CHAPTER 3

The Oceans as Peopled Seascapes

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To many, the status of the world's oceans is both troubling and inspiring. Mounting evidence has documented declines across all reaches of the oceans, from the poles to the tropics, the shoreline to the deep sea. Cross-disciplinary, international efforts have unequivocally shown the influence of humans on the ocean's capacity to provide essential services (e.g., MA 2005a). Natural and human factors causing changes to and often diminishing the capacity of the production of ecosystem services are increasingly global and synergistic. Yet the growing awareness of the declining health of the oceans has also propelled advances in the theories, practices, and strategies in support of marine ecosystem-based management (EBM). In this chapter, we describe the status of the world's oceans, as well as biophysical, social, and integrated drivers of change in ocean systems in the past, present, and future.

We begin with a review of current approaches to assessing the status of coastal and ocean systems. Then we examine the same issues from the perspective of coupled social–ecological systems (SES), an alternative way of thinking about human interactions with the marine environment. In doing so, we emphasize a broader view of marine SESs: one where humans and their activities are fully integrated into marine EBM, or, where oceans are treated as *peopled seascapes*. We then discuss six implications of approaching the status of marine ecosystems from the perspective of "peopled oceans." Basic assumptions about the relationship between human social and ocean systems need to be reconsidered, as we cannot continue to treat humans as largely exogenous, negative forces on the environment. Interdisciplinary cooperation is essential to the research and management of coupled SESs. In designing marine management strategies, the context, history, and human dimensions at local scales must be kept in mind, particularly when faced with global drivers of change. Finally, power relations among individuals and groups of people can help us better understand the nature and outcomes of human–environment interactions. We advocate recognizing people's varied perspectives and experiences with the marine realm and building these diverse perspectives into ocean management strategies.

The Status of Marine Ecosystems

Identifying key components of marine ecosystems from a biophysical perspective and describing the status of these ecosystems is a challenging but important topic to address before we can fully understand the effects of environmental variability and anthropogenic drivers of change on ocean systems. The status of marine ecosystems can be defined (1) at the ecosystem level (e.g., watersheds, coral reefs, the open ocean, deep sea hydrothermal vents) or (2) based on constituent parts of ecosystems, such as components (e.g., species, populations, communities), patterns (e.g., distribution, genetic variability, species richness, food webs), or processes (e.g., oceanographic linkages, dispersal of organisms, seascape connectivity). Differentiation among the components, patterns, and processes can be made on temporal as well as geographic scales: for example, coral reefs at the scales of leeward Maui, the Hawaiian Archipelago, or the Indo-Pacific across ten thousand, or a hundred thousand, years. Moreover, status can also be discussed with respect to connectivity between systems, such as watersheds upstream of coral reefs, offshore dynamics, or the global climate. Ecosystem services also can be examined to assess the status of ocean ecosystems and implications of changes to that status for human well-being (see also McLeod and Leslie, chap. 1 of this volume; Wainger and Boyd, chap. 6 of this volume; Barbier, chap. 8 of this volume).

Coastal and ocean habitats are in varying degraded states due to the increasing intensity and frequency of anthropogenic activities, coupled with natural environmental variation. For our purposes, the coast begins 100 km inland and extends to the start of the continental shelf, while open ocean systems are defined as waters greater than 50 m in depth (MA 2003). Coastal ecosystems, though more resilient to disturbance than the open ocean due to high natural variability in coastal processes, are more proximate to and are more affected by human activities (Lotze et al. 2006). The coastal zone occupies less than 11% of the world's oceans but accounts for 90% of marine fisheries landings (MA 2005a). Localized depletion of coastal species, particularly large vertebrates, occurred for thousands of years prior to the onset of ecological research (Jackson et al. 2001). The ecological extinctions of numerous species have likely decreased the resilience of these ecosystems to both natural and human-caused disturbances (Jackson et al. 2001). In wetlands and estuaries, polluted runoff from agriculture and urban areas impacts water quality, fisheries, and entire ecosystems and fisheries both acutely and chronically (MA 2005b). Hypoxic bottom waters have increased worldwide between the 1950s and the 1980s, and there has been no global trend toward reversal (Diaz 2001). Some 19% of the world's coral reef areas have been lost due to habitat degradation and loss and pollution, and 15% more are under imminent threat of being lost in the next 10 to 20 years (Wilkinson 2008). Sea grass beds and kelp forests—both highly productive ecosystems—show worldwide declines from pollution (Duarte 2002) and a loss of key consumers due to overfishing (Dayton 2003). Reports of sea grass bed loss have increased tenfold over the past four decades, mirroring similar coastal ecosystems (Orth et al. 2006). Globally, these highly productive coastal ecosystems have all been impacted, with over half of all coral reef and mangrove habitats experiencing medium-high to very high impact scores (Halpern et al. 2008). Mangrove forests have been lost at a rate of 2.1% per year over the past two decades—a total loss of 35% (Valiela et al. 2001). This rate has decreased globally to 0.66% through 2005; however, mangrove habitat is still decreasing in all continents, with an estimated loss of 500,000 ha worldwide during the period of 2000–2005 (FAO 2007). These examples highlight the degree to which a growing number of threats, including overexploitation, pollution, invasive species, climate change, diseases, and habitat loss, have compromised the resilience of coastal and marine systems and their ability to continue to provide services that people need and value (UNEP 2006).

