ADDRESSING BIODIVERSITY LOSS IN A CHANGING CLIMATE: THE IMPORTANCE OF COASTAL MARINE ECOSYSTEM-BASED REGULATORY POLICY IN THE EURO-MEDITERRANEAN, UNITED STATES, AND CALIFORNIA

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INTRODUCTION

Biodiversity loss in an era of climate change ultimately is a consequence of the globalizing force of economic trade (in this case, the exchange of coastal and marine resources) and anthropogenic climate change. To begin to address the cumulative impacts of the multiple-use of coastal marine resources and to mitigate the expected impacts from climate change, this paper's focus is on the development of coastal marine ecosystem-based planning activities in the Euro-Mediterranean, the United States, and California. Coastal marine ecosystem-based policy is one valuable tool to protect biodiversity in an era of climate change.

The Mediterranean-type ecosystems (MTEs) of the world are unique biomes that share a common natural history – people in this areas have had to adapt to major climate events such as flooding, earthquakes, fire, and changes in the available of water and food. The question is whether the contemporary cultures can adapt to anthropogenic climate change, and the synergistic impacts of coastal marine resource use. While the issue of biodiversity loss may seem an "ephemeral" issue in today's climate change debate, the consequences of biodiversity loss will have dramatic consequences of various peoples and places.

To begin to address the multi-scale pressures on coastal marine biodiversity, California, the US and EU have turned toward the development of coastal marine ecosystem-based approaches to planning and policymaking. This paper's focus is on two primary policy tools that support coastal marine ecosystem-based *regulatory* policy -- the designation of marine protected areas (MPAs) in California and Mediterranean Basin, and the development of Integrated Coastal Zone Management (ICZM) plans in the EU. This paper concludes with a description of ways to improve transatlantic learning and coordination to protect coastal marine biodiversity in California and the Euro-Mediterranean. Ultimately, new social alliances and partnerships that combine scientists, policymakers and non-governmental organizations that cut across MTE areas are needed to address coastal marine biodiversity loss in an age of climate change.

CLIMATE DISTURBANCE AND COASTAL MARINE ECOSYSTEMS

Mediterranean cultures have changed their landscapes and their landscapes have changed society; in many ways natural history of Mediterranean culture reflect adaptations to a turbulent climate (Grove and Racknam 2001; Fagan 2004). Mediterranean-type ecosystems (MTEs) are far from homeostatic or stable systems (Blondel and Aronson 1999). Natural history reveals that the cultures of the Mediterranean have adapted to dramatic long-term change in climate. Brian Fagan, a former Guggenheim Fellow, in his most recent book, *The Long Summer: How Climate Changed Civilization*, (2004) shows that fluctuations in climate dramatically affect human behavior, technology and culture. The diverse Chumash peoples of south-central coastal California faced dramatic climate events, and developed ways of adapting to changes in water availability, food supply, and dramatic weather events, including long-term, intergenerational change in the climate (Raab and Jones 2004). Mediterranean societies adapted to historic periods of drought, famine, flooding and catastrophic fire.

The five MTEs in the world are characterized by mild, rainy winters and hot, dry summers are extraordinarily rich in biodiversity, covering only 2.25 percent of the earth's land surface. The MTEs contain 20 percent of its named vascular plant species (Rundel et al. 1998; Blondel and Aronson 1999). The five regions are:

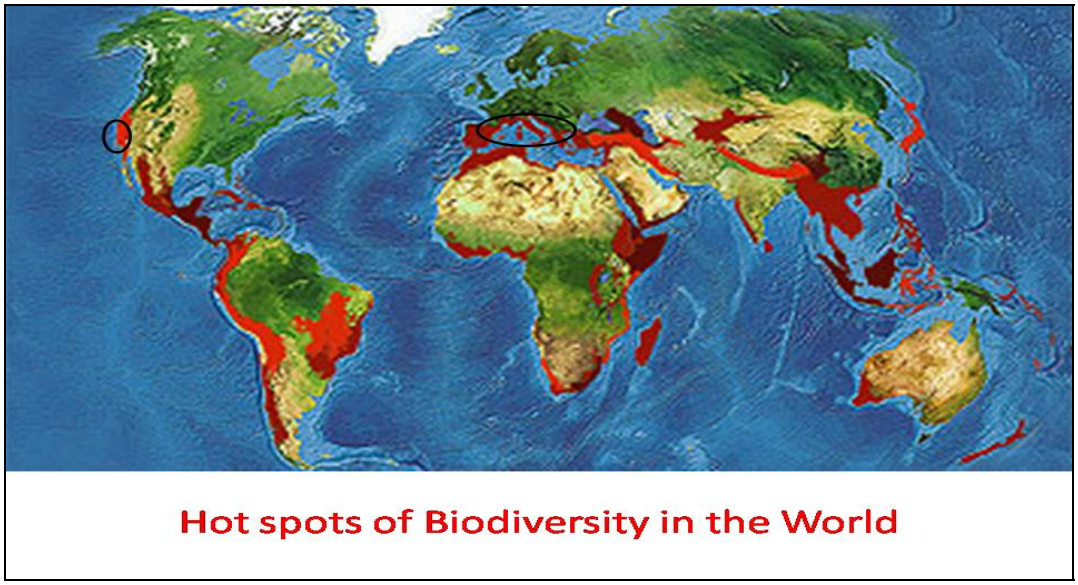
- The southern parts of the states of South Australia, Victoria, and Western Australia;
- All of California excluding desert and steppe, reaching into small parts of the state of Oregon and the Mexican state of Baja California;
- Central Chile;
- Parts of South Africa; and
- The Mediterranean region which covers all or part of thirty countries.

MTEs share many problems related to their climate, including sensitivity to climate disturbance, desertification, air and water pollution, overdrawing of groundwater, degradation of fresh water ecosystems, coastal marine habitat loss, overfishing, and urbanization. Rundel et al. (1998) note that MTEs are not steady-state ecosystems. For example, the Los Angeles River in southern California can increase its flow 3,000 fold in a 24-hour period (Davis 1998). California has experienced significant long-term droughts or extreme hydrological shifts: 892-1112 (220 years) and 1209-1350 (141 years). The longest drought of the 20th Century lasted 6 years during 1987-1992. During the last 60 years, urban development has taken place during what California Institute of Technology scientists call an "earthquake deficit" while major flooding events have been rather calm compared to the historical evidence of climate disturbance. Davis (1998) writes, "The urbanization of southern California seems to have taken place during one of the most *unusual episodes of climatic and seismic benignity* since the inception of the Holocene" [emphasis added]. The urban-industrial infrastructure of coastal California has changed the

character and future of the region. In hope of preventing major flood events, the Los Angeles (LA) River was paved and channelized. Forty-eight percent of the LA Basin is developed, a 5% of the historical coastal wetland remain. California includes over 1200 irrigation systems that feed coastal development, agriculture, and industry. The irrigation network is a significant contributor to the state's greenhouse gas emissions.

As depicted in red in Figure 1 the MTEs include California and Mediterranean Basin, and are identified as some of the world's hot spots for threatened biodiversity (Stein et al. 2000).

Figure 1. Hot spots for threatened biodiversity



Source: Stein, Kutner, and Adams. (2000).

While institutional focus and public attention has been on the need to curb greenhouse gas emissions, the Intergovernmental Panel on Climate Change (IPCC 2007) note that large-scale change in the world's coastal and marine ecosystems is expected even if greenhouse gas emissions were significantly reduced. The IPCC (2007) reports the following:

- Atmospheric concentrations of CO_2 have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values... The atmospheric concentrations of CO_2... in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution;
- It is likely that anthropogenic warming over the last three decades has had a discernible influence on many natural systems;
- Greenhouse gas emissions will continue to grow over the next few decades; and

- The uptake of anthropogenic carbon since 1750 has led to the ocean becoming more acidic. Increasing atmospheric CO_2 concentrations lead to further acidification. The resilience of many ecosystems is likely to be exceeded this century.[1]

The expected impacts from climate change on coastal marine biodiversity are likely to be dramatic. Reid (2006) describes the impacts of climate change in Europe. The average temperature in Europe has increased by about 0.95°C in the last 100 years, and the EC estimates that temperature will increase by 2.0–6.3C in Europe by 2100. Hansen et al. (2005) conclude their analysis of global warming by noting that a warming of more than 1°C, relative to 2000, will constitute dangerous climate change as judged from likely effects on sea level and extermination of species. The sixth mass extinction of plants and animals is likely underway -- nearly 50 percent of all species could disappear within the lifetimes of people now living on Earth (Cadotte et al. 2008). The last mass extinction took place 65 million years ago during the Cretaceous Tertiary extinction event. The most comprehensive assessment of the world's mammals confirms an extinction crisis, with almost one in four at risk of disappearing, according to The IUCN Red List of Threatened Species, revealed at the IUCN World Conservation Congress in October 2008.[2] The study to assess the world's mammals shows at least 1,141 of the 5,487 mammals on Earth are known to be threatened with extinction. One in four marine mammals may go extinct. Common dolphins were once the most populous cetacean species in the Mediterranean, and today have totally disappeared from the Adriatic Sea, and are going to become locally extinct in the eastern Ionian Sea probably within the next decade.

