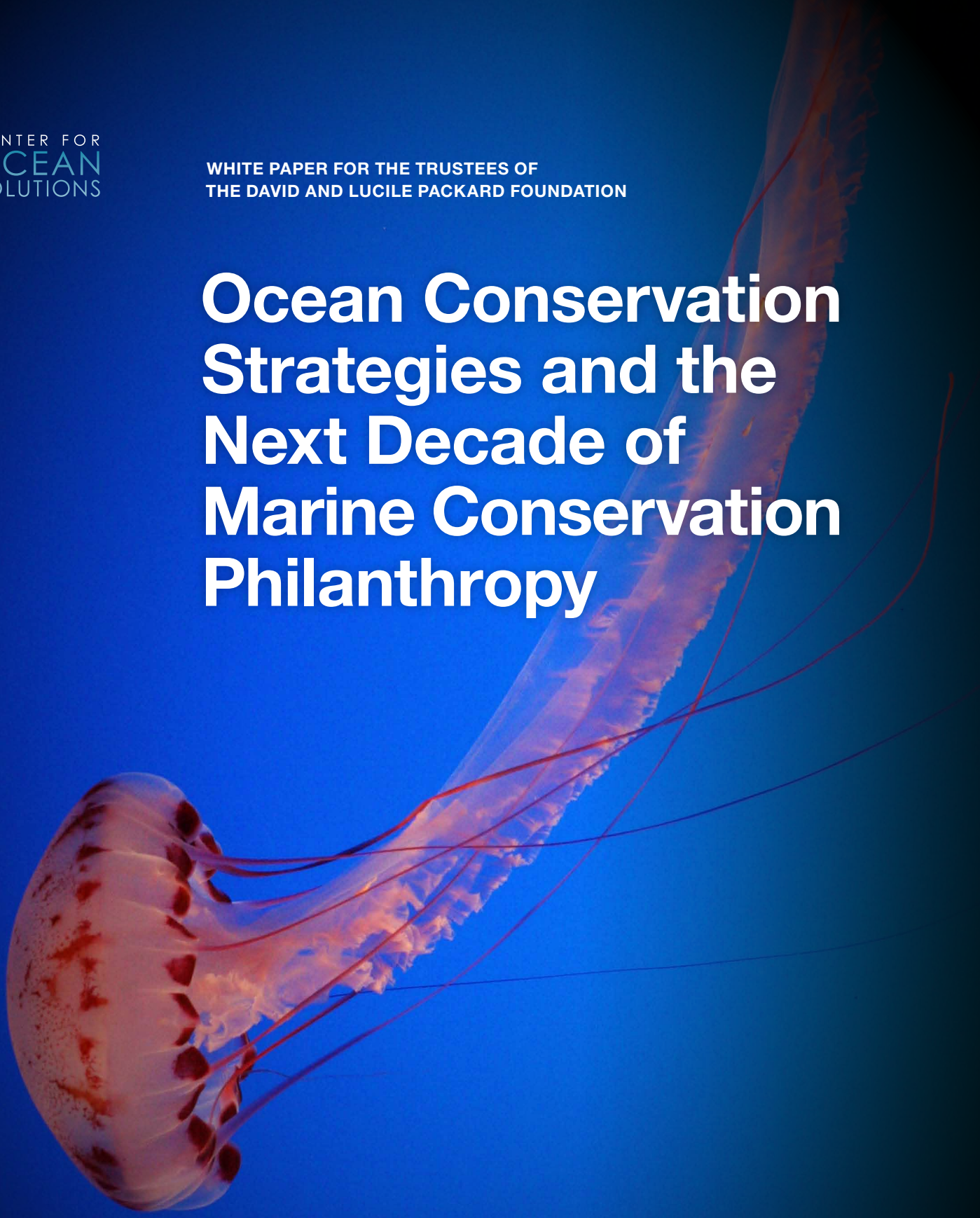
CENTER FOR OCEAN SOLUTIONS

WHITE PAPER FOR THE TRUSTEES OF
THE DAVID AND LUCILE PACKARD FOUNDATION

Ocean Conservation Strategies and the Next Decade of Marine Conservation Philanthropy



November 2011

Discussion Participants

Margaret R. Caldwell (Center for Ocean Solutions & Stanford University)
Xavier Basurto (Duke Marine Lab, Duke University)
Alice Chiu (Stanford University)
Larry Crowder (Center for Ocean Solutions & Stanford University)
Rod Fujita (EDF & Center for Ocean Solutions)
Peter Kareiva (The Nature Conservancy)
Stephen Palumbi (Hopkins Marine Station, Stanford University & Center for Ocean Solutions)
Whitney Smith (Center for Ocean Solutions)
Mike Weber (Resources Law Group)
Thomas Hayden (Stanford University)

Packard Foundation Staff Advisors

Walt Reid
Kai Lee
Lisa Monzon
Richard Cudney
Bernd Cordes
Heather Ludemann

Research Assistance

Blue Earth Consultants, LLC
Eric Hartge (Center for Ocean Solutions)
George Leonard (Ocean Conservancy)

Center for Ocean Solutions. 2011. Ocean Conservation Strategies and the Next Decade of Marine Conservation Philanthropy. The Woods Institute for the Environment, Stanford University, California.

Front Cover Photo: Pacific Sea Nettle (Chrysaora fuscescens). Gerick Bergsma 2009/Marine Photobank.

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I. Introduction to the Packard Foundation Ocean Conservation "Big Think"

Background

In 2010, the David and Lucile Packard Foundation (the "Packard Foundation" or the "Foundation") Staff and Board of Trustees initiated a process to look beyond their ongoing ocean conservation efforts and gain a sense of the greater context of needs and opportunities in ocean philanthropy. The Trustees gathered at a meeting in early June 2010 to review and discuss these opportunities. In preparation for the meeting, Foundation staff commissioned a discussion paper that presents trends and future issues, surveys various ocean conservation strategies, and provides a qualitative analysis of opportunities, barriers to implementation, and potential for conservation results. This paper was first prepared to help inform and stimulate discussion among the Trustees at the June 2010 meeting. This final version has since been updated and expanded, and is meant to fuel lively discussion into the future.

The Packard Foundation currently spends approximately $30 million annually on projects focused on the conservation of marine and coastal systems. The Foundation's ocean-related grant-making primarily occurs in the Western Pacific, along the California coast, and in the Gulf of California; it is predominantly focused on fisheries, marine birds, and coastal conservation. Over the next decade, the Foundation will continue to spend at least $30 million annually (~$300 million total) on ocean conservation. This paper represents an attempt to help the Foundation decide on what and where to focus this funding in order to maximize its impact. For the purpose of this discussion, the contributors to this paper selected two key geographies upon which to focus—the Coral Triangle and the California Current. We present a variety of key ocean conservation strategies and highlight the relative potential of each for impact in the key geographies and globally.

Methodology

The "Big Think" group, comprised of Packard Foundation staff and leading experts in the academic, non-profit, and private sectors, met in-person three times during 2010 to discuss principal driving forces, uncertainties, and pivotal choices that are shaping ocean and coastal ecosystems. We discussed and debated the value and impact of a range of ocean conservation strategies. We selected the Pacific Basin, and within that the Coral Triangle and the California Current, as our geographic region of focus to consider potential philanthropic investment (see *II. Focal Geographies: The Coral Triangle and the California Current Large Marine Ecosystem*). This geographic focus reflects two major geographies where the Foundation concentrates some of its philanthropy, both tropical and temperate marine and coastal ecosystems, and which possess a range of demographic, economic, social, and political attributes and systems. We also developed a narrative projecting the future toward 2050 for the oceans based on key trends and drivers of change in order to outline crucial goals and to help solidify a clear vision for ocean conservation efforts (see *III. Setting the Stage: Future Trends Impacting Human and Ecosystem Health*). Throughout, we maintain the perspective that marine ecosystems and human communities can demonstrate more resilience than they are often given credit for and that conservation strategies should be focused on meeting human needs in our rapidly changing world.

Finally, each of the listed participants and advisors has contributed to this paper by describing and evaluating several ocean conservation strategies (see *V. Achieving Sustainability and Conservation Results*). While not exhaustive, the ocean conservation strategies we consider in this section were selected based on the group's expertise and experience and were built upon promising solution strategies identified in the Center for Ocean Solutions' Pacific Ocean Synthesis Report.[1] Here, we discuss connections among the different strategies and present a set of recommendations for their implementation.

Our Vision: Building Interdependent, Resilient Systems to Achieve Transformational Marine Conservation Outcomes

At the foundation of this discussion, there exists a common thread upon which all of our conclusions are based. We firmly believe the key to conservation is to recognize the interdependence of humans and ecosystems and to honor this interdependence in policies, markets, and social institutions. This vision of an integrated, pragmatic, and transformational marine conservation and economic development rests on two assumptions. First, nature and human institutions can be far more resilient than commonly believed, if enabling conditions (both biophysical and social) exist.[2] Second, we have options that allow us to align the needs of people and nature. Solutions do exist.

We believe several broad approaches can help support this vision. Future conservation efforts should strive to foster working seascapes, in which the most intensive human activities are planned for and managed to minimize damage and in which the natural systems that cannot tolerate heavy impacts are avoided. In addition, by promoting new market forces, as well as social, cultural, and economic incentives, we can help make conservation practices more pervasive in marine management, particularly in places where centralized governance is weak and/or command-control strategies are ineffective. Finally, there must be a focus on aligning economics with social and economic wellbeing and developing solutions at the appropriate scale. There are potentially significant economic gains to be made from this approach, increasingly so as systemic inefficiencies and perverse incentives are eliminated. It is with these underlying beliefs that we frame the discussion presented in this paper.

[1] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[2] Christie, P., McCay, B., et al. (2003) "Toward Developing a Complete Understanding: a Social Science Research Agenda for Marine Protected Areas." *Fisheries 28* (12): 22–25.

Jiangang Luo/Marine Photobank

II. Focal Geographies:
The Coral Triangle and the California Current Large Marine Ecosystem

In this section, we introduce the two geographies that constitute the focus of this assessment of ocean conservation strategies: the tropical Coral Triangle of the Western Pacific and the temperate California Current Large Marine Ecosystem (California Current) of the Eastern Pacific. We selected these focal geographies because they possess distinct ecological, cultural, and socio-political characteristics and because they represent globally significant regions of the Packard Foundation's existing marine conservation portfolio. In addition, substantial data and information exist for both regions.

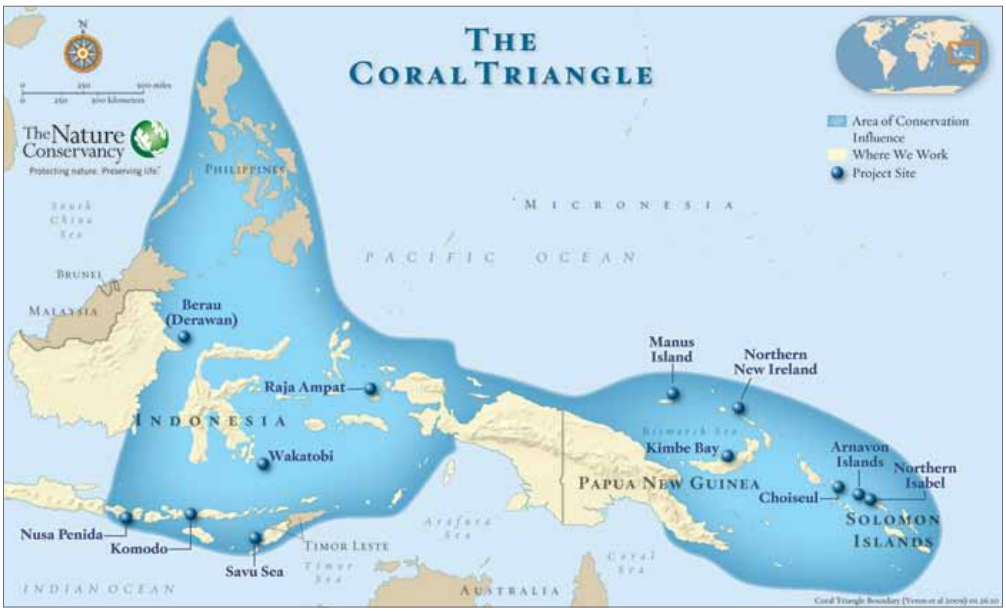
Coral Triangle

Background

The Coral Triangle encompasses 5.7 million km², from eastern Indonesia and Malaysia, through the Philippines, Timor-Leste and Papua New Guinea, to the Solomon Islands, and possesses the world's greatest concentration of marine diversity. It comprises just 1.5% of the earth's oceans, but is home to nearly one-third of the world's coral reefs, three-quarters of known coral species, more than three thousand species of fish, and the most extensive mangrove forests and seagrass beds on the planet. Several factors contribute to this abundant biodiversity: the large area and variety of habitats that allow for local adaptation, the persistence and diversification of local species through multiple periods of climate change, the accumulation and overlap of coral species from the Indian and Pacific Oceans, and the spread of local species to other parts of the Indo-Pacific.[3,4,5,6,7,8,9,10]

The extraordinary marine resources of the Coral Triangle sustain the lives of over 120 million people in the region.[11] They provide a number of ecosystem goods and services, including nursery grounds for commercially important fish species (~$2.4 billion industry), coastal protection from storms and tsunamis, eco-tourism (~$12 billion industry), and cultural and social value.[12,13]

Figure 1: Map of the Coral Triangle



Source: The Nature Conservancy. Map of the Coral Triangle. http://www.nature.org/ourinitiatives/regions/asiaandthepacific/coraltriangle/coral_triangle_map_final_july2010.jpg

An estimated 2.25 million fishers in the region depend on marine resources for their livelihoods, including many in rural, fisheries-dependent subsistence communities with limited opportunities for alternative livelihoods.[14]

Threats

The marine resources of the Coral Triangle are at risk. An estimated 88% of reefs in Southeast Asia face a host of threats, such as overfishing, destructive fishing practices (e.g. cyanide and blast fishing), coral bleaching, ocean acidification due to global climate change, and pollution and sedimentation from coastal development.[15] In addition, growing regional and global population puts mounting pressure on marine resources (see *III. Setting the Stage: Future Trends Affecting Human and Ecosystem Health for additional information on threats*).

Coordinated efforts to address these threats face substantial challenges.[16] Marine protected areas (MPAs) were established to reduce threats to coral reefs and other marine resources; yet, only 10% of these are considered effectively managed in Indonesia, Malaysia, and the Philippines.[17] Moreover, non-compliance with existing laws and weak institutional capacity for enforcement remain problems throughout the region.

Packard Foundation's Funding History in the Region

In 1998, the Packard Foundation's Conservation and Science Program launched the Western Pacific subprogram to support conservation and address threats in the Western Pacific region,

[3] Bureau of International Information Programs, U.S. Department of State. (2010). *Coral Triangle Initiative: Reducing Climate Change Impact in the Southeast*. April 23, 2010. http://www.america.gov/st/energy-english/2010/April/20100426160035xnyazria hs0.7867395.html&distid=ucs.

[4] Vernon, J. (1995). *Corals in Space and Time: the Biogeography and Evolution of Scieractinia*. Sydney: UNSW Press.

[5] Gaston, K. (2000). "Global Patterns in Biodiversity." Nature 405: 220-227.

[6] Pauly, G. (1990). "Effects of Late Cenozoic Sea-level Fluctuations on the Bivalve Faunas of Tropical Oceanic Islands." *Paleobiology* 16: 415–434.

[7] Palumbi, S. R. (1997). "Molecular biogeography of the Pacific." *Coral Reefs* 16: 47–52.

[8] Jackson, J. B. C., Jung, P., Coates, A. G., & Collins, L. S. (1993). "Diversity and Extinction of Tropical American Mollusks and Emergence of the Isthmus of Panama." *Science* 206(5114), 1624–1626.

[9] Wilson, M.E.J. & Rosen, B.R. (1998). "Implications for paucity of corals in the Paleogene of SE Asia: plate tectonics or Centre of Origin?" in *Biogeography and Geological Evolution of SE Asia*. ed. Hall, R. and Holloway, J.D. Leiden: Backhuys Publishers, 165–195.

[10] Bellwood, D. & Hughes, T. (2001). "Regional-scale Assembly Rules and Biodiversity of Coral Reefs." *Science* 292(5521): 1532–1534.

[11] Bureau of International Information Programs, U.S. Department of State. (2010).

[12] Burke, L., Selig, L, & Spalding, M. (2002). *Reefs at Risk in Southeast Asia*. Cambridge: UNEP-WCMC.

[13] World Wildlife Fund. *Coral Triangle*. http://wwf.panda.org/what_we_do/where_we_work/coraltriangle/#1.

[14] The Nature Conservancy. *Coral Triangle Center: Protecting the Most Diverse Reefs on Earth*. http://www.coraltrianglecenter.org/.

[15] Burke, L., Selig, L, & Spalding, M. (2002). *Reefs at Risk in Southeast Asia*. Cambridge: UNEP-WCMC.

[16] Blue Earth Consultants. (2010). *Ocean Conservation Strategic Funding Initiatives: a Study of Successes and Lessons Learned*. Commissioned by the David and Lucile Packard Foundation Conservation and Science Program. http://blueearthconsultants.com/pdf/BEC_FINALPackardOceanConservationStrategicFundingInitiatives172011TCHA.pdf.

[17] Burke, L., Selig, L, & Spalding, M. (2002). *Reefs at Risk in Southeast Asia*. Cambridge: UNEP-WCMC.

which encompasses some of the Coral Triangle countries, including Indonesia, Papua New Guinea, Solomon Islands, and previously, also included Malaysia and the Philippines. The Foundation was one of the first funders to invest in the Western Pacific and, to date, has directed more than $50 million toward supporting conservation and management efforts in the region.[18] In addition, the Science subprogram—launched in 2010[19] and focused on supporting some key science institutions and improving the use of scientific knowledge to meet critical conservation challenges—is cutting across all of the regions and ecosystems in which Packard's Conservation and Science Program invests. Between 2004 and 2009, prior to the Science subprogram being formalized, the Foundation supported an ecosystem-based management strategy, which made some investments in the Coral Triangle region. Thus, the Foundation's total investment in this geography has been substantial.

The Western Pacific subprogram has achieved notable successes related to effective MPA establishment, no-take zones, sanctuaries and reserves, with approximately 485 MPAs established or improved in the region since the Foundation initiated giving.[20] In addition, the Foundation has been a key player in the development of a network of locally-managed marine areas (LMMAs). The LMMA program has motivated many local governments to set more aggressive conservation targets. Indonesia, for example, raised its MPA target to 20% of its territorial waters.[21]

In spite of these successes, the Packard Foundation has encountered challenges within the region, and specifically within the Coral Triangle. For example, the Foundation experienced programmatic setbacks due to a lack of political will for conservation in Papua New Guinea. In Malaysia and the Philippines, the primary focus on the development of MPAs did not adequately eliminate broader threats; the Foundation employed a targeted strategy that could not address drivers such as poverty, population pressure, and limited enforcement capacity. Due to the level of funding that would have been required to address these drivers effectively, the Foundation opted to exit these countries.[22] In spite of its decision to withdraw conservation funding from these countries, however, Packard's investments in these areas prompted other funders to direct resources to the region. Within the Coral Triangle, the Packard Foundation still supports initiatives in Indonesia, Papua New Guinea, and the Solomon Islands that advance site-based conservation, skills exchange, and public education and media.

Emerging Opportunities

The Coral Triangle remains a crucial target for conservation gains, including through public-private partnership initiatives in the region, many led by international non-governmental organization (NGOs) with philanthropic backing. For instance, the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI—www.cti-secretariat.net) is a significant collaboration between regional governments, inter-governmental organizations, NGOs and funders. CTI is working to develop regional management mechanisms, legal frameworks for protection, networks of effectively managed MPAs, ecosystem-based management for ocean resources and building local capacity for resource management and conservation. CTI is engaging with the leadership of the six Coral Triangle countries and working toward a formal meeting of national leaders to develop a set of agreed-upon principles and a framework for a ten-year "CTI Plan of Action."

[18] Blue Earth Consultants. (2010). *Reflections on a Decade of Fostering Positive Change for the Oceans*. Commissioned by the David and Lucile Packard Foundation Conservation and Science Program.