Compared with coastal areas, open ocean ecosystems have experienced significantly less human activity, and we know less about them due to distance from land, rougher seas, and the obvious challenges associated with exploring deeper waters. Open ocean ecosystems are known principally through fishery landings data and patterns of fisheries' activities. Relatively less is known about biodiversity, pollution, and many open ocean ecosystem components and human activities therein (MA 2005a; UNEP 2006). An increase in fishing effort offshore and in deeper waters, combined with a leveling off of global fishery landings since the mid-1980s, indicates that pelagic communities have been impacted spatially through localized depletion (Myers and Worm 2003). A displacement of artisanal and local fisheries, which was masked for years by relatively constant landings globally (Watson and Pauly 2001), highlights the historical and contemporary changes in spatial distribution of fisheries, the loss of local ecological knowledge and practice, and localized changes in biomass, populations, and food webs, among others. The recent trend toward fishing at lower trophic levels suggests that humans may already have depleted many top predators (Pauly 1995; Myers and Worm 2003; Myers et al. 2007), while escalating demand has also increased fishing pressure on lower trophic levels (Essington et al. 2006). This results in severely impacted patterns (food web functioning, genetic variability, biodiversity) and processes (dispersal, behavior) of marine ecosystems (Worm et al. 2006). Populations of long-lived species such as the orange roughy (*Hoplestethus atlanticus*) and pelagic armorhead (*Pseudopentaceros wheeleri*) are showing signs of severe impacts from fishing (Roberts 2002). Moreover, the open ocean and deep sea are seen as the "next frontier" for energy resources (e.g., gas, wind, and tidal), deep sea mineral extraction, and aquaculture. Just as in coastal environments, we have no organized way in which to deal with these diverse and sometimes conflicting human activities.

Drivers of Change in Marine Ecosystems

Biophysical portions of marine ecosystems and their services are continually in flux due to environmental variation and anthropogenic drivers of change. A *driver of change* can be defined as "any natural or human-induced factor that directly or indirectly causes a change in the ecosystem" (MA 2003). Drivers of change in coastal and marine ecosystems can be direct or indirect (box 3.1). Direct drivers, such as the extraction of fish by the groundfish fishery in New England, act unequivocally on a resource. Indirect drivers operate more diffusely by influencing one or more direct drivers; for example, a change in market demand for groundfish may lead to increased or decreased fishing activity. Generally, an endogenous driver is one that can be directly influenced by a resource manager, while an exogenous one cannot. Complex relationships exist among humans, drivers of change, ecosystems, and ecosystem services (MA 2003; Leslie and Kinzig, chap. 4 of this volume). Without an understanding of the range of influential interactions that ultimately affect ecosystem services, it is impossible to effectively manage at the ecosystem scale.

Direct drivers of change can affect an individual species, a food web, or an entire ecosystem, and processes develop and respond at a variety of temporal and spatial scales. Examples include fisheries harvest, habitat change and land-based pollution, climate change, and invasive species (box 3.1). One of the most significant direct drivers of change in biophysical ocean ecosystems is fishing (commercial, recreational, and artisanal). In addition to direct extraction of a target species, nontarget species are often taken as bycatch, which contributes significantly to declines in seabird, marine mammal, sea turtle, and shark populations (Lewison et al. 2004). With declines in populations of target species and shifts to short-lived species, fishing effort has increased in many fisheries. Because bycatch is proportional to fishing effort, not landings, long-lived species taken inadvertently as bycatch are extremely adversely affected by increased fishing effort. Even small-scale fisheries can have strongly negative impacts (Peckham et al. 2007). Bottom trawling can significantly damage benthic habitat (Turner et al. 1999; Thrush and Dayton 2002), and lost gear from fisheries can lead to entanglement. Across the oceans, food webs have been significantly altered by overfishing (Jackson et al. 2001; Christensen et al. 2003), with as many as 90% of all fisheries fished at an unsustainable rate (Myers and Worm 2003). The resulting loss of biodiversity is substantial and may affect system resilience (Sala and Knowlton 2006; Worm et al. 2006). Relatively minor disturbances in one species can catalyze dramatic regime shifts toward less-productive environmental states. By steadily depleting the largest organisms in the population, fisheries may have evolutionary effects as well. Large-scale fishing for Atlantic cod (*Gadus morhua*) in New England has led to the rapid evolution of reduced size at age (Law 2000; Olsen et al. 2004). In heavily overfished ecosystems, population-level effects can last well after fishing pressure is reduced, reduced biodiversity can facilitate the establishment of invasive species, and loss of keystone species can have cascading effects throughout the food web. Decreased commercial catches have led to financial subsidies for unprofitable fisheries, which can exacerbate overfishing as well as create an oversaturation of the market and increase costs for consumers (Munro and Sumaila 2002; Pauly et al. 2002). Additional indirect, exogenous drivers of change associated with fishing include changes in market demand, technological advances in fishing, and globalization (box 3.1).

Population growth, particularly in coastal areas, leads to habitat alteration and increased nutrient loading of marine systems. Nitrogen and phosphorus runoff originates primarily from agricultural fertilizers and waste from farmed animals but is compounded by many other nonpoint sources (Rabalais et al. 2002). Rivers transport the nutrients downstream directly to estuaries, where eutrophication is a growing concern. Moderate levels of coastal eutrophication can act as a subsidy on the system by providing more resources for top-down-

Box 3.1. Direct and Indirect Drivers of Change in Coastal and Marine Ecosystems (adapted from MA 2005a)

	Type	Coastal	Oceanic
Direct	*Endogenous*	Fishing	
		Resource harvesting	
		Military activities	
		Pollution	
	Exogenous	Disease	
		Invasive Species	
Indirect	*Endogenous*	Land use changes	
		Fishing subsidies	
		Climate change	
	Exogenous	Technological change	
		Fishery demand	
		Resource demand	
		Globalization	
		Population growth	
		Disease	

regulated systems (Cloern 2001), but extreme eutrophication results in widespread bottom-water hypoxia (Rabalais et al. 2001). The Gulf of Mexico along the Louisiana coast receives nutrient inputs from 42% of the continental United States and experiences bottom-water hypoxia covering up to 26,000 km^2 (Rabalais et al. 2002; LUMCON 2008).

