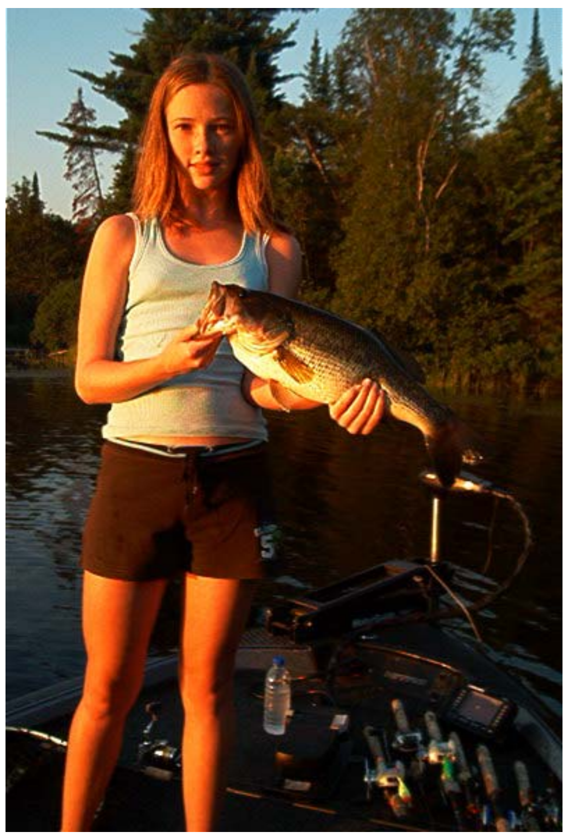
Bass Research and Management in Ontario II

Workshop Proceedings



Bass Research and Management in Ontario II

Workshop Proceedings

April 1, 2006
Georgina Resort and Conference Centre
Sutton, Ontario

Steven J. Kerr, Editor

These workshop proceedings should be cited as follows: Kerr, S. J. [ed.]. 2007. Bass research and management in Ontario II. Ontario Ministry of Natural Resources. Peterborough, Ontario. 82 p. + appendices.

Printed in Ontario, Canada
(0.1 k P.R. 2007 01 05)
MNR 52063
ISBN 978-1-4249-3087-6

Cette publication hautement spécialisée n'est disponible qu'en anglais en vertu du Règlement 411/97 qui en exempte l'application de la *Lois sur les services en français.* Pour obtenir de l'aide en français, veuillex communiquer avec le ministère des resources naturelles en Ontario au 705-755-1907

Cover photo by Wil Wegman

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Foreword

Bass (*Micropterus* spp.) are highly valued species in the Province of Ontario and among the most desired fish sought by anglers.

The popularity of bass has prompted a considerable amount of research and management activity in the past 20-30 years. The first 'National Bass Symposium' was held in February 1975 in Tulsa, Oklahoma (Stroud and Clepper 1975). The first international bass symposium was held at Nashville, Tennessee in 1989 (Jackson 1991). More recently, the symposium "Black Bass 2000: Conservation and Management of Black Bass in North America" was held in St. Louis, Missouri, in 2000 (Philipp and Ridgway 2002). One of the first bass workshops in Ontario ("Bass Management in Ontario") was held at the Queen's University Biological Station in 1994 (Kerr and Cholmondeley 1995).

A second Ontario bass research and management workshop (dubbed Bass Research and Management in Ontario II) was held at Jackson's Point, near Sutton, Ontario, on April 1, 2006. The event was co-organized by the Ontario Ministry of Natural Resources (MNR) and the Bass Anglers Sportsman Society (BASS). Sponsors for the event included Bass Pro Shops, Shimano Canada, Rapala, Lowrance Electronics, Atwater Fine Arts, Normack Canada, and the Georgina Resort and Conference Centre.

This workshop brought together some of Canada's leading bass experts including researchers, biologists, and dedicated bass anglers. It provided an excellent opportunity to keep abreast of new science, share information, and network with other bass enthusiasts. The one day event was attended by almost one hundred people. All thirteen presentations were informative, stimulating and thought provoking as they dealt with new science and current bass management issues.

These proceedings have been prepared to disseminate information from the workshop to those anglers, managers and researchers who were unable to attend.

Steven J. Kerr
Ontario Ministry of Natural Resources
Peterborough, Ontario
January 2007

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Recherches concernant l’achigan et sa gestion en Ontario
Deuxieme Atelier

L’achigan est l’une des espèces les plus en demande en Ontario et parmi les plus désirées par les pêcheurs à la ligne. Sa popularité a suscité une quantité considérable de recherches et d’activités de gestion dans les 20 à 30 dernières années.

Le premier atelier de recherche sur l’achigan s’est tenu à l’Université Queen en 1995. Le second s’est tenu en Avril 2006, à Jackson’s Point près Sutton en Ontario. Cet atelier a été organisé par le Ministère des Richesses Naturelles et le Bass Anglers Sportsman Society avec le support de Bass Pro Shops, Shimano, Rapala et Lowrance.

Ce compendium des présentations données lors de cet atelier a été créé pour disséminer l’information offerte par différents auteurs. Les documents sont reproduits tel que présentés par leur auteur respectif.

Imagine – The Future Possibilities of Bass Fishing in Ontario

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Several important messages about angling and the future management of Ontario's fisheries include:

- We must, indeed, all hang together or, most assuredly, we shall all hang together.

- Maximum sustainable yield is a myth - long before sustainability often becomes an issue we've lost any semblance of a quality fishery.

- Quality vs. quantity – four pounds or twelve inches? A 12-inch bass in Ontario, which weighs less than one pound, would be a four-pound fish in Kentucky or Tennessee at the same age. The question we need to ask ourselves is what do we want to manage for – quality or quantity?

- What are underutilized species? We have a difficult time living with success. We seem not to be comfortable until we take "underutilized species" and fish them down. We also tend to want to solve one problem (e.g. overharvest of walleye) by pushing the harvest over to another species instead of solving the underlying issue.

- We need to reconsider the notion of bass as an exotic species in northern Ontario. After 100+ years of being here, and often originally planted by the provincial government (indeed, they were the focus of the hatchery program in the late 1800s and early 1900s) when does an exotic become a resident? Are rainbow trout, brown trout, and pheasants still considered exotic species?

- "The government will look after us" – There are numerous examples to the contrary (e.g., northeastern Ontario regulation changes, southern Ontario regulations, Bay of Quinte, bear management).

- Be careful what you wish for – you just might get it.

- Believe in the science. The east coast cod fishery was the single greatest biomass we've ever seen. Scientists warned for years the fishery was in trouble but no one ***wanted*** to believe the data.

- Don't shoot the messenger.

- The time to act is when the fishing is good. It is easier to avoid fishery problems rather than solve them.

- We don't just need more conservation officers at least not at the expense of good science. One Ridgway, Kerr, Tufts, or Cooke is worth five COs.

- Tournaments – the good, the bad and the ugly – need to be addressed from a provincial policy perspective.

Ontario needs to grow up and support the good ones and weed out the bad ones.

- Not taking a position is not a position.

- If we build it (create a trophy fishery) they will come. There are numerous examples (Chequamagon Bay, Mille Lacs, Lake Fork, Dale Hollow, etc.) of phenomenal bass fishing examples around North America and when they are maintained anglers flock to them with the associated social and economic benefits

- Ontario fisheries management challenges include:
(a) too much resource
(b) no data
(c) broad vs. lake specific approaches
(d) MNR or Ministry of Forests?
(e) No one really cares (in the broad scheme of things – but that can be good (can fly under the radar)
(f) options not solutions
(g) vested self interests
(h) range in angling quality. With more than 250,000 lakes and countless miles of streams and rivers in Ontario, why is it we manage every bass water (and virtually every other fishery) to the same level of mediocrity? Why do we not have high quality bass fisheries like we have high quality musky waters?

- With proper management – Ontario has the opportunity to be the envy of the world with respect to bass fishing management and opportunities ***if*** anglers and managers are prepared to work for it.

Overview of the BASS Conservation Program

Noreen Clough
BASS Conservation Director
Bass Anglers Sportsmans Society

The Bass Anglers Sportsman Society (BASS), established in 1968 by Ray Scott, has almost 40 years of a history in taking a leadership role in aquatic resource conservation and issues to ensure the "future of fishing through conservation."

Being the "Worldwide Leader in Bass Fishing," means much more than membership in a global club of bass anglers. Since the early 1970s, BASS has taken a proactive response to addressing the nation's vital aquatic resource issues. In the early years, it meant taking legal action against industries making a toxic soup of the nation's waterways. Today, the agenda has grown more complex, and BASS follows a parallel path in dealing with the issues through its Conservation Program.

The backbone of the organization is founded on a grass-roots core of more than 20,000 members in 47 states and 5 countries, whose passion extends beyond bass fishing. These men and women, young and old, belong to bass clubs worldwide. They are environmental stewards always on the lookout for issues that have local, national and international significance.

BASS has been owned by ESPN Outdoors for nearly 4 years. Since that time we have continued to grow and refine the BASS Conservation and Youth programs to include adding a black bass biologist to our staff.

At BASS, we approach conservation in three ways – Strategic, Educational and Tactical, using a "top down" to "bottom up" approach.

Our strategic components are generally long-term and include participating in planning, policy making and legislative initiatives working through a variety of partnerships such as the American Sportfishing Association and Theodore Roosevelt Conservation Partnerships, as well as with federal and state agencies, the International Association of Fish and Wildlife Agencies, and non-governmental organizations such as the Izaak Walton League and Trust for Public Lands. We also are active members in the American Fisheries Society, and continue to seek advice and counsel from a number of universities.

Educational components include our very popular publications – Bassmaster Magazine and BASS Times, as well as an enhanced website link to conservation on Bassmaster.com. We have recently been working closely with our ESPN Production and Programming crew to include conservation messaging on TV. And of course, there are special publications such as Keeping Bass Alive and the new kids' book, Bass Fishing Fun and Facts, and Junior Bassmaster.

Special however, and growing, is our encouragement of and participation in workshops and seminars like this one.

Our strength lies in our tactical component – the true horsepower behind BASS - those of you in this room today, and across Canada and the US, Italy and South Africa – the BASS Federation Nation and your bass clubs. You are the eyes and ears on the ground that bring immediate attention to local, state and provincial issues and concerns. You are the individuals doing habitat work, preventing the spread of nuisance aquatic species, and keeping your fingers on the pulse of the resource.

From local bass clubs to the national level, where BASS works cooperatively with government to develop sound management policy, the protection and enhancement of aquatic resources will remain a top priority. To provide focus to our efforts, BASS Conservation works on six key, fundamental issues vital to the future health of the nation's aquatic resources: Habitat, Aquatic Nuisance Species, Tournament Fish Care, Aquatic Vegetation Management, Angler Access and Fish Health.

Habitat. This is our major priority these days, and we have and will continue to work from a "top down" and a "bottom up" approach to dealing with this problem. From the top, we work with national policy makers to enact laws and generate funding for watershed improvements. In addition to the legislation aspect, we continue to work on regional and national committees and teams that are developing long range plans to improve habitat, most notably the National Fish Habitat Action Plan From the bottom up, we prepare our state Federation Nation chapters to meet head on the habitat quality issues in their states. We accomplish this through training seminars on enhancing or restoring native vegetation, guidance on constructing and placing artificial habitats and working through complex planning processes to ensure development impacts are mitigated. Additionally, we now offer conservation funding through our grants program. BASS is in a unique position in that we hold the key to success, uniting grass root efforts with national policy.

Aquatic Nuisance Species. An aquarium owner dumps unwanted fish such as gobies or plants into a local river or lake with no harm intended. A freighter from overseas pumps ballast water into the Great Lakes, unknowingly setting free zebra mussels, and other organisms. The bane of our existence – Asian carp - have escaped from private aquaculture and are now rampant. These scenarios are very real and threaten to destroy or imperil the balance of aquatic ecosystems the size of the Great Lakes, the Mississippi River watershed and beyond. As the problem spreads, BASS Conservation has joined a growing coalition of concerned policy makers, government agencies, and scientists to regulate importation of exotics and stop their illegal introduction to the nation's waters, and control their spread.

Tournament Fish Care. Early on, Ray Scott, the founder of the Bass Anglers Sportsmens Society, recognized that bass are a renewable resource and concurrently developed the catch-and-release ethic that is standard with tournaments. BASS Conservation continues raising the bar on the practice by supporting scientific research focusing on care of tournament-caught bass. The latest practices and improvements are rolled out through the BASS Federation Nation and our professional tournament circuit. We also expend considerable effort educating anglers about how to better handle fish they intend to release, with the hallmark of this effort being our publication "Keeping Bass Alive." BASS Conservation extends its outreach to the general angling public through print, TV and other media to ensure a positive perception of bass fishing and tournament angling.

Aquatic Vegetation Management. Hydrilla and milfoil are unjustly perceived by many sportsmen as good habitat for fish and waterfowl. However, they choke out native vegetation, and when overabundant, they become a nuisance to other water users, from boaters to lakeshore homeowners and even municipal drinking water suppliers. BASS Conservation advocates and facilitates mediation between all user groups while encouraging stakeholders to establish diverse native plant communities. Ideally, striking the balance will benefit ecosystems and users alike.

Angler Access. A fishing trip begins with a place to launch the boat or shoreline to cast a line. Yet access to public waterways has suffered. And finding a boat ramp is the least of the problems. Demands on water supplies, restrictive fishery management regulations on fishing seasons, and horsepower limitations on motors merely scratch the surface of why anglers can't rightfully gain access to public waters. Through a grass-roots approach with bass clubs affiliated with the BASS Federation Nation, angler and boater rights are being heard. The cause is ongoing, with the Federation Nation and BASS Conservation collectively uniting to become more vigilant to access denial in all its forms, we intend to ensure and expand access throughout the country.

Fish Health. At the first outbreak of the Largemouth Bass Virus (LMBV), BASS Conservation adopted a leadership role to face the issue. The result is an annual summit attended by leading researchers, state fishery biologists and anglers to exchange information on new developments and implement plans of action. BASS and its coalition continue making strides to deal with and better understand LMBV while identifying other diseases or health problems, among those outbreaks of harmful algae and bacteria that can spark significant fish kills. BASS Conservation is an active participant in American Fisheries Society committees and other professional associations whose interests focus on fishery health.

So as you can see, BASS is more than just fishing, a magazine or a membership card. Members of BASS, BASS itself and ESPN Outdoors represent and support over thirty years of aquatic resource conservation. We are devoted to the challenges that lie ahead and will continue to work on behalf of our members and the aquatic resources we all value.

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Lake Simcoe – A World Class Fishery – An Angler's Perspective

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The largest inland lake in southcentral Ontario is home to some of the finest smallmouth bass (*Micropterus dolomieu*) fishing found anywhere in North America. This fact is truly remarkable considering that Lake Simcoe is also within an hour's drive of Canada's most populated region; that it's naturally reproducing cold water fishery collapsed by the early 1970's; and that it has endured a plethora of invasive species which has changed the biodiversity of the lake forever. Very little species-specific research or science-based monitoring of bass in Lake Simcoe has ever taken place. This has resulted in limited data on the bass fishery in this lake. Still, the bass fishery continues to flourish. The following overview of the bass fishery of Lake Simcoe is presented not-so-much from the standpoint of an employee working for the government agency responsible for managing the Lake Simcoe fishery, but more so from the perspective of a hard core bass angler who has spent the last two decades chasing bass and the other species bass are kind enough to share the lake with.

Facts About Lake Simcoe

Lake Simcoe is Ontario's sixth largest inland lake with a surface area of 745 square kilometres. It is located within a one hour drive from Canada's most populated region and overall is the most intensively fished inland lake in the province.

This 'claim-to-fame' is only because of the high fishing pressure the lake receives during the winter. More people fish it during the winter than all other three seasons combined. There are between 3-5,000 ice huts on the lake each winter with thousands more open ice anglers who prefer not to use a hut.

Lake Simcoe has one of the most diverse year-round fisheries in the country with 55 species of fish (and growing).

The average depth of the lake is approximately 22 meters (56 feet), with the deepest portion being 57 meters (145 feet). Even with an area of 745 square kilometers, Lake Simcoe has a relatively short and exposed shoreline of only 144 miles including that of a few islands. This means that unlike other big lakes which have countless back bays and other shorelines to fish, Lake Simcoe anglers have had to learn how to fish offshore, main lake structure. Therefore unlike northern lakes such as Lake of the Woods, there are very few back bays or out-of the way spots for people to fish. The lake can be very rough and unforgiving especially for smaller fishing craft and canoes.

Lake Simcoe is a diverse lake and can be described as actually being like three lakes in one:

1.) Oligotrophic – deep, hard bottom, no weed growth - lake trout & whitefish.

2.) Mesotrophic - mid depth, mixed substrate-sand/gravel some weed growth - smallmouth bass, yellow perch.

3.) Eutrophic – shallow, soft bottom, plenty of aquatic plant growth - largemouth bass, yellow perch, carp.

Invasive Species

A number of non-native species have become established in Lake Simcoe. Common carp (*Cyprinus carpio*) became established in Lake Simcoe by the late 1800's**.** Rainbow smelt (*Osmerus mordax*) were first found in 1962.

In 1987, black crappie (*Pomoxis nigromaculatus*) were reported in the lake. Zebra mussels (*Dreissena polymorpha*) have been established for over a decade. In the fall of 2000 the second confirmation of bluegill (*Lepomis macrochirus*) was reported by the Lake Simcoe Fisheries Assessment Unit. In 2004, rusty crayfish (*Orconectes rusticus*) were found in the Pefferlaw River and, by 2005, in many parts of Simcoe. In 2004 round gobies (*Neogobius melanostomus*) were advancing down the Pefferlaw River towards the lake. This prompted a goby removal project using rotenone in the fall of 2005 to stop the spread into Lake Simcoe. So far, no confirmed cases of round goby have been verified from Lake Simcoe.

Fisheries Management on Lake Simcoe

The Ontario Ministry of Natural Resources manages the fisheries of the lake. The lake is managed and patrolled by both the Midhurst and Aurora districts. Significant enforcement efforts are directed towards the lake which is currently managed under its own separate division (5). The Lake Simcoe Fisheries Assessment Unit, located directly on the water in Sibbald Point Provincial Park, monitors the fisheries of the lake. Very little species specific research has been conducted on Simcoe's largemouth or smallmouth bass however decades of monitoring the cold water fishery has resulted in considerable data on whitefish (*Coregonus clupeaformis*) and lake trout (*Salvelinus namaycush).*

The Lake Simcoe Fish Community

Lake Trout

Natural reproduction of lake trout had collapsed by the early 1970's and there was little evidence of recruitment until recently … now some small numbers of wild lake trout are reaching adult stage. There is currently an annual stocking program of 100,000 yearling lake trout. This program maintains this very popular and valuable fishery. The best angling for lake trout occurs during the winter and early spring

Lake Whitefish

Lake whitefish are one of the most sought after species during the hard water season. Lake Simcoe is recognized for producing above average size and even trophy whitefish. Some say it even has the potential to break the current 14.38 pound world record, caught in Georgian Bay. Lou Desjardin of Barrie came close in 1996, when he caught a 14.36 pounder through the ice. The lake is currently stocked at the rate of about 150,000 fingerlings per year in order to sustain this fishery.

Lake Herring (Cisco)

Lake herring (*Coregonus artedii*) are a sad story on Lake Simcoe. Once caught by the pail full and a major forage for lake trout, there is little evidence that this fish is still reproducing. Those few cisco that are caught every year are near the end of their life cycle and often in the 3-4 pound range. In spring of 1999, while jigging for whitefish, I personally caught a 4.20 pound cisco in Simcoe that was just shy of the 4.33 lb Ontario record. Lake herring are not stocked into Lake Simcoe. The Ministry of Natural Resources closed the cisco fishery on Lake Simcoe on January 1, 2001. Some anecdotal reports from anglers during the winter of 2006 tell of an increase in cisco catches from the lake however any rebound in this once very popular fishery remains to be verified.

Black Crappie

Black crappie were first captured by the Lake Simcoe Fisheries Assessment Unit in 1987. By 1997 they were reported as the most abundant fish in MNR trap nets. Subsequent reports from media stated that crappie were now the most plentiful sport fish in the lake; which of course was not really the case as the structure-craved black crappie gravitated towards the black trap nets like bees to honey. Native fish such as yellow perch, still far outnumber black crappie in Lake Simcoe.

Today, crappie remain as an enigma on the lake. Crappie fishing can be very productive in early spring and late fall when they move into marinas, channels and adjoining river systems. They are frustratingly difficult to locate at other times of the year either in the rivers or the main lake. This is because of the 'bowl-like' make up of lake and little structure to hold these fish in any one location. Therefore despite their high numbers and popularity among anglers, they remain a relatively low catch on the main lake.

Yellow Perch

The overall perch (*Perca flavescens*) population has fluctuated dramatically over the years. Currently their numbers appear to be stable with a large population present in the lake. Perch are the most popular fish in the lake. Lake Simcoe has been described by our friends at In-Fisherman magazine as *"The only world-class perch lake destination beyond debate remaining in North America!"* Simcoe is known for both quality and quantity of perch. Current Lake Simcoe record is 2.35 pounds just under the 2.42 pound Ontario record from Lake Erie

There is heavy pressure during the spring, fall and winter. Anglers with a sport fishing license can keep 50 perch daily and have a possession limit of 100. A conservation license allows for a 25 perch daily limit with a 50 fish possession.

There is some concern by anglers that overall size of perch is down. Simcoe is a changing lake and perch habits and habitat have changed with it. Increased water clarity has resulted in increased aquatic plant growth –which in turn has elevated the numbers of scuds or grass shrimp in the lake. Perch have been quick to capitalize on this easy forage, and their stomachs are now often full of these tiny, yet plentiful, morsels. Anglers who realize this and have adapted their fishing techniques to smaller lures, lighter line and even the use of maggots instead of minnows, continue to catch perch.

Northern Pike

Pike (*Esox lucius*) fishing in Lake Simcoe can be very good. Increased water clarity has resulted in more weed growth often in places that have never seen aquatic plants before. Naturally this has produced more habitat for northerns. Although fish exceeding 20 pounds are caught every year, pike average between 3-7 pounds.

Largemouth and Smallmouth Bass

The first recorded reference to Lake Simcoe bass (*Micropterus* spp.) was made in 1838 by William Bond: *"While riding with an Indian family in a canoe paddled by the squaw the Indian stood up all the time looking for fish … he killed three bass, turning round the spear each time to the squaw in order that she might extricate the fish."* Some would argue that this was the first team style bass tournament however it is doubtful that these fish were brought to a weigh-in stage afterwards and then carefully live-released by the Shimano Live release boat!

