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Moderator: Courtney Chambers
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Courtney Chambers: Okay now I'd like to introduce our speakers today:

Dr. Jack Killgore is a Research Fishery Biologist in the Environmental Laboratory Engineer Research and Development Center here in Vicksburg, Mississippi. He's studied and received his Bachelor's from the University of Arkansas. He got his Masters from Sam Houston State University in Huntsville, Texas and received a PhD from the University of Mississippi at Oxford. Dr. Killgore is the team leader conducting research on environmental biology of fishes threatened sturgeon and invasive carp, Asian carp species, ecosystem restoration and large river systems and environmental impact assessment of Corps Engineers flood control and navigation projects.

Our other presenter today is Dr. Phil Kirk. Dr. Kirk is a Research Fisheries Biologist in the Environmental Laboratory. Dr. Kirk received his Bachelors and Master’s degree from Auburn University in Wildlife Biology and entered the US Army where he served as a field artillery officer for eight years. In 1980 he returned to Auburn University and studied fisheries specializing in small impoundment management. After completing his PhD in 1984 he worked as a black bass biologist for the South Carolina Department of Natural Resources. Phil joined ERDC in 1992 and has since engaged in a wide variety of fisheries studies. He initially worked with triploid grass carp and was involved with major reservoir studies like Lake Guntersville Alabama and the Santee Cooper reservoirs in South Carolina. More recently he has worked with biologists and private industry and state agencies to develop successful hydrilla management strategies in Piedmont reservoirs. Additionally he has performed research with endangered sturgeon, zebra mussels, and Asian carp.

More information about Jack and Phil can be found in their bios posted on the Learning Exchange with the rest of today's meeting document.

And we're very thankful for their willingness to share with us today. Okay at this time Phil I'm going to give you the presenter rights and you can begin.

Dr. Phil Kirk: Okay. Can everyone hear me okay. Courtney am I coming through loud and clear?

Courtney Chambers: Yes sir we can.

Dr. Phil Kirk: Very good. Okay well I'd like to start off and just say that this talk that Jack and I are giving you is possible because of a long history of generous support through the Corps of Engineers.

Some of this work actually predates me coming to work here at the environmental lab and was funded by Jack while I was a fisheries biologist in the state of South Carolina. So I just again would like to mention that we do appreciate this support. And this support has allowed the Corps of Engineers to really take a leading edge in trying to make the triploid or the sterile grass carp an improved management tool for hydrilla in reservoirs.

The research objectives are pretty straightforward. We're trying to learn a lot more about the biology of grass carp. And more specifically we're trying to make the grass carp an improved management tool for primarily hydrilla. And let me repeat that again primarily hydrilla in reservoirs systems.

With that said hydrilla has become quite a problem in this country. It's an exotic. It was first noted in the 50s in Florida. And it has spread literally from coast to coast in the United States and as far north as the Pacific Northwest and into New England. And it's very problematic because chemicals can kill this plant in the water column but it will come back for perhaps decades from reproductive bodies called tubers that build up to tremendous numbers in the bottom mud.

So grass carp has seemed to work well for long term control of hydrilla, inexpensive long term control of hydrilla but the fish is also a pretty blunt instrument. And our goal is to try to figure out how to make this tool, the grass carp a better management tool.

Just a little timeline of the studies we've performed through Corps of Engineers sponsorship primarily the Aquatic Plant Control Research Program but also reimbursable funding from the districts a series of studies. And they span about a 30 year period.

We first started off looking at small impoundment sort of as a model for what we could do to control hydrilla in reservoirs. From there we started and Jack actually led a lot of these studies in the late 80s where we looked at how hydrilla affected the habitat availability and the availability of habitat after hydrilla had been controlled. And we also started telemetry studies where we put or we placed radio chips in grass carp and followed their movements. From there we started working primarily on the Santee Cooper Reservoirs but a little bit on Lake Guntersville. And we were interested in performing assessment or developing assessment techniques so that we could tell decision-makers in the state and federal government the status of their grass carp, how fast they were growing, how many were out there and how fast they were dying out through natural mortality. Remember the grass carp that went into the Santee Cooper system were sterile they were triploid. So that we did not have to account for reproduction.

