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A Framework for Sirenian Conservation in Developing Countries

ELLEN M. HINES

Sirenians are in danger of extinction because of factors common not only to other marine mammals but to endangered species worldwide: habitat degradation and destruction, and directed or incidental killing. Specific circumstances may change, but the results are the same. As seen in this volume, and as stated in figure 28.1, which introduces the concepts underpinning the framework I present in this chapter, the problems behind endangered species habitat and population decline are derived from human values, beliefs, and practices. The methods and issues discussed in previous chapters are designed to create an example of the foundation for a practical toolbox for the inclusion of sound scientific inquiry into an integrated conservation and management process for sirenians and other endangered species.

The reasons for endangerment discussed in this volume combine to form a net of factors intricately tangled into the structure of modern human society. Therefore, to be preoccupied with biological assessments and dependent on biological solutions ignores the risks to these animals associated with social, economic, and political factors[1]. In figure 28.1 the consideration of social, economic, and other related issues is as important as animal biology in sirenian conservation planning. Michael Soulé, who argued for the creation of the discipline of conservation biology in the 1980s, thought of conservation-oriented biology as a crisis science, a mixture of sci-

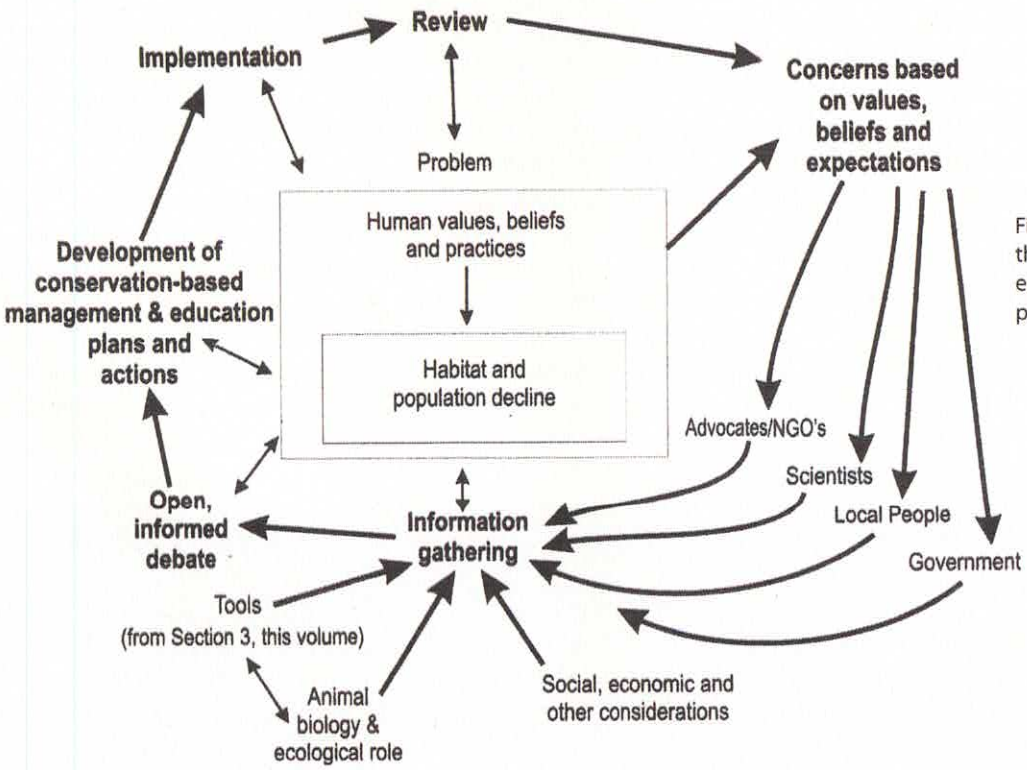

Figure 28.1. A diagram showing the format of an idealized endangered species conservation process. (Based on Hines 2002.)

ence and art, requiring intuition as well as information, and the integration of biological and social sciences[2]. In his 1991 paper entitled "Conservation: Tactics for a Crisis Science," Soulé stated:

> Reappraisal (of conservation's goals and tactics) would be more fruitful if there were a deeper appreciation of the biological and social contexts of conservation actions, particularly how both biogeography and political geography dictate different conservation tactics in different situations[3].

