

The Muskellunge Symposium: A Memorial Tribute to E.J. Crossman

Developments in environmental biology of fishes 26

Series Editor

DAVID L.G. NOAKES

The Muskellunge Symposium: A Memorial Tribute to E.J. Crossman

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The Muskellunge Symposium: A Memorial Tribute to E.J. Crossman

Editors

James S. Diana, University of Michigan, Ann Arbor, MI USA
Terry L. Margenau, Wisconsin Department of Natural Resources Spooner, WI, USA

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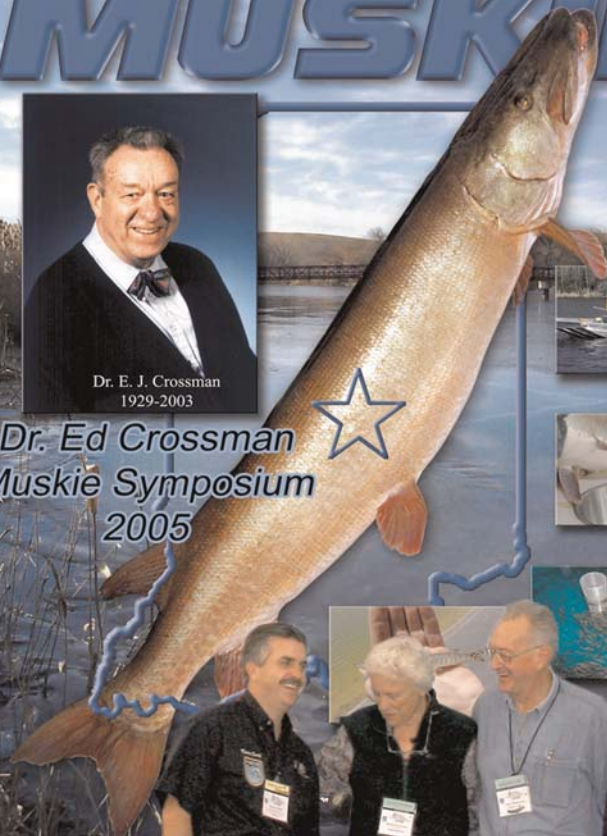
October 2005

MUSKIE



Dr. E. J. Crossman
1929-2003

Dr. Ed Crossman
Muskie Symposium
2005



Preface

This book represents the outcome of a symposium held in Indianapolis, Indiana on 28–30 October 2005. The symposium was an international program on the ecology and management of muskellunge and was held in memory of Dr. Edwin J. Crossman. The symposium structure was largely similar to the original International Musky Symposium, held in LaCrosse, Wisconsin in 1984. It was intended to bring together academic researchers, management biologists, and practical musky anglers into a common venue to review the current status of knowledge on muskellunge and their management.

The symposium was dedicated to the memory of Edwin J. Crossman. Dr. Crossman passed away on 21 December 2003, at the age of 74. While 74 is an advanced age for many people, Ed's passing occurred far too young. He was retired from the University of Toronto and the Royal Ontario Museum, but still an active researcher in fish systematics and muskellunge ecology. Dr. Crossman was influential in developing the knowledge of muskellunge we have today and encouraging many people to follow in his footsteps in the studies of muskellunge and their relatives.

The concept of a second musky symposium began with conversations between members of Muskies, Inc. and the Esocid Technical Committee (ETC) of the American Fisheries Society. As plans progressed, Steve Pallo of the ETC and Scott Law of Muskies, Inc. collaborated to set dates, determine a venue, and procure support for the symposium. As plans developed, we were enlisted to develop the presentations and ultimately edit the manuscripts. The intent of the symposium was to present current information on the ecology and management of muskellunge to the angling public, and at the same time, use the interests and desires of anglers to further educate the research and management community. While we are probably biased in this regard, the symposium was a great success at accomplishing this goal.

We had intentions to both include oral presentations and develop a published proceeding of high quality, as a tribute to the strong outreach skills and excellent scientific integrity of E. J. Crossman. In the hope of rapid publication, we requested manuscripts within one month of the symposium and contracted with *Environmental Biology of Fishes* for co-publication in an issue of the journal, as well as in a book. Not all papers presented at the symposium were published in the journal—some due to choices by the authors; others because of previous publication. In this book, all abstracts from papers presented but not published are also included.

The review process for manuscripts was of highest quality. Jim Diana served as the special editor of the contributions, while Terry Margenau, Dave Wahl, and Jerry Younk served as the editorial team. We appreciate the contributions of the many professionals who reviewed manuscripts for this proceeding. David Noakes, the editor for *Environmental Biology of Fishes*, made final decisions on acceptance of the manuscripts, as well as final editorial suggestions. We thank all of the people involved for their hard work in bringing these proceedings to fruition.

This symposium would not have occurred without the generous support and efforts of many organizations and individuals. Primary sponsorship was provided by Muskies, Inc., Gander Mountain, and the Hoosier Muskie Hunters Chapter of Muskies, Inc. These primary sponsors subsidized both the meeting itself and the publication of this book. Secondary sponsorship came from many musky clubs from around the United States, Muskies Canada and various chapters within Muskies, Inc. The Hoosier Muskie Hunters provided tremendous logistic support, as well as continual interest in the symposium. We have never been at a professional meeting where everyone attended all of the sessions before this symposium, which indicates the strong interests of musky anglers in the science and methods important for the management of this unique fish. The interest in this subject was also demonstrated by the state agencies involved, since they provide the time and travel costs of their employees that attended.