[19] The Science subprogram is a result of the merging of the Conservation Program and the Science Program, joined to form the Conservation and Science Program in 2003. Between 2004-2009 this program focused on an Ecosystem-based Management Strategy, which the Foundation reinvented to become the existing Science subprogram.

[20] *Ibid*.

[21] *Ibid*.

[22] Blue Earth Consultants. (2010). *Ocean Conservation Strategic Funding Initiatives: a Study of Successes and Lessons Learned*. Commissioned by the David and Lucile Packard Foundation Conservation and Science Program. http://blueearthconsultants.com/pdf/BEC_FINALPackardOceanConservationStrategicFundingInitiatives172011TCHA.pdf.

California Current Large Marine Ecosystem

Background

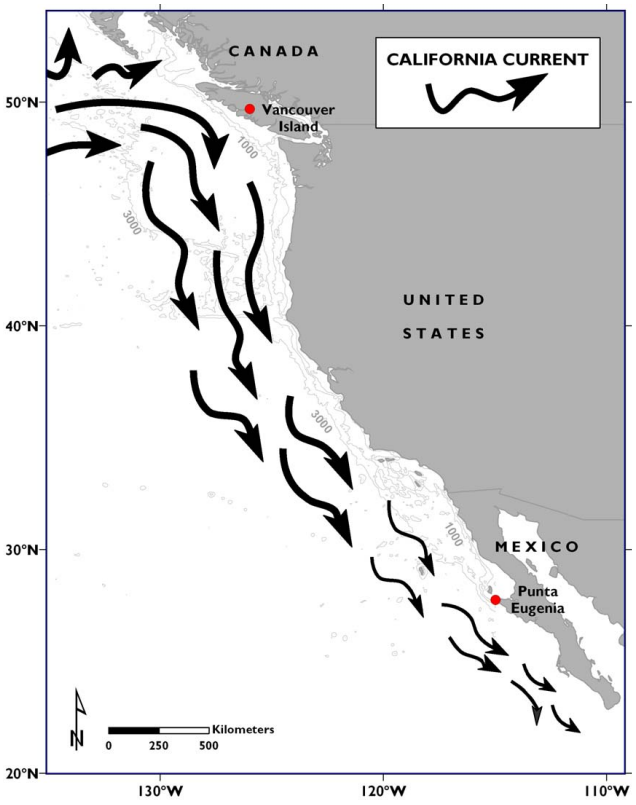
The California Current extends approximately 3,200 kilometers, from the Washington State-Canada border to the south of Baja California and seaward approximately 500-1,000 kilometers.[23,24] This region is a "transition ecosystem" situated between sub-tropical and subarctic water masses with a temperate climate and strong coastal upwelling along the west coast of North America. Due to its seasonal coastal upwelling, the California Current supports large populations of sardines, anchovies, and other pelagic fish and cephalopods.[25]

The California Current is home to fishery, shipping, and tourism industries that are essential to the coastal economies of western North America. In addition, its three major estuaries—San Francisco Bay, the Columbia River, and Puget Sound—contribute to the local economies of the area and enhance the quality of life for those who live nearby.[26]

Threats

The California Current faces significant threats. Changes to upwelling circulation and shifts in the Pacific Decadal Oscillation (PDO) and other ocean-climate regimes represent a major environmental stressor. In addition, intensive commercial harvesting of fish and other living resources, chronic low-level pollution from point and non-point sources, and the large-scale release of captive-bred salmon put marine resources at risk.[27] Similarly, the construction of dams, logging, and agricultural and urban runoff have degraded freshwater resources needed by Pacific Salmon.[28] Throughout the region, seabird populations are generally in decline due to lack of food.[29] Increasing demand for oil, gas, and mineral resources has stimulated exploration in national Exclusive Economic Zones (EEZs), under regulatory frameworks that are either unclear or vulnerable to revision (see *III. Setting the Stage: Future Trends Affecting Human and Ecosystem Health* for additional information on threats).

Figure 2: The California Current Large Marine Ecosystem



Source: Sydeman, W. and S. Thompson. (2010). "The California Current Large Marine Ecosystem." in The California Current Integrated Ecosystem Assessment (IEA), Module II: Trends and Variability in Climate-Ecosystem State: Farallon Institute for Advanced Ecosystem Research. Final Report to NOAA/NMFS/Environmental Research Division. http://www.farallоninstitute.org/Publications/SydemanThompson2010IEAModuleIIReport.pdf

[23] Ekstrom, J. (2006). *Quantifying institutional interplay in the California Current Large Marine Ecosystem*. Paper presented at the Institutional Dimensions of Global Environmental Change Synthesis Conference, Bali, Indonesia.

[24] McGowan, J. A., Chelton, D. B.., and Conversi, A. (1996). "Plankton Patterns, Climate, and Change in the California. Current." *CalCOFI Report*, 37: 45–68.

[25] Aquarone, M. & Adams, S. (2005). "XIV-II California Current: LME#3." in *The UNEP Large Marine Ecosystem Report: A Perspective on Changing Conditions in LMEs of the World's Regional Seas*. ed. UNEP. 593–605.

[26] Pendleton, L. (2007). *The Economic and Market Impacts of Estuary and Coastal Restoration: What's At Stake*. Edited by Linwood Pendleton for Restore America's Estuaries.

[27] Bottom, D., et al. (1993). *Research and management in the northern California Current ecosystem. in Large Marine Ecosystems: Stress, Mitigation and Sustainability*. ed. Sherman, K., Alexander, L. and Gold, B. Washington D.C.: AAAS, 259–271.

[28] National Marine Fisheries. (2010). *Through a Fish's Eye: The Status of Fish Habitats in the United States*. http://books.google.com/books?hl=en&lr=&id=Wk3W6dpKY4EC&oi=fnd&pg=PA1&dq=construction+of+dams,+logging,+and+agricultural+and+urban+runoff+have+degraded+freshwater+resources+needed+by+the+Pacific+Salmon++&ots=EI-WTZ2cix&sig=R0-b6IYJ9xiLU3ZHIT_JKVpOHGE#v=onepage&q&f=false.

[29] Aquarone, M. & Adams, S. (2005). "XIV-II California Current: LME#3." in *The UNEP Large Marine Ecosystem Report: A Perspective on Changing Conditions in LMEs of the World's Regional Seas*. ed. UNEP, 593–605.

Packard Foundation's Funding History in the Region

For more than a decade, the Packard Foundation has provided support for conservation of the California Current large marine ecosystem through five of its subprograms. In 1998, the Foundation initiated the Marine Fisheries subprogram, which funds projects along the United States West Coast, as well as other regions. The following year, the Gulf of California subprogram began, which supports conservation efforts on the Pacific side of the Baja peninsula. Since 2003, the Foundation has funded the Resources Legacy Fund Foundation to manage the California Coast Marine Initiative (CCMI), which aims to advance ecosystem-based conservation of coastal and marine resources in California. In 2004, the Foundation started funding the Marine Birds subprogram (which was formalized in 2006), which among other regions, funds projects along the Pacific Coast of North America to stop or reverse the decline of threatened and endangered seabird and shorebird populations. Finally, as noted above, the Science subprogram invests across all of the geographies the Foundation supports, bringing additional funds to the California Current region. Together, these subprograms have invested tens of millions of dollars in conservation projects along the California Current.[30]

The Foundation's subprograms have supported a variety of conservation approaches and led to tremendous successes in improved conservation and management of the California Current region, including policy reform (e.g., science-based decision making), legislative outcomes (e.g., California Ocean Protection Act), and management changes (e.g., 2005 to 2006 large bottom-trawling closures along the United States West Coast[31]). Development and implementation of the Marine Life Protection Act (MLPA) Initiative was made possible, in part, through Packard support of the CCMI, which played a critical role in the establishment of the California Ocean Protection Council (OPC). Through these policy innovations, the Foundation has helped create or improve 59 MPAs within the California Current.[32] The Marine Fisheries subprogram also supports the Joint Ocean Commission Initiative (JOCI), which works with all sectors of the marine stewardship ocean community to advance meaningful policy reform through ecosystem-based management mechanisms. Packard's support has also been critical in advancing the development of market-based mechanisms, such as the sustainable seafood movement, and the development of fishing concessions and cooperatives within the region.

By its own account, the Foundation has encountered some challenges in achieving enduring change through the years. Specifically, sustained conservation impacts are harder to achieve where limited or inadequate capacity to fully implement or maintain conservation and management mechanisms exists. For instance, Packard's ecosystem-based management investments produced substantial science, yet often failed to effectively link science data and information with key decision-makers and/or policy and management processes; similar challenges occurred with linking sustainable seafood producers with buyers and other consumers.[33] The Foundation also faced issues with vacillating political support from shifting administrations, and in some cases, lack of robust monitoring and evaluation frameworks and metrics reduced grantee ability to adaptively manage programs and ensure alignment with subprogram goals. Having undertaken extensive evaluation of its Conservation and Science funding outcomes and impacts, the Foundation is moving forward with renewed commitment to ocean and coastal conservation and management funding that is even more strategic and more fully addresses the critical role institution-building plays in achieving long-term solutions.

Emerging Opportunities

The California Current has extensive science-based management systems operating at multiple scales. At the local level, for example, the Washington Department of Fish and Wildlife has established citizen-based Marine Resource Committees (MRCs) to raise community awareness about marine issues and to generate support for state and county-level legislative actions. In Oregon, the Ocean Policy Advisory Council used citizen-generated proposals to inform nominations for a series of state-level marine reserves. In Baja California, limited government capacity for governance and enforcement has prompted artisanal fishing communities to form cooperatives around concessions they have for high-price species (e.g., lobster and abalone). They have developed voluntary community marine reserves and associated community-based enforcement systems. There exists the potential for funders to support expansion of voluntary reserves to create a network of marine reserves along the southern Baja coast and to push to formalize these voluntary reserves to become federally protected areas.

[30] Blue Earth Consultants. (2010). Reflections on a Decade of Fostering Positive Change for the Oceans. Commissioned by the David and Lucile Packard Foundation Conservation and Science Program.

[31] *Ibid*.

[32] *Ibid*.

[33] *Ibid*.

At the state level, California's MLPA provides legislative authority to conduct a process to reevaluate and redesign the state's existing system of MPAs and to design new MPAs to incorporate into the network. The related MLPA Initiative is a public-private partnership to help fund the planning process and implementation of the Act.[34] In Oregon, the state is designing a marine reserve network, as well as undergoing a revision of its territorial sea plan. The Oregon Nearshore Research Task Force has been charged with developing recommendations for long-term funding and coordination for nearshore management and research.[35] At the regional level, the US Federal Pacific Fishery Management Council (PFMC) is tasked with managing all 119 federally managed fish species off Washington, Oregon, and California. The West Coast Governors' Agreement on Ocean Health (WCGA) represents another significant regional-scale initiative in the California Current. It seeks to advance the goals of improving water quality and ocean health, implementing effective ecosystem-based management (EBM), reducing the impacts of offshore development, increasing ocean literacy and awareness, increasing collection and use of scientific information, and encouraging sustainable development in coastal communities. The Pacific Coast Collaborative (PCC), meanwhile, is focused on a wide variety of regional issues, including ocean conservation and sustainable economic development.[36]

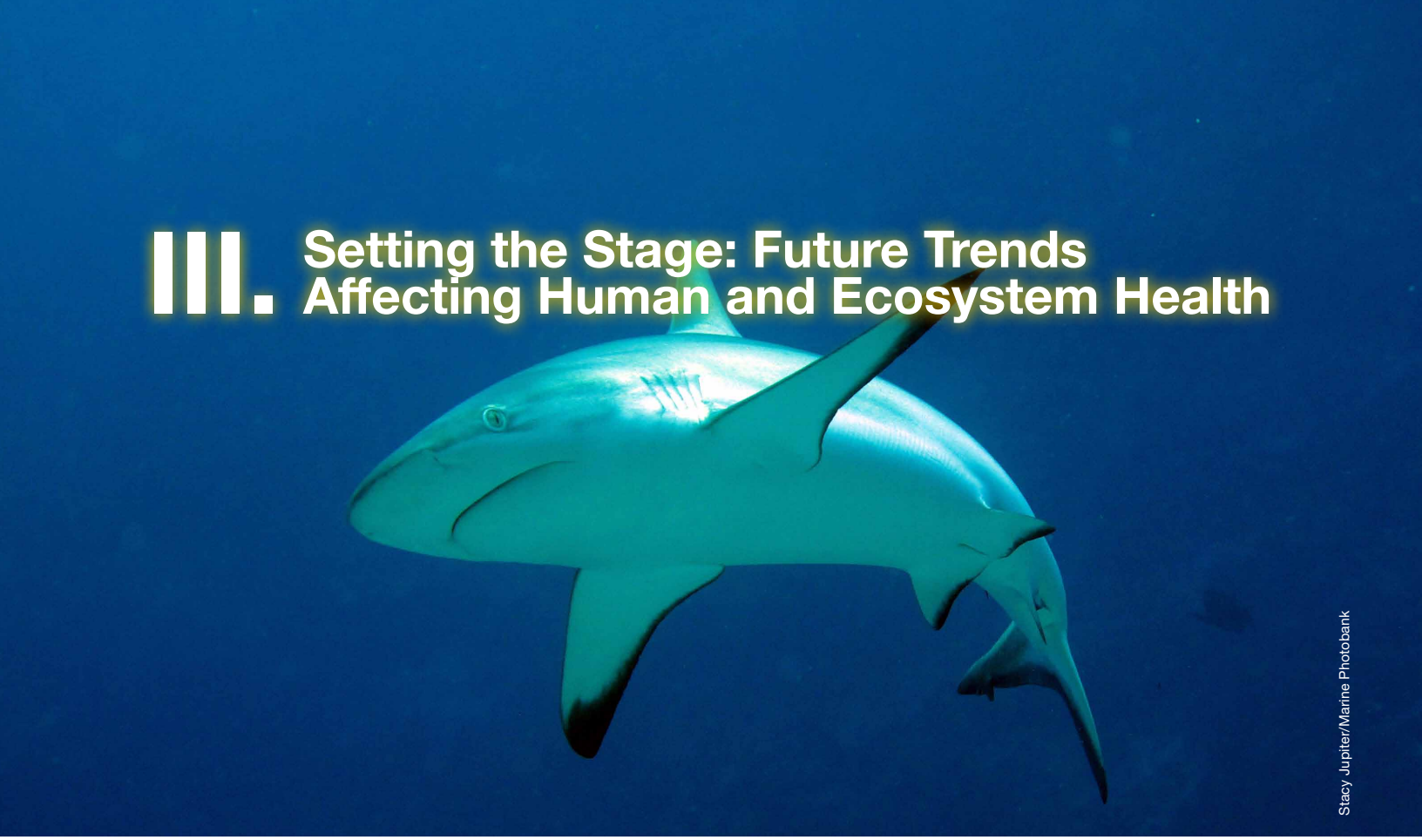
Throughout the California Current region, as elsewhere, partnership with these existing organizations offers a potential mechanism for aiding and advancing ongoing conservation efforts, such as those focused on marine spatial planning and adaptation to climate change.

[34] California Department of Fish and Game. *Marine life protection act initiative*. http://www.dfg.ca.gov/mlpa/.

[35] Oregon Ocean Information, (2010). *Status of Nearshore Task Force*. Nearshore Task Force. http://www.oregonocean.info/index.php?option=com_content&view=category&layout=blog&id=29&Itemid=21.

[36] Pacific Coast Collaborative. *Welcome*. http://www.pacificcoastcollaborative.org.

III. Setting the Stage: Future Trends Affecting Human and Ecosystem Health



Stacy Jupiter/Marine Photobank

Over the next 40 years, marine ecosystems and coastal communities will likely experience dramatic changes. Already marine ecosystems and coastal communities face major threats. Pollution, from sources such as urban runoff, toxic dumping, and oil spills causes degradation to marine ecosystems, including those in the Coral Triangle and the California Current. Habitat destruction, resulting from coastal development, poor agricultural practices, and wastewater discharges also presents dangers to productive marine and coastal habitats. Overfishing and exploitation of resources puts pressure on ecosystems and will likely increase as a growing population intensifies demands for edible marine resources. In addition, global climate change will have a number of serious impacts, including ocean acidification, sea level rise, severe weather events, and reduced availability of freshwater resources. Given these threats, and the potentially drastic consequences they could cause, greater attempts must be made to address these risks and to bolster marine and human adaptations to them.

Current Projections for 2050—Cause for Urgent Action

In the section below, we identify and describe the major global trends and drivers of change that will affect marine resources and the human populations that depend on them over the next 40 years. We include information about specific threats to and possible impacts on the Coral Triangle and the California Current.

Human Population, Resource Consumption, and Food Security

In the coming decades, marine resources will face heightened pressures due to growing human populations who will consume more. By 2050, an estimated 9.3 billion people will inhabit the planet, 2.5 billion more than today.[37] Feeding this growing population will remain a major challenge. According to the United Nation's Food and Agricultural Organization (FAO), more than one billion people already fall into the "hungry" category.[38]

Currently, marine resources provide the primary source of protein for more than 2.6 billion people.[39] In developing countries such as Bangladesh, Cambodia, Equatorial Guinea and others, including many small island developing states, more than one-half the annual animal protein consumed comes from fish.[40] For impoverished and undernourished people, fish also supply critical micronutrients such as iron and calcium, as well as vitamins A and C.[41] Rising populations will place increased demand on marine resources. Already, overfishing (artisanal/recreational/subsistence fishing, by-catch & discharge, and commercial fishing) poses "severe" to "moderate" impacts in much of the California Current and parts of the Coral Triangle.[42]

Urbanization and Land-Based Pollution

Increased urbanization and other land-based activities also will put pressure on marine resources and habitats. Currently, roughly 40% of the world's population lives within 100 kilometers of the coast,[43,44] and 634 million people—one-tenth of the global population—live in coastal areas that lie ten meters or less above sea level.[45] This number is likely to increase in the future, a prediction borne out by recent trends: between 1990 and 2000, the populations in the zero to ten meter zones of Bangladesh and China grew at more than twice the national population growth rate.[46]

Urbanization and land conversion can have negative impacts on marine resources. Nutrient pollution and sedimentation from land conversion already take a heavy toll on coastal and marine ecosystems; indeed, nutrient pollution and sedimentation are ranked among the most serious threats to the Pacific Ocean.[47] Sewage discharges, for instance, usually contain high levels of macronutrients, such as nitrogen and phosphorus, and can result in eutrophication, harmful algal blooms and dead zones in nearby marine areas.[48] A recent article in Science co-authored by COS science and legal experts and colleagues explains that nutrient and sediment discharges can worsen ocean acidification conditions in localized coastal waters.[49] In the California Current, solid waste currently presents a "low" threat in Canada, a "moderate" threat in the United States, and a "severe" threat in Mexico.[50] Similarly, land-based chemicals pose a "severe" threat to most areas in the Coral Triangle and a "severe" to "moderate" threat in much of the California Current.[51]

Climate Change

Climate change poses a significant global threat to marine resources. Actual carbon dioxide (CO_2) emissions are exceeding the IPCC's worst-case scenarios and recent evidence points to a continued rise in emissions above the worst-case projections (see Figure 3).

The continued increase in CO_2 may lead to large-scale acidification in the oceans. Since the Industrial Revolution, the oceans have absorbed approximately 525 billion tons of human-released CO_2 emissions. This absorption has moderated the warming effect of greenhouse gas emissions, but with devastating consequences. As CO_2 dissolves in the ocean, the water becomes more acidic and the amount of dissolved carbonate available for calcium carbonate, —a critical component for shell and skeleton formation in corals, plankton, and shellfish—decreases. CO_2, along with "traditional" stressors such as nutrient

[37] U.S. Census Bureau, International Database. From: Infoplease. *The population of the world by decade, 1950–2050*. http://www.infoplease.com/ipa/A0762181.html.

[38] Lester R. Brown. *Plan B 4.0: Mobilizing to Save Civilization*. New York: W.W. Norton & Company, 2009.

[39] UNDP (June 2010). *World oceans day: oceans of life*. Newsroom. http://content.undp.org/go/newsroom/updates/environment-energy/www-ee-news/world-oceans-day-oceans-of-life.en.

