Systems Thinking Applied to U.S. Federal Fisheries Management

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Systems Thinking Applied to U.S. Federal Fisheries Management

Chad J. McGuire and Bradley P. Harris

U.S. federal fisheries management offers a good example of how sets of laws and policies co-evolve with changes in our perceptions and understanding of natural system complexities. The ocean ecosystems in which federally managed fisheries take place are inherently complex and dynamic. Our understanding of these systems is nascent, but ongoing scientific research continually yields new perceptions that hopefully lead to greater understanding of the marine ecosystem. An historical view of the co-evolution of the federal fisheries management legal regime and our understanding of the marine system provides insights into how legal regimes evolve and suggest some legal structures for managing complex and dynamic systems.

The goal of this article is to provide the reader with a kind of historical case study on how fisheries law and policy evolution have brought management of the resource to a more “systems-centered” approach. In addition to this historical rendition, another goal of this article is to identify some areas of potential growth, specifically the development of legal instruments that are more adapted to systems principles. The historical portion of this article begins with the passage of the Fisheries Conservation and Management Act of 1976, 16 U.S.C. §§ 1801–1882, reviews briefly two substantial amendments, and discusses how systems principles are influencing current research on “place-based” management techniques. After this historical review, several suggestions on how legal instruments can be developed to be more in-line with systems principles are offered as ways for improving the current fisheries management regime in the United States.

Starting in 1976, the U.S. government began a process of “Americanizing” fisheries in the United States: closing off national waters to foreign fleets while encouraging the development of domestic fishing capacity. With the passage of the federal Fisheries Conservation and Management Act, the management of fisheries moved from a state-level concern to a national management regime. (Later versions of this Act are known as the Magnuson-Stevens Fisheries Conservation and Management Act. “Magnuson-Stevens” will be used hereafter.) Magnuson-Stevens established federal control over most fish species that existed in the Exclusive Economic Zone, the waters 3 to 200 miles offshore (or 9 to 200 miles offshore in western Florida and Texas), and gave fisheries management authority to the National Oceanic and Atmospheric Administration under the Department of Commerce. The 200-mile limit of jurisdiction was not based on any particular natural system consideration, meaning species of fish (especially those considered “highly migratory species”) might actively move between the 200-mile boundaries as part of their natural life cycle. Systems-based thinking was not a significant part of the decision-making process of management in these early years.

Magnuson-Stevens established a shared governance system, with eight management councils empowered to manage the fisheries in their respective geographical regions. Council members are recommended by state governors and appointed by the Secretary of Commerce. Council membership is intended to reflect the expertise and interest of the several constituent states in the ocean area over which such council is granted authority and generally includes elected officials, fishing and non-governmental organization interests, and academics. The councils make formal recommendations on fishing regulations in the form of fisheries management plans (FMPs). The Secretary of Commerce reviews each FMP submitted by councils for conformance to statutory goals, and the Secretary then either approves or denies the plan. The approval or disapproval of a plan is generally based on whether it adheres to the national standards set forth in Magnuson-Stevens, which have themselves evolved over the decades since the early enactment of the law.

Magnuson-Stevens was originally intended to build a domestic fishing capacity for economic development, and establish a scheme for managing that capacity at the federal level. The focus of fishery management in that era tilted toward distribution of the resource (who gets what) rather than focusing on sustaining the resource indefinitely. The focus on distribution stemmed from the prevailing view in the scientific community that fish populations were incapable of being exhausted by human fishing efforts. This understanding was ultimately proven inaccurate, by both observing fishery population crashes and advances in studying actual population biology of exploited fishery species and the ancillary impacts of fishing effort on the marine ecosystems.

Fishery stock crashes in the late 1980s and early 1990s led to the first system-based shift. Concern over declining landings changed the focus from exploitation of species toward concerted conservation efforts. In 1999 Congress amended Magnuson-Stevens to include systems-based requirements;
the amendments were collectively entitled the Sustainable Fisheries Act of 1996, Pub. L. No. 104-297. The goal of these amendments was to move fisheries management in a more holistic, ecosystem-based management direction. Rather than focusing on domestic capacity alone, the Sustainable Fisheries Act acknowledged the need to place a concerted effort on science as the primary source of information in making fisheries management decisions particularly, the kind of science that understood the dynamic nature in which fish live, ecosystem-based science. Calculations of stock assessment were no longer the only consideration. Now, science had to incorporate factors that attempt to understand the lifecycle of the fish species; habitat, species interactions, migrations, and other associated systems-based variables were placed as a priority in making management decisions.

The dynamic nature of the natural system creates a similar dynamic problem when trying to understand how different interactions might impact the system; counting fish is a much more “linear” approach.

In response to continued fishery population declines, Magnuson-Stevens was again amended during reauthorization in January 2007. Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, Pub. L. No. 109-479 (2007). The reauthorized act set a number of hard deadline goals, including a 10-year window in which depleted fishery stocks had to be rebuilt. Id. § 104. The reauthorization continued the mandated use of annual catch limits and accountability measures to end overfishing but also provided for widespread market-based fishery management through limited access privilege programs. Id. § 106. In addition, the reauthorization called for reducing by-catch and establishing fishery information monitoring systems, essentially establishing a science protocol that would provide better information on how components of the fishery ecosystem are interacting. Id. § 105.

