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SHIFTING BASELINES, MARINE RESERVES, AND LEOPOLD'S BIOTIC ETHIC

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ABSTRACT Different human expectations and environmental ethics are key factors preventing the creation of marine reserve networks. People are skeptical about the benefits of no-take marine reserves because they have adjusted to scarcity and have low expectations about the productive capability of marine ecosystems. Pauly (1995) described this as a shifting baseline in which each generation sets its expectations based on its direct experiences and discounts experiences of previous generations. I show evidence of a declining Caribbean baseline based on Nassau grouper landings from Cuba and the U.S., and review common and often conflicting types of conservation ethics existing in North America. No-take marine reserves can help reestablish human expectations about resource productivity by restoring past conditions in places. Leopold's biotic ethic provides a framework for achieving sustainable resource use based on laws of ecology and human self-interest. Because changing expectations usually requires direct local experience, education, and changes in conservation ethics, implementing successful marine reserve networks will probably be a slow, incremental process. Establishing no-take reserves can help restore human expectations and provide a common basis for conservation by providing a window to the past and a vision for the future.

Introduction

The extent and magnitude of human impacts on Caribbean marine ecosystems have only recently begun to be understood because most historical information is anecdotal or has been lost. Pauly (1995) suggested that many ecosystem changes are not recognized or appreciated because of a "shifting baseline" in which each generation discounts past accounts of fishing and sets its expectations based on its own direct experience. The result is disbelief in past accounts of abundant fishes as gross exaggerations and an acclimation to declining resources. Some studies have provided evidence that humans have significantly impacted Caribbean marine ecosystems for centuries by selectively removing top predators and keystone species (Jackson 1997, Pauly et al. 1998, Jackson et al. 2001).

Establishing networks of no-take marine reserves, areas protected from all fishing and other forms of extraction, may be one way to help reverse ecosystem degradation, restore fishery productivity, increase human knowledge, and enhance non-extractive human activities (Bohnsack 1996, 1998). User resistence, however, remains a key factor preventing the creation of such networks.

Here I show the decline of the Nassau grouper (*Epinephelus striatus*), an ecologically important coral reef predator, as evidence of a "shifting baseline" in the Caribbean. I also explore the possibility that resistence to creating no-take marine reserves results in part from low expectations among users focused on squabbling over scarcity and inherent conflicts between different conservation ethics.

Methods

Assuming that fishery landings reflect stock condition, I compared landings trends from Cuba and the Florida Keys using published data from the longest existing time series: commercial fisheries in Cuba (Claro et al. 2001) and recreational headboats in the Florida Keys (Bohnsack et al. 1994). Headboats are recreational fishing vessels that carry large groups of passengers who pay as individuals "by the head" to go fishing. Commercial landings data were collected by species in Cuba starting in 1960 due to Soviet influence, but not until 1986 in the U.S. (Bohnsack, et al. 1994). To provide an historical retrospective, I plotted landings trends standardized on comparatively scaled axes for three periods: 1980–1989, 1970–1989, and 1960–1989. I also reviewed the different marine conservation ethics recognized in North America to better understand the resistence to the establishment of no-take marine reserves.

Results

Fishery trends

Although the total quantity of fishery landings differed greatly, commercial landings from Cuba and recreational headboat landings from the Florida Keys showed similar proportional declines in the early 1980s before stabilizing at lower levels (Figure 1A). Based on these