Muskellunge are unique fish in several ways, and to many people they represent a lasting symbol of the wild nature of our northern woods. They have always been rare in inland fish communities, with typical densities less than 0.5 fish per hectare. They grow to large sizes that are unique among fish species in small inland lakes, and as such, are an important predator that is a keystone species of northern lakes, controlling prey types and sizes by their predation on large fish. They are an important game fish in the region, but even more important as a symbol of the magnificence of nature. They have been introduced to numerous reservoirs outside of their native range to provide trophy fishing opportunities, and are also an important component of the fish community and fishery in the Laurentian Great Lakes. The reintroduction of muskellunge throughout their original range is an important part of the current management practices for many states and provinces.

Ed Crossman spent his life studying and promoting his “noble muskellunge.” He was instrumental in the lives of virtually all of the authors in this volume, either by his important publications in the field or by his personal interactions. His critical but helpful review of our work, his continual drive for excellence, and his friendly and outgoing demeanor produced an excellent role model for all of us. He is missed by those who knew him well. We hope this volume does justice to his memory, and we believe he would be pleased to see the future of his fish highlighted in this book and emphasized in the work of so many scientists and managers.

James S. Diana and Terry L. Margenau

Preface

The Muskies, Inc. Perspective

The International Musky Symposium began as vision for Muskies, Inc., Chapter 42 (Hoosier Muskie Hunters) to plan, host and financially support an event that would gather scientists, researchers, professional musky anglers and musky enthusiasts at one venue to mutually share their working knowledge and experiences as a way to “Build for the Future.” The symposium would follow the fall Board of Directors meeting of Muskies, Inc. (MI) and therefore provide the International Board of Directors and MI chapter and regional vice presidents an opportunity to attend the event. This diverse group of highly educated musky managers, professionals and anglers would review current research projects and poster presentations as well as participate in workshops and panel discussions. This vision became a reality on the weekend of October 28–30, 2005 in Indianapolis, Indiana.

How could an individual chapter of a fishing organization plan for such an event that would gather the fishing public as well as fishery biologists and researchers from around the U.S. and Canada to Indianapolis? We started by contacting our own organization of MI and research directors Steve Budnik and Ron Mazur, who pointed us in the right direction and kept us moving forward. They suggested contacting the American Fisheries Society (AFS) for the technical part of the program.

AFS, through the Esocid Technical Committee (ETC), became the point of contact to help find individuals needed to fill the technical program. The original contact was through Steve Pallo, from the Illinois Department of Natural Resources (DNR), who was chair of the ETC at the time. Steve quickly recruited Terry Margenau from Wisconsin DNR and Jim Diana from University of Michigan to round out the symposium technical committee. These men contributed their time and efforts to ensure the success of the symposium. The symposium committee placed a “call for papers” in *Fisheries*, an AFS publication. The symposium technical program quickly filled as papers were sent to the committee for review and approval. Additionally, the committee asked Jack Wingate to share the success stories from fisheries management in Minnesota concerning the stocking program, fish size limits and genetics. Bill James, Chief of Fisheries – Indiana Department of Fish and Wildlife, enthusiastically committed to present the Indiana DNR strategy of developing its muskellunge fisheries.

Since the goal of the symposium included professional anglers, we contacted Jim Saric at *Musky Hunter* and Pete Mania at *Esox Angler* magazines to help fill the anglers’ program. These editors have contacts with musky fishing guides from across the U.S. and Canada who write fishing articles for their publications. The time spent on the water by these professional anglers lends itself to practical insight into daily, weekly and seasonal fishing patterns that interest musky anglers. Rob Kim from *Esox Angler*, as well as Jim Saric and Steve Heiting from *Musky Hunter* provided angling perspectives critical to researchers and managers making prudent decisions concerning fisheries. Larry Ramsell, MI historian, reviewed musky catch records, and Russ Wayre, author and educator, completed the anglers program by reviewing top angling waters in the U.S. and Canada.

Muskies, Inc., Gander Mountain and The Hoosier Muskie Hunters underwrote the symposium as primary sponsors. The individual chapters of MI, various individuals and Muskies Canada also contributed financial support to the symposium. Pete Barber and Jim Beaty of MI helped find sponsors for the event. Gary Dew, president of the Shawnee chapter of MI, developed a raffle for a new Triton boat, embossed with a special MI decal and logo. Ken Karbon from MI auctioned items at the Saturday evening banquet. Proceeds from the boat raffle and auction supported the symposium. Scott Unison, past president of Hoosier Muskie Hunters, served as symposium treasurer.

During the three-day symposium, Kenton Smith, the symposium program chairman, and his talented volunteer staff (Fred Boso, Bob Briney, Chris Craig, Paul Cruse, John Fawcett, Eric Flemming, Ken Irwin, Charlie Johnson, Kathy Lee, Jason Ronnebohm, John Routt, Jeremy Sivis, and John Unison) coordinated 14 general sessions, 18 workshops, poster presentations, a panel discussion, all meals and coffee breaks and a special presentation by Mrs. Margaret Crossman. Thanks also to Steve Worrall and his staff at *Muskies First* for documenting the event with photography and video.

A special thanks to Vance Bell and Tony Gray, Hoosier Muskie Hunters presidents, for their commitment to the symposium in the wake of an already busy calendar. Thanks also to Muskies Canada and their President, Rob Howitt, for attending the event. Finally, I appreciate the MI International Presidents, Greg Wells and Dave Cates, who unswervingly supported the vision of the symposium. Their personal commitment to the event guaranteed it would become a reality.