Collectively, the 2007 amendments emphasize a better understanding of the natural system dynamics of target species. The amendments do this most directly by identifying as a primary goal the conservation of fishery resources through the explicit identification and protection of essential fish habitats. The focus on essential habitat takes more than just fish populations into consideration, such as the traditional use of stock assessments, by calling for the identification of spatial habitat areas that are scientifically understood to be essential in the life cycle of this target fish species. Having a goal of defining essential habitat along with a 10-year deadline for rebuilding depleted stocks, the 2007 amendments collectively move Magnuson-Stevens into a legal framework that begins to adopt systems-based management principles, moving beyond numbers of fish and attempting to understand what environmental conditions help to support those numbers.

From 1976 to the present time, the focus of federal fisheries law has evolved from a capacity building framework aimed at managing access to what is treated as an unlimited resource, to the current framework that actively attempts to conserve and sustain what is seen as a vulnerable and limited resource. The restrictive tools currently in use to support the protection of what is presumed to be a vulnerable and limited resource include the following: (1) mandated multilevel precautions (harvest levels must be set well below biologically sustainable levels); (2) a focus on reducing commercial fleet capacity through limited access privilege programs (quotas); and (3) hard industry accountability measures (overfishing this year results in reduced allocation next year). Changes in management approaches under Magnuson-Stevens to a more systems-based approach are altering the orientation of the science that is used to support these new management approaches. The science-based monitoring system will promote collection of information that can then be used to make more insightful management decisions because the science of understanding fish populations has gone beyond stock assessments to an approach that aims at understanding the complex system in which fish live. The science demonstrates that healthy fish populations are dependent on a variety of environmental factors. For example, the destruction of habitat components essential to fish survival sometimes results in a mortality rate within a population greater than the influence of fishing harvests alone. Predator/prey relationships also play an important role. Overharvest of a prey species (e.g., herring) might precipitate a crash in a well-managed predatory stock. Our improved scientific understanding of system component interactions, like knowing the health of a prey species in a target fish species is dependent upon, is a critical piece in this newer systems-based management approach to fisheries.

If we compare earlier use of science with more current forms of system-based science, the historic difficulty in implementing the science becomes apparent. When fishery management was focused mainly on stock assessment, the review of assessments was relatively linear; stock assessment analyses were (and still are) reviewed through a process that emphasizes the single variable of population estimates. In contrast, today’s systems approach requires evaluating and understanding a greater variety of information, which integrates different studies of a fish population, each looking at different components of the natural system. Studies covering different aspects of fishery life cycles must be combined and evaluated in a meaningful way to make effective fishery management decisions, such as determining whether a particular type of gear restriction is necessary for protecting habitat. The dynamic nature of the natural system...
creates a similar dynamic problem when trying to understand how different interactions might impact the system; counting fish is a much more “linear” approach.

Nevertheless, there are obstacles to adoption of a systems-based management philosophy in fisheries management. These include a high reliance on scientific study, the necessarily diverse nature of the research being conducted, and the resulting difficulty in having this research properly identified and incorporated into council management decisions. Combining information from a variety of research areas can result in what is sometimes referred to as “information cascades,” situations where the information becomes so abundant that it is difficult to make the necessary connections between the information and management decision. In such cases, more information actually can harm the decision-making process. In the worst cases, the overabundance of information can obscure or cancel out the important messages contained in scientific studies that are meant to create more objectively informed management decisions.

Integrating system analysis into legal regimes as part of new policy directions creates a few questions that must be resolved. In systems approaches to management, we want system-based information to drive policy decisions, but we do not want the dynamic nature of that information to frustrate the decision-making process. Otherwise, an information cascade can prevent the meaningful inclusion of the system-based science. Thus, legal frameworks that incorporate systems thinking must understand both the goals of system integration, while also creating structures within the legal frameworks that allow for easy implementation of system principles. The question of how to best incorporate a systems-based set of guidelines into legal frameworks is important. For example, should laws prescribe system-based approaches as a means of implementing environmental goals at the regulatory level? Or, should laws directly employ the conclusions of the science itself, without actually including the science in the language of the law or its implementation?

We offer several suggestions to aid in implementing systems analysis into fishery law and management techniques. The suggestions focus on legal mechanisms that allow the integration of systems-based science. Legal mechanisms should focus on the implementation of scientific conclusions, rather than placing scientific principles into the components of the regulatory regime itself. Legal mechanisms should support scientific review of management decisions where necessary, allowing the process of management to move forward in the face of uncertainty, but also advancing the role of system-based science where uncertainty exists. Legal mechanisms should allow for management adaptation to new systems-based scientific understandings, so that adaptive management techniques can be used to readily respond to rapid changes in our understanding of the marine environment.

