Work In Progress

Deep History: Using Archaeology and Historical Ecology to Promote Marine Conservation

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> If our population doubles to 12 billion and our coastal population triples in this century, it's not going to be enough to protect the oceans. We're going to have to manage and use them wisely which means understanding them far better than we do today (Helvarg, 2001:10).
>
> A fundamental aspect of ecosystem restoration is learning how to rediscover the past and bring it forward into the present – to determine what needs to be restored, why it was lost, and how best to make it live again (Egan and Howell, 2001:1)

Abstract

Given the speed at which marine ecosystems are being degraded, it is increasingly important that we draw on our knowledge of ancient practices of both marine exploitation and management. Access to archaeological shell middens, containing evidence of past subsistence patterns and the long history of human interaction with marine ecosystems, positions archaeologists to contribute important insights into successful management practices and the costs of mismanagement or overexploitation at great temporal depth. These deep historical perspectives are crucial to understanding the past, present, and future of marine environments. We

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describe on-going work by University of Oregon archaeologists to develop deep historical data sets against which to measure the health of our marine ecosystems and to develop protocols for future conservation efforts.

Introduction

The oceans, comprising 71 percent of the earth's surface, are the cradle of life – providing food, work, and play for billions of people. Yet, our burgeoning population and heavy reliance on the ocean's resources has created a crisis. Overfishing, coastal development, pollution, and coral bleaching have severely degraded marine ecosystems (Pew Oceans Commission, 2003). An ecological baseline is an essential reference point for ecologists, resource managers, and environmentalists. Such baselines measure an ecosystem's health, provide information against which to evaluate change, and help assess the elusive 'natural' state (Jackson et al., 2001). Though there is no "pristine" environment, our baselines should reflect environmental states before the devastating impacts of human commercial and industrial impacts. By knowing the baseline for a degraded ecosystem, we can work to restore it. But if this baseline shifted before we had the chance to evaluate it, then we end up accepting a degraded state as normal or improved (Pauly et al., 1998). Historical ecological approaches can help to elucidate solutions to this crisis.

Why Historical Ecology?

The term 'historical ecology' was probably first coined by Deevey at the University of Florida in the early 1970s and popularized in 1994 by Crumley's edited volume *Historical Ecology: Cultural Knowledge and Changing Landscapes*. Crumley (1994:6) defined historical ecology as "…the study of past ecosystems by charting the change in landscapes over time."

Ecologists study the relationships between organisms and the physical environment, but they often rely on records that span just a few decades. They recognize that the state of modern ecosystems is a result of long-term organism-environment interactions, but rely on data gathered during historic times. No environment, then, is pristine since they are constantly in flux, the result of long, dialectical relationships. Historical ecology differs from traditional ecology, in that, it acknowledges the importance of human-environment interactions and reads the environment as an outcome of these.

Evidence of “the ongoing dialectical relations between human acts and acts of nature” (Crumley, 1994:9) is found in the landscape in the form of archaeological sites, pollen records, tree ring records, and etc. Historical ecologists use these data sets in combination with ecological, fisheries, and historical data to study past ecosystems and landscapes (see Kirch, 1997; Kirch et al., 1997; Redman et al., 2004). By utilizing a variety of temporal and spatial scales to understand human use of the land and sea and by integrating environmental and cultural data sets, we can develop more effective conservation, management, and environmental policies for the future.

A History of Exploitation

Between about 400 and 150 years ago, Euro-American explorers set in motion a “massive biological reorganization” of our continent’s terrestrial and marine ecosystems (Helvarg, 2001:10). These explorers and settlers caused catastrophic wildlife extinctions and deforestation. At the same time, marine ecosystems were severely altered, with the commercial hunting of sea otters, fishes, pinnipeds, cetaceans, and sea birds (see Bartholomew, 1967; Scammon, 1968) by Russians, Americans, and the English. Sea otters, for example, once numbered up to one million in Pacific Coastal waters from Russia to Baja (Helvarg, 2001:218; Ogden, 1941). Sea otters in California were thought to be eradicated by eighteenth and nineteenth-century fur trappers until 1939 when a remnant population was found along the Big Sur coast. Their subsequent protection, recovery, and geographic expansion in California coastal waters has generated considerable controversy and debate between commercial fishermen, environmentalists, and resource managers. Sea otters eat up to 25% of their body weight daily and pose fierce competition with fishermen for abalones, octopus, crab, sea urchin, and shellfish (VanBlaricom and Estes, 1988).