At a planning meeting for the 1984 International Musky Symposium, Gil Hamm, founder of MI, expressed these insightful words: “These are the things Muskies, Inc. needs to be associated with if we have any hope of good sport fishing in the future.” Gil’s comments are true today. This book is dedicated to those individuals whose vision is to “Build for the Future.”

Thank you to my wife, Lisa, and our sons, Josh and Tyler, for allowing me to serve as the chairman of the Dr. Ed Crossman International Musky Symposium. Certainly our boys will be the next generation of anglers to experience all nature has to offer, especially musky fishing.

Scott Law

Sponsors

Building for the Future

Dr. E.J. Crossman Muskie Symposium

October 28–30, 2005

Chapters:

- 01 – Twin Cities Chapter
- 02 – Fargo-Moorhead Chapter
- 03 – Chicagoland Chapter
- 05 – Pomme de Terre Chapter
- 06 – First Wisconsin Chapter
- 07 – South Side Muskie Hawks Chapter
- 08 – Capital City Chapter
- 09 – West Virginia Chapter
- 11 – Mississippi Valley Chapter
- 12 – Headwaters Chapter
- 13 – Hayward Lakes Chapter
- 14 – South of Border Chapter
- 15 – Star of the North Chapter
- 16 – Three Rivers Chapter
- 17 – Quad County Hawg Hunters Chapter
- 20 – Between the Lakes Chapter
- 21 – North Metro Chapter
- 22 – New Jersey Chapter
- 24 – Brainerd Lakes Chapter
- 27 – Central Illinois Chapter
- 28 – Shawnee Muskie Hunters Chapter
- 29 – Upper Great Plains Chapter
- 30 – God’s Country Chapter
- 32 – Flatlanders Chapter
- 35 – Milwaukee Chapter
- 36 – St. Cloud Chapter
- 39 – Fox River Valley Chapter
- 41 – Central Ohio Chapter
- 42 – Hoosier Muskie Hunters Chapter
- 44 – Colorado Chapter
- 45 – Kentucky Chapter
- 46 – Bemidji – Cass Lake Chapter
- 47 – Michigan Muskie Alliance Chapter
- 49 – Webster Lake Musky Club Chapter
- 52 – Daniel Boone Chapter

Corporations:

1. Gander Mountain, Muskies, Inc.

Others:

1. WI Muskie Alliance, PMTT

Individuals:

1. Greg & Ellen Wells, Danny Kurtilla, Jim & Carla Beaty, Jim Stella, Ken & Betty Karbon

Panel discussion

Panel members

Steve Budnick, *Muskies, Inc.*

John Casselman, *Queen's University*

James Diana, *University of Michigan*

Bill James, *Indiana Department of Natural Resources*

Rob Kim, *Esox Angler Magazine*

Larry Ramsell, *Musky Historian*

Jim Saric, *Musky Hunter Magazine*

Tim Simonson, *Wisconsin Department of Natural Resources*

Jim Smith, *Muskie Magazine*

Moderator: Steve Heiting, *Musky Hunter Magazine* Panel

Summarizers: Terry Margenau, *Wisconsin Department of Natural Resources*

Steve Heiting, *Musky Hunter Magazine*

A diverse group of muskellunge “experts” was assembled during the muskellunge symposium to discuss topics central to the management of muskellunge. The panel represented management biologists, university researchers, and musky angler groups. Collectively, the panel of nine brought over two hundred years of muskellunge management, research, and angling experience to the table. The group’s objective was to offer their perspectives on topics discussed during the symposium, in addition to touching on several current topics in muskellunge management. Among the items discussed were the importance of partnerships in management of muskellunge, tournaments, genetics and growth potential, aspects of live release, and of course, the world record muskellunge.

Partnerships. A theme that provided the genesis for the symposium in Indianapolis was communication. Communication between management agencies and musky anglers has long been recognized as a critical component for successful muskellunge management. The business of natural resource management incorporates both biology and sociology, and has to be a shared responsibility between management agencies and the public. The success that the state of Indiana has had in development of a successful muskellunge program serves as a good example of what can be achieved when the two facets work together. Meeting, talking, and working together have resulted in stocked fish, education, and financial assistance to research programs. The end result was going from 2 to about 20 lakes with muskellunge, and a program less than 15 years old has already produced fish over 40 pounds.

Musky anglers and their associated clubs have traditionally offered financial support to government agencies for muskellunge research and management efforts. However, as budget constraints continue, program cutbacks increase. The concept of a musky stamp to generate revenue for muskellunge programs has been considered for some time. Anglers wishing to catch and potentially harvest a muskellunge would be required to purchase a musky stamp in addition to their regular fishing license. Earmarking funds has some potential benefits. One obvious benefit would be the creation of a specific account where monies are used for a specific purpose. A good example would be an inland trout stamp, used by many government agencies to generate funds for trout stream improvement that would likely not otherwise be available. A musky stamp could also provide a communication link to anglers not associated with an organized club, and in essence bring in another group of people who want to catch muskellunge. This link would alert all musky anglers that there is something very specific going on between the professionals and the anglers that is making a difference. However, creation of a musky stamp may mean loss of general funds available for

muskellunge management and make muskellunge programs dependent on the revenue generated from a stamp, which is an unknown amount. In addition, the incidental catch of muskellunge by general anglers (not possessing a musky stamp) creates a potential problem. Would these anglers be expected to have purchased a musky stamp with the assumption that they may catch a legal length muskellunge while fishing for panfish or walleye? Regardless, the musky stamp concept warrants consideration as a potential source of funding as we move into the future of muskellunge management.