In addition, without the context of history, conservation problems cannot be fully understood, nor can effective conservation planning be developed. In this chapter I incorporate these contexts and the issues and strategies presented throughout this volume and then introduce a further tool into an overall framework that can be a guide to sirenian conservation planning. I believe this framework to be generally useful in most if not all situations and at all scales (local to national to regional).

I highlight three concepts, bolded and underlined in the framework shown in figure 28.2, that are the most crucial ingredients in conservation planning. The first two already have chapters that address them in detail. Chapter 24, on working with communities, demonstrates that it is critical for conservation-oriented scientists to understand the social context behind actions that deplete wildlife and degrade natural systems. To achieve conservation goals, the results of scientific inquiry need to be communicated to all people affected by or involved with management planning. The concept of collaboration between scientists and government, management, educators, and the community is an important step in increasing communication and education for conservation.

Chapter 25, on guidelines for developing protected areas for sirenians, introduces the concept of the designation of reserves to protect marine resources. Some protected areas have already been allocated and more have been suggested[4]. However, marine protected areas are dynamic and complicated, and as discussed by Marsh and Morales-Vela[5], lack of attention to management, the community, and local ecology has limited their success[6].

The third concept that I introduce here, focal species, is a tool for discerning the significance of the interactions or the ecological role of animals within their biotic and abiotic environments. One focal species concept, the flagship species, relies on the symbol or image

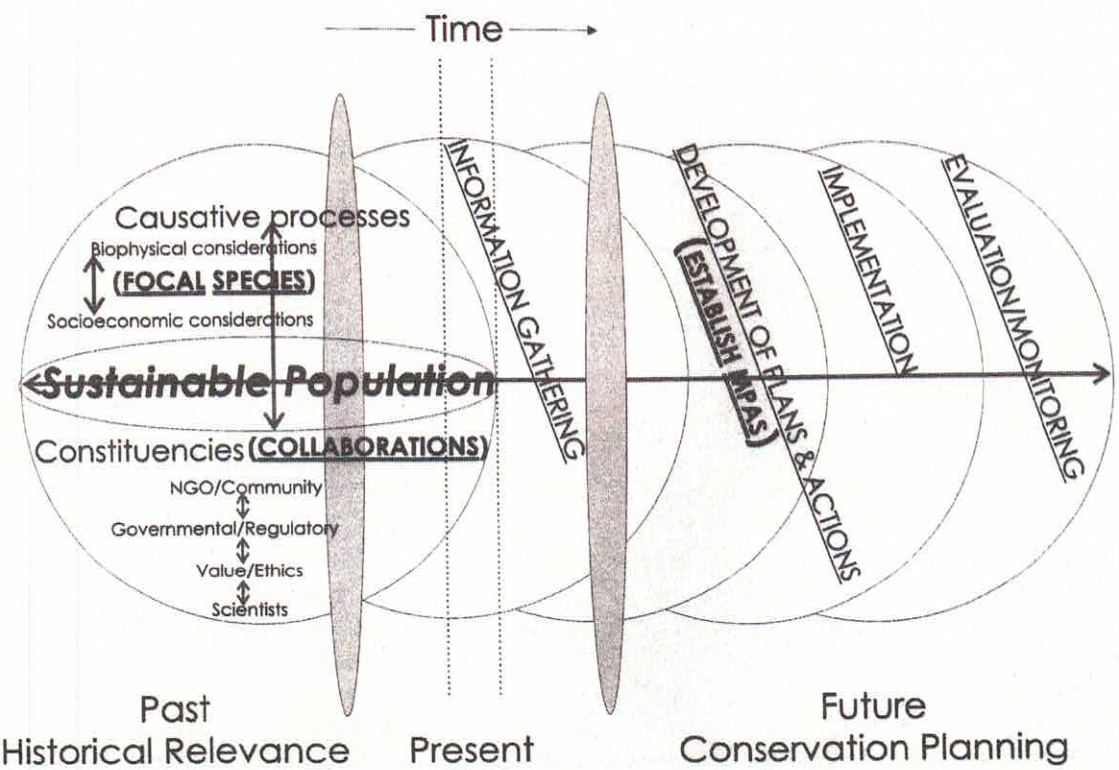

Figure 28.2. An example of an integrated framework for sirenian conservation planning. The three concepts discussed in this chapter are bolded and underlined where they fit into the planning process. (Based on Hines 2002.)