[40] FAO. (March 2, 2009). *State of world fisheries and aquaculture*. Media Center. http://www.fao.org/news/story/0/item/10270/icode/en/.

[41] Kurien, J. (2005). *Responsible fish trade and food security*. FAO Fisheries Technical Paper No. 456.

[42] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[43] FAO, (1997). *Seawater intrusion in coastal aquifers. Guideline for study, monitoring and control*. Rome: FAO Water Reports, 11, 152.

[44] Center for International Earth Science Information Network, (2007). *CSD Coastal Population Indicator: Data and Methodology Page*. SEDAC. http://sedac.ciesin.columbia.edu/es/papers/Coastal_Zone_Pop_Method.pdf.

[45] Pacific Center for International Earth Science Information Network. *Climate change: study maps those at greatest risk from cyclones and rising seas*. Press release: International Institute for Environment and Development. March 28, 2007. http://sedac.ciesin.columbia.edu/gpw/docs/lecz_IIED.pdf.

The ten countries with the largest number of people living within ten meters of the average sea level are: China (143,888,000); India (63,188,000); Bangladesh (62,524,000); Vietnam (43,051,000); Indonesia (41,610,000); Japan (30,477,000); Egypt (25,655,000); United States (22,859,000); Thailand (16,468,000); and the Philippines (13,329,000).

McGranahan G, Balk D, Anderson B, (2007). "The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones." *Environment and Urbanization*. 19, 17–37.

[46] *Ibid*.

[47] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[48] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[49] Kelly, R.P., Foley, M.M., Fisher, W.S., Feely, R.A., Halpern, B.S., Waldbusser, G.G., and M.R. Caldwell. (2011). "Mitigating Local Causes of Ocean Acidification with Existing Laws." *Science*: 332 (6033):1036–1037.

[50] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[51] California Natural Resources Agency. "California Coastal Salmon and Watersheds Program." Accessed 9/6/2011. http://resources.ca.gov/coastal_salmon_plan.html.

runoff, sedimentation from coastal development, agriculture and logging, and air emissions from industrial facilities, can create local ocean acidification "hotspots" that have negative ecological and economic impacts on coastal communities.[52] Moreover, recent studies suggest that the oceans are becoming less able to absorb as much carbon dioxide, decreasing their ability to buffer against climate change.[53,54,55,56,57,58] Currently, acidification due to climate change presents a "moderate" threat in parts of the California Current (United States, Canada, and Mexico).[59]

In addition, sea level rise and increased storm events will likely make coastal ecosystems and communities vulnerable. Rising sea levels exacerbate the inundation of wetlands and low lying islands and coastal areas and saltwater intrusion into aquifers. Sea level rise may also cause millions of people to lose their homes and move inland in search of food and income, which may lead to the breakdown of traditional communities.[60] Global climate change will also cause more extreme weather events, such as increased precipitation, floods, hurricanes, droughts, and heat waves. These realities, along with growing population and reduced food availability, are likely to cause social disruption on large scales, especially in less stable developing regions where most of the world's population resides.[61]

[52] Kelly, R.P., Foley, M.M., Fisher, W.S., Feely, R.A., Halpern, B.S., Waldbusser, G.G., and M.R. Caldwell. (2011). "Mitigating Local Causes of Ocean Acidification with Existing Laws." *Science*: 332 (6033):1036–1037.

[53] Cabanes, C., Cazenave, A., and Le Provost, C., (2001). "Sea Level Rise During Past 40 Years Determined from Satellite and in Situ Observations." *Science*. 294 (5543): 840–842.

[54] Baker, A.C., Glynn, P.W., and Riegl, B., (2008). "Climate Change and Coral Reef Bleaching: an Ecological Assessment of Long-term Impacts, Recovery Trends and Future Outlook." *Estuarine, Coastal and Shelf Science* 80: 435–471.

[55] Committee on the Development of an Integrated Science Strategy for Ocean Acidification Monitoring, Research, and Impacts Assessment; National Research Council (2010). *Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean*.

[56] Feely, R., Sabine, C., and Farby, V., *NOAA's Pacific Marine Environmental Laboratory Carbon Dioxide Program*. http://www.pmel.noaa.gov/pubs/PDF/feel2899/feel2899.pdf.

[57] Le Quere, C., et al. (2007). "Saturation of the Southern Ocean CO2 Sink Due to Recent Climate Change." *Science* 316: 1735–1738.

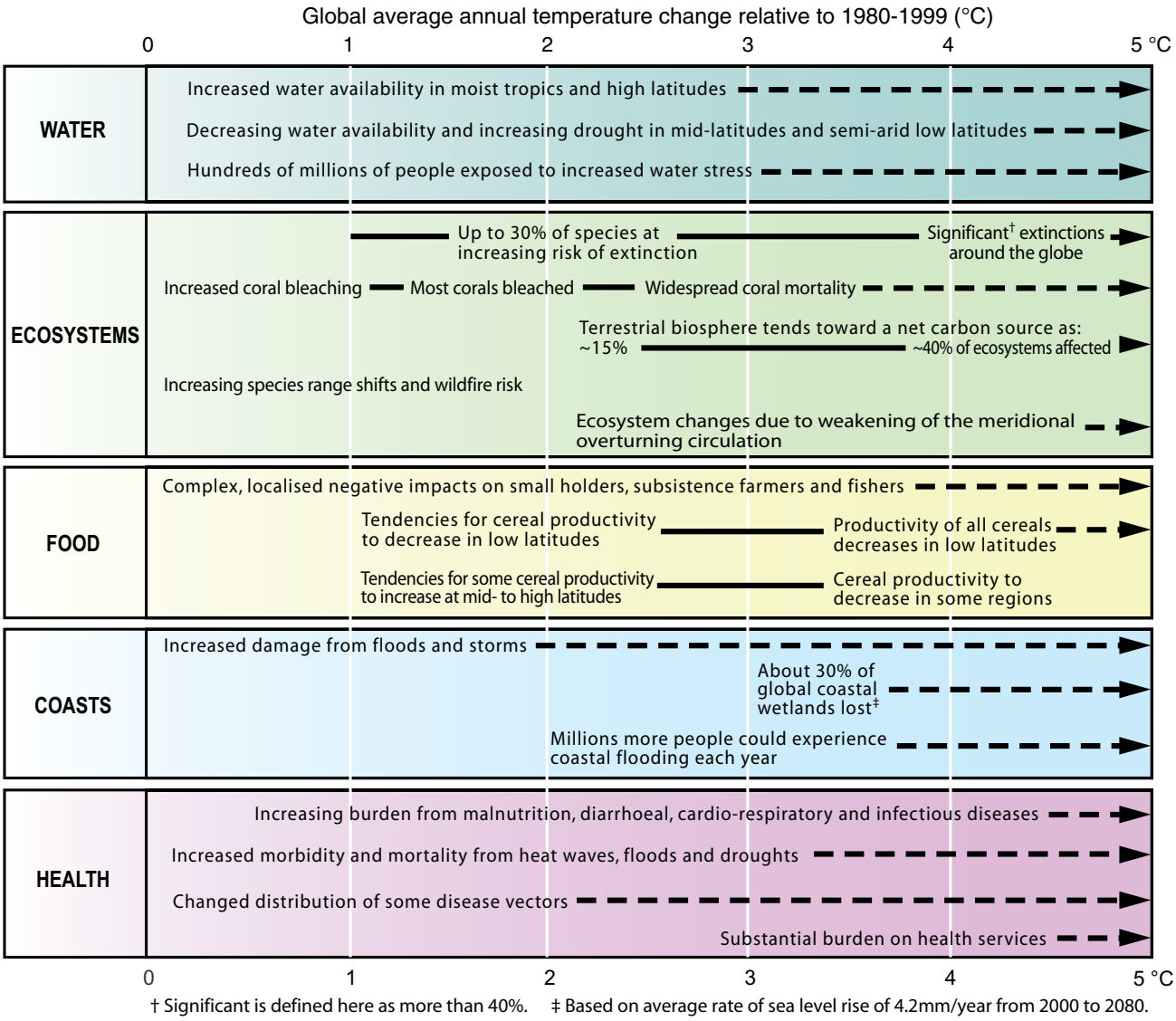
[58] Pew Center, (2009). *Science brief Pew Center on Global Climate Change*. http://www.pewclimate.org/docUploads/ocean-acidification-Aug2009.pdf.

[59] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[60] Kelly, R.P., Foley, M.M., Fisher, W.S., Feely, R.A., Halpern, B.S., Waldbusser, G.G., and M.R. Caldwell. (2011). "Mitigating Local Causes of Ocean Acidification with Existing Laws." *Science*: 332 (6033):1036–1037.

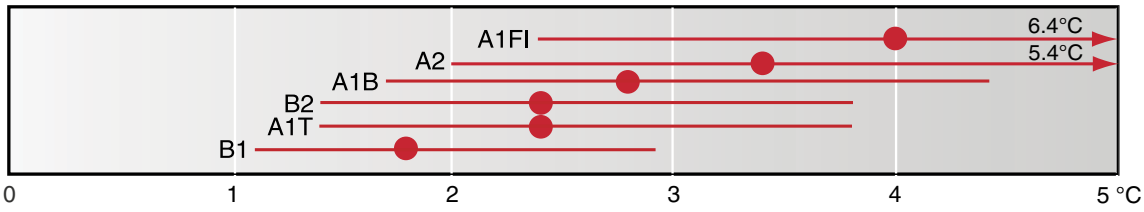
[61] Hoegh-Guldberg, O., et al. (2009). *The Coral Triangle and Climate Change: Ecosystems, People and Societies at Risk*. WWF Australia, Brisbane.

Figure 3: Upper: The global consequences of climate change resulting from different increases in average global surface temperatures in the twenty-first century. Lower: Warming related to six different SRES scenarios.



† Significant is defined here as more than 40%. ‡ Based on average rate of sea level rise of 4.2mm/year from 2000 to 2080.

Warming by 2090-2099 relative to 1980-1999 for non-mitigation scenarios



Source: IPCC (2007). *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms3.html.

Freshwater Resources

Climate change and population growth together impose significant pressure on freshwater supplies. Research predicts that potable water supplies will run out for one-half the world's population by 2050 under current water management practices.[62] The two primary options for increasing the available fresh water supply—capturing and storing more surface runoff from floods and snowmelt, and seawater desalination—both pose serious direct and indirect threats to coastal and marine ecosystems.[63] Dams destroy stream and river habitat, reduce freshwater flows to coastal ecosystems, and present structural barriers to fish passage and sediment flows. Desalination kills all organisms in the seawater that is processed. It also produces concentrated brine with toxic levels of salt. Moreover, most desalinization is energy intensive, likely exacerbating climate change.[64]

Ocean Commerce and Energy Development

The growing population, increased consumption, urbanization trends, and technological innovations are also creating strong demand for other ocean resources beyond food such as precious metals, strategic minerals including cobalt and manganese, oil and gas, and sand and gravel. The offshore area under contract for oil exploration, for instance, more than doubled between 1990 and 2006 (see Figure 4). As energy prices increase, exploitation is likely to intensify and, as technology develops, pristine areas of the ocean are likely to be exploited even in deep waters and remote sites.[65]

The coastal environment also offers an opportunity for renewable energy production. While there are no offshore wind farms currently operating in the United States, a number of projects are in the pipeline; the Cape Wind project off Cape Cod has received federal agency approval after years of often contentious planning. In Europe, roughly 2,000 megawatts of offshore wind energy generators have been installed.[66] On the west coast of North America, tidal energy, as opposed to wind energy, is being explored.[67]

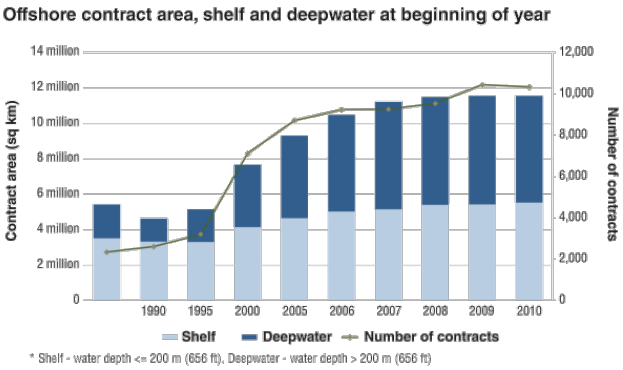


Figure 4: 2009 was a record year for ultra deepwater (UDW) offshore oil and gas drilling, totaling 150 wells. A preliminary well count also suggests strong deepwater and UDW drilling rates in 2010. On average, through 2005 and 2009, the drilled depth offshore increased from 3,100 m to 3,600 m (10,171 ft. to 11,811 ft.) and the average water depth from 450 m to 600 m (1,476 ft. to 1,969 ft.).

Source: Chakhmakhchev, A. and P. Rushworth. (2009). *Global Overview of Offshore Oil and Gas Operations for 2005–2009*. http://www.offshore-mag.com/index/article-tools-template/_saveArticle/articles/offshore/volume-70/issue-50/international-e_p/global-overview_of.html.

Maritime shipping also has been on a steady rise. Over the last forty years, the total volume of shipped material has more than tripled, from roughly 2.6 to 8.2 billion tons loaded. The volume of oil shipped has doubled from 1.4 to 2.7 billion tons loaded.[68] This increase in traffic results in shipping lanes that blanket the world's oceans. As ice disappears in the arctic and ports continue to grow, maritime traffic will only increase, posing a greater risk of oil spills and large-scale disasters in both heavily populated and remote areas.[69]

Moreover, the United States has launched an effort to move traditionally "wheel-based" transport into the water: the United States Department of Transportation (DOT) recently announced a new "Marine Highway Program" to secure reliable ocean, lake, and river transportation routes as alternatives to already congested land-based transportation routes. The new marine highway corridors are designed to move freight cargo in ways that will reduce the economic, environmental, and energy costs associated with land-based congestion. According to the DOT, the 25,000 miles of inland, intracoastal, and coastal waterways offer considerable opportunities for expansion of use by freight and containerized cargo.[70] Therefore, we can expect even more intense competition for marine space from the transportation sector.

[62] Less than 1% of the world's fresh water (~0.007% of all water on earth) is accessible for direct human uses. This is the water found in lakes, rivers, reservoirs and those underground sources that are shallow enough to be tapped at an affordable cost. Only this amount is regularly renewed by rain and snowfall, and is therefore available on a sustainable basis.

Gleick, P. H., (1996). "Water resources." in *Encyclopedia of Climate and Weather vol. 2. ed*. Schneider, S. H. New York: Oxford University Press. 817- 823. http://ga.water.usgs.gov/edu/waterdistribution.html.

[63] OECD, (2009). *Alternative Ways of Providing Water: Emerging Options and Their Policy Implications*. Advanced Copy for 5th World Water Forum. http://www.global-change.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html.

[64] Cooley, H., Gleick, P. H., Wolff, G. (June 2006). *Desalination, With a Grain of Salt: A California Perspective*. Pacific Institute. http://www.pacinst.org/reports/desalination/desalination_report.pdf.

[65] Halfar, J. & Fujita, R., (2007). "Danger of deep sea mining." *Science* 316:987.

[66] Global Wind and Energy Council, (15 February 2007). *US Interior Secretary visits offshore wind farm during COP15 participation*. Latest News.

[67] Pacific Fisheries Management Council, (10 March 2010) *West Coast Hydrokinetic Energy Projects*. http://www.pcouncil.org/wp-content/uploads/Hydrokinetics-3-24-10.pdf.

[68] UNCTAD, (2009). *Review of maritime transport 2009*. Presented at United Nations Conference on Trade and Development.

[69] Nuka Research and Planning Group and Pearson Consulting. (2010). *Oil Spill Prevention and Response in the U.S. Arctic Ocean: Unexamined Risks, Unacceptable Consequences*. Commissioned by the Pew Environment Group, U.S. Arctic Program. http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Protecting_ocean_life/PEW-1010_ARTIC_Report.pdf.

[70] "America's Marine Highway Program." Federal Register 75 (9 April 2010): 18095-18107.46 CFR Part 393. Accessed 8/31/2011. http://edocket.access.gpo.gov/2010/pdf/2010-7899.pdf.

Finally, growth in population and wealth are expected to increase the intensity of tourism and its impacts on ocean ecosystems, since coral reefs, beaches and other ocean ecosystems are popular destinations.[71] Explicit recognition of the interdependence between coastal and ocean tourism and healthy marine and coastal ecosystems is key to long-term sustainability for both tourism and oceans.

[71] World Wildlife Fund. *Marine Problems: Tourism & Coastal Development*. http://wwf.panda.org/about_our_earth/blue_planet/problems/tourism/.

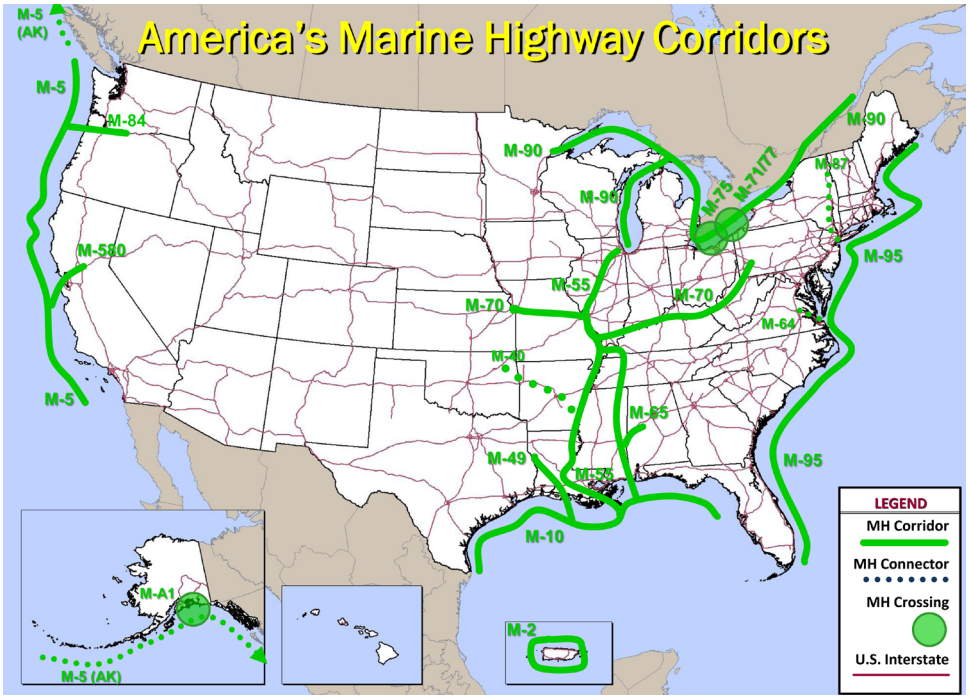


Figure 5

Source: U.S. Department of Transportation, Maritime Administration. (2010). *American's Marine Highway Corridors*. http://www.marad.dot.gov/ships_shipping_landing_page/mhi_home/mhi_home.htm.

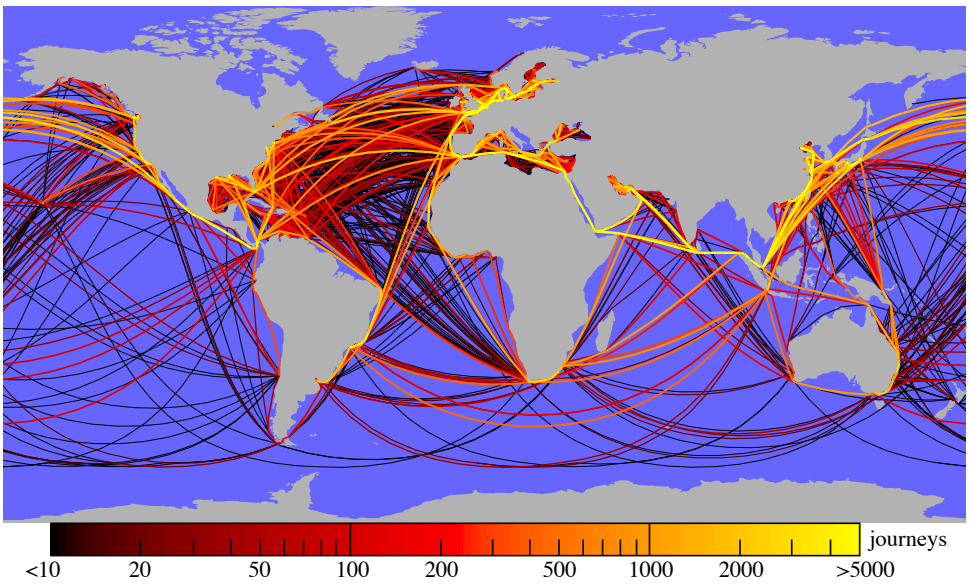


Figure 6: Map of global shipping traffic.