Muskellunge Tournaments Tournament fishing has been a current and somewhat contentious topic among the musky fraternity and other user groups. Are musky tournaments good, bad, or ugly?

Tournaments, by definition, can range from a club outing with 10 anglers on the water with the stakes being a round of drinks, to having 150 boats on the water fishing for \$25,000. Tournaments are about competition – some people like to compete, some people don't. Certainly, fishing tournaments focus a lot of attention on a group of anglers. This can provide either a positive or negative image of those involved, depending on how the tournament is conducted, and thus perceived by other user groups and the local community. One consensus among tournament anglers and organizers is that the fish is the number one priority. This includes handling the fish properly (time out of water, time held for measurement) and that tournaments do not exert too much pressure on any given water body. Many tournaments have taken steps to lower stress and improve post-release survival of muskellunge.

Judge boats are often used in tournaments to measure fish. One particular tournament series in Minnesota has been using digital cameras in combination with judge boats to measure fish. However, while tournament organizers are concerned about the fish, they are also concerned about the fishermen, not only making sure their time is safe, but making them believe that the event is fair and on a level playing field. From an organizational perspective, competitors in a tournament have to feel that no cheating has occurred.

Tournaments can also offer considerable financial benefits. For many clubs, a tournament is their major fundraiser. Tournaments have the potential to bring economic benefit to area communities. Some surveys indicate that an estimated \$ 1,000 per team is brought into the local community from the tournament. A large tournament with 150 teams can insert an estimated 150,000 into the community.

Tournament angling has become a popular sport for many species (bass and walleye, as well as muskellunge) and is likely here to stay. Participating in tournaments is a personal preference, and tournaments are certainly not for everyone. Tournament anglers, organizers, management agencies, other user groups, and communities all need to work together to ensure the resource is protected and that tournaments become a positive experience for all involved.

Trophy Muskellunge: How to get them and how to keep them Muskellunge are managed as a trophy species. However, the definition of trophy is relative. The definition varies from person to person and likely changes for each person as that individual gains experience in musky angling – wanting to catch more and bigger fish. For someone new to the sport, or a casual angler, a 35-inch muskellunge is a trophy. However, for more experienced/serious musky anglers the magic number seems to be 50 inches.

There has been considerable debate regarding how to produce trophy muskellunge. Is there a superior strain of muskellunge that will grow large wherever it is stocked? Several opinions exist on how to produce trophy muskellunge. Genetics and the receiving water body are the key components for trophy production. Other important considerations include whether native stocks exist, growth and survival of stocked fish, competition with other species such as northern pike, and if rehabilitation (successful reproduction) is the management goal. Studies have shown there is no “silver bullet” strain of muskellunge that can be expected to perform everywhere. For example, Mississippi River (Leech Lake) muskellunge did not perform well in Illinois environments. In Wisconsin, where natural reproduction occurs, protecting and enhancing the existing natural populations has been a top priority. This effort includes using discretion for strains when stocking does occur, along with the protection of critical habitat.

Where no natural reproduction occurs, or outside the native range of muskellunge, the genetic background of stocked fish has less importance. Indiana has used muskellunge from a variety of sources including Pennsylvania, Wisconsin, Iowa, and Ohio. Because no native populations exist in Indiana, the “cosmopolitan” strain chosen performs well in the hatchery, performs well in the wild, grows fast, gets big,

and anglers seem to appreciate it. Where rehabilitation is the management objective, strain selection may be based on slow growth, longevity, and growth potential. Once stocked, the fish becomes a product of the body of water it is in. From this perspective, to a great extent, the body of water controls the growth potential.

Live release, or catch-and-release, is practiced by most avid musky anglers and is an integral component in the successful management of musky fisheries. Not only does the release practice help sustain trophy fisheries, the replacement value of large fish removed from a fishery (in terms of number of fish stocked required to replace that fish) puts an economic component also into the picture. Should musky fisheries be total catch-and-release? Panel participants agreed that total catch-and-release takes away the flexibility to manage a fishery. Some fisheries will never produce large fish, and likely won't be a trophy fishery. In addition, people want to catch fish – and have the option of harvesting a fish.

Length limits, if set too high, can in practice create a total catch-and-release fishery. For example, a 54-inch minimum length limit could protect a group of fish to be caught, handled, and actually die of old age, while never attaining the length limit. In contrast, using the concept of minimum ultimate length (see the article in this book by Casselman), 99% of the fish in a population would eventually reach a length that would be susceptible to harvest. Naturally concern arises on how to appropriately use the resource. Is a fish not eventually harvested a wasted resource? Muskies, Inc., an organization that was one of the founders of the live release concept, encourages the catch and release of all muskellunge. However, the organization also recognizes that to release or harvest a fish is an individual decision. It is legal to keep a fish on occasion, and fish do die.

The use of barbless hooks for musky angling has been discussed as a means to improve survival of released fish. Barbless hooks offer some potential benefits for anglers and fish, but also raise some concerns. Barbless hooks would reduce handling time as hook removal would become quicker, and conceptually less tissue damage would occur to the fish removing hooks in comparison to barbed hooks. Conversely, some anglers are wary about the effectiveness of barbless hooks. The thought of losing a muskellunge because the fish threw the hook is unacceptable to some anglers. Too many hours are invested in getting a strike to afford having a fish shake a hook while jumping. In addition, there have been some studies with other fish species that suggest barbless hooks may actually cause more tissue damage by penetrating deeper into the fish than barbed hooks. From a regulatory/enforcement standpoint, mandating barbless hooks for muskellunge might be difficult, though some areas (Manitoba) have gone entirely to using barbless hooks. Another perspective offered was that if you want to harvest fish for food you use barbed hooks, but if you want to be concerned about the fish a barbless hook is a good thing to be thinking about. No scientific research currently exists on the effects of barbed vs. barbless hooks on muskellunge. Information will be necessary in the future before management agencies and anglers can act in the best interest of the fishery.