There was a commercial fishery for bass from 1868-1901 in which 789,000 lbs of bass were marketed. By 1890, a considerable sport fishery for smallmouth developed. By 1900, its value as a tourist attraction saw several large specimens of smallmouth bass shipped to several American cities in an attempt to entice visitors to the lake. By 1904, the fisheries overseer of Lake Simcoe stated that *"the bass fishing could not be exceeded in the whole of Canada."*

Stocking Bass In Lake Simcoe

In 1901, 1,290 adult smallmouth were released in three different locations around the lake marking the first stocking efforts. In 1904, 785 adults were stocked at Jackson's Point.

In 1906, 1,850 adults were released. This marked the last attempt at stocking parent fish. Other bass stocking occurred in 1916, when 200,000 fry and fingerlings were stocked. Between 1916-1960, over 1 million young smallmouth bass were stocked. Similarly, between 1935 and 1968, 61,000 young largemouth bass were stocked. No recorded bass stocking has taken place since that time.

Lake Simcoe Bass Regulations

In 1889, a closed season, from April 15th to June 15th , was established making it one of the first protected species in North America. It is interesting to note that, throughout southern and central Ontario, fishery managers from past and present have not changed their way of thinking in terms of protecting spawning bass. In 1892, the closed season was extended to June 19th and a length limit of ten inches with a daily creel of 12 bass was imposed. By 1916, there was a closed season from January 1 to June 15, with a limit of 8 bass per day. In 1917, the closed season was extended from

October 1 to June 30^{th}, and the creel limit was lowered to 6 bass per day. By the mid 1960's, the bass season extended to November 30^{th} to give bass anglers a longer angling season. In the current regulations the season extends from the last Saturday in June to November 30. There is a 6 bass catch limit and no size restriction.

Lake Simcoe Area Bass Clubs Conservation Projects

The Aurora Bassmasters have been involved in a number of projects including a three year Holland River erosion control and fish habitat project, an annual adult pike transfer, installation of 'No pre-season bass angling ' signs and involvement hosting the Pefferlaw River goby derby. In 2006 there are plans for a garbage collection tournament, and a bass tagging project with special emphasis on 'fizzed' bass.

The Barrie Bassmasters and the Barrie Junior Bassmasters have been involved with cleanup efforts, installation of bass signs, and more fish habitat creation projects ranging from the installation of skids, woody debris, Berkley fish habs, Christmas trees and spawning boxes,

Catching Lake Simcoe Bass

Smallmouth bass in Lake Simcoe appear to feed on an abundant crayfish population early in the season and then make a shift towards shiners (*Notropis* spp.) and smelt in the fall. The plethora of zebra mussels have resulted in unsurpassed water clarity. You can often see 30 feet down or more in some sections of the lake. It is believed the increase in water clarity has made it easier for smallmouth bass to capture their prey resulting in the large Simcoe smallies that anglers crave.

Clear water conditions have made smallmouth here very wary of overhead predators such as great blue herons, cormorants, and anglers. Shallow water patterns prevail throughout summer however calm, clear conditions can make for tough fishing. This can be especially true for inexperienced anglers who have not adapted their fishing techniques along with the change in water clarity. Poor lure presentations usually result in poor fishing. More consistent smallmouth bass fishing occurs in the fall when bass go to deeper water. Long casts or dragging your bait some distance behind the boat with natural looking artificials that mimic forage can be successful.

Largemouth bass (*Micropterus salmoides*) fishing takes a back seat to fishing for smallmouth bass on Lake Simcoe. The lake does have some outstanding largemouth habitat, particularly in the south end at Cooks Bay. There have been many bass tournaments over the years that have been won with largemouth bass and even today they can be more reliable than their smallmouth cousins. Largemouth bass in the six pound range are caught every year on Lake Simcoe however their average size would be 2-3 pounds. Their preferred habitat consists of either deep weedlines, cattail-lined shorelines, pencil reeds, flats and some boat docks.

Other Species

Lake Simcoe anglers are fortunate to have such a wide variety of fish species in the lake. I've discussed the most popular ones only. Some others are:

- Big bodacious carp
- Wall-sized walleye
- Bountiful bullhead

- Rudimentary rock bass
- Plentiful pumpkinseed and bluegill
- Brawling bowfin
- Lingering ling (burbot)
- Skinny smelt
- White sucker
- Mean muskie (closed season)

Catch and Release

Catch and release is the single greatest personal contribution an angler can make to the future of a fishery! One of the key reasons for the incredible bass fishing on Lake Simcoe is that more and more anglers are practicing catch and release - especially with those precious bass over three pounds.

Fishing Lake Simcoe - The Future

We all recognize the importance of the Lake Simcoe fishery to the economy - over $160 million is generated by anglers every year (1990 figures). We need to protect the lake not simply for economic reasons but for the enjoyment of future generations. Verifying the economic contribution that anglers make to the many Lake Simcoe communities however, will enable politicians and others to fully appreciate the value of this great waterbody. A full fledged economic impact study of the recreational fishery is long overdue. There is also the need for more bass research on Lake Simcoe so that we can better understand and manage this fishery. With little species- specific monitoring or research efforts there is little knowledge about seasonal movements, spawning sites, forage base, or population estimates of bass from Lake Simcoe. Despite all this though, the population appears stable and bass fishery seems to have a bright future. During a period when the bass fishery is recognized as world class there is an ideal opportunity for researchers, tournament organizations, industry and Bassmaster club members to join forces and partnerships in order to learn more about the bass in Lake Simcoe. Together we can all endeavor to understand Lake Simcoe bass … which hopefully will help ensure that bright future we all want

The future of the bass and other warmwater species looks promising as all of these fish reproduce naturally on their own and good habitat remains. There's hope too for the cold water fishery with recent news of some lake trout reproduction.

There is more to be done. We can all do our part to help ensure the future of this great fishery:

- Practice catch and release and selective harvest.
- Report poachers.
- Join a local Simcoe fishing club such as the Aurora or Barrie Bassmasters and contribute to conservation projects that enhance and protect our great bass fishery.
- Follow sound environmental practices.
- Support politicians who place high priority on the health of Lake Simcoe and it's entire native aquatic community.
- Teach our children to respect the lake so that they can become its future caretakers.
- Encourage more people, young and old, to fish the lake. The more who do, and do so wisely, the better our chances at having more stewards to protect the lake for future generations.

Disseminating Catch-and-Release Research Findings to the Bass Angler and Biologist: Ensuring that we Hook them with the Right Message

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Abstract There is compelling scientific evidence that angler behaviour and gear choice can affect the success of catch-and-release as a management and conservation strategy. However, there may be a disconnect between those that conduct research on catch-and-release with anglers and/or those who manage fisheries. This could be particularly important in the context of bass fishing in Ontario where there is much research activity and a great deal of interest in improving catch-and-release strategies for self-reproducing populations. When we evaluated online catch-and-release guidelines provided by state and provincial natural resource agencies we found that not all of their outreach material was consistent with the best available scientific information. In some cases, agency guidelines contradicted one another in several areas including air exposure, hook type, and resuscitation, all issues of relevance to bass anglers. The material provided by the Ontario Ministry of Natural Resources was one of the most comprehensive and actually was one of the few agencies that provided supporting scientific documentation to justify guidelines. Although our findings will hopefully lead to changes in how some agencies disseminate information on catch-and-release, we argue that there is a need for additional sources of credible scientific information that is subject to peer review and updated frequently to reflect the best available information. We suggest that the Aquatic Resource Conservation Electronic Library (ARCEL) being developed by American Fisheries Society and their outreach arm, the Fisheries Conservation Foundation, may be the ideal vehicle for ensuring the timely dissemination of credible information. Electronic presentations (Microsoft Power Point) are being prepared that will be freely available in several versions suitable for various audiences

(scientific community, general public, and children). We also recognize the important roles of the outdoor media, angling organizations, and the sport fishing industry in disseminating information, but similar to natural resource agencies, it is essential that the information that is shared with anglers is indeed correct as poor guidelines can quickly become standard practice. This analysis will assist in developing outreach materials that promote sustainable recreational fisheries and that maintain the welfare status of individual fish.

1. Author for correspondence

Introduction

Recreational angling is a popular activity in North America with more fish released than harvested. This is particularly true for the black bass (*Micropterus* spp.) which are perhaps one of the most frequently released sportfish, due to a strong catch-and-release ethic and the result of various management regulations. As such, there is interest in ensuring that fish, which are subject to catch-and-release, survive and experience negligible sublethal effects. In jurisdictions where stocking is not a common management strategy to deal with angling-induced mortality (such as Ontario), reducing mortality of fish in self-reproducing populations is particularly crucial. Coupled with the widespread adoption of catch-and-release by anglers and fisheries managers has been an increase in scientific literature examining the impacts of catch-and-release practices on fish and fish populations. While the dissemination of these research results within the scientific community is important to guide future research, equally important is the dissemination of this information to the angling public and fisheries managers/policy makers to ensure the best catch-and-release practices are being adopted. Unfortunately, published scientific studies tend to languish in academic journals that are not readily accessible to anglers or fisheries managers. Occasionally, the collective literature is synthesized and these reviews tend to be more widely distributed. For catch-and-release angling, there are now three such syntheses (Muoneke and Childress 1994; Bartholomew and Bohnsack 2005; Cooke and Suski 2005). It is also important to note that many of the developments that have lead to improvements in survival have been driven by anglers, conservation organizations and industry. For example, The Bass Anglers Sportsman Society (BASS) instituted a number of tournament procedures that lead to dramatic reductions in initial mortality of black bass (Wilde et al. 2002). However, not all anglers are members of conservation organizations or consult outdoor media. Many do not have access to the results of scientific studies dealing with the best catch-and-release practices, and thus turn to management agencies to learn of optimal angling practices. Furthermore, sometimes information that is not based on scientific fact (that has arisen as a result of misconceptions or misinterpretations) becomes entrained in angler behaviour and activities, potentially having negative impacts on released fish. In some cases, this information becomes so entrained that management agencies adopt this “knowledge” and actually advocate that behaviour.

Based on this background, the goal of the current study was to examine existing natural resource agency guidelines and assess their conformity with the best scientifically-based information on catch-and-release practices. To achieve this goal, we first created a database of on-line catch-and-release guidelines developed by every state and provincial natural resource agency across North America. We then assessed each agency's source to determine whether or not agency guidelines were consistent with best available scientific literature. We also identified specific topical areas where there was conflicting information (either among agencies – or among agency guidelines and published scientific data). Here we focus on several specific issues that are of relevance to bass anglers and biologists. We also summarized some of the other ways in which catch-and-release information is being shared with the angling public with a focus on outdoor media, conservation organizations, and industry. We concluded by describing a new peer reviewed electronic source of information on catch-and-release that will be a dynamic source for the latest credible information available in several forms for different audiences. Our objective here is not to criticize. Instead, we view this as an opportunity to reflect on how scientific information on catch-and-release is currently disseminated to anglers and suggest alternative approaches for moving forward. Because anglers often look to government natural resource agencies for guidance on how to handle and release fish properly, there is a need to assess whether their outreach materials provide the necessary information on the subject. We submit that the future of our common bass fishing resources depends on greater mutual exchange of credible information on catch-and-release angling.

How are governments doing with outreach?
This study compared the internet-based catch-and-release guidelines for 51 of 63 North American agencies; 10 Canadian and 39 American. We were unable to locate online guidelines for the remaining 2 agencies (Iowa and Nevada). All analyses were conducted between December 2005 and January 2006. Interestingly, we found widespread variation in the accessibility of catch-and-release guidelines as assessed by quantifying the number of mouse "clicks" required to locate guidelines from the primary agency website homepage. While the average number of "clicks" required to locate guidelines was 2.84, four agency guidelines could only be found using an internet search engine (either intra-agency or Google) because links to their information were not intuitively obvious. Eleven agency guidelines were accessed via a link directly from the primary "fisheries" web page.

Next, we discuss some of our more interesting findings relevant to bass anglers by first briefly summarizing the scientific basis for a guideline and then assessing how government websites addressed the specific issue. More detailed analyses of these analyses are available in Pelletier (2006).

(a) Air Exposure
The science: A number of studies have shown that air exposure in fish can cause physiological disturbances and mortality. During air exposure, fish gills do not function properly and there is a reduced ability for fish to obtain oxygen and eliminate waste products such as carbon dioxide. As such, air exposure can cause cardiovascular disturbance in smallmouth bass (Cooke et al. 2002) and largemouth bass (Suski et al. 2004),

as well as metabolic and biochemical disturbances in largemouth bass (Suski et al. 2004). Thus, air exposure for angled fish should be minimized as much as possible.

The agencies: The majority (64%) of agencies recommended that a fish be kept in the water at all times during a catch-and-release angling event. Other recommendations included “as little as possible” (25%), “no longer than you can hold your breath” (1%), and “15 seconds” (0.2%). Unfortunately there are not any specific thresholds for air exposure, although that type of information would be valuable in developing guidelines (Schreer et al. 2005).

(b) Playing Time

The science: Angling equates to exercise for fish, and playing time correlates positively with the magnitude of physiological disturbance and time required for recovery in smallmouth bass (Schreer et al. 2001). Because playing time is greatly affected by the choice of equipment, anglers should choose equipment matched to the size of fish they are expected to encounter.

The agencies: While 80% of agency websites recommend minimizing playing time, only 16% emphasized the importance of an appropriately sized rod, reel, and line. In bass fishing, use of ultra-light equipment may prolong the fight and increase physiological disturbance.

(c) Water Temperature

The science: The risk of angling-induced mortality increases considerably when water temperatures are elevated (i.e. over 24ºC for largemouth bass; Wilde 1998).

The agencies: Some agency websites (14%) recommend that angling be restricted when water temperatures are at their highest, and 4% discuss the problems associated with catch-and-release angling of fish from cold water; South Dakota was the only agency to address both extremes. Considering the commanding effect of water temperature on all fish (Cooke and Suski 2005), and the fact that many bass tournaments occur during summer months, there should be more emphasis on avoiding angling during extreme temperatures or at least adjusting angler behaviour to minimize stress.

(d) Resuscitation

The science: For a fish to efficiently uptake oxygen, water must pass over the gills from front to back (i.e., enter the mouth and exit from the opercula). Thus, resuscitating fish in a back-and-forth manner is not ideal because having the fish move backwards through the water does not optimize oxygen uptake. Because bass can be easily gripped by the lower jaw, the most sensible approach for resuscitation is to move fish in an S-shaped (or figure “eight”) pattern.

The agencies: Roughly half (45%) recommended moving the fish ‘back and forth’ in the water, 16% holding the fish facing upstream, 6% moving the fish slowly forward, 2 % moving the fish in an S-shaped pattern, and 2% moving the fish side to side. In this instance, the agency guidelines were clearly not based on the biology of the fish.

How is OMNR (Ontario) Doing?

Catch-and-release guidelines for Ontario were easily accessible via a link directly on the ‘Let’s Fish Ontario!’ homepage designed by the Ontario

Ministry of Natural Resources (MNR). MNR is one of only eight agencies that recommended using properly-sized gear to minimize playing time and one of three agencies (among the 6% total) of agencies that warned against angling during extremely cold days in the winter. However, there was no mention of the impacts associated with warm water.

Unlike most agencies, MNR actually had a technical document that is available in addition to their simplified online guidelines. This document (Catch-and-release angling: A review with guidelines for proper fish handling practices; Casselman 2005) was available via a separate link called ‘publications’. We recommend that there be a link from the general guidelines to the more comprehensive document so that anglers can easily find background information and justification for various recommendations. Overall, MNR guidelines were within the top 5 of all agencies in North America. Although there were some things that they did not cover, little of the information was factually incorrect.

Summary of Agency Guidelines

Our review of web-based catch-and-release guidelines prepared by various management agencies revealed immense variation in the breadth and depth of material presented. However, of more concern is the observation that some agencies actually recommend handling practices that could harm fish. For example, moving fish back and forth in an effort to resuscitate them can result in delayed recovery. There is also substantial contradiction among agency websites making it difficult for anglers to decide which was the best way to handle fish. At the very least, we hope that this synthesis will draw attention to the need to have consistent guidelines from one agency to the next. Inconsistent or vague information is less likely to be taken seriously by anglers and therefore does not help promote effective catch-and-release. We contend that agencies face a difficult task in trying to develop generic guidelines for catch-and-release when there is clearly substantial interspecific variation as well as differences in fishing techniques. Agencies are also forced to reconcile conflicting literature accounts, suggesting that more empirical catch-and-release research is needed.

Whenever possible, simplified guidelines should be supplemented with detailed scientific accounts and supporting citations (as in Ontario). For specialized fisheries (e.g., muskellunge) or issues (e.g., tournaments, circle hooks), it may be informative to have more detailed and specific guidelines that are linked from the generalized guidelines.

Catch-and-release guidelines should be accessible to anglers through a link on the primary agency webpage. Considering the increase in angler reliance on the internet for information, online catch-and-release guidelines are not trivial and efforts should be made to verify that they all conform with the best scientific information and are revisited regularly to update them pending new data.

How are the outdoor media, angling organizations, and industry doing with outreach?

Although many anglers look first to government sources for information on catch-and-release, a number of outdoor media outlets (e.g., BASSMaster, In-Fisherman, Ontario Out of Doors, etc.), angling organizations (e.g., BASS, Ontario Federation of Anglers and

Hunters), and industry (e.g., Shimano Canada) also play a pivotal role in disseminating information to anglers and fisheries managers. The organizations mentioned in the previous sentence are recognized leaders in the field of disseminating information to bass anglers. Two notable examples include the recent "Keeping Bass Alive" document produced by BASS (Gilliland and Schramm 2002) and the bass tournament biology and "water weigh-in" documents produced by Shimano Canada (Tufts and Morlock 2004). In both cases, scientists with expertise in catch-and-release were involved in the development of the documents. These are examples of outreach done the right way.

We believe there is opportunity to influence anglers directly through media outlets. Tournament anglers participating in a weigh-in in front of a jubilant crowd, television personalities captivating their Sunday morning audience, or magazine photos all serve as constant examples of optimal fish handling practices; at least, that is what most anglers would assume. However, next time you watch an angler hoist a bass high into the sky and then proceed to discuss how they captured the fish, the whole time with the fish exposed to air, one has to wonder how many anglers would begin to accept that handling behaviour as normal. This is not a generalization, and in fact, there are more and more examples of media outlets emphasizing how fish should be handled. The problem is that, on occasion, information that is not based in science gets passed along to other anglers. In many cases, these are strategies that anglers themselves have developed. We suggest that these strategies should be shared with scientists so that they can formally assess their potential benefits. In conservation science, physiological approaches are commonly used to determine if the strategies intended to benefit a population or species do indeed reduce stress, injury, or mortality (Wikelski and Cooke 2006). This discussion is not intended to stifle progress of various conservation agencies, outdoor media outlets, and industry in disseminating information. Instead, our intention is to ensure that the information is credible and receives appropriate peer review prior to dissemination.

A new approach to disseminating credible scientific information to anglers

The Fisheries Conservation Foundation is the outreach arm of the world's largest professional organization of fisheries scientists, the American Fisheries Society (AFS). Currently, the Fisheries Conservation Foundation (FCF) has undertaken an initiative called the Aquatic Resource Conservation electronic Library (ARCeL), designed to assist with the dissemination of primary fisheries research to a diverse group of audiences using Microsoft PowerPoint. This project will not only increase awareness of issues and pressures that face aquatic ecosystems around the world, but highlight non-biased scientific information and encourage audiences to take action. This electronic library can be used within existing educational curricula at all levels, as well as ensure that the best science available is injected into resource conservation decisions. Presentations on fisheries topics will be made available for download on the FCF website and will cover multiple fisheries topics such as aquatic invasive species, bycatch issues, aquaculture, and mercury contamination. Each library entry will emphasize the global importance of various topics, a summary of the relevant scientific information available, an unbiased presentation of various viewpoints, and how this issue relates to aquatic resource conservation and society in general. The FCF strives to ensure that objective, peer reviewed scientific information about fisheries and aquatic resources reach policy-makers and the public, so decisions made about the use freshwater and marine ecosystems are logical, informed, and based on long-term sustainable principles.

The Aquatic Resource Conservation Electronic Library is a program of FCF that provides a mechanism to deliver readily accessible, science-based information on aquatic resource conservation issues. To generate presentations on the different topics, the first step is to identify experts in the topic of interest and invite them to generate presentations in a PowerPoint format. Presentations will then be developed in three versions, each targeting a different audience: the scientific community, the general public and an executive summary version which will be appropriate for use by the media or legislative groups. Presentations for the scientific community will be built upon research from the peer-reviewed primary literature and will be used to generate talks similar in format to a review article published in a journal. These presentations will be approximately 45 minutes long, and will ideally be designed such that each presentation can 'stand alone' and the information contained within the presentation can be gleaned without having a speaker present. Completed entries will then be reviewed by experts using the traditional peer-review system, and reviewed presentations will then be made available for download on the Fisheries Conservation Foundation website.

"Catch-and-release" angling was chosen by the ARCeL project as the first topic for these presentations (Suski and Cooke *In Press*). For a number of reasons, catch-and-release angling is an ideal topic for this program. Recreational angling is a popular past time practiced around the world and many recreational fisheries are showing signs of distress. To help troubled fish populations, managers have increasingly turned to catch-and-release angling to aid in fisheries conservation. As a result, there has been an increase in scientific literature dealing with catch-and-release issues on individual and population levels. Research has shown that catch-and-release can be used to help preserve and enhance recreational fisheries. However, many controversies still exist concerning catch-and-release angling. The FCF presentation being prepared by Suski and Cooke (*In Press*) focused on two debates on this subject: 1) Is catch-and-release angling a viable management option? and 2) Are there ways to minimize the impacts of catch-and-release angling on released fish? While there are several instances where catch-and-release angling has worked to help troubled fisheries, angled fish may not survive due to hooking mortality, which sets up a debate for our first point in that catch-and release may not be a viable conservation option for troubled fisheries. For the second debate, we sought to inform anglers, educators and scientists of best management practices that can be used to ensure maximum survival of released fish.

To convey this information in the scientific-level presentation, data elements from the primary, peer-reviewed literature that serve to highlight debates on this topic will be incorporated into the presentation. In addition, annotations and text boxes will be added to the slides that emphasize the significance, importance and relevance of the data element and allow people to comprehend the significance of the slide from only reading it on their computer monitor. Rather than presenting original peer reviewed data, presentations for the general public will distill data down to essential concepts and ideas, and be approximately 20 minutes long, while presentations will be prepared that target media outlets be distilled down even further, and be approximately 5-10 slides in length.

