

Measuring the response of recreational fisheries to management strategies in the United States: the role of creel surveys

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Abstract

A fishery can be defined as a complex of interactions among environment, fish stocks, and man. Appropriate fisheries management demands understanding the interactions among these components. The creel survey is the sampling method by which information on the interaction of anglers with fish stocks is collected. Traditionally, creel surveys are the only way to obtain estimates of fishing pressure, catch and catch per unit effort (cpue); cpue is used as an index of stock density and as a measure of angling success. For development of optimum yield management strategies, creel surveys focus not only on measurement of biological responses of fish stocks to fishing pressure, but additionally on the socio-cultural, economic and fish consumption responses of people using the stocks. Creel surveys can be used routinely to provide the biological and human dimension data necessary for development of appropriate site-specific management plans.

Introduction

This paper provides a perspective on recreational fishery management in the United States, with special reference to the role of

creel surveys. A recreational fishery might be defined as a complex of interactions among environment, fish stocks, and man that provides recreation and food acquisition opportunities. Management is a planned manipulation of a fishery as per defined objectives to increase benefits to people. When fisheries are managed, they respond in certain ways. To measure response, variables must be identified and a pertinent question becomes 'Which variables should be measured to evaluate attainment of management objectives?' To properly evaluate management response, it is necessary to measure the specified variables both before, and after, the management action.

A management scenario

I will address the subject of measuring fishery response by stepping through a management scenario. Assume that we have sampled a freshwater reservoir fishery and this is our current assessment: (1) We are working on an oligotrophic to mesotrophic lake, i.e., not a highly productive system; (2) there is a major predator that is

the primary target species of anglers—this would be the largemouth bass in the south-eastern United States; (3) there are only one or two main prey species, also sought by anglers; (4) the limited productivity restricts the surplus production of larger individuals, so there is a limit to how many larger largemouth bass (greater than 30 cm) the system can support; (5) the stock density of the major predator is high for fish less than 30 cm because of a 30 cm minimum length limit—even limited spawning success is enough to ‘stockpile’ individuals just below the minimum length limit; (6) large individuals of the main prey species are rare because of high mortality of young prey inflicted by smaller predators—a few prey fishes escape being eaten and grow up to be large, desirable sport fish; and (7) fishing success is poor for both the major predator and the main prey species and anglers are dissatisfied.

Specification of management objectives

Based on the assessment itemized above, the general management goal would be to improve fishing success for both the predator and the prey species, which means increasing the stock densities of the larger individuals. The specific management objectives would be to: (1) encourage the harvest of the smaller predators (20 to 30 cm) to thin high stock density—this will increase the growth rate of these fish so that they reach harvestable sizes, and also will reduce predatory pressure on the prey species; (2) protect the larger predators over some length range in order to build the stock density—in this case we might want to promote catch and release fishing over this protected range; and (3) allow

harvest of memorable-sized predators to satisfy anglers.

Choice of management strategy

These management objectives might be satisfied by implementation of a slot length limit. A slot length limit protects individuals within the length slot, but both smaller and larger individuals can be harvested. For example, a 30 to 35 cm slot length limit would protect predators between 30 and 35 cm, but individuals below 30 cm (high density portion of the stock) could be removed, and larger individuals greater than 35 cm (memorable-sized fish) also could be taken home. The slot length limit is an example of the resurgence in the United States of customized length limits to control angling pressure on certain size classes of exploited stocks and to try to manipulate the populations to function in a more productive way.

Expected fishery response to management

If the 30–35 cm slot length limit were implemented, what changes would we expect to see? Over the short term, we would expect an increased harvest of smaller predators between 20 and 30 cm—we would be encouraging people to take home these smaller fish, thus inflicting higher mortality on the high density portion of the predator stock. We would expect no harvest of predators between 30 and 35 cm—this is evidence that people are adhering to the restriction. This situation provides an opportunity to promote catch-and-release fishing to maintain angler satisfaction even though fish of protected lengths cannot be taken home.

Over the long term, we expect to see stabilization of the harvest of the smaller predators, and continued catch and release of protected individuals. We expect decreased abundance and increased growth rates of predators between 20 and 30 cm, and increased harvest of memorable-sized predators greater than 35 cm. Ultimately, we would like to see shifts in the length structures of both predator and prey stocks toward larger proportions of larger individuals—we desire to create new size structures for the predator and prey populations that will allow more productive stock dynamics leading to increased harvests by man.

Definition of response variables

Given our expectations concerning changes due to the management plan, what variables should be measured to determine if our objectives have been met? Fishery independent surveys can provide measures of stock density, length structure, and growth for key species. Based on the proposed slot length limit, we are particularly concerned with abundance and growth within three length groups of the predator population, i.e. fish between 20 and 30 cm, fish between 30 and 35 cm, and fish greater than 35 cm. The creel survey will provide estimates of catch-and-release rates, harvest rates, and total harvests for target stocks within the three length groups.