A comprehensive review of the expected impacts from climate change on coastal marine ecosystems is found in Schubert et al. (2006). One primary pressure of growing concern is oceanic acidification, which is caused change in the pH of seawater and rising CO_2 levels in atmospheric and oceanographic processes. Oceanic acidification will likely have significant adverse impacts on the reproduction, metabolism and growth of several species of invertebrates and coastal marine ecosystems of California, including some of the top commercial fisheries in the state (Orr et al. 2005; Royal Society 2005; Kleypas et al. 2006; Fabry et al. 2008; Feely et al. 2008). A second issue of concern is sea level rise, which threats coastal ecosystems (e.g., wetlands), watersheds, and the urban infrastructure along the shoreline (IPCC 2007). A characterization of the impacts of sea level rise of coastal processes, beach ecology, and the social infrastructure of coastal California is found in Revell et al. (2008). In the past 100

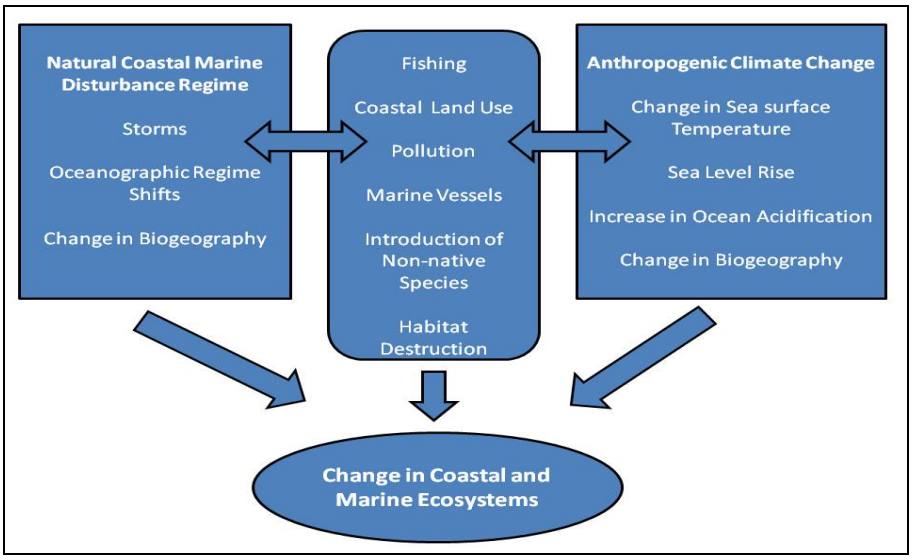
[1] The world's oceans have absorbed approximately 50% of the carbon dioxide (CO_2) emitted by human fossil fuel burning over the last 200 years (Royal Society 2005). There are some indications that the oceanic sink for CO_2 is at capacity, and without this sink, atmospheric CO_2 levels will be significantly higher and will lead to more rapid climate change than that already underway.

[2] See: http://sciencenow.sciencemag.org/cgi/content/full/2008/1006/1

years, European sea levels have risen by 0.1 to 0.2 m (IPCC 2001, 2007). Currently the sea level around European coasts is rising at a rate of 0.8 mm/year to 3.0 mm/year.

A general depiction of the relationships between the major pressures on coastal marine ecosystems is outlined in Figure 2. The cumulative impacts of the multiple-use of coastal marine resources can exacerbate a system's ability to adapt to climate-related disturbance (Worm et al. 2006). Significant emissions cut of greenhouse gases will not bring quick relief to the myriad pressures on coastal marine biodiversity. Some dangerous consequences for biodiversity and human beings may likely be triggered, and will persist for long periods of time, even if emissions were cut radically. Climate change will interact with and accelerate the existing pressures to biodiversity, such as natural ocean-climate variability (i.e., long and short term change in oceanographic regimes), habitat degradation, overexploitation of resources, such as fisheries, and the significant impacts of the introduction of non-native invasive species on coastal marine species. Indeed, scientists show that there are synergies among extinction drivers under global climate change that reflect the cumulative impacts of the multiple-use of coastal marine resources and anthropogenic climate disturbance (Brook et al. 2008; among others).

Figure 2. Pressures on Coastal Marine Ecosystems



With respect to these multiple pressures, California's coastal marine ecosystems have been significant degraded by human activities. Wetlands and watersheds have been dramatically altered or destroyed by human activities during the past 60 years. Most of the riparian areas of the coastal rivers and streams of the region have been lost. Rivers have been rerouted and dammed. Creeks have been paved and channelized. Wetlands have been filled. Important fresh-water and salt water inputs to coastal wetlands have been altered. Few estuaries are open to the necessary tidal influence. Along coastal southern California entire ecological communities are considered threatened or endangered. Coastal sage scrub communities in southern California are reported by the US Department of the Interior as

"endangered ecosystems" (Noss et al. 1995). The California's MTE has lost many important coastal habitats and associated biodiversity: 55% of the State listed animals and 25% of the threatened plants depend on wetlands; 43% of the Federally listed species rely directly on wetlands for survival; estuarine wetlands have decline by 75-90%; riparian communities have declined by 90-95%; and vernal pools have declined by 90% (McGinnis 2000, 2006). The native plants unique to California are very vulnerable to global climate change such that two-thirds of these "endemics" could suffer more than an 80 percent reduction in geographic range by the end of the century, according to a recent University of California, Berkeley, study (Loarie et al. 2008). Marine scientists document large-scale disturbance in the coastal marine ecosystems of California. McGowan et al. (1998) indicate that there has been a decline in primary and secondary level of marine ecological productivity since 1958.

Coastal ecosystem degradation of the Mediterranean Basin is well documented (Bianchi and Morri 2000). The Mediterranean Sea's variety of climatic and hydrologic situations within a single basin has probably no equal in the world. The lagoon areas of the Mediterranean Basin are very important, covering approximately a million hectares. Lagoons are responsible for 10-30% of fishery production, and are essential habitat areas for species of migratory birds. Millions of hectares of wetlands have been lost in the Mediterranean Basin.

COASTAL MARINE ECOSYSTEM-BASED REGULATORY POLICY IN THE US

Since the 1960s, a set of ideas took hold advocating "ecosystem-based planning" as one approach to protect biodiversity (Haeuber 1996). During the 1990s, an ecosystem-based approach to biodiversity protection was embraced by the Executive Office of the White House and at least 18 federal agencies (Yaffee 1996, 1999). State resource agencies used ideas drawn from ecosystem-based planning to develop new coastal programs that support the protection of biodiversity (Hourigan 1995). The scientific and intellectual basis of ecosystem-based planning garnered support within resource agencies, the scientific community and non-governmental organizations. During the development of this "first wave" of ecosystem-based planning programs, scholars note four prevailing themes: 1) the notion of boundary redefinition to deal with the spatial and temporal scale of ecosystem dynamic; 2) issues and concerns related to scientific uncertainty and conservation planning; 3) intergovernmental administration and coordination; and 4) the development of principles of ecosystem management (Keiter 1993; Haeuber 1996; Yaffee 1996, 1999). These principles of ecosystem-based planning "fly in the face of traditional administrative and political behavior, and that is the reason why [the approach] has not been the norm in the past" (Yaffee 1996: 725). In general, the idea of ecosystem-based planning remains a loose collection of resource agency program developments, government concept papers and technical reports, policy guidance documents, scientific papers and case studies (Gunderson et al. 1995). There remain many competing approaches to the meaning and application of ecosystem-based planning (Haeuber 1996).

A "second wave" of enthusiasm for ecosystem-based planning has emerged in the US. The Pew Oceans Commission and the US Commission on Ocean Policy recommend the adoption of an ecosystem-based approach to protect coastal marine biodiversity. Despite the recommendations by both commissions, coastal marine policy in the US remains sector-based, often emphasizing particular species or specific coastal or marine sectors, such as fisheries. Moreover, the Bush Administration failed to respond to the recommendations made by the commissions. Budgets and resources for federal environmental programs were cut by the Bush Administration, and several federal agency reports found that the agency officials often manipulated scientific facts to limit protections of species at risk of becoming extinct (Savage 2008). At the federal level, the Bush Administration relied on non-regulatory approaches to biodiversity policy by supporting the programmatic objective of "cooperative conservation".[3] Emphasis on the development of cooperative conservation encouraged voluntary measures and market-based incentives rather than regulatory rulemaking and authority. This shift away from regulatory rulemaking was reflected in the change in the number of species listed as threatened or endangered in accordance to the US Endangered Species Act. The Bush Administration added an average of 9.5 species a year to the endangered list, compared with 65 a year under President Bill Clinton and 59 a year under President George H.W. Bush (Eilperin 2004). The Bush Administration designated as "critical habitat" only half the acreage recommended by federal biologists. In addition, the Administration transferred key decision-making powers from the US Fish and Wildlife Service to other agencies with different priorities. It remains unclear whether the new administration of President Obama will continue to support decentralized policymaking and non-regulatory approaches to biodiversity protection.

Despite the lack of policy response during the Bush Administration to the Pew Ocean Commission (2004) and US Ocean Commission (2004) reports, there are existing federal and California programs that support coastal marine ecosystem-based planning and policy (Woolley and McGinnis 2002). This section's focus is on the National Marine Sanctuary Program, and the planning efforts to designate marine protected areas or MPAs in federal and California waters. The designation, enforcement, and monitoring of comprehensive networks of MPAs can be an important regulatory policy tool to curb the over-exploitation of coastal marine resources and potentially mitigate the impacts of climate change. If designed appropriately and enforced, a network of MPAs can support some level of biodiversity protection. But it depends on the quality and size of habitat represented in the MPA network designation.

[3] In August 2004, President Bush issued an Executive Order to encourage the development of "cooperative conservation". Section 1 of the EO states: "The purpose of this order is to ensure that the Departments of the Interior, Agriculture, Commerce, and Defense and the Environmental Protection Agency implement laws relating to the environment and natural resources in a manner that promotes cooperative conservation, with an emphasis on appropriate inclusion of local participation in Federal decisionmaking, in accordance with their respective agency missions, policies, and regulations."

The number of documented examples of successful marine reserves is rapidly increasing. There is substantial evidence showing that within areas protected from consumptive activities (e.g., fishing), rapid increases in abundance, size, biomass, and diversity of animals occur virtually regardless of where reserves are sited (Halpern and Warner 2002; Halpern, Gaines and Warner 2002; Halpern 2003; Micheli et al. 2004). In 2001, an expert panel of the National Academy of Sciences concluded their study of the importance of MPAs:

- A growing body of literature documents the effectiveness of marine reserves for conserving habitats, fostering the recovery of overexploited species, and maintaining marine communities;
- Networks of marine reserves, where the goal is to protect all components of the ecosystem through spatially defined closures, should be included as an essential element of ecosystem-based management;
- Marine reserves, together with conventional fisheries management strategies, can have significant ecological benefits. Protection afforded by reserves may allow targeted species to rebound, increasing local recruitment and contributing to spillover of adults and export of larvae into fished areas. Additionally, reserves may protect critical life stages and spawning aggregations of targeted species;
- Reserves may provide insurance and resilience in an uncertain world with unpredictable environmental fluctuations; and
- Reserves can serve as reference areas for research to determine the effects of consumptive activities on marine ecosystems.