World Record Muskellunge Discussion of the world record muskellunge can get emotional and most people have an opinion to offer. Is the current world record legitimate?¹ Will the world record ever be broken? Where will the next world record come from? Members of the panel were no exception and offered their thoughts on the topic of world record muskellunge. Feelings regarding the legitimacy of Louie Spray's current world record (69 pounds, 11 ounce) were mixed.

However, one message seemed to stand out – musky anglers and their sport have matured and evolved. Musky anglers of today are very capable of collecting data and providing accurate measurements of the fish they catch. Any muskellunge caught in this day and age that pushes the 60-pound barrier will be heavily scrutinized. Certainly the 61 pound 4-ounce muskellunge caught by Martin Williamson in 2000 serves as a modern day example. Nevertheless, the historic trophy fish are legendary things, and are part of what creates the lore and mystique of the muskellunge and musky fishing. Perhaps the time has come to let the historic fish be as they are, and move on.

For the world record to be broken, or even to register muskellunge in the 60pound category, special circumstances need to occur. The biggest and heaviest fish are going to be female fish that are full of eggs. These fish are at their heaviest during the late fall when egg development is occurring. For example, the Martin Williamson fish was caught in November, and likely had a considerable percent of its body weight

in eggs. Fall is also a time when large female fish are feeding, and a recently consumed prey item, while a legal part of the fish, will affect the fish's weight. Another important component is longevity. For a muskellunge to reach large size, 25-30 years are required for that fish to grow. That means the fish needs to live in a body of water for a long time, and likely be handled many times – handled carefully many times. Finally, the next world record will likely come from a body of water that doesn't have a lot of pressure (spatial refuge), because even though we have developed the best methods of handling muskellunge, there is still mortality. Two percent mortality may make the difference in getting fish to 25–30 years of age.

Where will the next world record come from? This question keeps all musky anglers wondering with every cast, and planning during those long winter hours. Perhaps it will be a large water body that receives low angling pressure such as Georgian Bay. Projections on growth and longevity for the St. Lawrence River have estimated that it is possible to have muskellunge weighing over 70 pounds, probably 72–73 pounds. Maybe the skull and jaws recently found and displayed at the Symposium were that of a world class muskellunge. One thing for certain – it was a big fish, and there are likely more out there.

Conclusion: Remembering the Past and Looking to the Future

The biology and science of the muskellunge, along with the knowledge of musky anglers about the fish they pursue has come a long way since the 1984 symposium held in LaCrosse, Wisconsin. The formation of partnerships between anglers and management agencies has been, and will continue to be critical to the management of this important fish. The passion, not only anglers have for muskellunge, but also that the scientists have for the fish they work with has resulted in significant progress in protecting the muskellunge resource. Important work that has been done collectively in these times of shrinking budgets and staff is an accomplishment to be proud of. Yet, there are some areas that can be improved on, and more work to be done. Certain geographic areas (e.g., Michigan) have not developed musky fisheries in their areas and have failed to recognize the potential economic benefits that come with such a program. Patience is an important attribute as we head into the future of musky angling and muskellunge management. Anglers develop patience because it can take forever to catch a musky, but we all want change – for musky fisheries to be better. Scientists develop patience, given it takes these fish time to grow, and studies don't happen overnight.

In conclusion, this symposium in Indianapolis served as a reaffirmation of the value of partnerships that musky anglers and resource management agencies enjoy, and what can happen when you dream, when you have a vision, and when you've got good people in leadership positions who step out and say, "We're going to put this together, not because it's easy, but because we need to do it, because it would be valuable." Ed Crossman would be immensely proud of what has been done at this symposium.

¹At the time of the muskellunge symposium, the World Record Muskie Alliance (WRMA) had filed a report to the National Fresh Water Fishing Hall of Fame (NFWFHF) recommending that Louie Spray's record muskellunge (69 pounds, 11 ounces) be disqualified based largely on photogrammetrical evidence. Upon review of that report, NFWFHF in January, 2006 upheld Spray's record fish having photo analysis of the fish length done with a different method (single plane/direct scaling geometry). WRMA issued a rebuttal to the decision in March 2006, but this rebuttal has not been reviewed by NFWFHF because protest protocol was not followed. Since that time (April 2006) a new record keeping group has been formed (Modern Day Muskellunge World Record Keeping Program) to maintain modern day muskellunge world records.