of an animal as a way to generate support for conservation[7]. Other focal species theories, such as umbrella, keystone, and indicator species, which attempt to explain and categorize the ecological interaction between an animal and its biological and physical surroundings[8], can have specific relevance to conservation planning. A concept that I do not discuss further here is that of sentinel species, which is specifically focused on animal health conditions as "indicators" of negative anthropogenic impacts on the environment and their effects on both humans and animals[9]. This concept illustrates a type of conditional indicator species, defined later.

Focal Species Concepts and Their Relevance to Sirenian Conservation

In figure 28.1 the ecological role of an animal is paired with animal biology as inputs into the information gathering process. Focal species patterns of abundance or simply presence are thought of as tools for understanding the relationships of species with their habitats and communities[10]. Simberloff[11] talks of focal species concepts as "shortcuts . . . whereby we monitor and protect single species." Focal species concepts can be considered tools for the understanding, management, and conservation of environments as well[12].

Focal concepts such as flagship, indicator, keystone, and umbrella species have potential in sirenian conservation strategies. A flagship species is not an ecological concept but a social one, for it focuses on a charismatic animal that can arouse public interest in conservation[13]. Indicator species are those for which presence or absence suggests the presence or condition of a particular habitat or community. A keystone species is critical to the ecological functioning of a community. The significance of that role is beyond what is expected in relation to the animals' biomass and abundance. Umbrella species need such a large habitat area that other species dependent on that habitat will be protected[14].

There are roles for focal species concepts in determining areas for marine reserves, habitat characterization and monitoring, identifying and monitoring biological communities, and integrated coastal zone management[15]. However, the use of focal species concepts depends on an understanding of species' interactions with their environment. Aragones et al.[16] discuss the importance of feeding ecology in the role or influence of sirenians on the structure of the marine environment. Bowen states that knowledge of the functional significance of marine mammals is central to conservation, as it provides a context through which to evaluate the potential impact of their predations on prey populations and community structure, and the impact of variation in prey populations, of harvesting by humans, and environmental change on the dynamics of marine mammals[17].

While this understanding is important, it is difficult to measure system properties with such variable temporal and spatial scales[18]. Food webs, trophic levels, and landscapes are complex and dynamic in the marine environment, so the ability to determine if any given species represents the structure or functioning of a community may be challenging[19].

Flagship Species

Community awareness of the significance of threats to the environment can be triggered by the presence of a species for which existence or habitat is in danger. Knowledge of an endangered species can enhance perception of the environment and the effects of continued deleterious use. A flagship species can serve as the representative of environmental conservation in educational processes[20]. There are well-known precedents in both popular and academic literature for the value of a flagship species in drawing attention to problems of resource exploitation[21]. Flagship species can also publicly represent their own depletion and threats from fishing or hunting, pollution, and loss of habitat, and they have been shown to contribute to the successful conservation of natural systems[22]. The manatee (*Trichechus manatus*) in Florida and the dugong (*Dugong dugon*) in Australia are recognized as flagship species representing coastal conservation efforts[23]. In Thailand, dugongs on the Andaman coast can be considered a flagship species based on their place in the cultures of the residents of nearby coastal settlements and on the concern of an international community[24].