So after developing assessment techniques we got in the business of actually doing what we call population assessments. It's very common in quantitative fisheries. We dealt with some environmental issues, particularly movements in coastal waterways. We started looking at the social economic aspects, the effect that hydrilla might have on local economies and also angler attitudes. We looked at the longevity of grass carp. We looked at the long term response of these management strategies both in terms of the effectiveness of hydrilla control but also the status of the population. We developed some patents to look at the ability to maybe limit the lifespan of grass carp that we stocked. And then lastly we worked over the last eight to ten years in North Carolina with Duke Energy to actually put what we learned over this period of time into actual management strategies to see if we could repeatedly be successful in managing hydrilla in Duke Energy Reservoirs.

Just to talk a little bit about each of these studies what I'm going to have is some bullets or the main points. And then at the bottom line we're going to have what we call milestones. They're usually a journal article or a conference proceeding or perhaps a patent. But they are - they're essentially the written a version of what we did that was published in the scientific literature.

The small impoundment studies were done in about 30 South Carolina impoundments. And what we were really interested in doing is developing or validating stocking rates. So we looked at three different stocking rates and we also evaluated grass carp survival. We would actually hold them in ponds sometimes with different sizes of largemouth bass and also ponds without largemouth bass. And we wanted to evaluate survival. Well the bottom line is that grass carp didn't work very well at any stocking rate, even rates that we knew should control aquatic vegetation in these small impoundments. And we found that early and erratic survival was likely the reason. That had huge consequences when we tried to or were thinking about using the sterile grass carp in large reservoirs. And we learned that the fish had to be of a certain size, usually 10 to 12 inches then they needed to be very carefully handled.

So I'll just show you a couple slides of this work. We had to actually go in during the wintertime and survey a lot of these small impoundments to determine their area. We would then actually come in with college kids who were hired during the summer to go out and measure the aquatic vegetation by wet weight in these ponds. And we did this study on a wet weight basis.

And then lastly this is what we saw a lot of. This is a fish that was picked off by a wading bird that it was too big to eat. We also saw a lot of predation to bass. And that's why we've made over the years the a - we've really emphasized to people when they're using hundreds or thousands of these fishing in major reservoirs to make sure they get a good quality fish, one that's been handled carefully and one that’s large enough to survive early predation.

From there we went on to do some early reservoirs studies primarily in Lake Guntersville, Alabama in the Santee Cooper systems that's Lakes Marion and Moultrie in South Carolina. And we evaluated fish communities movements and grass carp growth. But just a few slides, almost all of these original study sites in both Alabama and the Carolinas usually had a telemetry study that it was associated with and we were no exception. We took a lot of time and effort to learn how to implant telemetry tags in the fish. And we practiced and held some in captivity until we could get very good stocking rates. Some people rushed that step in the process and they tagged a lot of fish that swam off and died.

The Santee Cooper Rivers reservoirs we had a problem. Together this is about - these two reservoirs well they’re connected but they encompass almost

170,000 acres. And when this study was going on much of it was covered with hydrilla and it was very hard to get around. So in these early studies what we did is we borrowed a DNR aircraft and we would first locate the fish from the air and get an approximate location. Then it was much easier for graduate students to go in, locate the fish and get the habitat data.

Pretty soon we were in the position of having to talk to decision-makers of on how many grass carp that they had stocked previously were estimated to still be surviving. Then they would use that information for ordering grass carp for the next year.

We came from a traditional fisheries perspective on this and we almost failed because the traditional fisheries gear failed miserably to collect grass carp, electricity, gill nets -- you name it -- really didn't work. In an absolute desperation the leadership of the South Carolina DNR went out and found folks who had won the local bow fishing tournaments and we recruited and permitted those people to collect the fish. And it worked very well. It's cost effective and we understand the selectivity very well. Basically grass carp that are age 2 or older are fully vulnerable to this gear.

We also had to get up to speed on the age and growth techniques that we were going to use. Once we could age the fish and determine rates of growth and mortality we could use classical population modeling tools to predict densities and to provide input for decision-makers. And we've been doing this now for about 20 years. But this is the real heart of working with grass carp is collecting them and understanding your collection biases. And around the country today when people do grass carp studies they almost always recruit highly paid or highly skilled bow fishers that they pay a bounty.

We were pretty good at aging growth but since this was an important project we went to a recognized aging growth lab, in this case the laboratory at the University of South Carolina. And we used ear bones that are called otoliths and we got some guidance from the folks at this laboratory.

First they located the otoliths there's three different types in the grass carp. They have pairs. On your left you see the lapilli. To the right, top right you have the (histericus), and then on the right bottom you have a (sagilotoliths).

