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Current Status and Future Directions for Research in the Ecology, .Conservation, and Management of Black Bass in North America

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Introduction

Twenty-five years is a relatively long time spanwhen one considers the changes that have taken place between 1975 and 2000, then this time span becomes a significant boundary between two very different periods of science and resource management. Developments in computer technology and molecular biology have driven substantial changes in many different areas of science, leading to entirely new fields since the publication of the first black bass symposium (Clepper 1975). The conceptual basis of ecology is more broadly based and rigorous and is now seen to cover scales ranging from the behavior of individuals to landscape processes. Resource management has become more complex, and the need for multi-use considerations in developing and resolving policy issues at local and regional scales has never been greater. With all of this in mind, we believed that marking the 25th anniversary of the publication of the first black bass symposium was a way to acknowledge these changes and a way to look to the future of black bass ecology, conservation, and management. This was our goal in organizing the Black Bass 2000 Symposium in St. Louis. Here, we offer our thoughts and observations on its outcome.

The topics covered in the first black bass symposium in Tulsa, Oklahoma in 1975 provide an insight into what were important issues at that time (Clepper 1975). The publication stemming from that symposium represented the first compilation of species ecology for the black basses. It was also the first serious contact between what historically have been the two general approaches toward black bass biology and management that have persisted for more than 50 years: one approach views bass in a production systems context, while the other approach views bass in the context of population and community ecology. This dichotomy will be discussed in more detail below. Other areas covered in 1975 include various topics related to stocking, including the Florida largemouth bass debate, tournaments, genetics, water level fluctuations, habitat, and the ecology of bass in reservoirs, rivers, and lakes. Along with the original Black Bass "Green Book", there was a supplement published as a booklet entitled "Bass Management Practices". It was based on the question-and-answer period that occurred after the management session at the Tulsa symposium and reveals what people were talking about at that time. People were largely focused on the then relatively new phenomenon of bass tournaments, as well as the genetic questions concerning stocking Florida largemouth bass. It appears that there are certain enduring themes in black bass ecology, conservation, and management that have persisted over the years and serve to define long-term bass fisheries issues in North America.

The Black Bass 2000 Symposium in St. Louis highlighted and continued to address these traditional themes, but also highlighted many new themes as well. The uncertainty surrounding the effects of tournaments 25 years ago has given way to using these data for addressing ecological and management issues. Molecular genetic studies of bass provided a phylogenetic summary of this group of fish and have documented new species within the genus *Micropterus.* Stocking questions have become more sharply defined and now incorporate spatially-driven concerns related to stocking success.

Two areas that appear to have grown in research effort over the last 25 years are habitat use

and recruitment ecology. In this symposium, a number of contributions focused on bass habitat use in lakes, rivers, and reservoirs, reflecting the rise of habitat issues in fisheries science in general. The two life stages that received the greatest attention on habitat use were reproductive adults and age-O fish.

In many ways, bass are the ideal subjects for research into recruitment ecology. Adult bass move inshore to spawn, and offspring remain close to their nest sites for many days allowing for accurate enumeration. Calcified tissues provide good age and growth data. Various sampling techniques are efficient at catching different life stages, and an almost ubiquitous fishery exists that can be monitored and used for acquiring population level data. In this symposium, a number of contributions focused on recruitment ecology and the general interaction between biotic and abiotic factors that contribute to bass growth and production. The factors at the community and ecosystem levels that contribute to bass population dynamics are recognized by a number of contributions. Despite all the advantages that bass provide for research into recruitment ecology, one senses that the full potential of these species to contribute to the larger literature on fish recruitment mechanisms has not been fully realized. Many contributions in this symposium and elsewhere indicate that, in fact, recruitment ecology will be an expanding area of focus.

New conservation themes are taking shape as well. Several *Micropterus* species have limited distributions, a fact that presents legitimate conservation concerns because of this distribution, species introductions, and/ or habitat loss. The fish species on the cover of this symposium volume were selected, in part, to emphasize this issue, as well as to point out that there are new species that need to be recognized and managed with new approaches needed to protect their genetic resources.

