PERSPECTIVES ON BASS LENGTH LIMITS AND RESERVOIR FISHERY MANAGEMENT

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Effective management of large reservoir fisheries is one of the most important challenges in North American recreational fishery management today. By effective fishery management I mean successfully directing a program toward the goal of optimum yield, rather than maximum yield (Anderson 1975; Roedel 1975). Key measurable objectives in management plans should define: (1) satisfactory water quality and fish habitats; (2) satisfactory fish population structure and dynamics; and (3) satisfactory fishing quality as perceived by anglers.

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The potential for enhancing the recreational and commercial fishery benefits provided by impoundments is great. But how many reservoirs in North America today have effective fishery management plans in operation? Planning is unnecessary if objectives are not well defined; planning is difficult if models are weak or information is inadequate. However, progress is being made in determining the best approaches toward collecting the most important information on which to base management decisions. How can the key factors of habitat and water quality best be measured? What is the best index of productivity? What are the best methods of stock assessment? What are the best indices of the structure and dynamics of populations, fish communities, and ecosystems? How can the benefits provided by effective management best be evaluated? How can the cost effectiveness of programs be assessed? These are key questions; appropriate answers will shape the future direction and effectiveness of fishery management.

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Reservoirs can provide a multiplicity of benefits for society, including good fishing. Many factors and practices must be considered when management plans are being developed. A key question is, under what conditions should regulations be part of a management plan? If regulations are needed, what regulations will be likely to meet management objectives and achieve satisfactory yields and benefits, including fishing quality, on a sustained basis? Sometimes, regulations are being established for the wrong reasons: (1) to see what will happen; (2) because of political pressure; or (3) because that is what someone else is doing.

THE RANGE OF MANAGEMENT OBJECTIVES

Suppose that I am a travel agent and that I can organize a fishing trip for you to a secluded southern reservoir of a few thousand acres that is about 20 years old. (Please read slowly through the description of this reservoir. After each paragraph conjure a model of structure, dynamics, and fishing.)

It is a storage reservoir with a retention time of about 6 months, a mean depth of 20 feet, total alkalinity of 70 ppm, and a morphoedaphic index of 2.3. It has clear water and below average productivity. Aquatic plants are rather abundant in some coves. My uncle, who owns the lake, has a manufacturing plant that sometimes releases heated water into the lake.

The lake contains over 20 kinds of fish. Sport fish are primarily largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and black crappie (*Pomoxis nigromaculatus*). Other centrarchids, as well as percids, cyprinids, ictalurids, a clupeid, and some other fishes, are represented.

Estimated fish community biomass is about 175 pounds per acre.

My uncle is very fussy and allows only a few people to fish. All fish caught must be released.

The fish community is structured and functioning well. Many of the bluegills and crappies are large; maximum weights are over 1 and 2 pounds, respectively. Large Cladocera are usually common in zooplankton samples.

The lake is supporting about all the pounds of largemouth bass that can be fed. The standing crop of bass is at carrying capacity and has averaged more than 20 pounds per acre for longer than 10 years. Recruitment is sufficient to replace natural mortality. Proportional Stock Density (PSD), estimated by electrofishing every month for a year recently was about 60; Relative Stock Density of fish 16 inches long and longer (RSD-16) was about 20. The Relative Weight (*Wr*) of young bass—those about 10 inches long—is near 100. These bass grow rapidly. In large bass the average *Wr* declines to about 80 or 90.

Fishing has been pretty good over the years. Average catch rate for bass for 12 months recently was more than four fish per hour (Martin 1980). The PSD of fish caught by angling was about 90, and the RSD-16 was 65. Occasionally two bass weighing more than 5 pounds each have been caught on successive casts. Interested?

If you aren't interested in this lake, I might plan a trip for you to a public reservoir of similar size and productivity. I'm not sure how good fishing will be; some years are better than others—but you can probably keep all the fish you catch and take them home. There are no size limits and bag limits are liberal. Crappies bite rather well in the spring. Bluegills are small and few people fish for them. You may have to fish from 5 to 20 hours to catch a bass. Recruitment has been low in the last few years. Bass PSD has gone up and down like a Yo-Yo for the last 20 years. If you catch a bass of good size, its *Wr* will be well over 100; the smaller bass are lean and scrappy. When fishing is good, lots of people fish there. When it isn't so good, you can have the lake almost to yourself. By the way, the lake is stocked every year with threadfin shad (*Dorosoma petenense*) and striped bass (*Morone saxatilis*); walleyes (*Stizostedion vitreum*) were stocked a few years ago.