We section and look at the lapilli otoliths the one on your left. And when it's sectioned it looks like this. We did a couple other things. We validated this aging structure. In other words we made sure when we counted rings on the aging structure that it actually corresponded to the age of the fish. And we did that using both known age fish and by marginal increment analysis.

Other studies included environmental impacts where we looked at movements, particular movements and coastal rivers, water quality and temperature and things like that particularly associated with dense strains of hydrilla.

The use of grass carp in Virginia and North Carolina was problematic because the decision-makers there and the DNR were very concerned that large grass carp, adult grass carp would attempt to make spawning runs and could potentially get into coastal rivers and go into the estuarine areas and consume vegetation there that might have a just a devastating effect on commercial and recreational fisheries. And we with the aid of the South Carolina DNR and with funding from the Aquatic Plant Program and the Charleston district actually tackled this problem.

What we did is we worked very carefully and closely with the DNR using a series of their boats. And we would try to track the adult grass carp near floating aquatic vegetation where they couldn't get away from the current.

We would catch these larger fish that are up almost a meter in length. And then we would tranquilize them immediately because they're very, very powerful fish and they're hard to handle and they like to jump. But we tranquilized the fish by putting them into a holler with a tranquilizer until we could operate on the fish and implant telemetry gear.

We then released the fish in the Cooper River which runs about 70 kilometers into Charleston Harbor. We tracked these fish ourselves and in cooperation with South Carolina researchers actually for several years. And the good news from this was that the grass carp really didn't present much of a threat. They went to the nearest stands of hydrilla in the Cooper River and stayed there and didn't move much. I don't think we ever tracked any fish as far as Charleston Harbor. So the threat there was overstated.

We've also done a series of life span of evaluation. The life span, the length that they live is pretty important for a couple of reasons. First of all in a lot of your classical population modeling software it incorporates a lifespan as one of your input parameters. But more importantly it assists with maintenance stocking strategies. And that is the keeping of grass carp in a reservoir once you've eliminated hydrilla in the water column for a series of years, maybe decades to graze back hydrilla re-grow from the bottom muds. And the news is that the studies are still continuing after a decade or so. The average lifespan in the Santee Cooper system was about a decade although there a small percentage of fish that live much longer. However the lifespan in the Piedmont reservoir where there’s is very little aquatic vegetation in the water column particularly after hydrilla has been eliminated is very different. They have extremely short lifespans and as a matter fact some of the stockings may not even survive.

So these studies are continuing. And I'll talk a little bit more about some of the older fish just a little bit later on. But when we did these lifespan studies it's - it involves years of collecting grass carp and doing the age and growth studies.

This is the actual otoliths that I showed earlier the lapillar otoliths that are embedded in a resin. And then we section them with a diamond wafering blade. This is traditional in age and growth. And over the years thanks to support that we've gotten from the aquatic plant program to do grass carp work but actually other studies too, we've developed quite a nice age and growth facility at our laboratory. And we’re using these facilities for a lot more now than grass carp. We’re using them to age sturgeons and Asian carp but we got our start doing age and growth and longevity studies on grass carp.

We've also done a little bit of work I call it social economic work. But what we have done is we have incorporated some of the other scientists here at the lab and we’ve worked with the DNR. And we have - we've worked by adding questions to angler surveys. And the fisheries term is called an angler creel where you actually go out and you pull anglers or ask some questions while there fishing and then use that information to determine the number of fish that may be harvested on the reservoir, the fisheries catch rate. And in our case angler attitudes a point that we want to make is that once hydrilla comes into a system and gets established they get an extremely strong following from anglers. Even when hydrilla causes a lot of problems anglers quickly forget the problems and remember what they perceive as improved fishing near hydrilla. And we saw that everywhere. We saw it on surveys in Lake Murray where they had a hydrilla infestation. And we definitely saw it in the Santee Cooper system.

We've looked also at the long term responses of hydrilla, for example how long did it take to control hydrilla, what happened after it was controlled, what happened to the grass carp population? And in one case we actually followed a 20 year history in the Santee Cooper reservoirs of how the grass carp population responded control and also the - how the public felt about the hydrilla management.

One of the points that I want to mention here -- and I'll hit on it briefly -- hydrilla was eventually controlled in the Santee Cooper system after about three quarters of 1 million grass carp were stocked. And control was achieved about 1996 to 1997. Some of the grass carp that were stocked then, a very, very small percentage still survived. And this is an example of a grass carp that was collected last year that is about 21 or 22 years old. And that fish was among the original stockings in the late 80s or early 90s.