Key points to consider when disseminating information on catch-and-release to the public

To conclude, we provide a brief list of key points to consider when disseminating information on catch-and-release to the public. This is not an exhaustive list and those interested in the production of outreach materials should consult more specialized sources or experts in that field. We argue that the consideration of the following points could help to elevate catch-and-release science and ultimately lead to more sustainable recreational fisheries.

(a) Set goals when developing outreach materials. A laudable general goal relevant to catch-and-release would be to "contribute to societal understanding of scientific data with a focus on improving the sustainability of recreational catch-and-release fishing." In some cases, it will be possible to define more specific goals such as to "disseminate information on how to ensure adequate dispersal of bass following a catch-and-release tournament."

(b) Target material to the desired audience. For example, if targeting bass tournament organizers, assume general knowledge of tournament procedures. If targeting occasional anglers or youth, assume that their knowledge base will be less developed and thus provide adequate background material. It is possible to reproduce material with the same message in different forms to target different audiences.

(c) Test outreach materials by holding focused group sessions to help refine material and ensure that it is informative, clear, and relevant to a given audience.

(d) Ensure that the science is credible and based on published, peer-reviewed studies whenever possible. Essentially, it is important to justify the needs for a specific guideline rather than simply dictating how it needs to be done.

(e) Speculation should be minimized. "Wrong" information, or conservation practices not based on scientific fact that can actually harm released fish, can quickly become institutionalized and engrained in angler behaviour.

Failure to properly engage the public or share information with fisheries managers will lead to the perpetuation of catch-and-release strategies that have the potential to be harmful to fish. Outreach materials provide an excellent opportunity to engage anglers in research activity and to stimulate meaningful dialogue on contentious issues. Collectively, we feel that this analysis will assist in developing outreach materials that promote sustainable recreational fisheries and that maintain the welfare status of individual fish.

Acknowledgements

Funding for this project was provided by Carleton University and the Fisheries Conservation Foundation. We thank Fred Michel of the Environmental Science Institute at Carleton University and the many state and provincial biologists that assisted with this project. We also thank the Ontario Bass Federation for allowing us to present our ideas at the Ontario Bass Workshop. Kyle Hanson was supported by the Ron Ward Memorial Scholarship from the Champaign-Urbana BASS Club in Illinois. Julie Claussen and Jeff Koppelman from the Fisheries Conservation Foundation kindly provided information on the ARCel program.

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***Editor's Note**: A poster based on this paper titled "Do catch-and-release guidelines from state and provincial fisheries agencies conform to scientifically-based best practices?" was awarded the Ontario BASS Federation Best Poster Award for Student Research at the Ontario Chapter meeting of the American Fisheries Society in Orillia during March of 2006. Christine Pelletier, an undergraduate student in Environmental Science at Carleton University and a member of the Cooke Fish Ecology and Conservation Physiology Laboratory was the lead researcher and first author on the poster*

Monitoring Bass Behaviour in Real Time over a Three Year Period: Implications for Conservation and Management

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Abstract For the past three years, our research group has monitored the behaviour and activity of largemouth bass (*Micropterus salmoides*) year-round at the Warner Lake Ecological Observatory (WLEO) in eastern Ontario. The core of the WLEO is a novel whole-lake acoustic telemetry array that can provide real-time information on animal behaviour. Data has been gathered from approximately 20 fish per year implanted with acoustic transmitters with a burst rate of between 2 and 60 seconds, enabling their 3-dimensional positioning with sub-meter accuracy. Research into under-ice winter behaviour has found that largemouth bass form large aggregations in discrete areas of the lake. Within these aggregations, predictable sub groups of animals form daily, and individuals can travel up to 1 km per day under the ice. During springtime, the fish move from the winter aggregation to warmer areas of the lake in preparation for spawning. While some bass spawn, other fish travel extensively throughout the lake, most likely in search of food, mates, or suitable spawning habitat. In an experiment to determine the effects of angling on nest guarding male bass, fish angled from their nest, livewell contained for an hour, air exposed, and released 100 m from their nest showed considerable delay in returning to the nest and exhibited impaired parental care for days afterwards. Future research will focus on investigating basic questions on bass ecology and behaviour (e.g., responses to weather conditions, ontogenetic shifts in activity), as well as the effect of various anthropogenic activities (e.g., recreational boating, shoreline development, angling tournaments). We are also moving to a broader community level approach where we will be able to monitor predator-prey relations and interspecific variation in behaviour.

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Introduction

In North America, largemouth bass (*Micropterus salmoides*) is one of the most popular and coveted sport fish species (Pullis and Laughland 1999). This has led to significant interest in developing management and conservation strategies designed to sustain bass populations. Increasingly, research into basic and applied bass biology has benefited from advances in technology, especially in the field of biotelemetry which is the remote collection of data on the behaviour, physiology, or energetics of an animal (Cooke et al. 2004). Traditionally, telemetry studies were conducted by implanting data loggers that would constantly measure certain variables as well as by manual tracking of individuals implanted with transmitters (Cooke et al. 2004). With the advent of fixed telemetry stations, automatic receivers that remain in a study area monitoring transmitters indefinitely, and coded transmitters, researchers can now simultaneously track hundreds of animals on the same frequency in confined regions (Niezgoda et al. 2002). In addition, research can now be conducted under conditions that were previously difficult to monitor (e.g., under ice during winter) and during periods when researchers are typically not on site (e.g., night). Fixed telemetry arrays can provide information on the two- and three-dimensional position and movement of fish continuously and in a manner that is independent of the presence of a researcher. With sub-meter accuracy, an array of fixed stations also has the potential to provide detailed information on fish swimming speeds and energetics, data previously limited to physiological telemetry systems (e.g., Cooke et al. 2004). This paper relates the findings from a whole-lake ecological observatory that includes a fixed acoustic telemetry array that has been used to monitor bass behaviour and activity in real time continuously for three years. The use of a remote, three dimensional positioning system allows us to generate a continuous and detailed dataset of fish behaviour across multiple seasons as well as spatial and temporal scales.

Overview of the Telemetry Array

In 2003 a code division multiple access (CDMA) acoustic telemetry system was installed at Warner Lake, Queen's University Biological Station (QUBS), as the backbone of an aquatic "ecological observatory". Warner Lake is a private research lake located in eastern Ontario, and is wholly enclosed on QUBS property, thereby enabling the undisturbed deployment and field testing of equipment. Warner Lake (8.3 hectare surface area) is composed of a small, shallow basin (max depth = 2 m) and a slightly larger deep basin (max depth = 7 m). The entire shallow basin and the near shore regions of the deeper basin have extensive littoral zone characterized by emergent and submergent vegetation. The deeper areas of the lake have dense weed beds and the majority of the deeper bottom is covered by *Chara* spp. The fish community in the lake includes white sucker (*Catostomus commersoni*), pumpkinseed (*Lepomis gibbosus*), yellow perch (*Perca flavescens*), brown bullhead (*Ameiurus nebulosus*) and golden shiner (*Notemigonus crysoleucas*) in addition to largemouth bass.

The acoustic telemetry system installed at Warner Lake is a CDMA-based telemetry system (MAP_600, Lotek Wireless, Newmarket, Ontario). The telemetry equipment consists of two multi-port MAP_600 receivers connected by cable to a total of 13 hydrophones distributed to provide coverage of the entire lake, including the littoral zone. Equipment was configured to monitor eight hydrophones (large basin) on one receiver, with the remaining five hydrophones (small basin) on the other receiver (Figure 1).

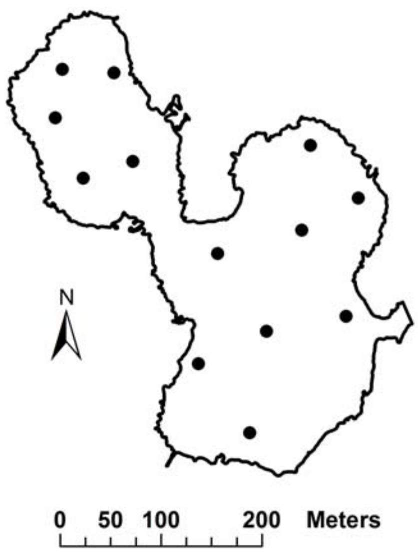

Figure 1. The acoustic telemetry array located at Warner Lake. Hydrophone locations are represented by closed circles.

Hydrophones were moored from fixed steel posts driven into the lake bottom at an approximate depth of 2 m from the water surface to ensure that lake ice conditions would not damage or move the hydrophones. Data was stored on flash cards within the receivers until being transferred to a personal computer for processing and archiving. Data processing details may be found in Niezgoda et al. (2002). Briefly, raw data were loaded into the Lotek Inc. program BioMAP (v. 2.1.12.1) and then subjected to a two-dimensional positioning engine to form raw position solutions followed by filtering to remove spurious position estimates. At this time, both temperature and depth information were determined by information related from sensors on the tags. At the conclusion of data processing, we were left with position estimates with sub meter precision.

Thus far, largemouth bass have been tagged as part of four distinct tagging episodes, three involving internal tag implantation and one involving external transmitter attachment. The intraperitoneal implantation followed the methods described by Cooke et al. (2003). Fish were collected by angling and then anesthetized in a bath of clove oil and ethanol (Anderson et al., 1997). Fish were then measured (total length to the nearest mm) and weighed (mass to nearest g). During surgery, a recirculating maintenance dose of anesthetic in lake water was passed over the fish's gills. A small incision on the ventral side of the fish was made, and the transmitter was inserted into the body cavity. The wound was then closed by two simple interrupted sutures (3/0 PDS II, absorbable monofilament sutures; Ethicon Inc.). Following surgery, fish recovered in coolers containing lake water and were released in the lake at a central location. A detailed list of tagging efforts in Warner Lake can be found in Table 1.

The external transmitter attachment was used for monitoring the reproductive biology and impacts of angling on nesting male bass. Some male bass (N = 20) had 2.5 second burst rate transmitters attached externally in May 2005 using the methods outlined by Cooke et al. (2003). Briefly, fish were placed dorsal side up in a trough filled with water but no anesthetic. Transmitters were attached to the fish using stainless steel wire passed through the dorsal tissue using hypodermic needles. The wires were then twisted in place against a backing plate (see Table 1 for details).

Table 1. A summary of tagging deployments for largemouth bass in Warner Lake.

Deployment	Transmitter Model	Sensors	Pulse Interval	Date of Tagging	Method of Attachment	Number of Tagged Fish	Life Expectancy	Primary Purpose of Study
1	CTPM 11-25	Temperature Pressure	15 s	10/14/03 – 10/15/03	Internal	13 Males 9 Females	~ 280 days	• Proof of concept and field validation. • Seasonal spatial ecology study, focus on winter period.
2a	MA-TP 16-25	Temperature Pressure	10 s	10/8/04-10/9/04	Internal	10 Males 9 Females	~ 330 days	• Seasonal spatial ecology study, focus on year-round period.
2b	CTPM 11-25	Temperature Pressure	15 s	10/8/04-10/9/04	Internal	5 Males 2 Females	~280 days	• Seasonal spatial ecology study, focus on year-round period.
3	MAP 11-25	None	2.5 s	5/9/05-5/31/05	External	22 Males	~ 30 days	• Assessment of parental care behaviour. • Assessment of impacts associated with catch-and-release angling. • Testing transmitters with short burst rates.
4	MA-TP 16-25	Temperature Pressure	60 s	10/5/05-10/6/05	Internal	11 Males 9 Females	~ 3 years	• Long term spatial ecology and reproductive dynamics study.

Findings on Bass Behaviour

Winter Behaviour

The winter behaviour of largemouth bass is not a very well researched or understood topic. Field studies have shown that bass aggregate in small areas during the winter months (Karchesky and Bennett, 2004). It has been commonly believed that during these times fish become more or less dormant and cease activity and feeding until ice melts and the water warms up (Heidinger 1975). This belief has often been promulgated by the fact that anglers going ice fishing rarely catch largemouth bass in numbers, if at all.

In each of our years of study, all bass from the lake moved into a large aggregation over the deepest part of the lake at the end of November, just prior to ice formation. For the duration of winter, bass remained in this general area and rarely traveled through the rest of the lake until just prior to ice out (Figure 2). Fish were never observed in the shallow basin during winter.

Surprisingly, while in the aggregations, bass were quite active, albeit on a very localized scale. It was not uncommon to find fish swimming up to 1 km per day, but remaining in an area approximately 50 m^2 (Figure 3). Within the aggregations themselves, fish reliably associated in subgroups with preferred members, but only during daylight hours (Figure 4). In effect, certain members of the population were commonly found within 1 m of the same group of fish over a number of days.

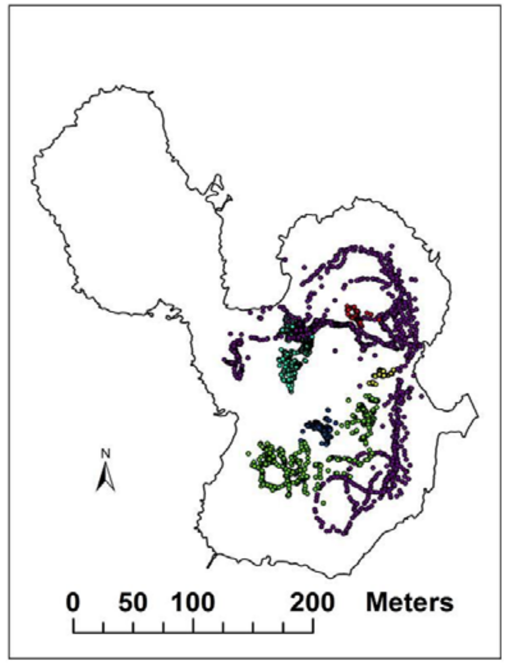

Figure 2. The movements of 5 largemouth bass on January 7, 2004 in Warner Lake. Most of the fish are clustered in the deepest portion of the lake in a winter aggregation and are active in small areas as indicated by the blue, green, red, and yellow dots. One fish (represented by the purple dots) is more active and cruising throughout the deeper areas of the lake.

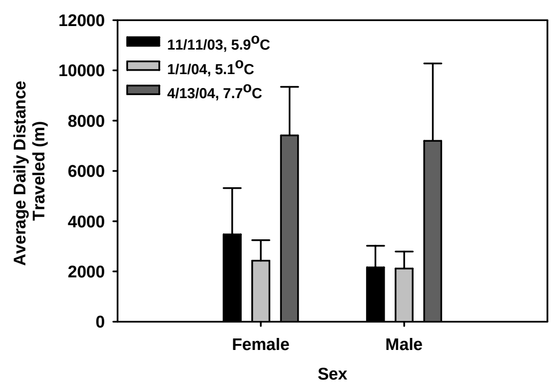

Figure 3. Individual average daily distance (m) travelled (swam) by sex, as recorded by the hydrophone array, for three dates representing fall, winter, and spring. Linear distances between each recorded position were determined and then summed for each individual. These values were averaged by sex.

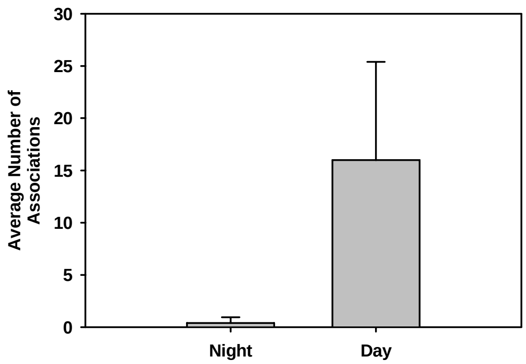

Figure 4. Average number of associations between largemouth bass by time of day in Warner Lake for the days of January 1-5, 2003. The majority of associations occur during the daytime hours.

Thus far, our findings have shed light on a number of interesting facts about largemouth bass winter ecology. Bass form large aggregations in discrete portions of the lake during the colder winter months. Contrary to popular belief (Heidinger 1975), during the winter bass are not dormant and move extensively during the day, but only in localized movements. Within the large aggregation, small sub groups form on a daily basis with the same members participating daily. This behaviour poses a unique challenge for fisheries managers. If large portions of the population congregate in a small area during the winter, they will be increasingly at risk to stress from degraded habitat or water quality in this area. Furthermore, if anglers were to identify these aggregation areas, it may be possible to catch large numbers of largemouth bass with very little effort. Identifying and protecting these critical overwintering areas should be a priority for natural resource agencies in north temperate regions.

Spring behaviour

During spring, when water temperatures reach ~15°C, male largemouth bass move into the shallows and construct saucer like nests in the substrate. They then court females to these nests and spawn before the departure of the female (Kramer and Smith 1962). Male bass guard their developing brood and maintain the nest until the brood is independent, a period which can often last a full month (Ridgway 1988). Contrary to some reports (DeWoody et al. 2000), once egg deposition is over, female bass leave the nest and do not stay to help guard the brood. During this time, adult male bass are unable to forage normally and the heightened activity is costly from an energetics perspective (Hinch and Collins 1991, Cooke et al. 2002). Stress from angling can lead to nest predation (Philipp et al. 1997, Suski et al. 2003), decreased nest guarding ability (Cooke et al. 2000), or premature nest abandonment (Philipp et al. 1997). As such, many northern jurisdictions, including Ontario, close the bass angling season during the reproductive period to ensure that these fish can successfully raise their broods (Quinn 1993, 2002).

Every year, around the time of ice out, all of the tagged largemouth bass moved from the site of the winter aggregation to the shallowest and warmest areas of the lake (Figure 5). After staying in these shallow, warm areas for about a week, some male bass moved to nesting sites, spawned, and began nest defense. Fish that were not engaged in spawning typically made extensive movements throughout the lake, most likely cruising in search of prey, suitable spawning habitat, or mates. During the spring, fish were quite active, swimming average distances of 2.5-3 km per day.

In May 2005, we conducted a study to determine the effects of different angling practices on the behaviour of nesting

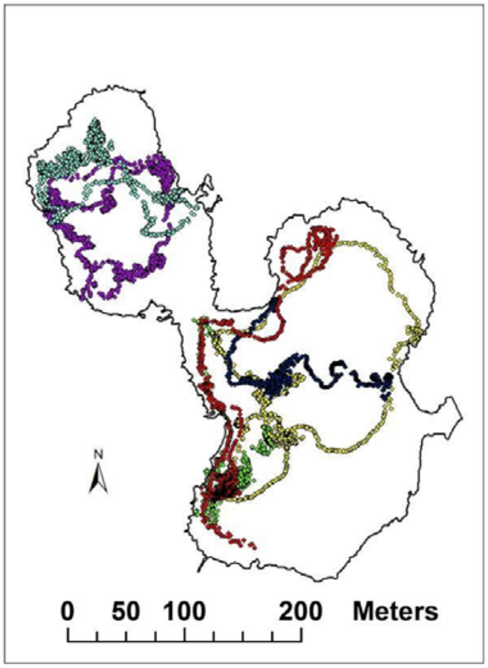

Figure 5. The movements of 5 largemouth bass on April 13, 2004 in Warner Lake. The fish have moved to the shallowest and warmest regions of the lake in preparation for spawning. Some fish also travel across the majority of the lake in wandering patterns.

male bass. Bass were angled from their nests, outfitted with acoustic tags, and then either immediately released 10 m from their nest or livewell confined for two hours and air exposed for two minutes prior to release 100 m from their nest. Fish immediately released rapidly returned to their nest and resumed normal nest guarding behaviour. Fish that were livewell-confined, air exposed, and released far away had difficulty returning to their nests, as evidenced by increased wandering around the periphery of the lake, although all did return at some point. Often, they followed the shoreline for extended periods of time until they returned to the nest (Figure 6).

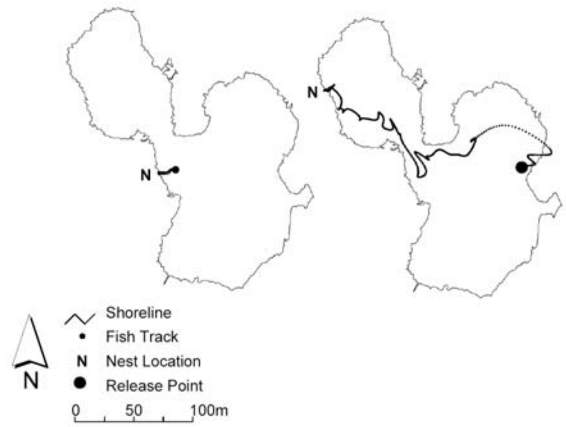

Figure 6. The effects of catch-and-release angling on nest guarding male black bass. The fish on the left was angled and released 10 m from his nest and returned to the nest quickly before resuming parental care behaviour. The fish on the right was angled, livewell-contained for an hour, and subjected to 2 minutes of air exposure prior to being released 100 m from his nest. This fish had a difficult time in locating the nest and did not readily resume parental care behaviour upon return.

After returning to the nest, these males did not stay as close to the nest as non-angled fish or those fish that were angled and immediately released, possibly an indication of an inability to provide proper parental care (Cooke et al. 2000).

Future projects

Future projects investigating the basic biology of largemouth bass as well as the effects of many human activities on behaviour have been planned. Research at the array will soon add a more community-level approach looking at interspecific interactions (e.g., between various fish species and other aquatic animals such as snapping turtles). Until present, we have focused solely on largemouth bass, but intend to tag brown bullhead, pumpkinseed, and snapping turtles within the next year.

Much of the research in the future, however, will continue to focus on largemouth bass. Specifically, we will be evaluating size and age specific variation in behaviour, as well as generating lifetime energetics models. We will also look to explore individual variation in fall and winter behaviour and how that impacts subsequent reproductive activities. Because not all bass reproduce in a given year, we are interested in learning more about the mechanisms that underlie these reproductive decisions. We also intend to use a more manipulative approach by implanting some fish with hormonal implants (e.g., cortisol) to assess the consequences of chronic stress on fish behaviour. To assess how humans affect largemouth bass populations, we intend to continue work on catch-and-release angling as well as on the effects that boating and shoreline development have on behaviour and spatial distribution. In the longer term, we will be evaluating inter-annual variation in behaviour relative to climatic conditions and possible climate change. Lastly, as the opportunities present themselves, we are interested in investigating any possible behavioural alterations in response to novel events such as earthquakes, storms, and solar and lunar eclipses.