The use of flagship species as an advocacy tool for the preservation of habitat has drawbacks. The notion of flagship species is more a means for advocating public support than an ecological concept. The animal's popularity can be based more on political or management strategies than on a scientific foundation of information about the species' needs and vulnerabilities[25]. Flagship conservation can also be expensive and, if not well planned, can de-emphasize the inherent importance of the ecological systems and other species it should represent[26]. In the case of the dugong in southern Thailand, its use as a flagship species is already starting to bring tourists to an area without the infrastructure to prevent

environmental degradation. Dugong watching by boat and microlight aircraft has begun without consideration of (1) the futility of attempting to see dugongs by boat, (2) the extent and effects of disturbance to dugongs from noise and the shadows of both boats and microlights, (3) damage to and pollution of seagrass from the boats, and (4) increased danger of boat strikes.

Simberloff has asked "But what happens when the flagship sinks? . . . Will public emotional investment in this species turn to despair and disenchantment with conservation in general?[27]" There is a real possibility that a sirenian could go extinct while being "watched." Again using the example of southern Thailand, there may be up to 200 animals remaining in Trang province. However, increasing development and tourism alone are enough to destroy local seagrass beds. The construction of a pier over seagrass in a nearby village is an indication of the importance placed on short-term economic development over careful expansion that considers the long-term well-being of the coastal environment. Most local people, even those who belong to conservation groups, welcome the pier as a boom to the local economy. Use of the dugong as a flagship will not overcome the effects of ongoing poverty or unrestrained development.

When a flagship species becomes the basis for a recreational experience from which a local population expects to benefit economically, there is a potential for both the animal and its habitat to be seriously disturbed[28]. For example, the question of long-term disturbance from recreational whale watching has been a concern of both the whale-watching public and researchers[29]. It is difficult to establish cause and effect relationships or to ascertain long-term biological significance based on measurable behavioral parameters[30].

There are numerous examples of marine mammals as flagship species, but even with comprehensive education programs and enforceable management planning, changing human perceptions and attitudes is difficult, especially as wildlife conservation is usually pitted against the interests of economic development and resource exploitation. Any management effort will be inadequate without public interest acting on behalf of an endangered species and its habitat[31].

Keystone Species

The keystone species concept is often explained using the example of the sea otter (*Enhydra lutris*)[32]. Sea otters forage on sea urchins. Urchins usually graze on kelp forests, but when otters come into a community, the larger urchins decline in abundance, and kelp forests increase in abundance. Fish species that inhabit kelp forests then increase, and the community changes. Recent research is finding, however, that outside influences such as storms, currents, or temperature changes can also have strong influences on the growth of kelp forests. Recently, killer whale predation on sea otters in Alaska has caused a decline in otter population abundance and has reduced or eliminated the keystone role of the sea otter[33].

Zacharias and Roff[34] argue that: (1) complex communities are rarely controlled by a single species, (2) all species are keystones to some degree, (3) identifying true keystones is difficult, (4) keystone species are only keystones in specific situations, (5) conservation centered around a keystone species does not guarantee that conservation objectives are met, especially in the variable and complex marine environment, and (6) most important, the presence or absence of a keystone species changes relative abundance in a community, not the community structure itself. Sirenians, as obligate herbivores in seagrass, and possibly as cultivation grazers, do have an influence on the species distribution within the seagrass beds[35]. However, as sirenian grazing changes the relative abundance of species only temporarily, and is not a strong enough influence to create a change in community structure, the keystone species concept is not the most relevant for sirenians.

Umbrella Species

Marsh et al.[36] identify the dugong as an umbrella species, because the large extent of reserve area required for dugong conservation will bring other species under protection. Characteristics of umbrella species have been described by Zacharias and Roff[37], identifying them as animals that:

- demonstrate fidelity to particular types of habitats,
- are nonmigratory,
- are specialists rather than generalists,
- decline in disturbed habitats,
- require large areas of relatively natural habitat, and
- will affect community and habitat structure if they disappear from an area.

Sirenians fit these criteria perfectly[38]. The problem with using the present distribution of sirenians as a decisive factor in the selection of protected areas is that in developing countries especially, sirenians are often found in groups that are remnants of their former distribution, and we have little if any knowledge of current population viability[39] or the true spatial extent of habitat use[40]. For example, little is known of historic or current dugong movement and distribution outside Australian waters. As conservation ideally considers past, present, and

future habitat areas, in such cases the umbrella species should be seagrass beds that contain species of seagrass suitable for sirenian foraging[41].