If we refer back to our definition of management, a logical question is, 'Which response variables really measure the benefits derived by the anglers?' We might answer that the number and sizes of fish harvested are measures of benefits to people; however, these variables relate more directly to the biological status of the stocks and the fishing pressure on the stocks,

rather than to the response of anglers to fishing. Numbers and sizes of fish are traditional maximum sustained yield (MSY) management end points and provide a very limited assessment of the human, or societal, response to management.

To adequately measure human response to fishery management requires definition of response variables that measure benefits to people. In a larger context, it would be desirable to have a standardized information framework for evaluating multiple yields from management strategies. In a conceptual sense, we need an empirical structure for moving from MSY to OSY, or optimum sustainable yield.

An information framework for application of OSY

To move toward the concept of OSY, I have established four social accounts that, in essence, categorize the kinds of information that should be collected to adequately assess fishery response to management (Malvestuto 1989). These four accounts are ecosystem value, human health value, economic value and socio-cultural value (Figure 1). The ecosystem value account concerns the health or integrity of the ecosystem. The human health value account measures the dietary and medicinal benefits associated with the harvest and consumption of fish or other aquatic organisms. The economic value account determines users' willingness to pay for recreational fishing, and the socio-cultural value account identifies benefits derived through resource use that cannot be valued conveniently using money. The idea is that concurrent consideration of all four accounts will provide an information framework for application of OSY.

Figure 2 depicts relationships that describe the interplay between the value of the ecosystem account and the values of the other three accounts. The x-axis represents use, with zero use at the origin. Increasing levels of use can be viewed as increasing levels of man-induced stress—the more use, the more stress, or pressure, the ecosystem must sustain. The vertical axes represent the yields from the ecosystem. As indicated, there are several yields. The straight line relation with the negative slope represents yield measured as the intrinsic value of the ecosystem. The ecosystem has value in, and of, itself, based on its health or integrity. The maximum intrinsic ecosystem value occurs when the ecosystem is in a pristine state, before it has been subjected to use by man. For the fish community, this would represent the equilibrium state in the absence of fishing pressure. As the negatively sloping line indicates, intrinsic value begins to decrease as the ecosystem begins to be used—man changes the ecosystem relative to its no-use equilibrium, and the ecosystem begins to degrade. The more pressure man applies, the more the ecosystem degrades, and the more the value of the ecosystem account declines.

On the other hand, when man begins to use the ecosystem, the health, economic and socio-cultural benefits to people begin to increase. It is visualized that these extrinsic values would peak as people continued to use the ecosystem—the maximum point on the parabolic curve in Figure 2 is represented by MEY (maximum extrinsic yield). Beyond this point of use, however, extrinsic values would fall as stress on the ecosystem continued to increase. As the intrinsic value of the ecosystem falls because of excessive use, the capacity of the resource to support extrinsic benefits to people also

declines. The circled intersection of the two curves represents the point of maximum extrinsic value at minimum devaluation of the ecosystem. Conceptually, this point might represent OSY.

To determine the status of the four accounts, it is necessary to measure each one in some manner. These response variables would provide a measure of the yields from these accounts. The intrinsic yield from the ecosystem account is more a measure of the health or integrity of the ecosystem, rather than a measure of something that people are taking away, or deriving from, the ecosystem. Thus, standard indicators of environmental health, such as biodiversity, water quantity and quality, habitat critical for reproduction and feeding, etc. are relevant here. Our traditional fish population assessment techniques fall into this account and most of the statistics that we traditionally measure from creel surveys, e.g. length frequency distributions, catch rates, species composition in the harvest, really describe how the fish populations are functioning, more than how people are benefiting from the resource. Fishing effort, measured through a creel survey, becomes a component of use measured on the x-axis of Figure 2—an ecosystem approach ultimately would require that the x-axis incorporate all types of commercial, residential and recreational use.

The human health account measures benefits from consumption of organisms harvested from the ecosystem, most notably fish. In a less direct manner, this account concerns human health benefits related to the provision of medicinal products from the ecosystem; however, this probably becomes a basic issue of protection of biodiversity for maximization of the potential to

derive useful medicines in the future. The more immediate purpose of this account is to measure benefits attributable to consumption of fish by anglers. At a very crude level, this might only entail determining if anglers perceive harvested fish to be important to family meals or family health (an importance ranking). At a more formal level, estimation of *per capita* consumption rates would be warranted, and at an even more sophisticated level, the dietary contribution of fish might be quantitatively assessed (e.g. in situations where other forms of high quality food are limited so that fish consumption is critical for good health).

The economic account measures benefits in monetary terms (dollars). In a general sense, we want to determine people's willingness to pay to use the ecosystem. Minimally, this would include willingness to pay for the opportunity to fish at a particular site, trip expenditures, and investments in durable equipment. For subsistence anglers, economic benefits might also include dollars saved on food bills because of consistent use of the resource.