If designed appropriately, the benefits of "no take" marine reserves accrue to a broad range of taxa, including migratory species (Roberts and Hawkins 2000; among others).

Marine Protected Area Designation in the US and California

There are 13 designated national marine sanctuaries in the US. The National Marine Sanctuary Act (NMSA) charges the National Oceanic and Atmospheric Administration (NOAA) under the US Department of Commerce to take a broad and comprehensive, ecosystem-based approach to protect biodiversity. The NMSA (16 U.S.C. §1431(a)(3)) states that *"…*while the need to control the effects of particular activities has led to enactment of resource-specific legislation, these laws cannot in all cases provide a coordinated and comprehensive approach to the conservation and management of special areas of the marine environment." The NMSA (16 U.S.C. §1431(a)(4)(A), (C)) prioritizes the protection of marine life and "maintain[enance] for future generations of the habitat, and ecological services, of the natural assemblage of living resources that inhabit these areas.

The use of MPAs was not explicitly described in the NMSA. Indeed, many of the marine sanctuaries do not areas that are set aside as no-take MPAs. Over-fishing is a primary factor contributing

to the decline in the primary and secondary levels of ecological productivity in coastal marine ecosystems (Jackson et al. 2001). This section reviews the ecosystem-based regulatory policymaking effort to designate federal and state MPAs in the Channel Islands National Marine Sanctuary (CINMS) off southern California which began in 1999. The planning process adopted by California and federal resource agencies for the CINMS represents the state's first attempt to designate MPAs in accordance to an ecosystem-based approach.

The CINMS is the only marine sanctuary in southern California, and includes state (0-3nm) and federal (0-6nm) waters associated with the northern Channel Islands. The northern Channel Islands are designated as a National Park. Since the designation of the CINMS in 1980, a number of new threats or pressures in the coastal marine ecosystem have emerged (Davis 2005; McGinnis 2006). In the mid-1980s and after the CINMS designation market squid became the top commercial fishery of California. Most of the market squid landed is exported to markets in China and Europe. A majority of the market squid landed is caught within the CINMS. To begin to address the impacts from recreational and commercial fishing of the CINMS, a state-federal partnership and collaborative planning process began in 1999 to consider the designation of MPAs within the CINMS. Before 2000, only a small percentage of the total marine area (around the south side of Anacapa Island) within the CINMS was off-limits to commercial or recreational fishing. Resource managers at the CINMS and the California Department of Fish and Game (CDFG) initiated a formal "community-based" process to consider setting aside marine areas as MPAs. The process was based primarily under the authority of the California Marine Life Protection Act of 1999 and the NMSA. Three advisory groups were established by the CINMS and the CDFG to consider the creation of marine protected areas: the Marine Reserve Work Group, Science Advisory Panel, and Socioeconomic Panel.

The Marine Reserve Work Group (MRWG) included 17 members that were purported to represent a wide diversity of interests and values within the community.[4] The MRWG included representatives from state and federal resource agencies, user groups (e.g. commercial and recreational fishers), local and national conservation organizations, and academics. The MRWG met for 22 months from July 1999 to May 2001. The group represented the first collaborative effort to develop and establish no-take MPAs in California.

Based on the goals agreed to by the members of the MRWG (e.g., biodiversity protection), in September 2000 the 15-member Science Advisory Panel (Panel) of experts recommended to the MRWG that a network of no-take marine reserves of 30–50% of the total CINMS would be required to protect a majority of species of the northern Channel Islands.[5] The Panel's recommendation was based on a

[4] Note, the author was a member of the MRWG, and a consultant to the CINMS from 1999-2008.
[5] For a comprehensive list of scientific articles on marine reserves, see: http://www.dfg.ca.gov/mlpa/science1.asp

comprehensive review of the effectiveness of MPAs in the world's oceans, analysis of a range of alternative reserve designs, public input, analysis of the socioeconomic costs associated with alternative reserve designs, and the priority management goals of state and federal resource agencies. The Panel's recommendation was based on the following scientific evidence:

- Larger reserves (from 30 to 70% of habitat) can protect more habitat and populations of species while providing a buffer against losses from environmental fluctuation or other natural factors;
- No-take marine reserves can enhance species diversity, biomass, abundance and size of marine animals;
- Case studies of no-take marine reserves show positive spillover effects from reserves into fishing areas; and
- Reserves that are designed to protect ecosystem biodiversity can also protect fisheries.

The Panel's recommendation included a range of maps and reserve scenarios that captured between 30 and 50% of the CINMS (Airame et al. 2003). The "characteristic scale" associated with each reserve alternative determined the level of biodiversity and habitat protection. Panel members reached consensus on this recommendation; there were few objections by members of the Panel. The Panel's recommendation did not reflect the needs of all the species associated with the marine area. The Panel estimated that the 30% recommendation may protect up to 70% of the sanctuary's biodiversity while a 50% reserve design captures roughly 85%. The Panel did not believe that less than 50% would protect birds or mammals. The Panel recommendation was based on the current state of the literature on the importance of MPAs as both a fishery management tool and biodiversity conservation strategy. In addition, the Panel noted the importance of "insurance" by developing larger reserves that can be resilient to major disturbance events and potential human impacts such as an oil spill and severe storm-related event. Any reserve scenario should include a multiplier (i.e. in this case, 120–180% of the reserve spatial design) in case of catastrophic events, such as an oil spill or a major warming event that can destroy marine habitats within a particular reserve (Allison et al. 2003). This insurance factor was described as essential factor in reserve design given ocean-climate variability, and the potential impacts of environmental fluctuation or impacts from human activities (such as an oil spill at sea) on the habitat and species within a proposed reserve. However, the insurance factor was eventually dropped by several members of the MRWG.

The Panel provided the participants in the MRWG process with one of the prerequisites for marine ecosystem-based protection - no less than 30% of a network of no-take MPAs could protect a majority of the species of the CINMS. Commercial and recreational fishing industries opposed the creation of a large network of reserves around the CINMS (Davis 2005; McGinnis 2006). After six months of political debate, the members of the MRWG failed to reach consensus on the recommendation

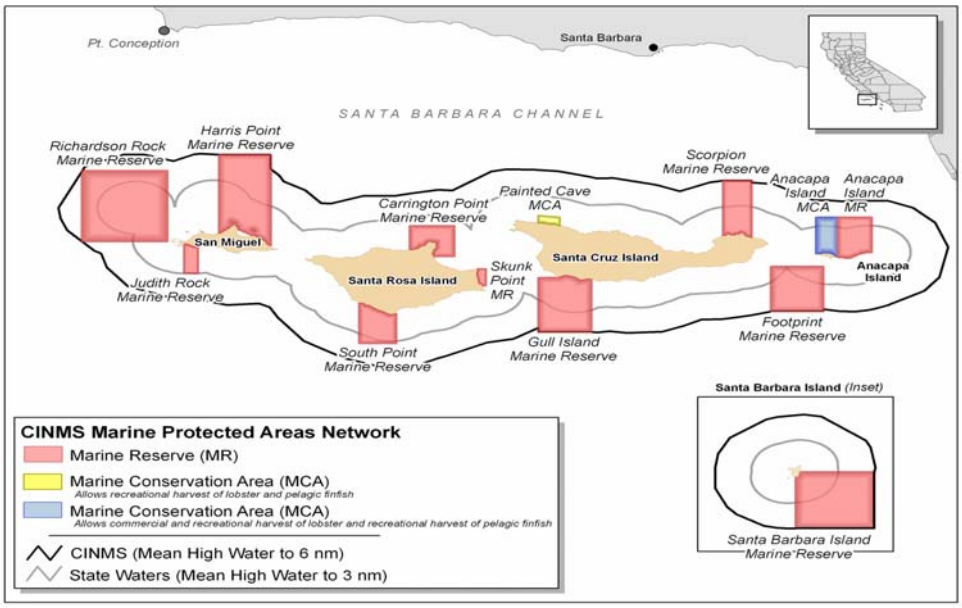
by the Science Panel. In May 2001, the MRWG was disbanded after failing to reach a consensus on the size and location of where to establish MPAs.

After the break-up of the MRWG, the staff at the CDFG in conjunction with CINMS personnel proposed a network of MPAs in State waters (0–3 nm) of the northern Channel Islands. The proposed MPA network in state waters of the CINMS was supported by the regulatory mandates set forth in the California Marine Life Protection Act. A range of alternative MPA designations was analyzed in terms of the economic costs to the fishing industries and various ecological criteria associated with marine life conservation and reserve design. After several years of a politically contentious environmental review process, in April 2003 new MPAs were formally adopted in State waters of the CINMS by the CDFG Commission (Davis 2005; McGinnis 2006). The designated of MPAs in federal waters (3-6 nm) was completed by NMSP in 2008. Figure 3 depicts the MPAs that were designated within CINMS. The MPA system includes a policy preference for the designation of no-take reserves. Two smaller-scale marine conservation areas were established to allow limited use or harvest of specific marine species, such as California Spiny Lobster. The total area protected by the state within the CINMS is approximately 12% of the entire marine area. The federal government set aside an additional 12% of the CINMS waters in 2008. Less than 30% of the CINMS was protected in the MPA system.

The designated MPA network has been extensively monitored by scientists during the past 5 years. Preliminary evidence of the effectiveness of the network of MPAs indicates that the level of biodiversity (number of species, types of species) has increased within no-take areas.[6] In addition, the level of commercial fishing in the CINMS has not been negatively impacted by the designation of the MPA network. Given the scale of biodiversity protection provided by the MPA network associated with the CINMS, it is unlikely that the reserves can protect habitat and associated species in an era of climate change. The MPA network is not large enough to protect species from long-term ocean-climate variability or anthropogenic climate change (McGinnis 2006). Note, as the size, quantity or scale of representative habitat in a MPA network design is reduced by decision-makers, the level of biodiversity protection also declines. One lesson learned in marine conservation is that the larger the no-take MPA network the better for biodiversity and overall biomass. In addition, the importance of a MPA network as one potential regulatory tool to mitigate the impacts of anthropogenic climate change on coastal marine biodiversity is reduced as the size, quantity or scale of representative habitat in a MPA network design is reduced by policymakers.