Source: Kaluza,P., Kölzsch, A., Gastner, M.T., and B. Blasius. (2010). "The complex network of global cargo ship movements" *J. Royal Society*. http://arxiv.org/PS_cache/arxiv/pdf/1001/1001.2172v1.pdf.

Kydd Pollock/Marine Photobank

IV. Designing Ocean Solutions: Aligning the Needs of Humans and Nature

As illustrated in *III. Setting the Stage: Future Trends Affecting Human and Ecosystem Health*, environmental trends in the future will follow historical patterns unless we take specific and strategic actions to change our course. The grand unifying story of the past 50 years of conservation and environmental awareness has been one of declining ecosystem health and natural resources. When tracked as global aggregates, these declines are astronomical. However, for every decline, there are also examples of localized reversal of these global patterns. Furthermore, many of these successful recoveries in natural systems are accompanied by improvements in individual and community wellbeing, leading in turn to greater overall resilience of both human and natural systems. These are the true successes of conservation, distinguished by actions that ensure that economic and social needs are met, as well as the needs of nature.

The oceans have long supported and promoted healthy and resilient social, economic, and ecological systems. Ocean-linked natural and human systems have traditionally been particularly resilient, able to absorb large shocks without sacrificing the ocean's basic functions and its ability to deliver critical goods and services to people. In the current context of decreased resilience and increasing local, regional, and global change, it is crucial to ensure that coastal and marine systems contain the components and processes needed for renewal and reorganization. That way, when massive transformation does occur, those systems will remain functional.[72] Fortunately, efforts to maintain resilience in ocean and coastal ecosystems can align closely with approaches intended to foster the resilience and adaptive capacity of human communities. The challenge to the architects of conservation for marine and terrestrial systems is to work within and with these dynamic systems, helping to shape them as they continue to change, with the ultimate goal of promoting positive transformation that benefits both human and ecological health.

In the sections that follow, we provide examples of successes and failures in marine conservation, not so much to serve as platforms for rethinking the future of ocean philanthropy, but as both cautionary tales and reasons for hope. We then provide insights and lessons learned that can help offer guidance for future action.

[72] Here we draw on resilience theory and thinking and the works of David Salt, Brian Walker, Jane Lubchenco, Carl Folke and others. Many integrated systems appear to move through cycles of rapid growth, accumulation of natural/social/economic capital, release, and reorganization on a variety of timescales, and interventions can be particularly effective at certain points along this trajectory. Solution strategies can promote resilience when they foster (i) biological and institutional diversity; (ii) modularity and redundancy (subsystems that are loosely connected to each other so that if one subsystem fails, the entire network does not crash); (iii) tight feedback loops at relevant spatial and institutional scales, so that timely course corrections can take place; (iv) integration across ecological and institutional scales; (v) effective monitoring of slow drivers, to avoid negative thresholds; and (vi) innovation and flexibility. Folke, C. et al, (2002). "Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations." *Ambio* 31(5): 437–440.

Aligning the Need of Human and Nature: Successes and Failures

In this section, we offer a brief overview of six ocean conservation case studies from around the world that highlight the value of utilizing a variety of strategies and tools that align the needs of humans and nature to successfully support global marine conservation and human resiliency.

Coral Triangle: Using a Multi-Faceted Approach

Over the past several decades, the Coral Triangle's reefs and fisheries have experienced relentless degradation due to pollution, habitat destruction, and overfishing.[73] Thanks to a multi-faceted approach, however, the region's prospects for successful conservation look better now than at any time in the last twenty to thirty years. While it is still too early for conservation to declare victory in the Coral Triangle, there are important lessons to learn from the successes and limitations of conservation efforts in this region.

First, the establishment of MPAs has led to significant conservation outcomes in a few areas. MPAs, for instance, helped fish stocks to recover and led to an end of destructive fishing activities at one site in Indonesia.[74] Indonesia also recently established the Savu Sea National Park—at approximately 35,000 km^2, it is the largest MPA in the Coral Triangle.[75] Second, substantial and long-term NGO engagement can help ensure effective management of MPAs—which often stretch local means—by filling capacity gaps between implementation of legislation and uptake within communities. NGOs can also assist with education and outreach, training, designing organizational and management frameworks, and generating support for community-based conservation and community involvement. In Kimbe Bay, Papua New Guinea, for instance, the Nature Conservancy has bolstered communities' role in the enforcement of the MPA by helping the local government draft and implement necessary legislation.[76]

Third, achieving community-based conservation and community involvement in conservation actions is critical for achieving long-term success, compliance, and durable outcomes. Given widespread reliance on marine species for subsistence, investments in alternative livelihoods is also important for effective conservation.[77] One of the best-documented successes is at the Arnavon Islands (within the Solomon Islands), where community-managed marine conservation areas led to the recovery of both fisheries and the highly endangered Hawksbill Turtle population (a nearly 400% increase in the number of turtles nesting on the Islands between 1995 and 2005).[78]

Despite the promises of these approaches, there are also noteworthy limitations. Lack of funding for management and of proper enforcement has limited MPA effectiveness in much of Indonesia and in other parts of Coral Triangle.[79] In addition, MPA status does not halt other causes of degradation (e.g., sedimentation and pollution) that occur near and adversely affect protected areas.[80] While NGO engagement can help address these limitations, there are substantial challenges to successful NGO engagement, such as creating effective coordination between and ensuring sufficient capacity of local implementing organizations.[81] Finally, bolstering community-based conservation and community involvement can be a costly, long-term investment. The success in the Arnavon Islands was hard won; it required more than 18 years of in-community engagement and 12 years of Packard Foundation support. This example underscores the need for legislation, long-term capacity-building, effective local coordination, and financial support to achieve ambitious marine conservation goals.[82]

[73] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[74] *Ibid*.

[75] The Phoenix Islands Protected Area Website: http://www.phoenixislands.org/index.php.

[76] The Nature Conservancy. (2011). *Papua New Guinea: Protecting Marine Life and Human Needs in Kimbe Bay*. http://www.nature.org/ourinitiatives/regions/asiaandthepacific/papuanewguinea/placesweprotect/kimbe-bay.xml.

[77] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[78] The Nature Conservancy. (2011). *Solomon Islands: Places We Protect: Arnavon Island*. http://www.nature.org/ourinitiatives/regions/asiaandthepacific/solomonislands/placesweprotect/arnavon-islands.xml.

[79] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[80] *Ibid*.

[81] Blue Earth Consultants (2010). *Ocean Conservation Strategic Funding Initiatives: a Study of Successes and Lessons Learned*. David and Lucile Packard Foundation.

[82] *Ibid*.

Apo Island, Philippines: Harmonizing Conservation and Livelihoods

In addition to advancing conservation goals, MPAs can help local communities' welfare. In Apo Island, Philippines, the creation of an MPA led to increased fish stocks, which benefited the majority of local people who depend on fish as a food source.[83,84,85] As evidenced in Apo Island, the creation of an MPA also can support alternative livelihoods. There, the increased tourism resulting from the creation of an MPA has led to a number of job opportunities for local people. Nearly half of Apo households now engage in tourist-related activities, such as diving boat charters, t-shirt vending, and lodging.[86,87] Moreover, tourist related activities now provide local people with more cash income than does fishing.[88]

In spite of the success in Apo Island, the benefits of MPA creation in other parts of the Philippines have been limited. Activities such as overfishing, damaging coastal development, and pollution continue to have significant ecological consequences for reefs. Moreover, MPAs fail to address the fundamental social issues underlying environmental threats to reefs, namely poverty, population pressure, and inadequate enforcement of MPAs. Indeed, the Packard Foundation decided to withdraw from its Philippines strategy, citing insufficient outcomes as a result of the failure to address these social drivers.[89] Effective conservation, then, requires considerable attention to the link between the environment and community economics, as well as the need for alternative livelihoods.

[83] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[84] *Ibid*.

[85] Russ, G., Alcala, A., Maypa, A.(2003). "Spillover from Marine Reserves: the Case of *Naso Vlamingii* at Apo Island, the Philippines." *Mar Ecol Prog Ser*. 263:15-20. http://www.int-res.com/articles/meps2003/ 264/m264p015.pdf.

[86] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[87] Leisher, C., van Beaukering, P., Scherl, L. (2007) *Nature's investment Bank: How Marine Protected Areas Contribute to Poverty Reduction*. The Nature Conservancy, Arlington, USA.

[88] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[89] Blue Earth Consultants (2010). *Ocean Conservation Strategic Funding Initiatives: a Study of Successes and Lessons Learned*. David and Lucile Packard Foundation. http://blueearthconsultants.com/pdf/BEC_FINALPackardOceanConservationStrategicFundingInitiatives172011TCHA.pdf.

California Current: Garnering Community Support

In California, conservationists' focus on community outreach and engagement has yielded important results. Through CCMI, environmental NGOs received funding to conduct outreach and engage local residents on the benefits of the MLPA. One grantee alone generated interest among 900 participants, who subsequently inspired thousands of residents to write letters in favor of the MLPA.[90]

Despite these successes, community outreach and engagement also face challenges. Well-funded stakeholders can present significant opposition to conservation outcomes, as also evidenced by the MLPA process. Commercial and recreational fishermen lobbied key decision-makers and continue to impede implementation of the MLPA through litigation.[91] Conservationists' efforts to engage these stakeholders has had mixed results.[92] CCMI grants to recreational fishers, approved in an effort to promote understanding and gain support, were unsuccessful.[93] In promoting community involvement in conservation, then, it is important to identify and address the local context and the complicated socio-political factors that could impede conservation success.

King County, Washington: Linking the Environment and the Economy

An understanding of the link between the environment and the economy, as well as the benefits of innovative design principles, also can lead to impressive conservation outcomes. In King County, Washington, for instance, officials' pursuit of a "triple bottom line" approach that aligns environmental, human, and economic health has led to innovative environmental design. Recognizing the economic, as well as ecological costs, of traditional flood management techniques, the County has implemented new flood management practices, such as planting levee systems with riparian vegetation and restoring woody debris to rivers, in place of traditional ones such as channelizing waterways. In addition, new land use policies have helped direct construction to existing urban areas, thereby promoting stream health by preventing more paved surfaces in more rural

[90] Blue Earth Consultants (2010). *Reflections on a Decade of Fostering Positive Change for the Oceans*. David and Lucile Packard Foundation.

[91] California League of Conservation Voters. Something's Fishy. Accessed September 15, 2011. http://www.somethingsfishyaboutpso.com/.

[92] Blue Earth Consultants (2010). *Reflections on a Decade of Fostering Positive Change for the Oceans*. David and Lucile Packard Foundation.

[93] *Ibid*.

areas.[94,95] These efforts have improved habitat for endangered salmon while simultaneously lowering the long-term costs associated with traditional hard-engineered flood control strategies.[96]

Although promising, a focus on innovative design with triple bottom line results faces challenges. For example, dedicated funding for innovative design projects is limited, particularly in light of recent reductions in state and local governments' budgets. Moreover, it can be difficult to find champions for innovative design, as officials may not understand the clear benefits, many of which may be long-term rather than short-term in nature. Finally, the approach does not always result in meeting quantitative goals, as is evident in King County's 2009 annual report which notes that several important environmental targets were not achieved (e.g., salmon restoration, air quality, energy plan implementation). Nevertheless, significant progress was made on numerous other environmental, public health, and organizational efficiency targets (e.g., residential stewardship, green building, flood safety). King County represents a promising model of using a holistic management approach that treats the environment and the community as linked systems.[97]

British Columbia, Canada: Restoring Fish Stocks through Fisheries Reform

Innovative fisheries management systems also have led to important conservation successes. In British Columbia, Canada, the sablefish fisheries faced degradation. The Canadian and British Columbian governments worked closely with harvesters and other stakeholders to reform the fishery through implementation of an Individual Vessel Quota (IVQ) system, which specifies an annual allowable catch per vessel. The IVQ program promotes fishermen's accountability for limiting their individual catches and gives them greater flexibility in the timing of their catches.[98] It also has proven economically successful: vessel owners obtain higher prices now for sablefish than prior to the IVQ system.[99] In addition, the IVQ system has resulted in dockside monitoring of catches, improving oversight of the fisheries.[100]

The sablefish fishery represents a promising example of co-management and effective fisheries reform, but IVQs depend on a strong governance structure and mutual respect between managers and harvesters, which many regions lack. Moreover, uncertainty remains about how the IVQ system has affected stock recovery.[101] Finally, research shows that quota systems can also hurt working fishermen, particularly those who must pay high quota leases.[102]

Isla Natividad, Mexico: Building Climate Resiliency through Marine Reserves

Isla Natividad in the Gulf of California is part of the "Marine Serengeti" and is home to abundant biodiversity.[103] Yet, the region's marine ecosystems face significant challenges, including overfishing and climate change.[104] In response to decreasing abalone populations, fishing cooperatives in Isla Natividad established two fully protected marine reserves, consisting of about 8% of the island's coastal zone in 2006. Several years later, the cooperative found that abalone egg production and juvenile recruitment were higher in the marine reserves compared to fished areas.[105]

Notably, researchers also found that the marine reserves appear to mitigate the effects of climate change.[106] In 2009, a hypoxic zone appeared near Isla Natividad, likely a result of climate change. Subsequently, abalone larval production in the marine reserves proved significantly higher than in fished areas, suggesting that marine reserves may be an important way to protect species from the effects of climate change.[107] While these findings are preliminary, they suggest the important role marine reserves and area-based management may have in promoting marine resilience to climate change.

[94] Booth, D. B. (2000). *Forest Cover, Impervious -surface Area, and the Mitigation of Urbanization Impacts in King County, Washington*. http://water.washington.edu/research/Reports/forest.pdf.

[95] King County, (2004). *Best Available Science Volume 1: a Review of Science Literature*. http://www.metrokc.gov/ddes/cao/#best, § 7.2.8, at 7-27.

[96] King County Department of natural Resources and Parks. (2009) *Environmental Stewardship in King County*. Seattle, Washington. http://your.kingcounty.gov/dnrp/library/natural-resources/annual-report/2009.pdf.

[97] *Ibid*.

[98] Ecotrust. (2009). *A Cautionary Tale About ITQ Fisheries*. http://ecotrust.ca/fisheries/cautionarytale.

[99] Sporer. C. (2008). *Co-management of Canada's Pacific Sablefish Fishery*. FAO Corporate Document Repository. ftp://ftp.fao.org/docrep/FAO/010/a1497e/a1497e35.pdf.

[100] Kidd. D. (2000). "A Minister's Perspective on Managing New Zealand Fisheries" in *Use of property rights in fisheries management volume 1*, ed. FAO. FAO Corporate Document Repository. http://www.fao.org/docrep/003/x7579e/x7579e06.htm.

[101] Sporer. C. (2008). *Co-management of Canada's Pacific Sablefish Fishery*. FAO Corporate Document Repository. ftp://ftp.fao.org/docrep/FAO/010/a1497e/a1497e35.pdf.

[102] Ecotrust. (2009). *A Cautionary Tale About ITQ Fisheries*. http://ecotrust.ca/fisheries/cautionarytale.

[103] Arriaga C.L., et al., *Regiones marinas prioritarias de México*. ed. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, (CONABIO). 1998: Mexico, City.

[104] Center for Ocean Solutions (2009). *Pacific Ocean Synthesis: Literature Review of Coastal and Ocean Threats, Impacts and Solutions*. The Woods Institute for the Environment, Stanford University, California.

[105] COBI. (2011). *Building Ocean Resilience: An Incentive Based Approach for Marine Conservation in Mexico*. http://www.cobi.org.mx/publicaciones/2011-building-ocean-resilience-web.pdf and Micheli, F., Sáenz-Arroyo, A., et al., "Marine Reserves Enhance Population Resilience to Climatic Impacts." *Science* Submitted.

[106] Gewin, V. 2010. "Dead in the water." *Nature* 466 (7308): 812–814.

[107] Micheli, F., Sáenz-Arroyo, A., et al., "Marine reserves enhance population resilience to climatic impacts.". *Science*. Submitted and Comunidad y Biodversidad (COBI) 2010.

Figure 7: Dramatic recovery of Porites corals within 50 years after extensive of atomic weapons testing at Bikini Atoll, in the Marshall Islands.

Source: Image presented in Richards et al. (2008) and copied from http://news.nationalgeographic.com/news/2008/04/photogalleries/coral-pictures/.

Chesapeake Bay: The Importance of Government Will

Historically, the Chesapeake Bay represented an iconic conservation failure. The estuary was highly degraded and severely damaged from overfishing, oyster dredging, and non-point source pollution. Little hope remained for its recovery. State governments and the Federal government have invested hundreds of millions of dollars in its restoration, with minimal evidence of success. Fortunately, through recent government actions, signs of improvement are emerging.

In May 2009, President Obama issued an Executive Order declaring the Chesapeake Bay a national treasure.[108] The Federal government is now enforcing rigorous regulations to restore clean water, implementing new conservation practices on four million acres of farms, conserving two million acres of undeveloped land in the Chesapeake watershed, and rebuilding oyster beds in 20 tributaries of the bay.[109] In addition, a transparent quantitative assessment program is tracking progress.[110]

In 2008, the states of Maryland and Virginia proposed new, strict, science-based restrictions on a blue crab fishery that had long been in decline.[111] Implemented in 2009, these policies were initially not well received by some stakeholder groups, specifically watermen.[112] However, attitudes changed when a survey the following year showed a 60% increase in blue crab population. Due to these encouraging population statistics, the Maryland Department of Natural Resources even removed a short-term fall closure of the female fishery in 2010.[113] The combination of aggressive coordinated government action and strong quantitative assessment has given the Chesapeake Bay new hope. As important as aggressive government action can be in advancing conservation efforts, these efforts also require significant political will and funding, both of which may be difficult to garner.

Bikini Atoll: The Resiliency of Nature

Human impacts on marine systems are often subtle, taking place over long periods before negative effects are measurable. At times, though, they can be immediate and catastrophic; such is the case with Bikini Atoll. On March 1, 1954, Bikini Atoll became the site of the most powerful United States nuclear bomb test ever; an early hydrogen bomb was detonated there with a yield estimated at fifteen megatons or greater. It was just one particularly stunning punctuation in more than a decade of nuclear tests on Bikini Atoll, leaving a crater more than a mile wide, devastating surrounding coral reefs, and spreading measureable radioactive fallout at least as far Australia and Japan.[114]

Amazingly, surveys conducted in 2002 document dramatic recovery of these reefs, including extensive stands of *Porites* corals that are over eight meters in height (Figure 7). The ecosystem that has emerged since the cessation of atomic testing is similar to that which previously existed, although there have been both gains and losses of species. Specifically, 183 coral species were recorded in 2002, compared to 126 species recorded prior to nuclear testing. At least 28 of the species present prior to testing have become locally extinct, but other previously unrecorded species have expanded their ranges into this area.[115]

An important, surprising message emerges from the dramatic recovery of the reefs at Bikini Atoll: nature may not be as fragile as often assumed. Understanding the relative fragility *versus* resilience of nature has become one of the key scientific questions for the coming decades. The answers will determine what compromises can be made and where the line must be held as we balance the needs of nature with those of the many competing human stakeholders in marine systems.

[108] Chesapeake Bay Executive Order. *About the executive order*. http://executiveorder.chesapeakebay.net/page/About-the-Executive-Order.aspx.

[109] USDA National Institute of Food and Agriculture. *Newsroom: NIFA update*, May 26, 2010. http://www.csrees.usda.gov/newsroom/newsletters/update10/052610_.html.