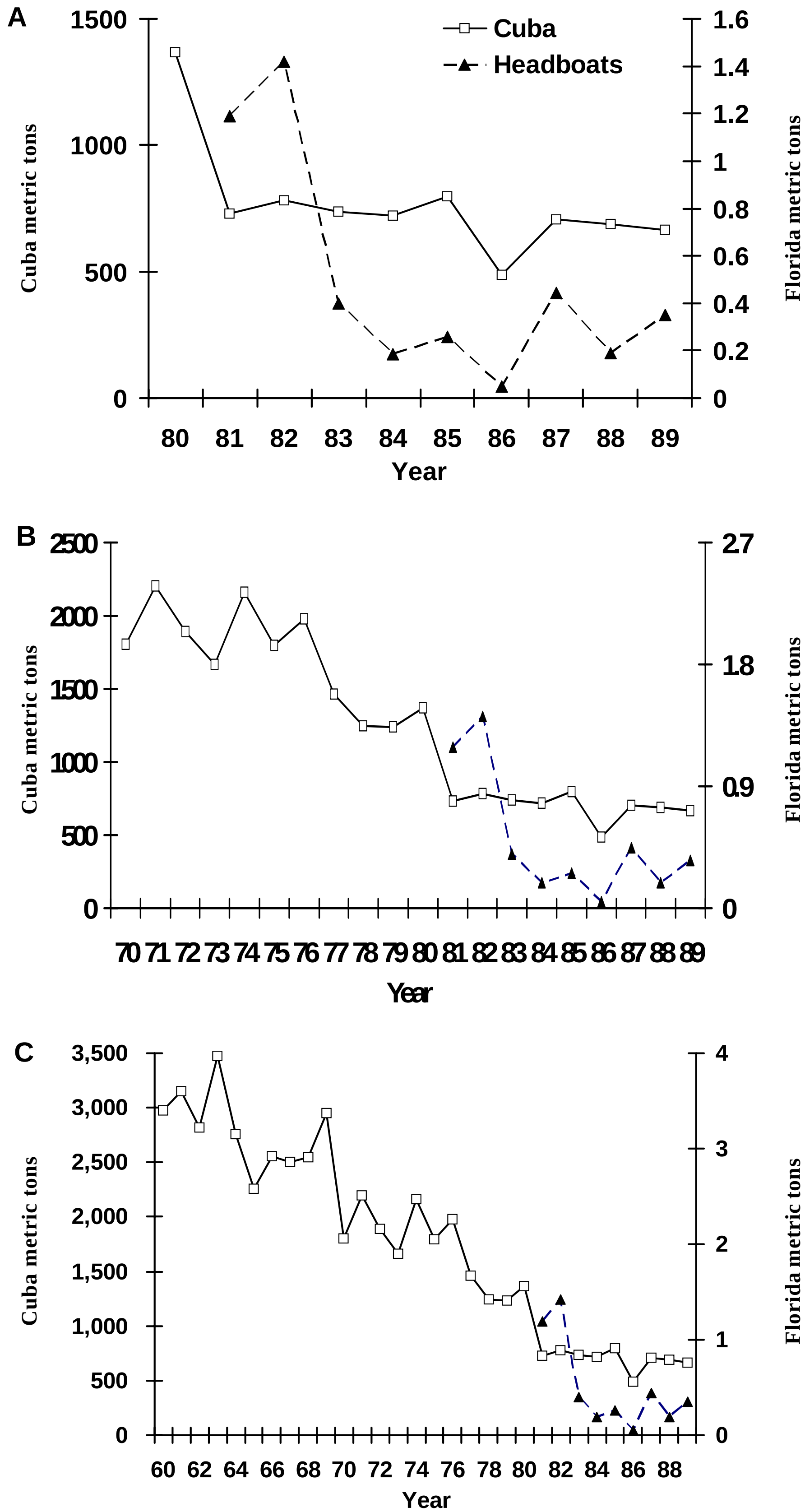

Figure 1. Nassau grouper landings from commercial fishing in Cuba and recreational headboats in the Florida Keys, U.S.A. over one decade, 1980-–1989 (1A), two decades, 1970-1989 (1B), and three decades, 1960–1989 (1C).

data, the expectation in total landings in the1980s was around 1.4 mt for the U.S. headboat fishery and 1,500 mt for the Cuban commercial fishery. Because of the decline, the Nassau grouper fishery was closed in the U.S. in 1990. Looking back a decade (Figure 1B), Cuban landings had also dropped in the 1970s after showing apparent stability around 2,000 mt early in the decade. Some of this decline may be attributed to the expulsion of Cuban fishermen from the Bahamas in 1975. Cuban landings plotted over 30 years show a continuous, approximately linear decline from a high of around 3,500 mt in the 1960s with no indication of stability (Figure 1C). The apparent stability shown in Figures 1A and B are artefacts of the time scale used in each plot.

Although no commercial data exist at the species level in the U.S. prior to 1986, the similarity of trends in Cuba and the U.S. in the 1980s implies a possibility that similar trends may have also occurred in Florida. This possibility is reasonable considering that Cuba and the Florida Keys are in close proximity (~ 150 km apart) and have similar coral reef habitats suitable for Nassau grouper. Also, reef fish in the Florida Keys are known to have undergone intense exploitation and were likely overfished for decades (Ault et al. 1998).