[6] See http://channelislands.noaa.gov/marineres/mpa_workshop.html

Figure 3. Designated MPAs in the State and Federal Waters of the CINMS



In 2004, the California Resources Agency began a planning process for State waters (0-3 nm) along the coastal mainland. In accordance to the California Marine Life Protection Act (MLPA) of 1999, a planning process was initiated in 2008 for the southern California region. (Planning efforts were completed for central and northern California, and were primarily funded by private foundations rather than State funds.) The CDFG Commission in December 2008 adopted a motion in support of the existing State MPAs in the CINMS, and would not consider alternative marine protected area proposals for the area; there will be no changes in the boundaries and regulations of the existing MPAs. The sixty-eight MLPA South Coast Regional Stakeholder Group is currently evaluating alternative reserve designs for the State waters off the coastal mainland. The question of MPA design remains a major political and scientific issue of contention in California and the US. Ultimately, the importance of the "size, quantity, and scale" of representative habitat protected in a MPA network, and the value of no-take MPA have been dropped by California resource managers. One consequence has been the value of MPAs as a regulatory tool that can protect coastal marine biodiversity has been relegated to an institutional preference for MPAs to better protect fisheries. The MLPA planning processes are different from the CINMS process (noted above) in many ways, including:

- an emphasis in "fishery-based science" rather than multiple-species ecosystem-based planning;
- a shift from the designation of no-take MPAs to State conservation areas that allow some type of fishing or use;
- a planning process that is not based on consensus among stakeholders;

- a preference for planning processes that emphasize stakeholder input rather than agreement on various MPA alternatives; and
- an emphasis in designing reserves based on MPA "network connectivity" rather than the "size, quantity or scale" of representative habitats protected in the MPA network.

In the case of the California MPA planning process, the institutional preference in California has been for small networks of reserves that can benefit fishery resources rather than the designation of MPAs that support a large number of endemic species. In general, birds, mammals, and pelagic species are not protected by the MPA networks that have been designated by federal and state resource agencies. Moreover, as of 2009, there are no deep water areas protected in MPAs.

COASTAL MARINE ECOSYSTEM-BASED REGULATORY POLICY IN THE EU

One of the major differences between the US and EU is the role of the Exclusive Economic Zone (EEZ) in coastal marine management and planning. The US federal waters extend out 200 n.m. (or roughly 11,351,000 km^2). While California jurisdiction is 0-3 n.m., the federal government has special rights over the exploration and use of marine resources within the EEZ. In the EU, the EEZ is shared. As a consequence, fishing vessels from one country can fish in another country's EEZ. For example, in January 2008 an Italian boat was intercepted for fishing waters protected by Croatia. The Croatian parliament proclaimed a 23,800 square kilometer MPA in the Adriatic in 2003, with the aim of protecting fishing stocks from Italy's larger fishing fleet. The EU warned Croatia that its refusal to open up its MPA to all member states would lead to "negative consequences". As this section shows, large-scale coastal marine biodiversity protection across EU member and non-member states has not been the case.

Under the EU Sustainable Development Strategy (SDS) launched in 2001, halting the loss of biodiversity in the EU by 2010 is listed as a priority. It is unlikely that the SDS's goal will be reached for coastal marine biodiversity. In 1998, the EC adopted a *Communication on a European Community Biodiversity Strategy* which reinforces the EU's focus on finding solutions for biodiversity within the framework of the UN Convention on Biological Diversity (CBD). Juda (2007) describes the historical development of marine policy in the European context. The section's focus is on integrated maritime policy, the designation of marine protected areas, and integrated coastal zone management.

In October 2005, the EC agreed to develop a *Marine Strategy Directive* (Borja 2006). Interest in the Directive was based on the recognition in the decline of marine biodiversity, the degradation of marine habitats, and increasing levels of air and water pollution. The EC's primary objective with respect to the Directive is to "protect and restore Europe's oceans and seas and ensure that human activities are carried out in a sustainable manner so that current and future generations enjoy and benefit from biologically diverse and dynamic oceans and seas that are safe, clean, healthy and productive". Future policy is meant to supplement existing national laws and frameworks, and each member state would be

responsible for formulating its own marine policy and coordinating it with those of neighboring countries (EU and non-EU). The EC opted for the EU to adopt "a flexible legal instrument in the form of a Marine Strategy Directive *rather than a regulation* or a decision" [emphasis added]. Development and implementation of new coastal and marine regulatory policy is the primary responsibility of each EU member state. The planning process is decentralized insofar as the Directive mandates that certain results be achieved, but allows freedom for each member state to decide how to accomplish the goal. The EC explicitly states in the Directive, "*No specific management measures will be set down at EU level*" [emphasis added].

The EC set a goal of achieving "good environmental status" of Europe's marine environment by 2021, the year scheduled for the first review of River Basin Management Plans established under the EU Water Framework Directive. The EC's focus is placed upon the promise of marine regions and sub-regions based on physical characteristics and ecosystems, as opposed to political boundaries. Three marine regions are recognized: the Baltic Sea, the Northeast Atlantic, and the Mediterranean Sea. Four sub-regions are identified in the Northeast Atlantic and the Mediterranean regions. With each sub-region, particular member states are responsible for developing a strategy, which must be approved by the EC (environmental targets, monitoring programs, etc). The EC can reject all or any part of a member state's proposed plan of action. Member states are required to provide the EC with unrestricted access to all data and information used for their marine strategies; and public comment must also be invited in each member state.

In 2007, member states agreed to a new vision of Europe's oceans and seas, as described in the EC's *Strategic Objectives for 2005-2009. An Integrated Maritime Policy for the European Union* (Commission of the European Communities *Working Document* 2007 October) calls for a more "holistic, integrated approach" to marine policymaking.[7] The EC will launch preparatory/pilot projects with an emphasis on evaluating needs and options for future legislation and possible financial impacts in 2009.

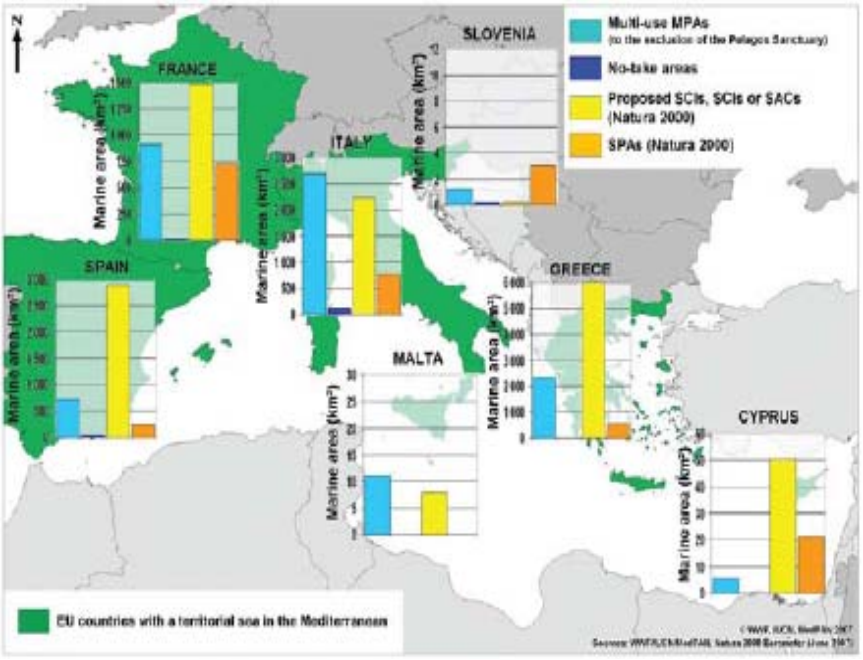
Marine Protected Areas in the Euro-Mediterranean Basin

As in the case of the US and California, the designation of MPAs is an important tool in coastal marine ecosystem-based policy in the Euro-Mediterranean Basin. The *Natura 2000 Barometer*, published by the EU in June 2007, identified 324 Marine Sites of Community Importance (Habitats Directive) and 51 Special Protection Areas (Birds Directive) with a marine component in the Mediterranean Sea. Note that the total size covered by the areas under the process of being established as *Natura 2000* sites is 12,673 km², which is an area greater than the cumulative area of other types of established MPAs in the Mediterranean Basin. Based on a number of international agreements between member and non-member states in the EU, there have been a number of MPAs designated within marine waters of the

[7] http://ec.europa.eu/maritimeaffairs/pdf/ActionPaper/EN_Action_plan_final.pdf

Mediterranean Basin. For a comprehensive review of the effectiveness of these MPAs to protect coastal marine ecosystems, see the recent analysis by the International Union of Conservation of Nature (IUCN) and Natural Resources, the World Wildlife Fund and MedPAN (2008). Figure 4 depicts the MPAs designated by EU member states within the Mediterranean Basin.

Figure 4. MPAs designated within the EU Member States in the Mediterranean Basin



Source: IUCN, the World Wildlife Fund and MedPAN. 2008. Comparison between Natura 2000 sites and the other types of MPAs. Surface area of MPAs, no-take zones, SCI (including also pSCI and SACs) and SPA sites are shown for each EU country (note that the axis scales are different in the graphics).