One new and emerging management theme centers on the issue of angling bass during their nesting period and the effects that this activity may or may not have on bass populations. In a number of locations, this theme may be eclipsing tournaments or size-based regulations as the leading management question.

Taken together, the contributions in this symposium illustrate the expanding range of research questions in fisheries science, in general, and for *Micropterus,* specifically, as well as provide insight into potential research topics that need to be addressed. Below, we offer our perspective on some general topics that were raised in discussions during the symposium, in addition to topics covered in this volume. We end with a listing of potential research topics for the future.

The Economics of Black Bass

Recreational fishing is one part of the larger economy of communities and regions. Local governments, angling groups, and the fishing industry, broadly defined, emphasize expenditures by anglers as a means of demonstrating both their commitment to and influence in resource management. While this is true for recreational fisheries that target all species, it is difficult to think of one that, in economic scale, exceeds the fishery targeting bass. Nationally-recognized bass tournaments and their organizations represent large medial corporate interests that, in turn, recognize these activities as both a spectator and participant sport for marketing purposes. Bass anglers enjoy the goods and services that flow from this relationship. Local governments and resource management agencies appear to be fully aware of this economic scale and use the support generated from this fishery for many activities that contribute to the conservation and sustainability of all recreational fisheries. Many local communities also benefit from the conservation activities of dedicated anglers and angler groups.

A cautionary point follows from this perspective. The economic scale of the bass fishery could lead to unforeseen tension with anglers interested in other fisheries, within segments of the bass fishery itself (e.g., tournament versus nontournament anglers), as well with segments of society interested in other kinds of recreational activity. Even with the best of intentions, interests can be narrowly expressed in ways that heighten multi-use conflicts. Either informally or in question-and-answer periods during the symposium, a number of administrators and fishery managers spoke of concerns over multi-use issues resulting from conflicting demands placed upon natural resources. Demands placed on limited agency budgets and local limitations on the availability of fishable waters are both, basically, competitions for limited resources. Broadly defining interests may be a way of achieving a reconciliation of many of these multi-use issues.

Ecological Approaches to Black Bass

As previously mentioned, there appear to be two traditional approaches towards black bass biology

and management. We realize that this kind of generalization runs the risk of revealing exceptions to the rule, but we believe that the pattern is present, and we leave to the reader the interpretation of whether or not this reflects an accurate representation. We offer representative citations that help to anchor the historical context of each traditional approach, recognizing that the body of research in each one is more complex and detailed than the caricature we present. We believe, however, that the process of reconciling these two traditional approaches is underway, and this process is represented in this volume, particularly by the contributions focusing on recruitment ecology.

Bass in a Production Systems Context

One traditional approach to black bass biology and management follows an agricultural model by viewing bass populations as an output from biotic interactions in simple fish communities that can be highly controlled and manipulated. A representative citation for historical context is Homer Swingle's concept of a balanced fish community (Swingle 1950), where the size structure of prey and predator are tightly linked. Prey size and availability and management regulations that attempt to shift predator size structure for the purpose of strengthening this linkage are important considerations in this approach. Generally, the productive limits of such a system and the ability of a management agency to manipulate size structure via regulations combine to define angler success.

Bass in a Natural Systems Context

Another traditional approach to black bass biology and management follows a population/community ecology model that focuses on year-class production in complex systems with highly stochastic properties. Representative citations for historical context come from Fred Fry and Ken Watt's research into year-class production of smallmouth bass in the Lake Huron area (Fry and Watt 1957; Watt 1959). In this approach, abiotic factors such as spring and summer temperatures are important components affecting year-class size through survival of young fish. Indeed, a time series of year-class measures reveals the effect of this stochastic element on bass populations. Management agencies cannot control this pattern of year-class production. Because the ultimate arbiter of production, the weather, can vary significantly from one year to the next, regulations aimed at manipulating size structure of bass appear fruitless. Risk-averse measures to sustain the fishery seem reasonable under these conditions.