Recognizing the devastation from early, commercial fisheries, scientists recorded the biological composition of our terrestrial and marine environments, studying and recording species populations after they had already been corrupted or destroyed. It is this information that has been used as a baseline to evaluate the health of our marine ecosystems. Such a shallow temporal scale, spanning less than a century, makes it difficult to imagine the ‘natural’ state. Ecologists, resource managers, and visitors often evaluate the health of marine ecosystems, unaware of how they used to look before the devastating effects of historical overfishing, coastal development, and environmental degradation. An outline for the “remediation and restoration” of marine ecosystems will remain invisible without a deep historical perspective, provided by paleoecological, archaeological, and historical data (Jackson et al., 2001:636). If we are willing to act on the basis of this historical data, and fix our baselines at a point before the devastating impacts of historical overfishing, we can begin to restore the oceans to a more ‘natural’ state.

Historical Ecology and Interdisciplinary Solutions

The reexamination of our notions of “pristine” marine ecosystems and the “shifting baselines” on which fisheries management has been based is due, in part, to the work of archaeologists who have shown that humans have exploited a variety of marine environments, built watercraft, and colonized islands for much longer than previously believed (Erlandson, 2001). Archaeological evidence has clearly demonstrated, for example, that marine hunting, fishing, and foraging began on the Channel Islands at least 12,000 years ago (Erlandson et al., 1996; Rick et al., 2001). Widespread, highly productive, and species-rich kelp forests played a key role in the development of maritime peoples along the Pacific Coast of North America supporting some of the most complex and populous hunter-gatherer cultures ever known. Kelp forests continue to be an extremely important economic, recreational, and aesthetic resource for California’s coastal communities, providing three dimensional gallery habitats that support a complex web of marine productivity and species diversity.

Ecological study of California kelp forests has shown that a variety of factors influence their extent, structure, and health (see Dayton, 1985; Dayton and Tegner, 1984; Steneck et al., 2002). Aside from physical factors (El Nino/La Nina cycles, storm intensity, etc.), several animals play important roles in the ecology of California kelp forests. These include sea otters, sheephead, sea urchins, lobster, and several other economically important species (abalones, rockfish, etc.) that depend heavily on the productivity of kelp beds. Beginning in the late 1700s, European and American commercial interests severely disrupted California coastal ecosystems and heavily impacted many marine species. Sea otters, several pinnipeds, and cetaceans were hunted to local extinction, for instance, and sea urchins, abalones, lobster, sheephead, and other species were heavily overfished. This commercial overexploitation has altered key ecological relationships in California kelp forests and other marine communities and has created tensions between conservation biologists, the fishing industry, and resource managers. Collaborative, interdisciplinary efforts are the key to mediating this debate and to understanding the long-term relationships between humans and kelp forest communities. However, we need detailed case studies to develop effective management protocols and to guide us along the way.

Case Study: San Miguel Island, California

For the last 12,000 years, the Northern Channel Islands and the Santa Barbara Channel area have been home to the Chumash and their ancestors, some of the most complex maritime hunter-gatherers in the world (see Arnold, 1987; 2000; Erlandson et al., 1996; Erlandson and Rick, 2002; Kennett, 2005; Moss and Erlandson, 1995). Unfortunately, most Chumash sites along the mainland coast have been devastated by development, bioturbation, agriculture, looting, historic construction, and other processes. These disturbances inhibit our ability to reconstruct past environments, interpret ancient lifeways, and understand human impacts on ancient ecosystems. The Channel Islands have been largely unaffected by development, plowing, and burrowing animals. Hundreds of archaeological sites – with well preserved stratigraphy, faunal remains, and artifacts – on the islands have remained largely intact.