An equally important driver—or really suite of drivers—is global climate change, which clearly acts over broad spatial and temporal scales. Impacts of climate change include sea level rise, changes in ocean chemistry and circulation, and shifts in the distribution and ecology of key species (Harley et al. 2006). Anthropogenically driven, directional climate change is confounded by natural climate variation (e.g., the El Niño Southern Oscillation [ENSO], Pacific Decadal Oscillation, and North Atlantic Oscillation), which makes it even more challenging to predict specific causal pathways. Nonetheless, the ecological and social effects of global climate change have already been detected and are predicted to be even more significant in coming decades (IPCC 2007). For example, in the case of coral reef ecosystems, the synergistic effects of rising temperatures and ocean acidification in particular are predicted to result in loss of carbonate reef structure and declines in reef community diversity (Hoegh-Guldberg et al. 2007) as well as significant impacts on dependent human populations (IPCC 2007).

Global temperatures have risen between 0.3°C and 0.6°C in the past century and are predicted to rise between 1.3°C and 3°C over the next century from greenhouse gases in the atmosphere (IPCC 2007). Increases in global temperatures will have a multitude of effects on marine communities and biodiversity. For example, increased ocean temperatures are one of the primary causes of coral bleaching (Knowlton 2001) and of decreased recruitment success of important forage species such as walleye pollock in Alaska (Wespestad et al. 2000) and krill in the Southern Ocean (Loeb et al. 1997). While mobile organisms (e.g., tuna) might alter their migration patterns with changes in ocean temperatures or prey distributions (Polovina 2005), long-lived community building blocks such as kelp forests and coral reefs cannot move rapidly (Steneck et al. 2002; Walther et al. 2002; Bellwood et al. 2004). Changes to ocean circulation patterns could negatively affect the recruitment of species such as corals (Harley et al 2006), resulting in a decrease in biodiversity. Most research has focused on the linear effects of climate change (e.g., sea level rise and temperature increases, Harley et al. 2006), but given the documented occurrence of nonlinear ecological responses to biotic and physical changes in the environment (i.e., regime shifts, Leslie and Kinzig, chap. 4 of this volume), strategies for managing nonlinear responses to climate change and other drivers must be developed.

Invasive marine species are another important driver of change in marine systems. The increase in global ship traffic has increased the transport vectors for invasive species. Marine invaders can impact vulnerable native species leading to decreased biodiversity and often extinction (Mack et al. 2000). Because systems with reduced biodiversity have greater available niche space, strong competitors such as invaders can dominate the landscape (Stachowicz et al. 1999). The Mediterranean Sea now contains over eighty-five species of introduced algal macrophytes, including large monocultures up to 30,000 ha, where substantial diversity once existed (Sala and Knowlton 2006). The number of successful invaders will continue to rise, considering that increases in global shipping and thus transport of invasives are likely, as are conditions like land-based pollution, which stress coastal ecosystems and therefore aid invaders' successful establishment.

As spatial scales increase, the effects of drivers of change take longer to propagate, and more time is needed to study them and to provide useful information for managers. In other words, fine-scale drivers have shorter feedback loops than broader processes. Many drivers that primarily impact coastal habitats (due to the proximity to humans) can eventually propagate to the open ocean. For example, destruction of mangroves and wetlands for aquaculture can reduce critical nursery habitat, thereby effectively reducing recruitment of new individuals to open ocean populations (Valiela et al. 2001; FAO 2007).

The disparity in scale between large-scale drivers and that of management exacerbates the already challenging task of managing human interactions with ecosystems. While endogenous drivers often operate at spatial and temporal scales similar to those of management activities, the feedback effects can be delayed (see also Guichard and Peterson, chap. 5 of this volume). While an increase in fishing rates might cause an initial decline in population abundance, long-term cascading effects for entire ecosystems are more difficult to forecast (Dayton et al. 2002). Exogenous and, often, indirect drivers such as globalization affect the ecosystem in ways that are more difficult to predict (MA 2003). Advances in technology allow more-efficient harvest of marine resources as well as easier transport of them around the globe (Berkes et al. 2006). As the distance increases between the location of harvest and where the resource is used, the effects become more dilute and the awareness of the eventual consumer decreases. In sum, biophysical as well as social and institutional processes can act at multiple scales, many of which extend beyond the geographic or authoritative jurisdiction of resource management. Consequently, effective management of human interactions with coastal and ocean environments demands that management institutions and the social and scientific infrastructure that support them (see Guichard and Peterson, chap. 5 of this volume; Rosenberg and Sandifer, chap. 2 of this volume) be able to adapt to changing conditions, and to learn from the past.

Synergistic Effects of Drivers of Change

Most marine systems are adapted to some level of disturbance, but oceans today are subject to increasing, cumulative, and synergistic effects of both natural and anthropogenic factors (UNEP 2006; Leslie and Kinzig, chap. 4 of this volume). Coastal systems in particular are at high risk from multiple stressors due to their proximity to humans and the prolonged timescale of degradation (Lotze et al. 2006). Synergism between increased temperatures and high levels of eutrophication has led to toxic dinoflagellate blooms and resultant fish kills. Often coastal properties are left with tons of rotting fish, and coastal food webs are impaired (Boesch et al. 2001). Disasters such as the Exxon *Valdez* oil spill in March of 1989 can lead to massive mortalities throughout the food web (Paine et al. 1996). While some species have recovered, chronic, long-lasting effects are still visible in the loss of kelp habitat, as well as reduced growth and physical deformities in fish with high biomarkers (Peterson et al. 2003).

Exemplifying cumulative and synergistic drivers, overharvest, sediment and nutrient pollution, disease, and global climate change have led to mass bleaching and shifts in species composition in coral reef ecosystems (Bellwood et al. 2004). The number of reefs damaged has increased exponentially since 1980 (Bellwood et al. 2004) due to the synergism of these anthropogenic disturbances (e.g., disease and overfishing in Discovery Bay, Jamaica, Knowlton 2001). The additional stressors of ocean warming and acidification could cause major changes in coral species composition, in many cases decreasing the capacity of reefs to provide social and economic services (Hughes et al. 2003). None of the aforementioned drivers act in isolation, but instead they have compounded effects. Elevated global temperatures have increased the intensity and frequency of coral bleaching, extensive nutrient loading has facilitated algal overgrowth of corals, and fishing has released predation pressure on coral grazers and removed significant herbivore biomass. The interactions among these impacts need to be considered to adequately manage marine ecosystems.