Based on an analysis of these MPAs by the IUCN, WWF, and MedPAN (2008), the CBD target of protection of 10% is not likely to be achieved in the marine protected and managed areas that cover 97,410 km². The design of the MPA system in the Mediterranean Sea, including the criteria of size or the spatial scale of the representative habitats in protected areas and the age (or the temporal scale of the reserve system) cannot protect biodiversity of the coastal marine area (Fraschetti et al. 2002). Excluding the Pelagos Sanctuary (87,500 km²), the area covered by coastal MPAs amounts to only 9,910 km², which is *0.4% of the total surface* of the Mediterranean Sea. The cumulative no-take area is 202 km², or *0.01% of the total surface* of the Mediterranean. Giuseppe Notarbartolo di Sciara, the Regional Coordinator, IUCN WCPA–Marine Mediterranean & Black Sea Region, writes (IUCN, WWF and MedPAN 2008: Forward), "Mediterranean MPAs all work as separate entities, and no functional network has appeared yet on the horizon. More than half of the region's MPAs have not adopted a management plan - many of them because a management body was never appointed. This means that more than half of the *Mediterranean MPAs could be considered paper parks, significantly*

downsizing the firepower of the region's conservation arsenal. Most importantly, effective marine conservation throughout the Mediterranean is still constrained by crippling heterogeneities in the region's governance, institutional structures, wealth distribution, social capital, and the knowledge environment"[emphasis added].

MPAs are located in coastal waters under EU member state jurisdiction, with the exception of the Pelagos Sanctuary, the only high-sea MPA to date in the Mediterranean Basin. The management of the MPAs is not adequate in approximately half of the MPAs of the region due to the lack of information (social, economic, ecological), the lack of administrative resources, the lack of enforcement and monitoring, and the general lack of management planning. Results reveal major needs and challenges related to management capacity. Local, regional, and global pressures continue to threaten coastal marine ecosystems, and the existing MPAs of the Mediterranean, which do not adequately protect coastal marine from ecosystem disturbance. More than half of MPAs in the Euro-Mediterranean are affected by anchoring, invasive plants, overfishing, noise pollution, solid waste, oil or diesel degassing or oil spills, plant/animal composition changes caused by climate change and urbanization or artificial construction. The illegal use of MPAs remains a major barrier to effective implementation of reserve areas.

The IUCN, WWF and MedPAN (2008) recommend a number of changes to the existing Euro-Mediterranean MPA system:

1) Establishing new MPAs to supplement existing ones is critical so as to create a geographically and ecologically balanced network. This requires identifying a subset of priority areas for conservation in the Mediterranean through a hierarchical approach (cascading from ecoregions, to priority conservation areas, to ecologically critical habitats, to key species areas). It will also be necessary to galvanize the political effort to drive this process and to move MPAs higher in the conservation agenda. Resource distribution, governance and legal frameworks, capacity building, and scientific and technical exchange should be improved to support countries in achieving their conservation goals. To improve management effectiveness, the EU needs to establish adequate management bodies that can assist in the development and implementation (including monitoring and enforcement) of a new MPA system for the Mediterranean Sea;
2) Particular attention should be paid to the lack of management plans in many Euro-Mediterranean countries (particularly Italy), and the influence of this lack in the overall implementation of MPAs.

There remain significant barriers to the protection of coastal marine biodiversity in the Mediterranean Basin, including the lack of coordination across states, the lack of scientific monitoring of

coastal marine areas, and the failure to enforce existing regulations that prohibit, for example, fishing activities.

Integrated Coastal Zone Management in the Euro-Mediterranean Basin

The concept of Integrated Coastal Zone Management (ICZM) extends back at least 40 years (Cicin-Sain and Knecht 1998; Sorensen 1997). Existing federal and states coastal management programs do not include a provision in the US for the development of ICZM Plans.[8] Coastal and marine management and planning activities are carried out under separate administrative jurisdictions in the US. Major amendments to federal and state coastal management acts would be needed in order to foster a more integrated coastal marine planning effort in the US.

This section's focus is on the ICZM programs in the EU. A comprehensive review of these programs is found in Cicin-Sain et al. (2002). ICZM programs in the EU remain the responsibility of member states and associated municipalities. Sorensen (1997: 19) writes in his review of national and international ICZM efforts, "Creation of a new ICZM agency, particularly with regulatory authority, is uncommon because of the associated loss of power by existing units of government and their interest groups. Recommendations about how political power ought to be redistributed rarely are neutral." This section describes the *Protocol on Integrated Coastal Zone Management in the Mediterranean*, signed January 21, 2008, which includes 14 contracting parties to the Barcelona Convention. Other parties are expected to sign the Protocol in the "very near future." The Protocol resulted after six years of negotiations and consultations by the Parties.

Part C of Article 6 specifically states, "The ecosystems approach to coastal planning and management shall be applied so as to ensure the sustainable development of coastal zones." The goals of the Protocol are described in Article 5 as follows:

1. To facilitate the sustainable development of coastal zones through rational planning;
2. To preserve coastal zones for current and future generations;
3. To ensure the sustainable use of resources, in particular water;
4. To ensure the preservation of the integrity of coastal ecosystems and landscapes;
5. To prevent and/or reduce the effects of natural hazards, in particular climate change; and
6. To achieve coherence between private and public initiatives and between all decisions which affect the use of the coastal zone.

[8] The coastal marine interface in the U.S. remains divided. In the US, approximately 16 federal agencies have jurisdiction in the EEZ (Cicin-Sain and Knecht 2000). State, county and city jurisdictions regulate various coastal areas. Coastal state programs, such as California's coastal zone management framework, support the development of county or city local coastal plans (LCPs) that require certification by the California Coastal Commission. Certification of a great majority of LCPs in California was completed in the late 1970s or early 1980s. LCPs in California have not been updated to address the expected impacts from climate disturbance on coastal marine ecosystems and social infrastructure.

Each Party is responsible for ensuring that their respective national laws incorporate the following criteria for sustainable use of the coastal zone:

- Identifying protected areas where urban development and other such activities are restricted or prohibited;
- Limiting the expansion of urban development and new transport infrastructure in the coastal zone;
- Ensuring that environmental concerns are incorporated into laws governing the public maritime domain;
- Allowing free public access to the sea and the shore; and
- Restricting or prohibiting the movement and parking of land and marine vessels in fragile terrestrial or marine areas.

Each Party is responsible for strengthening or formulating a national strategy for ICZM and coastal implementation plans and programs consistent with the common regional framework. With respect to the expected impacts from climate disturbance, Article 22 stipulates that national strategies for ICZM should include an assessment of the vulnerability and hazard assessments of coastal zones and take prevention, mitigation and adaptation measures to address the effects of natural disasters and climate change. The Protocol also includes a provision for the need to monitor and address coastal erosion as a result of rising ocean levels.

In a comprehensive study of the progress of the development and implementation of ICZM Programs by EU member states (including Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, Spain and Turkey) by the International Ocean Institute (Rupprecht Consulting 2006), there were a number of important findings:

- The conversion of agricultural land to urban landscapes has caused severe loss of natural habitats and biodiversity;
- ICZM laws and regulations are usually implemented on the municipal level in Europe;
- France, Spain and Turkey have special coastal laws to define the shoreline fringe as public property and to limit construction on private property up to a certain distance from the shore; and
- Although ICZM is still (too) often seen as an “environmental” (i.e. sectoral) strategy, it has increasingly been accepted as an “ecological” tool, i.e. requiring a holistic system management approach for the entire coastal zone.

In general, the existing governance and management structures in all Euro-Mediterranean state are deficient. Progress in implementing a national ICZM strategy varies to a great extent, and can only be formally reported for Malta, France, Slovenia and Spain. Most noteworthy in this latter group is the lack of ICZM activities in Italy. Since Italy is geographically central in the Mediterranean Basin, this lack of

ICZM governance is a major concern. The Po River remains a major source of terrestrial inputs and water pollution in the Mediterranean Sea. One impediment for Italy is the highly decentralized nature of the country, vesting almost all coastal planning and management to lower tiers of administration. In general, there remains a lack of "integration" across coastal sectors and governing institutions in the Mediterranean Basin. A report by Rupprecht Consulting (2006: 170) states, "[A] consistent set of laws directing coastal governance and management is usually lacking. The main legislative and policy frameworks governing the development in the coast are usually planning instruments that have a physical preponderance and little room for needs of integration of different sectors and participation of stakeholders." In most countries laws and regulations need to be systematically "overhauled" to reflect the promise of ICZM (Rupprecht Consulting 2006). In those few cases where a number of new laws and regulations with reference to coastal areas were recently promulgated (e.g. Slovenia) there is a lack of institutional capacity to monitor and enforce policy. In some instances (e.g. Greece, Cyprus and Malta) law enforcement is a significant problem. There is a paucity of scientific information and socio-economic baseline data on Mediterranean Basin's coastal marine ecology, and this scientific uncertainty remains a major barrier to policy innovation, integration, and coordination. Ultimately, successful development and implementation of ICZMs across the Euro-Mediterranean Basin require a stronger emphasis in scientific monitoring and baseline studies as a needed first step in program development.

Several non-member states in the EU, such as The Republic of Montenegro, have completed final drafts of their ICZM. In the case of Montenegro, the ICZM was completed in early 2008. As in the case of member states of the EU, the implementation of Montenegro's ICZM will be the primary responsibility of the municipalities. Illegal construction remains a major problem along the Adriatic Sea. Coastal municipalities and non-government organizations lack the institutional capacity to work across political and administrative boundaries. In many coastal areas, rampant illegal coastal development, the poor treatment of municipal wastes, the increase in point and non-point sources of pollutants, the degradation of existing coastal processes, the rise of non-native invasive species, and coastal climate disturbance have yet to be addressed by coastal states or municipalities of the Euro-Mediterranean. In the case of Montenegro, there are few environmental and community-based non-government organizations or NGOs involved in coastal planning. There is very little evidence that suggests that the Euro-Mediterranean member and non-member states are working together to begin to address the large-scale impacts from climate change and the cumulative impacts from multiple-use on coastal marine resources. Existing protocols lack the necessary regulatory policy to curb the over-use of coastal marine resources, or mitigate the climate-related impacts to ecosystems.