[110] Chesapeake Bay Program. *Restoration and protection efforts*. http://www.chesapeakebay.net/status_restoration.aspx?menuitem=15047.

[111] Maryland Department of Natural Resources. (2009). *DNR announces 2009 blue crab regulations*. http://www.dnr.state.md.us/dnrnews/pressrelease2009/031909.html.

[112] Baltimore Sun. (April 23, 2008). *Watermen ponder suit over crabbing plans*. http://www.bluecrab.info/forum/index.php?topic=24198.0;wap2.

[113] Maryland Department of Natural Resources. (2010). *News: Maryland to eliminate blue crab fall closure for 2010*. http://www.dnr.state.md.us/dnrnews/pressrelease2010/072110.asp.

[114] "Fish and coral thriving at site of U.S. atomic bomb test at Bikini Atoll in 1954." *New York Times*. 2008. http://www.nytimes.com/2008/04/15/world/asia/15iht-bikini.1.11998906.html.

[115] Richards, Z. T., Beger, M., Pinca, S. & Wallace, C. C. (2008). "Bikini Atoll coral biodiversity resilience five decades after nuclear testing." *Marine Pollution Bulletin* 56(3), 503–515.

Lessons Learned

The case studies presented in this section highlight some of the successes and challenges ocean conservation donors and practitioners face in identifying and implementing effective conservation strategies. Below, we highlight some lessons learned from these examples to help shed light on how the conservation community can more effectively utilize its suite of strategies and tools to more successfully address complex marine conservation challenges in the future.

Building the Foundation for Conservation Success

Successful conservation depends on more than just the implementation of specific strategies. Donors and practitioners must also address the underlying economic and social factors that exert an enormous influence on marine conservation outcomes. Consequently, donors and practitioners must adopt cross-cutting strategies that help to build a foundation for conservation success. As illustrated by the Coral Triangle example, these strategies include gaining NGO support for capacity building, strengthening institutions, developing community involvement, and promoting the uptake of community-based conservation.[116] Similarly, while providing alternative livelihoods on Apo Island in the Philippines bolstered MPA success, the lack of sufficient enforcement and compliance frameworks was one of the contributing factors that led to donors discontinuing support of ocean conservation initiatives in the region.

Utilizing the "Toolbox"

Initiatives that employ multiple strategies and a suite of associated tools tend to be more successful than those focusing on a single strategy. A recent study examining the successes and lessons learned from 20 ocean conservation initiatives found that employing one strategy is not as an effective approach to attaining goals as utilizing a cluster of strategies.[117] Selecting logical clusters of strategies that collectively and synergistically promote a specific goal is important. For example, supporting capacity-building, and education and outreach can create political will and stakeholder buy-in for governance and policy strategies.[118] Supporting strategies that lead to more tangible outcomes, such as fisheries reform and designation of MPAs, can yield more direct conservation results.[119]

Engaging in Partnership

Partnership plays a crucial role in creating conservation and management outcomes that are greater than the sum of their parts. Partnership with NGOs and other funders provides additional human and financial capacity and helps prevent duplication of efforts. Groups who engage in formal partnerships often experience greater success than those involved in informal partnerships or those not engaged in partnerships. Formal partnerships, however, require more coordination and management, thus sufficient resources need to be set aside for this purpose.[120] Moreover, engaging key government agencies in conservation and management actions is essential in creating broader, more durable, and lasting results. Chesapeake Bay offers a clear example of how coordination efforts must be supported by government. Without this, conservation and management initiatives will likely be constrained both spatially and temporally. Nevertheless, specifically for government partnerships, it takes time to assess risks and liabilities regarding lobbying and potential stakeholder pushback, and yet, these considerations need to be taken into account during project planning. To help further minimize potential challenges, it is important to establish partnership design processes and governance structures that are transparent, accountable, and communicated effectively to the public.[121]

Linking Economics and the Environment

In order to build greater momentum for and uptake of conservation efforts by the wider global community, the link between economics and the environment must be made more apparent. With the complexities of today's marine environmental challenges, actions must move beyond those taken by environmentalists, scientists, conservation practitioners, and resources managers. Focusing on the links between economic and environmental health can help engage new sectors in the conservation discussion, while offering decision-makers a better understanding of trade-offs.[122]

Seeking Multi-Dimensional Solutions

As illustrated by the outcomes at Isla Natividad, conservation strategies that can address multiple threats simultaneously, in both the short- and long-term, offer tremendous value. Although many of these positive interactions arise incidentally, greater efforts could be placed on identifying ways that one strategy (such as creation of an MPA) can yield multiple benefits.

[116] Blue Earth Consultants (2010). *Ocean Conservation Strategic Funding Initiatives: a Study of Successes and Lessons Learned*. David and Lucile Packard Foundation. http://blueearthconsultants.com/pdf/BEC_FINALPackardOceanConservationStrategicFundingInitiatives172011TCHA.pdf.

[117] *Ibid*.

[118] *Ibid*.

[119] *Ibid*.

[120] *Ibid*.

[121] *Ibid*.

[122] *Ibid*.

Konstantin Tkachenko/Marine Photobank

V. Achieving Sustainability and Conservation Results

Based on the collective experience of our group and our discussions over the course of three meetings, the contributors of this paper generated a set of fourteen potential ocean conservation strategies and tools (six cross-cutting foundational strategies and eight target strategies). In this section, we present these recommended strategies and tools aimed at addressing the current and future challenges facing marine ecosystems and global populations. These strategies and tools fall into two categories: 1) cross-cutting strategies that are fundamental to almost any conservation effort and build the foundation for effective ocean conservation outcomes, and 2) more classical, targeted approaches aimed at achieving specific conservation results.

Informing these strategies is our firm belief in the need to bolster resiliency in both ecosystems and human populations. The uncertainty about how climate change, economic shocks, and human-dominated biogeochemical cycles will affect the globe heightens the impetus for directed efforts to foster innovation and adaptation. Both marine ecosystems and human institutions will have to be resilient to survive and prosper in our increasingly uncertain world. Thus, fostering innovation and adaptation is an overarching key theme to ensure resilience. Here, we present a suite of strategies and tools that will promote conservation and resiliency at local levels and globally. We first discuss cross-cutting strategies and then present targeted strategies and tools. We conclude this section with a set of recommendations to assist effective implementation of conservation strategies.

Creating the Building Blocks for Sustainability and Ocean Conservation

Conservation options that align the needs of people and nature will incorporate some or all of the cross-cutting foundational strategies outlined below. Each of these can be applied across many targeted strategies, often supplying the vital glue that holds together fully integrated individual conservation strategies and helps to meld or link disparate strategies that fit together into a much larger architecture for marine conservation and sustainability. Many of these supporting strategies

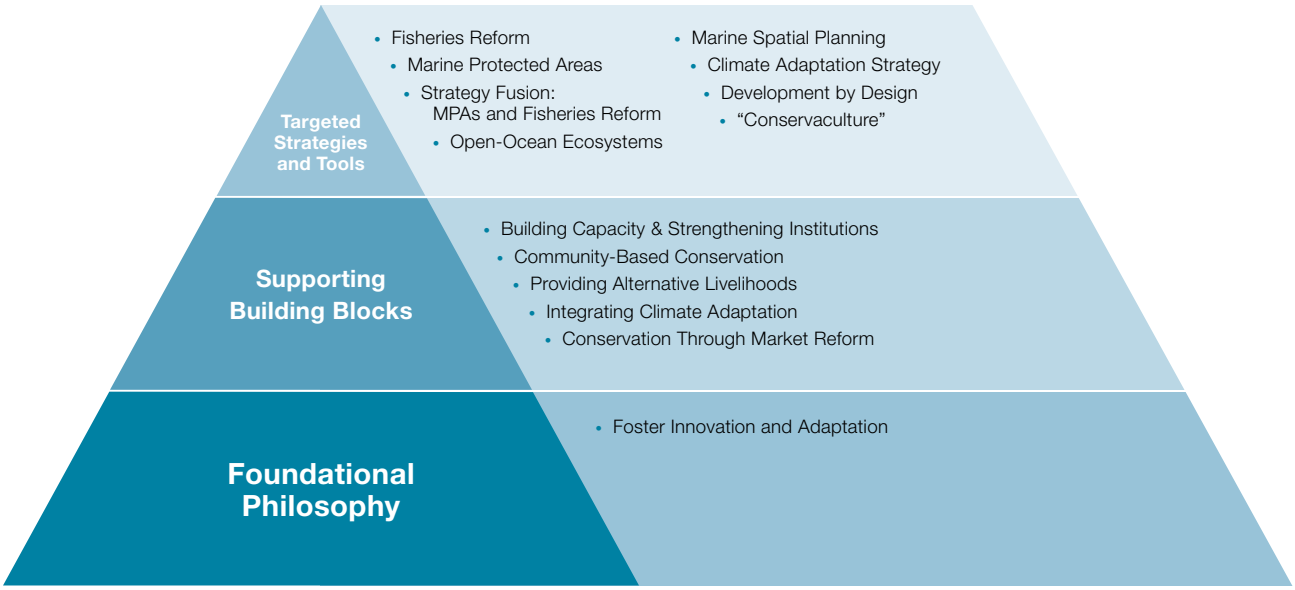


Figure 8: Relationship between Targeted and Foundational Cross-Cutting Marine Conservation and Sustainability Strategies.

may not seem as groundbreaking as emerging targeted strategies, but it would be a profound mistake to overlook them. The research literature and our collective experience tell us that learning from past failures can make or break multi-million dollar investments in conservation moving forward. Figure 8 depicts the relationship between our conservation philosophy, the cross-cutting foundational strategies, and the targeted strategies.

Fostering Innovation and Adaptation

All of the conservation strategies we propose call for innovation, whether in developing more effective implementation of existing tools like MPAs, creating ways to combine tools and strategies that create helpful synergies, or establishing new tools like context-specific market mechanisms or "ecomarkets," and marine spatial planning. Simply calling for adaptive management in the aid of ocean conservation has not been sufficient. Therefore, fostering innovation and promoting adaptability, at all scales, must be considered an overarching goal regardless of which other strategies are being employed. Ensuring innovation and adaptation in governance systems and institutions will be particularly important to developing conservation solutions. Although NGOs and funders have long sought to change institutions, their efforts have primarily focused on narrowly defined conservation agendas. By promoting innovation and adaptation with all actors—NGOs, government agencies, regional governance structures, and the private sector, we can help ensure resilience when unexpected events occur.

Barriers to innovation and adaptation need to be addressed at all levels. Structural barriers include such factors as excessive bureaucracy, silo funding and restrictions in flexible spending, and lack of rewards for innovation. Functional barriers include jurisdictional battles, subsidies, restrictions on data and information flow, group think, and lack of investment in research and development. Funders can help overcome these barriers by applying lessons from operations research and institutional analysis, supporting interventions aimed at increasing innovation and adaptation where it counts most, and by investing in research and development capacity within NGOs and other institutions. This is a cross-cutting strategy that would generate benefits for biodiversity and ecosystem services by making other conservation strategies more effective.

Building Capacity and Strengthening Institutions to Implement Solutions

The conservation community needs to accept that our global success will be constrained unless we work now to strengthen institutions and build the capacity of decision makers, NGOs, local communities, and researchers responsible for ocean conservation. Researchers, NGO staff, and managers are working to develop and test innovative approaches to managing global marine ecosystems, such as catch shares and marine spatial planning. But it is important to recognize that the promise of these approaches will be limited in application by institutional capacity to implement them.

A sharp focus on capacity building for fisheries management is a priority in both developing and developed countries. For example, regional fisheries management organizations (RMFOs), the cornerstone institutions of international fisheries governance, are struggling to fulfill their mandates despite concerted efforts to improve their performance. The greatest potential for gains

may come from targeted programs to identify individuals with the potential to form the next generation of ocean conservation leaders, both domestically and internationally. Strong local leadership can play a key role in helping effective programs become sustainable over the long term, adapting to and surviving shifts and reductions of funding from multi-national NGOs or other funders. Such individuals should be provided with interdisciplinary training in the natural and social sciences, institutional functioning, governance, communications, and social marketing, among others. Numerous universities, including Duke and Stanford, have interdisciplinary graduate environmental programs at the Master and Ph.D. levels; indeed these programs have been integral to "staffing up" government, NGOs, and United States foundations that address marine conservation.

Another model for building capacity for fisheries management is to work with current leaders, such as members of the regional fisheries management councils that have been served by the Stanford-Duke-EDF Fisheries Leadership and Sustainability Forum. This model has allowed the creation of a safe space for council members to consider key problems in management decision making as well as innovative tools they might want to consider in their region.

Involving the Community in Community-Based Conservation

Local community involvement in the design of conservation solutions heightens the likelihood of their success. Members of local communities usually have better information about the biophysical and social setting for projects than what well-intentioned, top-down planners can gather. Tapping into local ecological and social knowledge, in part by building the capacity of local institutions, is an important part of establishing long-term conservation solutions.

Yet, community involvement does not guarantee effective conservation outcomes. Communities are not always able to address environmental issues that extend over large spatial areas (such as highly mobile fish stocks) and long time periods. The desired balance between retaining communities' capacity to find innovative solutions to their own challenges and developing institutions that link communities across scales is a difficult one to achieve. Moreover, it is challenging to know how external intervention can elicit involvement of local communities' ecological and social knowledge for successful institutional design.

The very best results occur when top-down and community-level involvements operate simultaneously and synergistically. Conservation organizations can help communities build bridging institutions needed to address problems at larger spatial and longer temporal scales. However, in order for communities to develop successful conservation solutions that are well fitted to the biophysical and social setting, community members need to be able to engage in the processes of social learning, so that they can continue to adapt to new future challenges.

Social learning depends on trust-based interactions among individuals, the presence of entrepreneurship, and arenas for conflict resolution where individuals can vent their differences without depleting the group's social capital.[123] Unless we design interventions to promote social learning and empower local communities for conservation, we will miss important opportunities to create local cultures of collaboration for sustainable conservation action.

Alternative Livelihoods through Micro-Financing

In the wake of the recent global economic downturn, many countries are attempting to rebuild their economies with a focus on job creation and enhanced revenue. This reality gives new impetus to the need to establish sustainable financing mechanisms for ocean conservation and to create at least one new job for any job lost as a result of MPA creation, fishery reform, or other conservation strategy. Micro-financing of alternative livelihoods, based on business plans that emerge from the bottom up in response to real economic needs, has the potential to create large conservation gains by promoting beneficial forms of economic development and by increasing sustainability.

Yet, alternative livelihoods have mixed success in reducing fishing and/or absorbing fishermen displaced by MPAs, buyouts, and fishery management restrictions. Alternative livelihoods are difficult to plan and sustain due to the vagaries of markets and financing and may lack the lifestyle elements that attract people to fishing.

Research suggests that a more effective strategy may be to improve economic well-being by providing financing and business-planning assistance in order to reduce fishing, charcoal making (resulting in mangrove destruction), and other destructive activities that result from economic desperation. By making capital and credit available to more people, and by leveraging that capital and credit to steer people away from destructive

[123] Ostrom, E. (2009). *Beyond market and states: polycentric governance of complex economic systems*. Nobel Prize lecture. Indiana University and Center for the Study of Institutional Diversity, Arizona State University.

activities and toward environmentally neutral, benign, or even restorative activities, micro-financing could protect biodiversity and ecosystem services on relatively large scales. This approach could have positive applications in both the Coral Triangle and the California Current, where lack of access to credit is a major obstacle to sustainable entrepreneurialism.

Integrating Climate Adaptation

Global climate change will have tremendous impacts on marine resources and coastal habitats in the future. Thus, the integration of climate change adaptation measures into other conservation efforts will be essential to achieve long-term and durable outcomes. Because of the enormity of expected impacts, the contributors to this paper also identified climate change adaptation as an important target strategy. Please refer to *Investing in Natural Coastal Habitats as a Climate Adaptation Strategy* below (page 33) for additional information.

Making Conservation Pervasive Through Market Reform

Market failure is a primary reason for the degradation of marine resources. Existing markets price only a few of the many valuable goods and services that ecosystems produce. For example, people will pay for seafood, but not necessarily for biodiversity or for the protection of habitats that support fish species. Moreover, markets tend to concentrate profits in a few hands, while distributing the environmental costs of activities broadly. This lack of feedback between individuals' behaviors and consequences can promote practices that harm ecosystems. Similarly, the economic benefits of environmental stewardship do not always go to those who practice it.

In response to market failures, governments and NGOs try to counter incentives to maximize short-term profits from natural resources by promoting regulations and protected areas. While critically important, these approaches have limitations: protected areas suffer from lack of enforcement, compliance, and sustainable funding, and regulations often create perverse incentives and reduce profits. Both kinds of conservation actions are often highly controversial and viewed as threats to livelihoods or profit because they impose costs on resource users.

Market reform would help to counter these shortcomings by creating incentives for stewardship and long-term economic returns from sustainable resource use, instead of for short-term overexploitation. Reforming markets will require three innovations: 1) strengthening the rights of organizations such as fishing cooperatives and community-based management groups that commit to environmental performance standards; 2) creating markets and financial instruments based on the value of a full portfolio of ecosystem goods and services and that generate revenue for the local stewards; and, 3) establishing new economic entities that assign costs and benefits appropriately. Examples include catch shares for fisheries, auctions for limited numbers of dive-tourism permits that have conservation restrictions attached to them, and flood insurance premiums.

Market reform at small scales in key places could produce relatively large benefits by protecting portfolios of ecosystem services instead of one or just a few at a time. Reform at a large scale could be a game changer, transforming all activities that influence ocean resources. While a heroic challenge, progress has been made in areas such as cap and trade and conservation easements.

Targeted Strategies and Tools: Strengthening Ocean Conservation Results and Fostering Sustainable Communities and Ecosystems

In the sections that follow, we outline the eight targeted strategies that we believe take on a unique, distinct role in the architecture of marine conservation. These strategies are designed to protect biodiversity and ecosystem services, and promote resilience, and productive fisheries, all of which lead to linked human and ecosystem health. While we believe each strategy outlined here deserves careful consideration, it is important to note that a few of these strategies are emergent or new formulations. These include Integrating MPAs with Fisheries Reform (essentially a fusion of two traditional approaches that has the potential to produce more profound results); Development by Design (using spatial management and economic tools to hardwire the financing and design of major infrastructure and energy development to work for marine ecosystems); and Natural Coastal Habitats for Climate Adaptation (retaining and restoring coastal habitats as a cost-effective way to adapt to the expected coastal impacts of climate change). Also noteworthy is that financial tools, economic analysis, and market strategies pervade several approaches. In the subsequent section, we offer recommendations to support successful implementation of these targeted strategies. Figure 9 offers an overview of the targeted strategies and associated recommendations to support effective implementation.

Figure 9: Targeted Strategies and Associated Recommendations to Support Implementation

	Targeted Strategies							
	Fisheries Reform through Access Privileges	Support Existing and Establish New MPAs	Strategy Fusion: Integrating MPAs and Fisheries Reform	Conservation of Open-Ocean Ecosystems	Marine Spatial Planning	Natural Coastal Habitats as a Climate Adaptation Strategy	Development by Design	Investing in "Conservaculture"
Establish and Enhance MPAs	✓	✓	✓	✓	✓			
Increase enforcement and compliance	✓	✓	✓	✓	✓		✓	✓
Encourage buyouts and capacity reduction	✓		✓					
Reduce subsidies							✓	
Reduce pollution								✓
Use social pressure and conservation marketing		✓	✓	✓	✓			
Change institutions and behaviors through education		✓	✓	✓	✓	✓	✓	
Develop and deploy bycatch reduction technologies			✓	✓				
Shift shipping lanes to protect vulnerable habitat				✓	✓			

Essential Foundational Strategies

- Fostering Innovation and Adaptation
- Building Capacity and Strengthening Institutions to Implement Solution
- Involving the Community in Community-Based Conservation
- Providing Alternative Livelihoods
- Integrating Climate Adaptation
- Making Conservation Pervasive Through Market Reform

Fisheries Reform through Access Privileges

With 79% of fisheries worldwide either fully exploited or overexploited, overfishing and destructive fishing practices are among the most serious threats to the world's oceans.[124] In addition, annual global fisheries bycatch is about 38.5 million tons, which represents approximately 40% of total marine catch, most of which is discarded.[125] These inefficiencies also have substantial economic impacts; when governmental subsidies are included, global fisheries are losing money with some estimates of annual loss as high as $50 billion.[126]

Fishermen exceed catch limits and use harmful gear for many reasons. Most are responding rationally to perverse incentives created by conventional fisheries governance and the maldistribution of rights, privileges, and responsibilities. Catch share programs allocate secure fishing privileges in the form of either "shares" of the allowable catch, or of fishing territories. Shares are allocated, auctioned, or sold to individuals, cooperatives, communities or other groups according to specific rules, which vary from program to program. When the total allowable catch or fishing area is divided up into secure fishing privileges, the incentives change dramatically and fishing behavior and investment patterns follow suit.

