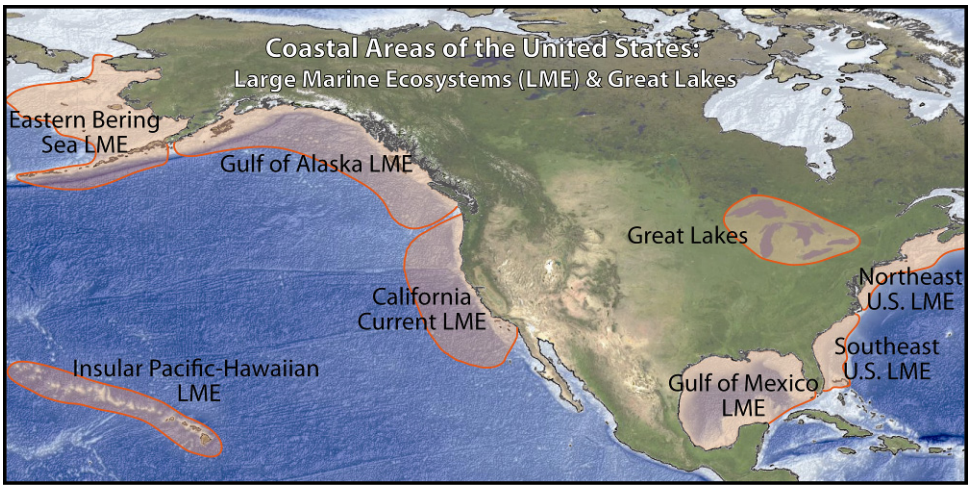
PISCO Partnership for Interdisciplinary Studies of Coastal Oceans

Proposing a National Ecosystem-Based Ocean Science Program

The nation's goals on energy, the economy, and climate change cannot be realized without a renewed focus on science. This is particularly true for ocean science, because the nation's coasts provide a wealth of economic services, including fisheries, storm protection, pollutant absorption, shipping centers, recreation, and renewable energy opportunities. Yet the health of natural ecosystems along our coasts is quickly eroding. These ecosystems provide much of the value we take from the oceans – a value that can be lost or preserved and expanded, depending on choices made. Ecosystem science is urgently needed for each of the nation's large marine ecosystems to guide those choices.

Changing climates will impact coasts severely – through increased sea levels, altered freshwater inputs, shifted fisheries, drowning of marshes and reefs, increased dead zones, bacterial blooms, and changed coastal animals and plants. Consequently, the policy tools used to manage marine ecosystem services – including ecosystem-based management, fishery regulation, and marine protected areas – will have to be modified. Ocean scientists are at the cusp of delivering the integrated ecosystem understanding and management tools needed to inform these adjustments. A national plan for sustainable and expanded use of the oceans will require this new approach to solve problems in coastal ecosystems and devise coordinated management strategies that are rooted in sound science and future sustainability.

Over the last decade, the **Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)** has built a unique research enterprise to discover basic ocean principles that inform a wide range of management decisions and policy tools in the west coast region. PISCO's focus on integrating science from genes to ecosystems provides a unique and timely model for delivering innovative solutions to managing the nation's changing coasts. The model, developed as a partnership of universities, agencies, and foundations, has been successful along the west coast and can be replicated nationally. We suggest the nation adopt this type of model to establish a **National Ecosystem-Based Ocean Science program** with interdisciplinary research and outreach components in *each* coastal large marine ecosystem across the U.S. and in the Great Lakes, which function as a freshwater ocean (see figure).



Because the economic prosperity of the United States is in part contingent on the health of our productive and extensive coastal ecosystems, and because they will be altered greatly by climate change, the time is ripe for a revitalized and effective commitment to coastal ecosystem-based science that serves the entire nation.

Developing Solutions ➢ A new approach for integrated science used in policy and management decisions for the nation's rapidly changing coastal ecosystems.