From the perspective of individual fishermen and assuming a constant number of participants in the fishery, a Cuban fisherman starting in the 1970s would have an approximately 33% higher expectation of what a healthy fishery looks like based on total landings compared to a fisherman starting in the 1980s. Expectations for fishermen starting in the 1960s would be 100% higher than for someone starting the 1980s. Conversely, someone starting to fish in the 1980s would have low expectations about Nassau grouper compared to someone starting in the 1970s and especially compared to someone starting in the 1960s. The total number of fishermen was probably not constant and has increased in response to human population growth, suggesting that differences in expectations based on individual catch-per-unit-effort would be even more extreme. Thus, it is easy to see why younger fishers would likely consider fishing stories from their parents or grandparents to be highly exaggerated.

This pattern of long-term declines is repeated in Puerto Rico and the U.S. Virgin Islands. Commercial landings of Nassau grouper in Puerto Rico declined from a major component of the fishery in the late 1800s (Wilcox 1899, Nichols 1929) to an insignificant component by the 1990s. Appeldoorn et al. (1992) reported that Nassau grouper accounted for 141 out of 26,294 total fishes sampled in 1985 and only 38 out of 26,054 fish sampled in 1990. Similar declines are indicated from St. John in the U.S. Virgin Islands. Between 1959 and 1961, a total of 124 adult Nassau grouper were tagged at Lameshur Bay, St. John (Randall 1961) and about 250 Nassau grouper were speared for stomach content analyses prior to 1965 (Randall 1967). By the 1990s, only 37 Nassau grouper were seen over five years of intensive field sampling in 32 sample plots of 5000 m^2 each around St. John (Beets and Rogers, in press). Also, among the 22 numerically dominant fish species observed in fish traps at Yawzi Point reef, Lameshur Bay, Nassau grouper declined from 30 of 1164 fish (2.58%) observed in 1982-83 to 4 of 934 fish (0.43%) observed in 1993–1994 (Beets 1996).

Conservation ethics

A problem limiting the adoption of marine reserves is the existence of different and conflicting conservation ethics regarding the use of marine resources (Williams 1997). Callicott (1992) described the four prevailing North American schools of ocean ethics (Figure 2). The **Puritan-Frontier Development Ethic** developed first when resources were largely unexploited and plentiful and persists to this day. Under this ethic, humans are superior to the natural environment which is viewed as an untamed wilderness that must be conquered. Because resources were plentiful, conservation was not highly valued or considered important. Regulations for the most part were considered unnecessary and any violations were minor problems to be dealt with by minimum penalties. If resources became depleted, users moved to new areas or utilized different resources. Marine reserves had little or no recognized value.

The **Romantic-Transcendental Preservation Ethic** values nature for intrinsic, often metaphysical reasons, independent of people. Under this ethic, protecting the natural environment is given equivalent consideration to human values. This ethic helped lead to modern concepts of wilderness preservation and endangered species protection. In the extreme, people would be considered an unnatural contamination of natural ecosystems. Marine reserves are important under this ethic for their preservation value. A difficulty with the preservation ethic is that it does not require self-interest and therefore its appeal varies considerably among individuals. For many people the ethic has no value.

The **Democratic-Utilitarian Resource Conservation Ethic** dominates most modern government and academic institutions. The environment is primarily considered a commodity to be used to support human activities. Economic self-interest and efficient exploita-

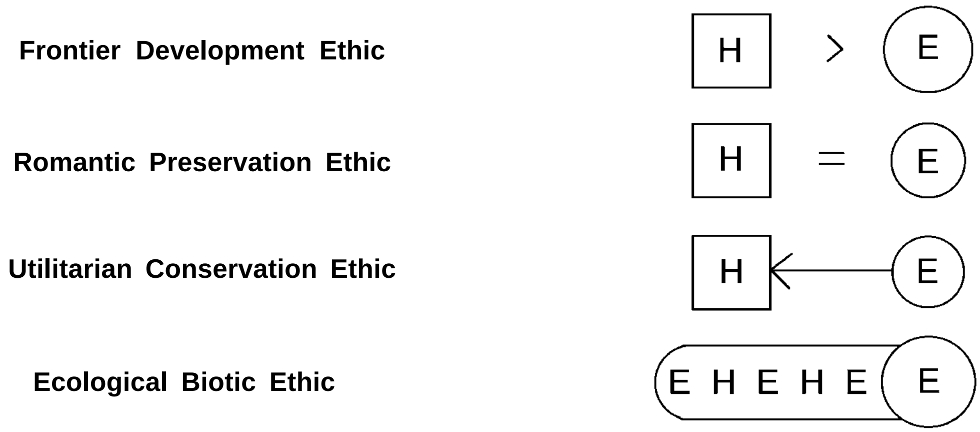

Figure 2. Relationships between humans (H) and marine ecosystems (E) under different conservation ethics. Under the frontier development ethic, humans dominate and are more important than ecosystems. Under the romantic preservation ethic, ecosystems have intrinsic values independent of human values. Under the utilitarian conservation ethic, ecosystems are valued for directly supporting human economic activities. Under Leopold's ecological biotic ethic, humans are integral parts of ecosystems and some areas (circled) are allowed to continue in a natural state.