Together, the Northern Channel Islands of Santa Cruz, Santa Rosa, San Miguel, and Anacapa constitute most of Channel Islands National Park (see Figure 1). Despite over a century of archaeological explorations, just a small percentage of archaeological sites within the park have been excavated or dated. Because of its smaller size (approximately 37 km^2), San Miguel Island offers a unique geographic advantage over larger islands. So far, researchers have been able to date over 11% of the island's 611 recorded sites, allowing an unprecedented resolution of human settlement, subsistence, technology, demography, and ecology (see Erlandson et al., 2004, 2005; Kennett, 2005).

These archaeological sites offer an impeccable record of high-resolution data, including the well preserved remains of a variety of marine mammals, fish, shellfish, and sea birds, as well as land animals (island fox, dogs, spotted skunk, etc.). The long record and pristine nature of Channel Island sites is unmatched in California and in virtually any coastal region in the world.

Dayton and Tegner (1984:471) hypothesized that Native Americans played an important role in kelp forest ecology along the California Coast. They proposed that Native sea otter hunting released shellfish populations from predation, increasing productivity of important shellfish fisheries for abalones, sea urchins, mussels, etc. Preliminary support for this idea has been found on San Miguel Island, where Erlandson et al. (2004; 2005) have documented Native American hunting of sea otters from at least 9500 years ago to early historic times. This hunting appears to have helped maintain productive shellfish and fish populations throughout the Holocene, as evidenced by hundreds of large middens containing enormous quantities of abalones and other large shellfish not normally found in coastal waters where otters are abundant. As Native populations grew over the millennia, marine fishing intensified (Kennett, 2005; Rick, 2004). By about 3000 to 4000 years ago, preliminary evidence suggests that heavy fishing may have impacted some local populations of sheephead, which also help control urchin populations in island waters. We are now studying several San Miguel middens dated to the last 3500 years, where some strata are dominated by sea urchin tests – possible evidence that Native hunting and fishing helped create localized and short-lived urchin barrens (Erlandson et al., 2005). In contrast to the devastation of the historic Euro-American era, however, Native peoples appear to have harvested the same species of marine mammals, fish, and shellfish relatively continuously for the past 10,000 years (Erlandson et al., 2004; Rick and Erlandson, 2003). By documenting the technological and behavioral adaptations of the Chumash and their ancestors over the millennia, we hope to learn (1) how they affected marine ecosystems of the Channel Islands, (2) what adjustments they made to sustain their large populations in a fragile island environment, and (3) how modern resource managers can more effectively conserve and restore the natural and cultural resources of America's national parks, manage commercial fisheries, and preserve the quantity and quality of our oceans' resources.

From Theory to the Field

Most of the archaeological work on San Miguel Island has been focused on the north coast, where a 10,000 year sequence of archaeological and ecological data has been identified (Rick and Erlandson, 2003). Our work extends these historical ecology studies to the poorly known south coast of San Miguel, where preliminary work in 2002-03 documented a series of shell middens dating between about 9000 and 100 years ago (Braje et al., 2004, 2005). We are employing several methodological approaches to help conserve these cultural data sets and to study the historical ecology of San Miguel Island:

1. Intensive archaeological survey of San Miguel's south coast, where we recently identified numerous previously undocumented sites eroding from gully systems.

2. Intensive radiocarbon (^{14}C) dating of south coast sites to reconstruct settlement and subsistence patterns and identify threatened sites that span the Holocene for limited archaeological investigation.

3. Surface collection, mapping, excavation, and analysis of threatened sites to reconstruct local marine and terrestrial environments through time, identify changes in human technology, demography, and subsistence over the last 9,000 – 10,000 years, and document human impacts on local ecosystems.

4. Oxygen isotope analysis of marine shells, paleoecological records of sea surface temperature, kelp forest extent, marine productivity, and sea level change to account for environmental fluctuations.