Synergistic effects require management strategies that deal with the entire ecosystem, multiple species, and drivers of change and account for natural environmental variability. Part 4 of this book offers examples of such management strategies.

Oceans as Peopled Seascapes

How inappropriate to call this planet Earth, when it is clearly Ocean.

Arthur C. Clark

We suspect that, like us, the readers of this book can quickly conjure a mental image of a coastline, or a little stretch of sea, that holds deep personal meaning. At the level of the individual, the idea of a sense of place (Relph 1976; Tuan 1977) helps us describe what it means for oceans to be "peopled." People develop a complex fabric of meanings of, relationships to, and interactions with the oceans. Consider, for instance, the different roles of the ocean in the lives of a big-wave surfer, a third-generation Sri Lankan fisherman, a sea turtle biologist, or a seafood restaurateur in China. These exemplify, on a micro scale, the textured human experiences with and relationships to the oceans—or what is referred to as the ocean's *human dimensions*. Human dimensions refer to the ways in which people affect, and are affected by, the oceans (NCCOS 2007). Herein, we suggest that the very richness and complexity of the oceans' human dimensions have long been underestimated and unwritten, yet are central to a discussion of drivers of change (fig. 3.1). They relate inextricably to *why people do the things they do* and, by extension, the small- to large-scale dynamics of the social–ecological system.

There is an alternative way of thinking about human impacts on, and interactions with, the marine environment, one in which human systems and the environment are inextricably linked and coevolved (see also McLeod and Leslie, chap. 1; Leslie and Kinzig, chap. 4 of this volume). We refer to these coupled systems, as mentioned above, as social–ecological systems, or SESs. The concept of SESs resonates with indigenous worldviews of human–environment interactions (Berkes 1999); for example, Native Hawaiian people conceive of the *'aina* (land) not simply as the soil. Rather, it is a place of shared lineage, encompassing generations of physical and metaphysical beings, including rocks, streams, trees and plants, air, earth, seas, fishes, humans, ancestors, and gods (Kamakau 1964). From the small to large scale, both social and ecological systems are complex and coevolved. Individual people, social networks, and institutions continually affect and are affected by ecological systems across local, regional, and global scales (Kinzig et al. 2006; Leslie and Kinzig, chap. 4 of this volume). A marine social–ecological system is thus multidimensional and integrative of people, their institutions, and economies as well as the biophysical system. In other words, the *oceans are peopled seascapes*.

Scientific intellectual traditions, until very recently, separated nature and society, creating significant intellectual and practical obstacles to managing the two as integrated domains. For example, biologists (or other physical scientists) typically see humans as exogenous forces of destruction on ecosystems, and applications of social science are often overly simplistic. Similar critiques have been made of investigations led by social scientists, where the environmental elements of the problem may be caricatures of reality. This is of course a challenge in any scientific study: Abstraction is vital for understanding of the most influential patterns and processes. Interdisciplinary approaches that capture both the ecological and sociocultural dynamics of interest