Conclusions

The Warner Lake Ecological Observatory and the associated telemetry infrastructure has provided the opportunity to learn about fish behaviour at temporal and spatial scales that are not possible using other field techniques. In some ways the work to date has been preliminary and descriptive, prerequisites for understanding the system and generating relevant research questions. Our research is now focused on more hypothesis-based questions and we envision the Observatory yielding answers to questions that have eluded researchers for many years. This is the only whole-lake telemetry system in the world and is one of the few systems deployed anywhere that allows 3-dimensional positioning with sub-meter accuracy. The research team working on Warner Lake has grown to include ecologists, behaviouralists, physiologists, geneticists, geographers, and engineers all working together to better understand bass biology. As we move forward with this research program, we envision many opportunities for involving other stakeholders including tournament organizers and resource managers in applied research activities that are only possible in this unique system.

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The Effects of Round Gobies (*Neogobius melanostomus*) on Nest Success of Smallmouth Bass (*Micropterus dolomieu*) and Energy Flow in the Lake Huron Food Web.

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Abstract. Round gobies (*Neogobius melanostomus*) occur at very high population densities and are egg predators of smallmouth bass (*Micropterus dolomieu*). Previous research has showed that energy expenditures by males defending nests were higher in Lake Erie, which has high goby densities, than in a very different lake (Lake Opeongo) that lacked gobies. This infers that predation threat by gobies was a reasonable explanation for the differences in bass behaviour and energetics. To test this hypothesis without the confounding differences between lakes, we investigated nest-guarding behaviours of smallmouth bass at sites with varying population densities of round gobies in a single waterbody (Port Severn area of Georgian Bay). Behaviour was recorded by snorkelers and an underwater digital video-recorder during the spawning season of 2005. Although our sample sizes were too small to be statistically significant by themselves, the trends in our data were generally consistent with the expectation that nest defense behaviour should be correlated with among-site variation in goby density. To examine overall nest success, we also conducted surveys to determine whether the probability of nest abandonment and the probability of inactive nests (nests without eggs, fry or guard male) were positively related to population density of round gobies. We found that the probability of nest abandonment tended to increase with goby density and the probability of a nest being inactive late in the spawning season was highly related to goby density. Although the gobies generally negatively affect bass nest success, they may also make a positive contribution to bass productivity when they are consumed by juvenile and adult bass. The net effect of gobies on smallmouth bass is therefore uncertain. What appears certain is that round gobies are effectively transforming the tremendous biomass of dreissenid mussels into food for piscivores. The goby resource is beginning to be utilized extensively by nearshore fishes and birds. Their numerical response to this huge food resource should begin to appear in the next few years.

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Introduction

The reproductive success of smallmouth bass (*Micropterus dolomieu*) can be affected by many stressors such as predation of offspring, competition for nest space, angling, and storms (Goff 1984, Steinhart et al. 2004a, 2005a, 2005b). Smallmouth bass spend a lot of energy when guarding their nests against predators, continuously fanning their eggs for aeration, and rarely feeding (Ridgway 1988, Hinch and Collins 1991). With the introduction of round gobies (*Neogobius melanostomus*) to the Great Lakes, the reproductive success of smallmouth bass may be impacted by this invasive species, whose density averages 7 fish m^{-2} in rocky substrates during the spawning season in western Lake Erie (Johnson et al. 2005) and with maxima greater than 100 fish per m^{-2} (Chotkowski and Marsden 1999). In the western basin of Lake Erie, Steinhart et al. (2004a) have quantified the egg loss by round goby predation during simulated catch-and-release angling events, and have concluded that all eggs in an undefended nest can be eaten by round gobies in approximately 15 minutes. Steinhart et al. (2005a) have also determined that smallmouth bass in Lake Erie chase predators from their nests at a significantly higher rate than smallmouth bass in Lake Opeongo which lacks round gobies. This behavioural contrast might be generated by interactions with gobies, but could also result from other substantial differences between Lakes Erie and Opeongo.

In this study we test Steinhart's hypothesis about the effects of gobies on nest guarding by observing male smallmouth bass across a range of goby densities in a single body of water (Port Severn area, Georgian Bay, Lake Huron). In addition, we evaluated whether an index of overall nest success was negatively related to goby density. Finally, we assembled previous observations on densities of zebra mussels and round gobies to dramatize the tremendous magnitude of the transformation of inshore energy flows taking place in response to the colonization of the Great Lakes by these two species.

Methods

Nest defence behaviour of male smallmouth bass was observed at various sites in the Port Severn area of Georgian Bay, Ontario, from late-May to mid-June, 2005. Rates of chasing and departing, and amount of time off the nest were determined by snorkelling observations and underwater digital video-recordings. The probability of abandonment in relation to round goby densities was also determined by repeated visits to nests known to have had eggs. Near the end of the spawning season we surveyed nests and goby densities simultaneously over many sites to determine whether the frequency of inactive nests (nests without eggs, fry, or male) was related to goby density. Goby population densities at depths < 2 m were estimated by visual counts by snorkelers swimming measured transects.

Results

Nest-guarding behaviour. The rates of chasing and departing, and percent time off the nest were within the range of those observed by Steinhart et al. (2005a), and the trends across goby densities were mostly consistent with their observed contrast between lakes with and without gobies. Our sample sizes and statistical power were low, and therefore there were no statistically significant differences related to population density of round gobies. Overall, our results suggest that the differences in defence behaviours observed by Steinhart et al. (2004a, 2005a) are likely to be real goby effects, and not artifacts of other differences between the two lakes.

Nest success. The probability of nest abandonment tended to increase as the population density of round gobies increased. However, this increase was not statistically significant (N=25, p=0.0834). The trend is consistent with a statistically significant positive relationship between goby density and the probability of a nest being inactive (N=124, p=0.0062) however.

Ecosystem change. In Lake Erie, colonization by zebra mussels increased the total biomass of the nearshore benthos by approximately 40 times (Johannsson et al. 2000, Figure 1). Similarly, round gobies have increased dramatically in biomass since their introduction, relative to other benthic fish such as logperch (Balshine et al. 2005; Figure 2). The biomass of round gobies in Lake Erie is among the top 10% of a large sample of species-level fish standing crops in Europe and North America (Hanson and Leggett 1982, Bachmann et al. 1996, Pierce et al. 1994; Figure 3). Round gobies are the only fish species that seems to be effectively utilizing the huge dreissenid mussel resource, while they themselves are showing up in the diet of most nearshore piscivores (Jude 1997; Figure 4).

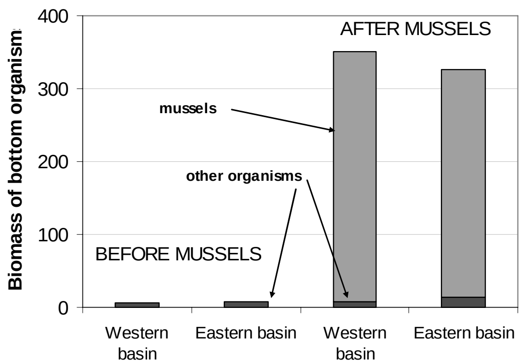

Figure 1. Zebra mussels increased the biomass of organisms in the nearshore sediment by 40 times in Lake Erie (from Johannsson et al. 2000)

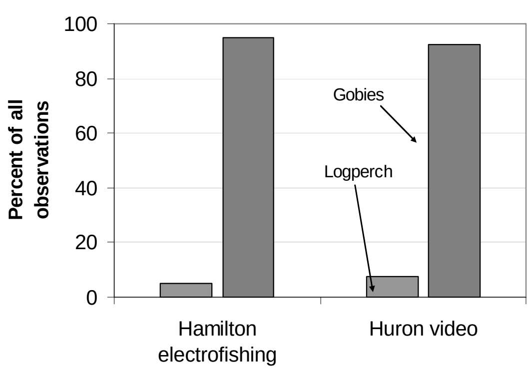

Figure 2. After their introduction to the Great Lakes, gobies became much more abundant than other inshore fish (Hamilton data modified from Balshine et al. 2005).

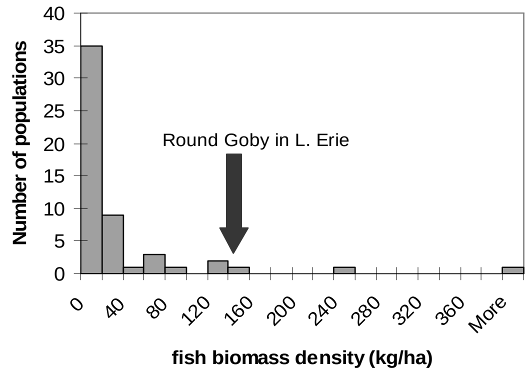

Figure 3. Round goby standing crop in Lake Erie is in the top 10% of a large sample of fish species standing crops in temperate and subtropical freshwater lakes.

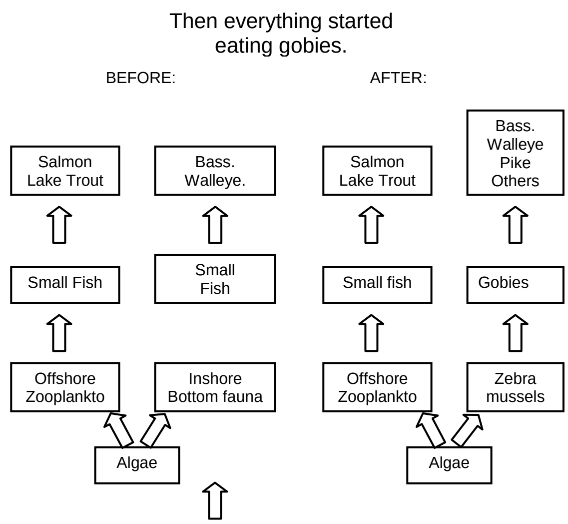

Figure 4. The biomass locked in the benthos by zebra mussels can be distributed to the rest of the food web by round gobies in the Great Lakes.

Discussion

Concerns about the negative effects of round gobies include transfer of contaminants throughout the food web (Corkum et al. 2004, Hanari et al. 2004, Lee and Johnson 2005), displacement of other benthic fish species (Dubs and Corkum 1996, Janssen and Jude 2001), and reduction in reproductive success of native species (Steinhart et al. 2004a, 2005a, 2005b). Our results extend previous work that indicated gobies make smallmouth bass nest defence more costly. We showed that these and perhaps other mechanisms are strong enough to affect the overall success of bass nests, at least in one area and one year in Georgian Bay. However, the net effect on the bass population remains unknown because predation on gobies can also enhance the growth of smallmouth bass. The diet of young-of-the-year bass in western Lake Erie has increased in fish content by almost 25% since 1975, and their achieved size has increased from 82 to 110 mm (Steinhart et al. 2004b). The contribution of gobies to diets of older bass have not yet been published, but it is likely to be positive.

Our compilation of published data on mussel and goby abundance shows that round gobies will have an extremely strong influence on the Great Lakes system because they combine two unusual species characteristics: the ability to feed on the huge dreissenid mussel resource, and their extremely high numerical abundance and biomass. Round gobies represent the only important trophic conduit between the tremendously productive dreissenid mussels on the one hand, and piscivores at the upper end of the food web. In response to this unusually abundant forage resource, we expect species in the nearshore piscivore community of the Great Lakes to become substantially more abundant over the next decade.

Acknowledgements

The authors would like to thank Monica Granados for her hard work and assistance in the field, especially during the stormy weeks. This research was funded by the Canada-Ontario Agreement, through the Upper Great Lakes Management Unit of the Ontario Ministry of Natural Resources, the Natural Science and Engineering Research Council of Canada, the Ontario Ministry of Natural Resources (Peterborough), an Ontario Federation of Anglers and Hunters Sport Fisheries Grant, and the Department of Biology at the University of Toronto at Mississauga.

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Choosing the Right Angling Regulation when Round Gobies Invade

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Abstract We used an individual based model to explore how angling pressure, a non-indigenous nest predator (round goby, *Neogobius melanostomus*), and parental care behavior affected how different fishing regulations influenced smallmouth bass (*Micropterus dolomieu*) offspring production in two very different systems: Lake Erie, Ohio, USA, and Lake Opeongo, Ontario, Canada. Our model assumed smallmouth bass made nest-guarding decisions that optimized their lifetime fitness under historical conditions in each lake. As fishing pressure increased, offspring production declined proportionally in both systems; however, when round gobies were included in simulations (currently, round gobies are present only in Lake Erie), offspring production declined more in Lake Opeongo than in Lake Erie. Responses to regulation changes (e.g., season closures, catch-and-release, and size limit) varied by lake because of lake-specific behaviours and population demographics. For example, high adult survival in Lake Opeongo caused smallmouth bass to devalue current broods and to abandon more offspring than smallmouth bass in Lake Erie. When we allowed males in Lake Opeongo to evolve new optimal behaviours to cope with high fishing pressure and presence of nest predators, males abandoned fewer offspring than when following old, sub-optimal behaviours; however, juvenile production remained constant, possibly because of unavoidable sources of offspring mortality (e.g., storms and daily offspring mortality). Differences in optimal nest-guarding behaviour, resulting from population-specific demographics and probability of nest success in lakes Erie and Opeongo, played a role in success of angling regulations, but behavioural changes within lakes had only a small effect on offspring production.

For related research, please see:

Steinhart, G.B., N.J. Leonard, R.A. Stein, and E.A. Marschall. 2005. Effects of storms, anglers, and predators on smallmouth bass nest success. Canadian Journal of Fisheries and Aquatic Sciences 62: 2649-2660.

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Copies of these manuscripts are available from Geoffrey Steinhart (steinhart.3@osu.edu).

***Editor's Note:** None of these authors attended the workshop. The paper was presented by Nick Collins. It has been submitted to the Canadian Journal of Fisheries and Aquatic Sciences for publication.*

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Maintaining Water Quality during Angling Tournaments

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Abstract The maintenance of adequate water quality is crucial for the survival and well-being of fish caught during live-release angling tournaments. In the current paper, we sought to summarize the type of water quality problems that can arise during live-release angling tournaments, and also to provide recommendations to anglers and tournament organizers to help maintain adequate water quality. Results showed that reductions in dissolved oxygen concentrations (hypoxia) can occur during livewell confinement, transport of fish in plastic holding bags, and on board live-release vessels. In addition, both additions of ice and the creation of hyperoxic water in a livewell can impair the ability of fish to recover from angling-induced exercise. It is therefore recommended that anglers run their livewell aerators regularly (even constantly) to maintain adequate dissolved oxygen concentrations in a livewell, and that anglers refrain from adding ice or supplemental oxygen to livewells. Also, it is recommended that tournament organizers measure dissolved oxygen concentrations with an oxygen meter in all vessels used to hold fish, that organizers strive to minimize the amount of time that fish are held in plastic transport bags, and that live-release boats receive regular additions of fresh water while fish are on board.

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Introduction

Reductions in water quality can have negative impacts on the health and well-being of many fish species. At several stages during an angling tournament, relatively high densities of fish can be held with relatively little water exchange, often for extended periods of time. Such conditions have the potential to result in sub-optimal water quality, resulting in additional physiological disturbances for tournament-caught fish. It is therefore crucial that water quality be maintained throughout an angling tournament to maximize the survival of released fish.

There were two objectives for this paper. First, we hoped to summarize the types of water quality problems that can occur at different stages of an angling tournament. Following that, we examined some of the practices currently in use by tournament organizers and anglers that are intended to prevent the creation of sub-optimal water conditions.

Livewells

During an angling tournament, fish that have been caught early in the day can spend in excess of 6 hours confined in a livewell. In many productive fisheries, 15 lbs (6.8 kg) or more of a waterbody's largest fish can be held during this period, possibly resulting in crowded, confined livewell conditions. More importantly, fish placed in a livewell have just experienced a large bout of exercise that resulted from angling (Suski et al. 2004) and require an appropriate environment to promote recovery. As a result, the livewell represents a significant period of time for tournament-caught fish, and at this time they are in the process of recovering for angling-induced exercise making optimal water quality essential.

In addition to stressors such as confinement and crowding, the two main challenges that fish can encounter while confined in a livewell are low levels of dissolved oxygen and/or elevated concentrations of ammonia. Without adequate exchange of water, there is potential for the rate of oxygen consumption by fish in the livewell to exceed the rate of oxygen replenishment by the aerator. This can result in a decline of dissolved oxygen in the livewell, and these hypoxic conditions can reach problematic levels if anglers are not careful. Similarly, ammonia is a toxic waste product that is excreted by fish almost continuously. Thus, confining fish in a livewell without adequate water exchange can cause ammonia levels to rise to problematic concentrations. The magnitude of these two potential problems will be influenced by the number (weight) of fish in the livewell, the rate of water exchange by the aeration system and the temperature of the water. Low numbers (weights) of fish with adequate aeration will not likely encounter significant problems with water quality, while large numbers (weights) of fish with inadequate aeration can result in sub-optimal water quality. Plus, because fish are poikilothermic ("cold-blooded") their metabolism is dictated by the temperature of the water; at higher water temperatures, the fish's metabolism is elevated, and they will both consume oxygen and produce ammonia at a greater rate than at cooler temperatures, accelerating the decline in water quality.

To help offset some of the potential problems encountered by fish during livewell confinement, many anglers use remedies such as ice or supplemental dissolved oxygen (oxygen infusion system). Additions of ice to livewells will cool water, which should reduce the metabolic rate of fish (essentially 'calm' them down), which in turn should reduce their oxygen demand and their ammonia production. As well, cool water naturally contains larger amounts of dissolved oxygen than warmer water, thereby making more oxygen available for fish in the livewell. Similarly, additions of supplemental dissolved oxygen using an oxygen infusion system should help prevent oxygen declines in livewells, thereby improving water conditions for the fish.

To test the effectiveness of these potential remedies at improving conditions for fish in livewells, a recent study by Suski et al. (2006) looked at the impact of different aquatic environments on the ability of largemouth bass to recover from exercise. In this experiment, fish were exercised for 1 minute to replicate angling-induced exercise and then allowed to recover in water that: 1) was aerated with an air stone (saturated with dissolved oxygen) and maintained at ambient temperature; 2) had low oxygen simulating an overcrowded livewell; 3) had elevated oxygen (supersaturation) due to excessive oxygen infusion; or 4) was cooled 11° C below ambient temperature (simulating the addition of ice to livewells). Results of the experiment by Suski et al. (2006) showed that full physiological recovery from exercise for largemouth bass occurred after 2-4 h if fish were left in oxygen saturated water and did not experience any change in water temperature (Figure 1). Forcing largemouth bass to recover from exercise in cool water (simulating the additions of ice to a live well) slowed the recovery of fish relative to individuals in water at ambient temperature, likely because the metabolism of fish in cool water was slowed and recovery processes were not performing at their optimum capacity (Figure 1). Similarly, forcing fish to recover in water that was warm relative to ambient conditions resulted in an impaired recovery, likely because the warm water caused the recovery processes inside the fish to break down and not function optimally (Figure 1). Finally, Suski et al. (2006) showed that both excessive quantities of dissolved oxygen and low quantities of dissolved oxygen impaired the recovery of fish relative to individuals in saturated oxygen environments, likely because these environments resulted in additional physiological challenges for fish, therefore impairing their recovery from exercise (Figure 1). Thus, recovery of fish during livewell confinement appears to be optimized when oxygen levels are maintained and water temperatures remain close to the temperature to which fish are acclimated. Changes in water temperature, low oxygen, and elevated oxygen impair recovery from exercise and should therefore be avoided.

In support of this theory, simulations of angling tournaments using both walleye (Killen et al. 2006) and largemouth bass (Suski et al. 2005) showed that full physiological recovery from angling-induced exercise is possible even if fish are held in livewells for 6 hours without

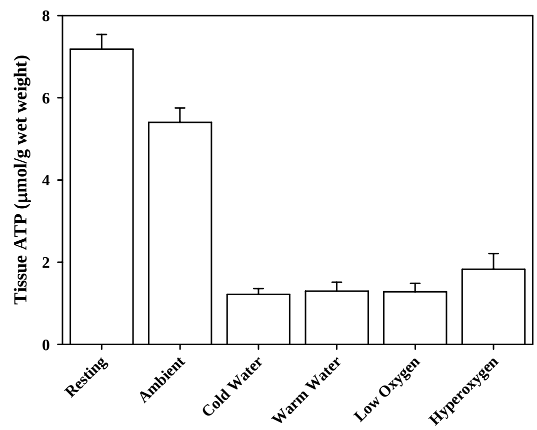

Figure 1. Concentration of adenosine triphosphae (ATP) in white muscle for largemouth bass exercised and allowed to recover for 2 h in different aquatic environments. Resting refers to undisturbed (control) fish, and ambient refers to fish recovered in fully oxygenated water at acclimation temperature. Cold water refers to largemouth bass recovered for 2 h in water 11° C below their acclimation temperature, Warm water refers to fish recovered for 2 h in water above their acclimation temperature, Low oxygen refers to fish recovered 2 h in water with low dissolved oxygen, and hyperoxygen refers to fish recovered 2 h in water with high quantities of dissolved oxygen. This figure was recreated from Suski et al. 2006.

the addition of supplemental oxygen. In the studies by Killen et al. (2006) and Suski et al. (2005), fish were first exercised for 1 minute to replicate angling, and then transferred to a livewell on a boat and driven around a lake for 6 h. During livewell confinement, 3-4 fish were held in the livewell and the aerator was regularly turned on to maintain an acceptable oxygen concentration. Despite the elevated activity rates of fish during livewell confinement as observed by Suski et al. (2005) (especially largemouth bass), fish were capable of full physiological recovery from angling during the 6 h livewell confinement (Figure 2) reinforcing the finding

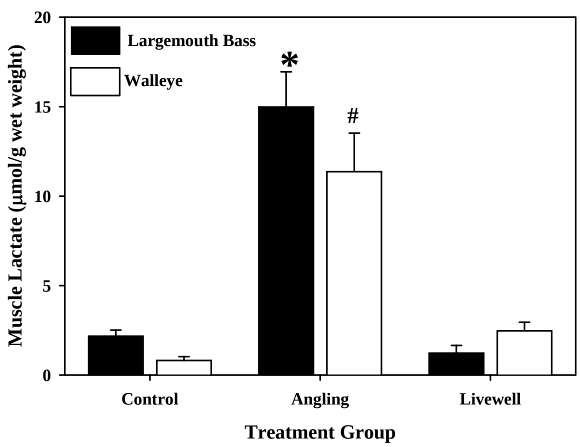

Figure 2. Quantity of lactate in white muscle for largemouth bass (filled bars) and walleye (open bars) that were exercised to replicate angling (Angling treatment), and then allowed to recover for 6 h in a livewell on a fishing boat that was driven around a lake (Livewell treatment). An asterisk (*) refers to a significant increase in muscle lactate in largemouth bass following exercise, and a pound sign (#) refers to a significant increase in muscle lactate for walleye following exercise. During the 6 h recovery period, the aerator was regularly switched on to ensure adequate aeration in the livewell. This figure was recreated from Killen et al. (2006) and Suski et al. (2004).

that recovery from exercise appears to be optimized in fully oxygenated water at ambient temperatures during the period of livewell holding.

