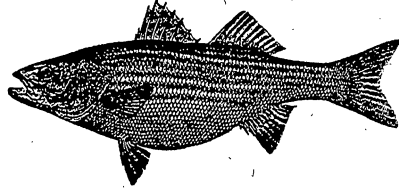


VT Fisheries Management

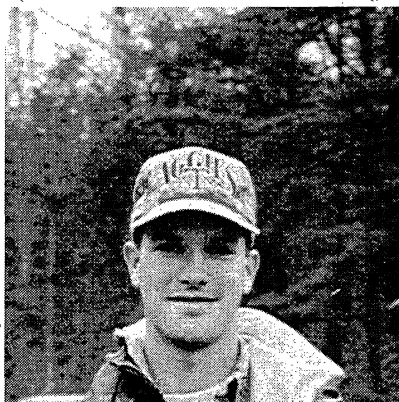


*Devoted to identifying fisheries management problems,
uncovering their causes, and developing creative solutions*

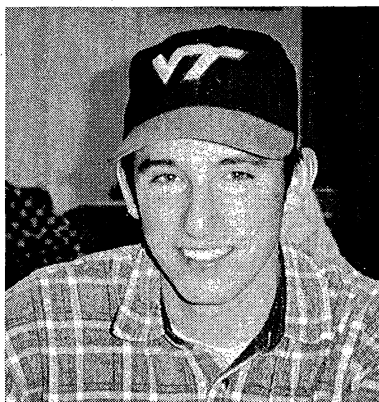


*A Class Magazine Produced by Students in Fisheries Management
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University*

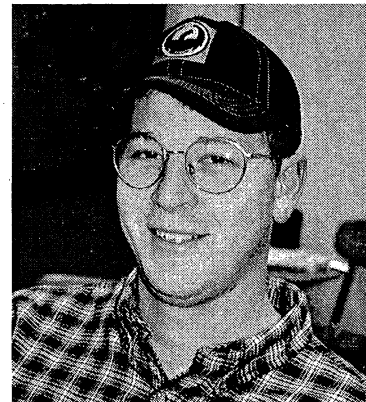
Volume 3, 1997



Craig Bonds, TA



Eric Brittle



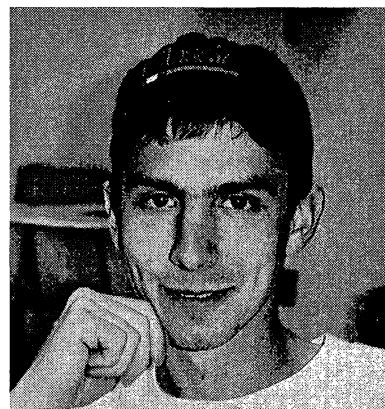
Jason Burton



Brett Coakley



Ryan Cool



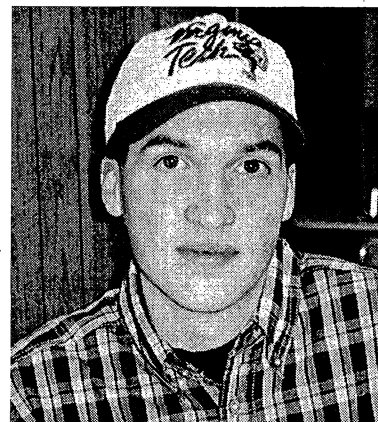
Blake Davis



Gregory Hylton



Ashley Kinney



Benjamin Newbill

VT Fisheries Management

Editor: Donald J. Orth

Table of Contents

Major Revision Required, Donald J. Orth.....2

Essays

Should Species and Ecosystems Have Rights?
Jason Burton.....3
To Stock or Not to Stock, That is the Question.
Troy Thompson.....3

Feedback 4

Emerging Issues

Animal Rights and Fisheries: Current Positions and
What Next? Michelle Steg.....5
Can Transgenic Fishes be Used in Fisheries
Management? Brian Watson.....8
Managing People or the Coelacanth
Ashley Kinney.....12

Multidisciplinary Problems

Effects of Hydroelectric Dams on Outmigrating
Salmon Smolts in the Columbia River
Michael Robertshaw.....14
Management of Row-Crop Agriculture: Reduction
of Eutrophication
Blake Davis.....15

Non-native Fishes

Management of Brown Trout in Shenandoah
National Park
Troy Thompson.....18
Muskellunge Stocking in the New River
Eric Brittle.....20
Should We Mandate Protocols for Species
Introductions ?
Michael Shaver.....22

Marine and Coastal Fisheries

Bycatch: A Catch without a Yield
Gregory Hylton.....24
Changing Management of North Atlantic Bluefin
Tuna
Brett Coakley.....26
The Long and Winding Road to Recovery of the
Shortnose Sturgeon
Jason Burton.....27
Atlantic Striped Bass: On the Road to Recovery
Ryan Cool.....30

Managing Virginia Reservoirs

Recharging the Ranks of Trophy Striped Bass in
Smith Mountain Lake
Kirk Rundle.....33
Assessing Shad Abundance: Alternatives to
Toxicant Sampling
Powell Wheeler.....36
Changing Trophic States of Smith Mountain Lake
Benjamin Newbill.....38

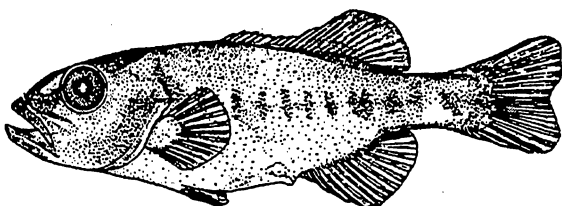
Lessons Learned in Lab

How to Let Learning Get Out of Control
Donald J. Orth.....40
Fisheries Management Plan for Smith Mountain
Lake
VT Fisheries Management Class.....41
Manager Viewpoints.....42
Stakeholder Viewpoints.....43
Pandapas Pond Assessment, Brian Watson,
Gregory Hylton, and Jason Burton.....48
North Fork Roanoke River Assessment
Brian Watson, Ashley Kinney, and Benjamin Newbill
.....51

*"The one real objective of education is to
have a person in the condition of
continually asking questions."*

Bishop Medell Creighton

VT Fisheries Management is published
annually by the Department of Fisheries and
Wildlife Sciences, Virginia Polytechnic Institute and
State University, Blacksburg, Virginia 24061-0321.
Printing supported by the University Writing
Program.





Major Revision Required **Donald J. Orth**

“Major Revision Required” is what I’ve come to expect from colleagues who review my manuscripts. It’s not that I’m a terrible writer (I believe). Writing is an ongoing process through which we discover and uncover knowledge. Seldom is the first, second, or tenth version of my thinking completely coherent and well organized. “Major revision required” may seem like a negative reaction to one’s hard work. I prefer to think of it as a reminder that I still have a long way to go in my current quest. Similarly students in Fisheries Management should realize that they have a long way to go to become Fisheries Management professionals. Major revision is still required. Comments such as “Looks good” are not helpful; “major revision required” is the rule!

As you read this magazine you will see the results of thinking about fisheries management. You should also see the results of time pressures that left little time to polish and clarify thinking. Practice in fisheries management is required to create a master fisheries scientist or manager. When I asked on the last day of class “What are some lingering doubts?” one student wrote “My knowledge is equivalent to a grain of sand on a beach 5 miles long.” Others commented on their confusion about what it’s like in the real world or whether they learned enough to be effective in the job. These lingering doubts are natural because the volume of information needed to be an effective manager is substantial. The best way to become an effective fisheries manager is to watch and work with managers as an apprentice. The past semester was the beginning of your apprenticeship and making errors was a natural part of the process. However, major revisions are required in your writing and other skills if you are to accept responsibilities for managing public fisheries.

Effective writing and communication are key skills for your professional and personal life. I hope each of you learned that writing helps you to think about questions and make connections to your existing knowledge. I also hope you learned that writing does not have to be a chore. Somehow it seems easier to get words on paper if you remember that “major revision required” is the norm.

One final assignment for the class: Please read the magazine carefully and report any errors to me. Save the magazine and read your writing in five years. If you follow the “major revision required” rule you should find that your writing has substantially improved.

I thank all students and paid and unpaid teaching assistants who helped make the Spring 1997 version of Fisheries Management an authentic learning experience. Michael Duval (Virginia Department of Game and Inland Fisheries) provided an outstanding overview of issues in Smith Mountain Lake and impersonated the disgruntled angler at the Mock Public Meeting. Eric Hallerman helped us all learn “genetics for fish squeezers” and Bill Ensign presented the fascinating saga of the brook trout of the Smoky Mountain National Park. Craig Bonds, Matthew Chan, Kevin Goodwin, Karen Hockett, Ed Pert, Ryan Smith worked to design, modify, grade, and assist with various assignments throughout the term; I hope they learned something in the process. Finally, I thank Carol Bailey, Director of the University Writing Program, for her generous praise of my writing assignments and the financial support for copying costs.

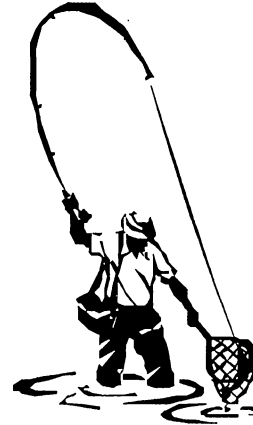
Essays

Should Species and Ecosystems Have Rights? Jason Burton

Ever since the beginning of time, species and ecosystems have evolved. Evolution has forced species and ecosystems into intraspecific, and interspecific competition long before *Homo sapiens* arrived. Though many theories have been proposed, one has been the most widely accepted (Survival of the fittest). As humans evolved, so did their abilities. All organisms have an instinct to survive. For an organism to survive it must infringe on other organisms. Whether it be space, nutrients, etc. Organisms seek a specific location, not because it is their right, but because of an instinctive fight to carry on. *Homo sapiens* possesses this same instinct. Humans are beginning to realize that the impact of our existence is a burden on the entire planet. Now, to prevent further desecration, we give "rights" to things man has abused for thousands of years. I believe the best approach to this is not "rights", but respect. Man has created an environment in which species and ecosystems are in danger of being lost forever. Due to ignorance and lack of respect, we must now impose laws and give "rights" to ecosystems, species, and individuals. I believe that all organisms have the "right" to life. I do not believe that hunting, fishing, or cutting down a tree is murder as long as it is done to serve basic human needs. Most animal rights activists would not agree with this statement; do they value their own lives as equal to a fish or a tree? If everything that contained life was given the same "rights" as humans, we could not exist. So the question arises, where do we draw the line? I will not try to define where this line should exist, because I do not believe one should exist. If one treats species and ecosystems with respect, he or she will not abuse them. Native Americans believed whatever you take, you should return. Respect in the Native American culture was and is taught at an early age. This respect is then reinforced through experience with nature. It astonishes me to know that at such an early time, people were so advanced with this idea. We as humans would not be in the predicament that we are in now if this philosophy had been followed.

Since the industrial revolution, human population has increased dramatically. As the population increases, so does the consumption of resources. This process, I believe, can not be stopped on a global level. However, it is possible to prolong the longevity of the nonrenewable resources. We must preserve whatever we can, including the rainforest as well as the golden trout or the Devil's Hole pupfish. The importance of such things are yet unknown and may never be known. If a species of the African violet was considered insignificant and left to become extinct, victims of childhood

leukemia could not have survived. The planet is like a large completed puzzle, but if we keep taking pieces from it, one day we will be left with nothing. Should species and ecosystems have "rights"? No, just RESPECT!



To Stock or Not to Stock? That is the Question Troy Thompson

The question of stocking does not have a simple yes or no answer. There are many situations where stocking is an invaluable asset to fisheries management just as there are times when stocking is not the solution, and in fact, could cause more problems. The best uses for stocking are in habitats created, or heavily altered, by humans. Stocking allows fishing enjoyment in many farm ponds and cattle tanks that otherwise would have no fish in them. Stocking in reservoirs is important to help obtain a good diversity and balance of game and forage fish. Since reservoirs are man-made "fake lakes", stocking will have very little impact on native fishes compared with the act of putting their stream habitat under 150 feet of water. Can you imagine fishing in Smith Mountain Lake if there were no largemouth, smallmouth, or striped bass? These gamefish are not native to the Roanoke River and had to be stocked. The New River is the same way. Channel catfish and rock bass would be its primary game fish if smallmouth, largemouth, walleye, muskellunge, and flathead catfish hadn't been stocked. Another good use for stocking (with trout) is in streams that can't support wild trout populations and when there is a large demand for fishing. In this case, stocking serves the dual purpose of bringing in new fishermen, because stocked creeks are easily accessible to city people and children, and keeping pressure off of the streams that do hold wild populations. Tom's Creek is a good example of this. It gives locals a place to fish for trout that is only ten minutes away. Otherwise, they would have an hour drive into Giles County to find creeks with native trout. Efforts to restore threatened and endangered fish as well as rare sport fish can be greatly improved by stocking. Many streams that are overrun with exotic competitors (e.g., carp) are cleaned out with rotenone and restocked with the native fish. This was done successfully in the South Fork Kern River in California to eliminate the

brown trout that were outcompeting the California golden trout, which is a threatened species.

There are other situations where stocking shouldn't be done because of the potential impacts on native fish. Stocking shouldn't be attempted in areas where wild game fish or threatened or endangered species are found, except in the case shown above. Sometimes its better to let Nature take its course than it is to try helping her along by supplemental stocking. Stocking can decrease genetic diversity of wild fish stocks and usually results in fewer fish than before because the hatchery fish aren't as well adapted as the wild fish. If wild fish are reproducing, it is much more cost- effective to improve habitat and water quality when possible, because stocking won't increase the carrying capacity. Stocking new species can be an irreversible mistake. In an effort to improve fishing, rainbow trout and northern strain brook trout were stocked in the Great Smoky Mountains National Park up until the mid 1950's. The rainbows are now outcompeting the natives and pushing them further into the headwaters while the northern strain brookies are interbreeding with the southern-strain natives. Fisheries managers have been trying to undo the damage done by these stockings for the last forty years. Pristine areas shouldn't be stocked, because these areas are few and far between and should be protected for future generations. My philosophy on stocking streams and natural lakes is this: if it ain't broke, don't fix it.

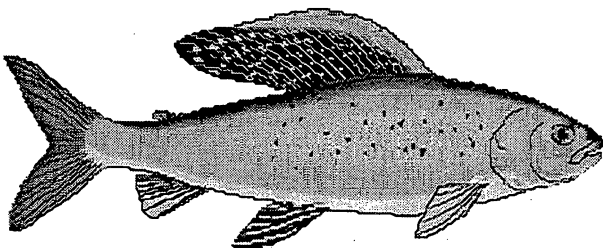
As a fisheries manager, I would be very conservative about stocking new, unproven exotics. It would be nearly impossible to convince me to do it because there is so much to lose if you screw up and I don't want that on my conscience. The basis for stocking depends on the potential impacts of the species as well as the type and condition of the system that you are planning on putting it in.

Fun Stuff

On Salmonidae Nomenclature *by George W. LaBar*

*Some salmon are trout and some trout are charr,
But some trout are salmon, adult or parr,
Whitefish are whitefish and ciscoes the same
And grayling are grayling, they have the right name.*

*It's very confusing, it's really a mess,
You can't tell by looking, you really must guess;
So next time you're tempted to call salmon trout,
Use name scientific, it's the only way out.*



Feedback

What Helped You Learn Fisheries Management?

Top Three Learning Activities from Student Survey:

1. Brainstorming and Group Work on Projects
2. Field Exercises and Report Preparation
3. Weekly Quizzes

Others that were frequently mentioned were the Fishman electronic listserv for out-of-class discussion, in-class questioning, issue paper for magazine, guest appearances, essay writing, library resources, semester-long management planning, using Excel, and effects of fishing computer lab.

Editor's Note: January 13 classes began. January 30, I asked them at the end of class to list two pretty good things and two pretty bad things about Fisheries Management class. The pretty bad things dealt mainly with the frequent due dates and written assignments. I discussed the initial assessment with the class. Next week I received this letter.

February 5, 1997

Dear Dr. Orth:

What, at first glance, appears to be tedious busy-work, soon develops into a meaningful lesson of tolerance. I am beginning to realize that classwork can, in a sense, be considered representative of field work. There are things we are to approach that will not always be a cycle of evolving technicalities, but that will be a droning repetition of the seemingly obvious. Such things as sampling may involve the same small monotonously simple procedures, but the end results are worth the strife and build the foundation of eternal thought processes. There are lessons to be learned from every assignment. If the chore seems to have no purpose, then its purpose is to build tolerance. If the chore seems to be ridiculously repetitive, then its purpose is to build patience. If the chore seems to be boring, then its purpose is to build creativity. If the chore seems to be evasive, then its purpose is to promote thinking. If the chore seems eternal then its purpose is to build endurance. Finally, if the chore seems to be too complex, then its purpose is to promote organization. Here the task changes to a challenge with specific goals and objectives.

It is those challenges in our lives (made up of all the various chores) that promote learning. It is that tough learning curveball that stimulates our interests and out constant quest for the perfect answers to the not-so-perfect questions.

This is my tidbit of a response to our responses to the questions you posed last week at the end of class.

Name withheld

Emerging Issues

Animal Rights and Fisheries: Current Positions and What Next? Michelle Steg

Imagine yourself boating along, approaching the festivities of a bass fishing tournament. The tournament is in a state of chaos. Animal rights activists line the pier, holding placards and harassing the fishermen. Their signs read "fish have feelings too", "get hooked on compassion, not on fishing", and so on. As you approach you realize this is a real war zone. Someone has accused the activists of stealing fishing equipment and of stationing people around the lake creating noise to scare away fish. Fishermen have retaliated by spraying protesters with bait. Sound outlandish? Don't speak too soon, scenes like this one are not uncommon in England and may be coming soon to a lake near you (Pisces Magazine, 1996).

The issue of animal rights in fisheries has received increased attention in the media and among animal rights groups in recent years, with increased incidents of violence in group clashes (McCoy, 1995). Traditionally, humans have shown much concern for the welfare of dolphins and turtles, but little for other aquatic organisms (Atwood, 1996). Among some groups this attitude may be changing. Through increasing numbers of editorial articles in popular publications and protests by animal rights groups, the conflict grows. Also of concern are the interests of fishers, both professional and recreational, and their economic needs and benefits. If we have learned anything from past animal rights conflicts, it is that they tend to become more divisive and violent with time. The issue of animal rights and fisheries needs addressing now, before it spirals out of control. Recently, fisheries professionals were warned in the publication *Fisheries* (1997) to take extra security precautions where animal rights demonstrations are being held. Tension will only escalate as opposing camps grow stronger and become more entrenched in their positions. The larger the conflict gets, the more time and money natural resource agencies will have to spend in dealing with it. Meanwhile, all of the world's 17 major fishing areas are over-fished, and the number of fish species worldwide classified as threatened or endangered (spring 1996) has increased to 1,081 (Lustgarten, 1996). A resolution to this fishing issue must take the interests of animal rights and consumptive fishers into account, promoting humane treatment while preserving an important dwindling natural resource.

Theorists in conflict resolution state that conflicts always bring out the worst in people, and that the least effective approach in a conflict situation is to project an adversarial manner and to take hard, extreme, unbending positions (Fisher and Ury, 1981; Kroeger and Thuesen, 1992). Unfortunately, this seems to be the exact approach many people are taking on the issue of animal rights and fisheries. In the United States articles such as "What Animal Rights Activists are Doing to Stop You From Fishing" (Armitage, 1996) are popping up in angler's magazines, anglers in

Montana have faced rock-throwing fish-scare tactics (McCoy, 1995), and PETA (People for the Ethical Treatment of Animals) began a coast-to-coast anti-fishing campaign called 'Save Our Schools' just last year (Armitage, 1996). Obviously, the issue is escalating, and sooner or later it will have to be addressed.

The Animal Rights Position of Fishing

First, a distinction must be made between animal rights and animal welfare organizations. Animal welfare organizations support the humane treatment of animals, while animal rights groups believe that animals have rights similar to that of humans, and our use of any animal is morally wrong (Thompson and Lapointe, 1995). Examples of both types of groups will be concurrently covered in this discussion. Conservationists Peter Singer and Tom Regan are well known for their writings on animal rights and welfare concerns. Singer states that we should "extend to other species the basic *principle* of equality" that we extend to members of our own species (animal-welfare) and Regan argues that all animals possess the same right to life that humans possess (animal-rights) (Regan and Singer, 1976). Many activist groups do not have a distinct policy concerning fish, but have pro-animal welfare blanket statements. Groups such as the National Wildlife Federation and the Earth Island Institute only concern themselves with incidental take issues (e.g. dolphins and sea turtles) rather than the rights of fishes per se (pers. comm.). Greenpeace is primarily concerned with over-fishing and the protection of environmental quality standards (Greenpeace, 1996).

When considering whether animals deserve rights, one issue that needs to be resolved is whether they experience pain and suffering. Philosopher Bentham stated "The question is not, Can they *reason*? nor Can they *talk*? but, *Can they suffer*?" (Regan and Singer, 1976). One of the leading organizations in the United States on animal rights and fishing is PETA, and they address pain in fish. Their 'Save our Schools' campaign is the first organized, national anti-fishing effort by a major animal rights organization in the US. Their position is that fish have a "neurochemical system" similar to that of humans and are capable of sensing fear and pain. (Dawn Carr, Save Our Schools Campaign Coordinator, pers. comm.). PETA feels that fish suffer greatly from the practice of fishing, and that even "catch and release" fisheries are highly harmful to fish, causing potentially fatal internal injuries and loss of their protective coating. Stress and fatigue (large lactic acid build-up) can lead to a lower survival rate of fish once they are released. Anglers 'playing' and 'fighting' with the fish while it is on the line or in the boat also greatly increases suffering and mortality. Though a fish may swim away apparently unharmed, it may die days later due to these types of injuries. PETA states that the lips and tongues of fish contain nerve endings and are highly sensitive, since they are used to collect food, build nests and guard their young. Due to the importance of their mouths, damage from angling is particularly devastating to fish. Also, fish may exhibit some fear in that they can learn to avoid hooks just by seeing other fish get caught (from a PETA publication: Fishing: An Activist's Guide).

A recent article in the Journal of Ichthyology addresses the issue of pain sensitivity in fishes (Chervova, 1997). Conclusions from the experiment imply that fishes experience pain in a manner similar to all other vertebrates, though the

issue of emotional and other types of pain reactions were not investigated. In particular, when damage to the mouth by a hook was implemented, a pain sensation was documented. Pain receptors were found to be localized over the whole body of the fish. Similar to other animals, when receiving a pain stimulus fish react with a behavioral response, as well as an increase in the production of a natural pain killer. This pain killer is produced as a survival tactic in order to enable the animal to perform vital functions (including foraging and defensive behaviors). This may be an explanation for feeding behavior in hungry fish which are simultaneously under much pain. Similar behavior has been observed in mammals as well and should not necessarily be considered proof of lack of pain sensation according to Chervova. Increased pain sensitivity during warmer, active feeding seasons (which are usually also angling seasons) was also documented in the Chevova study. More research needs to be conducted in the area of suffering and pain sensitivity in fishes in order to clarify, or refute, animal-rights group's justifications. However, it may never be possible to perceive whether fish experience emotional pain or not.

Based in the UK, Pisces is the only organization world wide solely campaigning against the 'bloodsport' of angling (Pisces Magazine, 1996). They have been successful in having sport angling banned in several waters in England and Germany, and have reportedly been coaching PETA in protest tactics (Armitage, 1996). Some of these 'tactics' include using scuba gear and boats to scare fish away from fishing tournaments. PETA says they plan to implement education programs and demonstrations before they consider disrupting any anglers. One tactic successful for Pisces is piggy-backing fishing bans in areas where the effects of sportfishing was already an issue, such as where litter, trespassing and bank erosion were a problem. The ultimate goals of both Pisces and PETA are to end all sportfishing, and to switch to other, less harmful outdoor recreations (Dawn Carr, Save Our Schools Campaign Coordinator, pers. comm.; Armitage, 1996).

PETA has several other arguments as to why people should not support the harvest and consumption of seafood (meaning fresh and saltwater). One is that seafood is in reality not good for your health. The doctors that they cite state that fish flesh contains cholesterol and saturated fat, and it contains no complex carbohydrates or fiber (PETA's Animal Times, 1997). A study in the New England Journal of medicine states that heavy fish consumption does not lead to better heart health (Lustgarden, 1996). PETA states that some fish have been found to contain toxins such as ciguatera, scrombold, PCB's, mercury, DDT, and dioxin, some of which can significantly increase your cancer risk and cause other illnesses. In addition, many people who eat sushi get sick (up to 1 in 250), some contracting parasites (PETA's Animal Times, 1997). PETA also condemns commercial fisheries for "vacuuming the oceans clean of sea-life" (PETA's Animal Times, 1997). An animal rights/conservation group called Earth Save, based in California, has

an extensive list as to why it is more environmentally and economically sound, and healthier to not eat seafood products (Lustgarden, 1996).

Finally, a few quotes from well-known conservationists:

"I have found repeatedly, of late years, that I cannot fish without falling a little in self-respect... I have skill at it, and, like many of my fellows, a certain instinct for it... But always ...I feel it would have been better had I not fished." - Henry David Thoreau (1817-1862) from *Walden*

"It is a curious situation that the sea, from which life first arose, should be threatened by the activities of one form of that life. But the sea, though changed in a sinister way, will continue to exist; the threat rather is to life itself." - Rachel Carson (from Lustgarden, 1988).

"Perhaps the time has come to formulate a moral code which would govern our relations with the great creatures of the sea as well as with those on dry land. That this will come to pass is [my] dear wish." - Jacques Cousteau (from PETA's Animal Times, 1995)



Anglers Position on Fish Rights and Fish Rights Activists

The February 1996 issue of Fisheries magazine contains a position statement for the American Fisheries Society (AFS) concerning human use of fish (Webb and Jackson, 1996). Their position is that the views of animal rights advocates are in direct opposition of the objectives of AFS. They cite increased (legal and illegal) interference by activists of the consumptive use of fish, leading to the occurrence of some states passing laws protecting hunters and trappers from harassment. AFS says regulations already exist enforcing the humane treatment of animals (e.g. the Animal Welfare Act) in all situations. They state greater actions on their part are needed to vocalize their position, such as to develop a strong proactive position supporting the management of fisheries by conservation principles, and to join with other organizations in combating the threat of animal rights activists. AFS supports and promotes the policies that fish are not equal to humans, and should be used by humans for purposes furthering the quality of human life, that humans are at the top of the food chain, but have a responsibility to maintain or enhance fish populations, that fish populations are dependent of human stewardship, and the highest ethical and scientific practices should be maintained in the use of animal populations and individuals (Webb and Jackson, 1996).

In his article "An argument in defense of fishing" Michael LaChat (a Christian ethicist) discusses his views on the animal rights issue. He states that though the arguments of well-known conservationists Peter Singer and Tom Regan

support animal-welfare and animal-rights positions, their logic is based on the assumption that the animal in question possesses "sentience" and/ or a "consciousness". LaChat feels that the "antis" greatly exaggerate the similarity of animals with humans, and that the possession of "higher" mental powers (e.g. that of emotions) in animals cannot be proven or shown legitimate based on our limited behavioral observations. Fish have been shown to experience pain, in as much as a brain-dead human still exhibits a reflex escape from pain stimuli. *Suffering* is an entirely different matter. Citing nervous system data from Sarnat and Netsky (1981), LaChat states fish do not possess the brain structures to consciously experience pain, and therefore should not be given any moral consideration. In addition, regardless of the consciousness of the fish, the psychological, spiritual, nutritional, economic, and environmental benefits of fishing far outweigh concerns for an individual fish. It is in the best interest for fishers to conserve the fish stocks they exploit, and therefore angling is for the "common good of humans and animals".

In regards to the "antis", LaChat states that their mere existence and competition with other animals is in direct opposition to their claim that they do not "intervene" in nature. Any organism's existence "negates" life for something else. Anglers following the Judeo-Christian tradition can easily defend the ethics of fishing (LaChat, 1996). According to them, God gave humans dominion over fish in the sea (Genesis 1:26) among other things, and they can follow the example of Jesus in taking up fishing (Luke 5:1-10).

LaChat points out that angler groups are not yet the potent force that they could be. In order to contend with the well-organized and vocal anti groups, anglers groups must band together and join with other groups who support the responsible use of animals (e.g. the medical community).

Norville Prosser, vice-president of the American Sportfishing Association, states that healthy fisheries provide enormous cultural, social and economic values, and that Americans participate in sportfishing more than any other outdoor activity (besides swimming) (Prosser, 1996). Their large numbers enable sportfishers the capability of doing a lot of good, or a lot of harm, to aquatic ecosystems. In 1995, President Clinton signed an executive order on recreational fisheries specifying that federal agencies, in cooperation with states, tribes and councils, prepare a Recreational Fishery Resources Plan. Though such plans have not resulted in much measurable change in the past, this one requires the reporting of measurable indices of progress. The stated vision of this plan is that all waters in the US be capable of supporting healthy fish populations, and that all Americans have access to a variety of recreational fish experiences (Prosser, 1996). With such grandiose plans, and with the supply of strong economic backing of sportfishers, the benefits of sportfishing could be far-reaching and their influence long-standing.

A recent article in Crappie World angling magazine (Armitage, 1996) is meant to inform anglers of what animal

rights groups are up to, and serves as a call to arms. Armitage bases some of angler's justification on economics. He states that millions of fishing license dollars fund most aspects of fisheries research and management in the US, that additional millions of dollars in excise taxes fund a range of projects from boating access projects to supporting fish hatcheries, and that hundreds of thousands of Americans rely on fishing as a way to support their families and as a traditional way of life. Lastly, he states that fishing is a shared resource that everyone has a right to use, unharassed. He claims that animal rights activists "care only about themselves and gaining attention for their primary goal of making sure animals have even more rights than people".

Where Do We Go From Here?

In his article, LaChat (1996) states that the "issue of human use of animals is here to stay, and we who are involved in fisheries cannot dodge it." Whether you are an angler, one of the "antis" or are middle-of-the-road, this is an issue that demands addressing. Is there a possibility for compromise? Statements such as "Those anti-fishing folks are cuckoo" and "You wouldn't sink a hook into your cat...would you?" attest to the strong emotions and divisiveness of the issue (Armitage, 1996). Fishers may never understand what drives activists to have such extreme "anti" positions. Activists may never compromise their "high" moral standing. Is there anything that we can agree upon? If nothing is done to promote a resolution, there's no telling who will "win", if the argument is winnable. Anglers are certainly more in number (some 60 million strong), but animal rights groups may be better organized and more vocal (Armitage, 1996; LaChat, 1996). One thing is for certain, the conflict will most certainly grow before it subsides, which

will lead to more time and energy spent by fisheries managers and others in dealing with it.

How can we attempt to arrive at a compromise when the sides are so oppositional? As recommended by conflict resolution theorists, common objectives must be identified (Fisher and Ury, 1981; Kroeger and Thuesen, 1992). Some of these may include keeping aquatic ecosystems healthy and

not over-exploiting them, so that they are sustainable. Perhaps a compromise can be achieved in the area of animal welfare and excessive suffering, and the Animal Welfare Act can be applied more seriously to fish and fisheries. To deal with non-game issues, some reorganization of funding sources/ allocation may be necessary to accommodate the split objectives of the two camps ("Teaming with Wildlife" is a good example). That way, funding for the management and protection of aquatic organisms will not rest so heavily upon revenues generated by sportfishing supporters. There is a way to generate at least some compromise on these issues, though fishers and animal-rights activists will most likely not come to a fundamental agreement. The key is to focus on common interests and goals, not divisive ones. Fisheries managers need to reach out to a broader constituency, to make sure they are taking into account the desires of all groups, and not just that of the consumptive users. If a

"...I cannot fish without falling a little in self-respect... I have skill at it, and, like many of my fellows, a certain instinct for it... But always ...I feel it would have been better had I not fished." - Henry David Thoreau (1817-1862) from Walden

mediated forum and a spirit of cooperation could be established, the environment and fish populations would most certainly benefit from the combined support of both groups on the fishing issue, and many of the impending future clashes could perhaps be avoided.