IMPROVING TRANSATLANTIC LEARNING AND COORDINATION

Coastal marine science often highlights the importance of addressing large-scale issues and concerns in biodiversity policymaking. Large-scale coastal marine ecosystems encompass a range of diverse social values, political interests, and economic preferences that are often in conflict. To address biodiversity loss in an age of climate change, institutions will have to address and resolve conflicts across political, economic and administrative jurisdictions. As the scope of conflict expands in large-scale planning efforts, the institutional preference may be to turn toward sector-based or smaller-scale concerns – such as the preference for ecosystem-based fisheries planning in the California MLPA process rather than multiple-species planning or the preference for municipal coastal management in the EU. These types of policy preferences reflect an institutional effort to control the scope of conflict but not to control human behavior and associated impacts to coastal marine biodiversity. Institutional preferences to reduce the scope of conflict may succeed in the short term to garner political and economic support but will likely fail to address the ecological and synergistic impacts of climate change on coastal marine biodiversity.

With respect the recent coastal marine policy initiatives in the EU, a layered approach to biodiversity protection that employs milder and less restrictive measures at progressively larger spatial scales sounds like a reasonable political idea. However, the current decentralized coastal marine governance regime that emphasizes the role of member states and their municipalities cannot address the multi-scale pressures on coastal marine biodiversity. The choice for less restrictive government measures, e.g., at the EC level, may not be an appropriate policy response to the synergistic pressures that are expected to impact coastal marine biodiversity.

To begin to address the large-scale drivers of climate disturbance, *re-allocation of legal authority* is required to address biodiversity loss. Ultimately, regulatory policy is needed at regional (or local) and international government levels. Some level of authority at international levels will likely be required to address the transboundary and multiscale character of biodiversity loss in coastal marine ecosystems. In increasingly dynamic ecosystems, the governance systems will have to become more "nimble" to make the types of large-scale decisions that can adapt to changing oceanographic and atmospheric conditions. Regional, place-based regulatory policy will also need to be developed and implemented to address biodiversity loss as well. The challenge is to combine both local, place-based planning efforts with larger-scale and international governance. Regulatory policy should link regional, national and international efforts in a comprehensive, ecosystem-based approach to protect coastal marine biodiversity.

In general, a focus on regional, municipal or place-based coastal marine policymaking reflects a "conservation conundrum" – addressing the cumulative impacts of anthropogenic climate change and the multiple-use impacts of coastal marine resources requires regulatory authority that transcend regional,

local or municipal administrative jurisdictions. Moreover, a preference for sector-based policy development and implement also fails to address the cumulative and synergistic impacts of coastal marine resource use and anthropogenic climate change. With respect to the physical scale of the biodiversity crisis, governing institutions continue to support non-regulatory policy tools, state sovereignty (i.e., re-nationalization policies), and policy diffusion to local (e.g., municipal) or sub-regional levels. One problem remains that municipal, place-based authorities lack the institutional capacity or institutional preference to carry out or implement ecosystem-based policy.

Conservation of coastal marine biodiversity is made more complicated by the privatization of resources in coastal marine ecosystems that are essentially "public trust" or commons areas. In the case of fishery management, private interests are often over-represented in federal resource management and planning activities (Okey 2003). Economic interests in institutional arenas support economies based on unsustainable ecological exploitation -- this has certainly been the case in history of the commercial fishing in California (McEvoy 1990; Hilborn et al. 1993). A decision for large reserves that can protect biodiversity threatens the global trade of marine resources. Overall, it has proven very difficult for resource managers to protect biodiversity when marine resources are traded globally. In an era of global climate change, the institutional deference to non-regulatory policies, and a preference for smaller-scale local or sub-regional mitigation measures remain barriers to coastal marine ecosystem-based regulatory policymaking.

Overcoming the conservation conundrum requires a combination of broad-based political support at international and national levels, and policy innovation at the regional level with regard to the creation and implementation of ecosystem-based plans that can match the changing character of coastal marine ecosystems. The emphasis is science-based descriptive models that organize socio-economic and ecological information into spatial models of processes, including identification of cumulative pressures is an important first step toward a more integrated approach to coastal marine ecosystem-based regulatory policy. As described earlier, the EC is currently developing *An Integrated Maritime Policy for the European Union* (Commission of the European Communities Working Document 2007 October), which includes the development of maritime spatial planning and the formation of the EU Marine Observation and Data Network (EMODNET) to streamline the way that data is gathered. Similar monitoring efforts are underway along the west coast of the US, with recent emphasis in scientific baseline studies that include both socio-economic and physical information and data gathering for the California Current.

Improvement of transatlantic learning and coordination across the Euro-Mediterranean, US and California to better address coastal marine biodiversity loss would represent one step to a more comprehensive, ecosystem-based approach to international regulatory policy development. While policies that can reduce greenhouse gas emission are developing in California and the EU, regulatory

policy is needed that emphasizes the priority of coastal marine biodiversity conservation. Coastal marine policy should also better support the linkages and ecological relationships that exist between coastal and marine ecosystems. An integrated, coastal marine ecosystem-based policy approach to mitigate the impacts of climate change is needed at both local or regional and international government levels. In the EU and California, there is a need to designate new coastal areas as "climate change refugia" that can support the goal of biodiversity protection in an era of climate change. Scientists have begun to identify important coastal areas that should be protected where large numbers of plants and animals hit the hardest by climate change are projected to relocate in California. Similar measures are needed across the Euro-Mediterranean coast, given the fact that less than 1% of the coast is protected.

Recent policy development in California represents a preliminary step to address the climate-related pressures on coastal marine biodiversity. The designation of MPAs represents one regulatory tool in support of an ecosystem-based approach to protect coastal marine biodiversity by limited use of marine areas. MPA network design and policy development should be linked to climate-related pressures, and should not be limited in terms of sector-based priorities, such as fisheries management. California has also begun to assess the pressures and potential policy responses to coastal marine biodiversity loss. Over the last six years the *California Climate Change Center*, a state program conducting climate change research relevant to the state, has begun to characterize the expected impacts on key state resources. The existing California policy framework includes Assembly Bill (AB) 32, Senate Bill (SB) 375, SB 97, as well as a host of additional topic-specific bills. The California policy framework presents various obligations and opportunities for each county and city to participate in this emerging State directive. Executive Order S-3-05, signed in 2005 by Governor Arnold Schwarzenegger, requires both mitigation plans and adaptation strategies to manage climate-related impacts. California policy requires that the public and private sectors participate in reducing California's greenhouse gas (GHG) emissions.

While AB 32 sets a framework and process for these achieving goals of greenhouse emission reductions, it does not operationalize them. To begin executing the intended actions, the State legislature has thus far adopted thirteen bills and the Governor has signed four executive orders to provide GHG producers and regulators with additional direction regarding implementation activities. This includes the passage of SB 97, on August 24, 2007, which provides guidance on how GHG emissions are to be addressed through CEQA analysis, as well as the recent passage of the closely watched SB 375. Signed on September 30, 2008, SB 375 aligns the State's housing mandate with regional transportation plans to effectuate a reduction in vehicle trips. Under SB 375, each of the California's 18 Municipal Planning Organizations (MPO), is required to develop an aligned transportation and housing plan for adoption by 2013.

In addition to these topic-specific bills, AB 32 charged the California Air Resources Board (CARB) to develop a Scoping Plan outlining the State's strategy to achieve the 2020 GHG goals. The Scoping Plan proposes 18 emission reduction measures, which are expected to be adopted in December 2009, with final reduction measures expected to be adopted by January 2011. These measures seek to implement AB 32's goal of framing a new statewide policy paradigm by outlining specific strategies and actions, including those related to energy conservation and efficiency, improvements to the state's infrastructure, regionally coordinated transportation planning practices, and market-mechanisms such as an emissions cap-and-trade program. These measures will be legally enforceable at the beginning of 2012, in order to reach the statewide emissions reduction target by 2020. The pending regulatory environment, however, does not necessarily undermine local control.

With the passage and implementation of the AB 32, California is currently investigating the various policy tools that may be needed to mitigate the expected impacts from climate change through reductions in greenhouse gas (GHG) emissions. In concert with these efforts, the California Resources Agency has undertaken the complicated task of developing California's first comprehensive *Climate Adaptation Strategy* (CAS). California's efforts include the development of a matrix of policy responses to impacts to coastal areas of the state. The CAS will have six different *Climate Adaptation Working Groups* that will identify and prioritize climate adaptation strategies on a per-sector basis, including:

- Biodiversity and Habitat
- Infrastructure (roads, levees, buildings, etc.)
- Oceans and Coastal Resources
- Public Health
- Water
- Working Landscapes (forestry and agriculture)

California's Ocean and Coastal Resources Climate Change Adaptation Strategy will be produced by the *Oceans and Coastal Resources Working Group.* As of March 2009, this working group is completing an analysis for state-wide strategy that includes: 1) a vulnerability assessment will establish the type and extent of potential climate changes such as sea level rise, storm surges, and changing ocean conditions and how these changes will impact infrastructure and development, human populations, economy, and natural habitats and species; and 2) coastal adaptation strategies (both overarching and specific) will address these impacts. As much as possible, each strategy will be accompanied by case studies that elucidate that strategy and guidance on how it should be implemented (i.e., potential changes to policies or legislation).

Similar processes could be established by the EU to begin to better understand the multiple pressures and threats from climate change and the multiple uses of coastal marine resources. In addition,

the California MPA planning approach could be used by the EU to redesign the Mediterranean Basin's MPA system, as recommended above. The scientific monitoring program that has developed during the past five years in California provides an excellent model for developing a stronger monitoring effort in the Euro-Mediterranean Basin. The California Ocean Protection Council and Ocean Science Trust, together with private foundations and federal agency support, are currently funding a number of interdisciplinary monitoring projects to review the effectiveness of MPA designation in State waters.

With respect to California and the Euro-Mediterranean, new partnerships that foster learning and coordination across these MTEs is warranted – these areas share similar coastal and marine concerns that include a rich history of coastal marine resource use and trade relationships. Certainly the role of non-governmental organizations in cooperation with government agencies should be fostered, including new relationships between MTE scientists and policymakers in the US and EU. California, the US and EU should embrace a more coordinated approach to regulatory policymaking across MTE areas – new social alliances should be extended to the other MTE areas in Chile, Australia and Africa.