The ocean science community clearly recognizes that climate change, overfishing, pollution, habitat destruction, and coastal development are seriously threatening the health of the world's oceans and that significant economic benefits depend on healthy coastal ecosystems. In a world of increasing atmospheric CO_2, ocean acidification, increased water temperature, sea level rise, changing upwelling events and oceanic currents, and more extreme storms and waves are already affecting coastal and inland communities. Impacts on coastal erosion, fisheries, recreation, air and water quality, and shipping are likely to increase – with potentially serious impacts on coastal economies that make up the **majority of national GDP**.

The expected changes to coastal ecosystems and economies will involve complex interacting processes. In light of these coming changes, the scientific community must be challenged to conduct innovative research that will rapidly help society make informed decisions about managing coastal ecosystems. The pace of scientific progress will likely be inadequate unless scientists join forces to approach problems in an integrated way that emphasizes collaborative work by different scientific disciplines. For example, new fishery management mandates and climate change adaptation in coastal areas will both require integrating ecosystem ecology, oceanography, economics, population biology, geography, and public planning.

Currently, however, research in the academic community tends to be short-term, small-scale, and single-discipline, and agencies tend to address environmental problems individually and often on a state-by-state basis. Neither approach provides the integrated understanding of ecosystem changes at geographic scales that are the most relevant to ocean species and management.

There is also an urgent need for mechanisms to transfer science outcomes to decision makers and policy makers' concerns to scientists. In short, the nation's current approach to ocean science and policy is not providing the necessary integrated ecosystem-scale knowledge nor is it effectively using scientific knowledge to frame policy and management options. PISCO was designed to transcend these limits and, over a decade of testing and refinement, has developed an approach that delivers high quality science, collaborative work, and policy engagement.

The ocean community has repeatedly called for an increased focus on ecosystem-based science, for example in a variety of ocean policy reports by the Pew Oceans Commission, U.S. Commission on Ocean Policy, Joint Ocean Commission Initiative, National Research Council, National Oceanic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF). The time has come for national actions that enable and inspire the science community to provide the requisite knowledge and develop the innovative policy options our coastal ecosystems require.

The Unique PISCO Approach ➢ Interdisciplinary collaboration, large geographic scope, integrated monitoring and experiments, public data, rapid conduit to policy makers, student training.

PISCO provides a model for innovative, integrated ecosystem-based science at the large marine ecosystem scale that serves societal needs. PISCO is a consortium of scientists from four universities – Oregon State University, University of California Santa Cruz, University of California Santa Barbara, and Stanford University – who conduct ecosystem-based science in the productive, nearshore portion (<10 miles from shore) of the large marine ecosystem along the west coast. Since PISCO is university-based, it is able to draw upon a culture of innovative, flexible research. Unlike most university efforts, PISCO combines new research with sustained monitoring and active outreach to communities, managers, and policy makers. Importantly, by integrating efforts of researchers across multiple universities and partnering with agency scientists, PISCO is able to span a large marine ecosystem – the 1200 mile coastline of Washington, Oregon, and California.

PISCO brings together disciplines that traditionally have had little interaction – coastal ecologists, molecular and organismal physiologists, geneticists, and physical oceanographers – to produce a holistic understanding of this ecosystem from genes to geography, including the way the physical climate interacts with ecological processes to generate ecosystem production. The result is a team approach to ecosystem science, akin to the team approach of a space expedition, that can flexibly apply the best of new research tools to important problems and can construct management options based on new understanding.

MAJOR PISCO SUCCESSES

DISCOVERY
Cause of Oregon/Washington dead zones
How ocean currents drive productivity on coast
ASSESSMENT
Biological response to acidification
How marine protected areas function in networks
PARTNERSHIPS
Coordinate w/ocean observing network
Monitoring in sanctuaries and reserves
POLICY
Designs for marine area protection
Impacts of alternative energy use