References

- Atwood, N. 1996. Fishing. Animal Rights Coalition News. Summer Issue. p.4.
- Armitage, D. 1996. What animal rights groups are doing to stop you from fishing. Crappie World. March/April:19-21.
- Chervova, L. S. 1997. Pain Sensitivity and Behavior of Fishes. Journal of Ichthyology. 37(1): 98-102.
- Fisher, R. and W. Ury. 1981. *Getting to Yes*. Penguin Books, New York. pp.3-15, 40-60.
- Fisheries. 1997. Fisheries professionals should be aware that animal rights organizations plan demonstrations. 22(4):62.
- Greenpeace. Northpacific Fisheries: on the Rocks. A report prepared by Greenpeace. Washington, D.C. 1996.
- Kroeger O. and J. M. Thuesen. 1992. *Type Talk at Work*. Dell Publishing, New York. pp. 153-175.
- LaChat, R. 1996. An argument in defense of fishing. Fisheries. 21(7):20-21.
- Lustgarden, S. 1996. Fish: what's the catch? EarthSave:7(1):3-7.
- McCoy, C. 1995 (Oct. 10). 'Anglers away!' Fish-rights activists tip scales of justice; campaign lures those who find hooking immoral; saving spike from rush. The Wall Street Journal. p. A1.
- PETA's Animal Times. Bulldozers of the sea. May/June 1995. p. 9.
- PETA's Animal Times. For Cod's Sake! Spring 1997. p. 16.
- PETA publication: Fishing: An activist's Guide. A report prepared by Peta: Norfolk, VA. 1996.
- Pisces Magazine. Angling News. Bristol, UK. Winter 1996. p.3.
- Prosser, N. 1996. Focus on fish and fishing. Fisheries. 21(8):4.
- Regan, T. and P. Singer, eds. 1976. *Animal rights and human obligations*. Prentice-Hall. New Jersey.
- Sarnat, H. B. and M. G. Netsky. 1981. Evolution of the nervous system., second edition. Oxford University Press, New York.
- Thompson, T. R. and G. D. Lapointe. 1995. Learning from animal activists: a workshop approach. Wildlife Society Bulletin. 23(4):588-593.
- Webb, J. F. and D. C. Jackson. 1996. Human use of fish and other living aquatic resources. Fisheries. 21(2):22-23.

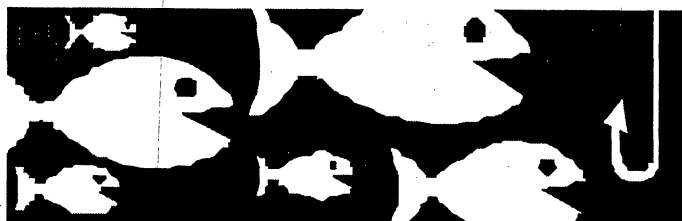
Can Transgenic Fishes be Used in Fisheries Management?

Brian Watson

Currently, there are two schools of thought as to the use of transgenic fishes as a fisheries management tool. The predominant thinking is that transgenic fishes should not presently be introduced into natural aquatic environments under any circumstances. This faction states that until baseline research is done to determine the possible effects that these organisms might have on aquatic communities, it would be too dangerous to freely release them especially when the past effects of introduced species are taken into account (e.g., disease introduction and habitat alteration). There is also doubt as to the effectiveness of the transgenic procedure itself and how effectively the genetic trait(s) will be expressed within the altered fishes. Some studies have shown that only a low percentage of genetically manipulated fishes incorporate the DNA construct within their genome. Other studies show that even if the DNA construct is incorporated within a fish's genome, the expected expression is not always achieved. The second faction believes that transgenic fishes can significantly contribute to fisheries science in a positive way. Transgenic fishes could allow for the hastened growth of fish species leading to better sport fishing and an increase in the commercial and recreational biomass harvested annually. Transgenics could also allow for the introduction of fish species into areas that were once inhospitable to them and infer increased disease resistance. Due to these attractive products, it is believed that transgenics should be aggressively researched to determine whether or not these goals can be achieved. The remainder of this discussion will address the pros and cons of each school of thought, and a final conclusion will be reached as to whether transgenic fishes should be used as a fisheries management tool.

Before I begin discussing the pros and cons of transgenic fishes, I feel it would be appropriate to explain what a transgenic is and how they are created, and what role they can play for fisheries managers. Transgenics are organisms that have been genetically "enhanced" through the addition of a specific trait(s). These traits are novel genetic constructs that are introduced into an organism's chromosomal DNA through the use of genetic techniques. The novel genetic constructs consist of two parts: structural genes that are linked to regulatory genes. Structural genes are DNA sequences that encode for a specific protein product, while regulatory genes are responsible for successful expression of the structural gene. A trait of interest can be introduced into an organism by a number of methods including gene bombardment and the use of sperm as a carrier. However, the method of choice is microinjection because it is usually the most direct and effective approach to transfer DNA, but it does require considerable technical skill and is tedious and time consuming when dealing with large numbers of eggs (Gong and Hew 1995).

The reasons that transgenic fishes are drawing a lot of attention from fisheries professionals is the possible benefits that they can create. Three of the most heavily researched areas with transgenics has been increased growth rates, increased disease resistance, and increased temperature tolerance (e.g., freeze resistance). It is fairly obvious to see the benefits that transgenic fishes could provide if used as an



active fisheries management tool. Some of the benefits include larger fish, increased numbers of fish (through disease resistance and faster growth rates), the ability to stock once temperature intolerant fishes into new areas, and increased angler satisfaction. However, since transgenics is a fairly young field all of these benefits are only speculation based on laboratory studies.

The first area that needs to be considered, even before the issue of using transgenic fishes as a fisheries management tool, is if the development and production of transgenic fishes is a practical and financially feasible option for fisheries managers. Gross et al. (1992) performed molecular analysis and growth evaluation of northern pike (*Esox lucius*) microinjected with growth hormone genes to determine the relative success of the experiment. Hatching rates for a total of 14,000 one-cell northern pike embryos showed that both control (58-78%) and microinjected (62-66%) groups were normal for artificial incubation of this species (Westers 1986), indicating no detrimental effects on the eggs that were genetically manipulated. DNA analysis of two-month-old juvenile fish (same as

above) indicated that on the average only 5-11% of the microinjected fish contained detectable levels of transgenic DNA within fin clips. Identical analysis of these same fishes' blood was performed and only 3% (36) tested positive for transgenic DNA. An interesting side note to both of these studies was that of the 36 fish that tested positive for transgenic DNA from blood samples, none showed any sign of transgenic DNA from fin clips. These results imply that a high degree of

mosaicism (incorporation of DNA into particular cells) is occurring within these fishes. Since not all of the fishes cells are incorporating the desired transgenic trait, this mosaicism might lead to an unexpected expression of the trait (e.g., lack of increased growth).

Because these transgenic fish appeared to be highly mosaic, Gross et al. (1992) performed additional tests on various tissues (brain, gonad, kidney, liver, muscle, and fin). Thirty percent of the fish from the additional analyses contained detectable transgenic DNA in at least one or more tissues. However, transgene DNA was only detectable within fin tissues of 41% of these same fish, indicating that non-lethal screening procedures utilizing fin clips may not be a suitable indicator of transgenic incorporation within host genomic DNA.

Growth analysis showed that the average weight of microinjected northern pike was greater than that of control fish in four out of six groups. However, significant increases in weight were only observed in one group of microinjected males when compared to the control group.

Similar studies have been applied to different species in order to test the effectiveness of various transgenic traits. The

effect of growth hormone on the growth rate of gilthead seabream, *Sparus aurata* (Cavari et al. 1993) showed a slight increase (about 15%) in fish growth when human or bovine growth hormones were administered. Tests with porcine (pig) and chicken growth hormones returned even less promising results, with minimal or no increase in growth occurring. However, use of the fishes native growth hormone did result in unquantified accelerated growth rates.

Transfer of the gene for neomycin (bacterial drug) resistance into goldfish, *Carassius auratus* (Yoon et al. 1990) has resulted in extremely high mortality rates using microinjected techniques. In early experiments the mortality rate was 90% while current levels are approximately 50%, compared with mortality rates of only 10% for uninjected control groups. Genetic analysis of these same goldfish showed that roughly only 7% of the microinjected individuals that survived through one month of age carried the transferred construct in at least some of their tissues. To determine to what extent the transferred neo gene was expressed, 40 neo-injected fish were exposed to a constant

concentration of neomycin. All of the fish died within 7 days after the test, presumably due to stress attributable to the drug exposure. Exposures conducted at a higher concentration resulted in all of the fish dying within 3 days after the test. Once again, the results of transgenic research appear to be lacking the success rate needed to seriously consider this technique as a viable fisheries management tool.

Transfer of disease resistance has also been attempted. Engelking and Leong (1989) cloned and sequenced the infectious hematopoietic necrosis virus (IHNV) gene and constructed plasmid vectors that expressed an antigenic determinant of the IHNV gene. Salmonids immunized with the resulting biosynthetic vaccine have shown a decrease in mortality of 50 to 70% when exposed to IHNV.

The results from these studies can be described as variable at best. While Yoon et al. (1990) didn't show any increased resistance of transgenic goldfish to neomycin, Engelking and Leong (1989) showed a marked decrease in the mortality rate of transgenic salmon to IHNV. Likewise, growth improvements within transgenic fishes were ambiguous. Northern pike did show an increase in growth but it was only significant for a single group. Gilthead seabream exhibited no or little augmented growth when injected with growth hormone unless it was from a native fish. Finally, while the percentages of actual incorporation of transgenic constructs within host genomic DNA might seem low, this is the average value that has been reported from many other studies (Zhang et al. 1990, Brem et al. 1988, Stuart et al. 1988).

The conclusion that can be drawn from such studies of

Some studies have shown that only a low percentage of genetically manipulated fishes incorporate the DNA construct within their genome. Other studies show that even if the DNA construct is incorporated within a fish's genome, the expected expression is not always achieved.

transgenic fish, is that very limited information is available on the integration and inheritance of transgenes. This limited information is the cause for delays in overcoming the previously mentioned variations in study results. Research efforts must be on-going to improve the method and efficiency of gene transfer, to target the site of gene integration, and to restrict the expression and inheritance of the resultant transgene. In some cases, progress has been made and the results are significantly better than those reported above. Jin (1989) achieved an integration rate of 22% into cytoplasm and 43% into the oocyte germinal vesicle of goldfish with a growth hormone. The rate of expression of this foreign gene was approximately 50%.

From a financial standpoint, the cost of transgenics has not been quantified in print to make a determination as to whether the procedure is monetarily feasible. The current cost of generating a small number of sheep (approximately 500) carrying a foreign gene is approximately \$3 million dollars (Clark et al. 1987). However, the cost of producing transgenic fish is much smaller since fertilization is external and a much larger number of eggs can be dealt with for a shorter period of time. These factors reduce the amount of technical demand needed and the time involved with developing the transgenics in fish.

From a technical standpoint, the potential of using transgenic fishes as a fisheries management tool does exist, but the field needs to continue to improve on results already achieved. The rates of gene integration and expression must increase to even higher levels and it must be conclusively determined if mosaic organisms are at a transgenic functional disadvantage compared to fully transgenic individuals. Additionally, techniques must continue to be modified so that the optimum cost-benefit ratio is achieved.

Now that the question of whether or not transgenic fishes are functionally feasible for fisheries management use has been answered with a conditional yes, it must be determined if the benefits of these fishes will significantly outweigh the negatives. As described above, the benefits of these fishes are still ambiguous and the consequences on natural ecosystems resulting from the use of modified organisms is unknown. Since the field of transgenics is relatively new, the majority of research has been spent studying the structural aspects of modifying organisms. No emphasis has been placed on the functional role these organisms will have on the systems they are released into. One might imagine that impacts if a fisheries manager were to release bass modified with a growth hormone into a reservoir or lake. Because of their increased growth rates, these bass would need to consume more food. This could lead to a decrease in the available amount of forage fish which could cause a decrease in the native species of the lake or reservoir through starvation. These larger modified bass could also prey upon other native bass which would be smaller than the altered fishes. Overall, a dramatic shift in the dynamics of the lake or reservoir may occur and the fishery could crash. What once seemed like a good idea for increased sport fishing, has now caused a once productive recreational fishery to disappear. While this is a highly speculative result regarding

the effects of transgenic fishes, it must be considered since the concern has been proposed by various scientists. It must also be considered since this is all the information that the scientific community has at this time. However, there is a large source of information regarding the effects of introduced species on native communities. Since this is a similar situation to transgenic fishes, ecological effects must be predicted from their results.

The best example of the effects that introduced fishes have on natural systems probably lies within the salmonid populations of North America. Changes in the dynamics of competition and predation and introduction of parasitism and disease through the introduction of non-native salmonids has caused dramatic declines in many of the native salmonid populations. For example, European brown trout are known to be piscivorous and feed upon native brook trout (Krueger and May 1991). A significant increase in the number of brook trout occurred when 40-66% of the brown trout larger than 22.9 cm were removed from Au Sable River (Shetter and Alexander 1970). Likewise, diseases and parasites have been introduced to native salmonids through the stocking of non-native salmonids. In Wyoming, bacterial kidney disease has been transmitted from stocked infected hatchery trout to non-native brook and rainbow trout populations (Mitchum et al. 1979).

Likewise, native salmonid populations have been negatively impacted genetically and by environmental modifications caused by the introduction of non-native salmonids. Genetic effects occur through the mixing of different gene complexes which can lead to a reduction in the amount of beneficial adaptive potential within the "new" gene pool or to the loss of genetically distinct populations. The hybridization between brown trout (*Salmo trutta*) and native

Atlantic salmon (*Salmo salar*) has been reported from a Nova Scotia river (Beland et al. 1981) and also within Forest Lake, Montana between native and introduced cutthroat trout (*Salmo clarki*) (Gyllensten et al. 1985). Both of these native species are losing their genetic distinctiveness since non-native genes have been introduced to the gene pool. The cutthroat trout are currently described as a hybrid

swarm. Environmental modification typically occurs by overabundant runs of stocked salmon destroying already deposited native trout eggs when they are dug up and spawned over (Krueger and May 1991).

Giving specific examples of how a fisheries manager might benefit from the use of transgenic fishes is difficult, because every situation is speculative since transgenic fishes have not been used in a natural setting yet. The most relevant example that I can think of would be to use transgenic striped bass within Smith Mountain Lake. Current catch rates and trophy citations are significantly lower for striped bass than they have been historically. Still, Smith Mountain Lake is one of the top ten striped bass fisheries in the United States, but the anglers are not satisfied with the current situation. It is believed that the reason for the decline in catch rates and trophy citations is that the number of stocked striped bass fingerlings surviving to the first and second year classes is very low. Stocking striped bass that

The conclusion that can be drawn from such studies of transgenic fish, is that very limited information is available on the integration and inheritance of transgenes.

have been genetically altered with a growth hormone might solve this problem. Since the fish grow faster, they are less likely to be affected by density-independent factors that might be leading to the early demise. Additionally, striped bass could be genetically altered to tolerate higher temperatures. A significant amount of striped bass mortality occurs because the fish cannot tolerate the increased water temperatures as they are brought to the surface. This intolerance to the temperature change leads to a high catch-and-release mortality. If transgenic striped bass that were less sensitive to the temperature change were stocked, the catch-and-release mortality would drop and the lake would have more and larger striped bass.

However, since the scientific community knows virtually nothing about the environmental impacts that transgenic fishes may have on natural ecosystems, these organisms should not be used as a tool in fisheries management. Based on past and present effects that have been caused by introduced species, it would be foolish to think that these genetically modified organisms could be released without a solid database of information. There might be benefits that we could reap from these fishes such as better sport fishing or increased biomass in commercial and recreational harvests, but it may only be for the short term. Once these fishes are released into natural ecosystems it will be a permanent and irreversible decision that can have severe impacts on all that use aquatic resources. Because of the potential ramifications of using these fishes and the ambiguity as to the status of their benefit, these organisms must be more intensely studied. Once the scientific community has reached a conclusion detailing the impacts and benefits regarding transgenic fishes, then and only then should a decision be made as to whether or not these organisms can be used by fisheries managers.

References

- Beland, K. F., F. L. Roberts, and R. L. Saunders. 1981. Evidence of *Salmo salar* x *Salmo trutta* hybridization in a North American river. *Canadian Journal of Fisheries and Aquatic Sciences* 38: 552-554.
- Brem, G., G. Brenig, G. Horstgen-Schwark, and E.L. Winnacker. 1988. Gene transfer in tilapia (*Oreochromis niloticus*). *Aquaculture* 68: 209-219.
- Cavari, B., B. Funkenstein, T.T. Chen, L.I. Gonzalez-Villasenor, and M. Scharl. 1993. Effect of growth hormone on the growth rate of the gilthead seabream (*Spartus aurata*), and use of different constructs for the production of transgenic fish. *Aquaculture* 111: 189-197.
- Clark, A., J. Simons, I.P. Kilmut, and R. Lathe. 1987. Pharmaceuticals from transgenic livestock. *Trends in Biotechnology* 5: 20-24.
- Engelking, H.M. and J.C. Leong. 1989. The glycoprotein of infectious hematopoietic necrosis virus elicits neutralizing antibody and protective responses. *Virus Research* 13: 213-230.
- Gong, Z. and C.L. Hew. 1995. Transgenic fish in aquaculture and developmental biology. In: *Current Topics in developmental Biology*. Academic Press 273 pp.
- Gross, M.L., J.F. Schneider, N. Moav, B. Moav, C. Alvarez, S.H. Myster, Z. Liu, E.M. Hallerman, P.B. Hackett, K.S. Guise, A.J. Faras, and A.R. Kapuscinski. 1992. Molecular analysis and growth evaluation of northern pike (*Esox lucius*) microinjected with growth hormone genes. *Aquaculture* 103: 253-273.
- Gyllensten, U., R. F. Leary, F. W. Allendorf, and A. C. Wilson. 1985. Introgression between two cutthroat trout subspecies with substantial karyotypic, nuclear and mitochondrial genomic divergence. *Genetics* 111: 905-915.
- Jin, Z. 1989. The expression of human growth gene after injection into oocyte of goldfish. Doctoral Dissertation, Institute of Marine Biology, Academia Sinica.
- Krueger, C.C. and B. May. 1991. Ecological and genetic effects of salmonid introductions in North America. *Canadian Journal of Fisheries and Aquatic Sciences* 48 (Suppl. 1): 66-77.
- Mitchum, D.L., L.E. Sherman, and G.T. Baxter. 1979. Bacterial kidney disease in feral populations of brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout (*Salmo gairdneri*). *Journal of Fisheries Research Board of Canada* 36: 1370-1376.
- Shetter, D. S. and G. R. Alexander. 1970. Results of predator reduction on brook trout and brown trout in 4.2 miles (6.76 km) of the North Branch of the Au Sable River. *Transactions of the American Fisheries Society* 99: 312-319.
- Stuart, G.W., J.V. McMurray, and M. Westerfield. 1988. Replication, integration, and stable germ line transmission of foreign sequences injected into early zebrafish embryos. *Development* 103: 403-412.
- Westers, H. 1986. Northern pike and muskellunge. In: R. Stickney, ed. *Culture of Non-salmonid Freshwater Fishes*. CRC Press, Boca Raton, FL, 201 pp.
- Yoon, S.J., E.M. Hallerman, M.L. Gross, Z. Liu, J.F. Schneider, A.J. Faras, P.B. Hackett, A.R. Kapuscinski, and K.S. Guise. 1990. Transfer of the gene for Neomycin resistance into goldfish, *Carassius auratus*. *Aquaculture* 85: 21-33.
- Zhang, P., M. Hayat, C. Joyce, L.I. Gonzalez-Villasenor, C.M. Lin, R.A. Dunham, T.T. Chen, and D.A. Powers. 1990. Gene transfer, expression and inheritance of pRSV-rainbow trout-GH cDNA in the common carp, *Cyprinus carpio* (Linnaeus). *Molecular Reproductive Development* 25: 3-13.

**"Teachers open the door,
but you must enter by
yourself."**

Chinese proverb

Managing People or the Coelacanth

Ashley D. Kinney

Synopsis

A brief background of the number of coelacanth known to be living and the number of annual catches is given. Details are given on the motives for harvesting for the coelacanth. These motives include the low economic status of the Comoran Islands, coelacanth that are caught as a bycatch, the high demand for profitable resources such as fish tissue oils (elixirs and aphrodisiac myths), and museum and scientific demands. Tactics to reduce harvesting the coelacanth are explained. These include short term natural resource management, incentives to use other products in place of those obtained by fish, establishing a Coelacanth park, eliminating market value of the coelacanth, and most importantly, reevaluating the financial status of the Comoran Islands.

Introduction

Recently, Hans Fricke estimated the numbers of living coelacanths to be in the low hundreds (based on number per cave and birth rate). Their exact numbers are not known due to incomplete data on rarely seen or caught juveniles and the possibility of other communities near Madagascar and surrounding inlets. The inventory as of 1991 of coelacanth species caught is 172 and averages 4.39 per year from 1952 to 1990 (Bruton and Coutouvidis 1991). The suggested management tactics for the coelacanth cannot be successful unless they are carried out and enforced. Enforcement ideally begins with the people of the Comoran Islands, because of their protective stance over the fisheries in their aquatic territory. However, because of their extreme financial and political weaknesses, they cannot be relied upon to actively monitor the catch. Outside help must be brought in from other countries to teach Comorans alternatives to their resource consumptive lifestyles. Before we are able to successfully manage a living fossil such as the coelacanth, *Latimeria chalumnae*, we must begin to manage the financial status of the people who are directly connected to the well being of that species, so that management tactics may be carried out and enforced.

Reasons the coelacanth is harvested

Bycatch of another fishery -- The oil derived from oilfish (*Ruvettus*) flesh contains nesa, which is used to make and market laxatives for the Comoran Islanders. These fish can only be caught during the night hours when they move to shallower waters to feed. The coelacanths are also reported to leave their caves in the late afternoon in order to seek forage in the coastal inclines at night. Therefore, they become a bycatch to the desired *Ruvettus* species, which share common nightfeeding patterns (Internet).

Income - In 1980, the Comoran Islands were importing 295% more than they were exporting (Gaspard 1983 Newitt 1984). In 1982, the Gross National Product of the Comoran Islands

was equivalent to US \$285 per capita (Anon 1987), although the average annual income for a Comoran is US \$30. The bounty placed on a coelacanth specimen on the open market is between US \$500-\$2000. However, the sum of \$150, which is received by the Comoran fishermen by their government, is incentive enough to increase their hunt of the coelacanth (Balon et al. 1988).

Demand for tissue oil- The oil derived from the fatty tissue of the coelacanth is thought by certain groups to have strong aphrodisiac qualities (Greenwood 1989). Therefore, it has been suggested that samples of the fish are sold on the black market for an unknown but large price (Bruton and Stobbs 1991).

Myths about an Elixir- It is believed by some Far Eastern people that the fluid obtained from the notochord of the coelacanth provides a life-extending elixir. This has created a huge demand on the Black Market for this fish, although Comoran Officials deny any such trade exists.

Novelty Demand- The coelacanth was listed as an Appendix I endangered species, making it illegal for countries who have signed the CITES agreement to offer any trades or prices for museums and displays. They may, however, be donated or sold to countries for genuine scientific research (Bruton and Stobbs 1991). Presently, fish are being actively sought after

because of their market appeal to museums, universities, private dealers, hotels and managers (Greenwood 1989).

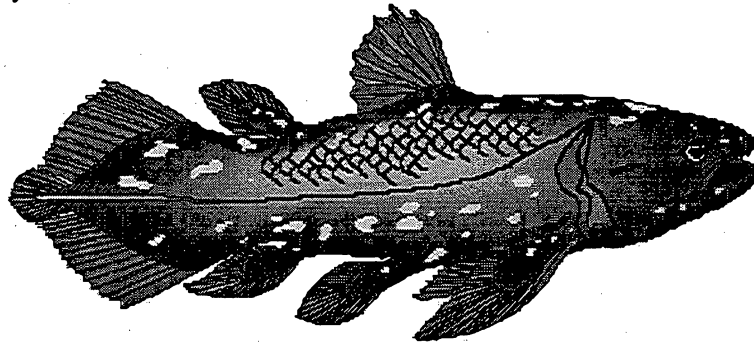
High use of natural resources - Long term planning in an economically poor country is one luxury

that the Comoran Islanders cannot afford. They must use every resource to its greatest extent regardless of its long term effects or availability. Resources such as oilfish and coral must be harvested as needed to provide daily finances.

Feasible Management Tactics

Eliminate bycatch -- By offering the Comorans a substitute prepackaged laxative at a lower cost than their oilfish nesa, the need for fishing for the oilfish, *Ruvettus*, at night will be reduced or eliminated. The Grand Comoran fisherman will gladly discontinue the dangerous occupation of night fishing for oilfish if offered another alternative (Bruton and Coutouvidis 1991). Because food fishes can be found during the daylight hours, the chance of catching the coelacanth as they move in to feed at night is eliminated (Bruton and Stobbs 1991).

Educate against myths -- Evidence supporting the claim by the Far Easterners that the fluid in the notochord of the coelacanth has life prolonging properties could not be found. Without proper biological evidence, the islanders should be taught that such myths should be dismissed to avoid any overharvesting tragedies.



Improve Socio-Economic Problems -- The primary focus of saving the coelacanth needs to be redirected from the fish itself to the people involved. Economic stability needs to be implemented in the Comoran Islands before they can afford to enforce the conservation acts. The Convention on International Trade in Endangered Species (CITES) is an alliance of countries fighting to limit and prevent trade of threatened species such as Appendix I listed species. As of 1991, the Comorons had not signed the CITES agreement, though they understand the importance of fighting illegal trade. However, even if they had signed the agreement, they would have been financially incapable of enforcing the laws of the agreement. We must educate the Comorans on management and growth of their country so they can reap the long-term benefits of resource management

Redirect research funds towards preservation - In 1994, the Explorers Club Coelacanth project changed their mission from displays and research to trying to prevent the post-release deaths of accidental catches in the Comorans. From November -December 1994, a 800-gallon tank with cooling and filtration units was set up using the club's redirected funds in hopes of reviving the fish so they may survive upon release. A transporter box has been built to move the fish from the ocean to the tanks. So far, the most successful transport occurred in the summer of 1995 when a coelacanth that was already out of the water for 15 hours was able to survive another 10 hours in the tank. Death, so far, has been inevitable due to a theory of capture stress combined with hypothermia and asphyxiation caused by the 20°F change in temperature as the fish was raised in the water column (Internet). Costs for this tank average \$250 monthly, making it difficult to operate without help outside of the country. To help ease this financial burden, the Coelacanth Conservation Council has recently begun to assist in raising funds and backing conservation and management ideas (Greenwood 1989).

Decrease museum demand - There must be a decrease in the greed for display of these fish out of the water and an increased respect for the privacy of the fish in the water. As long as a bounty is placed on parts of the coelacanth, there will be a market. These bounties need to be eliminated and enforced. For example, by establishing look-alike plastic models of the already preserved fish, educational demands for the fish may be relieved (Balon et al. 1988). Rather than collected, the fish must be observed. A Coelacanth television program has been suggested which will contain cameras set up around the coelacanth's habitat so they may be passively observed (Internet.) The desire to collect for profit and show needs to be altered towards the desire to preserve. Though it is not feasible to repress the joyful knowledge of an extant species from any group of people, it is feasible and of the utmost importance to, Randall suggested in *The Preservation of Species*, amend the "uses to which that organism may be put."

Create Coelacanth National Park -- A Coelacanth National Park has been suggested to the World Wide Fund for Nature, the Comoran authorities, and the International Union for the Conservation of Nature, by the Coelacanth Conservation Council. This will prevent bottom fishing at depths greater than 120 meters (Balon et al. 1988). The only type of fishing allowed would be by local artisanal fishermen using

paddled galawas (Bruton and Stobbs 1991). This would allow the coelacanth to roam with limited danger of being captured by modern equipment brought in by those with greater financial advantages.

Conclusion

The less we actively interfere, the better the coelacanth's chance of survival is. The Coelacanth National Park, a World Heritage Site by the southern shores of Grand Comorans, will help reestablish the coelacanths while allowing the local artisanal fishermen to use traditional methods of fishing (Burton 1993). This would allow the economy to be fed by the fishermen while reverting to less harmful fishing tactics.

The coelacanth's survival tactic for 345 million years (Balon et al. 1988) was to successfully remain hidden. The most effective management tool that we can ever implement on such a wise and timely species is to leave it alone. It has evolved to be tolerant of a very narrow environment (Greenwood 1989) and it may be in danger if we continue to uproot and expose them to the wrath of our greed. Research should be a non-profitable luxury rather than a life threatening invasion. Therefore, we must decide whether or not we will manage the coelacanth for research or preservation. Either way, control over the numbers harvested must occur, and can only be implemented if there are sufficient funds to support the luxury of conservation. Financial restructure to the Comoron Islands would help enhance their way of life so that the Comorans will not have to resort to selling an endangered species to science, museums, or superstitious private buyers. We must begin educating and managing people before managing a species we know so little about.

References

- Anon. 1987. The Comores. *South African Connection* 2:46-47.
- Balon, E. K., M. N. Bruton, and H. Fricke. 1988. A fiftieth anniversary reflection on the living coelacanth, *Latimeria chalumnae*: some new interpretations of its natural history and conservation status. *Environ. Biol. Fish.* 23(4):241-280.
- Bruton, M. N., and S. E. Coutouvidis. 1991. An inventory of all known specimens of the coelacanth *Latimeria chalumnae*, with comments on trends in the catches. *Environ. Biol. Fish.* 32:371-390.
- Bruton, M. N. 1993. Alterations and additions to the coelacanth inventory: III. *Environ. Biol. Fish.* 38:400-401.
- Bruton, M. N., and R. E. Stobbs. 1991. The ecology and conservation of the coelacanth *Latimeria chalumnae*. *Environ. Biol. Fish.* 32:313-339.
- Gaspard, C. 1983. The Comoro Islands since independence: an economic appraisal. *Proc. ICIOS Conference, 1979, Section 2, Perth.* 56 pp.
- Greenwood, P. H. 1989. Fifty years a 'Living Fossil' - The coelacanth fish *Latimeria chalumnae*. *Biologist* 36(1):15-19.
- Evolutionary Fish: The Coelacanth, Living Fossil. <http://www.dinofish.com/>
- Newitt, M. 1984. The Comoro islands. *Struggle against dependency in the Indian Ocean.* Gover, London. 144 pp.
- Thomson, K. S. Living fossil. *The story of the coelacanth.*

Multidisciplinary Problems

Effects of Hydroelectric Dams on Outmigrating Salmon Smolts in the Columbia River Michael Robertshaw

The Columbia River system in the Pacific Northwest at one time supported the largest numbers of coho, chinook, and steelhead salmon in the world. It was also host to breeding populations of sockeye, pink, and chum salmon. Many of the wild stocks of migratory salmon, however, have decreased substantially since the early part of the century. There are relatively few healthy stocks left; many either threatened, endangered, or already extinct (Wernstedt 1995).

In the Columbia River basin, the population of adult salmon species has decreased 75% to 80% in the last one hundred years with numbers falling from 12 to 16 million in the beginning part of the century to 2.5 million today (Hathorn 1992). In the last three years alone one wild stock of sockeye salmon has been placed on the Endangered Species List (ESL), and two wild stocks of chinook salmon have been declared as threatened. Another wild stock of coho salmon that had previously been up for status on the endangered species list has already been declared as extinct. Currently, there are approximately 79 wild stocks in the Columbia River Basin that have been identified as being in danger of extinction under one of three classifications as defined by NMFS: (1) 36 are considered under a *high risk of extinction*, (2) 14 are *moderate risk of extinction*, and (3) 26 are of *special concern* (Nehlsen et al. 1991).

The cause of these declines is due to a variety of factors among which are overfishing, agricultural runoff, deforestation, industrial pollution, commercial development, and mining. These, however, are simply compounding elements to a much greater problem - hydroelectric dams. Since the late thirties, fifty one dams have been constructed on the Columbia and its adjoining tributaries. They supply cheap electricity (60% of the national average) and water to households, businesses, industry, and agriculture in California, Oregon, Idaho, and Washington.. These dams act as blockades to salmon smolts on their migratory runs to the Pacific.