Recently, several studies have documented the benefits of catch share programs: prevention of fishery collapse, increasing overall catches, reduced fishing capacity and effort, reduced bycatch and discard, reduced gear deployment (a proxy for habitat impact), and improved compliance with conservation targets.[127,128] Fisheries reform can facilitate and enhance MPA establishment and effectiveness (see *Strategy Fusion: Integrating Marine Protected Areas and Fisheries Reform*) and many other conservation strategies (e.g., marine spatial planning). Thus, reforming poorly managed fisheries represents an opportunity to produce large economic and human welfare gains while greatly improving conservation performance and potentially reducing opposition to MPAs and other marine conservation measures.

Opportunities

Investment in development of catch shares is a moderate risk, high reward strategy. The opportunity lies in mainstreaming these types of management systems. Fortunately, catch shares are gaining acceptance in the scientific and economic literature and, importantly, in United States policy circles, the World Bank, the Food and Agriculture Organization, and other policy and funding entities.

To date, hundreds of fisheries throughout the world have implemented catch shares. In the United States, institutional readiness is growing, with NOAA's intensifying interest in expanding catch share programs around the fisheries management council regions. Other efforts are also underway, including along the West Coast, in New England, in the Gulf of Mexico, and in the southeast Atlantic. Furthermore, Mexico has recently begun implementing catch shares in the Gulf of California with plans to expand implementation to many other fisheries.[129]

Specific opportunities for funders to advance fisheries reform include supporting efforts to:

1. Develop criteria for selecting fisheries for reform and developing project pipelines.
2. Create catch shares in artisanal fisheries where there may be social readiness/willingness or pre-existing communal management structures.
3. Perform micro-economic studies and business planning support to demonstrate how individual fishermen and fleets and their profits may be affected by catch share management.
4. Conduct "bio-economic" analysis to illustrate potential national or regional economic and conservation benefits from catch shares.
5. Design and pilot financing tools that enable fisheries to transition to limited allocation systems and/or to procure quota once allocations are in place.

Barriers and Other Considerations

Key barriers to the widespread adoption of catch shares include:

- **Lack of buy-in and will:** Opposition by fishermen, processors, and other stakeholders to catch shares is significant and based largely on fears of inequitable share allocation and fear of losing fishing opportunity, revenue, or jobs.

[124] FAO. (2009). *The State of World Fisheries and Aquaculture 2008*. FAO Corporate Document Repository. http://www.fao.org/docrep/011/i0250e/i0250e00.htm.

[125] Davies R.W.D., Cripps S.J., Nickson A., Porter G. (2009) "Defining and Estimating Global Marine Fisheries Bycatch." *Marine Policy* 33: 661–672.

[126] FAO (2009). *The Economics of Ecosystems and Biodiversity*. TEEB for National and International Policy Makers.

[127] Costello, C., Gaines, S. D., Lynham, J. (2008). "Can Catch Shares Present Fisheries Collapse?" *Science* 321(5896): 1678–1681.

[128] Essington, T. (2009). *Ecological indicators display reduced variation in North American catch share fisheries*. Proceedings of the National Academy of Sciences.

[129] Center on Globalization Governance & Competitiveness. (2010). *A Value Chain Analysis of the Sinaloa, Mexico Shrimp Fishery*. Report prepared for the Environmental Defense Fund. http://www.cggc.duke.edu/environment/CGGC_SinaloaShrimp_Report.pdf.

- **Financial barriers:** Effective catch share design and implementation can be costly and although economic benefits often greatly exceed these costs, transition can be a substantial barrier, particularly for overcapitalized or collapsed fisheries. Lack of capital to procure fishing privileges (permits, individual transferable quotas, community allocations, etc.) also poses a challenge.
- **Poor governance:** Implementation of catch shares is often hindered by poor enforcement mechanisms for cooperative agreements and lack of robust co-management entities.

Beyond these barriers, there are other important considerations to bear in mind with fisheries reform. For one, quota systems can have drawbacks. They may result in "high-grading" (i.e. disposing of lower value species to maximize returns from the catch share), overfishing of non-target species in the system, and expensive fisheries management.[130] Adverse social consequences may also result from quota systems, including lost livelihoods, restricted resource access, and lower local investment.[131] A suite of strategies may be the best means to ensure conservation success, rather than reliance on quota systems alone.[132]

Potential for Conservation Results

Well designed and implemented catch shares and cooperative fishing arrangements can end overfishing, limit bycatch, and reduce habitat impacts within specific geographies by addressing underlying economic and social drivers of overfishing and destructive gear use. Catch shares can have enormous positive impacts if adopted broadly, or even if adopted in key fisheries with high ecological impact.

The most effective sequence of activities for reform will vary from fishery to fishery, depending on social readiness, the presence or absence of driving legislation, the level of economic urgency, the state of assessment science, and other factors. Timeframes for implementation also vary widely. Some catch share systems have taken over ten years to design and implement, while others have taken roughly one year. For example, the system for Sinaloa shrimp in Mexico, though not deemed a success given the lack of support from the industrial fishing fleet, was implemented in the 2009–2010 season.[133] Thus, while the potential exists for catch share management to produce conservation results, they will vary in intensity and timeframe depending on location and existing enabling conditions.

[130] T. Smith, M. Gibbs, and D. Smith (2009). "Fishing for More Effective Incentives." *Science* 323:337–338.

[131] N. Ban et al. (2009). "Diverse Fisheries Requires Diverse Solutions." *Science* 323: 338–339.

[132] *Ibid*.

[133] *Ibid*.

Support Existing and Establish New Marine Protected Areas

MPAs are one of the proven workhorses of marine conservation. They are areas of the seascape that are set aside for protection, ranging from no-take reserves with complete protection, to partial protection from recreational, subsistence, or commercial fishing. Scientific studies of MPAs around the world show that marine reserves produce substantial dividends in the form of enhanced biomass, size, and density of species, and increased biodiversity. When designed with active local community involvement using the best available science and data, and when there are institutions in place to actively support and manage MPAs into the future, these conservation tools can also be effective economic stimulants for tourism and local fisheries. Setting up MPAs involves much more than drawing lines on a map however. Typically, many individuals, businesses, governments, NGOs and local communities have stakes in the designation of an MPA, and all must be consulted and brought into the process.

Opportunities

In spite of the many benefits produced through the establishment of MPAs, relatively few have been created. As of February 2009, there were approximately 5,000 MPAs globally, protecting only 0.8% of the world's oceans.[134]

CORAL TRIANGLE

Within the Coral Triangle, MPAs are acknowledged as crucial tools for fisheries management and resource protection. Development of an integrated network of MPAs is an urgent priority. While numerous, MPAs cover less than 1% of the combined territorial waters in the region. This fact, combined with the incredible biodiversity of the region, makes the expansion of MPA networks in the Coral Triangle potentially a very high-opportunity and high-impact conservation strategy.[135]

The Coral Triangle Initiative offers enormous opportunity for creating new MPAs in the region. This six-country initiative involves development and implementation of a regional action plan to protect coral reefs, regional food security, and fisheries.

[134] Laffoley, D. et al. (2008). *Establishing Resilient Marine Protected Area Networks—Making It Happen*. Washington D.C.: The World Conservation Union. http://www.wdpa-marine.org/MPAResources/MPAPlanningResources/Docs/Establishing%20resilient%20MPA%20networks-making%20it%20happen.pdf.

[135] WCPA/IUCN. 2007. *Establishing Networks of Marine Protected Areas: a Guide for Developing National and Regional Capacity for Building MPA networks*. Non-technical summary report.

Best practices for planning MPA networks include:

1. Clearly defined goals and objectives
2. Legal authority and long-term political commitment
3. Incorporate stakeholders
4. Use of best available information and precautionary approach
5. Integrated management framework
6. Adaptive management measures

Source: see footnote 134.

CALIFORNIA CURRENT

In California, efforts are underway to implement the MLPA, which provides legislative authority to reevaluate and redesign the state's existing system of MPAs to incorporate them into a network. These larger networks of MPAs will offer further protection for the vast, connected ecosystems in the region. The MLPA Initiative is a public-private partnership to help fund the planning process and implementation of the Act.[136] A public stakeholder, science-based process is in place to complete the statewide network of MPAs by early 2012. Opportunities within California include continued support for the completion of California's MPA network, including support for development of a long-term funding strategy for ongoing management.

In Oregon, the state is undergoing a revision of its territorial sea plan and also is designing a marine reserve network. The Oregon Nearshore Research Task Force is charged with developing recommendations for long-term funding and coordination for nearshore management and research.[137] In the Gulf of California, a network of MPAs is being developed and a marine endowment has been established to support management. In Oregon and Mexico, political support for MPAs deserves strong philanthropic backing to promote the expansion of individual MPAs and to advance the creation of a true, well-functioning network.

[136] California Department of Fish and Game. *Marine life protection act initiative*. http://www.dfg.ca.gov/mlpa/.

[137] Oregon Ocean Information, (2010). *Status of Nearshore Task Force*. Nearshore Task Force. http://www.oregonocean.info/index.php?option=com_content&view=category&layout=blog&id=29&Itemid=21.

Barriers and Other Considerations

Success in the Coral Triangle is limited by insufficient resources for reserve management and proper enforcement of regulations. In some areas, such as western Indonesia, there are high failure rates of community-based, small-scale, no-take marine reserves, primarily due to lack of a long-term strategy linked to the local community's needs. In addition, lack of institutional capacity and true community involvement in MPA development and management design, as well as continued destructive fishing practices, sedimentation, and pollution are also creating challenges to MPA effectiveness within the region.

Along the California Current, depressed fisheries directly undermine MPA support by undercutting the fishing fleet's ability to take a long-term view of fishery management. Other barriers include lack of data, institutional resistance by government agencies, inadequate funding, and lack of experience with MPAs. In California, larger political agendas and opposition from some sectors, such as the national recreational fishing lobby, have erected significant barriers to MLPA implementation.

Another important point to consider is that regardless of the geography, establishment of MPAs is a two to ten year strategy. Thus, any MPA strategy must include a realistic timeframe for capacity building and cultivation of local support and engagement. This timeframe could potentially be shortened by linking this strategy with fisheries reform through access privileges.

Potential for Conservation Results

MPAs have the potential to generate economic and other benefits to local communities, and can serve as effective springboards for cultivating support for MPAs in regionally linked areas, as communities learn about the co-benefits of MPAs. Overall income from fishing can increase after MPA establishment, though there is often an initial period of reduced fishing immediately after MPA establishment. Therefore, expanding the number of MPAs must be coupled with community involvement, and development of effective and realistic compliance and enforcement mechanisms, as well as short-term funding to offset temporary fishing declines and long-term funding mechanisms to sustain community education and enforcement. In addition, capacity-building within local NGOs, communities and governments creates a crucial link for the expansion, long-term sustainability, and effectiveness of MPAs. If properly designed and implemented, MPAs can dramatically enhanced the livelihoods of people dependent on fishing as a subsistence livelihood, while also increasing tourism and preserving biodiversity.

Strategy Fusion: Integrating Marine Protected Areas and Fisheries Reform

High levels of fishing capacity and effort and low fishing revenues—fairly typical conditions in many fisheries—create economic pressure for higher allowable catch levels and fewer restrictions, and also lead to opposition to MPAs. Complex, ever-changing regulations create a lack of security within the fishing industry and incentivize competition to maximize catch, in direct opposition to conservation measures that restrict catch. This results in a perception of MPAs as threatening to livelihoods rather than as investments in more productive ecosystems, which can engender fierce opposition. Moreover, efforts to improve fisheries management and to establish MPAs have been going on largely in separate silos. This represents a missed opportunity for important synergies. Here, we explore how combining efforts to improve fisheries management with efforts to create MPAs can result in benefits to both and make successful, sustainable conservation easier to achieve.

The effectiveness of MPAs can be increased through improved fisheries management approaches, thereby reducing the amount of energy and resources required for successful conservation and increasing the scale at which conservation can be achieved. By timing fisheries management reforms and reforming fisheries management in certain ways—such as adjusting fishing capacity to match available fish stocks as they change, creating stewardship incentives, and increasing profit margins through dedicated access privileges—MPA establishment could be facilitated through the reduction of conflict, the creation of new constituencies, and possibly through the infusion of new funds.

Similarly, MPAs can be used to improve fisheries management. They can provide baseline information at appropriate spatial scales for stock assessment, serve as reference areas to reveal the impacts of fishing, reduce bycatch by keeping fishing away from diverse assemblages, and protect megaspawners (older, larger females) with higher fecundity levels.

Opportunities

The key to this strategy is to facilitate coordination of fisheries management reforms and tailor them specifically for the purpose of easing MPA adoption. Opportunities for funders to promote synergies between efforts to improve fisheries management and establishment of MPAs include:

1. Convening grantees working on fisheries and MPAs and develop common goals and coordinated strategies (e.g., fisheries reform first, then MPAs, Territorial Use Rights for Fishing (TURFs) connected to MPA spillover, networks of TURFs and MPAs to optimize yield and biodiversity conservation).
2. Funding partnerships between fisheries and MPA groups to create integrated catch share/MPA systems (e.g., in El Corredor, Baja California. See text box *The Case for Strategy Synergy*).
3. Supporting scientific and economic analysis related to fisheries and MPA integration (e.g., benefits, optimal design).

The Case for Strategy Synergy

Several examples illustrate the potential of coordinating fisheries reform and MPA strategies. New Zealand and Australia both manage fisheries with catch shares, and both have extensive MPA networks. In the United States, fishermen have supported no-trawl zones and MPAs in catch share fisheries (e.g., Alaska) or in response to structured buyouts (e.g., California's central coast). In Baja California, some MPAs, including marine reserves, have been established in the context of fishing concessions, which create more security and stewardship in the fishery. In addition, fishermen in El Corredor have agreed to establish a network of MPAs in exchange for fishing permits and over the longer term, a concession and potentially a TURF. In Belize, the Glover's Reef and Port Honduras MPAs are serving as testing grounds for fishery reform efforts in the form of area-based fishing privileges designed to exclude illegal fishermen and create community-based stewardship of both the fishery and the MPA. In Chile, MPAs and TURFs make up a network that covers much of the coastal nearshore waters and operates in the context of a catch share (ITQ) system for offshore fisheries.

Source: New Zealand Ministry of Fisheries. (January 2009). *Quota management system*. http://fs.fish.govt.nz/ Page.aspx?pk=81&tk=400.

New Zealand Ministry of Fisheries. (May 2010). *Commercial fisheries*. http://www.fish.govt.nz/en-nz/Commercial/default.htm.

New Zealand Department of Conservation. *Marine conservation and other protected areas*. Conservation, Marine and Coastal. http://www.doc.govt.nz/conservation/marine-and-coastal/marine-protected-areas/.

The Nature Conservancy, (2010). *California Central Coast Groundfish Project*. http://www.nature.org/wherewework/northamerica/states/california/initiatives/ccgp.html

Barriers and Other Considerations

CORAL TRIANGLE

Many MPAs already exist within this region, so for many places it may be unnecessary to use fisheries reform as a tool for facilitating MPA creation. In addition, lack of limited-access programs restricts the number and nature of fishing assets that

could be acquired, and lack of fisheries management capacity could hamper design and implementation of fisheries management reforms.

CALIFORNIA CURRENT

Within the California Current, lack of capacity at the federal and state level to undertake fisheries reform poses a challenge, as does political or ideological opposition to certain kinds of fisheries reform. Uneven establishment of MPAs within states along the West Coast, for example, may create barriers for developing a larger regional impact. Funding restrictions and lack of sufficient enforcement budgets also pose significant challenges.

It is also important to note that while coordination of MPAs and fisheries strategies can start immediately, actual integration of fisheries management and MPAs may take five to ten years.

Potential for Conservation Results

This is a relatively low-risk, moderate reward strategy. Integrating fisheries management with MPAs in this way has the potential for large-scale positive impact on biodiversity and ecosystem services affected by fishing. Tuning and timing fisheries management reforms so that they address the social and economic drivers of opposition to MPAs, and allowing fishermen to benefit from MPAs, could help reduce conflict, create newly supportive constituencies, and possibly generate an infusion of funds. Strategically designing MPA networks and spatial fishery management zones, such as TURFs, may result in higher yields and greater biodiversity protection over larger areas. In addition, the potential for sustainable MPA funding derived from increased fishery profits as a result of management improvement exists in the Coral Triangle and the California Current regions.

Conservation of Open-Ocean Ecosystems

The open-ocean ecosystems of the Pacific Ocean support some of the largest fisheries, and most vulnerable species and ecosystems in the world. Destructive fishing practices already have depleted and damaged major tuna populations, vulnerable species such as sea turtles, and degraded sensitive habitats such as deepwater coral communities and seamount ecosystems. Moreover, highly migratory species may also move between EEZs and the "high seas," where no single country has jurisdiction. As a result, effective management of these fisheries and their impacts on target and non-target species and marine habitats is complicated and requires international cooperation.

International agreements or treaties regulating fishing in the Pacific Ocean form the principal vehicles of the Conservation of Open-Ocean Ecosystems strategy. These agreements include:

- **The South Pacific Regional Fisheries Management Organization:** culminated from international consultations in November 2009.[138] The treaty, which has yet to go into effect as of this writing, spans the high seas of the South Pacific Ocean and focuses upon open-ocean fisheries as well as seamounts and ridges. New Zealand, Cook Islands, Chile, Colombia and Peru are signatories.
- **The Western and Central Pacific Fisheries Commission:** seeks to manage fisheries for highly migratory species and to reduce impacts on sea turtles, sea birds, and other vulnerable species.[139] Two dozen countries belong to the treaty organization, including the United States, China, the European Community, Mexico, Korea, Japan, and many island states and federations.
- **The Inter-American Tropical Tuna Commission and the South Pacific Tuna Treaty:** other treaty organizations of interest in the Pacific Ocean.[140,141,142]

Opportunities

Most of these international agreements are new and have enough national-level support that they could contribute greatly to the conservation of open-ocean wildlife and habitats. Any philanthropic efforts to enhance these vehicles should begin by assessing the capacity of both implementing organizations and relevant political relationships, as well as the development of a strategy based on priority issues and opportunities. That strategy could include direct technical or logistical assistance, support to national and international conservation and scientific organizations, outreach to industry, and public education and outreach. Coordination with several of the Packard Foundation's grantees' work on markets should also play a role.

Barriers and Other Considerations

For a variety of reasons, efforts to strengthen and encourage effective implementation of these treaties remain problematic. Key barriers include size of the region and its cultural, political, and economic complexity. In some cases, illegal and unregulated fishing is practiced, facilitated and/or tolerated by countries

[138] South Pacific Regional Fisheries Management Organization. (2010). *About the SPRFMO*. http://www.gc.noaa.gov/gcil_maritime.html.

[139] Western and Central Pacific Fisheries Commission. (March 2010). *Home*. http://www.wcpfc.int/.

[140] Inter-American Tropical Tuna Commission, (October 2010). *IATTC*. http://www.iattc.org/HomeENG.htm.

[141] NOAA National Marine Fisheries Service, Pacific Islands Regional Office. (June 2007). *South Pacific tuna treaty (SPTT)*. http://www.fpir.noaa.gov/IFD/ifd_sptt.html.

[142] U.S. Department of State. *South Pacific Tuna Treaty*. http://www.state.gov/g/oes/ocns/fish/bilateral/c33153.htm.

within the affected region. Moreover, not all countries in the region value or prioritize sustainable fisheries management.