Weigh-Ins

At almost all angling tournaments, a common problem faced by organizers is how to move fish from a competitor's boat to the weigh scale – a distance that can be quite sizeable in some tournament situations. For many organizers, the solution is to transport fish in water-filled plastic bags. Research by Killen et al. (2006), however, has shown that water quality in these fish-filled transport bags can deteriorate very quickly. More specifically, Killen et al. (2006) showed that 5 walleye (approximately 3.6 kg, or 8 lbs total weight) held in plastic transport bags at 22° C (72° F) may reach sub-optimal levels of dissolved oxygen after approximately 6-8 minutes of confinement. This rate of water quality degradation will be accelerated at higher temperatures (due to the elevated metabolism of the fish and reduced oxygen available in the water), and if heavier weights of fish are contained in the bags (Figure 3).

To prevent exposing fish to low oxygen from transport bags, there are several possible solutions that can be employed. One simple remedy to minimize the amount of time fish spend in transport bags is to limit the number of competitors that leave their boats and stand in lines to weigh their fish. As discussed above, a properly aerated livewell provides a well-oxygenated environment for fish, and organizers

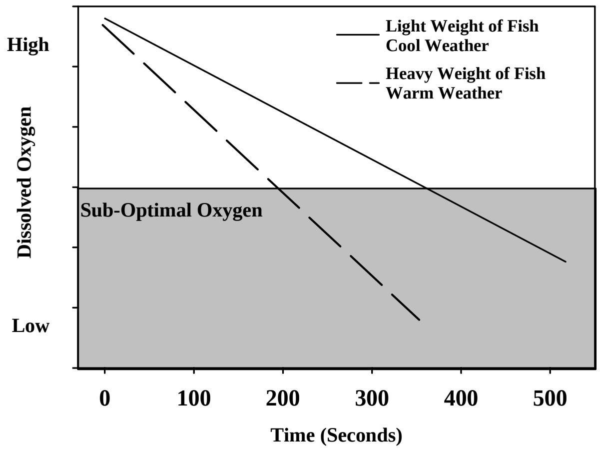

Figure 3. Representation of the decline in dissolved oxygen in water-filled transport bags that would occur with fish held in plastic transport bags for extended time periods. The solid line represents the decline in dissolved oxygen that would be expected for a light weight of fish on a cool day, while the dashed line represents the decline in dissolved oxygen that would be expected for a heavy weight of fish on a warm day. The shaded region of the graph represents sub-optimal dissolved oxygen concentrations that should be avoided.

should therefore work to minimize the number of competitors that leave their boats and stand in line prior to the weigh-in. As well, supplemental transportable air stones can be placed in transport bags for those anglers that do need to stand on shore, or bags can be eliminated completely with fish held in perforated, rigid plastic containers placed in aerated troughs. These preventative measures are particularly important in warm weather or with large weights of fish.

Live Release Boats

Following the weigh-in, many tournaments rely on live-release boats (or trucks equipped with tanks of water) to distribute fish around the waterbody. If tournament organizers are not careful, however, the water quality in these transport vehicles can degrade very quickly. Similar to other instances discussed above, the two main ways that water quality can degrade in live-release vessels is due to low dissolved oxygen and increased ammonia, and these factors are more problematic when large numbers of fish are held in warm conditions without adequate water exchange. Recent work has shown that ammonia can accumulate in live-release boats to a point that can have negative sub-lethal impacts on largemouth bass, impairing their ability to recover from the disturbances associated with the weigh-in (C.D. Suski and B. L. Tufts, unpublished data).

To prevent declines in water quality on live-release vessels, there are several steps that can be taken by tournament organizers. First, we suggest that live-release boats should have the potential to receive a continuous supply of water through a submersible pump (similar to the design of a livewell) rather than simply filling the live-release boat prior to the weigh-in and then allowing fish numbers to accumulate without any water changes. A regular exchange of water on the live-release boat will work to prevent ammonia accumulations and maintain dissolved oxygen at optimal levels. Next, we strongly recommend that all tournament organizers monitor dissolved oxygen concentrations and temperature on board live-release vessels with a combination dissolved oxygen/temperature meter. Dissolved oxygen meters are simple to use, easy to maintain, reliable, and inexpensive.

More importantly, these meters are the only way to confidently measure dissolved oxygen in water. If the numbers of fish in the live-release boat are high or if the tournament is occurring in warm conditions, monitoring water quality on board the live-release boat with a dissolved oxygen meter will allow tournament organizers to determine if water quality is declining outside optimal ranges for tournament fish species. Should dissolved oxygen levels continue to drop, we recommend a reduction of fish density in live-release boats (either by releasing accumulated fish or by adding additional tanks) or increasing the rate of water exchange through the live-release tanks.

Conclusions

Anglers and tournament organizers have a responsibility to provide the best care possible for their fish, and to ensure their safe return to the water in support of conservation efforts and sustainable recreational fisheries. Maintaining adequate water quality during an angling tournament will prevent fish from being exposed to several sub-lethal stressors (including low oxygen), reducing the exposure of fish to sub-lethal stressors, and likely resulting in increased survival.

Summary and Recommendations

- Use an oxygen/temperature meter to quantify dissolved oxygen levels and temperature in all situations where fish are held.
- Don't add ice to livewells.
- Don't add supplemental oxygen to livewells.
- Run livewell aerators regularly (even constantly) to maintain water quality.
- Minimize holding times in weigh-in bags – an adequately aerated livewell is preferable to confinement in water-filled bags.
- Weigh fish in water rather than in air.
- Exchange water on the live-release boat regularly.

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Decompression Issues for Bass: Implications for Angling and Tournament Events

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Abstract Catch-and-release angling has become a well-practiced conservation measure among anglers. Although catch-and-release has become very popular, the success of this conservation tool requires that fish are released in good condition. Many previous studies have shown that, in most circumstances, fish will fully recover from angling within a relatively short period of time. One possible exception, however, may arise when fish are angled from deep water. Previous research indicates that decompression may influence the survival of bass following angling. At present, however, there is still very little information about the impacts of angling fish from deep water. This paper summarizes a series of investigations into the physiological consequences of decompression in smallmouth bass (*Micropterus dolomieu*). Results from these studies indicate that decompression is not a significant concern when tournaments are held on shallow bodies of water. Where tournament anglers have access to deep water, however, significant numbers of smallmouth bass exhibit external signs of decompression (blood hemorrhaging and bloating) following the tournament weigh-in. Smallmouth bass showing these signs of decompression also experience significant internal physiological changes (characterized by tissue and red blood cell damage and a larger anaerobic disturbance) relative to non-decompressed fish. Further experiments also confirmed that these physiological changes were likely caused by angling smallmouth bass from relatively deep water.

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Introduction

To conserve recreational fish populations, fisheries managers routinely implement regulations such as harvest limits, seasons, length limits, and stipulations to angling methods (Post et al. 2002). Another option for managers is the promotion of live-release angling – where fish are returned to the water rather than harvested. Live-release regulations allow angling opportunities while avoiding the negative population level impacts associated with harvesting fish. Fortunately, numerous studies demonstrate that most recreational fish species appear to recover and survive following angling under normal conditions, and can be caught repeatedly (Quinn 1996, Muoneke and Childress 1994). Due to the recent success and wide acceptance of catch-and-release as a fisheries management technique, live-release is now an integral component of conservation strategies designed to promote the development of sustainable fisheries.

Conventional Angling Disturbances

Although the practice of live-release has gained notoriety over the last decade, the efficacy of this fisheries conservation strategy requires that fish survive following release (Cooke et al. 2002). The processes involved in a catch-and-release event generally include hooking, playing, landing, and release of fish. Each of these processes probably contributes to the physiological disturbance in released fish (Muoneke and Childress 1994, Kieffer 2000, Ferguson and Tufts 1992). In addition, various exogenous and endogenous factors such as water temperature and chemistry (Kieffer et al. 2002), angling during the reproductive period (Booth et al. 1995, Kieffer et al. 1995), and species-specific physiological differences (Furimsky et al. 2002) can exacerbate the physiological response to angling and influence the condition of fish following release.

Another factor that can influence the outcome of a catch-and-release event is decompression. As a result of angling in deep water, an angled fish can undergo rapid pressure changes due to movement through the water column to the surface. Changes in ambient hydrostatic pressure are equivalent to 1 atmosphere per 10 m of water (or 1 ATM = 1.03kg/cm^2). This rapid change in ambient pressure has been documented to cause a range of morphological and physiological changes to fish, and possibly lead to mortality in fish angled from deeper waters.

More specifically, decompression studies involving fish have documented several physiological complications such as damage to vital organs and arteries (Feathers and Knable 1983), external hemorrhaging (Feathers and Knable 1983), gas bubbles in the circular system and vital organs (Philip1974, Casillas et al. 1975, Feathers and Knable 1983), and tissue damage (Morrissey et al. 2005, Esseltine et al. unpublished manuscript). Decompression is believed to have more severe morphological effects on physoclistus fishes (fish with a “fixed” or swim bladder such as smallmouth bass) relative to physostomus fishes (e.g. lake trout) which posses a pneumatic duct connecting their swim bladder to their esophagus allowing for the release of excess gas from the swim bladder during an ascent from depth. The change in ambient pressure associated with deep water angling causes the "fixed" swim bladder in physoclistus fish to expand, resulting in bloating, and loss of equilibrium. This often results in the fish floating on the surface following angling. This expansion of the swim bladder can also place direct pressure on internal organs possibly impairing survival of decompressed fish (Feathers and Knable 1983, Lee 1992, Keniry et al. 1996, Shasteen and Sheehan 1997, Kerr 2001).

Based on this background, our research on decompression had the following objectives: 1) To compare the incidence of decompression in smallmouth bass following tournament events held on shallow and deep lakes; 2) To quantify the level of physiological disturbance resulting from decompression at deep water tournament events; and, 3) To quantify the level of physiological disturbance directly associated with angling smallmouth bass from various depths. By improving our understanding of the nature of the physiological disturbances that accompany decompression, we would ultimately be in a position to determine the best ways to minimize the impacts of decompression in live-release recreational fisheries.

Methods and Results

(1) Incidence of decompression on shallow vs. deep lakes

Decompression could be a common phenomenon following tournament events held on relatively deep bodies of water. To test this hypothesis, we attended tournaments on Rice Lake (mean depth 2.6 m) and Lake Erie/Lake St. Clair (mean depth 7.4/3.0 m) to visually assess smallmouth bass for external signs of decompression following the weigh-in on relatively shallow and deep lakes. External signs of decompression include hemorrhaging on the mouth, fins and body as well as swim bladder expansion as indicated by equilibrium loss (see Feathers and Knable 1983). Our observations from various tournament events demonstrate that smallmouth bass captured at live-release angling tournaments held on deep waterbodies express higher rates of external signs of decompression (Table 1).

Table 1. Incidence of two or more decompression signs (see Feathers and Knable 1983) in smallmouth bass following live-release angling tournaments on shallow (Rice Lake) and deep (Lake Erie/Lake St. Clair) bodies of water in southern Ontario. Figure recreated from Morrissey et al. 2005.

Lake	Category	Mean Depth (m)	% Bass Showing Two or More Signs of Decompression
Lake Erie/St. Clair	Deep	7.4/3.0	56.5%
Rice Lake	Shallow	2.6	1.9%

(2) Level of physiological disturbances associated with decompression

For the second study, we sampled smallmouth bass for physiological indicators of decompression disturbances following the weigh-in from tournaments held on deep bodies of water. We compared the physiological profile of smallmouth bass showing no outward signs of decompression ('non-decompressed') to smallmouth bass demonstrating the signs of decompression listed above ('decompressed'), and these groups were compared to resting smallmouth bass held in the laboratory ('control'). Physiological examinations of these groups of smallmouth bass demonstrated that smallmouth bass showing decompression signs also experience a greater physiological disturbance relative to control and non-decompressed bass following the tournament weigh-in (Figure 1). This physiological disturbance is characterized by cellular and tissue damage as indicated by the presence of intracellular enzymes (lactate dehydrogenase [LDH], creatine phosphokinase [CPK], and aspartate aminotransferase [AST]), red blood cell damage, and an elevated anaerobic disturbance following the weigh-in at deepwater angling tournaments – all indicative of decompression in fish.

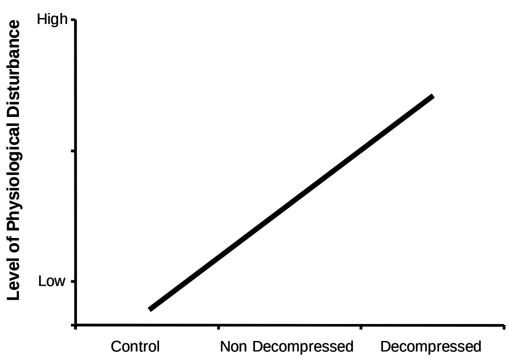

Figure 1. Combined physiological parameters (lactate dehydrogenase [LDH], creatine phosphokinase [CPK], aspartate aminotransferase [AST], and lactate in the plasma of control, non-decompressed, and decompressed smallmouth bass following live-release angling tournaments held in southern Ontario. Figure recreated from Morrissey et al. 2005.

(3) Physiological disturbances after angling from various depths

Because the physiological condition of smallmouth bass following tournaments on deep waterbodies may be influenced by conditions encountered in the tournament such as fish handling and livewell confinement, we also determined the physiological condition of smallmouth bass angled from various depths. To fulfill this third objective, smallmouth bass were first angled from 3 depth ranges: shallow (<2m), intermediate (5-8m), and deep (15-22m). These fish were then immediately placed in a livewell for an 8 hour holding period, examined for external signs of decompression (blood hemorrhaging and swim bladder expansion), and sampled for physiological parameters as above. Results relative to control values and additional depth treatments show that smallmouth bass angled from the deeper depth range exhibited significant changes in tissue damage (LDH, CPK, AST), swim bladder expansion, red blood cell damage, and a larger anaerobic disturbance following the 8 hour livewell holding period (Figure 2).

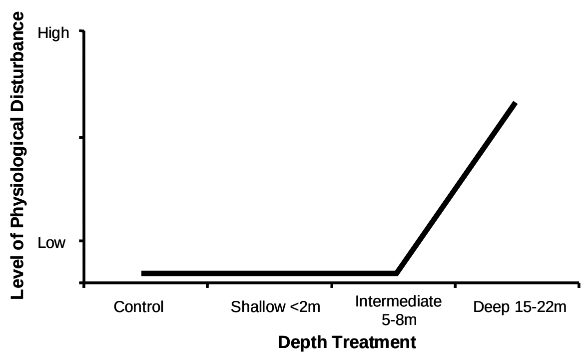

Figure 2. Generalized physiological profile (Lactate dehydrogenase [LDH], creatine phosphokinase [CPK], and, aspartate aminotransferase [AST] activities, and hemoglobin and lactate concentrations in the plasma) of smallmouth bass after angling from shallow, intermediate, and deep depth treatments. All smallmouth bass were recovered in a livewell for an 8-hour recovery period prior to sampling to replicate an angling tournament day following angling from depth. Figure recreated from Esseltine et al. (unpublished data).

Conclusions

Collectively, these three studies show that bass caught in tournaments held on deep bodies of water are prone to decompression disturbances. In addition, we have obtained evidence that common angling depths for smallmouth bass may produce a physiological disturbance characterized by cellular damage and swim bladder expansion. Further, the retention of smallmouth bass in livewells at surface pressure seems to impair recovery and exacerbates the physiological symptoms of fish angled from deep water.

Fish mortality following tournament events is largely believed to be caused by multiple, cumulative disturbances encountered by fish through the tournament event (Suski et al. 2003). The results presented in these studies demonstrate that decompression is another factor that may add to the physiological disturbance experienced by fish involved in tournaments. Although decompression may impact the physiological condition of angled bass, it is important to note that we have also found that these disturbances may often be sub-lethal. Taken together, these studies have improved our understanding of the nature of the physiological disturbance in fish angled from depth. At present, however, there is still much to be learned about the impacts of decompression in angled fish. It is our hope that this information will ultimately be used to develop strategies to release bass angled from depth in the best possible condition.

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The Physiological Impacts of Tournaments

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Abstract We describe results of a large scale project designed to evaluate physiological impacts associated with tournament angling practices. The project involved both laboratory and field components. Tournament practices were found to result in large reductions in energy reserves and substantial increases in lactate, a metabolic waste. The most significant amount of metabolic disturbance was experienced during the weigh-in and live release phases of a typical tournament. We conclude that the primary cause of fish mortality at tournaments arises from sequential bouts of hypoxia associated with confinement in transport bags, air exposure during the weigh-in, and confinement at high densities in live release boats. Smallmouth bass were more sensitive to hypoxia than largemouth bass. We describe a new water weigh-in system which is both accurate and less stressful for angled fish.

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Introduction

Most live-release angling tournaments are successful at releasing the vast majority of their catch alive at the end of the day. In some situations, however, significant levels of mortality have also been reported (Wilde 1998). Although there has been considerable research effort over the years directed towards improving our understanding of tournament mortality and the biological impacts of tournaments on fish, there were still many questions that remained unresolved prior to our recent research in this area. For this reason, we undertook a large scale project to address many of these critical issues. Some of the most important questions that we hoped to answer during the course of these studies were as follows: (1) What is the general physiological condition of most fish after tournaments? (2) What is the physiological reason for fish mortality in tournaments? (3) What tournament practices are most stressful for fish, and (4) Can tournament practices be altered to minimize stress?

Unlike the vast majority of previous studies in this area that had primarily monitored fish mortality, our general approach to these studies involved the monitoring of a wide range of physiological variables to gain insight into the physiological condition of fish in different tournament situations (Suski et al. 2003, Suski et al. 2004).

This large scale project also incorporated both laboratory and field experiments (Suski et al. 2004). In our opinion, this approach had a number of advantages over previous studies in this area. Using this approach, for example, we were able to conduct highly controlled laboratory studies where we manipulated only one experimental parameter. This laboratory approach allowed us to clearly identify specific factors that affected the magnitude of the physiological disturbance in tournament fish. This physiological approach was also much more sensitive than simply monitoring mortality and would therefore allow us to identify significant sub-lethal impacts that may affect other aspects of fish biology (e.g. behaviour, disease resistance, etc.). In the following sections, we describe the most important findings from this recent project.

What is the Physiological Condition of Fish after tournaments?

Our first study in this area examined the physiological condition of largemouth bass immediately following the weigh-in at a number of different tournaments (Suski et al 2003). As in many of our previous studies on the impacts of catch-and-release angling, we monitored a wide range of variables to gain insight about the nature of the physiological disturbance that occurs in largemouth bass following live-release tournaments and the magnitude of the changes in comparison to those following other types of disturbances.

The most striking changes among the variables that we monitored in largemouth bass following tournaments were associated with their metabolic status (Figure 1). Tournaments caused large reductions in the concentrations of several important muscle energy reserves. Specifically, the concentrations of white muscle PCr, ATP and glycogen were reduced by 92, 60 and 75%, respectively, following the weigh-in (Figure 1). There was also a large increase in the anaerobic end product, lactate, in bass sampled after the weigh-in. Interestingly, the nature of the metabolic disturbance in bass after tournaments was very similar to that in fish that have been exercised to exhaustion (Wang et al 1994, Kieffer et al. 1995, Milligan 1996). This explains why many bass appear to be very lethargic following the weigh-in at live-release tournaments.

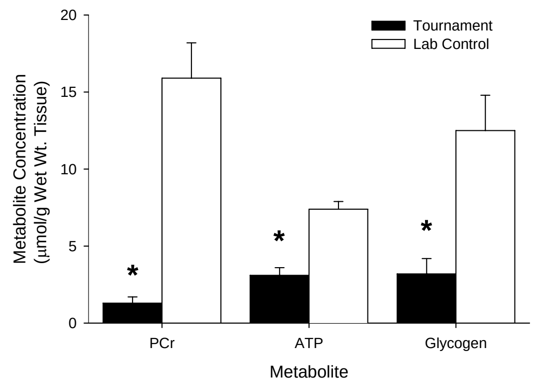

Figure 1. White muscle metabolite levels for largemouth bass sampled following the weigh-in at a live release angling tournament (N=11) and lab control (resting) largemouth bass (N=8) . Figure modified from Suski et al. (2003)

Because bass are normally only angled for very brief periods in tournaments, and the angling event often occurs many hours prior to the weigh-in, our results suggested that other factors, such as livewell confinement, handling and air exposure during the weigh-in, may be important factors contributing to the metabolic disturbance in tournament fish. Further studies were therefore conducted to determine which aspects of live-release tournaments were causing this large metabolic disturbance in bass.

Dissecting a tournament

Several approaches have been used by our lab to determine the components of live-release tournaments that are responsible for the large metabolic disturbance experienced by tournament-caught fish. The first of these approaches involved a controlled laboratory and field experiment that simulated an angling tournament and allowed us to sample fish following each of the main tournament components (Suski et al 2004). This study showed that the weigh-in was a major factor contributing to the large metabolic disturbance in tournament fish. Additional laboratory experiments and on-site field measurements were then conducted to determine the relative importance of different aspects of the weigh-in. These experiments identified three major problem areas in the traditional weigh-in process.

The first potential problem area in the traditional weigh-in process is the plastic bag system that is commonly used to transport fish from the boats to the weigh-in stage. Depending on the size of the tournament, the convenience of the weigh-in site, and the general organization of the weigh-in, anglers may often spend several minutes waiting to weigh their catch while their fish are confined in plastic bags.

The rate of oxygen consumption by fish contained in these bags is substantial and a typical limit of bass can deplete the oxygen in the bag within a very short time (Figure 2). If the fish end up being held in the bags for an extended period of time, it is therefore likely that the water in the bags will become very hypoxic.