There are approximately 581 miles of river from the Bonneville dam (the dam closest to the Pacific) to the border of Canada. That stretch of river now contains approximately fifty miles of free flowing river (Devine 1992). The network

of dams has turned the Columbia into a series of lakes creating a serious problem for the migrating smolts of salmon.

The effect on smolts migrating downstream is where the highest mortality rates of salmon are found. A study conducted to determine the mortality rates of young salmon approximates a 10%-30% loss at each dam encountered (Wood 1993). This occurs for a number of reasons.

First, the dams are equipped with large scale turbines which pump water from the dam to supply the surrounding area with electricity, drinking water, and irrigation. In an effort to get around the dam, thousands of young salmon get caught up in these turbines each year.

Second, power companies withhold peak flows during spring runoff (April through mid-June). This is stored for use in the fall when demand for electricity is highest. Traditionally, the young salmon would use these currents in order to reach the ocean in approximately two to three weeks. Since the river has been dammed, however, the journey can take anywhere from thirty to sixty days. The extended travel time creates a situation whereby the smolts miss the opportunity to make the necessary changes to suit its

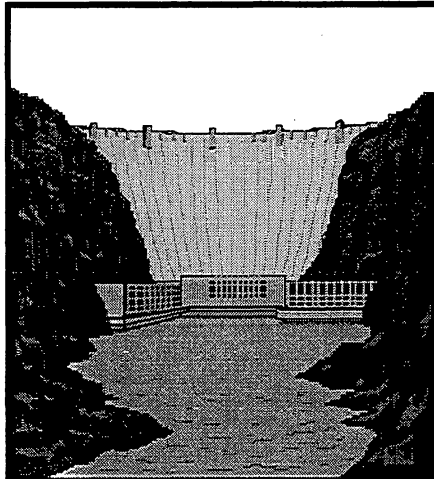
anadromous lifestyle.

Another problem for the young salmon is a higher susceptibility to predation. The lakes created by the dams are support large populations of piscivores, such as smallmouth bass and squawfish. While in the warm waters of the reservoir, they become easy prey for bass and squawfish, predators they have not adapted to avoiding (Devine 1992).

Solutions

Since the mid to late eighties, there has been growing concern for the salmon by the public, the power companies, and Indian tribes native to the region. The economic importance of the salmon to the region has forced many factions to develop methods of increasing salmon passage through dams. Some broad methods that have been developed to maximize smolt passage are: the construction of fish screens and bypass facilities to direct smolts away from the turbines; the use of trucks and barges to transport the young salmon around the dams; and finally [and the most crucial] is to increase the flow of water through the dams during the periods of peak migration' April through June (B.P.A. 1987).

The manipulation of flow through the dams is by far the most crucial, and effective method to decrease mortality on outmigrating salmon smolts. Increasing the flow during periods of peak migration would work to mimic pre-dam flows of the river decreasing the time it takes for the salmon to make it to the ocean. The Northwest Power Planning Council, in conjunction with Congress, dam operators, fisheries professionals, tribal leaders, and other Northwestern utilities companies have developed plans in an effort to allocate water for the outgoing salmon. The first is the *Water*



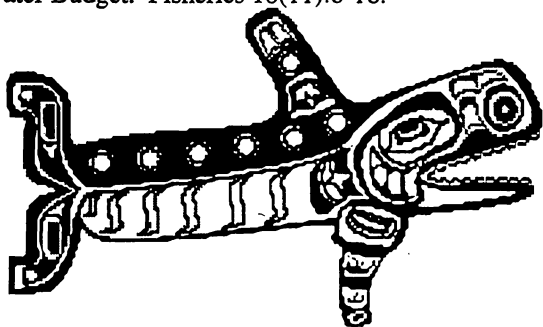
Budget Agreement. This plan allocates up to 4.64 million acre feet of water to be released to flush the salmon through the network of impoundments (B.P.A. 1991). Another plan which is directed at increasing salmon passage through each impoundment by 90% is the Long Term spill agreement. This agreement was designed for four dams; Lower Monumental, Ice Harbor, John Day, and The Dalles (B.P.A. 1991). The cost in annual revenue lost due to water allocation projects, along the cost of fish screens, fish transportation, and bypass facilities is estimated between \$65-\$85 million dollars (B.P.A. 1987).

Conclusion

Hydroelectric dams have had a major impact on salmon populations in the Columbia River Basin. Mainly, these effects have been the most detrimental to the juvenile salmon that are migrating to the ocean. Pacific run salmon are not only of major importance to the northwestern economy (12% of total annual fish harvest), but they are also considered to be a part of our heritage. Much time and money is now being spent in an effort to help salmon populations recover, however, as long as there is a demand for water, there will be controversy concerning whose well being is more important. Deciding whether or not there can be a compromise is up to us.

References

- Bonneville Power Administration. April 1987. Downstream fish migrations: Improving the odds of survival. Environment and Power.
- Bonneville Power Administration. July 1987. The world's biggest fish story: The Columbia River's salmon. Backrounder. 11-12
- Bonneville Power Administration. September 1991. The Columbia River System: The Inside Story. 38-42.
- Devine, B.. 1992. The Salmon Damned. Audubon: 82-89.
- Hathorn, C.. 1992. Save our salmon, save our soul. The Nation: 14-16.
- Nehlsen, W.; Williams J. E.; and Lichatowich J. A. 1991. Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washington.. Fisheries 16(2):4-19.
- Wernstedt, K., and C. M. Paulsen. 1995. Economic and Biological Analysis to Aid System for Salmon recovery in the Columbia River Basin. Journal of Environmental Management. 43(4):313.
- Wood, C. A. 1993. Implementation and Evaluation of the Water Budget. Fisheries 18(11):6-16.



Management of Row-Crop Agriculture: Reduction of Eutrophication Blake Davis

Row-crop agriculture is a large contributor to the nonpoint source pollution problem. Cropland erosion is responsible for 38% of the approximately 1.5 billion tons of sediments that enter freshwater systems each year (Welsch, 1991). This sediment also carries nutrients and pesticides. It has accounted for nine-billion dollars worth of damages annually in the United States alone (Lichtenberg et. al., 1992). These poor management practices cause contamination of groundwater and freshwater systems destroying aquatic habitat and contaminating water supplies (Youngberg et.al., 1985).

Eutrophication is defined as nutrient enrichment of a body of water. Nitrogen and phosphorous are the key players that stimulate growth of algae and other aquatic plants. In fisheries management, fertilization of oligotrophic, infertile, lakes is commonly practiced to increase production. Problems occur when humans inadvertently add nutrients to the environment. This is a case where too much of a good thing can be devastating. There are many causes of eutrophication. Wastes, detergents, raw sewage, river basin development, runoff from urban areas, fossil fuel burning, deforestation, and agricultural row-crop farming are all causes of this problem (Smith, 1992).

When excessive nutrients overflow into freshwater aquatic systems, initially things look great. Phytoplankton production increases working its way up the trophic food chain/web and what we see is an increase in game fish. Phytoplankton continues to proliferate causing masses of algal blooms to form. These algal mats die and settle to the bottom of these lakes where respiration and decomposition take place utilizing the dissolved oxygen. As dissolved oxygen decreases, intolerant species such as game fishes decline in numbers and tolerant species increase. At some points these massive algal blooms choke the system causing widespread fish kills (Smith, 1992).

A Brief History of Row-Crop Farming?

Before the 1930s, farming was based on small time operations with rotational crop management and little use of chemical fertilizer. With the Great Depression, there came a need for massive production. Research introduced chemical fertilizers which allowed farmers to specialize in planting one particular type of crop also known as monoculture. This form of agriculture promotes soil erosion and poor economic planning. Since the Clean Water Act of 1972, point source pollution had been a major concern but waters were still being polluted. Section 319 of the Clean Water Act was amended in 1987 make it mandatory for states to assess nonpoint pollution sources and submit this to the federal government (Youngberg et. al., 1985).

In 1990, the Farm Bill enacted the New Water Quality Incentive Program (WQIP). This gave incentives to farmers to implement multi-year management plans (approved by the Soil Conservation Service) to reduce fertilizer, manure, and pesticides. The conservation reserve program (CRP) was

created under WQIP in 1985 to add lands thought to be a direct cause of endangered water quality to be added to a "highly erodible" list. This added 11 million acres of land to the Farm Bill. These new policies gave the farmer the freedom to plant crops in rotation to allow reduced use of chemicals and pesticides (Carriker et. al., 1997).

Implemented management practices?

Best Management Practices (BMPs) are techniques specifically designed to reduce erosion, chemical fertilization, and pesticide uses. They tend to be less costly than present farming techniques and less hazardous to the environment, specifically freshwater systems. They can be implemented by the farmer with the help from a soil conservation manager and in some cases it can produce higher yields of crops (Wheaton, 1980).

The EPA and U.S. Department of Agriculture did a study on cost-effectiveness of BMPs and found that:

"BMP costs are low compared to the costs of conventional practices, BMP costs are relatively small when compared to overall costs, and BMPs provide additional aesthetic benefits that cannot easily be assigned a dollar value." (Meek, 1997)

There are three types of BMPs available for better crop management: structural measures, conservation tillage and cultural practices management, and land use changes. Structural measures are any measure that changes the landscape of the farm to decrease erosion of both soil and nutrients. Some structural management techniques include ponds, debris basins, fencing, and stream bank protection. Conservation tillage practices are related to nutrient and pesticide applications as well as how the soil is prepared before the crop is planted. These practices entail contour farming, row arrangement, strip cropping, and mulching to list a few. Land use changes consist of crop rotations and plant cover to reduce excess erosion. Some land use changes are field windbreaks, filterstrips, and pasture and hayland planting (Wheaton, 1980).

Riparian Zones: What good are they?

Riparian zone degradation is a primary cause of erosion. Riparian zone vegetation is responsible for shading streams as well as nutrient and sediment buffering providing the stream with optimum food and habitat. The streamside forests are effective in excess nutrient removal and soil erosion prevention.

When these regions are removed, shellfish as well as finfish production is also reduced. The vegetation is no longer there to buffer and filter the nutrients and sediment causing contamination and siltation. Stream habitat as well as natural flow is destroyed leaving it virtually inhospitable for aquatic life in extreme cases. With the reduction of nutrient and sediment overloads through BMPs, the erosion and nutrient problem is not over. The reestablishment of riparian zones can act as filters and sediment traps further protecting the freshwater sites.

Establishment of suitable riparian zone along with BMPs can solve the problem (Welsch, 1991).

How do the farmers feel about all these changes?

Everyone is in favor of improving the water quality in the environment. Improved water quality means better habitat for fishes, more aesthetic water systems, and the American dream. Wait just a second, this sounds too good to be true. Someone has to pay and that someone is the farmer.

Farmers chose their profession for the freedom it allowed. They are allowed to set their own hours and do their job in the most effective way they know how while making a living doing this. A survey of Virginia farmers showed that two-thirds stated water quality and soil erosion were a high priority as long as profitability of their efforts remained high. There was also a high level of concern related to agricultural chemicals and water quality (Halstead et. al., 1990). In a survey conducted on Maryland farmers, about one-half of Maryland stated that they will voluntarily adopt new and additional BMPs. About 11% of the farmers in Maryland stated they would adopt BMPs if cost-sharing, the initial costs of BMPs, was an issue. Most farmers agreed that degradation of the environment and freshwater was not acceptable if higher profits were a result. Farmers do consider this issue to be a problem and know they are part of it (Litchenberg et.al., 1992).

Issues: if a majority of the farmers are concerned, why not implement BMPs?

BMPs are cost-effective and improve the environment and farmers do want to improve the conditions of the environment. Why, then, are BMPs not being implemented? What are the major issues and controversies behind these techniques? Before these questions can be answered, other questions should be addressed.

- Who determines how clean is clean enough?
- Who decides when enough is enough?
- What is the primary objective of the program?
- How are the sources identified?
- Who will regulate programs, educate farmers, and research new management techniques?
- Are there any better alternatives?

We as fisheries managers have a role in the process of determining how clean the water should be. On a local, state, and national level, we have a say. We are in direct contact

with the above ground freshwater systems and our statewide goals and objectives are part of the quality of the water answer. We should be involved in the process of determining how clean the freshwater ecosystems should

become.

After the water quality goal is determined, the primary objective of the program will be to identify the sources of the problem. The EPA, Nature Conservancy, as well as fisheries managers can prioritize and prescribe BMPs for areas of major impact (Carriker et. al., 1997). Sometimes just prescribing BMPs is not enough. A Holistic Resource Management

...we need to jump into the program and communicate with the state and federal agencies to aid in freshwater quality goals as well as riparian zone and stream habitat reconstruction.

(HRM) program is needed. The HRM program takes into account the whole picture, economic, political, sociocultural, and ecological. This program looks at farming communities like an ecosystem. Monocropping has been known to wipe out entire farming communities because there is no diversity of crops to buffer the blow of bad weather. HRM allows for farm community planning to diversify the crops in the community. HRM acts like a doctor by diagnosing what problems the community encounters and implements BMPs to cure the problems. Assigning objectives under a HRM program and using BMPs as methods to obtain those objectives seems to be a more effective way at managing farms on a large scale (Boody, 1997).

These HRMs and BMPs are great little techniques but why is it still difficult to implement them? Voluntary programs are already in effect and in the grand scheme of the Clean Water Act, these programs are fairly recent. Some supporters of this program are stating that these programs are still evolving and need time to show their full potential. The addition of "Green Payments" to the Farm Bill will offer additional incentives that turn farmers onto the idea of using BMPs. Problems that exist with this program are:

- 1.) Payments: How much will it take to get the farmers' attention?
- 2.) Design: Should farmers be paid for individual management practices or whole-farm management?
- 3.) What level of government will be in charge of this program?
- 4.) How will the money be distributed?
- 5.) Will the farmers that try the hardest to comply be rewarded fairly?

Once these questions are answered and farmers comply, the program could be effective in implementing BMPs in row-crop agriculture. After a period of five years of implementation, funds will be dropped and because of the low-cost of the BMPs, these techniques will be continued (Carriker et. al., 1997).

To ensure the long-term use of BMPs by the farmers, the Universal Water Quality Compliance regulatory component will be attached to the Farm Bill. This will be adopted and completely implemented by a later date and will penalize farmers for causing off-site water pollution (Carriker et. al., 1997).

The only thing left to worry about is: who will enforce all these programs? Will small commercial farms be affected? And what about small time hobby farmers? From an interview with Tom Grain, a manager at the Natural Resource Conservation Service, I discovered that they are understaffed and have a difficult time getting to the smaller commercial farmers and hobby farmers. Enforcement can also be a problem if the new programs do not increase staff to monitor aquatic habitats.

The impacts of row-crop farming are enormous but large commercial row-crop farmers are willing to implement BMPs with education and some incentive. The voluntary programs will evolve and be very successful. It will be difficult to isolate the impacts of these smaller farms because of their limited individual impacts. Through education and some incentive, the majority of impacts can be reduced and the

leftovers will be easier to manage. As fisheries managers, we need to jump into the program and communicate with the state and federal agencies to aid in freshwater quality goals as well as riparian zone and stream habitat reconstruction. Our goals are basically all the same: to minimize impacts on wildlife and maintain safe and aesthetically pleasing environments for humans as well as wildlife. Solid communication with the public is key to this plan. People must know about new strategies for minimizing impacts and take responsibility for the problems. As James Meek, former USEPA liaison stated, "We want the involvement to lead to ownership of the problem and action." (Meek, 1997).

References

- Boody, G. "BMPs Aren't the Ultimate Prescription."
http://eko.serv.vo.shi.se/Docs/www/Subject/Definition_of_sust.ag/250-299/268Best_Management_Practices. (19 Mar. 1997). 1-3.
- Carriker, R. R. and Abdalla, C. W. "Agriculture and Water Quality Policy."
<http://ianrwww.unl.edu/farmbill/agricwatr.htm>. (24 Mar. 1997) 1-4.
- Halstead, J. M., Padgitt, S., and Batie, S. S. 1990. Groundwater Contamination from Agricultural Sources: Implications for Voluntary Policy Adherence from Iowa and Virginia Farmers' Attitudes. *American Journal of Alternative Agriculture*. 5(3): 126-33.
- Lichtenberg, E. and Lessley, V. 1992. Water Quality, Cost-Sharing, and Technical Assistance: Perceptions of Maryland Farmers. *Journal of Soil and Water Conservation*. 47:260-263.
- Meek, J. 1997. Nonpoint Source News-Notes: The Condition of the Water-Related Environment; The control of the Nonpoint Source of Water Pollution; The Ecological Management & Restoration of Watersheds. EPA & U.S. Department of Agriculture. Publication 47. Alexandria, VA, USA.
- Smith, R. L. 1992. *Elements of Ecology*. 3rd ed. HarperCollins Publishers Inc. New York, NY, USA. pp.538-541.
- Wheaton, R. Z. and Hale, E. B. 1980. *Best Management Practices for Row-Crop Agriculture*. VPI & SU: Extension Division. 4(3): 3-8.
- Youngberg, G., Anderson, E. J., and Breimyer et. al. 1985. Proposed 1985 Farm Bill Changes: Taking the Bias Out of Farm Policy. *Symposium Proceedings*. Institute for Alternative Agriculture (Second Annual Scientific Symposium). Washington, D. C., USA. pp.2-4;32-33.

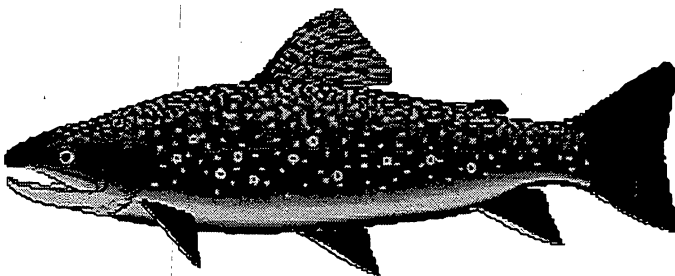
*"All thinking begins with wonderment."
Socrates*

Non-native Fishes

Management of Brown Trout in Shenandoah National Park Troy Thompson

The introduction of brown trout (*Salmo trutta*) into the U.S. has had a profound effect on sportfishing in the many rivers and lakes it now calls home. Since its first recorded stocking into Michigan's Pere Marquette River in 1884, the brown trout has been stocked almost anywhere that it can live and some places that it can't. By 1900, it had been stocked in thirty-eight states. This popular fish has become naturalized in at least thirty-four states, sometimes to the detriment of native fishes.

There is a concern that brown trout may be replacing indigenous fish, particularly native salmonids and also rare and endangered non-game fishes due to competition and predation. Several native salmonid species have been displaced by brown trout, the most common being the brook trout (*Salvelinus fontinalis*) (Nyman 1970; Fausch and White 1981). In most streams that contain both brook and brown trout, the brook trout (or natives as they are locally known) retreat to the headwaters as the browns march farther and farther upstream. This is usually overlooked because brown trout provide excellent fishing and also get bigger.



But, there is a place right here in Virginia where brown trout are not wanted and are actually removed by fisheries managers. This place is known as the Shenandoah National Park. The reasoning behind their stance is based in the mission statement of the national park service, which is to "preserve and conserve scenic and natural objects and *native* species." Since the brown is not native, they don't want it taking over park streams. This paper will focus on brown trout interactions with brook trout and other fishes native to Shenandoah National Park as well as look at the management alternatives that are currently utilized by the park service.

Impacts

Brown trout are in direct competition with brook trout for food and habitat when they are in the same waters and are able to outcompete them in a variety of ways. Browns are more aggressive than other stream salmonids (Fausch and White 1981). This is an important factor if the stream has a limited

supply of food or there is not enough resting places and good spawning sites to be had, such as when floods or heavy rains deposit a large amount of silt in the stream. This creates competition for the best remaining stream positions, which maximize the trout's chances for survival and growth. In 1965, after two floods caused severe erosion on Valley Creek, Minnesota, most of the pools and cover were filled in with sand. This caused dramatic reductions in the brook trout population because of the complete failure of the 1965 year class (Elwood and Waters 1969). The subsequent years saw more floods and habitat degradation. The brown trout took advantage as the trout population changed over fifteen years from nearly 100% brook trout to predominantly brown trout (Waters 1983).

Another area in which the brown trout has an advantage over native trout is growth. The main reason they outgrow other trout is they are more piscivorous and start eating fish at a younger age. Fish comprise up to 80% or more of the consumption of brown trout longer than 280mm (Hannuksela 1969). Brook trout very seldom eat important quantities of fish (Bridges 1958). Brown trout also adapt quickly to natural foods and are not as selective as other trout, such as in the utilization of the abundant sculpin in Valley Creek that the brook trout wouldn't eat (Waters 1983). The brown trout typically has a longer life span (5-6 years common) than other stream trout. Since brown trout live longer and grow larger, they also produce more eggs and spawn more during their life than other trout and are not as sensitive to spawning failure. The short-lived (3-4 years) brook trout must spawn successfully every year or at least not miss more than one year if the population is to be maintained, because the brown trout will move in if they're unsuccessful. Winter mortality is often lower for brown trout than other trout because they feed consistently throughout the winter (Brynnildson 1963). This may be linked to their piscivorous eating habits compared with the brook trout's mainly invertebrate food base that is for the most part inactive during the winter months.

The brown trout is more tolerant of environmental changes than other trout. It is adaptable and can thrive in a broad range of conditions which could stress other fish. When a stream has a physical or chemical change, the brown trout usually adapts to it first and becomes dominant before the other trout can rebound. According to Bachman (1978), browns can tolerate warmer temperatures than most other salmonids, with the exception of the trout native to the desert Southwest. Browns thrive in 12-16 degrees C water, while brook trout prefer much colder water (9-11.5C) (Peterson et al. 1979).

The brown trout is also less prone to being caught by angling than other trout (Cooper 1959) and can therefore maintain higher densities throughout the year. In one experiment in the southwestern U.S., brown trout outnumbered the threatened Apache trout (*Oncorhynchus gilae apache*) 20:1 and 4:1 in electrofishing samples in two sections of a stream. But twenty-two hours of fly-fishing yielded fifty-five Apache trout and only four brown trout (Robinson and Tash 1979). Alexander's research on the Au Sable River in Michigan (1977) showed that the most significant predator on young brook trout was brown trout,

which took nearly half of the brook trout that die in their first year of life. Brown trout can also have an adverse affect on many small non-game fish that would be vulnerable to predation throughout their lives, especially in those communities with no native predator (Larkin 1979). The presence of the brown trout in these areas could alter the structure of the community by prey selection which can lead to extirpation of populations (Johannes and Larkin 1961). This potential impact of brown trout on threatened and endangered species could be disastrous.

Brown trout can cause negative effects on the brook trout by hybridizing with it. The hybrid, which is known as the tiger trout, is sterile but can lead to an overall reduction in brook trout numbers if the population is already low. Although brook X brown hybrids have been documented in Shenandoah National Park (Josephson 1983), it is a rare occurrence that is not a concern at this time.

Although brown trout can outcompete the brook trout in the warmer portions of a stream, the opposite is true in the cold headwaters. The limit to upstream movement by brown trout is based on certain physical and chemical factors such as temperature, gradient, and stream size (Josephson 1983). The brook trout is better adapted to small, cold headwaters than is the brown. But the potential exists for further expansion of brown trout range in any headwater when adverse environmental impacts, such as deforestation, occur.

Management

The most important aspect concerning brook trout management is the protection of habitat and water quality, although this is not a real problem in Shenandoah National Park, where managers have control over land-usage. Unwanted fish can be removed in several ways, such as by removing restrictions on its harvest, netting (seining), and electrofishing (Willer 1981). Another approach is to wipe out all of the fish with Rotenone and reintroduce the native fish. If the removal is to last, it must be coupled with appropriate improvements in habitat and water quality or a barrier to upstream migration. If not, the unwanted fish will come right back.

In Shenandoah National Park, brown trout are actively removed by electrofishing from three streams where they are most problematic. These streams (Hughes, Rose, and North Fork Moorman's Rivers) are shocked once a year from the park boundary upstream to about a 1/2 mile above the last brown trout capture (Jim Atkinson, personal communication). A yearly monitoring program is in place to quantitatively track upstream movements of brown trout, if any, in all park streams. Rainbow trout are also commonly

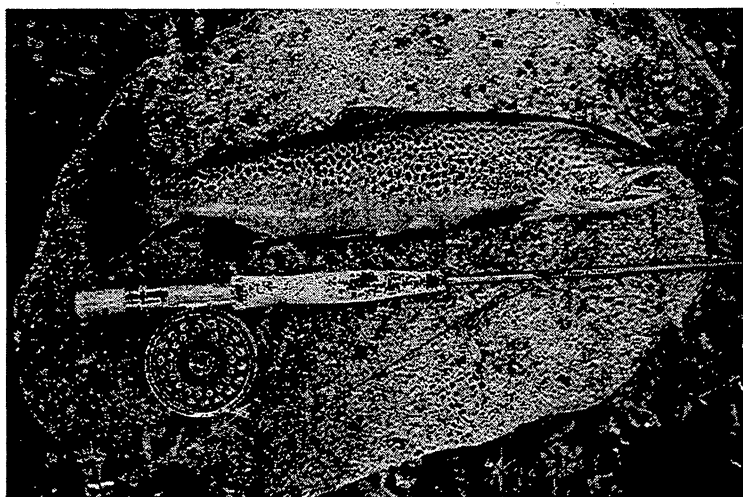
stocked by the VDGIF, although they not a problem in the park at this time.

The park has also implemented special regulations to protect and enhance their valuable brook trout resource. Only single hook artificial lures may be used in Shenandoah National Park and there is a 9-inch minimum length limit. Also, certain park streams are closed entirely to harvest. The 9-inch minimum limit allows the brook trout a chance to spawn and, since they rarely get over 9 inches, promotes the removal of brown trout.

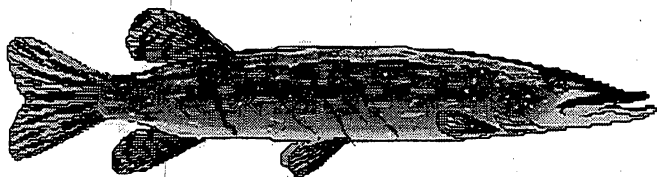
Although brown trout are not removed from any other streams in Virginia, special consideration is given to native trout. The VDGIF's current policy is to keep from stocking brown trout directly on natives although some streams with natives are stocked with browns further downstream (Larry Mohn, personal communication). This is probably because those streams have been stocked regularly long before the current policy took effect.

References

- Alexander, G.R. 1977. Consumption of small trout by large predatory brown trout in the North Branch Au Sable River, Michigan. Mich. Dept. Nat. Res. Report no. 1855.
- Atkinson, J., Director of Inventory and Monitoring at Shenandoah National Park. Personal Interview. 28 Apr. 1997.
- Bachman, R.A. 1984. Foraging behavior of free-ranging wild and hatchery brown trout in a stream. Trans. Am. Fish. Soc. 113:1-32.
- Bridges, C.H. and J. W. Mullan. 1958. A compendium of the life history and ecology of the eastern brook trout (*Salvelinus fontinalis*). Mass. Fish. Bull. 23:1-38.
- Brynildson, O.M., V.A. Hacker, and T.A. Klick. 1963. Brown trout: It's life history, ecology, and management. Wis. Cons. Dept., Pub. 324. Madison.
- Cooper, E.L. 1959. Trout stocking as an aid to fish management. Penn. St. Univ., Agri. Exp. Sta. Bull. no. 663.
- Elwood, J.W., and T.F. Waters. 1969. Effects of floods on food consumption and production rate of a stream brook trout population. Trans. Am. Fish. Soc. 98:253-262.
- Fausch, K.D., and R.J. White. 1981. Competition between brook trout and brown trout for positions in a Michigan stream. Can. J. Fish. Aquat. Sci. 115:1220-1227.
- Garman, G. and L.A. Nielsen. 1982. Piscivory by stocked brown trout (*Salmo trutta*) and its impacts on the nongame fish community of Bottom Creek, Virginia. Can. J. Fish. Aquat. Sci. 39:862-869.



- Hannuksela, P.R. 1969. Food habits of the brown trout in the Anna River, Michigan., Mich. Dept. Nat. Res. Rep. No. 1759.
- Johannes, R.E., and P.A. Larkin. 1961. Competition for food between reidside shiners (*Richardsonius balteatus*) and rainbow trout (*Salmo gairdneri*) in two British Columbia lakes. Can. J. Fish. Aquat. Sci. 18:203-220.
- Josephson, D.C. 1983. Environmental factors related to the abundance and distribution of brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) and seasonal movements of brown trout in selected Virginia streams. M.S. Thesis, VPI and SU.
- Larkin, P.A. 1979. Predator-prey relations in fishes: an overview of the theory. *in* H. Clepper (ed.) Predator-prey systems in fisheries management. Sport Fishing Institute. Washington, D.C., USA.
- Mohn, L. Personal Interview. 28 Apr. 1997.
- Nyman, O.L. 1970. Ecological interactions of brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) in a stream. Can. Fish. Nat. 84:343-350.
- Peterson, R.H., A.M. Sutterlin and J.L. Metcalfe. 1979. Temperature preference of several species of *Salmo* and *Salvelinus* and some of their hybrids. J. Fish. Res. Board Can. 36:1137-1140.
- Robinson, F.W., and J.C. Tash. 1979. Feeding by Arizona trout (*Salmo apache*) and rainbow trout (*Salmo gairdneri*). J. Ariz.-Nev. Acad. Sci. 20:63-69.
- Waters, T.F. 1983. Replacement of brook trout by brown trout over 15 years in a Minnesota stream: production and abundance. Trans. Amer. Fish. Soc. 112:137-146.
- Willer, W.B. 1981. Trout biology. The Univ. Wis. Press, Madison, Wisconsin.



Muskellunge Stocking in the New River

Eric Brittle

The New River is the oldest river in the western hemisphere and also the only one which flows north instead of south. It supports a diverse fauna of fish species including 44 native species and 42 introduced species. The effects of introducing these new species on native fishes in the river has not been researched. One of the more controversial introduced species is the muskellunge (*Esox masquinongy*). Muskies are a large piscivorous fish which has the potential to grow to forty to fifty pounds in weight and up to lengths over fifty inches. Tiger muskies are a hybrid of a musky and a northern pike (*Esox lucius*). Like their cousin they also are piscivorous and can grow to the same large sizes and have been introduced to the New River system.

The introduction of these fish to the New River fishery adds a very sought after species which many anglers pursue with great enthusiasm. This adds to the recreational value of the river and also unknown amounts of money to the local economies. However, positive and negative effects on the native species are unknown to regional biologists. This paper will report the opposing views on this problem, what is known about the effects of musky stocking and suggest possible future management options.

Who are the stakeholders?

Everyone who cares about the New River can be concerned about the introduction of muskies and the possible effects on native species. Anglers, residents, tackle shop owners, and biologists are all part of opinionated groups which will have their input heard about this situation. The fishermen are directly affected. The introduction of a new predator offers a new challenge to local fishermen and can generate revenues which were not there before. However, on the flip side, the new predator can eliminate the already existing fishery of blackbass including the smallmouth bass. This bass fishery is known to be one of the best around the state and any unfavorable changes will be hard to swallow by the locals. Fishermen are split between for and against stocking muskies. According to Vic DiCenzo the Blacksburg regional biologist, at a recent public meeting held on musky stocking in the river, anglers expressed feelings ranging from "no stocking at all" to "the biologists are not stocking enough." The polarity among anglers make management decisions difficult at best because no matter what decision is made, some one will be unhappy with it. Fisheries managers must weigh the pros and cons of this situation and implement a consistent program which is economically feasible, biologically sound and accepted by all parties.

The views expressed towards musky stocking are not limited to just local anglers on the river alone. Fishermen on Claytor Lake also are split in their views on musky stockings. River fish can enter the lake from the upper reach and effect the fish fauna much like what could happen in the river. Local tackle shops owners approve of the addition of a new sport fish to the river because it directly relates to increased bait and fishing gear sales. Revenue generated by the new fishery means a better and more stable economy for the local residents. Non-native species are also have the potential to be affected by the introduction of muskies. In a study conducted by Engstrom-Heg et al. (1986) found that esocid species prefer soft rayed prey over spiny rayed species. The soft rayed species include white suckers, golden shiners and close relatives of these which are native to the New River. It is unknown what affect muskies have on these populations at the present time. If these prey species are the primary food source of other native species, then competition between the predators may result in the possible removal of the less adapted. There is no evidence which shows this is occurring. Because of the twenty year co-existence of blackbass species and muskies along with good growth rates of the two, it is logical to conclude that competition is not hampering either population.