tion of living marine resources are emphasized under the premise that nature can be understood and successfully manipulated by analytic deductive methods. Profit and maximum or optimum production are valued while wasteful or inefficient resource uses are disdained. The economic focus is on maximum or sustained direct use by people. Some endangered species are protected despite economics if they are charismatic or aesthetically "cute and cuddly" (e.g., marine mammals and sea turtles). Most marine species fail to attract conservation interest because they are considered unappealing or have little intrinsic value as commodities. Application of non-use economics is used to justify wilderness protection in proportion to public interest. This ethic, however, frequently leads to overexploitation for a variety of biological and economic reasons including: excess fishing capacity; social and economic pressures to increase yield when resources decline; increased value of some resources with rarity (e.g., fur seals and tropical fish); continued depletion of highly vulnerable species in mixed species fisheries; and tendencies to take minimal instead of decisive action, and then only after problems have become critical (Ludwig et al. 1993, Bohnsack and Ault 1996).

Regulations play a significant role in management under the utilitarian ethic, but marine reserves have a minimal conservation role depending on their direct economic value and utilitarian usage. One problem with the utilitarian ethic is its emphasis on economics because economics is not an ethic. Although people must make a profit to stay in business, as Leopold (1949) noted, an ethic requires more, specifically, self-sacrifice, obligation and responsibility. Dealing with organisms only as commodities is doomed to failure: *"A system of conservation based solely on economic self-interest is hopelessly lopsided. It tends to ignore, and thus eventually to eliminate, many elements in the . . . community that lack commercial value, but that are (as far we know) essential to its healthy functioning. It assumes, falsely, I think, that the economic parts of the biotic clock will function without the uneconomic parts"* (Leopold 1949).

The **Evolutionary-Ecological Land Ethic** or **Ecological Biotic Ethic** (Leopold 1949) provided a significant advancement to conservation ethics derived from a modern understanding of the science of ecology and evolution (Callicott 1992, 1995). Leopold considered conservation a state of harmony between people and the ecosystem: *"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise"* (Leopold 1949). "Integrity" refers to protecting ecosystem structure and preserving all the parts. "Stability" refers to preserving ecosystem function and it persistence through time. Finally, "beauty" provides the human connection for conservation. Beauty is not just aesthetics, but also the beauty of a system that functions and continues to provide resources, employment, and enjoyment for people.

Leopold (1949) noted that: *"All ethics so far evolved rest on a single premise: that the individual is a member of a community of interdependent parts."* The Biotic Ethic enlarged the boundaries of the community to include soils, waters, plants, and animals. It changes the role of *Homo sapiens* as conqueror to plain member and citizen of the community. It implies respect for fellow members and the community at large. *"The biotic ethic represents a shift from the older conservation idea of* *economic biology, with its emphasis on sustained production of resources or commodities, to a recognition that true sustained yield requires preservation of the health of the entire system.*" Leopold defined 'health' as the capacity for self-renewal.

The biotic ethic has considerable potential for wide public appeal because self-interest becomes important for protecting marine ecosystems. Marine reserves play an essential role by providing increased knowledge for protecting and managing marine ecosystems. The existence of minimally disturbed marine areas is essential for acquiring scientific knowledge and assessing human impacts on marine resources. Reserves can also increase public understanding and appreciation of marine ecosystems and their management. Under the precautionary principle, setting aside minimally disturbed, representative natural areas is essential for protecting, understanding, and appreciating marine ecosystems (Ballantine 1997, Lauck et al. 1998). Leopold (1949) recognized that the biotic ethic " . . . *cannot prevent the alteration, management, and use of these 'resources,' but it does affirm their right to continued existence, and, at least in spots, their continued existence in a natural state.*" From Leopold's perspective, we abuse the ocean because we regard it as a commodity belonging to us. Only when we see the ocean as a community to which we belong, can we begin to use it with "love and respect." In this regard, marine reserves help maintain healthy marine ecosystems by allowing some organisms to exist in their natural state.