A larger-scale network should be created across MTEs to foster the development of effective development and implement of coastal marine ecosystem-based objectives, and to identify best practices for achieving ecosystem-based regulatory policy goals that can protect coastal marine biodiversity. Existing non-governmental networks, such as the IUCN Task Force on Cities and Protected Areas, should be linked to new scientific monitoring programs, such as NOAA's *Integrated Ocean Observing System* (IOOS)[9] so that common coastal marine issues and concerns can begin to be addressed across MTE areas. Coordination for a future MTE effort that includes practitioners across the Euro-Mediterranean and California MTEs could establish a common set of indicators to illustrate regional successes and illuminate the meaning of ecosystem management to elected officials and other decision makers at all levels of government. Such a coordinating network across MTEs could provide an international model to guide ecosystem-focused stewardship efforts that have failed or succeeded across the bioregions. An international network for coastal marine ecosystem-based policymaking and program development could perform the following major functions:

- Develop, maintain, and evaluate relationships and communication vehicles necessary for a successful learning network, including identification of what information, community-based and regional practices, and opportunities should be shared through the network.

[9] NOAA's Integrated Ocean Observing System (IOOS) is contributing to the recent efforts at globalizing ocean observation systems, and may also be an appropriate coordinating network for the EU. The goal of IOOS is to generate and disseminate data and information on coastal marine areas, and to foster a better understanding and improvement on efforts to address global climate variability. See: NOAA. 2008. *Communicating about the Integrated Ocean Observing System: A Communications Tool.* http://ioos.noaa.gov

• Identify and lead progress toward an international, long-term, collective vision for the development and implementation of coastal marine ecosystem-based regulatory policy.
• Ensure effective communication of principles and progress across MTE areas to policy makers, private foundations, scientists, regional authorities, local communities, and others.
• Scope common issues (restoration, biodiversity conservation, sediment management, water quality, etc) and needs (information and information delivery, methodologies, training, etc) in order to pursue policy responses to the cumulative pressures that are impacting coastal marine ecosystems. Support regional and non-governmental initiatives with technical expertise and identify relevant resources for data and information (including scientific literature and publications) as well as applicable tools.
• Coordinate targeted trainings or workshops for practitioners to further progress in coastal marine ecosystem-based regulatory policy development.
• Identify lessons learned and experiences in using the training, tools and information.
• Design performance measures of the overall effort as a learning network and annually assess the Network's usefulness and long-term need.

REFERENCES

Airame, S., J.E. Dugan, K.D. Lafferty, H. Leslie, D.A. McArdle, R.R. Warner. 2003. Applying ecological criteria to marine reserve design: a case study from the Channel Islands. *Ecological Applications* 13 S170–S184.

Allison, G.W., J. Lubchenco, and M. H. Carr. 1998. Marine Reserves Are Necessary But Not Sufficient for Marine Conservation. *Ecological Applications* 8(1), Supplement: S79–S92.

Allison, G.W., S.D. Gaines, J. Lubencho, and H.P. Possingham. 2003. Ensuring Persistence of Marine Reserves: Catastrophes Require Adopting an Insurance Factor. *Ecological Applications* 13(1) Supplement: S8-S24.

Arkema, KK, SC Abramson, and BM Dewsbury. 2006. Marine ecosystem-based management: From characterization to implementation. *Frontiers in Ecology and the Environment* 4: 525-532.

Bianchi, C.N. and C. Morri. 2000. Marine Biodiversity of the Mediterranean Sea: Situation, Problems and Prospects for Future Research. *Marine Pollution Bulletin* 40(5): 367-376.

Blondel, J. and J. Aronson. 1999. *Biology and Wildlife of the Mediterranean Region*. Oxford University Press, Oxford.

Borja, A. 2006. The new European Marine Strategy Directive: Difficulties, opportunities, and challenges. *Marine Pollution Bulletin*. 52(3): 239-242.

Botsford, L.W., F. Micheli, and A. Hastings. 2003. Principles for the Design of Marine Reserves. *Ecological Applications* 13(1) Supplement: S25-S31

Brook, B.W., N.S. Sodhi, and C.J.A. Bradshaw. 2008. Synergies among extinction drivers under global change. *Trends in Ecology & Evolution* 23, 8: 453-460.

Browman, H.I. and K.I. Stergiou. 2004. Perspectives on Ecosystem-based Approaches to the Management of Marine Resources. *Marine Ecology Progress Series* 274: 269-303.

Cadotte, M.W., B.J. Cardinale, T.H. Oakley. 2008. Evolutionary history and the effect of biodiversity on plant productivity. *PNAS* published ahead of print October 29, 2008, doi:10.1073/pnas.0805962105

CDFG. 2002. *Marine Protected Areas in NOAA's Channel Islands National Marine Sanctuary*. Final Environmental Document. Volume I and II. Sacramento, California, http://www.dfg.ca.gov/mrd/ci_ceqa/pdfs/cover_vol1.pdf.

Cicin-Sain, B. and R.W. Knecht. 1998. *Integrated Coastal and Ocean Management: Concepts and Practices*. Island Press.

Cicin-Sain, B. and R.W. Knecht. 2000. *The Future of U.S. Ocean Policy: Choices for a New Century*. Island Press.

Cicin-Sain, B., I. Pavlin, and S. Belfiore. 2002. *Sustainable Coastal Management: A Transatlantic and Euro-Mediterranean Perspective*. Springer.

Claudet, J., C. W. Osenberg, L. Benedetti-Cecchi, P. Domenici, J. A. Garcia-Charton, A. Perez-Ruzafa, F. Badalamenti, J. Bayle-Sempere, A. Brito, F. Bulleri, J. M. Culioli, M. Dimech, J. M. Falcon, I. Guala, M. Milazzo, J. Sanchez-Meca, P. J. Somerfield, B. Stobart, F. Vandeperre, C. Valle and S. Planes. 2008. Marine reserves: size and age do matter. *Ecology Letters* 11:481-489.

Commission of the European Communities. 2007. *An Integrated Maritime Policy for the European Union*. Communication from the Commission to the European Parliament, the Council, and the European Economic and Social Committee, and the Committee of Regions.

Dailey, M.D., D.J. Reish, and J.W. Anderson. (eds.). 1993. *Ecology of the Southern California Bight: A Synthesis and Interpretation*. University of California Press.

Dallman, P.R. 1998. *Plant Life in the World's Mediterranean Climates: California, Chile, South Africa, Australia, and the Mediterranean Basin*. University of California Press.

Davis, G.E. 2005. Science and Society: Marine Reserve Design for the California Channel Islands. *Conservation Biology* 19(6): 745 - 1751

Davis, M. 1998. *Ecology of Fear*. Metropolitan Books, New York.

Eilperin, J. 2004. Endangered Species Act's Protections Are Trimmed. *Washington Post*. Sunday, July 4, 2004; Page A01.

Fabry, V. J., B.A. Seibel, R.A. Feely, and J.C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. *ICES Journal of Marine Science* 65: 414–432.

Fagan, B. 2004. *The Long Summer: How Climate Changed Civilization*. Perseus Book Group, New York.

Feely, R., C. L. Sabine, J. M. Hernandez-Ayon, D. Ianson, B. Hales. 2008. Evidence for Upwelling of Corrosive 'Acidified' Seawater onto the Continental Shelf. *Science* 10.1126/science.1155676

Follesa, M. C., D. Cuccu, R. Cannas, S. Cabiddu, M. Murenu, A. Sabatini and A. Cau. 2008. Effects of marine reserve protection on spiny lobster (*Palinurus elephas Fabr.*, 1787) in a central western Mediterranean area. *Hydrobiologica* 606:63-68.

Francis, G. 1993. Ecosystem management. *Natural Resources Journal* 33: 315-345.

Fraschetti, S., A. Terlizzi, F. Micheli, L. Benedetti-Cecchi and F. Boero. 2002. Marine protected areas in the Mediterranean Sea: Objectives, effectiveness and monitoring. *Marine Ecology*. 23:190-200.

General Accounting Office (GAO). 1994. *Ecosystem Management: Additional Actions Needed to Adequately Test a Promising Approach*. GAO/RCED-94-111.

Gerber, L.R., L.W. Botsford, A. Hastings, H.P. Possingham, S.D. Gaines, S.R. Palumbi, and S. Andelman. 2003. Population models for marine reserve design: a retrospective and prospective synthesis. *Ecological Applications* 13: S47-S64.

Gore, Al. 1993. *From Red Tape to Results: Creating a Government that Works Better and Costs Less*. Report of the National Performance Review. Washington, D.C. Sept. 7.

Grove, A.T. and O. Rackham. 2001. *The Nature of Mediterranean Europe: An Ecological History*. Yale University Press, New Haven.

Grumbine, R.E. 1994. What is Ecosystem Management? *Conservation Biology* 8: 29-31.

Guerry, AD. 2005. Icarus and Daedalus: conceptual and tactical lessons for marine ecosystem-based management. *Frontiers in Ecology and the Environment* 3: 202-211.

Guidetti, P. 2002. The importance of experimental design in detecting the effects of protection measures on fish in Mediterranean MPAs. *Aquatic Conservation: Marine and Freshwater Ecosystems* 12: 619-634.

Guidetti, P. and E. Sala. 2007. Community-wide effects of marine reserves in the Mediterranean Sea. *Marine Ecology Progress Series*. 335: 43-56.

Gunderson, L.H., C.S. Holling, and S.S. Light. 1995. *Barriers and Bridges to the Renewal of Ecosystems and Institutions*. John Wiley & Associates, New York.

Haeuber, R. 1996. Setting the Environmental Policy Agenda: The Case of Ecosystem Management. *Natural Resources Journal* 36 (Winter): 1-28.

Halpern, B.S., S.D. Gaines, and R.R. Warner. 2002. Letter to the editor. *MPA News* 4(5): 5.

Halpern, B.S. and R.R. Warner. 2002. Marine reserves have rapid and lasting effects. *Ecology Letters* 5: 361-366.