The socio-cultural account includes characterization of angler groups, employment opportunities offered by the fishery, family benefits, community benefits, personal satisfactions, and attitudes and opinions of anglers. Angler groups can be characterized in terms of basic demographic descriptors (place of residence, sex, age, race, income), as well as by angling behaviour (facilities used, fishing location, fishing technique, reasons for fishing, and species sought). Personal satisfaction can be ranked in several areas, e.g. condition of the ecosystem, adequacy of facilities, fishing success.

It is possible to collect information representing all four accounts using a well

designed creel survey. Only through interaction with users can measures of human health, economic values and socio-cultural values be derived. Only through purposeful and integrated measurement of all four accounts can we move toward more optimum assessment and management of recreational fisheries.

Reference

- Malvestuto, S.P. (1989). Sociological perspectives on large river management: a framework for the application of optimum yield, pp. 589-599. In D.P. Dodge, editor. Proceedings of the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

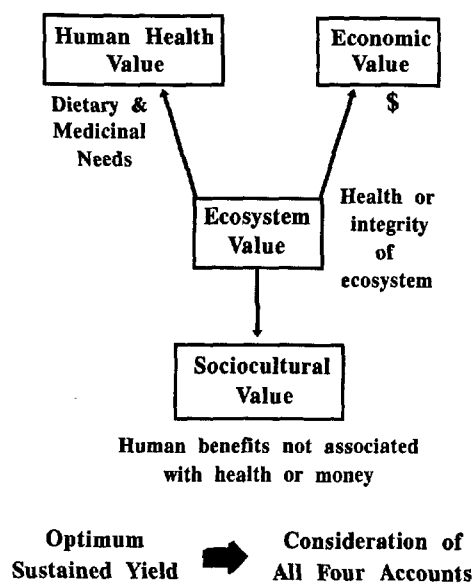


Figure 1. Definition of four social accounts for information acquisition. Integrated consideration of all four accounts is the basis for specification of optimum sustained yield for any given recreational fishery.

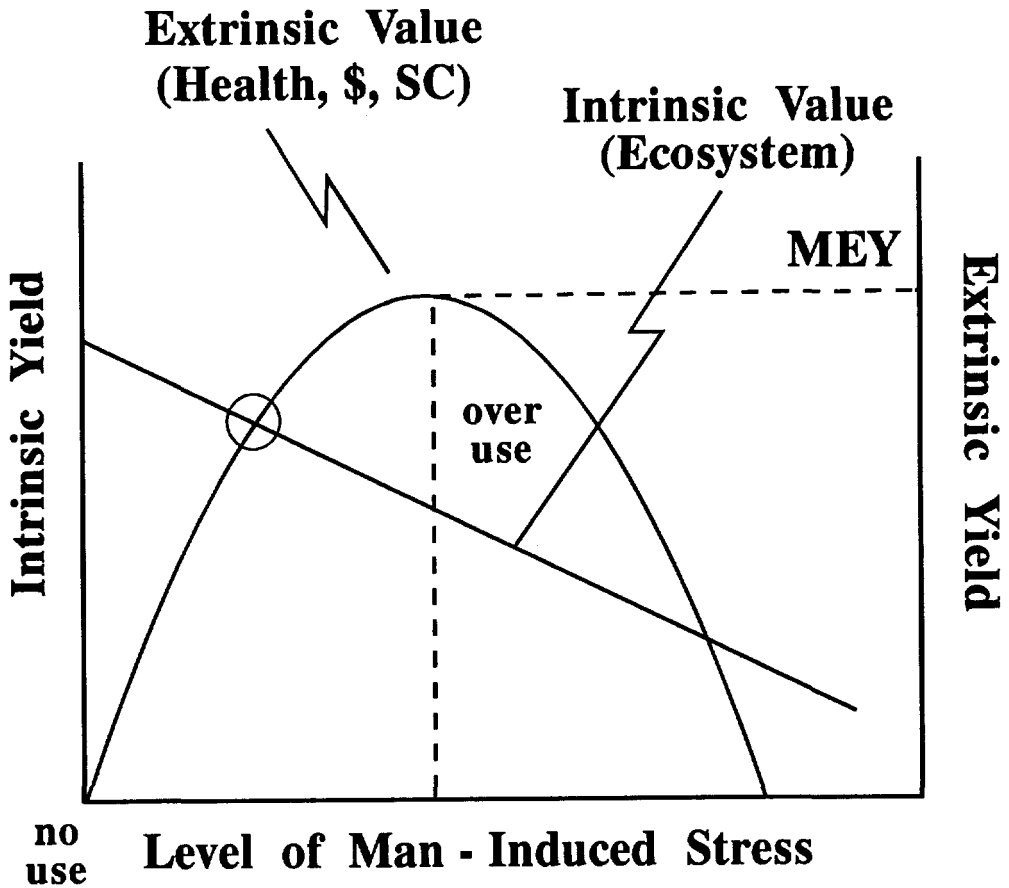


Figure 2. Conceptual relationships between human use of an ecosystem and social yields. Social yields are classified as either intrinsic (ecosystem value) or extrinsic (human health, economic and sociocultural values). Circled intersection represents logical OSY point where extrinsic yield is maximised relative to loss in intrinsic yield.