History

Muskellunge stockings in the New River began in 1975 with the release of almost 5000 fingerlings in the upper section. For the next four years no muskies were released. The tiger musky was released, however, in 1978 in both the upper and lower portions of the river. Releases of the tiger musky continued until 1987 when the last tiger muskies were released below the Claytor Lake Dam. In the lower section of the river, tiger muskies were not stocked in 1979, 1982-84, and in 1986. The upper section of the river had no muskies stocked between the years of 1982 and 1984. Musky stockings continued regularly from 1980 to the present in the lower portion of the river with the only gap in stockings occurring in 1981. In the upper portion of the river, musky stockings continued regularly from 1984 until the present except in 1992 and 1994 when no fish were stocked. It is unknown why muskies were not stocked in selected years but it is logical to think that because of a lack of funding and/or the lack of hatchery production caused these gaps.

Numbers of musky and tiger musky stocked in both the upper and lower sections of the river can be classified as erratic at best. Musky numbers, when stocked, range from fifty (lower section) in 1995 to a maximum of 4750 (upper section) fish in 1975. Tiger musky numbers ranged from 448 (upper section) in 1978 to a maximum of 2200 (lower section) fish in 1981. The numbers of fish stocked from year to year are not consistent. Because of these inconsistencies, results from musky sampling would not be able to produce information which would show trends detrimental to muskies or the native fish, especially the smallmouth bass. In years where the numbers of stocked muskies are high, then they may be out competing each other and smallmouth bass for a limited food base.

What this all means for the native fish populations is that each year new recruits are entering the river population and may be competing with native species for a limited prey base. The muskies may also be preying on smallmouth bass causing a significant decrease in this popular fishery.

Related Studies

Carline et al. found that interactions between largemouth bass and esocid species were contrary to what one would think. Largemouth bass preyed upon small (168-184 mm) muskies and tiger muskies with mortalities ranging from 0-100% (mean 30%). The mortality was affected by several factors including alternative prey abundances, largemouth bass densities, and the time of year when the muskies and tiger muskies were stocked. Similar behavior has been noted when the regional biologists have stocked muskies in portions of the New River, according to DiCenzo. Because of their piscivorous nature, intuition would lead one to believe that muskies and tiger muskies would prey heavily on the blackbass populations, the smallmouth bass in particular. This is unknown at the time because stomach analysis have

not been compiled by local taxidermists, but once this information has been made available answers to this question can be more easily understood.

Engstrom-Heg et al. (1986) found that, in general, esocid species prefer soft rayed species over spiny rayed species of prey in their study. The tiger muskies were highly selective, bottom-oriented feeders which preferred eating white suckers to golden shiners, and golden shiners in preference to yellow perch. These species are found in relatively high abundances in the New River. These species are not known to be the primary food source of smallmouth bass. New River smallmouths feed heavily on crayfish which are in great abundance. Muskies were found to be mid-water feeders and did not tend to be selective among the prey types.

Current Management Actions

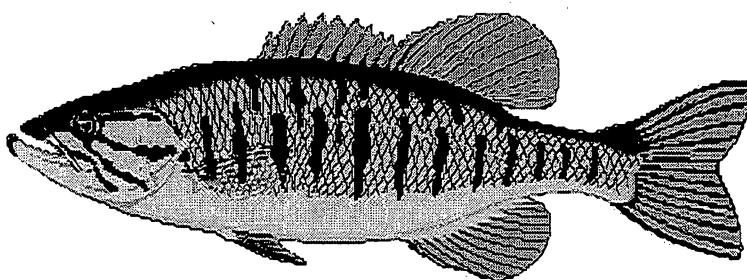
From 1992 through 1995 the Virginia Department of Game and Inland Fisheries (VDGIF) conducted a survey on available musky habitat in four western Virginia rivers and reported by Joe Williams. Good pool habitat was based on

log cover, submerged aquatic vegetation abundance and pool depth, length and width. The New River was found to have the highest available pool habitat (1,239.8 ha) for muskies, nearly twice as much as the next highest river, the James River. The lower reach

of the New River had more total hectares of pool habitat than was found in the upper reach of the river. The report suggest that the Clinch and James Rivers are stocking too many muskies for the amount of habitat available. The New River is stocking numbers of muskies which fall within the recommended range as determined by the amount of habitat available. These findings are good because problems will arise when too many muskies are stocked in a particular body of water.

Problems which could occur when the habitat cannot support the number of fish stocked can be but are not limited to interspecies competition, intraspecies competition, declines in reproduction success, poor recruitment, and increased predation from largemouth and smallmouth bass.

To complicate the problem on assessing the effects of stocking muskies is the fact that conventional sampling methods do not sufficiently provide enough information. Steps are being taken in order to gather information on the age and feeding habits of these elusive fish. Local taxidermists are being asked to pull otoliths of fish they receive for mounting. Otoliths will be pulled, prepared and then aged by regional biologists in order to age the trophy fish which are being harvested. They are also being asked to take stomach analysis so that prey species can be identified. Predator-prey interactions can be studied to identify potential problems which may be occurring. Information gathered by taxidermists will lead the biologists on their way to understanding more about this reclusive predator.



Future Management Options

Little is known about the effects of stocked muskies in the New River. Therefore the first step needed in assessing potential problems is to gather information on feeding habits, life history and prey preferences of muskies in the New River. Some of these steps are well on their way. Stream habitat for muskies has been analyzed and quantified for the New River. Also, efforts have been taken in order to gather information through local taxidermists. A better option for aging muskies is to pull the cleithrum instead of the otolith (Crossman & Casselman 1995). The cleithrum is associated with the pectoral fin girdle. One advantage of pulling the cleithrum is that it grows at one-tenth the rate of total body length. Measuring its length in millimeters can easily be converted to centimeters for an approximation of the length of the animal at each age (Crossman & Casselman 1995).

Another feasible option to gather information on muskies is to implement an angler log program as conducted in Canada. This is simply a volunteer program which allows biologists to gather information which is not available through creel surveys or index fishing programs (Kerr 1995). Information on number of anglers, hours fished, muskies landed, etc. is gathered and tabulated to better assess fishing pressure and relative numbers of fish present in certain bodies of water. Problems pointed out by Kerr in his study were: illegible handwriting, weatherproof booklets instead of just data sheets, the need for computerized databases, and the release of an annual summary. Much valuable information can be acquired through anglers which would otherwise be almost infeasible to gather through creel surveys and traditional sampling techniques.

One current problem with stocking program in the New River which can be adjusted to allow better conclusions to be drawn is the number of fish stocked in the upper and lower reaches. Those numbers need to be stabilized from year to year so that the range falls within the habitat sustainability. These numbers currently fall within that range but within that range need to be more consistent. Consistent stocking numbers allow managers down the line to predict better trends in recruitment numbers and the effects of a given number of fish on other populations.

In conclusion, musky management on the New River is in a stage of infancy. This provides an exciting future to regional biologists which will learn much as they explore this new fish and its effects on the current populations. Steps are being taken to advance our knowledge, but caution must be taken in order to insure proper management actions are implemented. These actions must consider that all stakeholders need to accept these actions, that these actions are biologically sound and are economically feasible. I trust that management will foresee future problems before they occur and make sound judgments in order to avoid such problems.

References

- Carline, Robert F., Roy A. Stein and Lawrence M. Riley.
1986. Effects of Size at Stocking, Season, Largemouth
Bass Predation and Forage Abundance on Survival of
Tiger Muskellunge. Managing Muskies. Gordon E. Hall,

Editor. American Fisheries Society Special Publication
15.

Crossman E.J. and John M Casselman. 1995. The
Cleithrum Project: An Update to 1995. Managing
Muskies in the '90s Workshop Proceedings. Ontario
Ministry of Natural Resources.

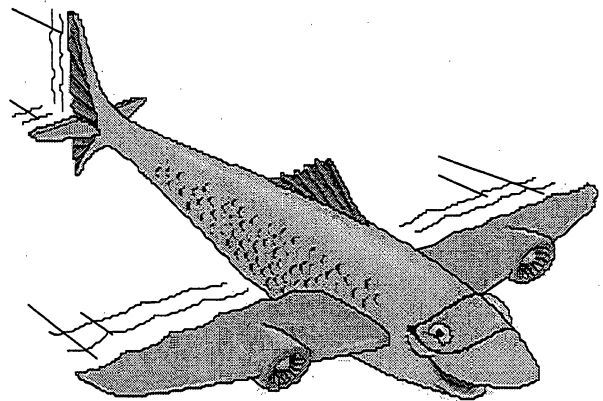
DiCenzo, Vic. Warmwater Streams Management Report.
Unpublished. 1996.

DiCenzo, Vic. Warmwater Streams Survey Current Segment
Report. Unpublished. 1996.

Engstrom-Heg, Robert, Richard T. Colesante, and Gerald A.
Stillings. 1986. Prey Selection by Three Esocid Species
and Hybrid Esocid. Managing Muskies. Gordon E. Hall,
Editor. American Fisheries Society Special Publication
15.

Kerr, Steven J. 1995. Highlights of the Muskies Canada
Angler Log Program, 1979- 93. Managing Muskies in the
'90s Workshop Proceedings. Ontario Ministry of Natural
Resources.

Williams, Joe. Musky Habitat Project Final Report.
Unpublished. 1996.



Should Species Introduction Plans Have Mandated Protocols?

Michael Shaver

Natural resource agencies use fish introductions to achieve a wide range of management goals. Increasing or diversifying angler opportunity and satisfaction, manipulating ecological and environmental characteristics, supplying food for local human populations or increasing aesthetic quality are prime examples of these goals. Without careful planning, an introduction may result in the "Frankenstein" effect: a situation where unexpected interactions between native and introduced fauna results in the destruction or degradation of the native fauna. For example, the opossum shrimp (*Mysis relicta*) introduced as a potential food source for kokanee salmon in Flathead Lake, Montana inadvertently overexploited the zooplankton food source for immature kokanee salmon causing a valuable fishery to crash (Moyle and Cech, 1996). Therefore, all management decisions should follow an established protocol to reduce risks associated with introductions, ensure the achievement of goals, and provide a record of accountability. This article focuses on the authorization procedure natural resource agencies should follow when considering a species introduction.

Discussion of species introductions must begin with assignment of definitions. The terms *introduction* and *stocking* are distinguishable because *stocking* entails the replenishment of existing species (natural or introduced) while *introduction* implies the placement of a species not previously in the system. *Exotic* and *non-native species* differ in that *exotic species* are not naturally within the given region, while a *non-native species* may exist in the given region but not in the specific drainage or water body.

Before utilizing an introduction protocol the agency must determine if an introduction will achieve their goals or can other management actions perform the same function. If introduction is in order, the protocol employed should begin with the following three parts: (1) comprehensive studies of the proposed and native species' habitats, (2) presentation of a complete implementation strategy indicating the reason and rationale for the introduction, and most importantly, (3) internal and external agency reviews to determine risk, reduce bias, and maintain focus on agency goals (Courtenay and Robins 1989). Public involvement throughout the process and follow-up evaluation by the agency must also be included in the protocol to ensure success and stay focused on goals and objectives.

The initial step in the fish introduction process is to conduct baseline studies of the habitat into which the proposed introduction will occur. Studies should focus on the trophic, reproductive, and microhabitat needs of existing fish species (Courtenay and Robins 1989). Introduced fishes can impact native fishes through competition, predation, habitat modification, genetic degradation and disease transmission (Bain 1993; Taylor et. al. 1984). Potential interactions between existing species and the proposed species can be inferred from comparing the existing habitat with the proposed species' habitat. In addition, a database consisting of these habitat studies will assist future managers considering species introductions (Bright 1995).

The next step is the development of an implementation strategy explicitly outlining the reason and rationale for the proposed introduction. Included in this stage is the evaluation of alternative species and alternate, non-introduction strategies. Advantages and disadvantages should be examined for each alternative species and strategy including the rationale for dismissal. Explaining exactly why the introduction has been proposed, managers will discover if goals can be reached effectively or if alternative strategies are more feasible (Courtenay and Robins 1989).

Active public disclosure of the proposal will invite internal and external review (Courtenay and Robins 1989). The agency should *seek* objective analysis and criticism of the proposal to discourage hasty decisions, reduce bias, assess risk, and add dimension to the decision making process (Bright 1995; Bain 1993; Wilcove et. al. 1992). This stage provides agencies with increased accountability to aid them in defense of their proposals.

If approved through public critique, the agency is again responsible for evaluating the potential success of the introduction through research. The hands-on evaluation carried out by introducing the proposed species in a closed system will model its effects on resident fauna. The evaluation should include all effects the introduction had on the ecology and environmental characteristics of the habitat. If the agency has followed the protocol and used qualified scientific methods, future agencies can use the information

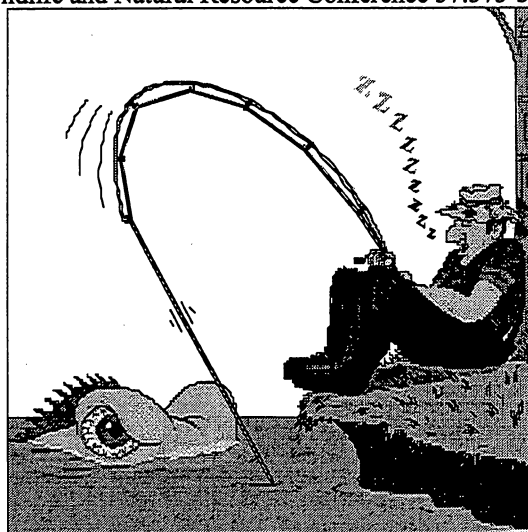
gathered during the decision making process to aid in future decisions.

Environmental Impact Statements (EIS) required at federal and state levels by the National Environmental Protection Act (NEPA) require agencies disclose the impacts of proposed governmental actions. These requirements are fulfilled by performing the habitat study in the initial stage of the protocol and the hands-on research in the final stage. Following the protocol outlined above aids the agency in achieving the legislature's goal of reducing environmental harm caused by requiring agencies to think before they leap into a decision.

By thoroughly assessing the risks involved, agencies will greatly reduce the occurrence of failed and disastrous fish introductions. Mandating a species introduction protocol, even in the limited form presented here, will ensure that agencies will be more responsible and effective when considering a species introduction.

References

- Bain, M. B. 1993. Assessing impacts of introduced aquatic species: grass carp in large systems. *Environmental Management* 17:211-224.
- Bright, C. 1995. Bio-invasions: the spread of exotic species. *World Watch* 8(4):10-20
- Courtenay, W. R., Jr. and Moyle, P. B. 1992. Crimes against biodiversity: the lasting legacy of fish introductions. *Transactions of the North American Wildlife and Natural Resource Conference* 57:365-372.
- Courtenay, W. R., Jr. and Robins, C. R. 1989. Fish introductions: good management, mismanagement, or no management? *Aquatic Sciences* 1(1):159-172.
- Moyle, P. B. and Cech, J. J., Jr. 1996. *Fishes: An Introduction to Ichthyology*, third edition. pg. 417. New Jersey, Prentice Hall.
- Taylor, J. N.; Courtenay, W. R., and McCann, J. A. 1984. Known impacts of introduced fishes in the continental United States. pg. 323-373 in W. R. Courtenay, Jr. and J. R. Stauffer, Jr., eds. *Distribution, biology, and management of exotic species*. Baltimore, The Johns Hopkins University Press.
- Wilcove, D.; Bean, M. and Lee, P. C. 1992. Fisheries Management and biological diversity: problems and opportunities. *Transactions of the North American Wildlife and Natural Resource Conference* 57:373-383.



Marine and Coastal Fisheries

Bycatch, a Catch Without a Yield Greg Hylton

Issue Definition

Commercial fishing has been a standard and accepted practice for a very long time. It encompasses many different species in many different countries. There is an aspect of the industry, however, that is not very well publicized. The aspect that I speak of is called bycatch. Bycatch is actually defined as, "the portion of a commercial catch that is not targeted and is either economically undesirable or is governmentally regulated and therefore cannot be landed (Joos 1996)." It occurs with finfish, mammals, reptiles, anything that is in the water. It has been brought to the public's attention with respect to dolphin and sea turtles. You will notice now, that on tuna fish cans in the grocery store, they read, "Dolphin safe." This is due to the public's outrage at the incidental catch of dolphin in tuna nets. In the news, you may also have heard of TED's (turtle excluder devices). This too was a function of the public's outrage at the incidental catch of turtles in the shrimp fishery. Bycatch, in most cases, brings 100% mortality to the animal. The fish that die in the nets are immediately lost, and the ones that live through the ordeal, are tossed overboard, severely stressed, and are left to die in the open ocean.

The problem isn't simply the aesthetic value of the species that are caught. There is a major concern of whether or not the bycatch is affecting the populations of these species. There is a question of whether we are just catching too many fish in general. The world harvests an estimated 84 million metric tons of fish each year (Steinhart 1994). In addition to that, there is an estimated 27 million metric tons of bycatch which is said to be an underestimate. However you look at it, we are harvesting over 100 million metric tons, which scientists have calculated to be the maximum sustainable yield of the oceans (Warren 1994).

Bycatch in all areas is a problem and a concern, but I couldn't even come close to covering all of the problems in all of the different fisheries. The one area that I will cover, is the southeast shrimp fishery. It has come under severe scrutiny for its level of bycatch. The two sides of the issue are the fishermen, and the managers and people who would like to see bycatch reduced. The fishermen haven't been too cooperative in the past, but have started to come around. They used to be highly against the use of TED's, much less any other kind of bycatch reduction device. This opposition has quieted with the commercial fishers growing concern for the waste of a resource, not to mention the desire to improve their negative public perception. The other people and the

managers would like, and are trying to bring about the reduction of bycatch in the shrimp fishery. There are numerous ways to go about this, and they will be covered.

Background Information

Most of the reason for the high levels of bycatch, is due to the inability of shrimpers being able to limit their catch to the target species. Shrimping is almost exclusively done with otter trawls, which is a very unselective gear type (Murray et al. 1992). Shrimp trawlers have reportedly discarded animals that outnumber their catch by between 128 percent and 830 percent (Warren 1994). It has also been said that, on the average, 10 pounds of finfish are killed for each pound of shrimp caught (Muskerjee 1996). The bycatch in the southeast shrimp fishery includes several finfish, crustaceans such as blue and calico crabs, and other invertebrates (Murray et al. 1992). Red snapper and spanish mackerel are two of the finfish that are of special concern because of dwindling populations (Hendrickson et al. 1993). These staggering statistics have created a growing concern over the effects on stocks associated with shrimp bycatch. A recent report done by the mackerel stock assessment panel stated that shrimp bycatch will reduce stock potential (Murray et al. 1992).

The view of the managers and the public is pretty easily seen. I don't think there is any doubt in the need to reduce bycatch. The question here is how to go about it. One management alternative is in net designs. If the trawl were to have some way of allowing fish and other animals to escape capture, bycatch would be decreased. As far as the modifications of the net are concerned, they come in all different shapes and sizes. Most are modifications from TED's. TED's don't only allow for the escape of turtles, they also allow for the escape of finfish. The basic idea is to have a flap at the top of the net, with an angled grid allowing shrimp to flow through, while bigger animals are angled up and out of the flap. In one design, shrimp loss was found to be no greater than 5 percent, with exceptional bycatch reduction of fish greater than 16 cm. However, the escape of fish smaller than 10 cm, was not satisfactory in this design (Isaken 1992).

Seasonal and area closures are another alternative to help in the reduction of bycatch. It has been seen that fish-to-shrimp catch ratios are much higher in May, than in other months. This suggests that bycatch can be reduced by delaying seasons until June. At the same time, this will allow another month of growth which should increase profits to make up for the extra month that the season would be closed (Hendrickson 1993). Closing areas is another method that could be used, especially if there is a high incidence of bycatch. In North Carolina, commercial trawling is prohibited year round in primary nursery areas (Murray et al. 1992).

There is also potential for reduction of bycatch by other means. In the Gulf of Mexico, 90 percent of shrimping happens at night, indicating that other means of deterring bycatch could be developed. Acoustics, electricity and other physical stimuli all show promise for possible bycatch reduction (Murray et al. 1992). In New England, "pingers"

have shown the ability to deter porpoises away from nets (Schneider 1996). Possibly, this could be modified to help the reduction of bycatch in the shrimping industry.

Speaking on the side of the shrimpers, the problem is one of money. All of the above methods would probably do a good job at reducing bycatch, but what effect would they have on the shrimpers? So, as far as shrimpers are concerned, finding a niche for their bycatch would best suit them. In this, I mean finding some monetary value for their bycatch. There has been some progress in this, however, there is not sufficient data to report it (Boyce 1995).

If the shrimpers had to choose one of the methods above, they would probably be more open to a net modification rather than a seasonal closure. There is evidence too, that supports this option. From a study done at Texas A&M, "using closures as a means of reducing bycatch was both ineffective and costly. Bycatch reduction devices generated fewer discards than closures, and did so at a much lower cost (Hendrickson et al. 1993)."

The economic value of the shrimping industry is another aspect of the problem that is in favor of the shrimper. In 1989, the Gulf of Mexico Management Council proposed the closing of the northern Gulf of Mexico in an attempt to bring back the red snapper population. Does this make sense though, when the shrimp fishery is more economically and socially important than the red snapper fishery (Murray et al. 1992)? Wouldn't it be better to sacrifice the red snapper fishery if it were to save the shrimp fishery?

Lack of information is another thing in the corner of the shrimper. There are very few definitive studies that show that shrimp trawling is causing the decline of finfish populations. The possible exceptions would be red snapper and weakfish. On top of this, none of the finfish that are associated with shrimping bycatch are listed as threatened or endangered (Murray et al. 1992).

Conclusions

The southeast commercial fishery is big business with a big bycatch problem. Solving the problem is so hard, because there is so much money at stake. In 1991, 228.9 million pounds of shrimp were landed with a value of \$410.7 million dollars (Hendrickson et al. 1993). It is quite hard to give that up. Not to mention the number of people that depend on the industry for their lively hood. On the flip side, can we consciously allow the continued bycatch of millions of pounds of other fish to support the shrimp industry. The shrimpers are just not doing a good enough job at catching what they want. There was a situation in Florida where the Florida Marine Fisheries Commission wanted to close shrimping because three area shrimpers produced 1,000 pounds of waste catch to produce 92 pounds of shrimp (Murray et al. 1992).

So where is the solution? From the data that I have seen, the solution lies in bycatch reduction devices. It has already been shown that season closures are not as efficient, or economically feasible as bycatch reduction devices (Hendrickson et al. 1993). There are already devices that can effectively protect fish larger than 16 cm, they just need to extend their effective range a little more (Isaksen et al. 1992).

As far as regulating them, once you have a design that appears to work effectively, make it a required thing on every trawl. Enforcement can be done at the dock easily enough. Simply doing random checks of shrimpers nets would probably be sufficient.

There is a problem still with the time of day that most of the shrimping is done. 90 percent is done at night, and there is evidence that the bycatch reduction devices being studied are reliant on the fish's ability to see it coming (Murray et al. 1992). So, I would like to see some further looks into alternate types of bycatch reduction devices. Meaning possible acoustic or electric types of devices. The theory behind these ideas would be to let the fish know ahead of time that something is coming, and would let them get out of the way well before the trawl was even close to them.

Education is another thing that I believe would help the industry. Educating the public somewhat on the trials and tribulations of shrimping, and the lives of the people who are putting the shrimp cocktails on their tables, would help the public understand what the shrimpers have to deal with. Educating the shrimpers on the repercussions of bycatch, and the ideas and reasons for reducing it, would help the shrimpers understand where the managers are coming from. Both educating goals are conceivable.

Bycatch is a problem all over the world, and it isn't confined to just shrimping or even just commercial fishing. Sport fishing has bycatch also. Anytime you catch something that you didn't mean to, you are producing bycatch. There are however alternatives and options that can be acted on to help reduce bycatch. These alternatives can be made to reduce it, but without having a huge impact on the industry itself. These kind of alternatives are the ones that we need.

References

- Boyce, J. R. 1996. An Economic Analysis of the Fisheries Bycatch Problem, *Journal of Environmental Economics and Management*. 31:314-336.
- Hendrickson, H., and W. Griffin. 1993. An Analysis of Management Policies for Reducing Shrimp Bycatch in the Gulf of Mexico. *North American journal of Fisheries Management*. 13:686-697.
- Isaksen, B., J.W. Valdemarsen, R.B. Larsen, L. Karlsen. 1992. Reduction of Fish Bycatch in Shrimp Trawl Using a Rigid Separator Grid in the Aft Belly. *Fisheries Research*. 13:335-352.
- Joos, P. 1996, Reducing Bycatch. 1996. NMFS Fisheries Assessment, NMFS Homepage. (5)pgs.
- Mukerjee, M. 1996. Pink Gold; the trials and tribulations of shrimp farming, *Scientific American*. 275: 24-25.
- Murray, J., J. Bahen, R. Rulifson. 1992. Management Considerations for Bycatch in the North Carolina and Southeast Shrimp Fishery. *Fisheries*. 17:21-26.
- Schneider, D. 1996. Alarming Nets: fishermen try acoustics to protect porpoises, *Scientific American*. 275, 40-41.
- Steinhart, P. 1994. The Cry of the Ocean (fishery depletion), *Mother Jones*. 19, 30-31.
- Warren, B. 1994. The Bycatch Bogey: a quarter of the world's catch is tossed overboard. *Audubon*. 96, 20-21.

The Changing Management of North Atlantic Bluefin Tuna

Brett Coakley

Stocks of the North Atlantic bluefin tuna (*Thunnus thynnus*) have dramatically declined over the past fifteen years. Due to their superb eating qualities and fighting ability, bluefin tuna are one of the most important game and commercial fish we have in our waters. Unfortunately, their populations cannot handle the increased pressure from our commercial and recreational fisheries. The current stocks of bluefin tuna are at an all time low, so the pressure on them must change before the fisheries collapse.

An increase in the allowable harvest from 1160 to 2660 metric tons (mt) in 1983 caused a major decline to the overall biomass of tuna stocks in the Northwest Atlantic (Safina 1993). Although the quota didn't stay at that level, within a few years the spawning stock biomass dropped to a critically low level, well below maximum sustainable yield (MSY)(NMFS 1997). Now the National Marine Fisheries Service (NMFS) is increasing the restrictions on bluefin tuna fishing in an effort to prevent a crash of the stocks.

However, there are a number of new factors that have entered the arena of bluefin tuna that may hamper NMFS efforts. In the winter, large numbers of reproductively mature tuna (>8yrs) congregate off the coast of North Carolina. Although it was just recently exploited, this mostly catch-and-release fishery has exploded, with substantial increases in effort expected every year. Anglers can catch up to 50 tuna per boat per day, most of which are breeders. Associated with this catch-and-release fishing comes angler-induced mortality. The fishermen claim that their fishing has no effect on the survival of the tuna, but the NMFS disagrees, and is completing research on the topic.

In addition to the new fishery off North Carolina, the price of tuna has risen recently, due to the demand for sushi in Japan. The price for uncleaned tuna rose to an all time high in 1995 of \$13.00 per pound(NMFS 1997). With this increase in price, comes an increase in the economic value of every tuna caught in U.S. waters. This puts a severe strain on the managers to overcome social and political pressures and do what is right for the fishery.

As of 1994, the spawning stock biomass (SSB) is only 13% of the level that is required to sustain MSY (NMFS 1997). The age composition of the stock has changed dramatically since 1970. At that time, the stocks were mostly comprised of spawning stock, which was estimated at 50,000 mt. The smaller "school" fish were estimated at about 10,000 mt. Between 1970 and 1980, landings of bluefin tuna averaged 5,000 mt. It then decreased in 1983 to its present level of about 2,000 mt. In 1994, the SSB reached an all time low of about 7,000 mt, with the smaller school fish biomass remaining about the same (NMFS 1995). These figures show that there has been an serious age composition shift in the stocks of bluefin tuna, indicative of overfishing.

The present management of bluefin tuna consists of a highly stratified quota system (Table 1). The fishery is broken up into categories based on gear type and areas fished. There

are categories for general, angling, charterboat, harpoon, incidental, and purse seine. Each category has its own specific quota, and size restrictions. Only the angling, general and charterboat categories (i.e. recreational fishermen) are allowed to harvest tuna under 73 inches. With the rapidly rising price for tuna overseas, the government placed a ban on the sale of any tuna over 73 inches to keep poaching low (NMFS 1996).

The general category is commercial, and includes many fishing types, such as rod and reel. The incidental category is unique. Under this, a vessel may declare that they are not targeting bluefin tuna, and they are a by-catch of their normal practices. Angling is the only strictly recreational category, which means that their fish cannot be sold (NMFS 1996).

Table 1. (NMFS 1996) 1996 Bluefin Tuna Regulations

Category	Gear Type	Status	Quota
General	Rod & Reel	Commercial	541 mt
Angling	Rod & Reel	Recreational	243 mt
Charterboat	Rod & Reel	Commercial	Inc. in Above
Harpoon	Harpoon	Commercial	53 mt
Incidental	All	Commercial	110 mt
Purse Seine	Purse Seine	Commercial	251 mt

These categories are controversial when dealing with a highly migratory species such as bluefin tuna. The quotas that recreational fishermen deal with start January 1 each year, when the fish are off the coast of North Carolina (NMFS 1996). The tuna congregate in astounding numbers, while overwintering, and are highly vulnerable to capture. The fear is that the quotas will be reached before the tuna have the chance to migrate up the coast to other areas. The fishermen in New England want a quota for each specific area, so they can have their chance at getting a part of the quota.

The NMFS created area stratified quotas to see if they would work. The angling category was stratified like this, with a north and south area divided by Delaware Bay (NMFS 1997). This regulation didn't solve the problem, however. This past summer of 1996, the quota was reached in the southern region before much good fishing could be had in Maryland or Virginia. This caused many recreational anglers to cancel trips that they had planned for the future.

The new recreational fishery off North Carolina has raised a serious question. Does the angler-induced mortality from catch-and-release fishing cause a additional strain on the stocks of bluefin tuna? Studies done on other species such as striped bass have revealed that there is a significant level of angler-induced mortality. These levels are directly related to water conditions, handling of the fish, and type of tackle used. Generally, the use of heavier tackle reduces the stress on the fish, and improves survivability after release. Most fishermen currently use the heaviest gear allowed by the IGFA, due to the size of the fish and to help reduce mortality after release. At the current time, the NMFS has not required the boats fishing for tuna to use the heavy gear(NMFS 1997). There are a few anglers who don't realize that using lighter tackle is more stressful.

There is research currently being done in North Carolina to try to determine how detrimental the catch-and-release fishery is. If it is found that the fishing is causing a

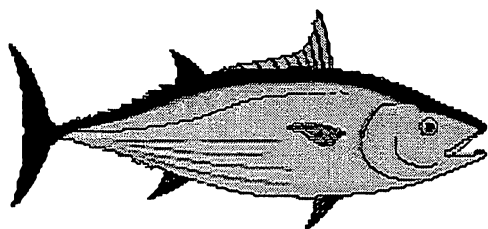
significant impact on the SSB, the NMFS could close the winter fishery altogether. The main problem is that since it is a catch-and-release fishery, there is no way they can prove that you are targeting bluefin tuna. The offshore fishing off NC is very good for a variety of species, such as yellowfin tuna and wahoo. They are caught with similar techniques, so where do you draw the line?

An addition to the mortality survey, the NMFS is proposing an alternative quota system. It would close fisheries to harvest such as the ones off NC in the winter, to allow other areas to harvest part of the quota. North Carolina won't be left out, it will just be opened at a later date (NMFS 1997). The problem with this option is when to open what areas? The only way to determine it is to have constant monitoring of the fish, to determine when to open, and when to close.