Indicator Species

The indicator species concept in application can be further delineated as either composition or condition indicators. Composition indicators are representative of the presence of a habitat or community. A condition indicator can be used to monitor the condition of, or the environmental change in, a habitat or community resulting from either anthropogenic or natural disturbances[42]. The concept of composition indicator is relevant for sirenians as it is independent of spatial scale and relatively independent of sample size. It demands that the species demonstrate a definable range of ecological tolerances and show fidelity to specific community and habitat types. This concept also corresponds to research directions and methodology to determine the nature and possible predictability of sirenian use of habitat. In terms of applicability for conservation, the habitat use of a composition indicator species can demarcate a community type or habitat area that can be mapped. Examples of critical habitat areas could include distinct areas based on courting, mating, nursing, or foraging behaviors[43].

A condition indicator species is the only one of these concepts that is focused on monitoring the effects of natural and anthropogenic stress on the habitat and the animal. Also independent of spatial scale and sample size, this concept is a tool for measuring ecologically significant change. The presence, absence, abundance, or behavior of a condition indicator can be considered representative of specific environmental factors. Condition indicators can also be used to evaluate conservation efforts once habitat areas have been identified[44]. As sirenians have specialized foraging needs, habitat areas used for grazing are usually identifiable. Continued research characterizing, modeling, or predicting the specialized foraging habitats of the manatee or dugong will more firmly establish their importance as conditional indicators and further establish the significance of sirenians within a coastal ecological system.

Indicator concepts have the most utility of all focal species concepts as ingredients in a framework for sirenian conservation planning, management, and monitoring. As focal species tools based on testable ecological theory, determination of both composition and condition indicator properties can answer basic questions about species ecology and behavior that are necessary both for conservation and for scientific inquiry. Examples of such questions include the species' behavioral correlation with measurable habitat variables, or how the presence of an animal or its absence from its historic range indicates anthropogenic stress.

The Role of Collaboration

The role and reason for scientific collaboration with government, management, community, and educational organizations is communication. A definition of communication in this context is "bridging understanding within a human community, exchanging messages to create meaning and enrich common knowledge, often in order to face change[45]." Scientific findings are not the only knowledge basis for management decisions. In both the developed and developing world people have local knowledge systems. These systems are not based on scientific method and do not necessarily rely on an understanding of scientific concepts[46]. The extent of discrepancies between scientific models and the perspective of resource users can be a major determinant of local acceptance of scientific information and the success of subsequent management strategies. Other factors that influence local user approval include (1) perceptions of the relationship between humans and nature—for example, small-scale fishers see coastal resources primarily from a utilitarian standpoint rather than a scientific perspective focused on ecological processes; (2) the magnitude of changes that communities will be expected to make, and how those changes will affect them politically, culturally, and economically; and (3) the social relationship and amount of trust between users and authorities. This last relationship can be complicated by a history of corruption or a lack of enforcement on the part of government representatives[47]. A history of such interactions can further alienate people who are already politically and economically marginalized.

Efforts at effective communication can be empowering, promoting social solidarity and, importantly, collaboration with conservation strategies. Orr[48] believes that the failure of scientists to communicate to societies comes from inadequate efforts by scientists to talk to the public or government in understandable terms. In his opinion, efforts of scientists to remain reasonable and objective have by default led to continuing environmental degradation and have damaged the standing of science as a source of common sense. There are, however, examples of individuals who have communicated widely the importance of the implications of their research and have become catalysts for social change. Sirenian scientists in developing countries, such as Kanjana Adulyanukosol in Thailand, Benjamín Morales-Vela in Mexico,

and the co-editors of this volume, have brought a wider awareness of critical environmental issues to the public as a whole and have influenced the directions of natural and social sciences as well as attitudes toward conservation.

The extent and details of involvement of each scientist depend, of course, on the nature of the circumstances. To be an effective catalyst, a conservation-oriented scientist, working with people with widely differing views, must acknowledge the validity of a diversity of values in order to be successful.

