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Response: The Interface between Fisheries Research and Habitat Management

Auster et al. (1997, this issue) reinforce our most important point in Langton et al. (1996)—that habitat protection is necessary for the management of sustainable fisheries resources—but they take issue with several points related to the role of science in habitat management. Specifically, they argue that the scientific approach we articulated is impractical because (1) it demands too high a standard of proof of habitat degradation, proof that requires much more knowledge about species and habitats than now exists; (2) it is based on the biology of single species and thus is vulnerable to the problems faced by current single-species management; and (3) it does not allow managers to base decisions on "expert judgment" or to apply the "precautionary approach" in habitat management. We disagree with these interpretations and appreciate this opportunity to clarify our perspective.

Our paper resulted from a collective effort among 12 scientists and managers from the United States and Canada who participated in a fisheries resources working group at a Gulf of Maine habitat workshop (Stevenson and Braasch 1994). The working group's initial conclusions were expanded by the chair and several participants and published as Langton et al. (1996). This paper was in press when an invited, derivative paper on the science–policy interface was published (Steneck 1995), and we draw from both those publications in articulating our differences with Auster et al. (1997). Although the Gulf of Maine was our focus, we built conceptually on the efforts of scientists worldwide who think deeply on issues of marine science and management (e.g., Grigg 1994; Brown 1995; Underwood 1995; Wells 1995). We hope that the broader, more important message of using science to assist managers in protecting marine habitats is not lost in this debate.

Adaptive Approaches to Science and Uncertainty

We never intended to require a higher standard of proof or a greater knowledge base than currently exists before habitats could be protected, nor did we suggest a need to defer management until certainty about habitat impacts reaches some high statistical level. Instead we argued for adopting an iterative approach to improve the effectiveness of the science that feeds into management processes. We join Auster et al. (1997) in support of precautionary risk-averse approaches to management decisions. However, those decisions would profit greatly from properly focused science. Focusing the science would also help granting agencies decide how best to spend their limited resources.

Our intent is to "assist managers in prioritizing scientific information" (Langton et al. 1996: abstract) and to "steer research in a productive and efficient way" (Steneck 1995) so that important habitats can be understood and managed to optimize harvests within biological limits. Our approach is meant to guide habitat-related management, not to replace it, make it more difficult, or restrict the decision-making role of managers. We recognize that managers must draw on the best available science, but that the scientific knowledge necessary to make informed policy decisions is often wanting.

Although management must make decisions based on the best available science, the efficacy of those decisions should be evaluated scientifically as well (Underwood 1995). Adaptive approaches to management bring scientists and managers together to reduce scientific uncertainty, and they also improve stakeholder confidence. However, as Steneck (1995) and Wells (1995) have pointed out, adaptive management measures can only be tested objectively if they are designed to be tested, and a feedback loop between scientist and manager must function if management goals are to be revised in light of new information. Writing about coral reefs, Wells (1995) noted that boundaries between basic research and applied management research are becoming increasingly blurred. Although "the fundamental scientific principle that no hypothesis is ever absolutely proven frequently conflicts with the manager's need for clear and conclusive results with which to justify his or her actions," Wells concluded, "good management decisions require sound scientific data, providing information on what to manage, for what purpose and in what order or priority." Our decision-making tree (Langton et al. 1996) was designed for exactly that purpose.

The decision tree is intended to help the makers of management policy ask the right questions. It proposes that answers can be found from existing information or can be obtained with targeted research action. The three components together make up the management–information–policy triad (shortened to "science–policy triad" by Steneck 1995). This approach too is being used for the management of coral reefs (Wells 1995), and it was endorsed in a 1994 workshop on the green sea urchin *Strongylocentrotus droebachiensis* in New England (Anonymous 1995). There is widespread support for improving the quality of scientific information and research on which management decisions are based. We hope the decision tree, by highlighting the information needs associated with prioritized questions about habitat, can help improve the quality of the information and thus improve the "expert judgement" used for management decisions. Armed with this information, managers must decide how risk-averse or precautionary their actions should be.

Multispecies Management and the Precautionary Principle

Auster et al. (1997) worry that our approach will fall prey to the shortcomings of single-species management. However, Langton et al. (1996) pointed out how this approach can be used for multispecies management. Each commercially important species can be considered with respect to essential habitats needed for its entire life history or for one critical phase in it. Although species with higher economic or ecosystem value should be ranked higher than those of low value or consequence to the system, we pointed out that "essential habitats that are used by several target species, even if these species individually rank low on an economic scale, may gain in ecological value and take on a higher overall ranking."

Auster et al. make a strong case for the importance of structurally complex habitats, and we agree with them. Given the number of organisms that require complex habitats for critical phases in their life history, extending the precautionary principle to protect those habitats makes sense. However, we disagree with exactly how they propose to do this. Based on their rationale, all habitats would have to be excluded from all activities that disturb the bottom in any way. They define "disturbance" broadly as any process that reduces important habitat structure, and they include sand waves and sediment depressions among their examples of relevant structure. They propose to sequester all habitats (or large fractions of them) whose structure is or could be reduced by fishing gear. A lobster trap that flattens a sand wave could qualify the habitat for protection by this rationale. This approach would effectively close most of the western North Atlantic to most fishing activities. We doubt that Auster et al. had such extreme management actions in mind, but their approach would be far less "surgical" than ours.

Because of asynchronous publication tracks, our most recent thinking about "essential habitats" was given not by Langton et al. (1996) but by Steneck (1995), who noted that "the linkage between a species and a specific habitat may functionally control the carrying capacity of the environment for that species." Our revised definition of essential habitats includes not only habitats associated with demographic bottlenecks (sensu Wahle and Steneck 1991) but also those that limit populations in any way. The new definition embraces much of what Auster et al. (1997) intend by the term "sensitive habitats." We have no disagreement with Auster et al. on the most important point: that habitat concerns should be part of management considerations. Our differences center on the way management deliberations about habitat might best proceed. Science should be used to improve habitat management, not to replace the decision-making role of managers.

We see that our paper could be interpreted as suggesting a higher standard of proof if the decision tree "required" research before action could be taken. We did not intend such a requirement. Rather, we hoped to assist managers by suggesting a decision-making process that might make the bewildering diversity of information contained in nature more tractable. Our scheme of prioritizing scientific information has the goal of improving that information in the most cost-effective way.

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