Only by having healthy ecosystems can we ensure continued economic and social well being. Achieving this objective requires changes in individual obligations and ethics. Lack of compliance and enforcement of regulations is often blamed on economics, but is in fact a reflection of flawed environmental ethics at individual and government levels. We expect fishers to act in economic-self interest, but without an environmental ethic they are unlikely to act for the common good if there is an economic cost. Government is then left with the role of protecting resources and making regulations for the common good. Eventually, government is overwhelmed and unable to enforce regulations without the cooperation and involvement of individual citizens.

Education is often considered the solution to environmental problems, but as Leopold noted, more education will fail without changing the content as well as the quantity. Under economic self-interest, resource users will continue to use practices that they know are harmful, but economically expedient. It is necessary to have values that emphasize ethical obligations, self sacrifice, and responsibility for self-interest.

Discussion

User resistence is a key factor preventing the creation of marine reserve networks. I propose that much of this resistence is a result of low user expectations from shifting baselines and conflicting environmental ethics. People are skeptical about predicted benefits of marine reserves because they have adjusted to scarcity and have low expectations about the productivity of marine ecosystems. Declining Nassau grouper landings shown in this study are evidence of a shifting Caribbean baseline in only three decades, which is not long in terms of fishing history. Declines probably occurred well before 1960 and perhaps for centuries (Jackson et al. 2001, Wing 2001).

Recovery of exploited populations within no-take marine reserves can help reestablish human expectations about marine ecosystem productivity by providing some idea of what historical conditions may have looked like in some places. Many scientific studies have documented population recovery within marine reserves in a variety of marine ecosystems (reviewed by Murray et al. 1999, Fogarty et al. 2000, Halpern and Warner 2002) including insular and continental ecosystems in the wider Caribbean (Polunin and Roberts 1993, Roberts and Polunin 1994, Rakitin and Kramer 1996, Sluka et al. 1996, Stoner and Ray 1996, Chapman and Kramer 1999, Sedberry et al. 1999, Tupper and Juanes 1999, Williams et al. 2000, Roberts et al. 2001). Unfortunately, scientific studies are not easily transferred into policy and public acceptance without education and some direct local experience. For this reason, human expectations are probably going to change slowly. Successfully establishment of marine reserve networks will probably need to be implemented incrementally in order to build popular support.

Solving conservation problems requires acquiring new visions about the role of science (Lubchenco 1998) but also a reevaluation of conservation ethics and human expectations. Establishing marine reserves and achieving marine conservation goals are difficult because human values vary widely. This review of the different and often conflicting types of conservation ethics existing in North America provides one basis for understanding the complexity and range of individual ethical values. I argue that a widespread change of ethics will be necessary, and suggest that Leopold's biotic ethic provides a suitable model for achieving sustainable resource use because it incorporates human self-interest and has a scientific basis derived from laws of ecology. The ultimate goal is to maintain the structure, function, and beauty of marine ecosystems. Maintaining healthy marine ecosystems supports human well-being.

Leopold's biotic ethic, however, may not be the only useful model. Many indigenous cultures have developed traditions and relationships with their local environment that may provide similar benefits. The traditional systems in many parts of Oceania, for example, have emphasized cultural and social controls and taboos on fishing with strict and enforced codes of conduct (Johannes 1984). Numerous similar examples of strong land and sea ethics exist among indigenous cultures around the world. Where possible, these values should be maintained, encouraged, or adapted (Agardy1997).

Despite the success of individual marine reserves, people must have realistic expectations about the limits of marine ecosystems to support human activities. It is impossible to simultaneously have fully exploited fisheries everywhere and unexploited ecosystems as existed historically. Measures that may be effective at low human population densities may not be adequate or fail when populations grow. Friedlander and DeMartini (2002) have shown, for example, that large, lightly fished areas in Hawaii supported far more fish that some small no-take areas surrounded by high exploitation. Ideally, a network of no-take marine reserves can potentially restore some sites to a condition more closely resembling the past while increasing overall fishery productivity from present low levels. To achieve this goal, human activities must be within sustainable limits determined by the capacity of marine ecosystems. Marine reserves not only protect marine resources but can help restore human expectations and provide a basis for new conservation ethics by providing a window to the past and a vision for the future.

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