As you have read, the management of North Atlantic bluefin tuna is a highly sensitive and complicated issue. Good fisheries management takes all aspects of a fishery into account before making a decisive action. Political, social, economic and ecological aspects must all be taken into account to make a good decision. According to the data, the stocks of bluefin tuna are severely overexploited. We are currently at the point at which a complete collapse of the fishery is imminent without more restrictions. It is time to put some things aside, such as economics and politics, and do what is right for the fish. A decrease in the quota of five metric tons will do nothing if your SSB is only at 13% of MSY. Regardless of what the research for the catch and release mortality says, the quota needs to be cut severely, or a complete moratorium needs to be implemented. I suggest a serious reduction or closure of the fishery, to allow the stocks to recover to sustainable levels. Once the stocks have recovered, you can allow a limited fishery, that is monitored constantly to prevent future problems. Educating recreational fishermen about catch-and-release fishing could help to extend the resource further. Recent successes such as the striped bass in the Chesapeake Bay, have showed that if you put the other aspects aside, you can save a fishery.

References

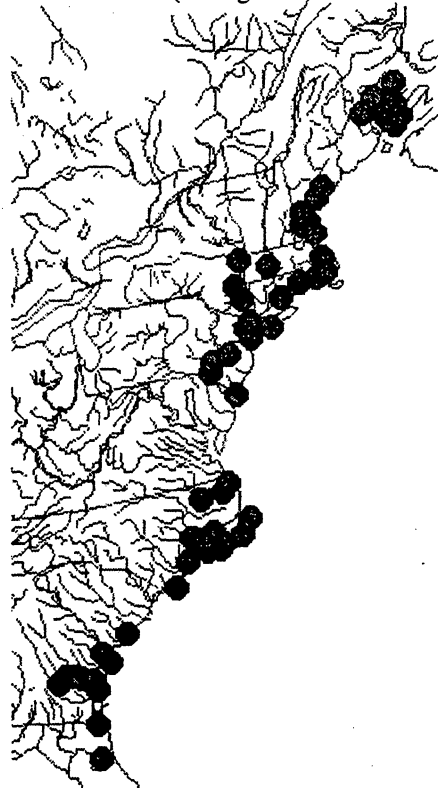
- National Marine Fisheries Service(NMFS). 1997. Draft Environmental Assessment and Regulatory Impact Review on a Proposed Rule for the Atlantic Bluefin Tuna. Fisheries. January 1997. Silver Spring, MD.
- Safina, Carl. 1993. Bluefin tuna in the West Atlantic: negligent management and the making of an endangered species. *Conservation Biology* 7: 229-233.
- Southeast Fisheries Science Center. 1992. Status of Fishery Resources off the Southeastern United States for 1991. NOAA Technical Memorandum NMFS-SEFSC- 306, 19-21



The Long Winding Road to the Recovery of the Shortnose Sturgeon

Jason Burton

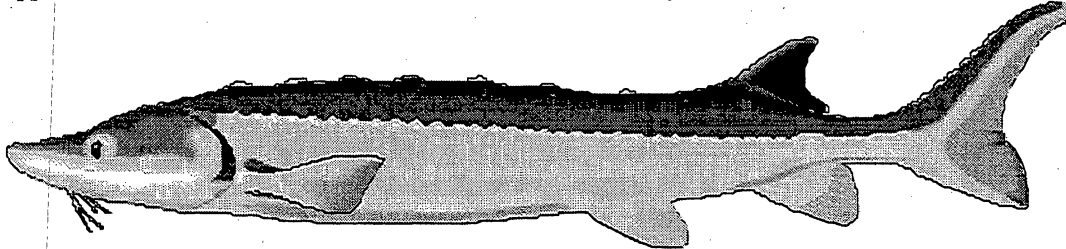
The shortnose sturgeon (*Acipenser brevirostrum*) was listed by the United States Fish and Wildlife Service on March 11, 1967 (USFWS 1996). When listed, the reason as to why the sturgeon population was in danger of becoming extinct was not given. It was not until 1973 that researchers identified the reasons for the depletion of shortnose sturgeon population as dam construction, siltation and pollution (White 1982). In 1987 researchers, after a status review, suggested that shortnose sturgeon should be treated according to specific population segments. They also added that populations in the St. John River, and the Kennebec River should be delisted because population numbers were stable, and the species faced few significant changes in habitat. Populations in the Connecticut, Hudson, and Delaware Rivers were also recommended to be listed as threatened instead of endangered due to high populations but low habitat stability. (National Marine Fisheries Society 1984). There are eighteen distinct populations of shortnose sturgeon along the east coast of the United States (see figure 1).



The National Marine Fisheries Service assembled a team of experts from state, federal and private levels to complete a recovery plan for the shortnose sturgeon. The goal of the recovery team is "To delist shortnose sturgeon populations throughout their range." The recovery objective is: "To recover populations to levels of abundance at which they no longer require protection under the Endangered Species Act. For each population segment, the minimum population will not only be large enough to prevent extinction, but will also be of a size to , make the loss of genetic diversity unlikely" (National Marine Fisheries Service 1996). Efforts to save the

shortnose sturgeon will have to be intense. The biology of this fish is one with great complexity.

Shortnose Sturgeon are found in many habitats such as rivers, estuaries and at sea, but populations are mostly in natal rivers and estuaries (White 1982). Sturgeon in the south, will forage in and spend much of their time where fresh tidal rivers and saline estuaries meet. When it is time to spawn, sometime in late winter, the shortnose sturgeon will move into the upper reaches of freshwater rivers. In the



northern part of the country sturgeon adults may occur in both freshwater and saline areas all year around (NMFS 1996).

Spawning usually begins in late winter in the south, and spring in the north. When sturgeon mature they have a length between forty-five and fifty-five centimeters (White 1982). Males first spawn anywhere from age three to age ten (depending on the latitude). Females begin spawning later than the males, starting at age six and as late as age eighteen, again varying with latitude (NMFS 1996). Boyd Kynard of the National Biological Service, has observed some post spawning mortality, but claims most fish survive. Spawning periodicity is poorly understood. Males seem to spawn more frequently than females. The periodicity in males is two years, while females spawn in three to five year intervals (NMFS 1996).

(The information in the next four paragraphs is from the NMFS 1996 Recover Plan)

Fecundity in sturgeon also varies with latitudes. Female sturgeon can have anywhere from twenty-seven thousand to two hundred-eight thousand eggs per female. When water temperatures rise to eight or nine degrees centigrade spawning begins. Spawning will last until warmer weather forces water temperatures up from twelve to fifteen degrees centigrade. Spawning habitat consists of waters with moderate flow. The substrate in which females position their eggs is that which has gravel, rubble or boulder substrate.

When sturgeon hatch they are about ten millimeters long and look much like tadpoles. These hatchling, due to poorly developed features, can only swim up and drift. The young of the year move downstream during the spring and summer and overwinter in freshwater. Depending upon the latitude, juveniles can range anywhere from three to ten years old. As juveniles, shortnose sturgeon spend most of their time in freshwater or the freshwater/saline interface.

Shortnose sturgeon are benthivores. Feeding at all times of the day, they continuously suck up crustaceans, worms, mollusks and insect larvae. Juveniles prefer small crustaceans, while adult tend to eat mollusks. One can look at the body form of the sturgeon and see that this fish evolved to feed from the bottom. The mouth is positioned on the

bottom of the fish, allowing it to move its ventrally flat body across the substrate while sucking food from the bottom.

One can see that the slow growth, late maturation and interval spawning make the shortnose sturgeon a tough species to recover. To add to this, dredging, pollutant discharges, bridge construction and removal, dam construction, power plant construction and operation, plague the sturgeons recovery. Shortnose sturgeon have been found in the gill nets of commercial shad fisherman. As with most

aquatic life, contaminants that enter the water are harmful to the sturgeon. Due to sturgeon being benthivores, they are more susceptible to heavy metal and PCB contamination. Contamination may cause growth and reproductive harm.

Since the listing in 1967, thirty years have passed and no recovery plan has been implemented. Why? The first team was assembled in 1977 to create a recovery plan for the sturgeon. The plan was finished in 1981, but the team decided that a population status review should be implemented. Another team was then assembled to generate a status review. The review was finished in 1987. The review revealed that individual population existed and represented distinct units under the ESA definition of species (NMFS 1996). To deal with such a delicate fish, experts from state, federal and private levels have come together to create the third, and hopefully final team to generate the recovery plan for the shortnose sturgeon. This plan consists of first establishing a criteria for listing the shortnose sturgeon. The listing criteria is required by the Secretary of the Interior who reviews all endanger species cases. The Secretary reviews all data which must include critical habitat before making a final decision to list the species (Rolf 1989). Listing gives researchers a strong foundation to work on. The team must also begin protecting the sturgeon and its habitats. Once the habitats are protected from preventable degradation, work on the restoration of these habitats and populations can begin. The recovery plan is a very complex process in which the next paragraphs will discuss.

(The following information is from the NMFS Recovery Plan) To establish listing criteria, the team must determine the size of the shortnose sturgeon populations and assess trends in recruitment. This information will help the team to set a minimum population size below which the population is endangered of going extinct. First, a rangewide genetic assessment will be implemented. The genetic makeup of the population is important to monitor genetic damage due to loss of alleles or inbreeding. The team must now determine the abundance, age structure, and recruitment of each population segment. With this information the team will set threatened and endangered population size thresholds. Due to shortnose sturgeon populations varying over latitudes, a status review for each population segment must be conducted.

This will help show the productivity including the stability or increase of each particular segment. Field research will be done to show seasonal distributions and map critical habitat. Lab experiments will proceed to document behavior, food/habitat preferences, and physiological tolerances to aid in a stability criteria for critical habitat. Mortality factors will be evaluated for each population segment and take limits defined. These factor must be considered due to the sturgeons limited population size.

The shortnose sturgeon recovery team will protect shortnose populations and their habitat. Cooperative agreements with the states must be established (a section 6 agreement). The team, needing all the support possible, must encourage the federal agencies to support research to promote the sturgeon recovery. Incidental mortality from accidental capture must be assessed. This information will help researchers to determine effects of incidental capture so they can provide guidelines to reduce bycatch mortality. To help protect the sturgeon, laws will be strictly enforced. Trying to protect the sturgeons, the team must designated critical habitats for all stages of the shortnose sturgeons life. These habitats must be mapped for each population segment. These habitats will be monitored regularly to show any changes which may occur. It will be up to the researchers to make sure that appropriate fish passage devices are adequate and do not alter migration or spawning behavior. Factors such as dredging, blasting, powerplants, in-river disposal and other human induced disruptions must be assessed so researcher can provide guidelines for minimizing the effects on the sturgeon. Dead fish will be examined to expose any contamination building in the tissue of the sturgeon. Along with tissue samples, food and sediment samples must be taken to asses the degree to which contamination is building up. Due to some industries causing changes in dissolved oxygen levels, sturgeon habitat's dissolve oxygen with be monitored to show the extent and duration of hypoxic events. Protecting the species means not only to protect it from man, but also from introduced species which are in most areas in which the sturgeon will recover. The impacts of these introduced species that are predators, competitors or parasites of the shortnose sturgeon must be identified. Public education programs will be implemented to create and awareness of the shortnose sturgeon and its need for protection. The education program will be done by printing articles, posters and pamphlets. Cultured shortnose sturgeon will be made available to aquariums and zoos were the public can see this beautiful fish first hand. Media will be used to update the concerned public on issues that arise. Schools will also partake in the recovery by educating students about the sturgeon as well as the aquatic environment.

A coordinator must be appointed and establish teams for regional recovery plans to begin working toward objectives. A network must be established providing researchers with a means of sharing data and implementing ideas. Funding for the shortnose sturgeon recovery activities must come from agencies who partake in funding such activities.

Once all the data has been analyzed and studied, work on rehabilitating the habitats and population can proceed. In each of the rivers where sturgeon populations exist, barriers

to spawning and migration must be modified to allow passage by the shortnose sturgeon. In spawning areas where river discharge levels are a factor on spawning habitat, research must be implemented on how the discharge levels and substrate affect spawning success. The natural discharge must be studied to show how sediments are remove from spawning habitats. In some cases artificial substrate may be used, so research must be done to see if females will spawn on artificial substrate. Using the data from discharge and sediments research the team will be able to use discharge rates during spawning seasons to increase spawning success. Diets must be determined for each population. In cases where sturgeons have poor growth, foraging habitat will be investigated. In cases where contaminants are causing degradation to the sturgeons habitat, sources must be identified and action taken to reduce loading.

To evaluate the success of the sturgeon the team must monitor the sturgeon reintroduction's, survival, movement pattern and distribution, foraging and reproduction. The shortnose recovery team does not want to use cultured sturgeon due to the threat of genetic contamination unless it is cultured from that particular population.

This recovery plan will affect many people and many industries. For the plan to work, all those involved must work together. Dredging, blasting, powerplants, dam operation and construction, all must consider the sturgeons habitat.

The shortnose sturgeon recovery plan is a valiant effort to save yet another species from extinction. Humans have been eliminating species at an incredible rate since the beginning of our existence. Also Leopold wrote in A Sand County Almanac, "If the land mechanism as a whole is god, then every part is good, whether we understand it or not." Leopold implies that ignorance is no excuse to eliminate a species. The sturgeon will require a lot of attention by managers to fully recover. The shortnose sturgeons road to recovery will be with many obstacles, but with the help of experts and the public, we should be able to restore the oldest bony fish- the shortnose sturgeon.

References

- National Marine Fisheries Service 1997. Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.
- National Marine Fisheries Society. 1984. Synopsis of Biology Data on Shortnose Sturgeon Technical Report. NMFS, 14. Gloucester Massachusetts.
- Rohlf, Daniel J. 1989. The Endangered Species Act. Stanford Environmental Law Society.
- United States Fish and Wildlife Service, 1990. The Official World Wildlife Fund Guide to Endangered Species of North America. Beacham Publishing Company. Volume II.
- White, Christopher P. 1982. Endangered and Threatened Species of the Chesapeake Bay Region. Tidewater Publishers, Centerville, Maryland.



Author with two striped bass.

Atlantic Striped Bass: On the Road to Recovery Ryan Cool

The Chesapeake Bay striped bass (*Morone saxatilis*) has formed the foundation of one of the most popular fisheries on the Atlantic coast. The popularity of this species to anglers, the complex nature of its seasonal distribution up and down the coast, and the decline in harvest and poor recruitment during the 1970's caught the eye of both the anglers and fisheries managers. This paper is about the Atlantic striped bass and the effects of management over the years. The question is, will the future of striped bass management produce steady stocks or will there continue to be spasmodic populations from year to year?

Striped bass harvest increased from 1930 through the 1960's. Commercial harvest peaked at almost 15 million pounds in 1973. The harvest then declined to 3.5 million pounds by 1983 (ASMFC 1997 [Amendment 5]). From 1980 to 1992, the majority of commercial striped bass harvest by weight was taken in Maryland (27 percent), New York (18 percent), Massachusetts (17 percent), North Carolina (14 percent), and the Potomac River (14 percent) (ASMFC 1997 [Amendment 5]). Obviously from the drastic decline in the numbers of striped bass, the management regulations were not restricting commercial harvests enough and the population was over-exploited. Management had to make drastic changes to save the striped bass from completely

collapsing via commercial harvests and this was done by quotas established annually in regards to fishing mortality (F). The fishing mortality rates were set based on the previous years recruitment levels and harvest rates. Unfortunately, commercial fishermen were not the only guilty party in the depletion of the striped bass populations.

Saltwater sport fishing was growing rapidly in popularity in the 1960's and 1970's. This resulted in major shifts in harvest rates. Since 1979, the first year sport harvest was surveyed, sport harvest ranged from 28 to 65 percent of the total harvest. Sport fishing harvest decreased in numbers of striped bass from over 1 million fish in 1979 to 127,000 fish in 1984 (ASMFC 1997 [Amendment 5]). The National Marine Fisheries Service sampling program of recreational anglers indicates the estimated total number of trips increased by 4 million from 1988 to 1992 (ASMFC 1997 [Amendment 5]). The spreading popularity of the striped bass fishery led to the over harvesting of the populations of mature, capable of spawning, fish throughout the 1970's and 80's which led to low recruitment levels. Stringent management regulations were mandatory to protect the future of the striped bass fishery.

The striped bass is a long-lived (up to 29 years of age) species which lives the majority of its adult life in coastal estuaries or the ocean and ventures up estuarine rivers to spawn. Mature females (at age 4 and older) produce large quantities of eggs and mature males (age 2 and older) fertilize the eggs. In the past few decades, these mature stripers were being harvested before they had a chance to produce multiple year classes. This was primarily due to management regulations that were not protecting the spawners and the fishermen were utilizing every bit of the insufficient regulations.

Management History

The Atlantic States Marine Fisheries Commission (ASMFC), composed of 15 coastal states from Maine to Florida, provides a forum for cooperative interstate fisheries management. These are the people who interpret the data and devise the goals, objectives, and regulations. Juvenile abundance indices have traditionally been used for analyzing the status of the striped bass along the Atlantic coast. The Maryland index, which consists of beach seine hauls for juvenile striped bass on coastal beaches in the state, has been the most widely used index and is the basis for management decisions (Goodyear 1985). The magnitude of the juvenile index is related to the amount of recruitment of that year class (age 0) into the fishable stock and reflects potential reproductive capacity of that year class (ASMFC 1990 [Amendment 4]). Low year class hauls can be related to harvestable size adults four years down the road. After 1970, decreasing abundances of juvenile year classes forced the ASMFC to devise a management plan to enhance recruitment.

In 1981, that plan was the Striped Bass Management Plan. The plan recommended increasing minimum size lengths and seasonal closures from Maine to North Carolina. From 1981-1985 a series of amendments were instituted. By the mid-1980's, both fishermen and managers realized that the

problem was larger than they had expected and more drastic measures were needed to prevent the striped bass from becoming endangered. In 1984, the Atlantic Striped Bass Act was signed into federal law, forcing states to comply with provisions of the ASMFC plan. From 1985-1989, Maryland, Delaware, North Carolina, Virginia, New York, and Rhode Island all imposed a moratorium prohibiting striped bass harvest.

It was said that the moratorium would not be lifted until a 3 year average of 8.0 fish/seine haul was met. In 1989, the index was 25.2 fish/seine haul and the ASMFC dropped the moratorium and adopted Amendment 4 by 1990. Amendment 4 addressed a reopening fishery in the initial stages of stock recovery. It used an adaptive management strategy that allowed the Commission to make changes in response to specific circumstances.

It stated that there was an 18 inch minimum size limit in producer areas, which pertained to the sport anglers, and a 28 inch minimum pertaining to both commercial and sport anglers on the coast. This helps to protect the fish that are mature and can

spawn. The sport anglers could harvest 1 fish/day.

Although extreme sacrifices were required during the closed seasons and the majority of watermen felt cheated, recreational and commercial fisheries for striped bass are now seeing the benefits of management. Neither recreational nor commercial fishermen are voicing many complaints do to the closing and reductions in harvest levels. Although they are trying to make a living, they saw how bad it could get and they do not want it to go back to those levels. In the past couple of years, we have been seeing an increasing amount of 18 inch or better fish due to strong year classes from the past. Due to this management program, Atlantic striped bass have made the most significant recovery ever experienced for a coastal finfish species; and are likely to increase to record levels over the next few years. This is due to the mature stripers spawning and the recruitment levels increasing. The ASMFC declared the Chesapeake Bay stocks of Atlantic striped bass, which support the greatest portion of the coastal stock, were recovered as of January 1, 1995 (ASMFC 1997 [Amendment 5]). The number of striped bass caught but released alive increased drastically from 1979 to 1992, due to regulations and conservation efforts by sport anglers. In 1980, only 11% of the sport catch was released alive. In 1992, 90% of the catch was released alive giving a promising outlook for the striped bass fishery (ASMFC 1997 [Amendment 5]).

In March of 1995, Amendment 4 was revised into Amendment 5 by the ASMFC Striped Bass Management Board. Amendment 5 completely replaces the original Fisheries Management Plan and all other amendments and addenda. "The goal of Amendment 5 is to perpetuate, through cooperative interstate fishery management, migratory stocks

of Atlantic striped bass so as to allow a commercial and recreational harvest consistent with the long-term maintenance of self-sustaining spawning stocks and to provide for the restoration and maintenance of their critical habitat" (ASMFC 1997 [Amendment 5]).

On October 21, 1996, the ASMFC called for an addendum to Amendment 5 to develop appropriate management measures for 1997 state fisheries through the adaptive management approach (ASMFC 1997 [Addendum]). This covered quotas, bag limits, and seasons for the 1995 and 1996 fisheries, but did not outline specific 1997 regulations. This was due to insufficient data by the time of the last meeting, yet the Management Board voted on a mortality rate $F=0.33$ for 1997. This will be accomplished by the reduction in harvest for commercial and recreational fishermen. It will

allow the population to grow until it is fully restored, and in the long-term, will allow a greater buffer against overharvest which ensures that the population will continue to sustain itself at its restored level. The ASMFC Striped Bass Technical Committee reported that coastal (ocean) commercial quotas were projected to fall from 1996

levels by about 500,000 pounds overall. Each state can submit alternative management proposals as long as they follow the guidelines of Amendment 5, which pertains to the minimum standards in the fisheries management plan. Under no circumstances will states be allowed to institute minimum sizes below 18 inches in alternate management plans (ASMFC 1997 [Addendum]).

The current regulations for recreational fisheries state: 18-inch minimum size in producer areas, 28-inch minimum size in coastal areas. Creel limits for the fishery ($F=0.33$) are: two fish creel limit along the coast and a one fish creel limit in producer areas (set by ASMFC).

The current regulations for commercial fisheries are to achieve a mortality target of $F=0.33$ and be constrained by size limit (same as above) and a state-by-state quota. Producer area jurisdictions are strongly discouraged from establishing commercial fisheries on spawning grounds during striped bass spawning season.

Future Prognosis

Through personal experience and speaking with many other anglers, the striped bass fishery is on the up and up. I saw more stripers this year in the mouth of the Chesapeake Bay area than any year in the past. Virginia Beach charter boat captain Kevin Seldon, who took out evening charters of 6-10 passengers said, "I could count on one hand the number of trips where the fishers did not catch their limits. It was a good year for striper fishing."

According to Maryland angler surveys, there are arguments that striped bass fishing is deteriorating. In 1996, a program called the Marine Recreational Fishery Statistics

...will the future of striped bass management produce steady stocks or will there continue to be spasmodic populations from year to year?

Survey (MRFSS) conducted 23,500 interviews of anglers completing their fishing trips and 70,000 telephone interviews which gives reliable information for estimations, angler satisfaction, and predicting future success. Statistics show that the overall catches reflect a 20 percent increase from last year (Burton 1997).

Although overfishing played a major part in the depletion of the Chesapeake Bay striped bass, habitat degradation, pollution, and other factors contributed to the problem also. Valuable coastal lands have shown an increase in development over the past century and has resulted in sedimentation and pollution. Agricultural runoff from 13 states finds its way into the bay causing a variety of problems too. These factors are hindering important spawning sights and causing a reduction in recruitment levels.

I feel that the current management is correct and the striped bass populations are increasing impressively. The lack of strict regulations in the 1970's and 80's hurt the bay badly, but due to better management in the 1990's, the Chesapeake Bay striped bass is making its comeback. The new regulations are aimed at protecting enough mature fish to produce a good year class and sustain future populations. This is currently being accomplished. Maintaining these successful annual year classes and good spawning sights will keep the populations increasing. I not think that due to this years increased catch rates, the management should be changed to give the anglers higher harvest rates. This will just push the situation back to the past conditions where overfishing caused drastic problems. I feel that the stocks should be monitored for a couple more years before any bag or size limit changes are made just to be safe. The striped bass reproduction rates are not predictable enough to be sure of a good year class annually. It will take more restoration of adult stocks to sustain predictable levels of juveniles and large populations of striped bass. The recovery of the Atlantic striped bass has come a long way and in order to keep the annual progression, fisheries managers need to keep on their toes along with the commercial and

recreational fishermen. Shoreline development and other forms of run off also need to be controlled to reduce sedimentation. If proper regulations are kept, the striped bass will continue to provide food and fun for many future generations.

References

Atlantic States Marine Fisheries Commission. 1981.

Interstate fisheries management plan for the striped bass of the Atlantic coast from Maine to North Carolina.

Atlantic States
Marine Fisheries
Commission,
Washington D.C.

----- 1989. Supplement
to the striped bass
FMP-Amendment
#4. Atlantic States
Fisheries
Commission,
Washington, D.C.
Fisheries
Management Report
No. 15

----- 1990. Source
document for the
supplement to the

striped bass FMP- #4. Atlantic States Marine Fisheries
Commission, Washington, D.C. Management Report
No. 16.

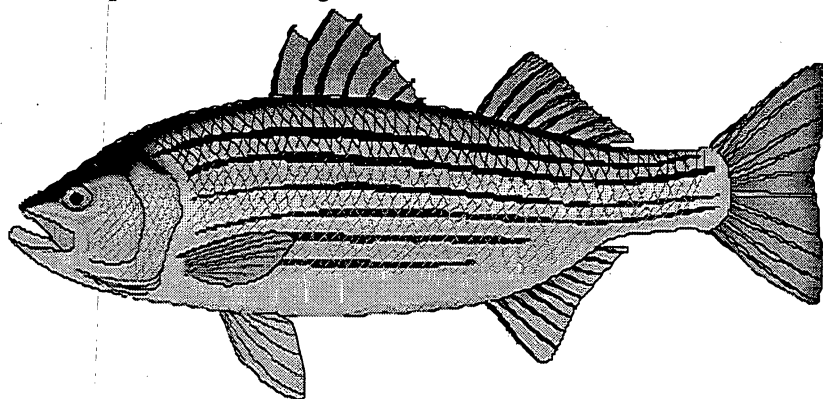
----- 1997. Source document for the supplement to the
striped bass FMP- #5. Atlantic States Marine Fisheries
Commission, Washington, D.C. Management Report No.
24.

----- 1997. Source document for the supplement to the
striped bass FMP- #5. Addendum I-1997 FISHERIES.
Atlantic States Marine Fisheries Commission,
Washington, D.C. 1-3 pp.

Burton, Bill. 1997. "Dissidents could drive off one of
DNR's best." The Sunday Capital. C12.

Goodyear, C.P., J.E. Cohen, and Christensen. 1985.
Maryland striped bass: Recruitment declining below
replacement. Trans. Am. Fish. Soc. 114(1): 146-151.

*...Chesapeake Bay stocks of
Atlantic striped bass, which
support the greatest portion of
the coastal stock, were
recovered as of January 1,
1995...*



Managing Virginia Reservoirs

Recharging the Ranks of Trophy Striped Bass in Smith Mountain Lake Kirk Rundle

An era of reservoir construction to provide electricity, flood control, and water supply took place in this country in the mid 1900's. These "fake lakes" have also provided for a high demand of water-based recreational activities. In Virginia 13 major impoundments have been built, starting with Claytor Lake in 1939. Of Virginias 13 reservoirs one of the most scenic and widely used is Smith Mountain Lake whose dam was closed in 1963. Smith Mountain Lake, located in the foothill mountains of the Piedmont, consists of two long, narrow tributary arms, the Blackwater River (12.4 mi) and the Roanoke River (>25 mi), and a broad, deep (>140 ft) lower lake extending 6.2 miles above the dam (Yurk and Ney, 1989). The lake is very dendritic in nature with over 500 miles of shoreline (Fig. 1) and a 3.2 year retention time.

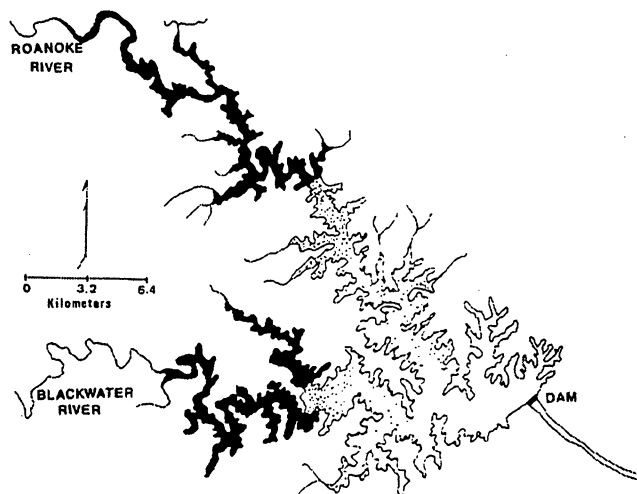


Figure 1.-Smith Mountain Lake, Virginia.

Thanks to its highland elevation Smith Mountain Lake provides excellent cool, deepwater habitat with over 40 species of fish, including many high profile gamefishes such as the muskellunge, black basses, crappie, walleye, and most notably the striped bass, *Morone saxatilis*, which is the focus of this paper. The Smith Mountain Lake striped bass population was developed soon after the lake was flooded with an initial stocking of approximately 75,000 striped bass fingerlings in 1963 (Ney, et al. 1988).

Striped bass were initially stocked in Smith Mountain Lake, along with many other reservoirs, because of their high appeal to anglers, and their use of the unoccupied pelagic zone. Stripers also fulfill a predatory niche by feeding on large clupeid fishes such as gizzard shad and alewives that

often glut reservoirs, tying up much productivity in biomass unused by humans (Coutant, 1985).

Smith Mountain Lake currently holds the state record for striped bass at 45 lb 10 oz, caught in February 1995 (Fig. 2), and was noted in the January 1997 issue of the *In-Fisherman* magazine as one of the top 10 striper lakes in the country. However, this fishery has developed a lot of controversial issues in the past few years with many striped bass anglers complaining of a reduction in the number and size of stripers caught now compared to the 1970's and 1980's. The Virginia Department of Game and Inland Fisheries (VDGIF) also recognizes that there has been a general decline in the catch of trophy-sized striped bass from Smith Mountain Lake since the "peak" fishing days of the 1970's and 1980's (Duval, 1996). Trophy striped bass citations peaked in 1991 with 341 fish over 20 pounds, but have been declining in recent years. Also, median citation weight increased through the 1970's and 1980's to a high of 24 pounds, but has recently dropped to 22 pounds. From this, the VDGIF staff has concluded that the abundance of large trophy-sized striped bass at Smith Mountain Lake has been declining, perhaps as early as 1988 (Duval, 1996).



Figure 2.- State record striped bass.

Identifiable potential causes of the declination in trophy-sized striped bass include: 1) reduced nutrient loading; 2) reduced fingerling stocking rates; 3) increased fishing pressure and harvest; 4) increased recreational boat traffic; and 5) increased hydroelectric pumpback. While reasons 4 and 5 are worth mentioning and can have a negative impact (i.e. spooked fish and the biologically hostile "intertidal zone") their ramifications on the trophy-sized striped bass fishery appear to be negligible. Therefore the first three potential causes are believed to have the greatest impact on the striped bass fishery at Smith Mountain Lake and will be discussed in greater detail.

Reduced Nutrients

In 1975, the upstream city of Roanoke installed an advanced, tertiary, wastewater treatment facility that removed 81% of the phosphorus entering Smith Mountain Lake from the Roanoke River, causing a greater than 50% reduction in total phosphorus loading to the reservoir (Yurk and Ney, 1989). This was significant because phosphorus is the major nutrient limiting primary production. With less primary

production there is less organic material "raining" down and accumulating on the bottom of the lake throughout the warmer months. This smaller quantity of organic material requires smaller quantities of oxygen to be broken down by bacteria. Hence, leaving more oxygen in cooler benthic waters and greatly expanding the summertime habitat of coolwater fish, such as the striped bass which require temperatures no greater than 75 degrees F, and dissolved oxygen no less than 5 mg/L. While this increase in summer habitat can provide the striped bass with more feeding opportunities, it can also breakdown habitat barriers that have minimized direct conflict between coolwater and native warmwater fish, such as the largemouth bass, in Smith Mountain Lake.

Another effect of reduced nutrient loading into Smith Mountain Lake has been its impact on the entire food chain. Fishes, at or near the top of a lake's trophic pyramid, such as striped bass, require abundant plant resources at the pyramid's base to achieve high production; the supply of aquatic plants is usually controlled by nutrient availability (Yurk and Ney, 1989). With fewer nutrients in the lake aquatic plant production, such as phytoplankton is down. With less phytoplankton available, zooplankton production has naturally gone down. This in turn has caused the primary forage fish species, gizzard shad and alewife, of the striped bass to decline in numbers. However, due to a carefully designed stocking plan, discussed in the next section, relative weights and back calculations show that striped bass in Smith Mountain Lake grow exceptionally well and faster than any other fresh water system in Virginia. This indicates that if striped bass are stocked in proportion to the capacity of the food supply at Smith Mountain Lake trophy-sized fish are certainly capable of being produced in spite of reduced nutrient inputs.