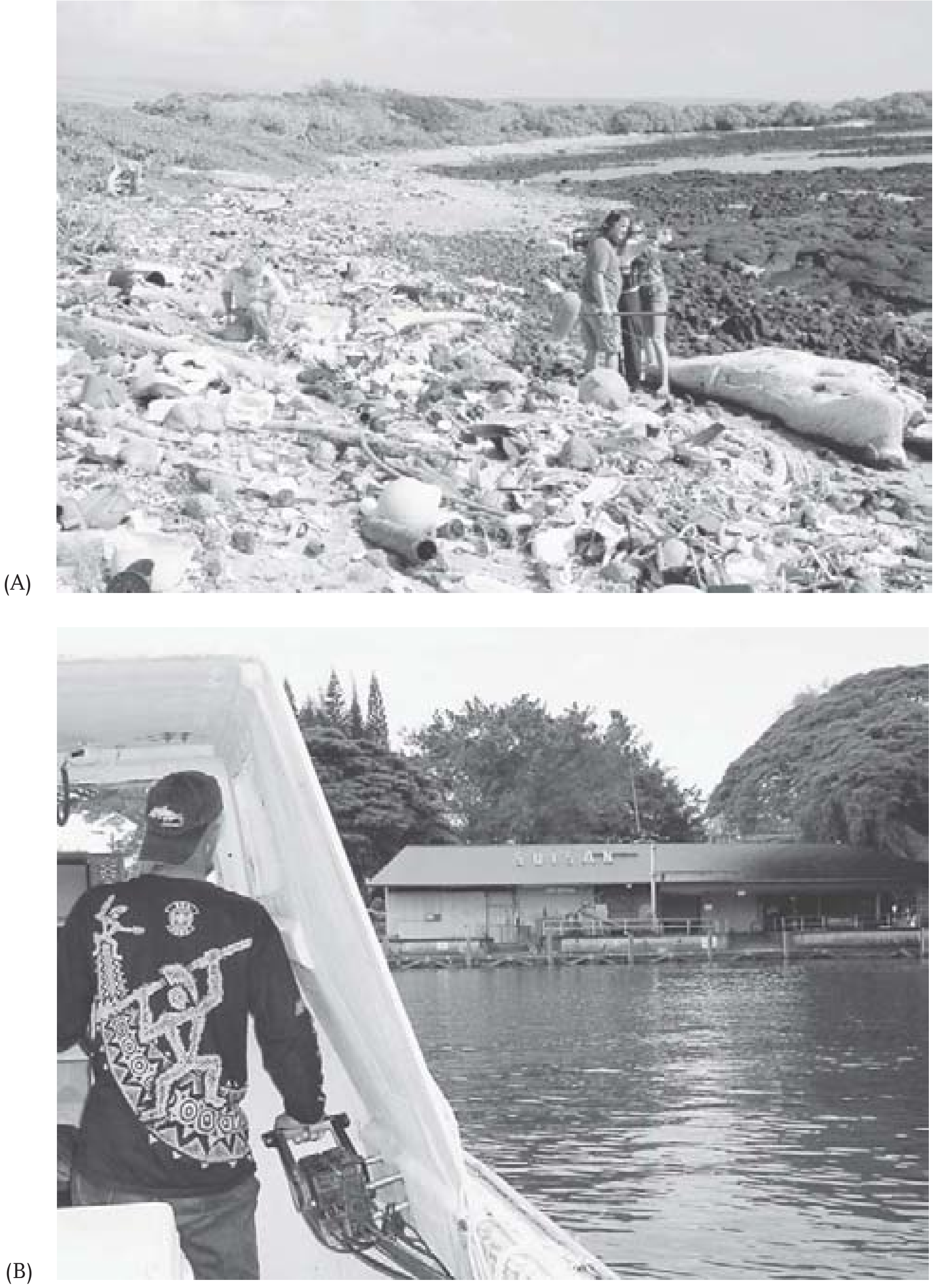

Figure 3.1 Mosaic of a Hawaiian coastal system, illustrating direct and indirect, endogenous and exogenous, drivers of change and signifying features of the social–ecological system less easy to illustrate, such as people's spiritual connection to oceans, ecological knowledge, and marine tenure practices. (A) Marine debris on isolated Kamilo Beach, Hawaii Island, originates from nations across the Pacific. (B) A multigenerational small-boat tuna fisherman heading out to ancient fishing grounds, Hilo, Hawaii. (C) Ancient Native Hawaiian *heiau* (place of worship) protected in a national park, a subsistence fisherman "picking seaweed," and a contemporary fishing canoe. (D) Young surfers passing the Waikiki surf racks. All photos courtesy of J. M. Shackeroff.

(C)

(D)

are proliferating, advancing the scholarship of coevolved systems, and beginning to offer guidance for more integrated, ecosystem-based management approaches (e.g., Turner et al. 2003; Hughes et al. 2005). While it is too early to have a complete understanding of social–ecological synergy, status, and drivers in the oceans, we can offer a framework for understanding key linkages and indicate some areas for future research and practice.

Below we identify six issues, which identify knowledge gaps, discuss complexities, and elucidate the links between oceans and humans. Tending to these issues will prepare us to identify drivers of change of coastal and marine social–ecological systems and thus aid in the implementation of true marine ecosystem-based management.

1. Overcoming an Unwritten History

First, in the writing of history and generation of academic knowledge, the oceans have not been treated as peopled. Indeed, as Arthur C. Clark's words at the beginning of this passage indicate, we are a terrestrial people, and perhaps naturally terra-centric. Many maps of the world, for instance, portray the ocean as a featureless blue space. While the ocean has a history in which people have been deeply involved, this history has remained largely uninvestigated and unwritten. Bolster (2006) provides a sense of what a historicizing of the oceans may reveal and what it means for oceans to be peopled:

> We need to better understand many things: how different groups of people made themselves in the context of marine environments, how race, class, fashion, and geo-politics influenced the exploitation and conservation of marine resources, how individual and community identities (and economies) changed as a function of the availability of marine resources, how technological innovation frequently masked declining catches, how fishermen's knowledge of localized depletions accumulated in the past, how public policy debates revealed historically specific values associated with the ocean, how collaboration between (and then antagonism among) fishermen and scientists affected marine environments, how faith in the certainty of marine science waxed and waned, how different cultures perceived the ocean at specific times, and—when possible—how past marine environments looked in terms of abundance and distribution of important species. These are the constituent parts that get to a deeper historical question: the nature of the greatest sea change in human history (Bolster 2006).

The richness of human context in the oceans is a vast area in need of exploration. As illustrated above, the social has historically been separated from the ecological in academia, research, management, and practice. Within Western traditions, many self-reinforcing mechanisms have fostered this divide (distinct epistemologies, departmentalization, differing expectations within literature, publishing, tenure, academic jargon). Yet, human dimensions of marine systems have been identified as key knowledge gaps in multiple fields: political ecology (Bryant 1998), historical ecology (van Sittert 2005), marine environmental history (Bolster 2006), and resilience theory (Walker et al. 2006), to name a few. Until intellectual traditions weave together, in a sophisticated manner, the complex science of social and ecological systems, we risk making management decisions based on incomplete knowledge of the linkages among people and ocean places.

2. Humans as Deterrents versus Humans as Coevolved

Second, part of understanding the human dimensions of the oceans will involve reconceptualizing the relationship between oceans and society. According to conventional wisdom, people threaten the oceans. Human beings pollute and build in the coastal zone, consume seafood and thereby support excessive fisheries extractions, and burn fossil fuels and contribute to global climate change (MA 2005a; UNEP 2006). While we are responsible for these impacts, this perspective casts humans as exogenous to the natural world. It is much harder to get at the question, Under what historic or sociopolitical circumstances are fisheries sustainable? when wisdom suggests humans are external agents rather than part of the marine food web. The conventional wisdom also suggests that human–marine environmental interactions are largely negative—whereas we can have positive impacts on ecosystem structure and functioning through ecosystem engineering, restoration, and other management interventions (e.g., Long et al. 2003; Olsson et al. 2004; Palmer et al. 2004). Such assumptions pervade management and are often paired with a classical economic assumption of the "tragedy of the commons," which views people as rational actors motivated solely by self-interest and invariably overexploiting resources held in common (Hardin 1968).

Yet the prevailing assumptions of ocean–society relationships are being challenged and, in some cases, overturned. Marine management successes and failures are found in all private, state, and communally based property rights regimes (e.g., McCay 1995, 1996; Ostrom et al. 2002). Many cases of self-restraint and sustainable practices by marine stakeholders exist (e.g., see Basurto 2005), and the tragedy of the commons does not always come to pass (Berkes et al. 1989). For example, St. Martin's (2001) work mapping fisheries based on fishers' perceptions revealed landscapes different from what was assumed based on fish stock and fishing-effort numerical data. St. Martin showed that, rather than behaving individually in a homogeneous and unbounded commons, fishers cooperate and form communities and can even act as the basis for more-formal forms of resource management that avoid depletion and sustain their equitable distribution. In summary, social–ecological relationships are proving more complex than previously considered. In addition to *people as culprits of ocean change,* we can describe *people as cooperative, recuperative, restorative agents of ocean change.* People affect, and are affected by, the oceans in positive, negative, and neutral ways. Moreover, humans are not exogenous; rather, they are no less a part of the ocean system than the California grunion, San Francisco Bay, or ENSO.