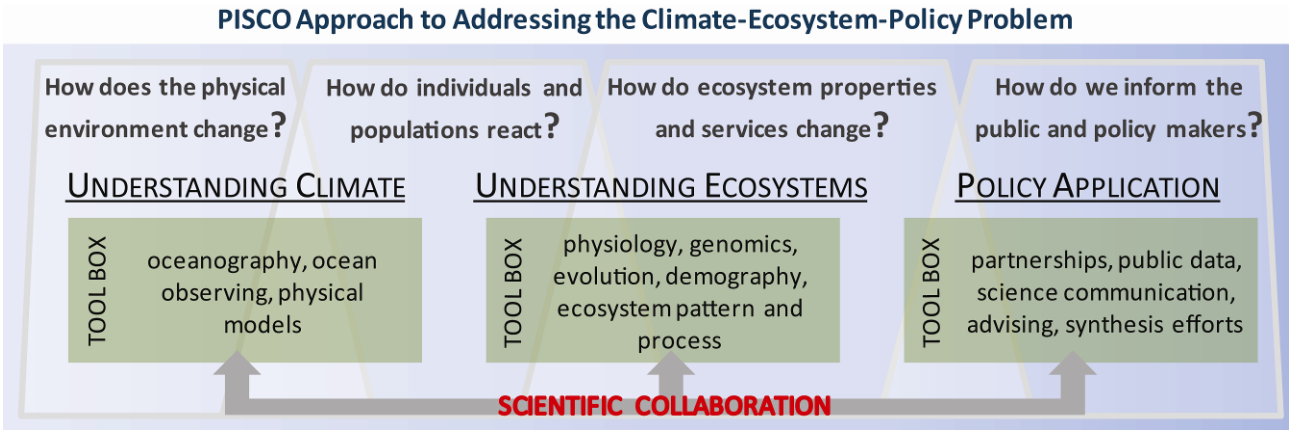
Using a combination of experimental approaches and long-term monitoring, PISCO scientists have provided unique and important insights into ecosystem changes on geographic scales that are relevant to marine species and management. For example, devastating low-oxygen ocean water has appeared off the coasts of Oregon and Washington in each of the last seven years. PISCO scientists led research efforts to trace the cause to global shifts in atmospheric winds and deep ocean layers related to climate change – not to land-based causes such as those that create the dead zones in the Gulf of Mexico. PISCO scientists also led the creation of a set of simple design rules for pioneering networks of marine protected areas in California. They analyzed the movement patterns of ocean species (based on genetics, chemistry, acoustics tagging, and ocean modeling) and the mosaic of different habitats along the coast (based on sonar and oceanic current measurements), to create a compact and smart design that reduces regulatory impact while delivering ecosystem benefits. PISCO has also designed and promoted schemes for cost-effective monitoring of marine areas under strong management to help local state and federal agencies promote their missions. New science at PISCO is unraveling the impact of temperature and acidity

changes on marine ecosystems from the level of gene regulation responses to shifts in species interactions to rapid immigration and emigration of animals and plants.

A core feature of the consortium is the integration of programs and activities across campuses via data archives, information sharing, central administration, and shared staff. This integration coupled with the flexibility and innovation of academic research, enables PISCO scientists to respond immediately to environmental events or critical policy needs by shifting their research and outreach efforts. PISCO scientists have standardized data collection, experimental methods, and data processing within the consortium and built partnerships with federal, state, and local groups to ensure that other projects adopt similar protocols for monitoring and share findings to expand the scientific knowledge base. Over its ten years, PISCO has demonstrated the power of this approach through its successful work on west coast issues such as hypoxia, marine reserve networks, and recruitment patterns of commercially-important fish.

PISCO has also significantly reduced the time from scientific discovery to effective policy changes by supporting coordinated, efficient links between scientists and key decision makers. This **science-to-policy pipeline** flows in both directions to ensure that research is addressing policy needs and to transmit new discoveries more rapidly to managers and decision-makers. PISCO's successes have made it an essential long-term partner for many west coast policy makers and resource managers. The PISCO model is readily transferable to other coasts where new consortia can develop regional priorities, integrate ongoing activities, build upon existing regional networks, and provide much-needed regional knowledge to serve societal needs.