Research results must be communicated even where the fundamental values of essential collaborators differ, and conservation plans must be negotiated to meet the needs of all constituencies[49]. The quality of conservation science should be judged not only by the empirical work but also by "a thoughtful evaluation of the research in the context of the social-scientific community in which it was carried out"[50].

By this criterion, one of the most important avenues of communication is with the local community[51]. Local nongovernmental organizations (NGOs) have increasingly been the impetus for community organization, mobilization, and education[52]. This applies both in developed and in developing countries. The Save the Manatee Club in Florida, a vast organization built around manatee conservation, also generates public support to fund much applied and basic research[53]. According to Perrin, "NGOs help keep us as scientists accountable and focused in the right direction[54]."

Environmental NGOs in developing countries are largely dedicated to alleviating poverty and empowering villagers as well as supporting long-term conservation strategies. They have created partnerships that have benefited villagers and can present suggestions in a culturally appropriate manner.

I feel strongly that for a conservation process to be effective in a developing country, the role of scientific advisor should fall to local scientists. This process can include the cooperation of the outside scientific community, who may have skills or technology that can augment local scientific work that is limited by economic or political realities. Unfortunately, governments sometimes listen to the recommendations of outside scientists or give projects more credibility once they have attracted outside researchers or funding. Therefore, collaboration between scientists from abroad and local scientists should be done carefully.

Data and specimens from developing countries still flow for the most part to the developed nations, though the days of the worst exploitation are largely over. Some scientists still do their research, publish in academic publications, and leave[55]. Research results are then not disseminated locally, leaving the local scientists who assisted them feeling exploited. Such research has little if any conservation value beyond broad recommendations in a scientific publication. Conservation-oriented scientists must establish rapport in the communities, both scientific and local, where they work. It can take time and effort to learn how to cope in a country where tasks are approached very differently.

The extent of collaboration with governments, NGOs, local scientists, educators, and communities in both native and foreign countries depends on many factors, personal and political. Long-term, multinational, collaborative research projects are needed that train native scientists and work closely with local NGOs. While challenging, such collaborations are necessary to increase sensitivity and achieve effective communication within the social parameters surrounding conservation needs.

Protected Areas for Marine Mammals

In their chapter on protected areas in this volume, Marsh and Morales-Vela[56] quote the IUCN's definition of a protected area as "an area . . . especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." This definition includes an important point: "managed through legal . . . means" implies that the protected area has the committed support of and enforcement by the government[57]. As stated by Perrin, "Laws without the will and resources to enforce them are worse than no laws at all[58]."

However, the opposite is not effective either. Without legislation, there is no backbone to enforcement, and people have no guidelines with which to defend common resources or elucidated goals to which planners aspire[59]. If a conservation ethic is needed to protect both endangered species and local communities, and many say it is[60], then stakeholders, especially marginalized groups such as artisanal fishing communities in developing countries[61], need the inclusion of integrated planning, and need protection under an ethically mandated authority of regional, national, or international legislation.

Summary

In any conservation or management planning process, it is necessary to take a detailed view of the historical and socioeconomic perspective of the issues that have

been influencing the interactions between people and nature[62]. In many developing areas, a rapidly increasing human population has resulted in the degradation of coastal resources that were historically sustainable.

Every region has unique issues owing to its distinctive geography, biological resources, political structure, and social concerns. Thorough analysis, awareness, and consideration of all these parameters can reveal the necessities and constraints necessary for developing successful conservation and management strategies[63].

The use of focal species concepts and marine protected areas for the conservation of sirenians demands an integrated approach that combines biological assessment and an awareness of socioeconomic context. Further research is needed to define sirenian behavior, life history, and genetics in relation to habitat distribution and oceanographic parameters.

Scientists need to collaborate with agencies, users, educators, and other research institutions. The roles of each need to be clearly defined and, by necessity, integrated. Science is only one part of sirenian conservation; its function is the investigation and objective description of specific phenomena and processes. Effective conservation entails "interactive, reciprocal, and continuous" communication and education of scientific findings to the public and decision makers"[64].