3. A New Interdisciplinary Marine Research Agenda

Third, managing marine systems in an integrated manner will require a research agenda that is sophisticated in its treatment of *both* human dimensions and the biophysical environment. Several interdisciplinary research fields—political ecology, resilience science, common pool resources, and historical ecology—are particularly well poised to answer key questions about marine social–ecological systems. Other research fields also have made substantial contributions to understanding the connections between coastal and marine ecosystems and associated human communities, including ecological economics, human ecology, political economy, environmental philosophy, and cultural ecology. We highlight the following four because they explore connections among (1) marine ecosystems, (2) local perspectives on human dimensions, and (3) broader political and economic processes, across scales of space and time.

Scholars of political ecology employ a multiscalar approach to examine power relationships among diverse communities and how these relationships relate to broader ecological, political, and economic events. Political ecologists are particularly cognizant of the social and institutional processes by which decisions are made, and how the resulting benefits are distributed among actors (individuals, households, or other social entities) that vary in their degree of vulnerability and marginality. Reviews of the political ecology literature include work by Bryant (1998) and Castree and Braun (2001), and recent ocean-related scholarship has ranged from investigations of fisheries and aquaculture production to endangered species conservation and research (Hanna 1998; Campbell et al. 2002; Young 2003; Mansfield 2004; Campbell 2007).

Resilience science focuses on the dynamics of complex systems, with an emphasis on the coupling and coevolution of social and ecological systems. Leslie and Kinzig (chap. 4 of this volume) expand on this area, so we will not review details here. Ocean-specific applications of resilience science have been focused primarily in coral reef and other tropical environments, as well as with Arctic indigenous societies (e.g., Berkes 1998; Berkes et al. 2003; Hughes et al. 2003, 2005; Wilson 2006).

Historical ecology emerged concurrently from both the social and natural sciences. Both approaches are focused on interdisciplinary investigations of the role of humans in global change. Social scientists focus on the coevolution of human communities and (largely terrestrial) ecosystems (e.g., Crumley 1994; Balée 1998), while biophysical scientists tend to emphasize the reconstruction of past ecosystem conditions based on diverse data sets (e.g., Jackson et al. 2001; Rosenberg et al. 2005).

Finally, scholars of common pool resources examine the links between resource management and social organization. Using approaches from political science, economics, anthropology, and other social science disciplines, they investigate how institutions and property-rights systems negotiate and, in some cases, overcome the tragedy of the commons (McCay 1995, 1996; Ostrom et al. 1999, 2002; St. Martin 2001).

Compared with oceans, human–environment studies are quite advanced in terrestrial environments, as is the use of human dimensions in land resource management (e.g., Zimmerer and Bassett 2003). We believe that the very features that define oceans (three-dimensional, saline, aquatic environment) and that have contributed to its characterization as unpeopled also ensure that humans interact with the ocean in fundamentally different ways than they do with the land. This conclusion corresponds with that of Carr and colleagues (2003), who argued that terrestrial principles of protected area networks should not be applied ad hoc to marine ecosystems and the development of no-take marine reserves. Limitations in data through space and time, differences in the biophysical environment of oceans versus terrestrial ecosystems, and fundamental differences between human–environment relationships on land and in the sea motivate our call for the development of a distinct approach to oceans as peopled seascapes (box 3.2).

4. The Case for Balanced Interdisciplinary Engagement

Fourth, shifting ocean research and management into a framework of "oceans as peopled seascapes" should come, at least in part, from balanced interdisciplinary engagement. By this we mean that biological, social, and interdisciplinary experts all participate from the earliest design and research phases of a management action. Interdisciplinary engagement entails cooperative teams of people trained in various disciplines *and* interdisciplinary research. Without interdisciplinarity and balance across disciplines, marine management actions have been shown to fail. For example, marine protected areas (MPAs), an important EBM tool, are evaluated principally based on biological criteria. While an MPA may be biologically successful, it can fail socially, which may lead

Box 3.2. Terrestrial Approaches Are Necessary but Not Sufficient for Understanding Oceans as Peopled Seascapes

While it is not necessary to reinvent the wheel—many human–environment relationships in terrestrial environments may indeed be relevant to oceans—we suggest terrestrial approaches should be applied with caution. Given the complexity of human systems and marine systems alone, we suggest that we must constantly ask of a marine EBM approach, Is it *marine* enough? Is it *peopled* enough? In particular, the following should be considered:

1. *Limitations of data are more of an issue in marine environments than in terrestrial environments.* In the generation of scientific knowledge, marine ecologists are generally limited to various forms of remote sensing and underwater sampling technologies, due to our land-centric physiologies. Reliance on technology has meant that the span of ecological data tends to be far shorter in duration than for those on land. The origin of the longest coral reef data sets, for instance, almost directly coincides with the advent of scuba technology in the 1960s, long after the onset of ecological change to these systems (Knowlton and Jackson 2001). Today, novel approaches to reconstructing ecological "baselines" are necessary to understand *relatively* pristine, normal ecological conditions (e.g., Jackson 1997, 2001; Rosenberg et al. 2005; HMAP 2008). While these novel approaches can fill some gaps, data paucity remains a problem.
2. *Ocean ecosystems exhibit fundamental ecological and evolutionary differences from terrestrial systems.* The "openness" of transport of nutrients, materials, organisms, and reproductive propagules in the oceans connects coastal and open ocean ecosystems. Moreover, the aquatic, three-dimensional environment is driven by physical processes operating on multiple spatial and temporal scales. These drivers in turn influence the ecology of ocean ecosystems (Carr et al. 2003; see also Guichard and Peterson, chap. 5 of this volume).
3. *Human–environment interactions are fundamentally different on land and in the sea.* Changes to the landscape are more visible to air-breathing humans than changes to the seascape. As people are unable to directly observe most marine processes without assistance (pole and line, scuba, satellite imagery), human–ocean interactions are often mediated by technology. Culturally, the characteristics of fishing communities and fishers around the globe seem to share more similarities with each other than with the cultures of the nations in which they reside (McGoodwin 2001). Historically, the oceans were unhistoried, forgotten in the writings of history compared with the land (Bolster 2006). Moreover, tenure, use, and property rights related to ocean resources differ quite significantly from those in terrestrial environments (Hanna et al. 1996; Osherenko et al. 2006). These observations suggest something different about how people interact with, come to know, perceive, and respond to the oceans.

to dwindling biological success in the long term (e.g., Christie et al. 2003).