To address these challenges, conservation practitioners and funders should work to ensure that the best available science is communicated effectively and in a timely manner. Building the capacity of secretariats to provide sound advice and support to member countries can also instill an organizational culture that values science and the long-term view. The interest of individual political leaders to build a reputation for leadership in international conservation may also be a useful technique for overcoming barriers.

Potential for Conservation Results

It is conceivable that a consistent, thoughtful strategy over ten years could significantly elevate the inclination and ability of these treaty organizations to integrate precautionary approaches and best available science into conservation and management measures. It could also help them gain significant compliance through the use of state-of-the art monitoring and enforcement technology and other means. It is clear that such success is vital to the recovery of several endangered species, including leatherback sea turtles, and of several important commercial species, such as bigeye tuna and swordfish. It will also be essential for the protection of remaining seamount habitats from destructive fishing gear such as trawls and gillnets.

Any such effort, however, should include an explicit and thorough review of progress five years into the strategy. Such a review is particularly important in work with treaty organizations, some of which have fallen far short of meeting the needs they were established to address. If the current momentum that led to these new organizations dissipates, the strategy should be revised or abandoned.

Marine Spatial Planning

Marine conservation researchers and funders over the last ten years have focused on the well-known drivers of change, or threats, to marine ecosystems—overfishing and bycatch, habitat damage, pollution, invasive species, and climate change—and have sought tools to reduce or eliminate them. The conservation community of researchers and funders has also sought ways to protect and enhance biodiversity, resilience, and ecosystem services. For decades, MPAs have been a frequently employed tool to try to integrate ocean uses with marine conservation goals. Presently, emerging ocean uses such as aquaculture and renewable energy generation are adding new management challenges to already-crowded seascapes. Although maintaining pressure to establish MPAs is essential, the current sector-by-sector approach to management fails to address cumulative effects of human activities on ecosystem services and cannot provide guidance for evaluating tradeoffs among human activities. Thus, a more comprehensive approach to ecosystem-based management is required to effectively balance competing ocean use demands with a healthy marine environment. Rational spatial planning, based on insights from the natural, physical, and social sciences, is essential if we are to balance all of the demands on coastal and ocean systems in ways that do not exacerbate existing problems or introduce new ones.

Marine Spatial Planning (MSP) is a means of implementing ecosystem-based management for an increasingly developed seascape. The United States Interagency Ocean Policy Task Force (2009) defines MSP as "a comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of the ocean, coastal and Great Lakes areas. [MSP] identifies areas most suitable for various types or classes of activities in order to reduce conflicts among users, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives." A robust MSP process involves a multi-step approach starting with a comprehensive ecosystem assessment that includes information on the biophysical environment, human activities within marine geographies, and the

The MSP process typically includes several steps, with extensive stakeholder engagement at all points of the process:

- Identify need and establish authority
- Obtain financial support
- Perform pre-planning (e.g., data collection)
- Organize stakeholder participation
- Define/analyze existing conditions
- Define/analyze future conditions
- Prepare/approve spatial management plan
- Implement/enforce spatial management plan
- Monitor/evaluate performance
- Adapt/update the plan
- Adapt management measures

Source: Ecosystem-based Management Tools Network. (2010). *Tools for Marine Spatial Planning*. http://www.ebmtools.org/msptools.html.

economic implications of these activities. It also considers business plans and agency planning documents to provide insight on emerging activities and potential synergies and conflicts, and includes stakeholder engagement processes for current and future planning activities.

Opportunities

In December 2009, *Scientific American* included MSP as one of twenty "world-changing" ideas. Recent editorials in *Nature*, *Science*, and *Scientific American* all point to the potential for MSP to rise above sectoral management and to foster science- and ecosystem-based management.[143] Furthermore, at least a dozen countries have developed or are developing MSP approaches for managing human activities in marine ecosystems. Some of these plans prioritize industrial uses, as seen in China, while others favor conservation, as in Australia's Great Barrier Reef Marine Park. In the United States, states such as Massachusetts, Rhode Island, and New York have implemented MSP, and California is establishing a foundation for MSP through the MLPA Initiative. At the federal level, increasing interest in MSP is reflected in plans drafted by the United States Interagency Ocean Policy Task Force in fall 2009[144] and the executive order, signed by President Obama in July 2010, which created the National Ocean Council. The Council is charged with advancing the National Ocean Policy using science-based MSP as the foundation for implementation.

Barriers and Other Considerations

Perception is important on all fronts. If environmental NGOs perceive MSP as a way to streamline industrialization of the oceans, they may oppose its implementation. Conversely, extractive industries may oppose MSP if they perceive it as a new vehicle for additional conservation without corresponding gains in regulatory certainty and permitting efficiency. Moreover, both camps may oppose any new structure that creates more uncertainty than the status quo.

In addition, typical preconditions for MSP receptivity and adoption can be substantial, and include:

- Conflicting uses and/or new uses are increasing in number
- Strong institutions exist with capacity to implement MSP
- Spatially explicit data is available
- Marine ecosystems are valued

Potential for Conservation Results

Because implementing MSP will require strong institutions and funding, it may be limited to regions where significant ocean use conflicts exist and institutional strength and government support are relatively high (California Current), rather than areas with limited institutional capacity and government will (Coral Triangle). MSP is a critically important step beyond MPAs, which often pits the environmental sector against the fishing sector. Comprehensive, cross-sectoral marine spatial planning would assure everyone a seat at the table. And while it could reduce access to parts of the ocean for some sectors, the goal is to find everyone appropriate space to address their interests while achieving ocean health goals. Several working groups are currently attempting to identify ocean health indicators that could serve as metrics for evaluating MSP conservation outcomes and impacts. Concurrently, traditional metrics such as biodiversity remain strong contenders for evaluating conservation success of MSP designation schemes. More attention needs to be focused on effective goal and objective-setting and for MSP that accounts for impacts on both "natural" and human systems.

Investing in Natural Coastal Habitats as a Climate Adaptation Strategy

By 2025, over 75% of the world's population will live within one hundred km of the coast. The converging trends in human settlement and climate change are creating a collision between coastal development and coastal risks.[145] Climate change already has caused sea level rise; on California's coast, for instance, sea levels have risen roughly seven inches since 1900. If emissions continue unabated, sea levels are projected to rise somewhere between an additional 40 to 69 inches by 2100, accelerating coastal erosion, threatening inland water systems, and damaging wetlands.[146,147]

[143] Mims, C. et al. (November 2009). "World Changing Ideas: 20 Ways to Build a Cleaner, Healthier, Smarter World". *Scientific American Magazine*. http://www.scientificamerican.com/article.cfm? id=world-changing-ideas.

[144] Exec. Order. *Stewardship of the Ocean, Our Coasts, and the Great Lakes*. (July 19, 2010). http://www.whitehouse.gov/the-press-office/executive-order-stewardship-ocean-our-coasts-and-great-lakes.

[145] Burke L., Kura Y., Kassem K., Revenga C., Spalding M.D. and McAllister D. (2001). *Pilot Analysis of Global Ecosystems: Coastal Ecosystems*. World Resources Institute, Washington DC.

[146] Kefer, Jennifer, (2007). *America's Flood Risk if Heating Up: as Temperatures Rise, the Army Corps of Engineers Must Improve the Nation's Flood-Control System*. Environmental Defense. http://www.edf.org/documents/6271_AmericasFloodRiskIsHeatingUp.pdf.

[147] Sea-Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team, (2010). *State of California Sea-Level Rise Interim Guidance Document*. http://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20110311/12.SLR_Resolution/SLR-Guidance-Document.pdf.

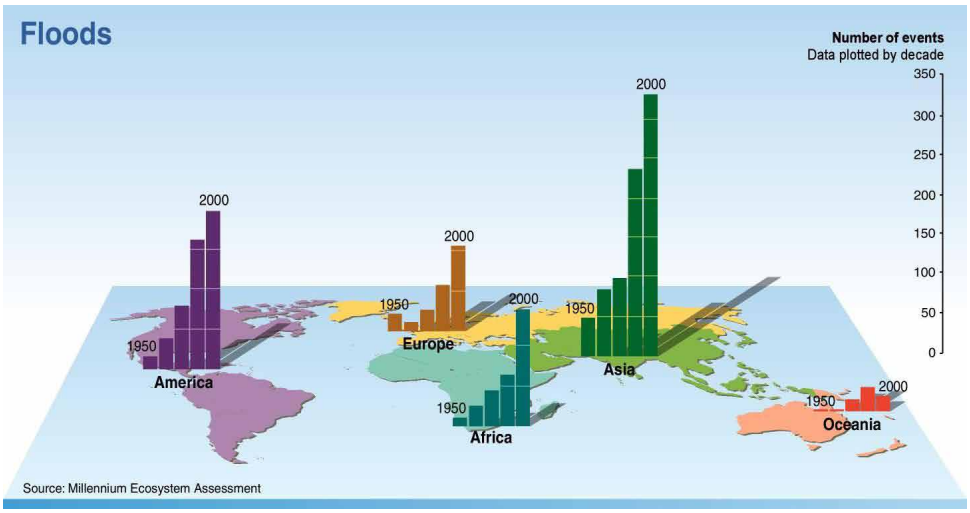


Figure 9: The temporal trend in severe flood frequency from 1950 to 2000, in decadal increments.

Source: Philippe Rekacewicz, Emmanuelle Bournay, UNEP/GRID-Arendal. (2005). "Number of Flood Events by Continent and Decade Since 1950." in *UNEP Millennium Ecosystem Assessment*. http://maps.grida.no/go/graphic/number-of-flood-events-by-continent-and-decade-since-1950

Global climate change will also cause more extreme weather events, such as floods, monsoons, droughts, heat waves and hurricanes (see Figure 9). Thus, there is an enormous need to adapt to climate change to enhance the wellbeing and long-term sustainability of coastal communities.

Hard-engineered solutions (such as seawalls, levees, channeled rivers, flood-control dams and dikes) have been the traditional response to severe weather events, but these management options have several downsides: they are expensive, require upkeep, and alter ecosystems. "Soft" engineering or natural management options (such as maintenance and/or restoration) and systems of protection (i.e. mangroves, salt marshes, eelgrass beds, and floodplains) provide equal and sometimes more effective protection for less investment, a particular benefit for developing countries and communities with less capital. Moreover, they help protect natural ecosystems instead of degrading them.

To effectively employ this strategy, some common components are required regardless of where natural management options are employed, including in the Coral Triangle and the California Current:

- an **ecosystem services assessment** of historic, existing, and potential services as well as their tradeoffs between different adaptation options;
- a **full-cost economic cost-benefit analysis** of different options;
- a **robustness assessment** across different mitigation and impacts scenarios to gauge long-term sustainability of different options; and
- **new policies** (e.g., requiring ecosystem services assessments for adaptation options) and **private sector efforts** (e.g., pegging insurance rates to risk) that modify markets and financial incentives in a way that shapes land-use planning and the assessed value of assets at risk of sea level rise and storm damage.

In addition, any climate change adaptation strategy should mix a top-down approach influencing major institutional funders and the development of national adaptation plans, with a bottom-up approach of involving local communities in adaptation planning, especially where local economies depend on natural ecosystems.

Opportunities

The clear opportunity is to shape massive public investments in coastal adaptation in ways that cost-effectively benefit people while also protecting or restoring dwindling critical habitat. The Foundation's role could be to support actual assessments and pilot applications of alternative adaptation investments in specific places where investments are being and will be made. This could be done by supplying matching funds to attract government or multilateral aid agency/bank investments. There is also a need to support policy work in the Coral Triangle, Micronesia, the Gulf of California, and the United States, as well as with multilateral institutions and private and professional associations in the United States and internationally. This policy work would identify capital flows and plot influence maps to better target engagements.

Below we identify specific opportunities within the Coral Triangle and California Current geographies.

Habitat Restoration:
More Value than Meets the Eye

Restoration has traditionally been seen as too expensive to be an effective conservation strategy, but can start to look like a bargain when compared to coastal hardening. For example, it costs $1 million to restore one mile of oyster reef along the Louisiana coast. After restoration, the oyster reef provides sand nourishment, storm surge protection, and food. That cost has been judged prohibitive if viewed as an "oyster production" investment, alone. As an adaptation investment, however, that $1 million pales in comparison to the cost of engineered solutions such as the elaborate dikes, dams, and levees being built in New Orleans. Moreover, major infrastructure projects like dams and levee systems are promoted as job creators, while employment figures for restoration efforts are rarely publicized. TNC is tracking job creation to date for eight NOAA "recovery act" restoration projects managed by TNC, with a combined budget of approximately $25 million. That data show:

- Projected jobs created or maintained: 415
- Projected acres restored or enhanced: 1,118[36]
- Projected river kilometers opened and improved: 130[36]
- Habitats improved: salt marshes, underwater grass beds, oyster reefs, coral reefs, rivers and streams that provide juvenile and adult salmon habitat.

Source: The Nature Conservancy (April 2010). *Investing in nature: creating jobs and Restoring Coastal Habitats*. http://www.habitat.noaa.gov/pdf/tnc_noaa_arra_restoration_summary.pdf.

CORAL TRIANGLE

The World Bank and the Inter-American Development Bank (the main sources of multilateral financing in Latin America) have expressed great interest in vulnerability assessments for coastal systems. These lending institutions have standard procedures for environmental assessments. If these institutions were provided easy-to-use tools that contrasted engineered with nature-based solutions, conducting such an analysis could become an integral requirement for future loans.

In addition, nature-based solutions that focus on maintaining or restoring mangroves and protecting coral reefs and sea grass beds can represent a poverty reduction strategy, a conservation strategy, and an adaptation strategy all at once—one that local communities and the development sector could back.

CALIFORNIA CURRENT

California is currently formulating a statewide climate adaptation plan, and environmental NGOs are advocating a focus on soft adaptation, such as habitat restoration, over engineered solutions. Providing support to advance these efforts offers an opportunity to generate significant environmental and economic benefits within California.

Barriers and Other Considerations

Although natural habitats can afford protection, several factors may impede widespread implementation of this strategy, including:

- Local political considerations, short-term economic goals, and the status quo market structure, which fails to accurately value natural systems of protection over engineered solutions.
- The absence of basic data, unproven methodology for cost-benefit analyses, and unproven methodologies for robustness analyses across different scenarios.
- Opposition from real estate and construction sectors that stand to make a great deal of money from land-use and hard-adaptation plans may also prove challenging and will require a smart, highly leveraged strategy.

Potential for Conservation Results

Within the Coral Triangle, an ecosystem-based adaptation approach is a high-reward proposition, perhaps one of the highest possible rewards in the Coral Triangle over the next five to ten years. Importantly, the same strategies that provide coastal adaptation options in the Coral Triangle also provide improved food security and livelihoods to poor coastal populations. However, the use of green solutions must be balanced with careful analysis, the creation of realistic expectations, effective coastal development policies, and strategic use of engineered solutions to mitigate risks should mangroves and/or coral reefs fail to provide adequate protection when a major storm hits. There are beacons of hope for building internal capacity, such as the Universitas Indonesia. In addition, USAID, AUSAID, and foundations have led efforts to develop pilot programs that demonstrate how to effectively employ this strategy.

Within the California Current, a modest investment in assessing policy windows (for example, the ongoing efforts of the WCGA on Ocean Health and the California Coastal Commission), coupled with scientific scenario analyses that contrast different adaptation approaches along with their full costs and benefits are necessary first steps that will form the foundation of significant on-the-ground conservation results. In addition, engaging

state or regional efforts to develop and implement an adaptation strategy is another area that could produce valuable long-term conservation results.

Development by Design

The global demand for energy has prompted new energy projects that pose serious threats to coastal ecosystems and marine resources. Oil exploration and extraction can have disastrous consequences, as demonstrated by the recent Gulf oil blowout. Even "green" energy projects (such as hydroelectric dams and wind farms) can have negative results if poorly situated. Dams, for instance, block the migration of anadromous fish and degrade wetland and delta habitats. To date, marine conservation efforts have given little attention to such emerging threats. Development by design seeks to address these threats by balancing economic development and ecosystem protection.

Opportunity

Development by design emphasizes the economic benefits of conservation, an especially important strategy in the wake of the global economic downturn when Americans' support for environmental protection plummeted.[148] It promotes economic damage assessment with performance-based offset payments. With this approach, measurable objectives are framed in terms of the value of offset payments generated and the proportion of development projects that are implemented with minimized biodiversity impacts. For example, emerging methods to characterize and quantify cumulative impacts on coastal and marine ecosystems, coupled with marine spatial planning, would allow developers to place their facilities in preferred locations for energy potential while mitigating the real increases in cumulative impacts of their facilities by purchasing decreases in other stressors within the region.[149,150]

In addition, development by design can take advantage of performance-based standards, where facility or project applicants are scored against project design features and metrics. High-scoring projects would be given priority for permit processing, and low-scoring projects would be required to revise their design to meet minimum thresholds for permitting. This approach has been used effectively, especially in jurisdictions where performance expectations are well articulated in zoning and planning guidelines and legally adopted plans such as general plans and zoning ordinances.

Development by design could gain traction with development institutions such as USAID, AusAid, the Asia development Bank, the World Bank, and the Inter-American Development Bank that already conduct environmental assessments. In addition, global corporations, which often seek to maintain their social capital, might be guided by biodiversity and ecosystem management concerns so long as transaction costs are minimal.

Barriers and Other Considerations

Despite the promises afforded by development by design, barriers exist that could prevent its successful implementation. In both the Coral Triangle and the California Current, there is lack of basic data on the risks and impacts of development, as well as unproven methodologies for economic analyses. Another key barrier is the absence of a policy intervention point. This barrier is greatest in the Coral Triangle, where governance is weak. In contrast, California Current state and federal agencies possess and use the authority to regulate coastal energy extraction and development and, as in the case of the California Coastal Commission, have already demonstrated both willingness and capacity to embrace performance-based standards.[151]

Potential for Conservation Results

The potential reward for implementation of development by design in the Coral Triangle is large. Coral Triangle nations are desperate for cash and offshore energy projects will be extremely tempting to them. For example, the Indonesian government and its oil and gas industry regulator, BP Migas, have introduced policies aimed at developing oil resources throughout the country, including waived import taxes on oil and gas exploration and production equipment.[152] Similarly, new offshore wells are being drilled in Indonesian waters at a rapid pace. The lure of oil money will make Coral Triangle nations anxious to rush ahead with energy development. Now is the time to convince them that they can still make money, but in a way that will reduce risks to valuable fisheries, tourism, and public health.

[148] The Pew Research Center for the People and the Press (January 2009). *Economy, Jobs Trump All Other Policy Priorities in 2009: Environment, Immigration, Health Care Slip Down the List*. Survey Reports. http://people-press.org/report/485/economy-top-policy-priority.

[149] Halpern, B.S., Walbridge, S., Selkoe, K.A., Kappel, C.V., Micheli, F., D'Agrosa, C., Bruno, J.F., Casey, K.S., Ebert, C., Fox, H.E., Fujita, R., Heinemann, D., Lenihan, H.S., Madin, E.M., Perry, M.T., Selig, E.R., Spalding, M., Steneck, R., and R. Watson. (2008). "A Global Map of Human Impact on Marine Ecosystems." *Science* 319 (5865): 948–952.

[150] Caldwell, M. "What comes next? The future of ecosystem planning in California." Paper presented at the 2nd International Marine Conservation Congress, Victoria, BC, Canada, 14–18 May 2011.

[151] California Coastal Commission. Build Green, Save Green: Reduced Permit Fees for Building Green. Last Accessed September 15, 2011. http://www.coastal.ca.gov/climate/feereduction.html.

[152] U.S. Energy Information Administration. *Oil*. Indonesia. http://www.eia.doe.gov/cabs/Indonesia/Oil.html.

In contrast, the potential reward in the California Current is modest to small. Energy exploration and other development are likely to be resisted by the public to such an extent that the payoff on investing in development by design is small, although Surfrider Foundation is among a number of environmental NGOs who endorse responsible siting of hydrokinetic energy facilities and is actively working with the State of Oregon and wave energy proponents to locate facilities in the water. Opportunities for development by design solutions are many, with wind energy development in the Northeast as well as with continued oil development along the Alaska and Gulf coasts.