5. Detailed analysis of faunal constituents and measurement of relative sizes to elucidate changes in prey species and size through the Holocene.

In documenting a trans-Holocene ecological record of nearshore marine ecosystems on San Miguel Island, we are exploring some of the ecological relationships first proposed by Dayton and Tegner (1984) 20 years ago. In the process, we are collecting a variety of ecological and archaeological data that will help archaeologists, marine ecologists, and resource managers better understand the nature of intertidal, kelp forest, and other nearshore ecosystems prior to European contact.

The nature of this picture is complicated by environmental fluctuations that effect marine and terrestrial ecosystems outside the domain of human agency. To manage this complex picture we will use oxygen isotope studies to help differentiate climatic from human-driven marine and terrestrial changes, which are not easy to distinguish in midden deposits. In addition, Kennett and Kennett (2000) have developed a high-resolution sea surface temperature curve for the Santa Barbara Channel region that can help identify changes in kelp forest and intertidal species composition due to sea temperature oscillations.

Without doubt, the Chumash had an effect on San Miguel's marine and terrestrial environments. As their populations increased during the Holocene, their technologies became more sophisticated, and their subsistence practices intensified, they altered the environment in significant ways. But, when compared to the devastation of historical practices, they may have employed relatively sustainable and low-impact strategies. If we can better understand their impacts and conservation practices, we may be able to better understand management practices today (Erlandson et al., 2004, 2005; Rick and Erlandson, 2003).

Conclusions

Millions of people around the world rely on the ocean's resources for sustenance. The crisis of the oceans and our marine fisheries calls into question how long these resources will last in the face of growing global populations and continuing environmental degradation. The state of modern ecosystems is the result of complex and continuous interactions between organisms and humans that have deep historical roots. Applying historical perspectives and the interdisciplinary work of ecologists, biologists, historians, archaeologists, and other scientists to specific case studies, we can identify the "shifting baselines" we need to solve this crisis. Archaeologists can play a key role in reconstructing past ecosystems and understanding the more sustainable practices of some past human societies. By studying past human impacts we can gain a better understanding of what the future might hold and develop more effective protocols for present conservation efforts.

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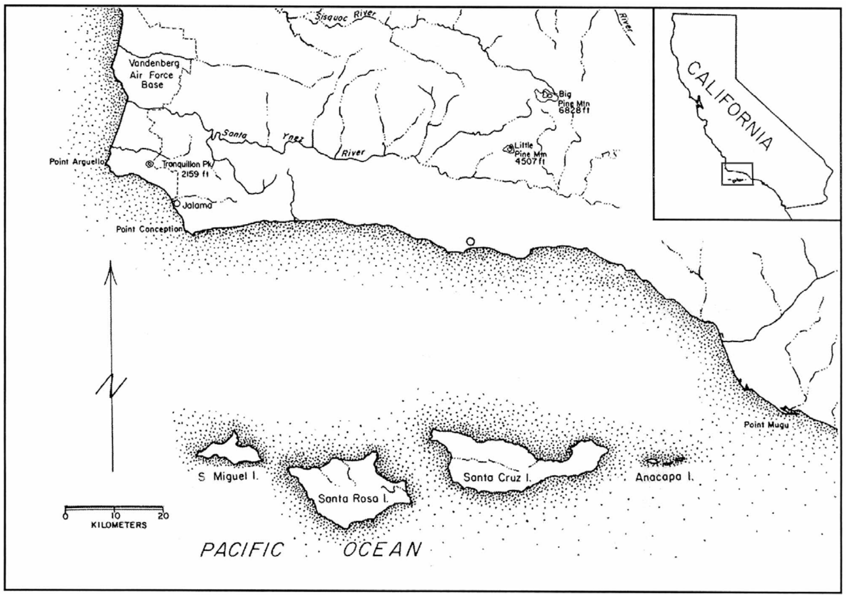

Figure 1. Location of San Miguel Island and the Santa Barbara Channel area.