The first suggestion is to provide scientific research criteria as a management decisions tool when decisions are being made under certain thresholds of uncertainty. The supported research criteria can be triggered by certain events, like the closing of an area because there is some evidence it contains an important attribute for the fishery in question (e.g., existing evidence to support an essential fish habitat designation). The research criteria could also be required where a closure is made based on temporal considerations, such as when a fishery is closed because of evidence that a particular season is critical for spawning of the fish population. The scientific research criteria can be made a statutory requirement which triggers specific scientific research when the threshold uncertainly level is met during a management action that results in limitations like the kinds described above. The goal of the criterion would be to ensure the active and purposeful engagement of scientific research to assess the validity of current fish population biology assumptions.

Marine protected areas, seasonal closures, and other geospatial designations are frequently used to achieve ecosystem-level protections. However, there is often limited scientific support for specific area designations and boundary delineations. If the law provided a more directed mechanism to enhance scientific understanding and address uncertainty, then more pointed research could be undertaken to test the assumptions associated with the uncertainty; and this would lead to improved ecosystem-based management tools.

Councils can provide recommendations for research, but do not have a mechanism for ensuring that the needed research actually gets done; there is no funding component to support such recommendations.

Management councils presently have the authority to designate areas and to limit or prohibit fishing there if evidence suggests, for example, that continued fishing would result in adverse impacts to essential fish habitat. Councils can provide recommendations for research, but they do not have a mechanism for ensuring that the needed research actually gets done; there is no funding component to support such recommendations. Legal authority for the councils to request and administer research funding (say from a National Oceanic and Atmospheric Administration budget line for that purpose) in association with dedicated research areas would allow for the gathering of important scientific information that would speak directly to ongoing management uncertainties. In addition, such research would provide important “information feedback” for the adaptive management goals outlined in the current version of Magnuson-Stevens, while also furthering our understanding of systems interactions.

The second suggestion is to begin a practice of providing for
hard sunset date provisions in the statutory framework itself directed at management tools with limited scientific support, or which may have substantial unintended consequences. In the case of the Georges Bank closures, there is clear evidence that marine protected areas can provide substantial benefits to marine ecosystems and even enhance fisheries. However, the specific knowledge about groundfish species life history and habitat requirements did not exist when those protected areas were established. Because of this lack of knowledge there was substantial uncertainty about what areas to close specifically, or what to expect from the fish after the closures were established. On the human side, there was also uncertainty about where the fishing fleet that normally fished those now closed grounds would go. A sunset date and dedicated habitat research designation for the closures (including the required funding to support the research questions) would have ensured scientific review of the management decision, provided meaningful feedback for adaptation, and would have explicitly addressed the uncertainty in the management of a dynamic system.

The two regulatory suggestions provided above are meant to offer examples of how systems-based thinking can be integrated into the legal and policy fabric of fishery management. Systems are complex things that are constantly changing; even if we were able to understand a natural system at a particular moment in time, the underlying factors that allowed for that understanding are subject to change. The approaches highlighted here offer insights into how current fishery management can continue to move in a direction of a more holistic approach to fishery management, one that embraces change as the norm.

In addition to the two recommendations identified above, several general principles should be employed to move law and policy regimes toward ecosystem-based management. Good ecosystem-based management requires decision makers to: (1) develop management boundaries that match natural boundaries of fish populations; (2) identify and maintain critical food-web connections, including predators and forage species; (3) incorporate spatial and temporal considerations into management objectives and adapt to ecosystem changes through time; and (4) keep a holistic and adaptive perspective.

These general principles are essential elements in any systems-based analysis of fish population health. Holistic knowledge, ecosystem integration, and adaptive management of the resource are all directly part of systems management. Legal structures must be developed to incorporate changes in scientific understanding about the environment. For example, what might a holistic, adaptive, integrative management regime look like under Magnuson-Stevens? We have offered a few simple suggestions.

In sum, the history of fisheries management offers a good example of the complexities of systems thinking and how these complexities are being applied to a set of laws and policies. Law can offer simple tools to further integrate systems analysis into a functional decision-making tool. The complexities involved in understanding natural systems do not necessarily require complex legal instruments or management tools to integrate natural system complexity into legal decision making. Rather, simple legal instruments can be adopted that provide a frequent and thorough reassessment of current practices and adaption to new information and lessons learned. It is important that the legal instruments not become overly complex, or create overly complex decision-making processes. Otherwise the complexities of the management process will override the science, resulting in decisions that are not based on what we actually know, or can know, about the complex system. 🌳

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**One Million Trees Project**

The Section’s “One Million Trees Project—Right Tree for the Right Place at the Right Time” public service project calls on ABA members to further the Section’s goal of planting one million trees across the United States by 2014.

As Earth Day 2012 approaches, we encourage everyone to participate in hands-on tree planting activities in their communities.

Members can also contribute to the One Million Trees Project by purchasing trees through our program partners: American Forests, Arbor Day Foundation, or The Black Bear Conservation Coalition. These organizations will plant one tree for every dollar donated, bringing the project closer to its goal. To donate, visit [www.ambar.org/EnvironTrees](http://www.ambar.org/EnvironTrees).