In some cases, problems in interdisciplinary engagement relate to how issues are addressed, and in others, problems are about misunderstandings of what social science is and can do. Including social scientists from the outset of research and management initiatives can offer a way to better understand the people affected by management, including their motivations, cultural heritage, social and economic situations, local or indigenous expert knowledge, and cooperative management. Lessons learned from the fisheries council processes indicate that cooperative or joint research efforts with fishers, particularly those impacted by management decisions, can improve trust, communication, and good faith among constituencies (Kaplan and McCay 2004). If social science approaches to working with local communities are implemented from the outset, as a means rather than an end, compliance and communication with stakeholders may improve (see also Kliskey et al., chap. 9 of this volume). Another example comes from Campbell (2005), a social scientist who frequently participates in interdisciplinary marine research. Some of her natural science colleagues have thought that her role should include environment education and remediation of social and economic problems, neither of which is a role of a social scientist (Campbell 2005).

Social science and interdisciplinary efforts can foster successful marine management—but only if approached in a way that respects the social scientific process as well as the communities within which social science is achieved. Recent growth in interdisciplinary engagement is evident in many areas, including interdisciplinary teams of biophysical and social scientists (see Pomeroy et al. 2004), changing research agendas (e.g., Maurstad 2000; St. Martin 2001; Mansfield 2003, 2004), and interdisciplinary training programs for scientists and practitioners. These changes suggest that the concerns enumerated above will fade over time.

5. Keeping Sight of the "Local" when Facing Global-Scale Change

Fifth, the local scale is particularly important to consider in new approaches to peopled oceans. Scale is a theme that arises throughout this volume because cross-scale interactions within and between social–ecological systems are considered a pressing marine management challenge. The rising prevalence of global issues such as climate change is increasingly demanding a large-scale emphasis, as reflected in the tendency to focus on broadscale processes and change in oceans. This is despite burgeoning work in marine political ecology, which tends to look at smaller scales (as well as across scales), and attention to the local context of common pool resources. Few case studies examine integrated marine systems, and even fewer using a multiscalar approach. Yet terrestrial literatures and marine case studies that do take a multiscalar approach find that the complexity of local communities and human experiences are extremely important in explaining broader processes (terrestrial overviews, Leach and Mearns 1996b and Zimmerer and Bassett 2003; for marine case studies, see below).

Keeping the local scale in mind is important in any approach (Campbell 2007) and has often been the focus of terrestrial interdisciplinary studies, to the point that scholars have begun to criticize an *over*-emphasis on the local (Brown and Purcell 2005). But the opposite has tended to be the case with oceans, where the local is often invisible, as people are absent or transitory. Many processes cannot be understood outside of the context (geographic, social, cultural, political, economic, psychological, etc.) in which they exist. Just as fine-scale ecological patterns of recruitment, wave exposure, and habitats are important in designing networks of MPAs, the social, cultural, and economic complexities in human communities are critical to explain patterns and implement effective management measures. The local scale provides the context (political, economic, social, ecological, etc.) to implement scientific knowledge and management practices meaningfully.

Local knowledge is receiving increased consideration for its potential contributions to marine science and management (Davis and Wagner 2003; Kliskey et al., chap. 9 of this volume), including new insights into marine ecosystem dynamics, human dimensions, and local social context (Berkes 1999). Local "eyes" on the system may provide efficient feedback and response to environmental change. Local people, knowledge, and community structure may offer new ideas for management strategies attuned to the local social–ecological context (McGoodwin 2001; Berkes 2003a), as well as help bring attention to what local communities can do to achieve effective management (Olson 2005). When looking closely at fishing communities (McGoodwin 2001) or fishers' knowledge (Berkes 2003a), complex stories of culturally evolved environmental management practices can offer great insights into human dimensions and potential management strategies allowing for small-scale use (St. Martin 2001). These all reflect the benefits of a mostly local-scale approach.

To give an interdisciplinary, cross-scalar research example, Mansfield (2003) traced how different people and groups make distinctions about the biophysical world. Debates surrounding which places were more appropriate than others for certain kinds of production activities—such as whether imported seafood from Vietnam could be labeled "catfish" or whether farmed shellfish could be labeled "organic"—showed that the biophysical world, as manifest in individuals and their cultures, is related to international relations and trade (Mansfield 2003). Examining local complexities has enabled researchers to identify and describe why particular fisheries are sustainable and how sustainability is achieved. Because of the local sociopolitical context and the Maine lobster's unique biology, Acheson (1997) suggests, the Maine lobster fishery instigated shifts toward sustainable practices following periods of decline, three separate times across a century.

Heterogeneity in local contexts must be taken into account, particularly in considering the scale of management actions. Campbell and colleagues (2002) examine the scalar mismatch between an international treaty and community-based conservation. In their example, the use of an international instrument to eliminate the local use of marine turtles, without considering whether turtle use might be sustainable in specific communities, ultimately may undermine the treaty's effectiveness. This international instrument failed to reflect the local emphasis in current conservation thinking, and it seems to demonstrate that both international treaties and local efforts may be effective in some ways—and ineffective in others (Campbell et al. 2002). Indeed, institutional diversity is now considered as essential as biological diversity (Ostrom et al. 1999), and emergent place-based approaches emphasize the importance of local context to overcome mismatched scales of governance and ocean management issues (Young et al. 2007).

