As a society, we require a better scientific understanding of the potential effects that climate and human activity will have on coastal margin ecosystems, to ensure positive outcomes for environmental sustainability, economic development, and public health," says Baptista. "At CMOP, we see addressing this requirement as our Grand Challenge. Having invested earlier in building a collaboratory as a multi-purpose infrastructure for Columbia River studies, we are now entering the exciting phase of exploring how and to what extent collaboratory-enabled science can meet the Grand Challenge. In particular, we should be able to learn a great deal about the estuary as a 'bioreactor' that reflects many of the behaviors and changes of the entire region."

Reflecting back on the first five years of CMOP, Baptista is particularly fond of the emergence of a Center culture that is strong and highly effective in both advancing and applying science. He credits his colleagues for buying deeply into the concept of "team science," often putting the interests of the collective ahead of their own, and actively exploring ways to leverage each other's diverse expertise. "Sharing data, tools, and concepts is the accepted norm within CMOP," he affirms. "Our science can serve as a catalyst for new educational pathways and as the basis for objective regional decision-making."



Antonio Baptista, director of CMOP
Photo: Jeff Schilling/CMOP