The second area that we identified as a problem within the traditional weigh-in process was the extended period of air exposure that the fish often experience while being weighed or photographed. As first shown by Ferguson and Tufts (1992), air exposure can significantly increase the physiological disturbance in exhausted fish. Results from another

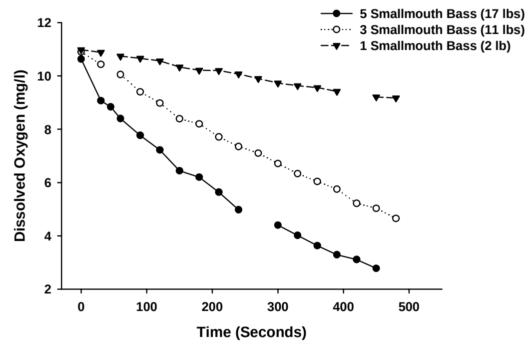

Figure 2. Decline in dissolved oxygen over time for 1, 3 or 5 smallmouth bass held in plastic transport bags.

series of weigh-in simulation experiments that we conducted indicated that removing bass from water also had a large impact on the metabolic disturbance arising from the weigh-in (Figure 3).

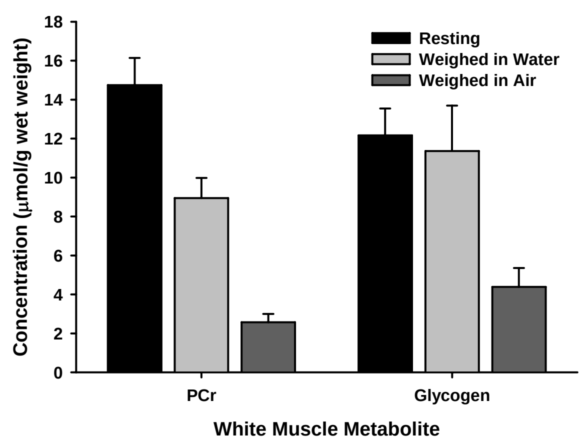

Figure 3. Tissue PCr and tissue glycogen concentrations of largemouth bass sampled following either air or water treatments during a simulated angling tournament weigh-in. Figure modified from Suski et al. (2004).

The final aspect of the traditional weigh-in format that we identified as problematic was the live-release vessel used to distribute fish following the weigh-in of many angling tournaments. Although attempts were always made by tournament organizers to aerate the holding tanks on these vessels, we found that the large numbers of big fish added to these vessels during the course of the weigh-in often caused substantial changes in water quality. In some cases, for example, the water contained on the live-release boats had become extremely hypoxic prior to the time that the fish were released (Figure 4). While the water quality in live-release boats did not consistently reach lethal levels for the target species, these findings clearly identify another serious area of concern because these vessels typically contain hundreds of the most valuable fish in a particular water body. It is likely that these results would also apply to any type of holding tank used to redistribute fish following a tournament.

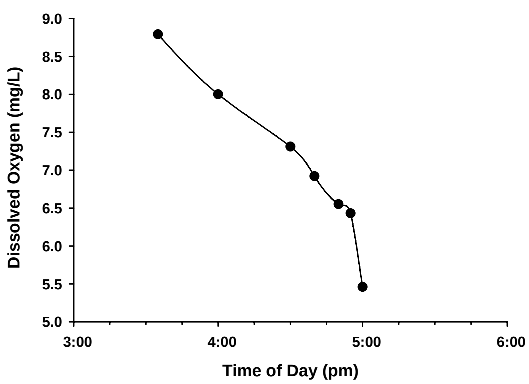

Figure 4. Decline in dissolved oxygen over time for smallmouth bass and largemouth bass held on board a live-release vessel used during a live-release angling tournament.

Mortality at Tournaments

Based on the results of our studies, we believe that the primary reason for fish mortality at some tournaments is probably severe bouts of hypoxia. The main areas within the traditional tournament format that probably contribute to hypoxia in tournament fish include: (1) confinement in transport bags, (2) air exposure for weighing and/or photographs and (3) confinement in live-release boats or holding tanks. Interestingly, fish are typically exposed to all three of these tournament components in sequence. Thus, it is likely that fish are often exposed to sequential bouts of severe hypoxia at some events. In our opinion, this potential combination of hypoxic stresses is a major problem with the traditional tournament format that will contribute to fish mortality in some situations.

Species Differences

Anecdotal observations suggest that some species of fish are much more tolerant of tournament procedures than others. According to the tournament organizers that we worked with during the course of this project, smallmouth bass are typically less tolerant of tournament practices than are largemouth bass. Based on these observations, we designed a series of experiments to determine whether the different tolerance of these two black bass species for tournament procedures could be explained by interspecific differences in their sensitivity to hypoxia. As predicted, smallmouth bass were found to be less capable of dealing with progressive hypoxia than largemouth bass (Furimsky et al 2003). These findings explain why smallmouth bass often appear to be in worse condition than largemouth bass immediately following the weigh-in. These findings also provide additional evidence that hypoxia is one of the most important problems during live-release tournaments.

A New Weigh-In Process

In view of the fact that the traditional weigh-in format was found to include several potential problem areas, another aspect of this project was to design a new weigh-in process. This new weigh-in procedure has become known as the "Shimano Water Weigh-In System" and is described in detail in an information booklet produced by Shimano Canada Ltd. (Tufts and Morlock, 2005). The main goals of the new "water weigh-in" system were to eliminate the major problem areas of the traditional weigh-in format.

In the new water weigh-in process, an aerated trough system is used to hold fish prior to the time that they are weighed. This largely eliminates the need to hold fish in bags, except for the brief period when they are moved from the livewells to the troughs. We also developed a procedure where fish can be weighed in water, rather than in air. This simple procedure is described in detail in the weigh-in booklet (Tufts and Morlock, 2005). The basic principle involves taring (zeroing) a basin of water and a weigh-in basket and then inserting a weigh-in basket of fish into the basin. The end result is that the weight obtained is solely attributable to the fish in the weigh-in basket, assuming that all the weigh-in baskets used have similar weights. Multiple trials were conducted in our laboratory to determine the accuracy of this method of weighing fish in comparison to the traditional method. The new "water" method was found to be just as accurate and also much faster because the fish settle down immediately on the weigh scale (because they are in water).
The final portion of the traditional weigh-in format that needed improvement was the live-release vessel, or other holding tanks, used to accumulate fish following the weigh-in and prior to release. Because these boats, or tanks, will typically hold large numbers of the biggest fish in a waterbody, it is essential to closely monitor their water quality in order to maintain fish in the best possible condition prior to release. Another component of the new weigh-in system therefore involves frequent measurements of critical variables, such as oxygen and temperature, in the live-release boats, or tanks, used to hold the fish until they are released. This strategy ensures that tournament personnel will quickly detect any significant changes in water quality which can then be corrected through a variety of means. It is also interesting to note that the tournament circuit that we worked with during much of this project has now purchased new live-release boats with much improved aeration systems.

Conclusions

The most significant physiological consequence for most fish after tournaments is probably the large metabolic disturbance. The combined results of our studies indicate that this metabolic disturbance is likely a result of significant bouts of anaerobic activity during the weigh-in. In our opinion, the sequential bouts of hypoxia arising from several stages of the traditional weigh-in process are probably the biggest potential problem for fish in tournaments. The new Shimano "water weigh-in" process, developed as a result of these studies, will minimize this problem and vastly improve the physiological condition of fish following tournaments. Interestingly, the reason that some species are less tolerant of tournaments can be primarily explained by their different tolerances for hypoxia.

Recommendations for Tournament Organizers

As a result of our large scale project on tournaments, we have developed a number of recommendations for tournament organizers. These recommendations are described in detail, in lay terms, in the Shimano "Water-In" Guide, which was produced following these studies. Rather than re-iterate all of these recommendations, we strongly recommend that all tournament organizers should obtain and read this guide (available online at: http://fish.shimano.com/publish/content/fish/sac/us/en/why_shimano/environmental_statement.-MainContent-0011-DownloadFile.tmp/Shimano%20Weigh-In%20Brochure%20.pdf.pdf#search=%22water%20weigh-in%22). Two of the most important recommendations are also worth emphasizing here. First, we recommend that all tournaments should dedicate at least one person entirely to fish care issues at the weigh-in. In addition, we recommend that all tournament circuits purchase a reliable oxygen meter, and learn how to use it, so that water oxygen levels can be carefully monitored at all stages of the weigh-in.

Acknowledgements

Once again, we extend our sincere appreciation to Shimano Canada who had the foresight to fund this project to protect the resource. We also extend our appreciation to several tournament circuits, including the Canadian Fishing Tour and Bassmania, who allowed us to conduct field studies at their events. This project was also funded by an NSERC CRD grant to BLT. Last, but not least, we would like to thank "Big Jim" who was able to provide us with fish for these experiments, when no one else could catch them.

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Practical Applications of Tournament Data for Fisheries Management

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Abstract Although tournaments are numerous and popular with anglers in Ontario, they have been largely ignored or underutilized as a source of fisheries management information. Since 1992, the Kenora District of the Ministry of Natural Resources has monitored and sampled smallmouth bass and largemouth bass captured during the Kenora Bass International tournament held annually on Lake of the Woods. This program has proven to be an invaluable tool providing an abundance of life history information to local fisheries managers. We now have a better understanding of the Lake of the Woods bass fishery and with annual monitoring of the tournament we can evaluate the effectiveness of our management actions by analyzing trend-through-time data. The data collected from the tournament has also been used to understand and provide solutions to fisheries management issues. In 2001 Lake of the Woods bass anglers were concerned with a decrease in the size of bass caught. Anglers attributed this decrease in fishing quality to the overharvest of bass and inadequate regulations to protect them. Using tournament data, fisheries managers were able to demonstrate that the decrease in quality was caused by a natural phenomenon and existing regulations were achieving the high quality management objective for this fishery. This paper demonstrates, through practical examples, that tournaments are an efficient and cost-effective means to obtain fisheries management information.

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Introduction

Fisheries science is not an exact science. Fisheries managers use information from a variety of sources to measure and try to understand a foreign world (the aquatic environment). Using this information, fisheries managers develop indicators that are analyzed individually or collectively to evaluate the status of a fishery and identify what stresses the fishery may be experiencing.

Traditionally, the core of Ministry of Natural Resources (MNR) assessment programs has involved index netting projects (e.g. gill nets, trap nets, seines, trawls etc.) We favour these techniques because the information collected is unbiased and all portions of the population and fish community are sampled. Furthermore, they are the best sources of life history parameters such as growth, maturity, relative abundance, and year class strength. Unfortunately, these programs tend to be expensive and labour intensive and these two factors often limit the number of lakes and frequency they can be sampled. In addition, some capture methodologies (e.g. gill nets) can result in high mortality which may not be acceptable. Finally, some species, such as bass, may not be as susceptible to the traditional sampling gear as others.

In addition to these sampling programs conducted “directly” by MNR, we also utilize information and collect samples from the catches of anglers and commercial fishers. Although this data may be biased depending on the gear used by the commercial fishers or the angler's preference, this "indirect" source of information provides similar life history parameters and is a valued component of MNR's monitoring program. However, tournament fishing is one source of information we have been reluctant or, at the very least, have not taken advantage of. Ironically, tournaments may be the "best" or most appropriate source of information depending on the management objective. For example, if the fishery is being managed for "trophy, high quality or memorable opportunities", what better way to evaluate the fishery than to measure the fish brought in by tournament anglers. These anglers are motivated, generally more knowledgeable of the targeted species than the average angler, and are focused on catching the largest fish available in the fishery. As a result, what they bring to the "weigh in" is a good representation of what is available in that component of the fishery.

Similar to sampling commercial net fisheries, tournaments provide the opportunity to sample large numbers of fish for little investment or cost to MNR. The anglers do the "work" of collecting, while MNR's costs are limited to providing staff and sampling equipment for the duration or a portion of the tournament. Consequently, we can afford to sample the same tournament annually and thereby obtain the most prized fisheries management commodity - "trend through time data". Other advantages include low mortality (catch-and-release tournaments) and many of the same measurements (e.g. lengths, weights and aging structures) collected through our traditional sampling programs are also available through tournament sampling.

The disadvantages of catch-and-release tournaments is that no information can be collected on sex or maturity and, since the anglers are focused on catching large fish, the younger year classes are not adequately represented in the catch. However, with "trend through time data", year class strengths can ultimately be determined.

The primary objective of this paper is to demonstrate that sampling tournaments is an efficient and cost-effective tool to obtain fisheries management data. The materials and methods section will briefly describe the equipment and methodology used by Kenora District staff to monitor one tournament, the Kenora Bass International (KBI). These are meant as suggestions only and methodologies can be tailored to local situations and the types of information desired. The remaining three sections will discuss results from the generic to a specific case history. Section 1 illustrates a variety of "typical" fisheries data used by managers to evaluate fisheries and provide information to their clients. Section 2 demonstrates the value of "trend through time data", and Section 3 presents a case history documenting an actual management issue and how tournament data was used to identify what had happened to the fishery and what management actions were required.

Materials and Methods

The equipment (measuring board, weigh scale, knife, cutting pliers) and staff required to sample a tournament is minimal. In the case of the KBI on Lake of the Woods, three staff "set up" between the tournament weigh-in station and the boats and trucks used for post release distribution. After the bass are officially weighed in, MNR staff selects a random sample of the catch. Lake of the Woods is divided into six distinct sectors based on fish communities and water quality and anglers are asked to identify which sector the bass were captured in. This allows the organizers to return bass to their "home" sector and provides MNR the opportunity to evaluate bass populations in the different sectors. Both largemouth bass (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*) are sampled.

A three person team can comfortably sample 500 to 700 bass daily without delaying the tournament or causing undue stress to the fish. In addition to the sector locations, total length (mm) and weight (grams) are measured and an aging structure (scales and/or dorsal spines) is taken from each bass. Scales are taken from all bass and dorsal spines are taken from bass weighing greater than 1400 grams. Scales can be difficult to read in older individuals and spines are used to verify age. In past tournaments, we have also applied floy tags and/or radio tags to monitor the movements of displaced smallmouth and largemouth bass.

Results and Discussion

Section 1 – Diversity of Opportunities

The intent of this section is not to undertake an exhaustive review or interpretation of data, but instead to illustrate, using examples and basic analysis, the diversity of information that can be collected and how it can used for practical fisheries management. Besides the obvious benefits of evaluating the status of a fishery, this information is invaluable for extension work. All biologists are frequently asked questions by anglers, such as: "how old does a bass live to"; "how old is a one kg. bass"; "how much does a seven year old bass weigh"; "which lake produces the biggest bass", etc. Again, tournaments can provide much of this basic information.

Comparisons of smallmouth bass length and weight vs. age

Figures 1 and 2 compare smallmouth bass length and weight with age. The solid line represents the mean (average) length or weight at age, while the vertical bars illustrate the range of lengths and weights that can occur at any given age.

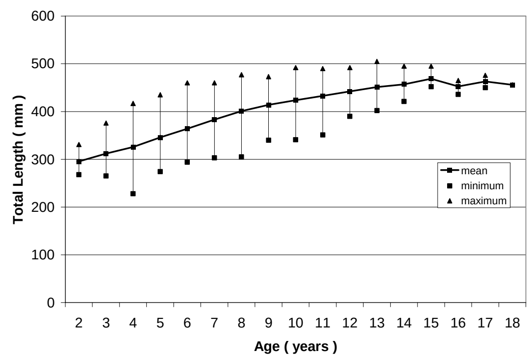


Figure 1. Lake of the Woods smallmouth bass total length vs. age based on KBI samples collected from 1992 to 2002.

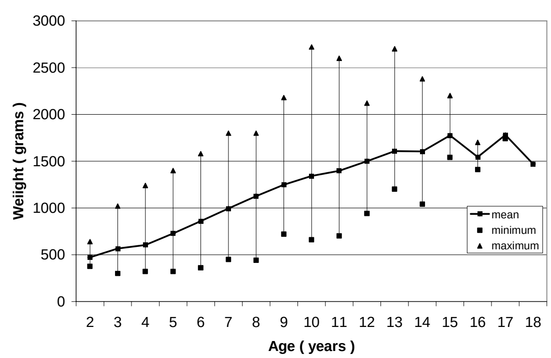


Figure 2. Lake of the Woods smallmouth bass weight vs. age based on KBI samples collected from 1992 to 2002.

For example, a seven year old Lake of

the Woods bass on average is 383 mm (15 in) long and weighs 994 grams (2.2 lbs). However, within this age class the size can range from as small as 303 mm (11.9 in) and 450 grams (1 lb) to as large as 460 mm (18.1 in) and 1800 grams (4 lb). Maximum length and weight can be easily estimated by observation and Figures 1 and 2 suggest on average smallmouth bass will achieve a maximum length of 468 mm (18.4 in) and weight of 1775 grams (3.9 lb). Of course some individuals will exceed this maximum size (e.g. 505 mm and 2720 grams) but usually this is what an angler can expect from the Lake of the Woods bass fishery. The visual estimate can be refined using growth models such as von Bertalanffy and Walford (Everhart and Youngs 1981).

Comparison of largemouth bass vs. smallmouth bass growth

Figures 3 and 4 show that, at any given age, largemouth bass are longer and weigh more than smallmouth bass.

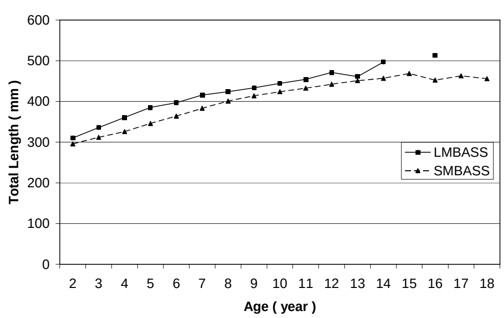


Figure 3. Comparison of Lake of the Woods largemouth and smallmouth bass mean total length vs. age from KBI samples collected from 1992 to 2002.

Usually of greater interest to anglers is the difference in weight. Largemouth bass are typically 227 to 454 grams (0.5 to 1 lb.) heavier than smallmouth bass at any age and reach weights greater than 3000 grams (6.6 lbs.) while smallmouth rarely exceed 1775 grams

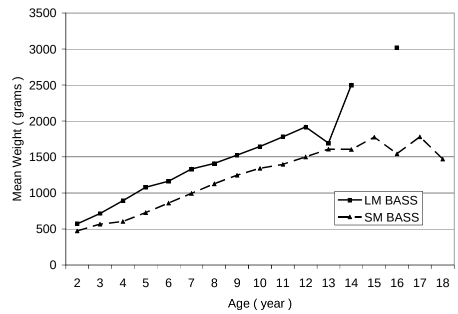


Figure 4. Comparison of Lake of the Woods largemouth and smallmouth mean weight vs. age from KBI samples collected from 1992 to 2002.

(approximately 4 lbs). Again, these estimated maximums are based on means and individuals of both species could exceed them.

Comparison of smallmouth bass growth between sectors

Figure 5 illustrates that the Sector 1 catch is dominated by younger smallmouth bass (4, 5, 6 year olds), whereas Sector 6 offers the opportunity to catch older smallmouth (7 to 11 years old). The difference in age abundance is probably a reflection of angling pressure. Sector 1 is closest to the population centre of Kenora, while Sector 6 is the furthest away.

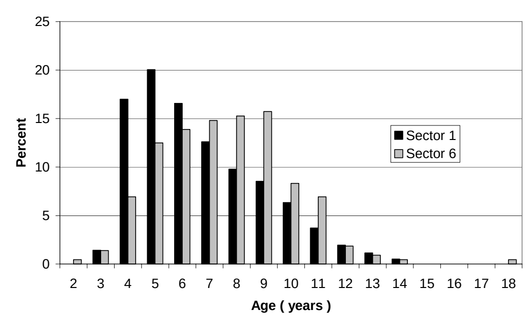


Figure 5. Comparison of smallmouth bass mean age frequency from Sectors 1 and 6 of Lake of the Woods from KBI samples collected from 1992 to 2002.

Comparison of smallmouth bass growth between water bodies

Immediately south of Lake of the Woods is Rainy Lake which also hosts a major bass tournament, the Fort Frances Canadian Bass Tournament. This event is sampled by MNR staff from the Fort Frances District. Amongst tournament anglers, Rainy Lake has a reputation of producing larger smallmouth bass than Lake of the Woods. At first glance (Figure 6) there appears to be little difference in smallmouth bass lengths between the two waterbodies. However, Figure 7 confirms that Rainy Lake smallmouth bass achieve greater weights than Lake of the Woods smallmouth bass and this difference in weight becomes more apparent after age seven. The difference may be attributed to a less complex fish community in Rainy Lake and therefore less competition for food.

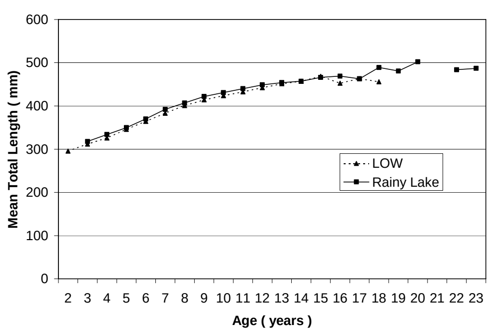


Figure 6. Comparison of smallmouth bass total length in Lake of the Woods vs. Rainy Lake (2000-2001).

After age seven, there is an acceleration in smallmouth bass growth in Rainy Lake that may be the result of diet preference and availability. On the North Arm of Rainy Lake, smallmouth bass take advantage of an abundant forage base of small fish and rainbow smelt (*Osmerus mordax*)(D. McLeod, pers. comm.) which are food items of high caloric value. Conversely, in Lake of the Woods, smallmouth bass rely primarily on crayfish (*Orconectes* spp.) a prey item of lower caloric value.

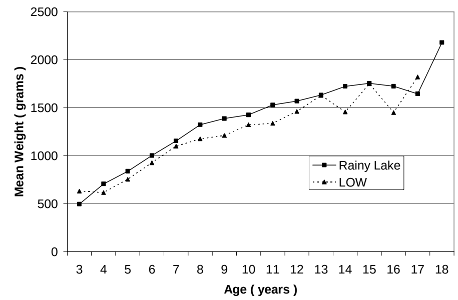


Figure 7. Comparison of smallmouth bass weights in Lake of the Woods vs. Rainy Lake (2000-2001).

Comparison of fishing quality

Using size categories is a useful technique to assess fishing quality and evaluate the effectiveness of management actions to maintain or improve quality. Gablehouse (1984) developed a length category system based on the following categories and respective size: “Quality” (28-35 cm total length), “Preferred” (35-43 cm total length), “Memorable” (43-51 cm total length), and “Trophy” (greater than 51 cm total length). Figure 8 illustrates the application of this evaluation system to the KBI data from 1992 to 2003.