Reduced Stocking Rates

Due to specific requirements striped bass are successful at reproducing in only five landlocked systems in the United States (Karas, 1974). This has caused the vast majority of reservoirs, including Smith Mountain Lake, to rely on a put-grow-and-take fishery for striped bass. The number of striped bass stocked at Smith Mountain Lake has been a topic of hot debate for many years now. Many would like to see much higher stocking rates, such as those prior to 1982, than the current level of approximately 300,000 fish per year. It seems logical that if you put in more fingerlings you're bound to have more fish in the long run. However, due to the density-dependent nature of striped bass and limited food availability, a "bottleneck" effect occurs which limits the number of survivors no matter how many fingerlings are stocked. The current stocking rate of 300,000 fish was implemented as a management recommendation from a contractual study conducted for the VDGF by Virginia Polytechnic Institute and State University during the early 1980's. Results of the study indicated that stocking survival is density dependent and that high fingerling mortality takes place in the system at stocking rates greater than 350,000 fish per year. When too many fingerlings are stocked there isn't enough food available for these young fish to build up a

sufficient level of body fat to carry them through their first critical winter of life. Another factor in favor of the current stocking rate of 300,000 fingerlings annually has been a stable recruitment of striped bass (Duval, 1996). Average recruitment of age I+ striped bass of 70,183 fish, since reduced stocking rates were implemented in 1982, are almost identical to the estimated average recruitment of 70,865 age 1+ fish from higher stocking rates prior to 1982 (Fig. 3). In summary, the current stocking rates of approximately 300,000 fingerlings annually are the highest possible level that Smith Mountain Lake can support.

Stocking rates may have been higher in the past, but nutrients were also higher in the lake. Also, the higher stocking rates did take their toll on the fish community by negatively impacting other sport-fish in the lake, such as the largemouth bass, causing an unbalanced situation. Furthermore, recruitment is as high now as it has ever been, there is a balanced fish population, and stocking more than 300,000 striped bass fingerlings annually would be a waste of resources.

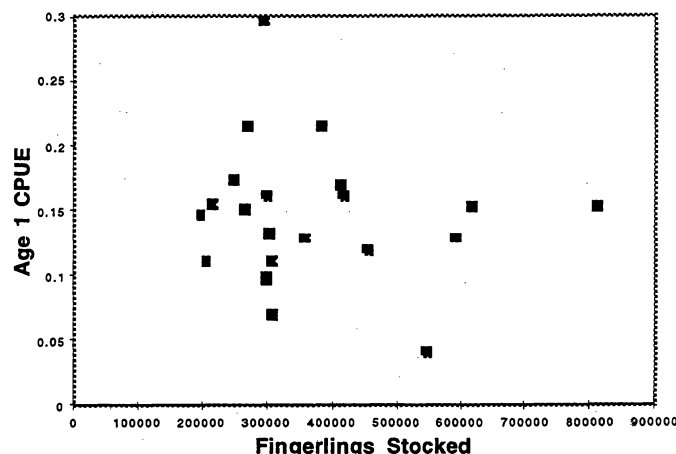


Figure 3.-Recruitment of striped bass at age 1 is unrelated to number of fingerlings stocked.

Increased Fishing Pressure

Acknowledging that growth rates and recruitment of striped bass in Smith Mountain Lake are both good, the only possibility causing a reduced number of large striped bass in the lake is a high mortality rate of these fish before they reach trophy status. This can either be caused by natural mortality or angling mortality. However, after being recruited at age I+, the fish has an average length of approximately 16 inches and natural mortality is rare. Therefore, the most likely cause of recruited striped bass mortality is due to angling pressure. The Smith Mountain Lake striped bass population receives a high amount of angling pressure with over 40% of the total hours of effort exerted by all anglers at the lake spent in pursuit of the striped bass (Duval, 1996). Striped bass take approximately 10 years to reach citation (20 lb) size, and considering the high number of striped bass anglers, using highly efficient techniques, the likelihood of many stripers reaching age 10 and older is rare.

Possible solutions for "recharging" the ranks of older, larger striped bass include: 1) size and creel limit changes; 2)

a reduction in fishing pressure; and 3) educational efforts to improve the striped bass population. The current regulations for striped bass at Smith Mountain Lake are two fish per day with a minimum size limit of 20 inches. Changing either the creel limit or the minimum size limit would only be effective if the survival of released fish is high.

Unfortunately, striped bass suffer extremely high levels of mortality after being released by anglers. Mortality rates of striped bass caught and released at a reservoir in Tennessee were 67% during the month of August (Osborne, 1995). Therefore, reducing the creel limit or increasing the minimum size limit would most likely be ineffective due to the high catch-and-release mortality of striped bass.

A reduction in fishing pressure could be accomplished in many ways, such as: a limited entry fishery to restrict the number of anglers eligible to take stripers, a yearly harvest quota that when met would result in closure of the fishery, a moratorium period allowing stripers to grow to trophy-size (i.e. the Chesapeake Bay example), or a striper season to reduce the time available to fish for stripers. Any one of these would probably be very successful at increasing trophy-sized stripers in Smith Mountain Lake, but would be extremely difficult to get the large-scale support and endorsement needed by the striper anglers themselves.

The most feasible way to go about increasing the number of striped bass making it to trophy proportions is by educating anglers on how susceptible the striped bass is to angling mortality and the need to reduce culling.

Anglers definitely need to practice no cull fishing and stop fishing for stripers once they have caught their limit. However, there are a few things to keep in mind that can improve the survival of released stripers if they are under the minimum size limit, or for whatever reason are going to be released. The use of large hooks can cause more severe injuries than smaller hooks (Gjernes, et al. 1993). Also, higher hooking mortality is associated with live baits versus artificial baits (Hysmith et al. 1992). This has to do with the hooking location and its effect on vital tissues. Therefore, the use of single hook artificial lures, such as bucktails, is highly recommended. The time of year is also a crucial factor determining survival of released striped bass. The summer and early fall are the worst times to practice catch-and-release fishing of striped bass. At this time of year most of the fish are caught in deeper water, hauled to the top, and exposed to high temperatures. The pressure change that the fish must undergo in this situation can cause the swim bladder to expand greatly and sometimes rupture leaving the fish incapable of regulating buoyancy. Also, the high temperature fluctuations a fish caught at this time of year, especially during the day, endures can be very stressful and often times fatal. Another thing anglers should keep in mind is that ultra-violet light rays can cause permanent blindness to a fishes unblinking eyes. In summary, the practice of catch-and-release striped bass fishing is strongly discouraged. However, with minimal handling, artificial lures, and cool weather fishing, fairly good survival rates can be expected. Osborne (1995) reported survival of hooked and released striped bass at a reservoir in Tennessee of > 75% during fall, winter, and spring. An increased minimum size limit during

these cooler times of the year could possibly help increase the abundance of larger striped bass in Smith Mountain Lake. Yet, at Smith Mountain Lake most of the fishing pressure is during the warmer months and anglers are encouraged to try for another species of fish once they have caught their limit of two striped bass.

Conclusion

Smith Mountain Lake is a multiple use reservoir that currently has an excellent balance of many popular game-fish. While the population of trophy-sized striped bass in the reservoir may have declined somewhat from the "peak" fishing of past years, the lake still fosters a first-rate striped bass population. New state record stripers were caught in July 1992 (44 lb 14 oz) and February 1995 (45 lb 10 oz) proving that the lake remains quite capable of producing trophy-sized catches. Also, some guides working the lake continue to report catches of up to 40 fish a day (Duval, 1996).

There are several options that could be employed to increase the number of trophy-sized striped bass in Smith Mountain Lake. However, the more promising options, such as a seasonal closure, are too harsh to be accepted by most anglers and are not very likely to be implemented. Besides maintaining quality habitat and optimum stocking levels, the most reasonable way for a fisheries manager to improve the striped bass population at Smith Mountain Lake is to maintain good communication in educating the striped bass anglers of their role and importance to the future of the fishery. The rest is up to the actions of the anglers themselves.

References

- Duval, M. C. 1996. Smith Mountain Lake striped bass management. Virginia Department of Game and Inland Fisheries. Fisheries Division issue paper.
- Gjernes, T., A.R. Kronlund, and T.J. Mulligan. 1993. Mortality of chinook salmon in their first year of ocean life following catch and release by anglers. *Journal of Fisheries Management* 13:524-539.
- Hysmith, B.T., J. H. Moczygemba, and G.R. Wilde. 1992. Hooking mortality of striped bass in Lake Texoma, Texas-Oklahoma. *Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies* 46:413-420.
- Karas, N., 1974. *The complete book of the striped bass*. Winchester Press, New York.
- Ney, J. J., C. M. Moore, R. J. Neyes, M. S. Tisa, J. J. Yurk. 1988. *The Smith Mountain Lake fishery: Factors affecting major sport and forage fish populations*. Dep. Fish Wildl. Sci., Virginia Polytechnic Institute and State University, Blacksburg.
- Osborne, R. S. 1995. *Survival of striped bass caught and released by anglers in Tims Ford reservoir, Tennessee*. M. S. thesis, Tenn. Technol. University.
- Yurk, J. J., and J. J. Ney. 1989. Phosphorus-fish community biomass relationships in southern Appalachian reservoirs: Can lakes be too clean for fish? *Lake Reserv. Manage.* 5(2):83-90.

Assessing Shad Abundance: Alternatives to Toxicant Sampling

Powell Wheeler

It has been said, unless a man constructs his house on solid rock it will not endure. Likewise, attempting to build a pelagic predator sport fishery without a solid foundation of available forage fish (Ney 1981), is destined for failure. Shad (*Dorosoma spp.*) form the foundation in many reservoirs by being the principle forage fish for many piscivorous predators (Noble 1981). Effective predator management requires a knowledge of the abundance of these prey species, and this is possible only through our ability to quantify their abundance (Ney 1981). A lack of accurate and precise sampling techniques has always hampered our ability to understand foundational shad populations (Van Den Avyle et al. 1995b), and the future of effective management for many predator fisheries hinges on our ability to develop and further refine population assessment techniques (Ney 1981).

Toxicant sampling of lake and reservoir coves using rotenone has been used for years to assess fish populations and build standing crop data bases. Since the 1940s, data collected from the rotenone sampling of coves has been used to estimate shad populations (Russell 1978). While it is true that toxicants provide a good means to obtain population estimates for a variety of purposes (Davies 1983; Russell 1978), and several studies have been conducted to evaluate and improve cove sampling procedures (Aggus 1980; Hayne 1967), the results often prove to be poor. It seems that this sampling technique has out lived its usefulness for several reasons.

For measuring shad abundance and biomass, cove rotenone sampling is undesirable for many reasons. First, traditional rotenone sampling often fails to accurately evaluate the specific cove. Some fish will always escape enclosures, fail to rise, become scavenged or survive within the enclosure (Degan 1995). Abundance is always underestimated due to the numbers of young fish not collected, this is due to higher flotation of larger fish, higher predation of smaller fish, and the lower visibility of smaller fish to the dip netters (Henley 1967). Age-0 shad sink and decompose quickly after succumbing to the toxicant (Johnson et al. 1988). First, cove selection is very limited due to the parameters of locating a cove of convenient size (Johnson et al. 1988), sufficiently shallow depth (Van Den Avyle et al. 1995a) and a minimum of public interaction (Johnson et al. 1988). Furthermore, the coves selected from these limitations often do not represent the entire body of water (Hayne 1967) either by abundance or biomass (Aggus 1980). This is due to the fact that shad populations show extreme variation in abundance among coves (Van Den Avyle et al. 1995b). The high number of sample sizes this technique requires uses ridiculous amounts of labor (exceeding all other applicable methods (Van Den Avyle et al. 1995a)). Generally, to collect and record the data from one rotenone sample, labor can be estimated to be six-ten people per hectare poisoned (note table at the end of this article) (Van Den Avyle et al. 1995a). Finally, shad are a pelagic species meaning and they prefer open water. The problem here is that cove rotenone sampling

is only effective in near-shore or littoral areas (Van Den Avyle et al. 1995b). In summation, traditional toxicant sampling is undesirable due to the low availability of coves, high labor costs and extremely imprecise, inaccurate data, so it would only seem logical to pursue some alternative sampling techniques. Four other techniques that have been used to gauge shad populations include trawling, acoustic assessment, gill netting, and electro-fishing. They all have unique strengths and weaknesses which will be addressed in this article.

Trawling is an effective method for evaluating shad populations. Trawling has many advantages over rotenone sampling and other techniques. First of all it is very species specific, targeting small pelagic fish it catches little more than shad (Van Den Avyle et al. 1995a). Also, trawls sample an area over a distance (volume) this makes it very simple to quantify indices of population abundance (Hayes 1996). But the primary advantage of trawling is that the gear is not limited to one type of habitat but can be used to sample both limnetic and littoral zones (Hayes 1996). This allows spatial comparisons of shad density to be made (Siler 1986). Few other techniques are this versatile. This versatility allows the use of a randomized sampling design. This sampling design allows a more statistically valid basis for expanding the sample data to the entire body of water (Siler 1986). A large study performed on a North Carolina lake compared trawling with rotenone sampling. The study concluded that trawling provides more precise data with considerably less effort (Hayes 1996).

However, there are several important disadvantages to trawling. This technique is very expensive. Expenses include purchasing very powerful, specialized boats and moderate labor costs (see table) (Van Den Avyle et al. 1995a). Another disadvantage to trawling is that it selects only for smaller fish, rarely catching anything older or longer than age-0 (Van Den Avyle et al. 1995a).

Another method is the use of hydro acoustics. This technology was first developed during World War I to detect enemy submarines. By the 1930s, this technology was being applied to calculating relative abundance of fishes and by the late 1960s to early 1970s, had advanced to being able to quantify absolute abundance. During the 1980s, the available technology continued to evolve and statistical procedures were developed to estimate sampling volume and sizes of fishes. The technology has continued to advance rapidly over the last decade (Brandt 1996).

There are two major advantages to acoustic assessment; incredibly high precision and extremely low labor requirements. This method records both abundance and length of individuals. The data is so precise that only a very few small samples are necessary. This results in the lowest human effort of any other method of shad assessment (see table) (Van Den Avyle et al. 1995a). There are several important weakness of this method. The primary problem is that even though this techniques produces and records amazing observations of both abundance and length of individuals it cannot distinguish between species. For this reason it must be used along with another technique (for example trawling), which can judge species composition. An alternative to

verifying the sample with the trawl is to sample only during seasons and places where shad dominate the environment (Brandt 1996). Another problem this method runs into are that shad are partial to schooling behavior. This is inconvenient because high fish densities, has a tendency to confound the equipment. To counter-act this difficulty shad cannot be sampled effectively during the day but rather only at night when the individuals are the most disperse. Also, the equipment cannot sample the shallow zones near shore and is limited to deep offshore areas only (Van Den Avyle et al. 1995a). Finally, the initial equipment investment is incredibly expensive (see table).

Another technique that is often over looked, is to sample shad with the traditional gill net. The primary advantage of this method is it is one of the only methods that can be used in inshore as well as off shore habitats, and well as over a long vertical range (Van Den Avyle et al. 1995a). This allows comparisons to be made between areas and depths (Van Den Avyle et al. 1995b). Experimental gill nets with multiple mesh sizes can be used to sample a large range of fish sizes including the larger individuals of the population which other methods fail to sample very well (Van Den Avyle et al. 1995a). Lastly, the equipment is relatively inexpensive (see table).

The two major disadvantages are the labor and biases. The labor required is moderately high (see table) and the mesh sizes bias specific lengths. This bias causes peaks in the length distribution of fish caught (Van Den Avyle et al. 1995a), however, sometimes this bias can be calculated and the catch data can be adjusted accordingly (Van Den Avyle et al. 1995b).

Another option is electro-fishing. Electro-fishing is commonly used to capture littoral fishes (Devries 1995). This technique can take advantage of active or passive fish collection or both. Active collection involves using dip netters to scoop up stunned fish, in passive collection, the boat pushes a net behind the electrodes to trap the stunned fish.

The disadvantages of electro-fishing are considerable. They include moderately expensive equipment and very high labor requirements (see table) (Van Den Avyle et al. 1995a). Both collection methods target a certain range of fish. Active collection has a tendency to overestimate the abundance of older fish due to the human tendency to target the large fish. Passive collection underestimates the larger shad because these larger fish recover more quickly and are strong enough swimmers to escape the net. In short, both passive and active fish collection methods have proved too imprecise to use their data to quantify shad populations (DeVries 1995).

A study which compared all these sampling gears on Lake Texoma concluded that no technique was clearly superior. All the gears had advantages and disadvantages. The different techniques all showed selectivity on both the size and species they targeted. All the gears have some biases as to the environment in which they are the most effective to some degree. While some methods can be used in a variety of habitats, no one gear could sample every habitat with equal effectiveness. The conclusion is that there is really no one best method. The optimum method is relative to the

individual situation, depending on factors such as the available funds for the projected experiment, the sizes of shad necessary for collection and labor available (Van Den Avyle et al. 1995a).

Sampling Technique	Equipment Cost	Man Hours*
Hydro-acoustics	25,000	14-25
Trawling	42,000	15-127
Gill Netting	300	22-242
Electro-fishing	6,200	171-973
Cove Rotenone	5,000	1524-5384

* The amount of labor needed to estimate CPUE within 25% of the true median with 95% probability on the 35,600 ha Lake Texoma (Van Den Avyle et al. 1995a)

References

- Aggus, L. R., D. C. Carver, L. L. Olmsted, L. L. Rider, and G. L. Summers. 1980. Evaluation of standing crops of fishes in Crooked Creek Bay, Barkley Lake, Kentucky. *Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies* 33:710- 722.
- Brandt, S. B. 1996. Acoustic assessment of fish abundance and distribution. Pages 385- 432 in B. R. Murphy and D. W. Willis editors. *Fisheries Techniques*. American Fisheries Society, Bethesda, Maryland.
- Davies, W. D., and W. L. Shelton. 1983. Sampling with toxicants. Pages 199-213 in L.A. Nielsen and D. L. Johnson, editors. *Fisheries techniques*. American Fisheries Society, Bethesda, Maryland.
- Degan, D. J., and Wilson, W. 1995. Comparison of four hydroacoustic frequencies of sampling pelagic fish populations in Lake Texoma. *North American Journal of Fisheries Management* 15:924-932.
- DeVries, D. R., M. J. Van Den Avyle, and E. R. Gilliland. 1995. Assessing shad abundance: electrofishing with active and passive fish collection. *North American Journal of Fisheries Management* 15:891-897.
- Hayes, D. B., C. P. Ferreri, and W. W. Taylor. 1996. Active fish capture methods. Pages 193-220 in B. R. Murphy and D. W. Willis editors. *Fisheries Techniques*. American Fisheries Society, Bethesda, Maryland.
- Hayne, D. W., G. E. Hall, and H. M. Nichols. 1967. An evaluation of rotenone sampling of fish populations in Douglas Reservoir, Tennessee. Pages 244-297 in *Reservoir Fisheries Resources Symposium*, American Fisheries Society, Southern Division, Reservoir Committee, Bethesda, Maryland.
- Henley, J. P. 1967. Evaluation of rotenone sampling with SCUBA gear. *Proceedings of the Annual Conference*

Southeastern Association of Fish and Wildlife Agencies
20:439-446.

- Jenkins, R. M. 1978. Predator-prey relationships in reservoirs. Pages 123-134 in H. Clepper, editor. Predator-prey systems in fisheries management. Sport Fishing Institute, Washington, D. C.
- Johnson, B. M., R. A. Stein, and R. F. Carline. 1988. Use of a quadrant rotenone technique and bioenergetics modeling to evaluate prey availability to stocked piscivores. Transactions of the American Fisheries Society 117:127-141.
- Ney, J. J. 1981. Evolution of forage fish management in lakes and reservoirs. Transactions of the American Fisheries Society 110:725-728.
- Nobel, R. L. 1981. Management of forage fishes in impoundments of the southern United States Transactions of the American Fisheries Society 110:738-750.
- Russell, B. C., F. H. Talbot, G. R. V. Anderson, and B. Goldman. 1978. Collection and sampling of reef fishes. Pages 329-343 in D. R. Stoddard and R. E. Johannes, eds. Coral reefs: research methods. UNESCO. Page Bros., Norwich, England.
- Siler, J. R.. 1986. Comparison of rotenone and trawling methodology for estimating threadfin shad populations. Pages 73-78 in G. E. Hall and M. J. Van Den Avyle editors. Reservoir Fisheries Management: Strategies for the 80's. Reservoir Committee, Southern Division American Fisheries Society, Bethesda, Maryland.
- Van Den Avyle, M. J., J. Boxrucker, P. Michaletz, B. Vondracek, and G. R. Ploskey. 1995. Comparison of catch rate, length distribution, and precision of six gears used to sample reservoir shad populations. North American Journal of Fisheries Management 15:940- 955.
- Van Den Avyle, M. J., G. R. Ploskey, and P. W. Bettoli. 1995. Evaluation of gill-net sampling for estimating abundance and length frequency of reservoir shad populations. North American Journal of Fisheries Management 15:898-917.

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

Changing Trophic States of Smith Mountain Lake

Benjamin Newbill

This paper will focus on the nutrient loading of Smith Mountain Lake. Smith Mountain Lake, is a typical multiple-use reservoir, created in 1963 as an 8,3000ha hydroelectric impoundment of the Roanoke River in south-central Virginia. Smith Mountain Lake has two long, narrow tributary arms, the Roanoke and Blackwater River segments, and a broad and deep lower lake extending out from the dam. Thermal stratification of the lake extends from June to October (Ney et al. 1990). The lower lake is mesotrophic with littoral areas that contain only sparse fish cover and grade steeply into profundal zones (Ney et al. 1988). The upper tributary arms, are eutrophic with expansive and vegetated littoral areas, there are a wide range

of zonation that must be managed effectively (Ney et al. 1990). This fishery was considered to be excellent until the late 1970's when it experienced a sharp decline in its sport fishery. Potential causes were investigated over a three-year period and include: (1) increased hydroelectric pumpback operations; (2) trophic interactions between native and introduced fishes; and (3) reduced nutrient loading (Ney et al. 1990).

What is eutrophication and where does it come from?

Eutrophication refers to the physical, chemical, and biological changes that take place after a lake, river, or any other body of water receives inputs of nutrients and silt from the surrounding area as a result of natural erosion and runoff over a long period of time (Miller, 1993). These nutrients come from many places. Wastes, such as raw sewage, laundry and other detergents, land development, deforestation, runoff from urban locations, practice of row-crop farming (a method of turning the land over with a plow, planting seeds in row and heavily fertilizing the seeds most of which runs off with soil erosion), and home / golf course fertilizers are all causes of eutrophication (Smith, 1992). Phosphorus and nitrogen are the main nutrient enrichers that stimulate algae and other aquatic growth. Phosphorus and nitrogen are both essential nutrients for plant and animal growth, and are the limiting factors for their growth. In the phytoplankton community, diversity decreases as lakes and rivers become more eutrophic. These eutrophic lakes and rivers tend to become dominated by one or two algal species. High phosphorus levels in a lake during the summer months are responsible for dense phytoplankton growths, which in turn may be responsible for the reduction of other organisms under the water (Welch, 1978).

How is Smith Mountain Lake affected by reduced Nutrients levels?

The correlation of standing fish stocks was highly affected with total phosphorus concentration; both declined by over 75 percent between 1975 and 1984 (Ney et al. 1990). The water quality of Smith Mountain lake is dependant on input from the upstream city of Roanoke. Smith Mountain Lake's primary production is limited by the concentrations of phosphorus in the water body (VA. State Water Control Board, 1980). The phosphorus loading to the lake has declined more than 50 percent since 1975, when a municipal advanced sewage treatment plant began operation on the Roanoke River (Obenshain and McLeod, 1981;Ney et al. 1988).

The reduction of phosphorus loading should in turn lower lake phosphorus concentrations and primary productivity, but the impact on the fishery is not as predictable (Ney et al. 1990). "Prediction is also complicated by a fertility gradient in Smith Mountain Lake. Prior to 1975, the upper tributary arms were very eutrophic, with hypolimnetic oxygen deficits that limited useable fish habitat (Benfield and Hendricks, 1975)." In these upper segments of Smith Mountain Lake nutrient loading could prove beneficial to the fishery (Ney et al. 1990). Because of the lowered amounts of nutrients in the

lake, there will also be a lowered amount of quality sized sport fish in the lake. "A reduction in nutrient concentrations will result in less algae blooms but also fewer fish, because energy flows from the bottom of the food chain to the top. (Nutrients to phytoplankton to zooplankton to planktivore fish to piscivore fish) This bottom up control of community structure can force lake users to make hard choices between clear water and good fishing (Ney, 1993).

Impacts of Excessive Nutrients on Aquatic Life

Once phosphorus and other nutrients have reached the water, it adds an excessive supply of nutrient to the water and causes explosive growth of algae and various other aquatic plants that disrupt life in the aquatic ecosystem. Phytoplankton growth will get out of control, causing masses of algal blooms to form. Blue-green algae is an algae often affected by the overabundance of phosphorus. These large algal blooms will die and settle to the bottom of the lake, where respiration and decomposition take place utilizing the dissolved oxygen. When the dissolved oxygen plummets, intolerant species of fish, such as black bass, bluegill and other game fishes decline in population size and undesirable fish will tend to thrive in these poor conditions (Smith, 1992). While some blue-green algae may indirectly impact herbivores by reducing their food resources, some also directly influence other trophic levels by the production of toxins. This toxin is produced and released by the algae upon decay (Welch, 1978). Fish kills in eutrophic waters have been attributed to "toxins as well as oxygen depletion produced by blue-green algal blooms" (Welch, 1978). While most blooms are not directly toxic to animals and fish, the fact remains that "blue-green algae common in eutrophic lakes and ponds can be toxic to other members of the aquatic and terrestrial community (Welch, 1978)." Other plant species such as submerged aquatic vegetation and rooted plants, are affected by huge concentrations of phosphates in the water as well.

One of the most affected plant groups are the submerged aquatic vegetation. Any reduction in submerged vegetation can have a detrimental effects on the aquatic ecosystems. High levels of phosphorus cause algae to explosively bloom, which in turn, block the amount of sunlight reaching the submerged aquatic vegetation and causes them to die out. With a die off of these submerged plants we can see a direct and noticeable depletion of the animals and fish that directly use the submerged aquatic vegetation. The survival of submerged aquatic vegetation depends on the amount of sunlight that reaches the plants. These "plants provide food and shelter for diverse communities of waterfowl, fish, shellfish, and invertebrates" (U.S. Fish and Wildlife Service). Submerged vegetation produces oxygen which is needed and used by aquatic organisms. The "Submerged Aquatic Vegetation" (SAV), "filter and trap sediment, which can cloud the water and bury bottom dwelling organisms like oysters" and fresh water muscles (U.S. Fish and Wildlife Service).

Other organisms use SAV's for a food source; microscopic zooplankton for example feed on the decaying SAV and, in turn are food for larger organisms, such as fish and clams (U.S. Fish and Wildlife Service). Waterfowl feed on the

seeds, tubers, and roots of SAV which are a valuable source of food for them year-round. Submerged vegetation form plant and grass beds on the bottom of rivers and lakes. Nearly every submerged aquatic vegetation bed serves as habitat for a multitude of aquatic animals (U.S. Fish and Wildlife Service). Barnacles and scallop larvae attach to the leaves and stems of SAV, fish like largemouth bass and bluegill as well as other fish live in freshwater grasses, and minnows and other small fish use SAV as a means of protection from larger fish, that might prey on them (U.S. Fish and Wildlife Service). With a reduction of submerged vegetation, fish are left in open waters that offer little or no means of protection and offers very little habitat for fish to live in. In phosphate-rich lakes some fish populations directly suffer.

For salmonids there is an initial growth and increase incidence of parasitism; after some time there are changes in distribution and spawning habits. Nearly every species of fish is effected in some form or the other. This has not been studied as much as other areas of fish management, but it is known that fish are directly affected because they live in the phosphate rich water. We do know phosphate-rich water is harmful to fish because it leads to anoxic hypolimnion and shift in species composition to warmwater tolerant fishes. Very eutrophic waters, with hypolimnetic oxygen deficits also limit usable fish habitat (Benfield and Hendricks, 1975). There is a strong relationship between phosphorus and fish biomass, as many studies have shown. "Total phosphorus concentration is regressed with total fish standing stock and against standing stock partitioned by trophic status (Yurk and Ney, 1989)." Popular sport fishes can end up with winterkill or summerkill and the lakes they live in can have a low pH if the nutrient levels are too high in that area of the lake (Hayes, Taylor, Mills, 1993).

How to Manage a Multiple-Use Reservoir

In Smith Mountain Lake there are two major groups using the lake. The fishermen and the recreational boaters, skiers, and land owners. This presents a problem, the fishermen want Smith Mountain lake to be the best sport fishing lake it can be, and the other recreational users want the water to be clean for swimming, skiing and boating. The most often recommended management areas include "species manipulation, fishing regulations, habitat enhancement and angler education (Ney et al. 1989)." There are also generic management applications for multiple use reservoirs as listed:

- **Limit annual stocking of juvenile striped bass and walleye combined to 300,000 fish.** (Moore, 1988)
- **Increase harvest of juvenile sport-fish through size limit regulations.** (Redmond, 1986).
- **Monitor summer temperature and dissolved oxygen as well as fish distribution in the tributary arms of Smith Mountain Lake.** (Ney et al. 1990)
- **Enhance fish habitat in the lower lake.** (Prince, 1976).
- **Adjust angler expectations to present reality.** (Hudgins and Davies, 1984). One of the hardest things

to get across to the fishermen is that with the lowered amounts of nutrient levels means that the fishermen must get used to lowered catch rates.

Conclusion

Smith Mountain Lake will never be the way it was in the early 1970's, because of the reduction of nutrients via the Roanoke sewage treatment plant. Now that this is known we have to manage the fishery with nutrients at the levels they are now. Smith Mountain Lake can be a great fishery, and is. If we can raise the striper populations just a little, keep the black bass populations the way they are now and have fairly clear water, then the management of Smith Mountain Lake would be simple. The problem is that a lake is a living growth aquatic system, that has to be managed season to season, and year to year. The lake is ever changing and so to must the management techniques.

References

- Benfield, E.F. and A.C. Hendricks. 1975. Eutrophic gradient in Smith Mountain Lake, Virginia. VA. J. Sci. 26:20-26.
- Davies, W.D. and W.L. Shelton. 1993. Sampling with toxicants. 199-214 in L.A. Nielson and D.L. Johnson, eds. Fisheries Techniques. Am. Fish Soc. Bethesda, MD.
- Hudgins, M.D. and W.D. Davies. 1984. Probability angling: A recreational fishery management strategy. N. Am. J. Fish. Manage. 4(4a):431-39.
- Ney et al. 1990. Factors Affecting the sport fishery in a Multiple-use Virginia Reservoir. 6(1):21-32 North American Lake Management Society.
- Lake and Reservoir Management. 1989. Phosphorus-Fish community Biomass Relationships in Southern Appalachian Reservoirs: Can Lakes be too Clean for Fish? 5(2): 83-90 North American Lake Management Society.
- Li, Hiram W. and Peter B. Moyle. "Natural Lakes and Large Impoundments." Inland Fisheries Management in North America. Ed. D.B. Hayes, W.W. Taylor, and E.L. Mills. Bethesda: American Fisheries Society, 1993. pp. 505-506.
- Miller, Tyler. 1993. Environmental Science. Fourth edition, Wadsworth Publishing Company. Belmont California. pp.100-101
- Moore, C.M. 1988. Food Habits, Population Dynamics, and Bioenergetics of four Predatory Fish Species in Smith Mountain Lake, VA. Ph.D. diss. Virginia Polytech. Inst. State Univ. Blacksburg.
- Ney, J.J. 1993. Top-Down Management of Water Quality: Clean Lakes Plus Better Fishing? Virginia Lakes Association. Chp.4 16- 17.
- Ney, J.J. et al. 1988. The Smith Mountain Lake Fishery: Factors Affecting Major Sport and Forage Fish Populations. Dep. Fish. Wildl. Sci., Virginia Polytech. Inst. State Univ. Blacksburg.
- Obenshain, N.A. and D.M. McLeod. 1981. Phosphorus control in the Smith Mountain Lake Drainage Basin. Spec. Rep. Va. Water Control Board, Richmond.
- Prince, E.D. 1976. The Biological Effects of Artificial Reefs in Smith Mountain Lake, Va. Ph.D. diss. Virginia Polytech. Inst. State Univ. Blacksburg.
- Redmond, L.C. 1986. The History and Development of Warmwater Fish Harvest Regulations. pp. 186-195 in G.E. Hall and M.J. Van Den Aayle, eds. Reservoir Fisheries Management: Strategies for the 80's. Am. Fish. Soc. Bethesda, MD.
- Smith, R.L. 1992. Elements of Ecology. Third edition. Harper Collins Publishers Inc. New York, NY, USA. pp. 538-541.
- U.S. Fish and Wildlife Service. "Where Have All the Grasses Gone." <http://www.fws.gov/~cep/cbsav.htm/>
- Virginia State Water Control Board. 1980. The Impact of Nonpoint Sources on the Water Quality of Smith Mountain Lake. Plan. Bull. 326.
- Welch, Justine. 1978. The Impact of Inorganic Phosphates in the Environment. U.S. Environmental Protection Agency. Washington, D.C. pp. 12-19.
- Yurk, J.J. and J.J. Ney. 1989. Phosphorus-Fish Community Biomass Relationships in Southern Appalachian Reservoirs: "Can Lakes be too Clean for Fish?" Lake Reserv. Manage. 5(2):83-90.