Of the many ways that cross-scalar interactions are implicated in marine systems, the local scale is emphasized here because it is so often oversimplified or reduced to technicalities in oceans. The small, local scale of human beings is a fundamental variable in describing drivers—why we do the things we do—and iterative relationships between ecological change and human change.

6. A Multiplicity of Perspectives and Power Relations

The sixth and final implication of oceans as peopled seascapes is one that underlies all of those previously discussed. Many people hold understandings of the oceans different from those described in science; these represent a "multiplicity of perspectives." Suggesting both practical and philosophical reasons for learning about these diverse perspectives, and applying them toward environmental management and conservation, Berkes and colleagues (2003, p. 8) state:

> The need to use a multiplicity of perspectives follows from complex systems thinking. Because of a multiplicity of scales, there is no one "correct" and all-encompassing perspective on a system. . . . Especially with social systems, it is difficult or impossible to understand a system without considering its history, as well as its social and political contexts. . . . A complex social–ecological system cannot be captured using a single perspective.

The single "all-encompassing perspective" to which these authors refer is science. Outside of science there are many environmental perspectives that tell stories of the environment that differ from conventional wisdom (e.g., Leach and Mearns 1996b; Bryant 1998). Science, particularly Western science, has had more direct access to environmental policy and management than other perspectives (Forsyth 2003; Nader 1996). Pragmatically, capturing more perspectives on environmental change will help address data gaps, as well as recognize the "social" as the complex system that it is. In addition, it will better enable managers to *situate*, or contextualize, marine management strategies socially, historically, and geographically. Many other pragmatic justifications for attending to multiple perspectives are addressed elsewhere in this chapter.

In addition to more-practical issues, there is a philosophical argument relating to the need to recognize local and nonscientific knowledge as legitimate. Historically having the most direct access to environmental discourse, management, and policy (Forsyth 2003), science has excluded many other perspectives and knowledge systems (Raffles 2002; Kliskey et al., chap. 9 of this volume). Being excluded historically from the dominant discourse remains a "deeply remembered" aspect of many indigenous peoples' cultural memories (Tuhiwai-Smith 1999). Efforts to reassert their "contested stories," or alternative perspectives on history, have driven political movements and, according to an indigenous scholar/advocate, influence indigenous peoples' perceptions of science and researchers today (Tuhiwai-Smith 1999). Reflecting the science–local knowledge tension, many indigenous communities have written ethical protocols that scientists must adhere to when conducting research in their communities (e.g., Desert Knowledge 2008). Intellectual property rights are also addressed within traditional ecological knowledge research (e.g., Hansen and VanFleet 2003; Gibbs 2001).

Power relations between science and other perspectives not only underlie these issues, but also offer compelling explanations for human–environmental dynamics (Leach and Mearns 1996b). Due to differences in power, equity, access to political power and voice, and level of vulnerability and marginalization, people are affected differently by environmental change, leading to such different perspectives (Leach and Mearns 1996a; Bryant 1998). In sub-Saharan Africa, conventional wisdom long considered pastoralists to be the primary agents of deforestation, despite local peoples' contesting otherwise. This untested assumption pervaded science, policy, and public perception of peoples of sub-Saharan Africa for many years. Examining aerial photos and geology and interviewing local people indeed demonstrated pastoralists were agents of *re*-forestation (Leach and Mearns 1996a). Power and legitimization issues are very much enveloped in considerations of scale—local interests have been shown to struggle as marine management is implemented at broader scales. Across scales, ecological arguments are employed to promote certain types of conservation interests—with consequences to the local rights of access to the resource (Campbell 2007). In certain circumstances worldwide, there is evidence to suggest local knowledge is still considered less legitimate than science, suggesting there is still much progress to be made in attending to local perspectives (e.g., Campbell and Vainio-Mattila 2003).

Scientific knowledge of marine ecosystems will only be as powerful as it is inclusive of other ways of knowing the oceans. For example, in a case study by a Finnish researcher, despite the existence of highly sophisticated silvicultural expertise in Finland, the main reason for the relative health of Finnish forests is that conservation practices are based on traditional knowledge passed from one generation to another (Oksa 1993, as cited in Campbell and Vanio-Mattila 2003). Similarly, Berkes (2003b) suggests a strong need to link community-based conservation to the livelihoods, knowledge, and interests of local people. Small-scale farmers, fishers, and forest users may be the best allies for conservationists (Alcorn 1993, cited in Berkes 2003). In marine management, local, often indigenous, knowledge is increasingly given consideration (Davis and Wagner 2003; Kliskey et al., chap. 9 of this volume). For example, Native Hawaiian traditional ecological knowledge and traditional tenure practices are explicitly recognized in recent reauthorizations of the Hawaii state ocean plan and federal Magnuson–Stevens Fishery Conservation and Management Act (1996), as well as in the development of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (see also Kliskey et al., chap. 9 of this volume). Attending to local peoples' perspectives has the potential to empower people. However, empowerment is not always inherent, as commonly assumed; rather, it must be fostered and achieved (Davis and Wagner 2003). Other chapters in this volume describe *how* to elicit diverse perspectives and *why* they are so important to marine management (e.g., Kliskey et al., chap. 9 of this volume; Moore and Russell, chap. 18 of this volume). We simply state here that there is much to be learned and gained by an inclusive frame.

Closing Thoughts

Throughout this chapter, we have argued that the oceans are peopled seascapes, and thus understanding the drivers of change in coastal and marine systems requires understanding coupled social–ecological systems. Interdisciplinary marine research will continue to unravel the synergistic relationship between oceans and society. Solutions to what ails the oceans may lie in collaborative efforts between local people and managers to learn about, work with, and work within local communities. Management approaches that better reflect local communities' diversity, a multiplicity of perspectives, and power relations are needed in order to achieve true ecosystem-based management of the oceans.

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