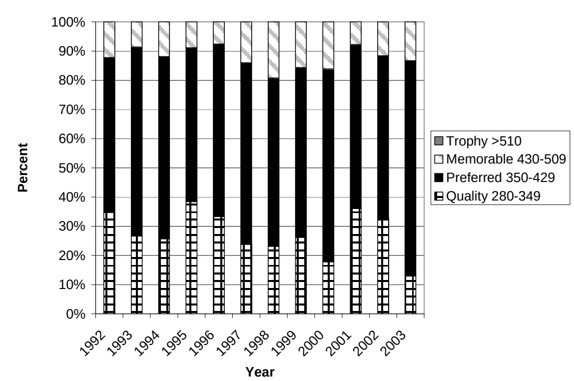


Figure 8. Lake of the Woods smallmouth bass fishing quality based on size categories.

Although a valuable tool, the size categories were developed for southern waterbodies and it would be more useful if a ranking system were developed for northern waters reflecting slower growth rates and smaller sizes. Furthermore, weight may be more appropriate than length categories since angler preference is usually based on weight.

Section 2 – Long Term vs. Single Year Monitoring

Given the choice, most biologists, would prefer long term monitoring with trend-through-time data as opposed to evaluating a fishery based on a single sampling event. As previously discussed, costs and staffing commitments generally limit the opportunities for long term monitoring programs, whereas annual monitoring of tournaments is easily achievable and affordable. Figure 9 compares age frequency distributions from the 1993 KBI and a 1993 Lake of the Woods lake-wide creel survey (Mosindy 1998).

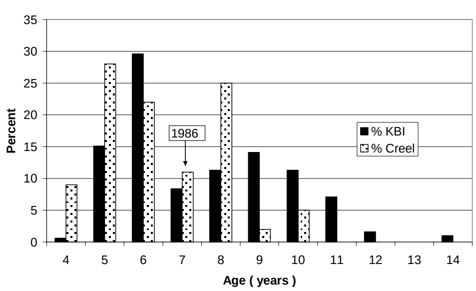


Figure 9. Comparison of smallmouth bass age frequency based on samples collected from a Lake of the Woods creel survey and the 1993 KBI tournament.

While both data sets show some similarities (e.g. weak 1986 year class), there are obvious differences. The creel data suggests erratic year class strengths and a predominance of younger bass, whereas the KBI data suggests an abundance of older year classes.

Which data set is true or more accurate? In fact, both data sets provide an accurate representation of the population sampled, if you consider the skill of the angler, the component of the fishery the angler is targeting, and the time of year when the samples were obtained. For example, the KBI data should be dominated by older bass since tournament anglers are fishing for the largest bass available and generally have a greater skill level than the average angler. Conversely, we would expect a greater percentage of smaller bass in the creel data since these anglers are selecting bass for consumption and could be fishing for other species. The creel data does reveal a slight aberration to this generality. An unusually high number of eight year old bass are represented in the creel compared to the KBI. This is probably the result of anglers harvesting large nest guarding males. Prior to 1996, harvesting was permitted while bass were nesting and past creels have shown that over two-thirds of bass harvested in Lake of the Woods occurred during the months of May and June.

More critically, Figure 9 reveals the weakness of relying on a single collection event to evaluate a fishery. The creel data suggest poor representation of older age classes and erratic year class strengths. These results imply the fishery has experienced heavy fishing pressure or widely fluctuating spawning success. Although not as dramatic, a fisheries manager might draw a similar conclusion from the 1993 KBI results. Fortunately, the tournament has been monitored every year since 1992 and the data collected confirms the value of utilizing several years of data to interpret or understand what is occurring in a fishery. Figure 10 depicts year class strengths of smallmouth bass captured in the KBI from 1993 to 1996 and the initial concerns regarding potential overharvesting are alleviated by the consistent representation of older year classes in all years sampled at the KBI. With this multi-year data set, a manager evaluating this fishery would determine that the 1985 and 1986 year classes were weak, probably the result of poor nesting success. However, good year classes in 1987, 1988, 1989, 1990 and 1991 would sustain this recreational fishery.

Section 3 – Lake of the Woods Bass Case History or Where Did All the Big Bass Go?

The previous example was presented at a competitive fishing workshop in Kemptville in 1999 (Corbett 1999). At that time, we had stated "one of the most exciting uses of the KBI data will be to evaluate the effectiveness of the 1996 catch-and-release regulation during the nesting period (June) on enhancing the quality of bass fishing in Lake of the Woods". By protecting and eliminating the harvest of large nesting males when they are the most vulnerable and in combination with strong year classes available to the fishery, MNR predicted an increase in the abundance of large bass in Lake of the Woods. The resulting increase in angling quality should be readily detectable and measurable in the tournament data. That is, if larger bass are more abundant in the population then mean weights in the tournament should increase.

Figures 11 and 12 illustrate that mean age and weight initially increased in the tournament confirming the positive prediction. However, beginning in 1998, there was an obvious and steady decline in mean age but the decline in mean weight was not as apparent and, as a result, competitors were not concerned. This pattern was confirmed and mirrored in the results of the ten top contestants. In 2001, there was a drastic decline in the mean weight and anglers were convinced something was wrong with the fishery and management action in the form of a restrictive regulation was required to stop the decline and reverse the trend.

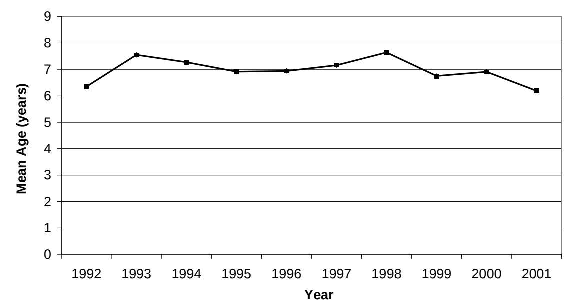


Figure 11. Mean age of smallmouth bass captured in the KBI from 1992 to 2001.

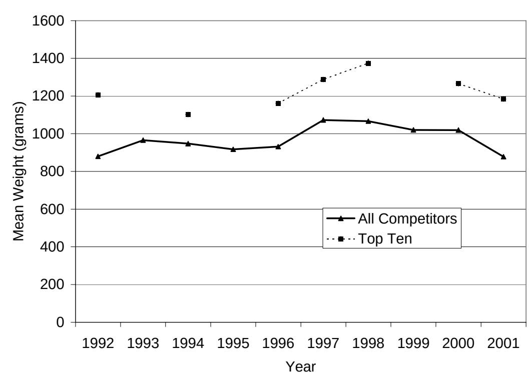


Figure 12. Mean weight of smallmouth bass captured in the KBI from 1992-2001.

A number of factors can affect fish populations but three of the most common are loss of habitat, overharvest and climate (usual in relation to spawning success). In Lake of the

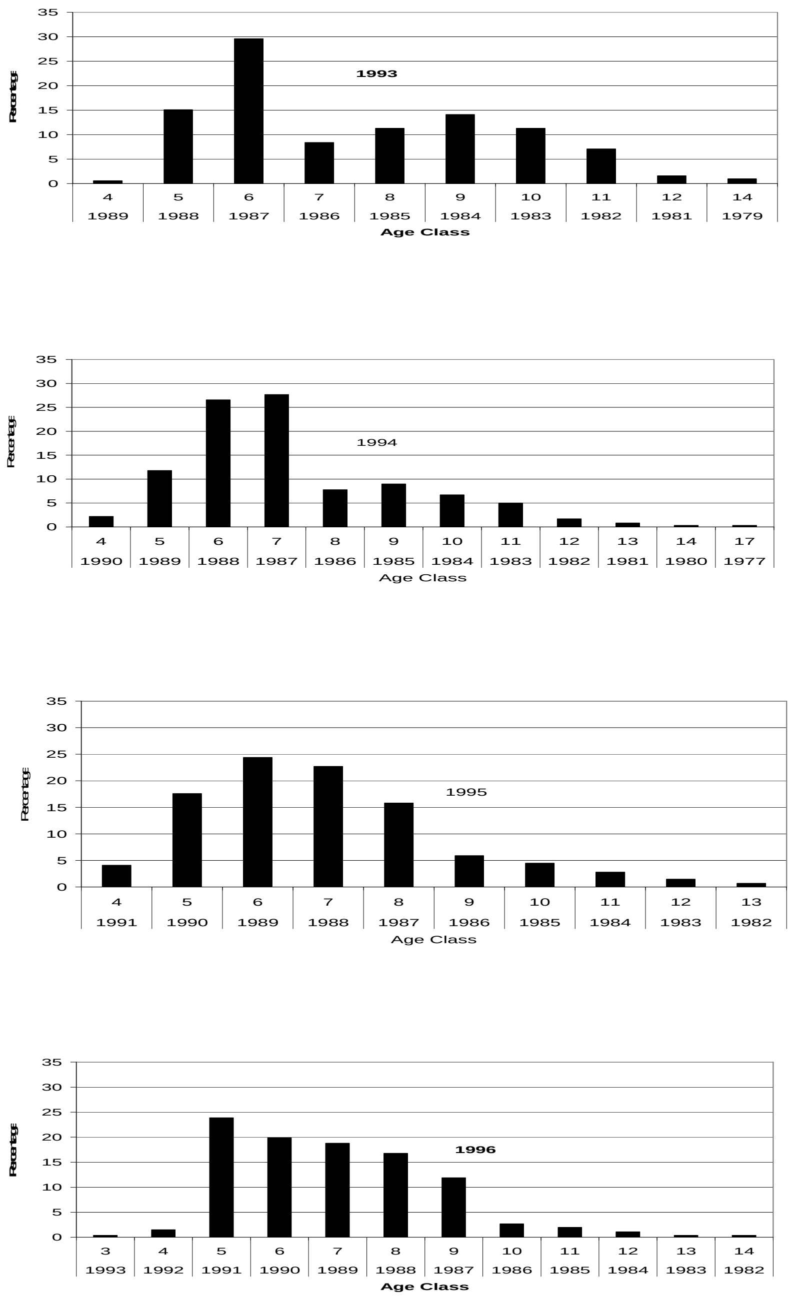
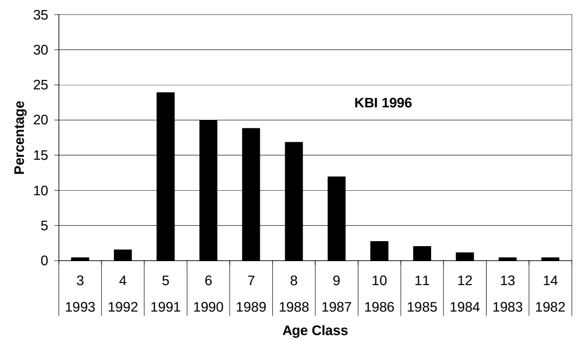


Figure 10. Year class strength of smallmouth bass captured in the KBI from 1993-1996.

Woods there is no shortage of smallmouth bass habitat and no drastic habitat changes have occurred in recent history. In fact the multitude of islands, rocky shorelines, protected bays and an abundance of crayfish make Lake of the Woods ideal smallmouth bass habitat. Although bass are harvested primarily by guests of the tourist industry for shore lunches and, to a lesser extent, by residents, harvest is well below the potential maximum sustainable yield (MSY) of 117,318 kg (258,100 lbs). In fact, angler harvest has never even approached the high quality management objective (MNR and MDNR 1998, 2004) of maintaining harvest below 25% of the MSY or 29,330 kg (64,525 lbs). From 1983 to 2001, the mean bass harvest was 11,750 kg (25,851 lbs) with a high of 20,614 kg (45,352 lbs) in 1988 and a low of 5,840 kg (12,850 lbs) in 2001.

With two of the most plausible causes eliminated, we focussed our attention on what the tournament data showed, specifically with regard to year class abundance. Typically a fishery should be dominated by an abundance of younger fish and the age frequency graph should be skewed to the left. However, since most tournaments set a minimum size limit (e.g. 12 inches) and because tournament anglers focus on catching the largest bass present in the population, a typical tournament age frequency graph should be poorly represented by the younger age classes. This results in the graph being skewed to the right with a greater representation of older fish. Simply put, if tournament anglers bring in small young bass, it is an indicator that large bass are not abundant in the fishery.

Figure 13 illustrates the 1996 and 1997 KBI age/year class frequencies and suggests a healthy tournament fishery. That is, few young few fish; no apparent weak year classes; and an array of older year classes. There is good representation of middle-aged bass (6 to 10 year olds) with representation of older year classes up to age 16.



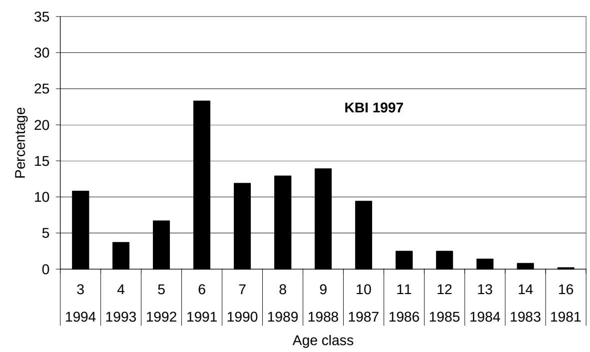


Figure 13 – Year class strength of smallmouth bass captured in the KBI, 1996 and 1997.

Figure 14 illustrates the 1998 to 2001 KBI age/year class frequencies.
In 1998, signs of concern began to show. This is apparent with the strong representation of four year old fish in comparison to five and six year old bass (1993 and 1992 year classes). Tournament anglers would not normally bring young bass in unless older bass were not abundant or available. Although we see a decrease in the mean age of the catch (Figure 11), it has not materialized in a decrease in the

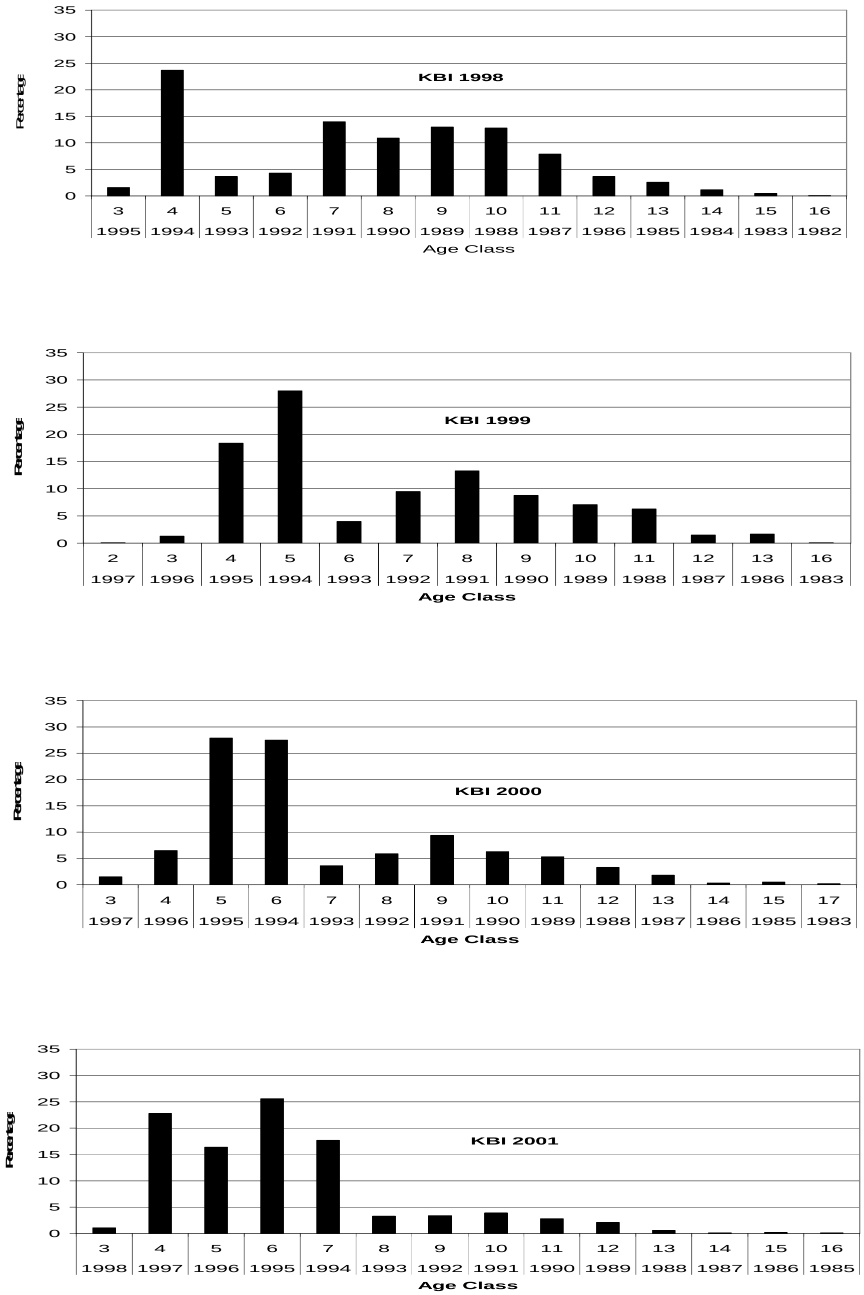


Figure 14 – Year class strength of smallmouth bass captured in the KBI from 1998-2001

mean weight of the catch (Figure 12) and as a result anglers were not aware of a problem yet. As the 1992 and 1993 year classes move through the fishery (i.e., the tournaments of 1999, 2000, and 2001) it is obvious how weak the 1992 and 1993 year classes are and how dependent the tournament anglers had become on younger age groups. By 2001, the tournament was primarily dependent on younger age classes and as a result the mean weight dropped substantially (Figure 12).

But how could the failure of two year classes (1992 and 1993) have such an effect on the tournament. More importantly, what caused poor recruitment in 1992 and 1993? Although the age/year class frequency graphs show upwards of 13-14 year classes can be present in tournament results, usually four to five year classes make up the majority of the weigh in. Figure 15 represents the cumulative age frequency of the tournament catch and reveals the importance of seven, eight and nine year old fish to the tournament. Usually, seven and eight year olds account for about 25% of the total catch and when nine year old bass are included, this increases to 34% or over one-third of the total catch.

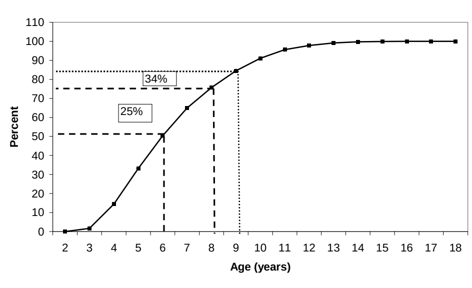


Figure 15. Cumulative age of smallmouth bass captured in the KBI from 1992 to 2002.

The average weight of seven to nine year old fish is approximately 1000 to 1300 grams (two to three lbs.) and represents the bulk of the tournament weight. When cumulative weights are plotted (Figure 16), these three ages account for 27% of the tournament weight. In reality, when you consider the wide range in weight at age (Figure 2), the cumulative weight is probably closer to one-third of the total tournament weight.

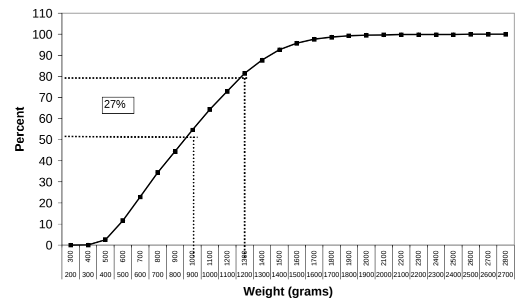


Figure 16. Cumulative weight of smallmouth bass captured in the KBI from 1992 to 2002.

When the 1992 and 1993 age classes first entered the tournament catch, their weakness was not noticed because the tournament anglers were targeting larger and older bass. However as these weak year classes moved through the fishery and become the seven, eight and nine year olds, or the “bread and butter” fish of the tournament, their poor representation raised alarms. Mean weights fell drastically in 2001 because of the poor representation of the eight and nine year olds (1992 and 1993 year classes) and a moderate representation of seven year olds (1994). Figure 14 (KBI 2001) confirms the tournament was now almost exclusively dependent on young small bass.

But what caused the failure of these two year classes? Figure 17 plots cumulative growing degree days greater than 5°C. This is a surrogate indicator used by MNR to represent how warm or cool the growing or open water season was. In 1992 and 1993 there was a noticeable decrease in growing degree days caused by the eruption of Mount Pinatubo in the Philippines. The resulting ash that was emitted into the atmosphere affected the world climate causing below average temperatures (Robock 2002). The poor year classes of 1992 and 1993 were the result of a simple but dramatic act of nature. Two cold springs and summers resulted in poor nesting success and recruitment failure.

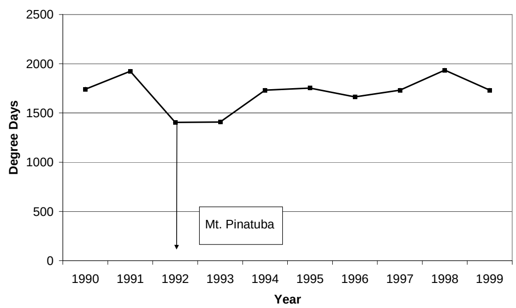


Figure 17. Cumulative growing degree days > 5°C for the Lake of the Woods area, 1990-1999.

Finally, Figure 18 shows that, after 2001, mean weights were beginning to increase in the tournament indicating the fishery was beginning to recover naturally.

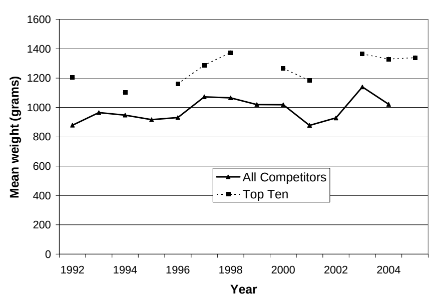


Figure 18. Mean weight of smallmouth bass captured in the KBI from 1992 to 2005.

It is interesting to note that, in 2004, the overall tournament results indicate a decrease in mean weight whereas the top ten competitors show only a slight decline. In 2004 we were only able to sample the first day of the tournament and the average weigh in was low compared to remaining two days. This aberration confirms the value of obtaining samples from each day of the tournament to avoid biases caused by weather conditions etc.

Case History Conclusions

In conclusion, sampling the KBI has provided the data necessary to document and verify a decline in the bass fishery and more importantly what had caused it. The decrease in mean weight or quality was the result of a natural phenomenon and the fishery was recovering and responding positively to the 1996 catch-and-release regulation. No further management intervention or regulations were required. Monitoring tournaments can also provide clues to the future status of a fishery. That is, a predominance of young, small bass in the tournament catch suggests there will be a reduction in fishing quality in the near future. Fishing tournaments are an efficient and cost-effective means of collecting information for use in fisheries management.