Lessons Learned in Lab

How to Let Learning Get Out of Your Control Donald Orth

I never really thought of it as role-playing, but that's what my students have been doing each semester in Fisheries Management. The final major class activity is a mock public meeting. Why? It's stressful for both students and for me, it takes careful planning weeks months in advance, the outcome is unpredictable, public involvement is a messy topic, and it's only one meeting. How much can students learn? Students are each assigned to study one stakeholder or player in a case study of a real fishery. One case study is emphasized throughout the semester so the students are familiarized with the management issues. This year we focused on Smith Mountain Lake fisheries and there are many difficult dilemmas that have yet to be resolved. Fishing just ain't like it used to be and only some of the reasons are clear. Phosphorus loading is down, recreational boating is up, angling pressure is up. The striper club wants the game department to stock more stripers, black bass anglers are suspicious about claims that hungry striped bass won't eat the black bass, VT researchers say more study is needed, recreational boaters want the lake to themselves, and everyone is concerned about safety but no one knows what to do. The one thing that is clear is that everyone has a position on some issue. Fisheries management is all about imposing some orderly process on top of apparent chaos. How else

would I create a laboratory exercise to demonstrate the principles of fisheries management? I don't know what else to do so I have used this approach annually since 1981. I've learned a few tricks that help to make the mock public meeting resemble the real thing. First, I invite the public. Sometimes no one shows -- that's reality. Sometimes the dispossessed, misinformed, and disgruntled anglers show up -- they help to gauge how the public servant reacts to verbal abuse? Second, I give students names and phone numbers of real people in positions they are to represent. During a few minutes of phone conversation students can learn to talk like a bureaucrat or spout off like a radical environmentalist. Third, students are all equally prepared to discuss issues because they develop a strategic plan that is the focus of the public meeting. Do students complain? Always! this is a difficult assignment and they are dismayed that the members of the invited public are able to be unreasonable and present indefensible positions or misinformation. Welcome to the real world!

Fisheries Management Plan for Smith Mountain Lake *VT Fisheries Management Class - Spring 1997* *Mock Public Meeting Exercise*

Mission Statement - VDGIF

- To manage Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth
- To provide opportunity for all to enjoy wildlife, inland fish, boating, and related outdoor recreation
- To promote safety for persons and property in connection with boating, hunting and fishing

Background

Smith Mountain Lake is a 8,300 hectare hydroelectric impoundment of the Roanoke River. Fertility declines from upper arms to the lower lake as nutrients are removed. Gizzard shad and alewife dominate the forage base and largemouth bass, smallmouth bass, and stocked striped bass are targeted sport fish. A sewage treatment upgrade in the mid 1970s significantly reduced phosphorous loading to the Roanoke arm and resulted in declines of standing stocks of fish.

Today's Situation - Striped Bass

- Catch rates for striped bass are reduced from levels observed in the 1970s
- Trophy catches are declining
- Striped bass are believed to be more difficult to catch than in the past
- Catch rates of striped bass, while down from peak levels, are still considered good when compared to other striped bass fisheries.
- Recruitment of striped bass (from stocking) is relatively stable
- Citation for trophy size (20+ pounds) peaked in 90-92 and have recently declined.
- Decline in striped bass catch rates are correlated with several factors, including:
 - 1. increasing fishing pressure and harvest

- 2. decline in lake productivity (phosphorous loading)
- 3. increased recreational boat traffic
- 4. reduced fingerling stocking rate

Black Bass Situation

Black bass catch rates and average size have increased dramatically since 1982 (approximately 1/3 of catchable largemouth bass are >15 inches). Improvements in black bass fishery are believed to be related to:

- 1. catch-and-release fishing
- 2. stable forage base since 1982
- 3. reduced striped bass population

Goal and Objectives - Fishing

- To maintain the quality largemouth bass fishing at current levels, and increase trophy striped bass catches
- To reduce fishing mortality of striped bass by 25% by the year 2000.
- To increase trophy citation numbers of striped bass back to peak levels by the year 2006.
- To reduce catch and release mortality of striped bass by 15% by the year 2000.
- Maintain current catch rates of black basses.

Available Options-Fishing

- Create a lottery permit system that will limit the striped bass fishing pressure.
- Make a new regulation that makes culling illegal.
- Encourage voluntary "no culling"
- Switch to more aggressive education campaigns to decrease catch and release mortality.

Goal and Objectives - Safety

To promote public safety on and around Smith Mountain Lake for all watercraft users.

- To increase the cost of fines by 50% for boating violations by the summer of 1998.
- Reduce boating accidents.

Available Options - Safety

- Segregate recreational uses into specific areas for different types of boating, fishing, and swimming by the year 1998 to reduce incidence of boating accidents.
- Implement a size limit on the motor allowed on the lake by the year 1998.
- Post weather advisories and warnings about lake conditions to inform users of potential hazards on the lake immediately

Goal and Objectives - Aesthetics

To improve and maintain positive aesthetic qualities of the lake environment.

- To reduce trash and debris by 90% of their present level in 5 years.

Available options - Aesthetics

- Develop a comprehensive clean-up operation to patrol the shoreline and surface waters collecting and removing trash and debris.

Goal - Communication

To promote an environment conducive to communication between user groups and fisheries managers in order to create safe and aesthetically pleasing outdoor experiences.

Objectives - Communications

- Provide a medium to inform management of public concerns.

■ Inform the public of current events and issues concerning condition of Smith Mountain Lake.

■ Increase public participation in management actions.

Available Options - Communication

■ Place a suggestion/concern box at all major entrances of Smith Mountain Lake.

■ Provide an optional user survey to monitor usage of the lake's resources.

■ Conduct annual meetings discussing current issues between user groups based on collected concerns.

■ Publish and provide a calendar of events and newsletter.

■ Publish projects conducted on the lake by fishery managers offering positions available for public volunteers.

Goal and Objectives - Habitat

To provide and maintain optimal habitat for the enhancement of the resident fish fauna.

■ Maintain catch rates of blackbass and panfish through the year 2000..

■ Decrease mortality on striped bass fingerlings by the summer of 1998.

Available Options-Habitat

■ Provide suitable habitat for blackbass and panfish by adding different forms of submerged vegetation (i.e. christmas trees, tires, etc.)

■ Provide manmade structures that will provide for protection for striped bass fingerlings.

Recommendations as of Today

■ Seek Public Input on Strategies

■ Propose New or Revised Strategies

■ Budget for New Projects

■ Prepare Proposals for Regulations

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

Manager Viewpoints

Overview of Mock Public Meeting Eric M Brittle

I thoroughly enjoyed being the head regional biologist in charge of the Smith Mountain Lake Striped Bass study. I would not have traded to get the biologist's position if I did not feel I could do a good job. I learned more about the striped bass situation than in any classroom exercise. I really enjoyed reading all of the literature surrounding the situation. During the mock public meeting, I gained great respect for the "abuse" that a biologist can come under when trying to introduce plans and changes on such a hot topic. Dealing with irate individuals comes with the job and I believe that those 90 minutes in front of the stakeholders prepared me greatly for what I hope will come to me in my career. Talking with Mike Duvall (District Manager) gave me much insight on what to expect and he gave me some ideas on how they are handling the situation at hand. The papers that I read gave me a good background on which to base some of ideas behind our management objectives and

strategies. I enjoyed this exercise greatly and I suggest it every year in management.

Assistant District Biologist Kirk Rundle

Managing a multiple-use reservoir such as Smith Mountain Lake is no easy task. However, that was my role as the Assistant District Fisheries Biologist in a recent mock public meeting held by the fisheries management class here at Virginia Tech. I will admit that I was very nervous at first, yet things went very smoothly and I am glad that I played the role I did. The experience was very practical, realistic, and helpful. I worked along with the District Fisheries Manager, who was in charge of managing the striped bass and black bass at Smith Mountain Lake. I was in charge of crappie, catfish, and bluegill, yet collaborated with the manager on all projects. Therefore, we split the work load equally and prepared a brief introduction to Smith Mountain Lake along with our current goals, objectives, and strategies for meeting the many demands of the various stakeholders. Stakeholder interests included: fishing, habitat, safety, and communication.

Our goals for each stakeholder interest were tied in closely to the broad mission statement of the Virginia Department of Game and Inland Fisheries. The objectives narrowed the goals down to a measurable characteristic to be completed within a set time-frame. And our strategies indicated specific ways of obtaining our objectives. After giving a brief overview of the situation at Smith Mountain Lake, the manager and myself were responsible for answering the various questions of the stakeholders and keeping the meeting flowing in a timely manner. To provide a fair opportunity for all to express their opinion, we had a list of stakeholders and each one was given a guaranteed amount of time to voice his or her concern. However, we wanted to have a non-formal atmosphere and encouraged stakeholders to speak their mind whenever they felt there was a point to be made.

As the District Fisheries Manager and myself expected, the stakeholders care very much about their own interests and were more than willing to share their viewpoints. While many issues were addressed, the majority of the time was spent discussing the fishing situation at Smith Mountain Lake. And as expected the majority of questions were concerning the striped bass and largemouth bass fishing at Smith Mountain Lake.

Both species of fish were discussed in great detail. The striped bass anglers thought fishing was not as good as it used to be, while the largemouth bass anglers thought too much attention was given to the striped bass. I believe that the manager and myself did an effective job of convincing all groups that we have created a balanced fishery at Smith Mountain Lake. We are concerned about all species in the lake and want to maintain the balance that exists. The meeting was very educational for all of us involved, even that goofy fellow!

Stakeholders Viewpoints

Smith Mountain Lake Chamber Partnership Mike Shaver

The business community around Smith Mountain Lake is as diverse as its recreational opportunities. My organization, the Smith Mountain Lake Chamber Partnership, is a support group for this diverse community. Our goal is to promote and protect business and tourism opportunities on and around Smith Mountain lake. The management plan presented by the Virginia Department of Game and Inland Fisheries (VDGIF) on April 28 was a start in the right direction. However, there are some changes the Partnership would like to see implemented to ensure the business community is represented in the management plan.

On average, an angler on Smith Mountain Lake spends \$150 per day. This represents the largest industry in the area. Proposed restrictions and reductions of fishing pressure on Smith Mountain Lake will severely harm the businesses which support this industry: bait shops, guides, boat rentals and sales, restaurants and hotels.

Instead of restricting access to the existing fishery, we propose the VDGIF improve the striped bass hatchery and increase the number of fingerlings stocked per year to enhance the existing fishery. The main thrust of the proposed plan is to minimize mortality of stocked fish. Stocking larger, more robust fish from the beginning will ensure stronger year classes and reduced mortality.

Safety is an important issue on Smith Mountain Lake. However, the plan proposes regulations that will not effectively increase safety on the lake. On the contrary, the regulations will make the lake less user-friendly. Segregation of user groups does not promote an inviting environment. When a person visits from out of state and rents a condo, they do not want to have to travel to the other side of the lake to enjoy their type of recreation. The potential for conflict between users increases because users will resist the segregation, feeling other groups received better resources.

A horsepower restriction on boat motors will send boaters to other reservoirs faster than the largest outboard motor. A large motor does not automatically make a person irresponsible. Therefore, we support the establishment of a licensing procedure for boats and boaters. If a boat displays a Smith Mountain Lake safety decal, it will not have to be spot checked while on the lake. This will make the users experience more enjoyable by not being hassled by law enforcement while on the lake. Requiring boaters to take a boat safety and operation test, the agency will increase the amount of responsible boaters on the lake.

The aesthetics of the lake are very important to visitors and business owners. A clean-up project already exists and will take place on May 10. However, a once a year project is not sufficient to keep the lake clean. We propose a quarterly clean-up project carried out by volunteers from the local business community and homeowners in the area. For this project to be successful, the VDGIF must provide the initial

effort organizing volunteers who will then take over the project and report back to the VDGIF on progress.

The most important issue in the proposed management plan is communication. Issues pertaining to Smith Mountain Lake cannot be resolved without communication between managers and users, as well as, between the users themselves. The creation of an 800 number for people to call and give their opinion immediately increases the effectiveness of the suggestion box proposal. This will give the user a greater sense of participation. Meetings to discuss issues should be a bi-annual event, before and after the season, to gauge changes in the issues over the season. Publication costs associated with the calendar and newsletter can be reduced by including them in the Smith Mountain Lake Eagle, a local newspaper. Out of state users can be contacted by direct mailing.

The habitat concerns addressed in the proposal enhance the fishery and therefore are directly in line with our concerns.

The Smith Mountain Lake fishery supports the largest industry in the area. Management goals should focus on enhancing, not restricting the fishery. This will provide an inviting, user-friendly environment for people around the country to visit. The Smith Mountain Lake Chamber Partnership appreciates the VDGIF efforts and the opportunity to contribute to the management process.

Striped Bass Guide, Mr. I.B. Fischen Jason Burton

Smith Mountain Lake is a huge reservoir which contributes to the best inland striper fishery on the east coast. This fishery generates millions of dollars for the state, and provides jobs for the public. One such individual is myself, Mr. I.B. Fischen. I am a well known striped bass guide on Smith Mountain Lake. All of my annual income comes from my guide service. My business began in the 1970's. Clients came from all around to fish with me for a chance to land a huge, aggressive, striped bass. As more and more clients came, income increased greatly. The more money I made the more equipment and assets I accumulated. This led to more bills which I am required to pay. In the last seven to eight years I have managed to divorce three times and have eleven children to whom I have to pay alimony and child support. Since 1990, business has decreased due to the decrease in striped bass catch rates and trophy size. Somehow I have managed to squeak by paying bills, alimony and child support. A rumor that the VDGIF is planning on closing down the striped bass fishery has caused much concern with my well-being. Striped bass are my sole income and the only thing I really know how to do is fish for them. Closing down the fishery, even for a day, would cause me to go bankrupt.

Black bass fishing is great. I see all these tournaments going on and big black bass being caught. Those greedy S.O.B.'s (black bass anglers) still want more when there black bass catch rates have increased since 1982. The number of black bass anglers far outnumber the striper anglers. The black bass angler must be pressuring the biologist into doing what they want, well I am not going to take it. That Mike Duval comes up with crap like hooking mortality of striped

bass. I know when I catch fish and release stripers (all year around), they swim right off without any sign of being hurt. Duval says to us striped bass guides and anglers, "After you catch your two fish striped bass limit, why don't you just go after other species?" WHAT? I have a striped bass guide service! My clients want to catch striped bass, that is what they pay me to help them do. Besides, my boats is only rigged for stripers anyway.

Mike Duval and his biologist seem as though they want us striped bass fisherman to stop fishing. YEAH RIGHT! May be if Mr. Duval and his biologist would have done their job right and not screwed up the fishery, I would not be in the low income situation I am in now.

Being the striped bass know it all that I am, I think the biologist should implement a special permit system to fish for striped bass. Guides should be guaranteed special permits which give us the right to take whoever we want out to catch stripers without the clients having to buy or be selected for a permit. Guides should also be exempt from any type of motor or boat restrictions. We have a business to run! I hope Mike Duval and his biologist can get striped bass catch rates and trophy sizes back up to what they used to be, or I might not be able to keep paying all this child support and alimony.

Power Company Viewpoint Brett Coakley

Smith Mountain Lake (SML) was created by American Electric Power Company (AEP) to create electric power, control flooding and to make a new multi-recreational area for The Commonwealth. SML is a large impoundment, its current surface area encompasses about 8,300 hectares. Since the lake is so large, it was envisioned to provide a abundance of opportunities for outdoor recreational users. Lately, SML has experienced a substantial increase in the numbers and diversity of its users. At AEP, we recognize that we are not the correct group to manage the variety of resources that SML provides. When the lake was created, it was decided that VDGIF was going to ultimately decide how to manage the lake.

With the current changes in the needs of the lake, we have done our best to assist VDGIF with any problems that occur. In past years, we had water fluctuations that were adversely affecting boaters and fish populations. We then manipulated our generating schedule to reduce the fluctuation to an average of 1.8 feet. In addition to adjusting the water schedules, we have funded various scientific studies to assure that we are providing the best electric service possible without harming the lake's ecosystem.

As stated earlier, AEP is a neutral group; we cannot take a stand on either side of the arguments on the fisheries and boating management of SML. Recent studies done by VDGIF and Virginia Tech have shown that we are not a significant factor in many of the current fisheries issues. The only thing we can do is cooperate with VDGIF in any way possible to help them with issues where we are directly involved.

Striped Bass Angler Ryan Cool

I am a long-time striped bass fisherman who has seen the decline in trophy size stripers over the years. I want to see the lake go back to the 1970's level of producing a good number of big stripers. I think the problem is that the VDGIF isn't stocking enough stripers each year. I know that the VDGIF doesn't think that there are bait fish in the lake to support higher numbers of stripers, but there are plenty of them. Every night I go out fishing, I see tons of them swimming right up on the surface. There are also an extremely high number of anglers on the lake targeting striped bass. It seems like everyone has figured out how to catch them, and you can bet that if that fish is above the minimum size limit, their going to keep it. That is why they need to stock the stripers as we catch them. For every fish that an angler keeps, they should stock one in its place.

I was out in a thunderstorm just the other night with lightning out on the horizon and I counted at least seventy other boats in the cove I was fishing. They need to take the popularity off of our lake and point it over to Claytor Lake. If these people want to catch alot of keeper size stripers, they need to go to Claytor. Smith Mountain Lake is a trophy striper lake and if everyone keeps taking out the fish when they become 18 inches, we will never catch a trophy. The officials need to raise the minimum size limit to around 23-25 inches for Smith Mountain Lake so the fish can get bigger. This will help to get some of the fishermen over to Claytor Lake where they can keep 18 inchers.

I spoke my opinion at the public meeting and I think the officials got the point. They just like to talk about statistics and how they are doing every thing they can to make the lake better. I think the lake would be better if they would just stock more fish and keep some of the people off of the lake. I just want the lake to go back to the way it used to be so I can caught some trophy size striped bass.

The Black Bass Angler Blake Davis

I am a well know local bass fisherman from the Smith Mountain Lake region. I enjoy fishing for smallmouth and largemouth bass, specifically in Smith Mountain Lake. Since the 1970s, there has been a substantial change in the local black bass fishery. Fishing has been great and I'd like it to stay that way. I had two basic concerns going into the Smith Mountain Lake Public meeting: reduction of my black bass fishery and the lobbying for unreasonable restrictions on boat speed and noise restrictions. I don't like the idea that people want me to obtain a mandatory license to operate my boat. The way I see it, I'm not the problem, it's the drunks and those jet skiers that zip around on the lake without regard for safety.

The black bass fishery at Smith Mountain Lake is very satisfying to me. I have enjoyed many hours relaxing and fishing. When I found out this meeting was to discuss increasing the striped bass fishing, I was disappointed. The fisheries biologists and managers can't give me or anyone

else a sound guarantee that an increase in striped populations will not affect my black bass fishing. In their goals and objectives, they state that they want to maintain the quality of the black bass population but if they increase the populations of stripers, can they do that? That's the answer I wanted but to my disappointment Mr. Duvall and the assistant district biologist couldn't give me any guarantees because they don't have "substantial evidence to prove stripers affect black bass populations". They say the stripers don't occupy the same habitat as the black bass but my question is "why did the black bass populations increase when the striped populations decreased?"

I have also been a boater on Smith Mountain Lake. I abide by all the laws and have all my safety equipment on my boat at all times. I am a safe and considerate boater and don't see any reason for mandatory licenses for boaters that are safe. I am not the one causing the problems. The crazy, drunk recreational users are the ones messing things up for everybody. They have the home owners in an uproar, other anglers are angry, and I for one am fed up with the thought of spending more money to get licensed to use this resource. I have been using the lake for over 20 years now and I see no need in this unfair and biased restriction. At the public meeting, I heard a suggestion for boater safety education. This seems to be a simple solution: educate the uneducated and the few bad apples that are left will be easier to manage. I believe that there are people who don't know what they are doing and a free boater education class would be ideal for teaching them. This would reduce accidents but it will not solve the problem of those inconsiderate users. This will reduce them to the point where the stressed wardens can focus on the job of enforcing fishing regulations as opposed to being traffic cops. Volunteers with safe boating experience, such as myself, can assist in these classes. It is a first step and if it doesn't work, then impose the mandatory license and I'll be the first in line to buy it. All I am saying is: it costs enough to fish down there already, don't just charge us whenever there is a problem because there may be other solutions.

In conclusion, I am all for the volunteer boater safety course. As for the black bass fishing, I hope these biologists do get "substantial evidence to prove stripers affect black bass populations" before they decide to increase the stripers. I would sure hate to lose this excellent fishery because of the striped fisherman.

Crappie Fisherman, Ben Ketchinem Greg Hylton

I have recently been a participant in a public meeting that informed me about the intentions of the VDGIF and their upcoming management plan for Smith Mountain Lake. The District Fisheries Manager was very adequate in explaining the intentions of the plan, and his lack of concern for my needs. I do understand that the plan is incomplete and will be revised for final approval, but I don't believe that my concerns were taken into account.

The management plan that the VDGIF presented was quite sufficient in many areas. They have increased communication

as a major goal, habitat improvements as a major goal, and a goal to improve the aesthetics of the lake. All of these goals were presented well and appeared well thought out with sufficient strategies for success. I did not, however, agree with, or appreciate, their plan for handling the fish in the lake. It appears that all they are worried about is how the striped or black bass are doing. I want to know when they are going to start worrying about the other fish in the lake, Crappie in particular. I have been a crappie fishermen for many years and have seen the decline in their abundance. I have voiced my opinion in all of their past public meetings and still have yet to see any actions toward improvements. The reason may be that I am not a part of the Striper Clubs or Bass Clubs in the area.

I believe that the process is the problem. I don't think that the public meetings are working. Maybe there is room for a public meeting every now and then, but it cannot be their only means of communication. I can only hope that their communication goals and objectives were sincere and will be achieved. Then, the VGDIF might hear me and look into the decline of the crappie population.

Tackle Shop Owner, Sam Rapala Troy Thompson

My name is Sam Rapala (no relation) and I own a tackle shop in the Penhook community on the southern side of Smith Mountain Lake. The shop was started by my father in the sixties, so I have customers that have been coming here since I was a little boy. Because of the reputation that the lake has for great fishing, I do more and more business every year. My shop is the local hangout for striped guides and fishermen and the last three 30+ pound stripers were caught on my handmade Super Striper Slammer jig. But, the guides have been saying that the stripers are becoming harder to catch. They think that there is less of them than there was five or six years ago. A lot of them are saying that food is not the problem, because they can go out with a throw net and catch all of the shad that they want. Some people think that the largemouth are outcompeting the stripers. I think the problem is that most people release the bass that they catch and keep the stripers. When it comes to the fishing for bass and panfish, you all must be doing something right, because I hardly ever hear any complaints.

Looking at your proposals, I agree with most of them, because they are all there to maintain and improve the fishing overall experience here. The only problem seems to be with the stripers. I like the option that would make culling illegal. Although this would be hard to enforce, most people would probably do it voluntarily if they realized how important it is. On the other hand, I don't agree with the option that would limit fishing by selling lottery permits. This would hurt the local economy because less fishermen would come to the lake. They would simply take their money somewhere else. I thought the reason you stocked in the first place was to bring in more fishermen. A better option would be to outlaw bait fishing, because the stripers can swallow the hook and die if released. They only get lip-hooked with jigs, so the stripers wouldn't die if you threw them back. This would also be

much easier to enforce than the culling option. If you want to discuss this personally, I can be reached anytime at 1-800-STRIPER.

**Black Bass Fishing Guide, Bobby Joe
"Skeeter" Williams
Brian Watson**

Hello good folks. My name is Bobby Joe "Skeeter" Williams and I am a professional black bass fishing guide. I have been a guide within southwest Virginia for the past 20 years, with most of my focus centered on Smith Mountain Lake. Don't get me wrong, the black bass fishery in southwest Virginia is very strong as a whole but the best fishing occurs within Smith Mountain Lake. Recently the Virginia Department of Game and Inland Fisheries (VDGIF) put together and proposed a fisheries management plan for Smith Mountain Lake in response to the apparent decline in striped bass catch rates and trophy citations. After reviewing the plan and attending the public meeting, I have serious reservations about what VDGIF is planning for Smith Mountain Lake. Not all parts of the plan are bad, matter of fact I strongly agree with some of them. However, I believe my livelihood could be threatened by the proposed fishing objectives and goals.

After initially reviewing the fisheries management plan, I was for the most part in full agreement with three of the five areas that VDGIF targeted for improvement. I like the idea that communication between user groups and fisheries managers will be enhanced in an attempt to create a more safe and aesthetically pleasing experience on the lake. It's about time that the VDGIF personnel listens to all the users of Smith Mountain Lake instead of just the most vocal and influential groups. I also like the idea of improving the aesthetics and safety of the lake. Too many times over the past few years I have had to abandon what used to be great fishing holes because of trash and debris on the surface water. This same trash and debris has also caused numerous dents and scratches in my boat as I travel to and from fishing sites, costing me hard earned money to get it fixed. Trying to remove 90% of this trash and debris through paid and volunteer efforts should at least solve some of the problems that I have encountered. Then you have those reckless jet skiers and "party" boaters who think they own the entire lake and can act any way they see fit. It's about time that VDGIF gets tough with these people and increases the cost of fines by 50% as proposed. If this action doesn't curb some of these folks reckless behavior then I would be in full support of requiring a license for all watercraft.

The parts of the proposed plan that I have the most problems with is the fishing goals and objectives and the actual safety options that VDGIF recommends as solutions to the current problems. Beginning with the fishing goals and objectives, VDGIF states that the largemouth bass fishing would be maintained at current levels but they gave no strategies on how they plan to achieve this goal. Instead, the fishing goals and objectives are dominated by the needs and concerns of the striped bass anglers. If striped bass anglers get their way and catch rates increase, the bass fishing might

suffer since the correlation between decreased striped bass catch rates and increased bass catch rates has never been conclusively refuted. As far as the safety options are concerned, I cannot believe that VDGIF would even suggest placing a horse power limit on boat motors. Part of my operation includes getting my customers to the appropriate sites as quickly and safely as I can. A size restriction on motors will prevent me from carrying out this practice. I believe the safety focus should be directed more at educating people about proper boating procedures.

I also disagree with the methods by which VDGIF wants to create habitat for the resident fish fauna. Instead of using the aesthetically displeasing woody debris that is floating on Smith Mountain Lake, tires and Christmas trees are the planned structures that will serve as new habitat. At this point I would be curious to know if there is an actual habitat problem or if VDGIF is just trying to appease the striped bass anglers by creating more habitat for young striped bass to forage and avoid predation.

At the meeting, my worst fears were confirmed. The striped bass contingent was getting the majority of the attention from VDGIF biologists while the future status of bass fishing seemed to be ignored since it is in good condition at the present time. When I challenged the biologists on the fact that their proposal catered to the striped bass anglers and no specific objectives were listed as to how bass fishing would be maintained at current levels, the response was that in fact specific objectives were listed for the bass fishery even though the biologists could not give me any legitimate reasons. They stated that catch and release mortality would be targeted for reduction and culling would be discouraged. However, these two problems are more common for striped bass anglers than bass anglers once again indicating to me that VDGIF is catering to the striped bass anglers. The biologists also stated that licenses might be limited for all anglers on Smith Mountain Lake, even though there is no problem with catch rates for us anglers who fish exclusively for bass. This action is targeted at increasing the number of striped bass within Smith Mountain Lake but it does not take into consideration the fact that the bass populations are stable and abundant and many guides depend on these populations to make a living.

When questioned about why artificial structures were going to be used in habitat enhancement and why motor size might be limited, the biologists struggled to support either issue. The question was raised as to why tires and Christmas trees were going to be used instead of natural structures like large woody debris and the biologists answer was that it had been used in the past and that it was easy. Then the issue of whether or not habitat enhancement was even necessary was raised. The biologists had no supporting data to show that habitat enhancement was necessary and once again it seemed like they were catering to the wishes of the striped bass anglers. When asked why boater safety and other educational courses were not considered before limiting motor size, the biologists gave me the impression that this idea was not seriously considered. Instead they wanted to impose their regulations upon the users of Smith Mountain Lake without trying voluntary methods first.

Overall, I think VDGIF needs to seriously reconsider some of their goals and objectives for Smith Mountain Lake. The emphasis seems to be on restoring the striped bass fishery to peak levels even though the lake is nationally one of the top ten striped bass fisheries. If the striped bass fishery is restored to peak levels, VDGIF biologists have no idea what the implications on the bass fishery will be. How can I, a bass fishing guide, agree with a fisheries plan that has not devoted the proper attention to the fish that supports me. I also think that VDGIF should consider more voluntary ways to make Smith Mountain Lake a safer place. Placing regulations like motor size limits and licenses for all users of the lake should be the last actions taken and not the first as VDGIF has proposed. Unless a more encompassing and less restrictive plan is offered as an alternative to this plan, I would urge all bass anglers and recreational users of the lake to show their disapproval for the current plan.

**Black Bass Anglers Association
(B.A.S.S.)
Powell Wheeler**

This lake once housed a truly epic striped bass fishery. But that lake no longer exists. Over twenty years ago, an upgraded sewage treatment plant has resulted in less waste entering the lake. As a result, the striper population has crashed.

However, in recent years, Smith Mountain Lake has become an incredibly good black bass impoundment, and one of the reasons for this has been the lower striped bass abundance. Over one third of all catchable bass in the impoundment are over 15 inches long. This exceptional bass fishing attracts many tournaments, both on the regional and national levels. The regional tournaments alone bring thousands of dollars into the local economy and the national competitions provide national advertisement that becomes millions to the local economy.

But all we hear is the constant whining of the striper fishermen..."there's not enough fish...we can't catch any fish"...etc. et. etc. However, the truth they overlook is this is essentially a different lake than it was two decades ago. Eutrophically, it cannot support the old striper fishery. Even with the abundance crash, this lake remains on of the most productive striper fisheries in the country, but they still complain.

So how does it help us to join the side that is slaughtered? Why do we waste all our time and limited resources trying to make this lake do something it simply cannot? Let's invest some more time and effort into improving the bass fishing. Let the lake do what it does best.

**Smith Mountain Lake Association
Michelle Steg**

I speak on behalf of all residents of Smith Mountain Lake, and in particular on behalf of the members of the Smith Mountain Lake Association. Many of us have worked long and hard to build our dream houses along the lake, and we chose this location for many reasons. For a place to relax, a

place for recreation, a place to enjoy time with our families, for fishing, and for a place to get away from it all. Over the past number of years we have seen the quality of life around the lake deteriorate. It is no longer as safe and enjoyable as it once was. The lake is crowded with speeding, reckless watercraft. Sitting in our back yards, we are unable to have a peaceful evening meal due to the roaring boat motors, that continue well into the night. I feel that "recreation" has gotten out of hand on the lake, and it has compromised the quality of life that us homeowners have worked so hard to achieve. We live here, we're not just passing through, and we want our neighborhood to be safe and pleasant.