We believe that these two traditional approaches have led to different strategies for bass management. When bass are viewed as a tightly linked production system, shifting the size structure of bass to more desirable distributions seems possible, and fishery management is appraised on this deliverable. When bass are viewed as a natural population in a stochastic system, size frequency distributions of bass literally change with the weather, and fishery management is appraised on precautionary approaches. In one respect, the two views may reflect the scale of the relevant ecosystems under management consideration. In ponds and small impoundments, bass production may be more predictable than in large lake and river systems that are often subject to stochastic change. In another respect, the two views may, instead, reflect the magnitude of fishing effort targeted towards bass. Bass fisheries in ponds and small impoundments generally occur in areas with very high fishing effort and relatively few fishable waters (on a per capita basis) compared with the fisheries in large lake and river systems. The size of aquatic ecosystems and the intensity of the fishing effort on them can combine to produce different yields and to provide different risks of fishery declines (Shuter et a11998; Post et al. 2002). A 'one size fits all' approach is not suitable for bass management across North America because of differences in growing seasons, size of aquatic ecosystems, and fishing intensity. What constitutes a desirable size distribution of bass in some systems may simply be unattainable or unpredictable in other systems for a number of reasons.

The Policy Conundrums

A number of contributions in this volume specifically address two areas of difficult policy choices ahead. Resolving these conundrums will require addressing additional future research in one case (angling nesting bass) and hard choices in the other (species introductions).

Angling Nesting Bass

There is a fairly widespread belief that there is no relationship between spawner abundance and recruitment for *Micropterus* species. Regulations that permit the harvest or disruption of a spawning stock must rest on this assumption because the alternative, essentially indifference as to whether or not such a relationship exists at all, is unpalatable as a policy choice. Reports in this volume, however, document the disruption of the spawning

stock when nesting males are targeted. Because we lack any clear understanding of the nature of the spawner abundance and recruitment relationship in *Micropterus* species, the population level consequences of this activity remain unclear. Is optimizing yield per recruit, therefore, sufficient for managing bass fisheries? We offer both a quote and a wager as a means of motivating research interest in this area. In their review of stock and recruitment models in fisheries assessment, Hilborn and Walters (1992) offer a general observation:

> As techniques for measuring spawning stock size and recruitment have improved and as stocks have been exploited harder, a significant relationship between spawning stock size and recruitment has emerged for a wide variety of species. Any fisheries manager who acts as if recruitment will remain constant as a fishery increases is foolish (p. 242).

We are willing to offer one bottle of high-quality single malt scotch to any research group that tests whether or not a spawner abundance and recruitment relationship exists for any species in the genus *Micropterus* and shows unequivocally that it does not. Tackling this topic correctly will require improved estimates of spawning stock size, as well as the implementation of management experiments that manipulate the size of the bass spawning stock. We hope our friendly wager serves as adequate stimulus for these experiments.

Effects of Species Introductions

There is little question that the introduction of bass into new waters leads to a reduction in the abundance of small bodied fish species and, in many cases, their local extirpation. Ecologists refer to this 'reduction/removal' phenomenon following the introduction of fish predators as homogenization of a fish fauna (RaheI2000). Repetitive patterns in fish communities develop as a consequence of a loss of species diversity. In addition to changes in community composition, there are also changes in trophic structure of food webs that accompany this process. This issue seems to be understood conceptually by most fisheries scientists and managers, yet many management agencies continue to promote introductions of non-native predators (especially black bass) into their waters. Site-by-site changes in fish communities can appear insignificant, but because these introductions occur over a landscape, they are not. This issue is a significant policy conundrum for state, provincial, and federal agencies, in large part because of their combined responsibility for managing species at risk, on one hand, and for providing fishing opportunities, on the other. Hard choices lay ahead, and new ways of resource planning, such as approaches that emphasize watershed-level strategies, for both species conservation and recreational fishing may be part of a solution. In today's society, however, the question remains whether or not a solution is a priority. The economics of bass may supercede its ecology in this issue. An interesting twist in this issue is provided by the presence of largemouth bass virus. It appears to have arisen from a group of viruses associated with aquarium fish imported from southeast Asia and may be spread through stocking efforts.

Future Directions

There are several key areas in black bass ecology, conservation, and management that we feel are in need of more research effort. Below, we offer a list of some of research questions to illustrate them, but acknowledge that readers may have their own items to add to the list we present.