Abstract of posters and presentations

Muskellunge management and distribution analysis in a south east Wisconsin urban lake

Susan M. Beyler & Robert C. Anderson¹

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Synopsis

Pewaukee Lake is a shallow 2,493-acre drainage lake in heavily populated Southeast Wisconsin. Musky management began in 1967 with the introduction of 1,200 musky fingerlings. Through 1981, average annual stocking was 1,625 fingerlings. Average annual stocking from 1982 through 1997 was 3,014 fingerlings. The Pewaukee Lake musky population was evaluated by use of fyke nets and electrofishing in spring 1998. Adult musky density was estimated at 0.52 per acre, both sexes combined. Muskellunge movement and home range size were evaluated based on 40 radio-tagged individuals over a four year period (1998-2002). Both external and internal radio transmitters were attached to muskellunge collected in fyke nets, by electroshocking, and by anglers. Average home range sizes were 43 acres for male and 85 acres for female muskellunge. Home range size and musky movement were greatest during spring and fall. Mean length of the sampled population was 33 inches for males and 37 inches for females. Random, stratified creel surveys were conducted in 1982 and 1998 to assess changes in fishing pressure and angler exploitation. Musky catch rate (per hour) dropped 43 percent and harvest rate dropped 70 percent, while directed angling effort increased 135 percent. Mean length of muskies harvested increased 46 percent, from 29.7 inches in 1982, under a 30-inch minimum length limit, to 43.5 inches in 1998, under a 34-inch size limit.

Missouri's musky program, egg to angler

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Synopsis

The Missouri Department of Conservation introduced muskellunge into Missouri waters in 1966 when 51,000 small fingerlings (1.5–2.0 inches) and 1,500 large fingerlings (7.0–15.0 inches) were stocked into 7,820-acre Pomme de Terre Reservoir. The original objective of the Missouri Muskie Program was to provide anglers with a trophy fishery utilizing a predator that could prey upon large non-game fishes such as gizzard shad, carp, and various sucker species and continues to be an objective today. In 1967 and 1968, 249 large fingerlings were stocked into Lake of the Ozarks. A musky from this stocking was caught by a bass angler in 1981. This fish measured 49.5 inches, weighed 41 pounds 2 ounces and remains the current Missouri state record. From 1967 through 1975, the average stocking rate at Pomme de Terre Reservoir was one fish per 20 acres. The stocking rate increased to one fish per 5 acres from 1976 through 1982, then to one fish per three acres from 1983 through 1990. Beginning in 1995, Missouri's musky program was expanded to small lakes that met the minimum criteria for stocking musky. Currently, Lost Valley Hatchery at Warsaw, MO conducts spawning and rearing of musky for stocking in lakes Pomme de Terre, Hazel Creek, Fellows, Henry Sever, and Busch Conservation Area in Missouri.

Muskellunge population and fishery dynamics in Green River Lake, Kentucky

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Synopsis

Damming of the Green River in 1969 degraded a historic muskellunge fishery necessitating annual stockings muskellunge to reestablish and maintain a muskellunge fishery. Muskellunge population dynamics and angler use were examined to evaluate success of annual stockings of large fingerlings (> 305 mm) in establishing a quality fishery. Muskellunge recruited to the 762-mm size limit in 2.6 years. Angler catch rates for all size muskellunge averaged 16.9 hours per fish; catch rate for “keeper” sized muskellunge averaged 28.6 hours per fish. Total catch averaged 0.25 fish per hectare; mean harvest was 0.06 fish per hectare. Average size caught and released (voluntary) was 856-mm; average size harvested was 892-mm. Muskellunge angler catch and release rates averaged 43.8%. The percentage of nonresident anglers targeting muskellunge has doubled since a quality fishery was established with the large fingerling stockings. However, fishing pressure for muskellunge was nearly half to a quarter of that experienced by other muskellunge fisheries with similar characteristics.

Human influences on natural spawning and reproductive success of muskellunge

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Synopsis

Natural reproduction of muskellunge *Esox masquinongy* in northern Wisconsin is often insufficient to sustain populations in many lakes where the species is native. Presence of the congeneric northern pike *E. lucius*, poor conditions in spawning sediments, altered hydrologic regimes, and human development are all suspected as contributing to the decline in natural reproduction of muskellunge. The purpose of this study was to further describe muskellunge spawning habitat and determine physical, chemical, biological, and land use characteristics that can be used to distinguish self-sustaining muskellunge lakes from lakes where stocking is required to maintain populations.

Survival of eggs from experimental enclosures was low (< 3%) for eggs reared on sediments or woody substrates, and even for eggs suspended in the water. Poor survival was common in good and poor reproductive lakes. Young fish could be collected throughout the summer and in fall electrofishing surveys, and were far more common in good than poor reproductive lakes. Spawning habitats in good reproductive lakes had softer sediments, with higher dissolved oxygen and more organic nitrogen content, and occurred in lakes with few shoreline alterations. A multiple regression model for this relationship relating development to organic nitrogen content of spawning sediments included deadfall trees per kilometer and percent shore totally developed (adjusted $R^2 = 0.60$, $p < 0.01$). The type of human development on the shoreline, was also correlated with fitness of spawning habitats. Direction of water level change during the spawning period, percent of woody debris on the spawning habitat sediment, number of deadfall trees per kilometer of shore, and percent of shore that was totally developed were the most important variables used in classifying the level of muskellunge reproduction a lake could support. The model developed in this study correctly classified 75% of good reproductive and 89% of poor reproductive lakes. If lake managers wish to use muskellunge stocking programs to re-establish self-sustaining populations, they should critically review each candidate lake by considering the Dombeck et al. (1986) model and the model derived in this study.

A conceptual model of muskellunge spawning habitat in Georgian Bay, Ontario, Canada

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Synopsis

Georgian Bay in Lake Huron, Canada, has a potential to produce a trophy-status muskellunge fishery; however, some evidence suggests that the population is in decline, especially in areas impacted by recreational development. To assist research and management, we developed a conceptual model to predict spawning habitat of muskellunge, using meta-analysis of available peer-reviewed and technical literature.