Acknowledgements

We would like to thank the organizers and competitors of the Kenora Bass International for the opportunity to sample fish at their tournament. Over the years the Sportsmen's Conservation Club of Kenora and numerous MNR staff have provided invaluable assistance with this sampling program.

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Regulatory Guidelines for Managing the Recreational Fishery for Largemouth and Smallmouth Bass in Ontario: The Bass 'Tool Kit' Update

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Abstract As part of a provincial initiative, regulatory 'tool kits' are being prepared to streamline and standardize recreational fishing regulations for various fish species in Ontario. The bass tool kit, which is currently in development, is reviewing a variety of options for open seasons, catch and possession limits, size limits, sanctuaries and special regulations. Anglers are urged to provide input when these draft proposals are released for public review expected in the summer of 2006.

Introduction

In recent years it has become evident that Ontario's fisheries regulations have become overly complex. The regulation summary is almost 100 pages in length. There are 37 fishing divisions, different seasons and catch limits for 18 species of fish, and thousands of exceptions to the general rules. There is little, if any, biological rationale for many of the regulations which are currently in place.

With the myriad of exceptions based on individual lakes, the fishing summary is becoming increasingly harder to understand and the regulations are difficult to interpret and enforce. In some cases, the complexity may even be a barrier for people to get out and fish – particularly for young people or those for whom English is their second language.

The current focus on individual lakes is a costly and ineffective way of managing the resource. Due to the high cost of managing individual lakes this approach does not adequately consider sustainability and other resource management concerns for the vast majority of waterbodies in the province. There was a real need to shift from individual lake management to a system that functions on a broader scale.

In recent years, efforts have been initiated to develop a new ecological framework for recreational fisheries management in Ontario (MNR 2005). This initiative has focused on four key components:

(1) Development of new Fisheries Management Zones (FMZs),
(2) Preparation of regulatory 'tool kits' for individual fish species,
(3) Enhanced stewardship through formation of FMZ advisory councils, and
(4) Implementation of a landscape level State of the Resource (SOR) monitoring program.

This presentation is intended to provide an update on the regulatory options currently being considered for bass (*Micropterus* spp.) in Ontario.

General Tool Kit Principles

Regulatory tool kits are intended to provide direction for standard regulations to ensure sustainable fisheries at the FMZ level. Some exceptions for stressed fisheries or quality fisheries are acceptable but they must be consistent with direction of the tool kits and will be subject to a rigorous review and approval process.

General principles for the development of regulatory tool kits may be summarized as follows:

- Sustainability of the fisheries resource is the foundation for fisheries regulations.
- Fisheries regulations should be based on sound science while realizing that other factors, including economics, social acceptance, and enforceability, must also be considered.
- Regulations should provide for a range of fishing opportunities wherever possible.
- Fisheries regulations should be developed to ensure protection of fisheries at a broad landscape level such as a Fisheries Management Zone.

Bass Tool Kit Options

Regulatory options for bass are being considered under the following categories: seasons, catch and possession limits, size limits, sanctuaries, and special regulations.

(a) Seasons – There are currently eight division-wide open seasons for bass in the province and five exceptions by waterbody. Season proposals currently being evaluated include:

- Open all year
- Closed all year (in FMZs where bass are not present)
- Season opening date of the 4th Saturday in June (for southern Ontario) and June 30 in northern Ontario.
- Bass seasons should close on November 30 and remain closed for the entire winter to protect winter aggregations of bass.

(b) Catch and Possession Limits – A catch limit is defined as the number of fish a person is allowed to catch and keep in one day. Fish which are caught and eaten that day as a shore lunch are counted as part of the daily catch limit. The possession limit is the number of fish a person is allowed to legally possess at any one time whether on hand, in cold storage, or in transit. In most cases, possession limits are the same as one day's catch limit. The general goals of catch and possession regulations are to limit the harvest, to equitably distribute the resource among users, and to convey a realistic expectation regarding capacity of the resource.

There are currently three division-wide catch and possession limits for bass in Ontario and four exceptions by waterbody. Catch and possession limit options being considered are:

- Six (6) fish for holders of a Sport Fishing Licence and two (2) fish for holders of a Conservation Licence.
- Four (4) fish for holders of a Sport Fishing Licence and two (2) fish for holders of a Conservation Licence (northwestern Ontario)
- Two (2) fish for holders of a Sport Fishing Licence and one (1) fish for holders of a Conservation Licence.

- Largemouth bass and smallmouth bass limits should still be considered in aggregate.

(c) Size Limits – Size-based regulations are intended to reduce the biological impacts of angling but not restrict angling opportunities. Size limit regulations are usually intended to increase the size of fish caught, maximize yield, and protect brood stock while maintaining angling quality often at intense levels of effort.

There are currently two division-wide size limits and two exceptions by waterbody. Recommended options for size limit regulations include:

- Where required (i.e., where there are resource sustainability concerns or where a quality fishery is desired) maximum size limits should be used. Maximum size limits should be based on restricting the harvest of large (> 35 cm (14 inch) smallmouth bass and > 38 cm (17 inch) largemouth bass), sexually mature (i.e., > age 7) fish.
- The division-wide use of minimum size limit regulations should be discontinued.
- The protective slot size limit on the French River should be thoroughly evaluated with the goal to retain only a maximum size limit.
- Northwestern Ontario's temporal size limits should be reviewed.

(d) Sanctuaries – Fish sanctuaries are designated areas where all fishing is prohibited. Sanctuaries can be seasonal in nature or extend for the entire year. Standardized options for fish sanctuaries are:

- Where a bass sanctuary is required, the standard date of May 15-June 30 should be used.
- Year-round sanctuaries for bass are overly restrictive and should be removed wherever possible.
- The use of voluntary sanctuaries should not be promoted.

(e) Special Regulations – Special regulations are those that differ considerably from province-wide regulations and are designed to recyle all or a portion of the anglers creel. They may include restrictions on gear (e.g., fly-fishing only, barbless hooks only, etc.) or bait (e.g., artificial bait only, live bait, etc.) as well as harvest (e.g., catch-and-release only). Special regulations must be established based on valid biological criteria and with well established objectives.

Special regulations may be considered for some fisheries where they are implemented on an experimental basis with plans for a through assessment of their relative effectiveness and a reasonable expectation for ensuring compliance so that the integrity of the experimental project is maintained.

Public Consultation

Every effort will be made to seek public input into these proposals. All proposals are posted on the Environmental Bill of Rights registry for public review. Clients and major interest groups are notified when a posting is made. It is anticipated that regulatory options will be available for public review by the summer of 2006.

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The Tri-Lakes Bass Project, 1999-2003

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Abstract Bass tournaments in the Kawartha Tri-lakes were monitored from 1999-2003. Largemouth bass comprised the majority (88%) of the bass which were weighed in. Bass biomass and density estimates are indicative of high productivity waters. Annual survival rates averaged 0.51 over the study period. The tournament fishery is approximately 19% of the recreational fishery and is not believed to represent a sustainability issue. Tournaments provide an efficient and cost-effective means of monitoring status of bass stocks

1. Author for correspondence.

Introduction

A number of issues continue to be associated with competitive fishing events. These include boat ramp congestion, social issues, and concerns from shoreline residents regarding the impact on local bass populations. Previous research has addressed survival of fish at the weigh-in and movements of fish after displacement and release. Some of the key findings with regard to displacement include:

- Largemouth bass spend an average of 8.6 days near the release site after a tournament. Smallmouth bass average 7.8 days near the release site.
- Largemouth bass average 3-3.5 weeks away from home range for returning fish. Smallmouth bass average less than 2 weeks away from home range for returning fish.
- The return rate is low for largemouth bass and high for smallmouth bass.
- Largemouth bass return to their home range if displacement is small (e.g., < 8 km). Smallmouth bass return to their home range irrespective of distance of displacement (e.g., 0.8-14 km).

Current research activities are directed to evaluating the physiological consequences of tournament handling procedures, the long term survival of captured and released fish, and the overall impacts to the bass population.

Study Objectives

This project attempted to address a number of issues. From the science side it converts tournaments into a fishery monitoring tool. From the management perspective it provides a partnership and means of developing a resource stewardship…all cost effective. From the public side it helps resolve some of the debate about tournament fishing.

There were a number of goals in this study:

1.) Use tournament-generated information to derive bass population estimates.

2.) Estimate survival rates by age distribution and tag returns.
3.)Determine growth (in terms of both length and weight) for production estimates.
4.) Determine the size of the tournament fishery in the context of the total recreational fishery on the Tri-Lakes.

Study Area

This study encompassed three of the Kawartha lakes known locally as the Tri-lakes: Pigeon, Buckhorn and Chemong (Figure 1). They are located north of the City of Peterborough. All three lakes are interconnected as part of the Trent-Severn waterway.

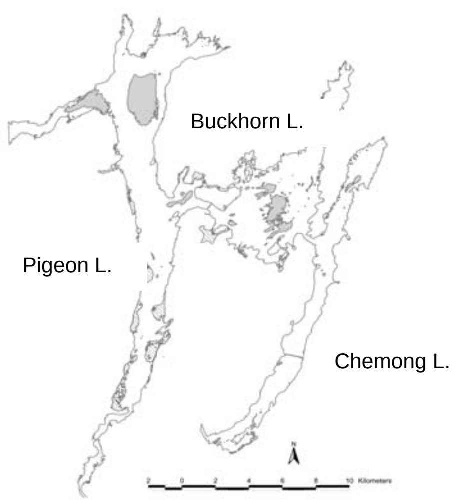

Figure 1. The Tri-lakes: Pigeon, Buckhorn and Chemong.

The Kawartha lakes represent one of the largest concentrations of competitive fishing activities in Ontario (Bell 1999, Kerr 2004). The Tri-lakes account for a substantial proportion of tournament angling activity in that area (Figures 2 and 3).

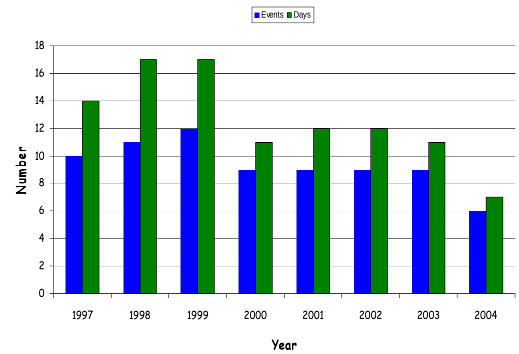

Figure 2. Fishing tournaments on the Tri-lakes, 1997-2004.

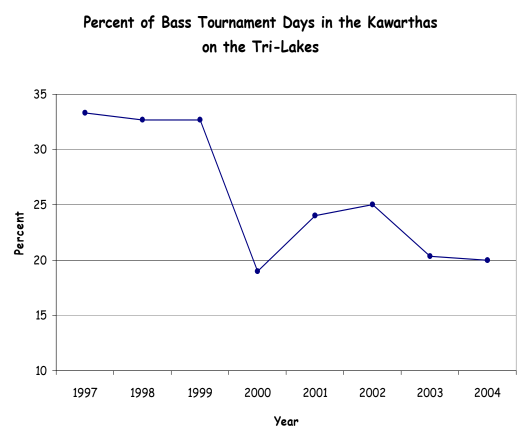

Figure 3. Proportion of bass tournament days in the Kawartha Lakes system which are on the Tri-lakes, 1997-2004.

Data Collection

Bass were sampled at several Tri-lakes tournaments each year. A creel census was conducted in 2001 in order to determine the amount of recreational angling on the Tri-lakes.

Results

A total of 5,187 bass were sampled during the multi-year study. The vast majority (88.2%) of these fish were largemouth bass (Table 1).

Table 1. Bass sampled at tournaments held on the Tri-lakes, 1999-2002.

Year	No. Largemouth Bass Sampled	No. Smallmouth Bass Sampled
1999	1,329	153
2000	1,036	148
2001	1,234	176
2002	976	135
1999-2002	4,575	612

Density and biomass estimates for largemouth bass are presented in Table 2.

Table 2. Density and biomass estimates of age 4+ largemouth bass from the Tri-lakes, 1999-2002.

Year	Density (fish/ha)	Biomass (kg/ha)
1999	14.8	7.36
2000	9.8	5.11
2001	10.9	5.77
2002	9.9	5.73

Estimated production of largemouth bass is summarized in Table 3. Both the density and production of largemouth bass in the Tri-lakes area is consistent with similar estimates from lakes in other locations. The Tri-lakes estimates represent the largest lake system with density and production estimates pointing to the magnitude of productivity that can be expected from the Kawartha lakes system.

Table 3. Estimated production of largemouth bass from the Tri-Lakes, 1999-2002.

Year	Age 4+ combined	All ages combined
1999	2.41	23.47
2000	1.67	14.57
2001	1.77	14.46
2002	1.71	12.82

A comparison of characteristics between the tournament creel and the overall recreational creel on the Tri-lakes is outlined in Table 4.

Table 4. Creel statistics for the 2001 recreational fishery and tournament fishery on the Tri-lakes.

	Recreational Creel	Tournament Creel
Largemouth bass catch	38,634 fish	8,896 fish
Largemouth bass harvest	9,995 fish	3,001 fish (weighed in)
Largemouth bass fishing effort	49,089 hours	11,548 hours
Largemouth bass CUE	0.51	0.77
Smallmouth bass catch	26,345 fish	1,545 fish
Smallmouth bass harvest	3,470 fish	501 fish (weighed in)
Smallmouth bass fishing effort	49,089 hours	11,548 hours
Smallmouth bass CUE	0.81	0.13

CUE – catch per unit of effort expressed in terms of the number of fish caught per hour of fishing effort.

After five years of tagging, the annual survival rate (accounting for tag loss) averaged 0.51 (0.36-0.59).

There is a clear contrast between tournament anglers and non-tournament anglers in preferences. The tournament fishery is targeting largemouth bass with a catch rate that is 50% higher than the average angler on the Tri-lakes (angler CUE 0.51; tournament angler CUE

0.77). Smallmouth bass has a higher catch rate than largemouth bass for non-tournament anglers (smallmouth bass CUE 0.81; largemouth bass CUE 0.51), but among tournament anglers, smallmouth bass is generally not targeted to any significant degree (smallmouth bass CUE 0.13)

Conclusions

Fishing tournaments offer an excellent means for monitoring fish stocks. Tournament monitoring on the Tri-lakes provided useful estimates of bass population size, survival and mortality, growth and biomass, production, and year class strengths.

Some of the conclusions reached:

1.) Tri-lakes tournaments are largely largemouth bass oriented. The CUE for both species provides an interesting contrast between the tournament and recreational fishery.

2.) The tournament fishery is approximately 19% of the effort of the recreational fishery. Fishing mortality in the Tri-lakes is largely driven by the recreational fishery. There is approximately a 24% exploitation rate.

3.) Biomass and production estimates are good in comparison to published studies. This study is the largest scale undertaken.

4.) Tournaments on the Tri-lakes do not represent a sustainability issue.

References

Bell, D. 1999. Kawartha Lakes competitive fishing events committee. p. 79-86 *In* S. J. Kerr [ed.]. Competitive Fishing in Ontario Workshop Proceedings. Workshop Proceedings WP-01. Southcentral Sciences Section, Ontario Ministry of Natural Resources. Kemptville, Ontario. 107 p.

Kerr, S. J. 2004. A 2004 survey of competitive fishing events in Ontario. Fish and Wildlife Branch. Ontario Ministry of Natural Resources. Peterborough, Ontario. 80 p.

APPENDIX 1. Agenda for the Bass Research and Management Workshop, April 1, 2006.

8:30 **Robert Grossi**, Mayor of Georgian Township - *Welcome*

8:45 **Gord Pyzer** - *Imagine – The Future Possibilities of Bass Fishing in Ontario*

9:30 **Noreen Clough** - *Overview of the BASS Conservation Program*

10:10-10:20 **Break**

10:20 **Wil Wegman** - *Lake Simcoe, A World Class Bass Fishery – An Anglers Perspective*

10:45 **Dr. Steven Cooke** - *The State of the Art in Bass Science: What Anglers and Biologists Need to Know*

11:30 **Kyle Hanson** - *Monitoring Bass Behaviour in Real Time Over a Three Year Period: Implications for Conservation and Management*

12:00 **Lunch**

1:00 **Jennifer Tran and Dr. Nick Collins** - *Nesting Bass and the Round Goby: Video Recorded Interactions and Ultimate outcomes Defined by Surveys of Bass' Nest Success across a Goby Gradient*

1:30 **Geoffrey Steinhart** - *Choosing the Right Angling Regulations When Round Gobies Invade*

2:00 **Corey Suski** - *Maintaining Water Quality During Angling Tournaments*

2:30 **Kevin Esseltine** - *Decompression Issues for Bass: Implications for Angling and Tournament Events*

3:00 **Dr. Bruce Tufts** - *'Big Picture' Tournament Issues*

3:45 **Break**

4:00 **Barry Corbett** - *How MNR Can Utilize Information Collected From Catch-and-Release Tournaments to Provide Practical Fisheries Data for Management*

- *An Update on the Status of Largemouth and Smallmouth Bass Fisheries Management Tool Kits*

4:30 **Dr. Mark Ridgway** - *The Tri Lakes Bass Project, 1999-2003*

5:15 Question and Answer Panel Discussion (Moderated by Steven Kerr)

6:00 Conclusion of Workshop

APPENDIX 2. Attendees and participants at the 2006 Bass Research and Management Workshop (S – speaker, O – Organizer, M – Moderator, V - Volunteer)

ANDERS, John
Barrie Bassmasters
Barrie, Ontario

ARMITAGE, Garnet
Port Perry Bassmasters
Port Perry, Ontario

BANFIELD, Amanda
Eastern Ontario Bassmasters
Napanee, Ontario

BANFIELD, Rob
Eastern Ontario Bassmasters
Napanee, Ontario

BARKER, Mike
Aurora Bassmasters
Keswick, Ontario

BARNUCZ, Jason (O)
Ontario Bass Federation
Lindsay, Ontario

BEARDSALL, John
Georgian Bay Bassmasters

BERTULLI, Jim
Marshall Maclin Monaghan
Aurora, Ontario

BIRCH, Tim
Kitchener-Waterloo Bassmasters
Kitchener, Ontario

BIRD, Linda
Port Perry Bassmasters
Port Perry, Ontario

BORWICK, Jason (V)
Ministry of Natural Resources
Aurora, Ontario

CECE, Mark
Marshal Maclin Monaghan
Aurora, Ontario

CHARLEBOIS, Laurie (V)
Georgian Bay Bassmasters
Penetang, Ontario

CHONG, Dave
Fish Hard Dream Big
Mississauga, Ontario

CLAYTON, Tom
Credit Valley Conservation Authority
Mississauga, Ontario

CLOUGH, Noreen (S)
Bass Anglers Sportsman Society
Lake Bueno Vista, Florida

COLLINS, Nick (S)
University of Toronto
Toronto, Ontario

COOKE, Steven (S)
Carleton University
Ottawa, Ontario

CORBETT, Barry (S)
Ministry of Natural Resources
Kenora, Ontario

CORATTI, Marc
Aurora Bassmasters
Keswick, Ontario

COUCH, Rob
Quinte Bassmasters

DODD, Jim
Normark Pro Staff

EDWARDS, Chuck
Georgian Bay Bassmasters

ENGLISH, Jeff
Hawgtown Bassmasters
Toronto, Ontario

ESSELTINE, Kevin (S)
Ministry of Natural Resources
Kingston, Ontario

FARWELL, Jim
Downtown Bass Anglers
Toronto, Ontario

FITZPATRICK, Peter
Unafilliated Angler

GARNIER, Peter
Lindsay Bassmasters
Lindsay, Ontario

GREEN, Bill
Unaffilliated Angler
Peterborough, Ontario

HALEY, Brian
Ontario Bass Federation
Bradford, Ontario

HAMILTON, Ken (V)
Ontario Bass Federation

HANSON, Kyle (S)
Carleton University
Ottawa, Ontario

HEELS, Gerry
Barrie Bassmasters
Barrie, Ontario

HEELS, Kyle
Barrie Junior Bassmasters
Barrie, Ontario

HILL, Jon
Minden, Ontario

HINBEST, Mike
Muskoka Bassmasters

HSI, Richard
Chinese Anglers Association
Toronto, Ontario

JOHNSON, Callum
Barrie Bassmasters
Barrie, Ontario

JOHNSON, Ryan
Barrie Bassmasters
Barrie, Ontario

KELLY, Leonard
Aurora Bassmasters
Aurora, Ontario

KENNEDY, Pat
Tournament Angler
Haliburton, Ontario

KERR, Steven (M)
Ministry of Natural Resources
Peterborough, Ontario

KIDD, Murray
Unaffiliated Angler
City of Kawartha Lakes

KLATT, Greg
Pro Fish Angling Services
Fenelon Falls, Ontario

KLATT, Mitch
Pro Fish Angling Services
Fenelon Falls, Ontario

KROISENBRUNNER, Paul
Kitchener-Waterloo Bassmasters
Kitchener, Ontario

LEMERY, Jamie
Eastern Ontario Bassmasters
Kingston, Ontario

LISKAUSKAS, Arunas
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Owen Sound, Ontario

LISCIO, John
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Aurora, Ontario

LUZAK, Bruno
Fenelon Falls, Ontario

LUZAK, Eric
Fenelon Falls, Ontario

MacCONNELL, Art
Quinte Bassmasters
Stirling, Ontario

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Aurora, Ontario

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Aurora Bassmasters
Aurora, Ontario

MERKLEY, Glenn
Renegade Bass
Ottawa Valley

MOORE, Brent
Cambridge Bassmasters
Kitchener, Ontario

MOWERS, Bob
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Aurora, Ontario

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ROBBINS, Mark
Ministry of Natural Resources
Peterborough, Ontario

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Lindsay Bassmasters
Lindsay, Ontario

SEBO, Frank
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Sutton, Ontario

SEDGWICK, John
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Cobourg, Ontario

SEXTON, Bob
Outdoor Canada Magazine

SLYKHUISE, John
Georgian Advocate
Sutton, Ontario

SPIRO, Cherin
City of Kawartha Lakes

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Marshal Maclin Monagahan

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TROTTMAN, Don
Quinte Bassmasters

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Queen's University
Kingston, Ontario

VALLEAU, Alan
Stouville, Ontario

VALLEAU, Christopher
Stouville, Ontario

VERGE, Shawn (V)
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Aurora, Ontario

WALSH, Mike
Muskoka Bassmasters
Bracebridge, Ontario

WARING, Peter
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WATTERS, Rob
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WEGMAN, Wil (O, S)
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