The objective of this chapter has been to create a general framework to integrate the many issues surrounding sirenian conservation in the developing world into a template for cross-cultural application. The elements and relationships for this framework are derived from both the elements discussed in the volume and the issues discussed in this chapter.

A major component of figure 28.2 is that the elements are adapted to fit along a timeline. The vertical dotted lines in the middle of the diagram show the present. Conservation-based management and education planning decisions made in the present need to be filtered through lenses (the gray ellipses) of both the past events that have created the current situation and the realistic desired goals for the future. In each concentric circle, the goal of a sustainable population remains, accompanied by the elements comprising causative processes and constituencies. The vertical arrows connecting these elements stand for the need to connect knowledge of biophysical and socioeconomic considerations to all stakeholders through education and collaboration. The horizontal arrow with arrowheads in both directions represents the necessity for an ongoing adaptive process of conservation planning and implementation based on continual information gathering, evaluation, and monitoring.

The three concepts of focal species, collaboration, and marine protected areas fit into the framework implicitly. Focal species concepts are included in causative processes. A flagship species is related to both socioeconomic and biophysical considerations, as knowledge of cultural roles as well as habitat requirements is pertinent. Exploration of a sirenian's role as an umbrella or indicator species can be a guide to research questions and management decisions throughout present and future planning. The collaboration between constituencies, including a realization of cultural values and ethics, is addressed here and, in this framework, is ongoing throughout each stage. If a marine protected area (MPA) is prescribed during the development of plans and actions, the protected area should be planned and implemented using the information gathered considering the combined causative processes: past, present, and anticipated. This MPA would also address the concerns arrived at as a result of the collaboration of all constituencies. The MPA will, ideally, be continually evaluated by a succession of monitoring and information gathering actions.

This framework is a tool to help organize and guide research and conservation planning for an endangered marine mammal, especially when incorporating the element of time. For example, beyond research on the animals themselves across time, which is a requirement for most ecological-process-based research, research conducted within this framework will include exploration of past and present socioeconomic considerations that may have caused destructive fishing practices or incidental catch: factors that have degraded habitat or depleted a population. The key is that both ecological and social research look to history and toward the future in tandem. At each stage in the past, both of these domains have interacted to produce the conditions of endangerment.

If future conservation planning is to be successful, it too should function by linking ecological and social factors. Future research on causative processes based on this framework could be directed at gathering specific data to test hypotheses regarding the ecological role of a sirenian through a more detailed investigation of the relationship between manatees and dugongs and their habitat. The information gathering as outlined in the framework is ongoing, as are the management and education plans and actions to which the information contributes, which are in turn continually adjusted by evaluation and monitoring.

Perhaps a key to the framework I present here is the idea that the research methods are open to local knowledge and continual review. Of course, the population and habitat issues are best studied by scientific methods. But science can be informed and supported by local knowledge to greater or lesser degrees depending on the setting. Social research can be carried on under a wide variety of methodological approaches. In one instance an open interview can be conducted; in other area a statistical sample or an attitude survey may better reveal the required information.

A final point is the role of the researcher as catalyst. In this arena there is no single method per se. Each individual engaging in conservation-oriented science has to build a suite of skills and develop his or her judgment and sensitivity as to how to approach the various stakeholders. As scientists we contribute to understanding causative processes, but in the processes of doing so, information is created that is used by many parties, some of whom have competing goals. In fact, some of the users may have goals that directly compete with conservation-oriented goals for the species and its habitat. Thus conservation biologists are faced with a conundrum. While gathering information, one enters into the interactive social sphere of conservation: attends meetings, cajoles with government figures, and builds relationships with local communities and scientists.

Long-term planning requires long-term research. Collaboration between constituencies is crucial for future conservation planning. I would be remiss in not mentioning the threat of climate change to sirenians. While the effects of sea-level rise and a rapidly changing physical environment (predictions for significant changes are on the decadal time scale) on sirenians and their habitat are complex, and are only beginning to be addressed, paradigms for conserving nearshore species, communities, and ecosystems as we know them will need to shift dynamically[65]. Without sound conservation planning and effort, I believe several remnant populations of sirenians around the globe will be extirpated before the end of the twenty-first century.