If you were getting this pitch from a travel agent, which trip would you choose? How much would you be willing to pay for each trip? Bass anglers in Texas willingly paid a $200 fine to fish once in a cooling water reservoir that was closed to fishing (P. Durocher, personal communication).

Reservoirs that provide these two options exist. The first reservoir is unique and the only reservoir I know of with limited fishing. The second reservoir might be considered average for large public reservoirs. The two examples represent the extremes of a management continuum ranging from limited entry, catch-and-release only, to unlimited entry, keep all you want.

I believe the first lake represents the structure and dynamics characteristic of the balance of nature. Fish community structure over time is relatively stable. I believe the average public reservoir reflects the structure and dynamics of an ecosystem where largemouth bass are usually at less than 50% of their carrying capacity.

What management objectives should be set for these two lakes? What would you predict would happen if my uncle were to sell the lake to the state and it were managed with unlimited entry and statewide regulations? How fast would structure and dynamics and fishing quality change? The decline in quality is often rapid when new lakes are opened to fishing. A dramatic change was documented when Mid Lake in Wisconsin was opened to fishing after being closed for 20 years (Goede and Coble 1981). What would happen if the state opened the lake to unlimited entry but allowed only catch-and-release fishing? What might be the best number and sizes to harvest each year to achieve optimum yield? What would happen if regulations were imposed to protect bass from harvest during periods of high vulnerability or to protect some proportion of the fish of quality size? What if the daily bag were limited to no more than 2 pounds plus one fish? After you answer these questions, consider what would happen to fish community structure and dynamics, and fishing success and effort in the second lake if the following restrictions on bass were enforced: (1) a 14-inch minimum size limit except that two fish shorter than 14 inches could be kept; or (2, 3, and 4) a minimum size limit of 15, 18, or 20 inches; or (5) a minimum size limit of 13 inches combined with a protected range of 16–19 inches; or (6 and 7) a slot length limit of 13–18 or 14–20 inches, or (8) catch-and-release only. It won't be too long before we will be able to predict the effect of each of these measures. I expect the best results might be achieved by a high minimum size limit followed by a conservative slot length limit if or when bass recruitment is adequate.

DEFINITION OF PROBLEMS

Population Structure and Dynamics

A critical phase of any planning process is the identification of problems and the recognition of opportunities. In large reservoirs, gizzard shad (*Dorosoma cepedianum*) often comprise 50% or more of the fish biomass as measured in cove rotenone samples. Gizzard shad populations often have unfavorable structural characteristics such as low PSD and *Wr*. Annual production of young gizzard shad is often low, and boom and bust population dynamics are evident. Graphs of available prey per predator suggest a deficiency of prey for small predators and a surplus of prey for large predators. Populations of bluegills or crappies often show characteristics of structural imbalance and unfavorable dynamics such as low PSD or *Wr*. Low bass recruitment is recognized as a problem in many large reservoirs.

The way some biologists have perceived reservoir problems over the last 30 years might be likened to a group of blind veterinarians examining a sick elephant or to a mechanic who changes fouled spark plugs every 100 miles when in fact the automobile is not functioning properly because of broken piston rings. Their prescriptions or treatments have often been wanting.

"Too many gizzard shad. Let's selectively treat to kill shad." Such projects have successfully killed many pounds of shad and at times produced a short-term gain in bass harvest. A boom in gizzard shad reproduction has often followed. Few or no long-term benefits such as improved fish population or community structure and fishing have been reported. Acute toxicity is clearly not the solution to a problem of too many shad, unless the kill is 100%.

"The problem is not enough food for small fish. Let's stock threadfin shad." How many times has stocking threadfin shad solved problems of unfavorable fish population and community structure and dynamics? Not many cases have been reported. I believe there is a role for threadfin shad in management plans, but routine stocking of prey does not solve serious problems of fish community structure and dynamics.

"There aren't enough predators. Let's stock some." The likely choice could be striped bass, walleye, or tiger muskellunge (*Esox lucius* × *E. masquinongy*). There is no question that these predators can be great sport fish, can play important roles in management plans, and benefit fishing. However, they seem to do best under rather specific water quality and environmental conditions. In a few reservoirs in Kansas, Nebraska, and Texas, it has been suspected that too many predators—particularly striped bass—can cause problems. In some food habit studies, striped bass have been observed to feed on sizes of gizzard shad often eaten by largemouth bass, white bass (*Morone chrysops*), and crappies; the question of competition can be raised but is difficult to answer. In general, there is a great need for much more research and better evaluation of the results of stocking additional game fish.