There is great strength in this coordinated, regional approach with the capacity to address a full spectrum of scientific questions from physical and biological changes through to policy applications (see figure below). Understanding and addressing impacts of climate change requires integrating multiple disciplines and diverse scientific tools. A collaborative approach that spans institutions can provide both the disciplinary breadth and the geographic range. Over the last decade, PISCO has developed the key elements of a program that can now be focused on each level of the **climate-ecosystem-policy** approach as well as integrating across the levels. This powerful approach holds great promise and can be used as a model to build consortia with comparable power in the nation's other large marine ecosystems and the Great Lakes.



National Ecosystem-Based Ocean Science Program ➢ Regional partnerships to solve a national problem.

The success of PISCO's approach in connecting academic institutions within a region suggests this is likely a powerful approach for other regions, and indeed for the nation. This approach would allow the ocean community to work efficiently towards understanding key dynamics of all the nation's coastal ecosystems, inform policy discussions in those regions, and contribute to national solutions that will preserve the services our coastal ecosystems provide. For example, a PISCO-like consortium of universities within each of the nation's 7 large marine ecosystems and the Great Lakes could pursue answers of fundamental importance to regional coastal management and stable ecosystem use. The consortia could be facilitated by a national center that would provide unifying functions such as a public database and national outreach.

This program would complement existing federal and state agency programs that are focused on more specific strategic mission and goals. The PISCO academic-collaborative model would greatly enhance the research capabilities of agencies by linking the scientific expertise at multiple universities and creating a constant influx of young scientists and new ideas. The PISCO experience demonstrates that the consortium model creates commitments in the regions by spreading ownership among scientists, institutions, and states and harnesses a network of federal and academic scientists, resource managers, and policy makers. University settings that focus on collaborative science also produce a new generation of scientists who are trained in interdisciplinary approaches and exposed to the societal relevance of their research.

Consortia in each region would partner with existing regional programs, such as the ocean observing communities, National Marine Sanctuaries, regional NOAA fisheries offices, Long Term Ecological Research network, and other programs within U.S. Fish and Wildlife, National Park Service, Minerals and Management Service, U.S. Geological Survey, and Environmental Protection Agency, to fill the gaps in oceanic and ecological research and monitoring in the nearshore ecosystem. Building on these partnerships is a cost-effective use of resources and reduces duplicative efforts. These regional components of a national program and the partnerships created are a powerful recipe for synthetic scientific discovery relevant to informing policy and driving economic prosperity.

A National Ecosystem-Based Ocean Science program would vastly enhance the likelihood of sustainable use of resources, conservation of biodiversity, and creation of vibrant coastal communities, especially in the face of climate change.

Key Recommendations ➢ What the Obama Administration can do to empower the ocean science community to develop innovative solutions in the next 4 years.

1 – Introduce legislation to fund expansion of the **PISCO program as a prototype** for a national system of regional academic consortia to provide interdisciplinary, regional-scale, ecosystem-based knowledge about climate change impacts and options for adaptation.

2 – Submit a **robust FY2010 budget request** for the ocean sciences in general, and especially for NOAA and NSF.
3 – Task NSF as the lead scientific agency, in conjunction with NOAA as the lead ocean agency, to **coordinate experts in the ocean science community** to advise the nation on development and implementation of a university-based National Ecosystem-Based Ocean Science program and to begin the process of creating the other 7 PISCO-like collaborations linked together by a national center.
4 – **Strengthen existing efforts** in regional and integrated ecosystem-level initiatives and programs, such as NOAA Integrated Ecosystem Assessments, NOAA Regional Collaboration, NSF Science and Technology Centers Program, and near-term priorities identified in the nation's Ocean Research Priorities Plan (e.g., Forecasting the Response of Coastal Ecosystems to Persistent Forcing and Extreme Events, Comparative Analysis of Marine Ecosystem Organization, and Sensors for Marine Ecosystems).
5 – Work to expand these disparate efforts to **function seamlessly with a National Ecosystem-Based Ocean Science program**.

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PARTNERSHIP FOR INTERDISCIPLINARY STUDIES OF COASTAL OCEANS

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