The model incorporates three primary variables: water temperature (7.5–15°C), dissolved oxygen (> 5 mg/L) at the sediment-water interface, and adequate separation of individual eggs after deposition. The model also assumes that muskellunge spawning occurs in wetlands because of their known association with aquatic vegetation. Secondary variables influencing primary conditions include (1) depth, current and substrate colour (assumed to have an effect on temperature); (2) current, sediment oxygen demand, sediment compactness and plant density (assumed to have an effect on dissolved oxygen concentrations); and (3) particle size and plant density (assumed to have an effect on egg separation). Field data will be used to validate the model and to help clarify the relative importance of each variable, and thus allow for refinement of the model.

Spawning and post-spawning movements of the St. Lawrence River muskellunge (*Esox masquinongy*)

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Synopsis

Radiotelemetry tracking and long-term tagging studies revealed strong reproductive homing of muskellunge (*Esox masquinongy*) in the Thousand Islands region of the St. Lawrence River. Radiolocation also was useful in the identification of critical spawning and nursery habitats. From 1984 to 1989, 47 adult muskellunge were radio-tagged during the spawning season at 22 sites. Radio-tagged fish were located at least once daily during the spawning period. Capture sites of adult muskellunge and areas frequented by tagged muskellunge during the spawning period were subsequently seined to document the presence or absence of young-of-the-year (YOY) muskellunge. YOY muskellunge were collected at 13 of the 22 adult capture sites and also at an additional 14 sites frequented by radio-tagged adults. Post-spawning muskellunge generally migrated upstream to Lake Ontario, remained in the vicinity of their respective spawning site, or moved into deep water where they could not be located. Radio transmitters that functioned into the following spawning season revealed a high degree of reproductive homing. Strong muskellunge spawning site fidelity was also observed in tagging and recaptures during spring trapnetting surveys. Of 184 muskellunge tagged from 1990 to 2003 at twelve sites separated by over 35 km, 33/34(97%) were recaptured at the original tagging location. The one exception was a male muskellunge caught in an adjacent bay five years after the original tagging. Reproductive homing has important implications for management of muskellunge and their habitats.

Biological characteristics of record class muskellunge populations in Georgian Bay and the North Channel, Lake Huron

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Synopsis

The nearshore waters of eastern Georgian Bay and the North Channel of Lake Huron comprise a vast area of diverse aquatic habitat supporting numerous muskellunge populations. Since 1996 muskellunge spawning surveys using live-capture trapnets have been conducted at eight locations distributed throughout the area. Captured fish were biologically sampled and tagged to assist in establishing home ranges and recapture rates in the recreational fishery. More than 500 adult muskellunge were captured during these surveys and several dozen potential spawning locations were identified. Ripe females were captured over a wide range of temperatures (8-22°C) and over a prolonged time frame (4–6 weeks). The average size of muskellunge did not vary significantly between sites with females averaging 1174 mm (46.2 in) and males averaging 998 mm (39.3 in) in total length. The relative abundance of muskellunge varied across sampling sites, ranging from 0.11 to 1.53 fish per trapnet night. The recovery of tagged fish in subsequent years provided evidence for homing to specific spawning areas and of pair bonding. The results from these surveys have already proved beneficial in providing justification for the implementation of a record class designation for these waters (minimum size limit of 137 cm (54 inches)). In addition, the identification of sensitive spawning areas and acquisition of genetic material for establishment of population diversity, should contribute to the sustainable management of this important aquatic resource.

Biological characteristics of a riverine muskellunge population

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Synopsis

Muskellunge *Esox masquinongy ohioensis* examined to determine movement patterns and habitat preferences in Middle Island Creek, a stream in West Central West Virginia. Since 2002, over 120 muskellunge were collected with pDC- boatmounted electrofishing equipment. Individual fish were measured and inserted with PIT tags prior to release. Release locations were noted with GPS and later included into a GIS based system. Approximately 40 fish have been recaptured during subsequent electrofishing-based surveys and via anglers. Recaptured locations were noted with GPS, included in a GIS based system, and compared with initial capture locations. Movement distances varied both between sexed and size of fish. Growth patterns were also dependent on sex and to some degrees location and year of capture.

Considerations in muskellunge (*Esox masquinongy*) introductions: A management dilemma?

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Synopsis

The increasing popularity of muskellunge fishing has led to a desire by anglers and fisheries managers to expand the range of muskellunge. Often the expansions are proposed close to population centers well outside the original range of the species. Several biological and social considerations are appropriate in deciding if and where the introductions are to take place. In Wisconsin, an Environmental Assessment (EA) must be prepared for initial introductions. The EA then receives public review, with approval dependent on the results of that review. Factors considered in the review include the impact of the introduction on the

existing fish community, the availability of forage, the cost of long term management (stocking), the likelihood of successful development of a fishable population of muskellunge, the social acceptance of a muskellunge fishery and the ethical consideration of range expansion. A review of the original and current range of muskellunge will be presented.

