Incorporating Space into Fisheries Models: Comment

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The three papers in this section illustrate the exciting new research challenges associated with trying to incorporate space in a realistic manner into renewable resource models. As those who have worked with spatially explicit models are beginning to appreciate, the spatial dimension adds a degree of complexity that at times seems disproportionate. New analytical and statistical methods, new data collection and management systems, new geometric ways of depicting linkages and interaction, and new intuition are all needed to develop serious understanding of the spatial dimensions of resource problems.

Given the extra work required, it is natural to ask whether the added insight from spatial analysis is worth the effort. The author believes that the answer is yes, and for several reasons. First, resource economics lags considerably behind other complementary disciplines that adopted new paradigms depicting the distribution of biological resources as clumped or patchy and linked with dispersal mechanisms. If one selects a cutting-edge paper from leading journals in ecology or population biology, one is likely to see populations depicted with character, that is, with age-, size-, and gender-structure, and with patchy spatial distributions like those that we observe in real resource systems. In contrast, one can select virtually any paper from the renewable resource economics literature and the odds are very high that the paper will begin with a sentence like "let $X(t)$ represent biomass, assumed to be homogenous and uniformly distributed. . . ." The point is that economics has not progressed very far beyond the very simple abstractions adopted twenty years ago to gain insights into dynamic problems. At the same time, ecology has gone considerably beyond in understanding other features of real populations, including (importantly) their spatial character.

The past decade has also seen an explosion in information and data gathering and processing capabilities, all aimed at the provision of spatially detailed description of landscapes and resource systems. With remote sensing, GIS, spatial statistics, and enhanced computational power, we now have available a massive amount of information that can be used to understand the spatial nature of the biosphere's resource systems and the impact of human activities on these systems. Spatially explicit data introduce new opportunities to understand the heterogeneity of economic activity over the spatial landscape and the manner in which spatial processes are linked in bioeconomic systems. While technological advancements will make this information increasingly accessible, the key to effective use will be the development of new conceptual models that incorporate spatial character and the development and application of spatial econometric methods such as those discussed in the papers of this session.

A final reason why it is important to take space into explicit account in renewable resource analysis is that some policy problems simply cannot be analyzed without such a perspective. A good example is the recent flurry of interest in systems of marine reserves. Marine reserves are areas of coastal habitat that are set aside and are protected from consumptive activities such as fishing. While there are only a small number currently in existence, there has been a groundswell of interest among marine ecologists and other scientists for sizeable systems, on the order of 20–30% of all coastal habitat. In response to the arguments of influential marine ecologists, President Clinton recently endorsed the notion of marine reserves for the United States, and directed appropriate agencies to begin planning and implementing reserves as an integral part of U.S. coastal management. As yet, it is not clear exactly how such set-aside areas would affect

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either coastal ecosystems or the range of services provided to various user groups. What is clear, however, is that one cannot begin to analyze such policies without models that capture the spatial heterogeneity of marine populations, the various oceanographic and other processes that link populations, and the manner in which user groups consume marine resources over space.

Given the justifications for increased attention by resource economists to spatial analysis, it is especially exciting to see analysis of the kind discussed in these three papers. The Curtis-Hicks paper examines the impact of a recent spatial closure ordered to protect sea turtles from incidental take in the Hawaiian longline fishery. There are several innovative features of the modeling approach applied in this paper. First, the behavioral model attempts to predict choice behavior in a fishery with considerable flexibility, including targeted species, fishing technology, and location. Results presented here emphasize the location part of the decision, and location choice is assumed to depend upon expected revenues at each site and the variance of those expected revenues, among other variables. While the methods for computing expected revenues are not discussed in detail, it is apparent that the authors use a spatial autoregressive estimation scheme, an approach that is not commonly used in resource economics. Another interesting feature of the modeling approach is the depiction of a site's attraction as composed of its own expected revenues plus distance weighted expected revenues of adjacent sites. This gets at the notion that fishermen might plan trips around larger areas, making decisions about exactly where to fish after arriving and gathering new information on site.

The Mistianen-Strand paper uses a data set on spatial site choices made by New England and Gulf longline fishermen targeting swordfish and tuna. They, like Curtis-Hicks, are interested in the welfare implications of closing particular sites. The Mistainen-Strand analysis also relies on a considerable amount of computation over the sampled data to derive proxies for expected net revenues and the variance of revenues. They use these computations in a discrete choice model by postulating a quadratic utility function to represent risk preferences. The novel feature of this paper is the use of Train's random parameters logit specification, which allows the quadratic coefficient to vary randomly over the sample instead of being assumed fixed for the representative individual. This paper is thus properly considered to be an investigation of risk preferences that uses spatial choices to infer preferences, rather than a paper intended to forecast policy impacts per se. At the same time, the paper points to the potential importance of both preference heterogeneity and risk preferences to assessing the welfare implications of eliminating a choice in a site choice setting.

The Smith paper takes an in-depth look at some important methodological issues associated with trying to analyze fishermen's discrete spatial choice behavior that is postulated to depend upon expectations of revenues. The issues raised in this paper are germane to the approaches in the Curtis-Hicks paper, the Mistianen-Strand paper, and the handful of other papers that examine fishing site choice. Smith makes the point that the computation of expected revenues (and variance) is fundamentally complicated by the fact that individual fishermen's beliefs are unobservable. As analysts, econometricians can observe individual and fishery-wide data, but the issue is: how do data observable to the analyst coincide with beliefs used by decision makers in making site choices? Smith raises this question within the context of real fisheries, in which decision makers are making repeated spatial choices with both "public" and "private" information, and for which old information decays as biological and environmental information change and as new information is gathered. He concludes that the specification problem is similar to that faced when trying to analyze the implications of quality change in recreational fishing, and that we are essentially reduced to ad hoc specifications.

All in all, these papers just scratch the surface of what promises to be an interesting and an important new line of inquiry, namely, the manner in which fishing effort distributes over space and time. With new tracking technology, it is now possible to monitor virtually every movement of fishing vessels so that data can be collected on nearly continuous spatial and temporal scales. This has several policy implications. First, it will allow a much more fine-tuned set of policy instruments that take account of the patchiness of real resource distribution. Second, it will make possible networks of multiple use areas, some of which may include no-take reserves of either a permanent or a rotating nature.

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Third, it will present the possibility to craft a whole new array of policies with spatial character, such as area-specific limited entry programs, area-specific transferable quotas, and area-based cooperatives. These kinds of policies are new to the policy arena and their potential impacts have not yet been clearly spelled out. The modeling approaches illustrated and discussed in this session are among the first to undertake the behavioral modeling that is necessary to predict impacts and to evaluate the usefulness of these new options.

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