"Crappie fishermen are keeping too many small bass. Let's set a 12-inch size limit on bass." The cases of year class failures, low recruitment, and depleted stocks are common for largemouth bass in many large reservoirs. Protecting young bass may promote survival and recruitment to a quality size, particularly when the stocks of bass are low. Hooking mortality for bass released immediately appears to be low. With such a regulation, bass catch rate and fishing success should increase. However, how much gain in bass stocks might be expected by such protection, when many anglers already release bass less than 12 inches long whether or not there is a minimum size limit? The sizes of bass that are protected often exhibit relatively low *Wr* in large reservoirs. This fact and unfavorable ratios of available prey to predators often suggest a shortage of available prey. Will food resources be adequate for satisfactory growth and survival if a strong year class is produced? How much can a 12-inch minimum size limit be expected to change bass population structure and dynamics and bass fishing, if bass populations are below 50% of their carrying capacity?

"We need more and larger bass. Let's put on a slot length limit of 12–15 inches." The application of a length limit to protect certain bass of quality size appears to have been successful in improving bass population structure in some ponds and small impoundments. In other waters, no improvements were observed because anglers failed to reduce the surplus of bass shorter than the protected range. Sometimes anglers and bass populations seem to respond almost as though a 15-inch minimum size limit was in effect. In waters where bass growth rate is satisfactory, a protected range of 3 inches may provide protection of 12-inch fish for only about 1 year. If angler compliance is inadequate and fish of a protected size are "shrunk" or "stretched," a 12- to 15-inch slot may not provide adequate protection to rebuild depleted stocks. If adult gizzard shad 8 or 9 inches long are abundant, bass large enough to feed on these shad and put on high annual weight gains are not protected.

"A key problem is low annual recruitment of largemouth bass to a stock size of 8 inches long. Let's establish a high minimum size limit or a wide protected size range." My logic and calculations based on data from Beaver Reservoir in Arkansas led to the conclusion that if recruitment to age II was as low as six bass per acre per year, a minimum size limit of 18 inches would be needed to maintain bass standing crop at a biomass of 26 pounds per acre, and provide satisfactory bass fishing (Anderson 1974).

In many reservoirs smallmouth bass (*Micropterus dolomieui*) or spotted bass (*Micropterus punctulatus*) comprise an important part of the bass fishery. Because largemouth bass have the capacity to grow faster and longer than smallmouth or spotted bass, a high minimum size limit provides relatively more protection to the smaller species. A wide protected size range such as 13 to 18 inches should provide relatively more protection to largemouth bass.

Is there any possibility or probability that if depleted bass stocks are increased by a factor of three to six, annual recruitment will be enhanced? Most studies of largemouth bass population dynamics have concluded that there is no relationship between the density of adults and the production of young of the year. It has been shown that water levels can influence the number of young bass. However, more recent analyses suggest that numbers of young bass in midsummer may not correlate with the number at age I a year later. Survival to the second summer appears to be related to food and feeding conditions and the number of young with satisfactory growth and condition. How can food and feeding conditions be improved for young bass in large reservoirs?

Research has not shown any relation between the structure and dynamics of gizzard shad and bluegill populations and largemouth bass biomass in large reservoirs. However, I suggest that if data were available for an adequate period of time and included periods with adequate bass biomass, a negative relationship would be expected between biomass of gizzard shad and bluegills and biomass of largemouth bass. Adequate predation should reduce the density and biomass of populations of prey and improve their structure and dynamics. A good bluegill population should have a PSD of from 20 to 60 and have a *Wr* of over 95 for the first half of the growing season in order to have extended and frequent spawning. Young bluegills in midsummer should be an important food for young bass. For gizzard shad, data are indicating that females must be in good condition in order to exhibit high fecundity. This may increase the probability of high density of young and slow growth rates of those young such that some can be used as prey by young largemouth bass. These bass should have a high probability of survival and recruitment. My expectation is that adequate bass biomass is important in order to sustain satisfactory structure and dynamics of reservoir fish populations and communities. Such ecological relations need to be tested in order to build the scientific foundation of fishery management.