Factors affecting historical year-class strengths of trophy muskellunge (*Esox masquinongy*) populations

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Synopsis

The longevity, relative rarity, and consequent perceived value of muskellunge (*Esox masquinongy*) have made the assessment of population characteristics through traditional fisheries methods difficult for this species. Using a subset of 1351 angler-contributed samples (mean age 10.6 years) collected by the Cleithrum Project since 1978, we are now able to quantitatively examine historical year-class strengths for 15 muskellunge populations, with emphasis on four populations in Ontario. Cleithra were interpreted for age, and proportional year-class strengths calculated for each population to account for multiple, sporadic, years of capture. Temperature, water level, size-limit changes, and the presence of northern pike were examined for correlations with year-class strength. Year-class strength histories had varying correlations with summer (Lake St. Clair: $p=0.009$, $r^2=0.36$; all Ontario populations: $p=0.044$, $r^2=0.13$) or spring (Kawartha lakes populations: $p=0.044$, $r^2=0.15$) temperatures in the first year of life, but no significant relationships were observed with the other factors. In one instance, populations from water bodies of similar characteristics had strongly similar year-class histories (Eagle Lake and Lake of the Woods, Ontario; $p=0.0016$, $r^2=0.546$). The 11 Wisconsin muskellunge populations, which only had summer air temperature examined, had p values ranging from 0.014 (Buckatabon Lake) to 0.814 (Lac Vieux Desert). We discuss the implications of these results for future muskellunge management.

Historical trends in body growth of five Ontario muskellunge (*Esox masquinongy*) populations

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Synopsis

Muskellunge (*Esox masquinongy*) management in Ontario has primarily focused on harvest control through minimum size limits, requiring information on the growth potential, responses, and variability of populations. We examined historical muskellunge body growth trends, as recorded in the cleithrum bone, from five muskellunge populations, including two populations with extended data sets (overall $n=456$). Two measures were digitally collected – an index of annual growth and cleithrum size at age eight - and linearly regressed against log-transformed mean daily summer temperatures. There were no significant correlations between temperature and annual growth ($p=0.120$ to 0.762). However, cleithrum size at age eight increased significantly over time (Lake St. Clair $p=0.026$; St. Lawrence River $p<0.0001$); mean temperature and growth over eight-year periods had a significant but weak relationship in the St. Lawrence River population ($p=0.020$; $r^2=0.055$). Analysis of a significant difference ($p=0.004$) in growth amongst five-year year-class groupings of the St. Lawrence River population showed muskellunge produced from 1975 to 1989 were 9.3% larger than those produced from 1940 to 1959. Temperature has had a significant but relatively minor direct effect on growth of muskellunge, and factors such as prey composition, behavioral thermoregulation, and handling may have overridden or compensated for temperature effects.

Development of muskellunge fisheries in Lakes Monona and Wingra, Wisconsin

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Synopsis

When dreaming of muskellunge and the lakes they inhabit, most anglers do not picture urban settings. However, in densely populated Madison, WI, Lakes Monona and Wingra have progressed to regionally renowned fisheries characterized by excellent densities of robust fish. These populations developed due to a unique combination of aggressive stocking involving the state and the public, restrictive size limits, and a rotation of sampling to periodically quantify the populations. Annual stocking of both hybrid and true muskellunge began as early as the mid-70s, with a shift to predominantly true musky in the early 90s. A stocking rate of 2 fish per acre annually led to a population of approximately 4 fish per acre by 1997, in Lake Wingra. The stocking rate was reduced in subsequent years and an updated population estimate for musky in the lake will be complete in the spring of 2005. In Lake Monona, an average stocking rate of 0.6 fish per acre annually resulted in a population of 0.49 fish per acre. The Capital City Chapter of Muskie Inc. and the Oregon Muskie Busters have made substantial financial contributions to supplement state stocking. In 2004, the minimum size limit on both lakes was raised from the statewide 34" limit to a 45" limit. We plan to use our future sampling rotation to evaluate not only musky density and size structure, but also to continue to fine tune stocking rates and watch for possible impacts on other fish populations.

Analysis of 40 years of Lake St. Clair musky fishing records

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Synopsis

The Michigan-Ontario Muskie Club (MOMC) has been the major organization representing musky anglers in the Lake St. Clair area since the 1950s. Among other activities, the club sponsored derbies or tournaments each year. Through the years, catch records were diligently maintained by club officers. These records present a historical documentation of trends in the musky population and musky fishery of Lake St. Clair over more than four decades. In this paper, we analyze MOMC catch records for trends in the context of changes in the ecology of the lake and fishing regulations. With permission from the club, we conducted a time series analysis of: 1. the single heaviest fish entered in all club events within each year 2. the ten heaviest fish entered in all club events within each year and 3. the top 250 heaviest fish entered in all club events across the time series. Our analysis revealed a consistent pattern of heavier fish in the catch since 1990. This coincides with significant ecological and regulatory changes during the 1980s. Additionally, voluntary catch and release of musky became widely practiced by Lake St. Clair musky anglers during the 1980s. We submit that the MOMC catch records provide valuable insight into the response of the Lake St. Clair musky population to ecological and regulatory changes. We encourage other fishing clubs and organizations to carefully record their catches. Similarly, we suggest that resource management agencies can glean useful data from well-maintained catch records of fishing groups when they are available.

Muskellunge movement in the Manitowish Chain, Vilas County, Wisconsin

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Synopsis

We quantified movement and spawning site fidelity of muskellunge in the Manitowish Chain of 10 interconnected lakes in Vilas County Wisconsin. We marked 314 muskellunge (16–60 fish per lake) with T-bar anchor tags and tabulated tag returns from catches in electrofishing, trap-netting, angler returns and creel surveys. During the first summer after spawning in spring 2004, 3.47% of tagged muskellunge were

recovered (0.0–10.5% per lake). Over all lakes, 51.7% of muskellunge (0.0–1.0% per lake) were recovered in the same lake in which they were tagged. We will quantify spawning site fidelity through spring of 2005 and seasonal movement and home range through summer of 2005. Our findings will be used to determine if spearing and angling fisheries should be managed for individual lakes or for the entire set of interconnected lakes within the chain.