1. Is recruitment overfishing occurring in recreational bass fisheries either by the targeting of spawning/nesting adults or by a level of exploitation that reduces the spawning stock as part of an overall population reduction? The summaries of research in recruitment ecology in this volume highlight the relevance of this question (and takes us back to our wager).
2. How many individuals in a population contribute to a year-class? It is often stated that 'it only takes a few bass to repopulate a lake.' Unfortunately, there are no data to either support or refute that claim. The new molecular genetic tools available can and should be used to address this key issue. The answer may have broad implications in fisheries science.
3. At what life history stage does density-dependent mortality occur? Evidence from this volume and elsewhere is pointing towards the juvenile stage as a key point in population regulation in bass. The generality of this observation is uncertain and the processes by which density-dependent mortality occurs and associated habitats where this takes place are all open questions. The bulk of research on mortality in bass has focused on the mechanisms lead

ing to variation in body size of age-O fish and the implications this has for first year survival. Is this fhe point of regulation in bass populations, or does this occur at later life history stages?

4. How and why are bass populations responding to different size-based regulations (Le., we repeat the call from Wilde [1997] for research in this area)? The plasticity of the centrarchid life history (e.g., age-at-maturation and growth rates) can combine to have great impacts on population size structures. How the social structure of a population shapes its size structure and how angling impacts this are clearly areas that need research.
5. What policy changes and regulatory mechanisms are needed to resolve multiuse issues? Natural resources and natural spaces are not limitless and the demands placed on these provide constant challenges for resource managers. How will they be resolved in the case of bass fisheries and the demands of other user groups? What experiences do different agencies have ~n confronting this topic?
6. Are bass populations open or closed? In a closed population, birth and death rates govern population persistence. In an open population, emigration and immigration add to these processes in population persistence. This has largely been a question focusing on marine fish ecology, but in aquatic systems that are large and/ or where bass undertake significant seasonal movements in watersheds, the possibility that subpopulations exist with exchanges of individuals is one that would provide a rich set of research questions.
7. Does the trophic position of bass change in response to such factors as fish community composition or productivity gradients? The application of stable isotope analysis in fish ecology promises to reveal new relationships among species. Using this approach to address trophic structure of fish communities in lake, river, and reservoir ecosystems will likely change some of our preconceived notions about fish communities containing different *Micropterus* species. Stable isotope analysis in ecology always seems to provide surprising insights.
8. What is the conservation status of the rare bass species? As reflected in the pages of this symposium volume, much of the focus of bass research and approaches toward bass management focus on two species, largemouth and smallmouth bass. Other species of bass have limited ranges, use specific habitats, and have a different array of threats. Until we know substantially more about their ecology, we will not be able to devise truly productive strategies for their management and conservation.
9. What is the extent of life history variation within and among species of *Micropterus?* Much of life history theory, the body of work that describes age, growth, survival and reproductive output, can now be understood' from basic ideas of the trade-off between allocation of energy for growth versus reproduction. One of the most cited articles we came across was by Beamesderfer and North (1995), which represents the largest compilation of life history for smallmouth and largemouth bass. Similar databases are needed for all species of bass, and these should be referenced based on populations and not political or broad regional boundaries.
10. What impact will global climate change have on bass populations? Abiotic factors have long been known to playa role in year class formation and recruitment in bass. With changes in warming rates and climatic variability, large areas of the *Micropterus* range are anticipated to experience substantial weather changes. We need data to help predict those changes and anticipate the management approaches that will be needed to deal with them.
11. What are the true costs and benefits of stocking bass? Although it may be difficult for agencies to recognize this need, the effectiveness of stocking programs often goes unexamined. The spatial approach adopted in some contributions in this volume should be combined with specific stocking projects to test a number of hypotheses concerning juvenile bass ecology, including recruitment and the success of stocking programs. Stocking could be used to manipulate recruitment independently of spawner abundance as a possible approach towards understanding spawner abundance and recruitment relationships.

We hope this symposium volume will provide the impetus to push ahead on relevant research

questions on bass. Our strong recommendation is that we not allow another 25 years to pass before we gather again to compare our results.

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