Yield and Socioeconomic Benefits

The harvest and effort statistics for reservoirs over a span of years illustrate how dynamic these systems can be. In contrast to commercial fishery statistics, harvest as a function of effort for recreational reservoir fisheries has been shown to be positive and linear. It has been extrapolated that all that is needed to harvest more pounds of fish is to have more angling effort. However, in recreational fisheries, demand is often a function of supply. It is difficult to increase angling effort if anglers conclude that fishing success does not make the effort worthwhile. Fishermen may be like good football players—when the going gets tough, the tough get going. Only fishermen may get going somewhere else or not as often.

New reservoirs have a history of producing good fish and good fishing. This is explained in part by short-term high productivity resulting from flooding terrestrial organic material and an expanding system. However, if lack of productivity is a problem in older reservoirs, why is there a positive relation between biomass of shad populations and reservoir age?

When maximum harvest is the goal for a reservoir fishery, the best management plan might be to drain the reservoir. If the reservoir can't be drained, all fish caught should be kept so that the numbers and pounds can be counted. Catch-and-release fishing should be discouraged. When the stocks of exploitable fish are high and vulnerable, this renewable resource should be mined. The populations will not become extinct. Fishing opportunities will remain, barring an environmental catastrophe. There will be some years of high yield and angling effort that will naturally be followed by years of tough going until good year classes again enter the fishery. Such dynamics do not provide economic stability for any enterprises associated with recreational fishing. Turnover in ownership or leases may be high when the lean years outnumber the fat years, or when several lean years occur in succession. I strongly suspect that a goal of maximum yield will not achieve harvests, fishing success, fishing effort, or economic benefits on a sustained basis as well as a goal of optimum yield.

CONCLUSION

I am not a travel agent but I am trying to sell something. I am trying to sell the idea that we need much more reservoir research and management evaluation. I am trying to give a perspective of how I view some of the problems of structure and dynamics of reservoir fish populations and communities and aquatic ecosystems. What I am trying to sell is the idea that fishery researchers, managers, and administrators should stand back from the elephant or the automobile and look at the whole system. Are there density-dependent mechanisms operating that help make fish populations in large reservoirs tick? I am trying to sell the concept that overharvest is removal of more than the surplus relative to management objectives. I am trying to sell the idea that, for recreational fisheries, the number and size of fish removed is not as important as the number and size of fish left to satisfy angler demand next week, next month, and next year. I am trying to sell the idea that regulations can go part of the way toward solving problems and effectively manipulating densities, structure, and dynamics over the long term. We need to maintain the health and well being of these systems that are so valuable, and which must work better in the future to satisfy the increasing demand for recreational fishing. I am trying to sell the idea that we must manage to maintain a satisfactory quality of fishing if public expectations are to be served. We need to analyze angler values and expectations, and probably manage waters in a way that will ensure that those expectations are met on 50% or more of angling trips.

A recent national survey provided some interesting insight into the values of local club members affiliated with Bass Anglers Sportsmens Society (Bryan 1983). The respondents indicated that they would accept a moderate reduction in number of bass caught per trip from a weighted average of 5.5 to 3.5, but that they would be less likely to accept a reduction in the 13.6-inch average length of fish caught. They would like to see fewer, larger bass instead of more, smaller bass. More than 90% of these avid anglers would accept minimum size limits, a reduction in bag limits, and catch-and-release fishing on selected waters.

We won't be building many more new large reservoirs. We must better manage the warmwater habitat we have. If the 18,259,000 anglers 16 years of age and older reported in the 1980 survey (U.S. Fish and Wildlife Service 1982) who fished for bass on 333 million trips, each caught 3.5 bass averaging slightly over 1 pound, the total catch would amount to about 40 pounds of bass from each acre of warmwater fish habitat in the nation (not including the Great Lakes). Well-managed, productive lakes do not often have the capacity for a sustained bass harvest of more than 20 pounds per acre per year. If you add the young anglers under 16 who like to catch bass too, it becomes increasingly obvious that many of the bass caught will need to be released to be caught again if good fishing is to be sustained. Effective management plans with a goal of optimum yield will be needed. The role of regulations should be to maintain a satisfactory quality of fishing or to make fishing better.

ACKNOWLEDGMENTS

I thank Robert Martin of the Sport Fishing Institute for his comments and many stimulating discussions on fishery management. The perspectives and ideas presented in this paper would not have been possible without the extensive data collection and research coordination provided by the National Reservoir Research Program and many other biologists and graduate students. This is a contribution from Missouri Cooperative Fishery Research Unit (jointly sponsored by the U.S. Fish and Wildlife Service; Missouri Department of Conservation; and School of Forestry, Fisheries and Wildlife, University of Missouri).

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