I understand that this lake is a shared resource, and we are all more than happy to share it, but in order to maintain the quality and safety of the resource we feel that some adjustments to regulations need to be made. We are not taking issue with the situation of the lake fishery, and leave that to the fishery managers and anglers. Our primary concern is with safety. We feel that there should be legislation passed mandating the licensing of watercraft operators. Boats are just as dangerous as cars and should be treated with similar caution and respect. We support a statewide maximum speed limit. The actions of reckless boaters should not have to endanger the lives of others. We support a noise restriction for boat motors. Noise carries very well over the lake, and the noise is compromising the quality of the environment for residents as well as for visitors and wildlife. Finally, we support generally tightened laws for personal watercraft. Presently it seems that people can behave however they like out on the lake, and it is endangering the lives of others and the quality of the lake experience. We appreciate the opportunity to have our desires heard in the public meeting forum, and hope that they will be taken into account during the Smith Mountain Lake management decision making process.

**Marina Owner, Carly Boatslip
Ashley Kinney**

I am Ms. Carly Boatslip, owner of the Drift Inn Marina. I would like to thank you for the opportunity to speak with you today. I am sure you all know how important my restaurant is to this community. My girls at the Drift Inn Marina work hard to assure that you get the best BBQ and service available. I work hard to provide you with the most up-to-date fishing conditions, including all the gossip on which fish are biting what and where. I have accrued quite a number of regular guests who are dependent on my marina for an enjoyable lunch or dinner after an enjoyable day.

I work closely with you boys at V-D-G-I-F (pronounced very slowly and deliberately), to assure that my info is accurate. I am not here to mislead any of my guests, therefore it is pertinent that you do your part to be honest with me. Lately, I have been a bit concerned with the water level fluctuations implemented by the power company. Now they claim that there is only a 1.8 ft/day change, but I am quite sure that this is a very exaggerated average. Now I am not here to complain about the depth in the fluctuations, but I

do believe that they have been increasingly lower. My marina is set up to accommodate certain levels, but my guests are becoming oh so wary of the safety of their boats. Why just the other day, one fine fellow who has been coming here since we opened, came to me to inquiry about a fresh abrasion which had occurred on his boat while he was having his daily leisurely dinner at the bar. It was apparent that it had occurred when the water level dropped.

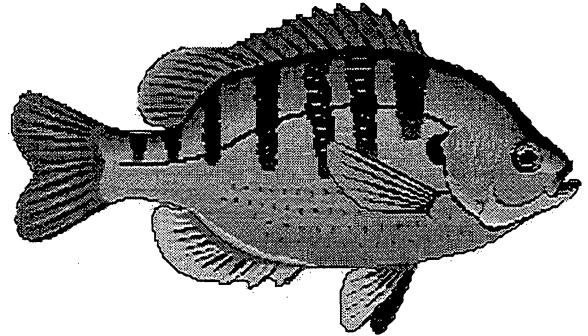
If at all possible, I would like you to request a schedule from the electric company warning boaters of their "high" and "low" fluctuations. If I can provide my guests with the best times to come into my restaurant (with minimal to no damages done on their boats from bashing into the pilings) compliments of you, then they are more apt to provide you with the cooperation you are looking for when you develop regulations. I can be a positive link for you if you work with me. Why, just earlier, one of my finest customers came to me and said that he will be willing to run a boat safety course and provide the boats if people are willing to come. Now that is right nice of our dear fellow. He understands what it takes to keep himself, a safe boat driver, from being punished due to a few careless derelicts. We both agreed to work together to solicit support from the users of Smith Mountain Lake. I, of course, am providing the marina space for his needs. This is a service that can help all of us on the lake. It will also help to lighten the public pressure from your backs concerning reckless boaters. Another thing, I ask is that you keep me updated on fish abundances and the results of your studies. I want more boaters to come in and feel comfortable with the idea of catching healthy fish. It breaks my heart to see the boys come in with empty buckets. I want to be able to fill my customer's buckets with complimentary ice so their fish won't be a' spoiling while they are dining with us. I have nothing to offer to any empty bucket. Less fish to me means less business. Now marinas are my business and business is good, so I hope you can help me keep the Drift Inn the elite establishment it has become.

Smith Mountain Lake Striper Club Benjamin Newbill

During the public meeting I was to portray a member of the Smith Mountain Lake Striper Club. Club membership depends on the quality and numbers of strippers being caught in the lake. I argued that there are not enough strippers being stocked in the lake because the black bass fishermen are complaining to VDGIF to not stock strippers, because it might hurt the now, great black bass populations. I also offered the club's help in working with VDGIF on solutions provided that they keep his club informed and listen to their interests. I was impressed with the meeting. It was handled in a very professional manner. The staff members handled themselves in a cool and collected fashion. I think that most everybody's views and concerns were listened to and given a informative answer. The mission statement was clearly given. The topics of striped bass, black bass, crappie as well as goals, objectives and options were covered in the amount of time given. I was impressed with the input people had in

voicing their opinions and the feedback that was given in return. I think the management plan covered all the major needs of the fishermen and other users of the lake. The process that was followed allowed for everyone to have input and get answers back on their concerns. Everyone did a great job on their roles and I think it showed in our performance.

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆



Pandapas Pond Assessment Brian Watson, Gregory Hylton, and Jason Burton

Pandapas Pond is a manmade impoundment located in the Jefferson National Forest, Montgomery County, Virginia. Located between Brush Mountain and Gap Mountain, Pandapas Pond lies at an elevation of 2,200 feet in the headwaters of Poverty Creek drainage. The pond has maximum widths of approximately 400 meters (east-west) and 120 meters (north-south) and the maximum depth is 4.2 meters. The bottom of the pond consists of shallow flats, which give rise to a mean average depth of 1.3 meters. Water chemistry data is limited to conductivity, alkalinity and pH. The conductivity of the water is relatively low at 5-10 microhms, but proved to be sufficient for electrofishing as various sizes of fishes were sampled. Alkalinity ranges from 15-20 mg/L, which offers the pond a low resistance to change in pH. Probably due to a shale substrate, the pond's pH is buffered near 7. A variety of fish species reside within Pandapas Pond such as largemouth bass, bluegill, pumpkinseed, chain pickerel, and carp. These populations of fishes are easily accessible by bank anglers from the entire shoreline. Due to its easy access and its close proximity to Blacksburg and Christiansburg, the citizens of both communities heavily fish Pandapas Pond. However, anglers claim that the fishing is "lousy". The purpose of this paper is to assess the fish quality within Pandapas Pond and correlate this to the current fishing quality. By doing this, we should be able to determine if a problem exists within the pond, what the problem is (if one exists), and how we may be able to correct the problem. As managers for Pandapas Pond, our goal is to maintain a high quality recreational experience for a variety of local anglers.

Methods

Samples were taken with two different gear types. One was a boat electroshocker and the other was a seine net. Electroshocking was done around the entire perimeter of the pond and around the island located near the middle of the pond. Seine hauls were taken in shallow water closer to shore. Fish captured from electroshocking were recorded by length (mm) and weight (g) and then released back into the water. Fish captured in the seine hauls were simply counted and then released back into the water.

There were a few questions that we were trying to answer from the samples that we collected from Pandapas Pond. First, we need to determine the balance within the pond. This information will allow us to analyze whether there are too many predators, too much prey, or a good number of both in the pond. Second, we need to know whether or not the fish are reproducing. This will help us determine if habitat is suitable for spawning. Finally, we need to know if the fish are growing. This will help us determine if there is trophic competition occurring and how the competition is affecting the species composition within Pandapas Pond.

Three calculations will be made from the data collected. From the length and weight data, proportional stock density (PSD) and relative weight will be calculated for each fish species. Relative weights for largemouth bass (*Micropterus salmoides*) will be calculated according to Wege and Anderson (1979), and bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*) and chain pickerel (*Esox niger*) according to Anderson (1980). Anderson (1980) was chosen for chain pickerel since the family Esocidae used to be classified under the order Salmoniformes. Analyses of these indices should reveal what the balance is within the pond, and whether or not fish are growing. We will also calculate young-adult ratios (YAR) to examine the extent of reproduction occurring within Pandapas Pond. Finally, size frequency distributions will be calculated for the appropriate species (those collected in suitable numbers).

RESULTS

A total of 350 fish comprising five species were captured by electrofishing and seining. All five species totaling 256 individuals (73.1%) were taken by electrofishing alone (Appendix A). Seining catches yielded three of the same species but only 94 individuals (26.9%), all of which was young-of-the-year (Appendix B). The percentages of young-of-the-year and adults varied from these numbers slightly since a single young-of-the-year largemouth bass was collected during electrofishing. The actual values are 27.1% and 72.9% respectively.

The species composition of Pandapas Pond is dominated by bluegill (Fig.1). Over 70% of the juveniles and adults collected were bluegill, while largemouth bass and pumpkinseed together only contributed nearly 26%. Likewise, bluegill dominated the young-of-the-year composition of the pond comprising nearly 93% of the recruitment potential. However, our results do indicate that there is at least some reproduction occurring for all of the species with the exception of carp (*Cyprinus carpio*).

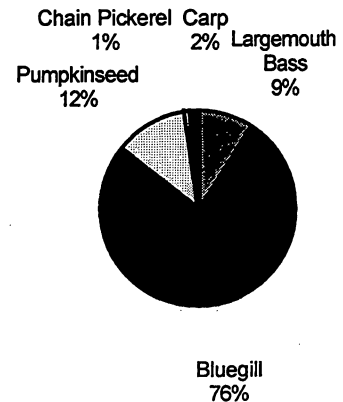


Figure 1. Species composition of Pandapas Pond.

A size distribution of the centrarchid species tends to exhibit that there are few large fish within any of the three species (Fig. 2-4). Bluegill and largemouth bass are slightly positively skewed, while the pumpkin seed appears to be bimodal. Inclusion of young-of-the-year may have shown a more pronounced skew towards smaller fishes of these species. Young adult ratios show that bluegill are reproducing well (YAR=4.1), whereas largemouth bass are not (YAR=0.3). Proportional stock densities confirm the size distribution conclusion with all of the values well below good fishing standards (largemouth bass, 16.7; bluegill, 13.0; pumpkinseed, 0.0).

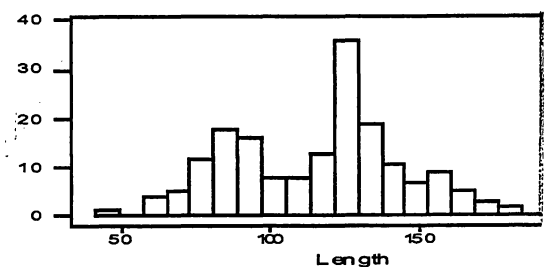


Figure 2. Size-frequency distribution (mm) for the bluegill population within Pandapas Pond.

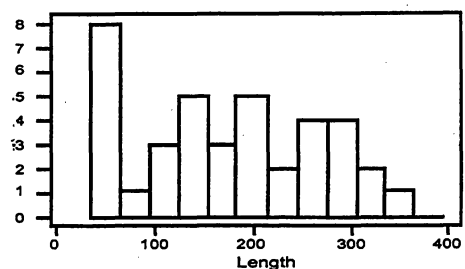


Figure3. Size-frequency distribution (mm) for the largemouth bass population within Pandapas Pond.

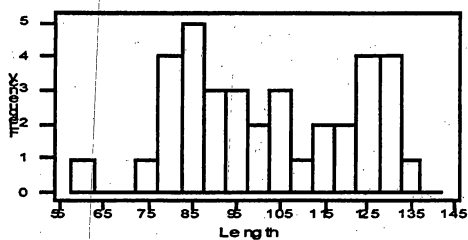


Figure 4. Size frequency distribution (mm) for the pumpkinseed population within Pandapas Pond.

Relative weights (W_r) for the individual fishes also appeared to be below quality fishing standards. Average values for relative weights were near or above 100 (except for pickerel) which would seem to contradict the statement that the relative weights were below quality fishing standards. However, closer examination of the data shows that many of the fishes have relative weights near or less than 80.0 and that some extreme outliers tended to skew the results towards a "normal" value of 100.

Conclusions and Recommendations

Results showed low relative weights and PSDs for largemouth bass and bluegill populations. This leads us to believe that the fish are not growing well or surviving to a quality size. We attribute a majority of this to an abundant, but stunted bluegill population. This overabundance results in competition between bluegill and largemouth bass, which leads to the loss of spawning habitat for adult bass and reduced food availability for larval bass. The competition for spawning habitat is causing low largemouth bass reproduction, which is indicated by the low YAR for this centrarchid. Lack of a sufficient food base could lead to poor growth rates and the reduction of largemouth bass recruitment, resulting in low abundance. Low relative weights for the largemouth bass tend to indicate that this problem may be occurring. Furthermore, the presence of quality size largemouth bass is reduced through the pressures of overfishing.

Pumpkinseed had an extremely low PSD though their relative weights were acceptable. This could be the effect of the large bluegill population competing for food. Pumpkinseed do seem to be reproducing, but not as well as bluegill. This could be the effect of the bluegill population competing with pumpkinseed for spawning habitat.

Carp and pickerel, though present in the pond, do not seem to be reproducing at a substantial rate. For this reason, it does not appear that they are having a pronounced effect on any of the other populations in the pond.

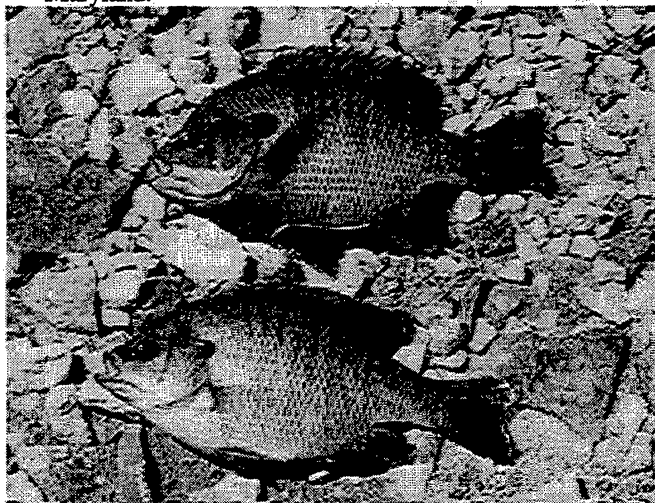
Water chemistry may also be limiting the fish abundance and growth within Pandapas Pond. Ponds with alkalinity concentrations lower than 50 ppm typically produce a maximum of 100 pounds of fish per acre. The alkalinity of Pandapas Pond is substantially lower than this standard. Low alkalinity reduces the solubility of phosphorus in water and causes the element to settle in the sediment. Since phosphorus is usually the limiting factor within aquatic

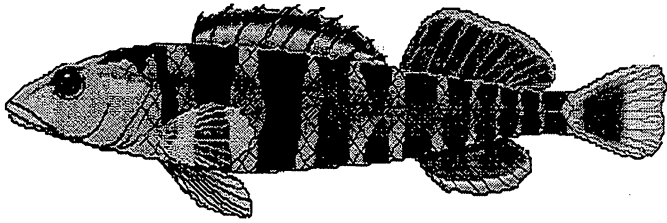
systems, the low alkalinity of Pandapas pond may be severely limiting an already highly competed for food base. This condition would lead to poor growth and recruitment of fish species, which we have seen in the analyses of our data for Pandapas Pond.

From what we have observed, we feel that the bluegill population needs to be reduced if largemouth bass are to have a chance. It appears that young bass can't survive due to the high trophic and reproductive competition they experience with bluegill. Overfishing is also contributing to the low number of quality size largemouth bass. So, it is our recommendation that a strict slot limit be set for largemouth in an attempt to increase recruitment and average size. It might also be beneficial to stock fingerling bass prior to bluegill spawning, to reduce the bluegill population. Additionally, an assessment of available suitable quality habitat should be performed. It is possible that habitat restoration or enhancement projects may be required. Finally, the food base within Pandapas Pond should be quantified to determine if it is sufficient for the fish populations currently present. If the food base is not sufficiently abundant, it should be determined if phosphorus is a limiting factor within the pond. If phosphorus is a limiting factor, liming the pond might become necessary to increase the fertility of the pond. An increase in fertility should result in a larger food base that would support larger fish and more abundant fish populations.

References

- Anderson, R. O. 1980. Proportional stock density (PSD) and relative weight (W_r): interpretive indices for fish populations and communities. Pages 27-33 in S. Gloss and B. Shup, editors. Practical fisheries management: more with less in the 1980's. American Fisheries Society, New York Chapter, Ithaca, New York.
- Wege, G. J. and R. O. Anderson. 1979. Influence of artificial structures on largemouth bass and bluegills in small ponds. Pages 59-69 in D. L. Johnson and R. A. Stein, editors. Response of fish to habitat structure in standing water. American Fisheries Society, North Central Division, Special Publication 6, Bethesda, Maryland.





North Fork Roanoke River Assessment Brian Watson, Ashley Kinney, and Benjamin Newbill

Although a variety of factors interact to influence the structure of the stream fauna, scientists seldom have the resources to evaluate all factors in stream inventories. Therefore, various indices are employed to serve as “red flags” or warnings of current stream conditions to help design more detailed field monitoring and tests. Assessment of the physical habitat is one method used to identify possible degraded conditions. Since the stream channel is an integration of watershed processes, we expect that the particle size distribution of the streambed is the first component to change when sediment and hydrologic regimes are altered. Three common methods used to assess the physical habitat are: 1) Riffle Stability Index, 2) Channel Stability Evaluation, and 3) Bank Erosion Potential. Evaluation of the aquatic life within streams is also a critical factor for determining the relative health of a stream. The Index of Biotic integrity (IBI) was developed by James Karr in 1981 as a method of assessing fish community health. Through use of this index, effects of environmental degradation, often human caused, can be detected in fish communities (Karr 1981). The use of fish as indicators of aquatic habitat quality is effective due to their meaningfulness to non-biologists, their relative ease of collection, and their direct application to legislative mandates (e.g., “fishable waters”) (Berkman *et al.* 1986). Being highly visible and sensitive components of aquatic communities, fish are an ideal indicator of overall ecosystem health (Simon and Lyons 1995). The IBI has been found to be relatively reliable and broadly sensitive to the various effects of degradation. This is because it covers an array of community characters, such as species composition, trophic habits, and fish health (Angermeier and Schlosser 1987). Although the final numerical scores obtained from the IBI are useful for summarizing many samples, the utility of the IBI in a management context is for identifying degraded reaches, interpreting the causes of degradation, and prioritizing restoration efforts to correct problems. In addition to fish communities, benthic macroinvertebrates can be assessed to determine the relative health of a stream. Within Virginia, Save Our Streams (SOS) organized an indices based on the relative abundance and types of benthic macroinvertebrates to rate the quality of water.

Methods

Field techniques to evaluate physical habitat and biological conditions were performed at a site on the North Fork Roanoke River, Montgomery County, Virginia. A total of three physical habitat indices and two biological indices were used. The physical habitat indices included: 1) Riffle Stability Index (RSI), 2) Channel Stability Evaluation, and 3) Bank Erosion Potential. The biological indices included the Index of Biotic Integrity and SOS aquatic benthic macroinvertebrate assessment.

The RSI was performed on the top, middle, and bottom of a randomly chosen riffle. A total of five transects were chosen from the riffle, from which, 219 samples were taken. The samples were collected by walking the transect lines (starting at bankfull width) heel-to-toe and blindly selecting the first substrate particle located directly in front of your boot. The intermediate diameter of the substrate particle was then measured (mm) and recorded in the appropriate size class. The samples were then graphed as a cumulative percent of fines (Fig. 1). Next, 30 of the largest dominant particles residing on a fresh depositional area were measured (mm; intermediate diameter) to estimate the largest particle size moved at bankfull discharge. Finally, this mean diameter was compared with the plotted cumulative particle size distribution from the riffle to determine the RSI.

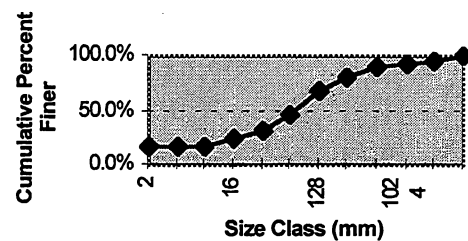


Figure 1. Cumulative percent finer graph for substrate particles measures within a riffle of the North Fork Roanoke River.

The channel stability evaluation was conducted by walking an area of the river and visually assessing various categories according to Pfankuch. Each category was rated as excellent, good, fair, or poor and a predetermined number was assigned to the categories. The numbers were totaled and compared to the set ranges for the condition of a stream (North Fork Roanoke River = C4) and a rating was assigned.

Bank erosion potential was determined in a similar fashion to the channel stability index. The same area of the river was visually assessed and five criteria were rated from Rosgen. Each criteria was assigned a numerical value and totaled for a final score. The final score was compared to a rating guide and an erosion potential was assigned for the stretch of the river.

The benthic macroinvertebrate community was assessed by SOS stream quality survey. A 3x3 foot square area within the river was sampled by placing a kick-seine downstream of the area. The streambed within the area was then disturbed by kicking and moving the substrate so that the organisms would dislodge and was into the seine. All organisms were

removed from the kick-seine and identified to class, order, suborder, or family based on the identification guide. A water quality rating was then assigned to the river based on the number and types of benthic macroinvertebrates collected.

Finally, the fish community was assessed using the IBI. Various areas of the river were sampled using backpack electroshockers and seines. All fishes collected were identified to species and then returned to the river. The IBI is composed of eleven separate metrics covering the categories of species richness and composition, trophic composition, and fish health (Angermeier and Karr 1986). An established scoring criteria was used to rate each of the 11 metrics, and a composite IBI score was calculated for the river.

Results

A total of 219 substrate particles were measured and assigned to the various size class categories (Table 1). Based on the distributions within each size class, the cumulative percent finer was graphed (Fig. 1). The average grain size within the depositional area below the riffle was calculated at 65mm (Table 2). Comparing this value to the graph in figure 1, the RSI was determined to be approximately 46.

Table 1. Totals, percentages, and cumulative percentages for substrate particles measured within a riffle of the North Fork Roanoke River.

Size Range (mm)	PEBBLE COUNT		
	Total	% in Class	Cumulative %
0-2	35	16.0%	16.0%
2-4	1	0.5%	16.4%
4-8	2	0.9%	17.4%
8-16	15	6.8%	24.2%
16-32	15	6.8%	31.1%
32-64	32	14.6%	45.7%
64-128	49	22.4%	68.0%
128-256	25	11.4%	79.5%
256-512	25	11.4%	90.9%
512-1024	5	2.3%	93.2%
1024-2048	4	1.8%	95.0%
2048-4096	11	5.0%	100.0%

TABLE 2. Diameter of Bar Sample Rocks (millimeters)

Sample	Size	Sample	Size	Sample	Size
1	70	11	50	21	60
2	120	12	85	22	75
3	50	13	90	23	70
4	80	14	55	24	80
5	70	15	50	25	70
6	35	16	60	26	50
7	70	17	80	27	65
8	50	18	55	28	46
9	65	19	50	29	65
10	50	20	65	30	60
MEAN GRAIN SIZE			65 mm		

The channel stability evaluation resulted in a Pfankuch rating of 108. According to the conversion rating for a C4 stream, the examined reach of the North Fork Roanoke River is fairly stable. A total of 7 benthic macroinvertebrate groups were collected totaling 86 individuals. Four of these groups were classified as sensitive, one was classified as somewhat-sensitive, and two were classified as tolerant. The

total index value based on this data is 22 which gives the North Fork Roanoke River a good water quality rating.

A total of 319 fish were collected representing 6 families and 22 species (Appendix A). Analysis of this data resulted in an IBI of 43 (Appendix B). Overall, the rating for North Fork Roanoke River was designated as fair based on criteria according to Angermeier and Karr (1986).

Conclusions and Recommendations

According to the aforementioned RSI, the examined reach of the North Fork of the Roanoke River was determined to be slightly degrading. This stability was measured on a calm, sunny day when the water was low and the effects of erosion were not directly observed. However, there were areas on the bank that were indicative of spring regrowth. This new growth vegetation serves to prevent erosion during the warmer growing seasons, but the worn banks showed evidence of the cooler low growth periods. The stability was on the verge of being poor quality, therefore, some land-use management strategies must be implemented to prevent the stream stability from becoming increasingly unstable. It may be beneficial to create a buffer strip between the golf course and the stream. This strip would allow for the increase of year round vegetation along the bare areas of the bank, reducing siltation. If siltation continues, habitat for spawning and cover will decrease as areas will begin to aggrade.

Additionally, riparian and stream bank restoration needs to be implemented since many areas around and within the river were lacking these important natural structures. With the increase of riparian vegetation, the flows within the river should become more stable in terms of the frequency and intensity of high flow events since runoff will be decreased. Furthermore, the addition of stream bank structures or vegetation will serve to stabilize the stream banks leading to less sedimentation and degradation caused by high flow events. As shown in Figure 1, a dirt road runs through the stream disrupting the bank and the stream bottom. A ford, if properly constructed, may provide solid ground for the vehicles, therefore reducing the disruptive nature of travel over the silty bottom.

A Water Quality Rating of 22 indicates a good quality stream. The biodiversity of aquatic insects found which are sensitive to pollution, shows that the stream's water quality is not a major issue in this assessment. As long as the numbers of sensitive species do not decrease over time, then for our purposes, it can be assumed that the water is fairly clean.

The Index of Biotic Integrity was determined to be a 43 out of 55. This is a rather high index of overall species composition, trophic composition, fish health and abundance. However, one weakness the stream showed in species abundance was the low species number of native sunfish. This may be due to the fact that there is little surrounding vegetation in the stream for the sunfish to use as spawning habitat and little vegetative cover to protect the young from predation. To enhance the numbers and diversity of sunfish vegetation must be enhanced. There are also low numbers of species that are simple lithophilic spawners, therefore sedimentation may be occurring within the river leading to

high areas of sediment covered bottom. This is caused by frequent disruptions in the streambed leading to an unstable environment. However, these low numbers may have been influenced by sampling error. Many fish were observed passing under the lead line of the seine which may have been these simple lithophilic spawners since they are typically benthic in nature. However, if the category of simple lithophilic spawners was expanded to include all lithophilic spawners, the additional Percids raised the percent of this category from 11.5% to 56%, which has a rating of 5 (excellence). So it appears that sedimentation may not be a critical problem yet. The largest indicator of stress on fish in the stream was that 5.6% of the individuals sampled had external anomalies. This may be the result of pulse events that caused abnormally high stress periods within the stream, such as high rains causing periods of erosion and increased pollution from runoff. Some other nonpoint sources of stress to the fish may be runoff from the golf course. This potential problem could be reduced by implementing a buffer zone.

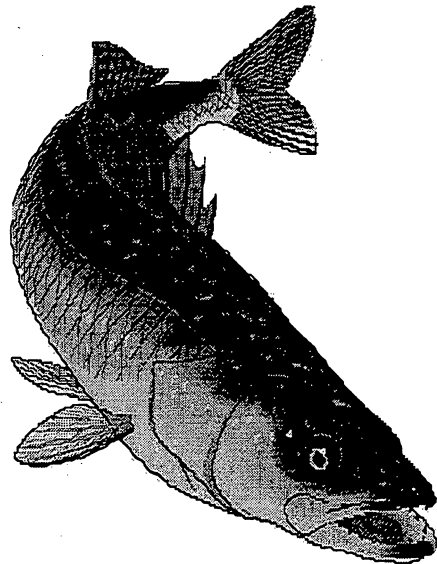
The overall health of the stream is relatively high. The stream is able to support a wide variety of predators, prey and because water quality was very good and riffle stability was very low, the primary concern should be directed towards improving the riparian health of the stream. Once the stream's banks become stable, then the stream may have a chance to stabilize itself providing a suitable environment for all species involved.

References

- Angermeier, P. L. and J. R. Karr. 1986. Applying an index of biotic integrity based on stream- fish communities: consideration in sampling and interpretation. *North American Journal of Fisheries Management* 6: 418-429.
- Angermeier, P. L. and I. J. Schlosser. 1987. Assessing biotic integrity of the fish community in a small Illinois stream. *North American Journal of Fisheries Management* 7: 331-338.
- Berkman, H. E., C. F. Rabeni, and T. P. Boyle. 1986. Biomonitoring of stream quality in agricultural areas: Fish versus invertebrates. *Environmental Management* 10(3): 413-419.
- Karr, J. R. 1981. Assessment of biotic integrity using fish communities. *Fisheries* 6(6): 21-27.
- Simon, T. P. and J. Lyons. 1995. Application of the index of biotic integrity to evaluate water resource integrity in freshwater ecosystems. Pp. 245-254 in W.S. Davis and T.P. Simon, eds. *Biological assessment and criteria: tools for water resource planning and decision making*. CRC Press/Lewis Publishers. Boca Raton, FL.

Appendix A. Fish sampled April 15, 1997 in the North Fork, Roanoke River,

Family	Species	Number
Catostomidae	Northern Hog Sucker	2
	Roanoke Hog Sucker	10
	Torrent Sucker	21
	Black Jumprock	3
	White Sucker	9
Centrarchidae	Smallmouth Bass	
	Largemouth Bass	2
	Rockbass	3
	Redbreast Sunfish	18
Cottidae	Mottled Sculpin	51
Cyprinidae	Central Stoneroller	19
	White Shiner	13
	Blacknose Dace	8
	Mountain Redbelly Dace	33
	Rosefin Shiner	4
	Rosyside Dace	29
	Crescent Shiner	14
	Bluehead Chub	29
Ictaluridae	Margined Madtom	7
Percidae	Fantail Darter	100
	Riverweed Darter	3
	Roanoke Darter	6
	Roanoke Logperch	7
Anomalies		22
Total fish collected		391



There once was a fellow named Fressor.
Whose knowledge grew lessor and lessor.
It at last grew so small,
He knew nothing at all.
And now he's a college professor.

How to write a letter of recommendation for a person who isn't really qualified?

I use the LIAR or Lexicon of Inconspicuous Ambiguous Recommendations, so named by Professor Robert J. Thornton, Lehigh University.

Some examples:

In my opinion, you will be very fornturnate to get this person to work for you

I most enthusiastically recommend this candidate with no qualifications whatsoever.

I can assure you that no person would be better for the job.

I would urge you to waste no time in making this candidate an offer of employment.

Now you should understand how important unambiguous writing is! D.J.O.

“We only get credit for what we finish, not for what we start.”



Mike Robertshaw



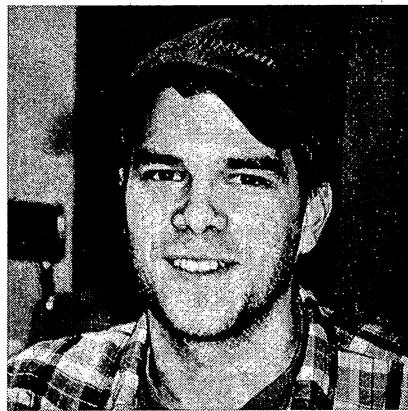
Kirk Rundle



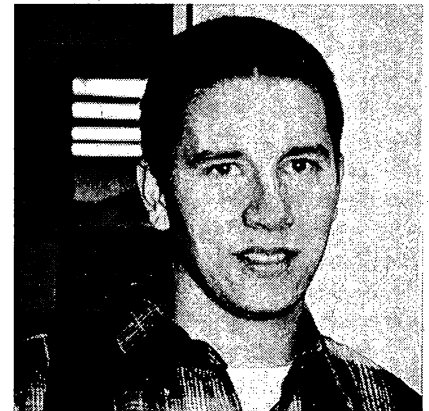
Michael Shaver



Michelle Steg



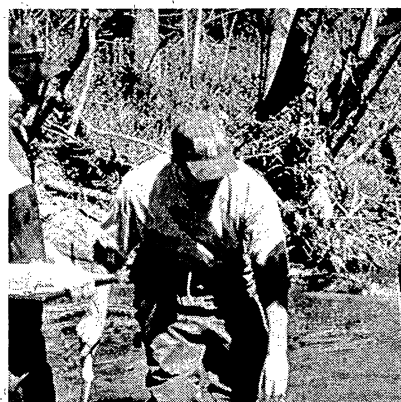
Troy Thompson



Brian Watson



Powell Wheeler



Pebble Counts



Electroshocking



Electroshocking Fish from North Fork Roanoke River



Boat Electroshocking on Pandapas Pond