Halpern, B.S. 2003. The impact of marine reserve: do reserves work and does reserve size matter? *Ecological Applications* 13: S117-S137.

Halpern, B. S., K. L. McLeod, A. A. Rosenberg and L. B. Crowder. 2008. Managing for cumulative impacts in ecosystem-based management through ocean zoning. *Ocean and Coastal Management* 51: 203-211.

Halpern, B.S., K.L. McLeod, A.A. Rosenberg, and L.B. Crowder. 2008. Understanding cumulative and interactive impacts as a basis for ecosystem-based management and ocean zoning. *Ocean and Coastal Management* 51:203-211.

Halpern, B.S., S. Walbridge, K.A. Selkoe, C. Kappel, F. Micheli, C. D'Agrosa, J.F. Bruno, K.S. Casey, C. Ebert, H. Fox, R. Fujita, D. Heinemann, H.S. Lenihan, E.M.P. Madin, M. Perry, E.R. Selig, M. Spalding, R.S. Steneck, R. Watson. 2008. A global map of human impact on marine ecosystems. *Science* 319: 948-952.

Hansen, J., M. Sato, R. Ruedy, K. Lo, D.W. Lea, and M. Medina-Elizade. 2006. Global temperature change. *PNAS* 2006 103:14288-14293.

Hastings, A. and L.W. Botsford. 2003. Comparing Designs of Marine Reserves for Fisheries and for Biodiversity. *Ecological Applications* 13(1) Supplement: S65-S70.

Hilborn, C., D. Ludwig, R. Hilborn, C. Walters. 1993. Uncertainty, resource exploitation, and conservation: Lessons from history. *Science* 260: 17–36.

Hourigan, T.F. 1999. Conserving Ocean Biodiversity: Trends and Challenges. In *Trends and Future Challenges for U.S. National and Coastal Policy*. Pp. 45-50. Proceedings of a Workshop. Washington, DC. NOAA. January 22.

Intergovernmental Panel on Climate Change (IPCC). 2001. Third Assessment Report *Climate Change 2001* and the Synthesis Report. Geneva, Switzerland.

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.)]. Geneva, Switzerland, 104 pp.

Jackson, J. et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293: 629–637.

Juda, L. 2007. The European Union and Ocean use Management: The Marine Strategy and the Maritime Policy. *Ocean Development & International Law* 38(3): 259-282.

Keiter, R. 1993. Beyond the Boundary Line: Ecosystems and Law on the Public Domain. *University of Colorado Law Revie*w 65: 293-300.

Kleypas, J.A., R.A. Feely, V.J. Fabry, C. Langdon, C.L. Sabine, and L.L. Robbins. 2006. Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for Future Research. Report of a workshop held 18–20 April 2005. St. Petersburg, FL. Sponsored by NSF, NOAA, and the U.S. Geological Survey. 88 pp.

Leslie, H.L. and K.L. McLeod. 2007. Confronting the challenges of implementing marine ecosystem-based management. *Frontiers in Ecology and Evolution*. 5: 540-548.

Loarie, S.R., B.E. Carter, K. Hayhoe, S. McMahon, R. Moe, et al. 2008. Climate Change and the Future of California's Endemic Flora. *PLoS ONE* 3(6): e2502. doi:10.1371/journal.pone.0002502

McEvoy, A.F. 1990. *The Fisherman's Problem*: *Ecology and Law in the California Fisheries, 1850-1980*. New York: Cambridge University.

McGinnis, M.V. 2000. *A Recommended Study Area for the CINMS Management Planning Process: Ecological Linkages in the marine ecology from Point Sal to Point Mugu, including the Marine Sanctuary*. Prepared for the CINMS. January.

McGinnis, M.V. 2006. Negotiating ecology: marine bioregions and the Southern California Bight. *Futures* 38(3): 1-24.

McGowan, J.A., D.R. Cayan, L.M. Dorman. 1998. Climate-ocean variability and ecosystem response in the Northeast Pacific. *Science* 281 (5374): 210–217.

Morrissey, W.A. 1996. Science policy and federal ecosystem-based management. *Ecological Applications* 6(2): 717-720.

National Oceanic and Atmospheric Administration [NOAA]. 2008. *Final Environmental Impact Statement for the Channel Islands National Marine Sanctuary*. National Marine Sanctuaries Program. U.S. Department of Commerce.

Norton, B. 1995. Ecological Integrity and Social Values: At What Scale? *Ecosystem Health* 1(4): 228-241.

Norton, B.G. and R.E. Ulanowicz. 1992. Scale and Biodiversity Policy: A Hierarchical Approach. *Ambio* 21(3) 244-249.

Noss, R.F., E.T. LaRoe III, and J.M. Scott. 1995. Endangered Ecosystems of the United States: A preliminary assessment of loss and degradation. *Biological Report* 28. U.S. Department of the Interior. Washington, D.C.

Okey, T.A. 2003. Membership of the eight Regional Fishery Management Councils in the United States: are special interests over-represented? *Marine Policy* 27: 193–206.

Orr, J.C., V. J. Fabry, O. Aumont, L. Bopp, S. C. Doney, R. A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, R. M. Key, K. Lindsay, E. Maier-Reimer, R. Matear, P. Monfray, A. Mouchet, R. G. Najjar, G. Plattner, K. B. Rodgers, C. L. Sabine, J. L. Sarmiento, R. Schlitzer, R. D. Slater, I. J. Totterdell, M. Weirig, Y. Yamanaka, and A. Yool. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature* 437:681-686.

PEW Oceans Commission. 2004. *America's Living Oceans: Charting a course for Sea Change*. Summary Report. Recommendations for a New Ocean Policy. http://www.pewoceans.org/.

Raab, L.M. and T.L. Jones. 2004. *Prehistoric California: Archaeology and the Myth of Paradise*. The University of Utah Press, Salt Lake City, UT.

Reid, H. 2006. Climate Change and Biodiversity in Europe. *Conservation and Society* 4(1): 84–101.

Revell, D., M. Heberger, P. Gleick, B. Battalio, H. Cooley, and J. Vandever. 2008 In Press. *An Initial Assessment of the Impacts of Sea Level Rise to the California Coast*. Project Funded by the California Energy Commission's Energy Research Program, CalTrans, and the California Ocean Protection Council. www.pacinst.org

Roberts, C.M., J.P. Hawkins. 2000. *Fully-protected marine reserves*. World Wildlife Fund Endangered Seas Campaign, New York.

Rosenberg, A.A. and K.L. McLeod. 2005. Implementing ecosystem-based approaches to management for the conservation of ecosystem services. In: Browman HI and KI Stergiou (eds) Politics and socio-economics of ecosystem-based management of marine resources. *Marine Ecology Progress Series* 300: 270-274.

Royal Society. 2005. *Ocean Acidification due to Atmospheric Carbon Dioxide*. Working Group members: Raven, J., K. Caldeira, H. Elderfield, O. Hoegh-Guldberg, P. Liss, U. Riebesell, J. Shepherd, C. Turley, A. Watson. The Royal Society, London. 68pp. Available at: http://www.royalsoc.ac.uk

Rundel, P.W., G. Montenegro, and F.M. Jaksic, eds. 1998. *Landscape Disturbance and Biodiversity in Mediterranean-type Ecosystems*. Springer, Berlin.

Rupprecht Consulting. 2006. *Evaluation of Integrated Coastal Zone Management (ICZM) in Europe*. Final Report. 18 August. Germany

Savage, C. 2008. Report Finds Manipulation in Interior Department Actions. *New York Times*, A-19. December 16.

Schattsneider, E.E. 1960. *The Semi-sovereign people*. New York: Viking.

Schubert, R., et al. 2006. *The Future Oceans – Warming up, Rising High, Turning Sour*. Special Report. German Advisory Council on Global Change. Berlin.

Slocombe, D. 1993. Environmental Planning, Ecosystem science, and Ecosystem Approaches for Integrating Environment and Development. *Environmental Management* 17, 3: 289-304.

Sorensen, J. 1997. National and International Efforts at Integrated Coastal Management: Definitions, Achievements, and Lessons. *Coastal Management* 25: 3-41.

Steele, J.H. 1998. Regime Shifts in Marine Ecosystems. *Ecological Applications* 8(1): S33-S36.

Stein, B. A., L.S. Kutner, and J.S. Adams. 2000. *Precious Heritage: The Status of Biodiversity in the United States*. Oxford University Press.

Stoms, D. M., F. W. Davis, S. J. Andelman, M. H. Carr, S. D. Gaines, B. S. Halpern, R. Hoenicke, S. G. Leibowitz, A. Leydecker, E. Madin, H. Tallis and R. R. Warner. 2005. Integrated coastal reserve planning: making the land-sea connection. *Frontiers in Ecology and the Environment* 3: 429-436.

The International Union of Conservation of Nature and Natural Resources, the World Wildlife Fund and MedPAN. 2008. *Status of Marine Protected Areas in the Mediterranean Sea*. With the support of the UNEP Regional Activity Centre for Specially Protected Areas (UNEP RAC/SPA). IUCN, Gland, Switzerland and Malaga, Spain and World Wildlife Fund, France.

U.S. Commission on Ocean Policy. 2004. An Ocean Blueprint for the 21st Century. Washington, D.C. September 20. http://oceancommission.gov/documents/prepub_report/welcome.html#final.

United Nations Millennium Ecosystem Assessment. 2005. *Living Beyond our Means: Natural Assets and Human Well Being*.

White House Office on Environmental Policy. 1994. *Memorandum: Questions and Answers on the Interagency Ecosystem Management Initiative*.

Woolley, J.T. and M.V. McGinnis. 2002. The California Watershed Movement: Science and the Politics of Place. *Natural Resources Journal* 42, 1: 133-183

Worm, B. et al. 2006. Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science* 314: 787-790.

Yaffee, S.L. 1996. Ecosystem Management in Practice: The Importance of Human Institutions. *Ecological Applications* 6(3): 724-727.

Zhang, D.D., P. Brecke, H.F. Lee, Y. He, and J. Zhang. 2007. Global climate change, war, and population decline in recent human history. *PNAS* 104: 19214-19219.