Investing in "Conservaculture"

As noted, mounting human demands for fish and invertebrates places increasing pressure on marine resources. Effective integration of aquaculture (the farming of fish, invertebrates, and seaweed) and fisheries could help to mitigate this pressure and yield benefits to human populations and marine ecosystems.

Opportunity

Aquaculture may provide a substantial boost to food security. Currently, aquaculture accounts for roughly 47% of world food-fish consumption[153] and is the world's fastest growing form of food production, increasing by 6.9% each year.[154] The number of marine species used in aquaculture also is expanding at a significant rate. Over 400 aquatic species have been domesticated since the beginning of the twentieth century; over 100 species have been newly domesticated in just the last decade. This rate of domestication is approximately 100 times the rate at which terrestrial plants and animals were domesticated over the preceding 11,000 years.[155] The pace of expansion suggests the possibility of aquaculture replacing fisheries in the future.

Barriers and Other Considerations

However, aquaculture has negative impacts on marine resources. These include habitat loss, increased fishing pressure on wild feed species, nutrient pollution, and the spread of disease to and genetic competition with wild species.[156] In addition, global aquaculture production may deprive local communities of needed protein. The aquaculture industry, for instance, is diverting small, oily forage fish, important for local food security in developing nations, to high value farms for export. In addition, any expansion of aquaculture will likely be controversial, especially in the United States, where fishermen may express concern that aquaculture expansion will drive them out of business.

Potential for Conservation Results

Integrating fisheries and aquaculture can help to minimize these negative effects and achieve conservation and consumer benefits. This strategy requires more than minimizing the environmental impacts of the aquaculture industry; it entails funding strategies that help aquaculture to yield net positive benefits. Several approaches can support this strategy. For example, seafood businesses and conservation organizations can help develop a campaign to protect the base of marine food webs. It is critical to ensure that there is adequate forage fish to serve as prey for high trophic level fish, marine predators, and birds.

Second, expansion of environmentally responsible aquaculture could reduce pressure on wild capture species. For instance, a relevant Fishery Management Council could eliminate a unit of production of wild capture fisheries for every unit of production harvested from aquaculture (as noted, though, this approach is likely to be controversial).

Third, farming of shellfish and marine algae could help to improve coastal water quality. For instance, oysters filter phytoplankton and detritus from the water column, an effective means for capturing excess nutrient runoff. Filter feeders can also be used to lessen escape of pollution from finfish aquaculture through integrated multi-trophic aquaculture (IMTA) systems. In IMTA, a variety of aquatic species is grown together such that the waste products of one species are used as food or nutrients for another. For example, surrounding salmon net pens with seaweed and/or mollusk culturing helps to reduce nutrient pollution from fish feces and uneaten feed, with mollusks consuming particulate organic matter and seaweeds absorbing dissolved nutrients.[157] This "conservaculture" approach mimics both traditional aquaculture practices and natural ecosystems, and creates additional products and revenue streams while also reducing the negative nutrient impact of growing finfish. Although many forms of aquaculture can have negative ecosystem impacts, IMTA is just one example of multiple opportunities for improvement that should be explored.

[153] FAO. (2009). *The State of World Fisheries and Aquaculture 2008: Part 1—World Review of Fisheries and Aquaculture*. FAO Corporate Document Repository. ftp://ftp.fao.org/docrep/fao/011/i0250e/i0250e01.pdf.

[154] FAO. (2007). *State of the World Fisheries and Aquaculture*. FAO Corporate Document Repository. http://www.fao.org/docrep/009/a0699e/a0699e00.htm.

[155] Duarte, C. M., Marbá, N., Holmer, M., (2007). "Rapid domestication of marine species." *Science* 316, 382–383.

[156] Goldburg, R., and Naylor, R. (2005). "Future seascapes, fishing, and fish farming." *Front Ecol Environ* 3(1): 21–28.

[157] Neori, A. (2008). "Essential Role of Seaweed Cultivation in Integrated Multi-Trophic Aquaculture Farms for Global Expansion of Mariculture: an Analysis." *Journal of Applied Phycology* 20 (5): 567–570.

Finally, regional aquaculture initiatives could help sustain local communities. Building on the "local foods" movement, this type of aquaculture could ensure that regionally specific aquaculture projects are designed to sell to local communities and to ensure that the socioeconomic benefits accrue to local communities.

Recommendations for Implementation

Here we offer a set of recommendations to help support more effective implementation and uptake of the cross-cutting and targeted strategies presented above. They are multi-purpose in their function and can be tailored for specific situations and needs. Though all of these recommendations have been demonstrated to be effective, each can also benefit from innovations in design and deployment. It is our hope that this ongoing improvement of these recommendations includes the expertise of scientists and practitioners across disciplines as well as the invaluable knowledge of those who make their living on or near the ocean.

- **Establish and Enhance MPAs.** MPAs have been shown to be an effective conservation tool when coupled with meaningful community involvement in planning and management, effective enforcement mechanisms, short-term funding to offset temporary fishing declines after MPA establishment and long-term funding mechanisms to sustain community engagement, education and enforcement. MPAs can be key tools for comprehensive, multi-sector marine spatial planning, fisheries reform and open ocean conservation strategies, as well as for direct MPA expansion strategies.
- **Increase enforcement and compliance.** Compliance generally arises from community and stakeholder agreement with regulatory efforts and engagement in planning and implementation stages. Enforcement relies at least in part on access to consistent resources for monitoring, such as boats and fuel, and on workable social systems for handling infractions. Enforcement options differ widely depending on the remoteness of an activity or protected area and the local culture, traditions, legal regimes, and capacity. Nearly every primary strategy we suggest requires effective enforcement and compliance to succeed.
- **Encourage buyouts and capacity reduction.** Short-term reduction in marine resource extraction can be achieved by purchase of fishing boats or licenses, so long as there are limits on reentry to the fishery. Buyouts can yield lower fishing pressure together with higher per capita income for the remaining fishing fleet, while also providing a strategy that allows fishermen to exit a fishery without disastrous financial losses.
- **Reduce subsidies.** Governments underwrite excess fishing pressure through subsidies for boat construction, fuel costs, and other aspects of industrial fishing. By artificially reducing costs, subsidies can increase profits even for fisheries in decline. Efforts to reduce subsidies must be directed toward top-level government agencies that are in control of payments. For globally traded seafood, subsidies may also be considered an unfair trading practice under international free trade agreements. In addition, subsidies also play an important role in encouraging shortsighted approaches to coastal adaptation to climate change, such as disaster relief and reconstruction in vulnerable areas, and insurance subsidies that encourage settlement in those areas and government-funded coastal armoring projects.
- **Reduce pollution.** Pollution is seldom a locally desirable outcome, however pollution creating industries are frequently allowed to continue polluting because of some perceived benefit such as job creation. Pollution can be reduced by working with communities to develop less polluting or more sustainable ways to produce the same benefits. Possibilities include promoting land use practices that reduce runoff and deter erosion of topsoil, efficiency-based reductions in excess fertilizer use, segregation of livestock or human waste from ocean environments, direct government payments to abate pollution, and design of alternatives that increase the efficiency or sustainability of local development projects.
- **Use social pressure and conservation marketing.** Peer groups can model conservation behavior and stimulate broader adoption of conservation standards. Those examples can be spread more widely by social networking and conservation marketing. Marketing of "dolphin safe" tuna is the classic example. Social networking and conservation marketing are much better known in economic, political, and social sciences circles than in the natural sciences. Properly used, they may be able to enhance the penetration of conservation behaviors into diverse elements of society. They can also be valuable in small group settings, such as in villages, where key social leaders can provide visible agents of change.
- **Change institutions and behaviors through education.** Conservation and sustainability education can empower people to conceive and implement their own effective solutions—and these are likely to be more tailored to the needs of their own societies, businesses, agencies, or governments. It can also help those who create successful solutions become leaders in society. Education can be formal, or take the form of learning networks—informal leagues of professionals facing similar problems who exchange information and ideas outside a traditional educational setting.

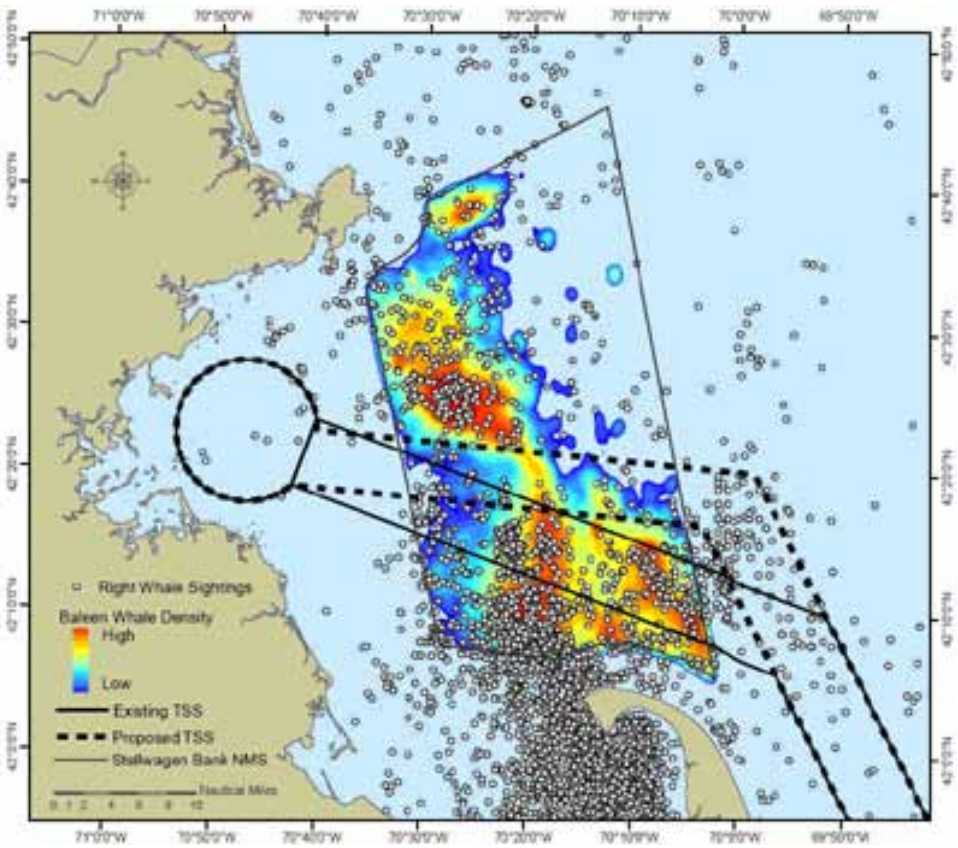


Figure 10: Shifting the Boston Traffic Separation Scheme (TSS)

The Stellwagen Bank National Marine Sanctuary and surrounding waters showing (a) the distribution and relative density of all baleen whales in the sanctuary, (b) the location of right whale sightings and (c) the current and proposed Traffic Separation Schemes through the sanctuary. Data consist of over 350,000 sightings over a 24 year period.

- **Develop and deploy bycatch reduction technologies.** Turtle excluder devices, albatross deflectors, ground fish excluders on scallop dredges, and fish escape technology on shrimp trawls are examples of simple changes to fishing gear that have reduced mortality of non-target species during high-intensity fishing. Supporting continued invention and adoption of these devices by the fishing industry, by national and state management agencies, and through conservation can be a powerful means for advancing conservation.

- **Shift shipping lanes to protect vulnerable habitat.** For species or ecosystems harmed by ship traffic, altering shipping lanes can provide crucial protection. Examples include ship lanes in the Monterey Bay National Marine Sanctuary that keep vessels away from the Farallon Islands and the Stellwagen Bank Traffic Separation Scheme (see Figure 10) to protect the 300 to 400 remaining Atlantic right whales.[158] A small shift in the shipping lane led to an estimated reduction in collisions by 81% for all whales, and 58% for the endangered right whales.[159]

[158] NOAA Fisheries, Office of Protected Resources. (July 2011). *North Atlantic Right Whales (Eubalaena glacialis)*. http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northatlantic.htm.

[159] NOAA/Stellwagen Bank NMS/NMFS, Wiley, Thompson, and Merrick. (2009). *Shifting the Boston Traffic Separation Scheme (TSS)*. http://stateofthecoast.noaa.gov/mpa/cmsp_whales.html.

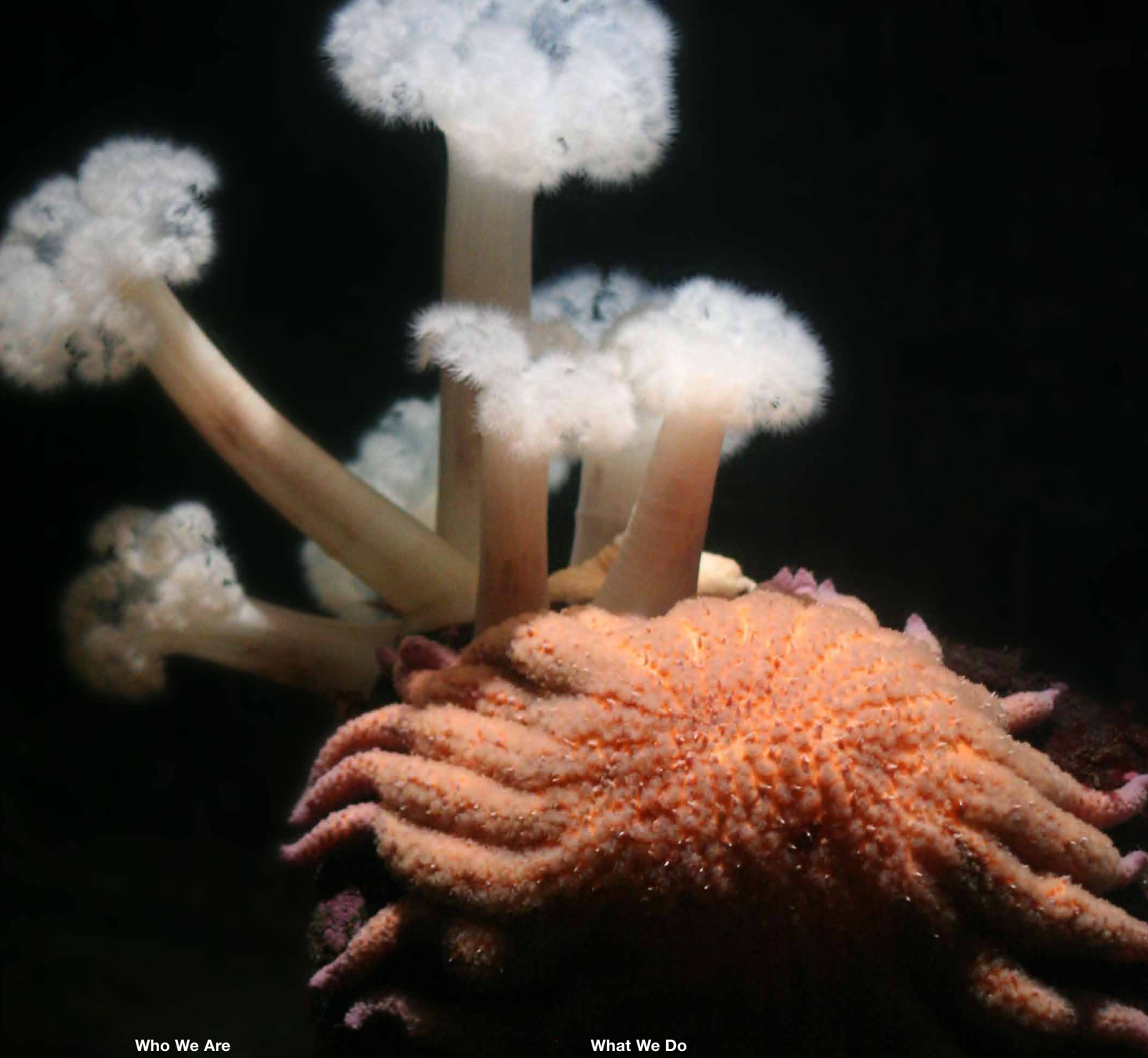
Projeto Tamar Brazil/Marine Photobank

VI. Conclusion and Next Steps

Reviewing the strategies and tools described here, the experienced ocean conservationist might conclude that little is new. Nothing could be further from the truth—we are closer now to understanding what it takes to conserve and promote healthy human and natural systems in the marine and coastal areas than we have ever been. The newness comes in how we think about using, fusing, and adapting these tools and strategies to address the needs of human communities and the environment in a rapidly changing world. The innovation is to invade and occupy the worlds of finance, infrastructure and energy development, planning, fisheries management, climate change adaptation, and the study of human institutions in a way that underscores the importance of immediate action—the world's marine ecosystems depend on it! The contributors to this discussion paper do not intend to minimize the crucial role of the biological and ocean sciences in marine conservation—these fields become ever more important as the pace of change in the oceans increases. Nevertheless, we are struck by the role social science must play in contributing to marine conservation over the next decade. In particular, social science can help the marine conservation community better develop and implement the cross-cutting, foundational strategies that undergird and strengthen both innovative and long-used aspects of a coordinated marine conservation initiative.

This coordination forms another key observation of this discussion. After decades of approaching marine conservation goals in isolation from one another, we have begun to explore the power of linking and fusing strategies. For example, the Packard Foundation has invested in both Fisheries Reform and in MPAs; however, MPAs may gain greater traction when specifically combined with fisheries reforms that provide stewardship incentives. Development by design adds economic tools to MSP that can both encourage conservation and potentially provide a funding mechanism to further conservation initiatives. Finally, ongoing concern with loss of coastal habitats and associated ecosystem services can be fused with emerging concerns about climate change and sea-level rise by focusing on coastal habitat restoration. By understanding and promoting natural adaptation strategies that can improve protection as sea levels rise, we can achieve greater economic and environmental gains than from employing engineered approaches alone.

More brainstorming and thoughtful piecing together of strategies and tools remains to be done. The coalescence and coordination of strategies holds tremendous potential and suggests that the Packard Foundation can be a frontrunner in pursuing leveraged approaches where the individual pieces when combined, are greater than the sum of their parts, creating something truly transformational. All of this relies on supporting strategies that strengthen institutions, build capacity and train emerging leaders in order to implement the emerging fusion strategies.



Who We Are

The Center for Ocean Solutions (COS) is a collaboration among Stanford University's Woods Institute for the Environment and Hopkins Marine Station, the Monterey Bay Aquarium and the Monterey Bay Aquarium Research Institute (MBARI). COS includes about 80 scholars across our three institutions who work on coastal and ocean ecosystems in the natural, physical, and social sciences. Located at Stanford and in Monterey, COS is uniquely placed within a premier research university and is in partnership with MBARI, a leading ocean science/engineering research institution, and the Monterey Bay Aquarium, which defines excellence in their outreach to the public and to decision makers regarding ocean issues.

What We Do

Our first task was to synthesize the best available scientific information to document the major threats to the Pacific, the geographic focus of our work. Based on this analysis, we have launched three initiatives: Ecosystem Health, Climate Change, and Land-Sea. Our Ecosystem Health Initiative aims to improve governance of marine resources to ensure long-term sustainability of marine ecosystem services. COS adopted marine spatial planning (MSP) as the initial focus of its ecosystem health strategy. Now, COS is expanding its work within this initiative to include cumulative impacts on marine and coastal systems, fisheries management and research, as well as managing coupled social-ecological systems for resilience and ecosystem services.

Photo: Sunflower sea star (Pycnopodia helianthoides). Gerick Bergsma 2010/Marine Photobank.
Back Cover Photo: Remora swims alone in the dark. Dave Weeks/Marine Photobank.

Our Mission

The Center for Ocean Solutions develops, synthesizes, and catalyzes understanding and tools to solve the major problems facing the oceans, and prepares both current and future leaders who take on these challenges.

Developed with financial support of

the David & Lucile Packard FOUNDATION

CENTER FOR OCEAN SOLUTIONS

99 Pacific Street, Suite 155A
Monterey, CA 93940
831.333.2077

473 Via Ortega, Room 193
Stanford, CA 94305
650.725.9475

www.centerforoceansolutions.org
contact@centerforoceansolutions.org