Florida has some serious problems with hydrilla. They have a lot of it. The grass carp are sometimes problematic because they work too well there. Dr. Steve Miranda at the University - or at Mississippi State University's Cooperative Fish and Wildlife unit suggested a device to limit the lifespan of grass carp about the size of a small tag that we put into fish to identify. It's called a pet tag. These tags are also used in your pets and they're approximately 6 to 8 millimeters long and about a millimeter in diameter. And Steve's idea was to put a toxicant into this and have that toxicant released at a specific time to kill the fish. This would be a specific response to Florida's problem where they felt like the grass carp just lived too long. And so Steve came to us and we provided Steve some support to study a toxicant and the delivery system.

And in the meantime we all decided that probably this was intellectual property that should belong to the government. And ERDC expedited a series of patent applications. And over the last decade we've been granted three US patents for this lifespan limitation device. The last patent that you see there on your screen was actually just assigned back on the 17th of April of this year.

Well I talked to you about the development of techniques and what we've learned in terms of stocking densities and perhaps maintenance densities. We had a chance to test a lot of these ideas out over the last seven to eight years with Duke Energy. They were interested in incorporating these techniques. And we've worked together on a series of reservoirs in North Carolina and in South Carolina. But basically from what we learned in the Santee Cooper system we decided to stock grass carp at 20 per vegetated acre. We did something a little bit unusual. And that is way tried to keep the hydrilla treated and suppressed with registered herbicides. Then lastly we decided to keep grass carp in the system for extended periods of time after hydrilla was controlled. We call those maintenance stockings. And our goal was to keep about one grass carp per every eight surface acres. And while we were successful in all cases in controlling hydrilla, overtime we became better at it. And eventually were able to control hydrilla at 1% coverage of the reservoir.

The study sites are basically in south central North Carolina. We've got Lake James, Lake Norman, Mountain Island Lake and Lake Wylie that are on the Catawba system and then Lake (Valoos) is a separate reservoir some ways away. These are all operated by Duke Energy but they're managed in cooperation with the state agencies and what are called Marine commissions which are governing bodies that are composed of several counties.

I'd like to just show you a little bit of data and make a couple of points. I know the slides can get busy but these are the reservoirs that we worked on. You notice that they vary in size from about 32,000 to 3000 acres. Lake Norman is actually the largest reservoir in North Carolina. The potential infestation, that's really the area that was available and suitable for hydrilla to invade. And we made a decision that it was at the 20 foot depth contour. And generally in the area that's available is roughly 1/4 of the reservoir surface acreage. You can see in the next column over the infested areas and then lastly lag period.

I want to talk a little bit about lag period. Usually when you use grass carp to control hydrilla you talk about a three to four - well really two to three year life period after grass were stocked to when they control hydrilla. And what we think is happening here is a three step process. The grass carp first have to control hydrilla that's out there and spreading that you have not detected. The grass carp have to control the known hydrilla in the water column. And then lastly they have to control very substantial amounts of hydrilla regrowth from tubers. And as I said it's usually a two to three year period. However in our case we were aggressively going after known stands of hydrilla with registered herbicides. And in four out of the five cases where we stocked grass carp we had control of all hydrilla in the water column within one year.

The other thing is as we got better and better at detecting hydrilla that is often widely spread around a reservoir and mapping it, initiating management activities we went from having hydrilla infestations that approached carrying capacity and were close to 1000 acres to being able to eliminate very small widely spread patches of hydrilla that made up a very small part of the reservoir.

The benefit is when hydrilla can be tackled early and successfully like that and then prevented by maintenance stockings from coming back is number one you don't use very much herbicide compared to a large infestation and you never stock very many grass carp. So it's quite desirable to be able to manage hydrilla early in the infestation.

Just a couple of take home points from these reservoirs. These were in the Piedmont - these reservoirs you should be able to based on our experience to successfully manage hydrilla just about every time.

The key to it is early detection mapping and responding. In response it's going to be involved bringing all of the stakeholders and all of the interested parties and agreeing on a management strategy that integrates herbicides and grass carp.

Use this strategy early and decisively. You need to remember too that hydrilla is unlikely to be eliminated in the short term. You need to have a timeframe of ten to 20 years that you need to periodically stock grass carp to maintain a density of about one per every eight surface acres of the reservoir.

And then lastly hydrilla management should be - you should be successful with this approach. But it gets a little bit more difficult and hydrilla may be harder to control at lower densities if hydrilla is number one, mixed with other submersive aquatic vegetation or number two if it's gotten away from you and it’s rapidly expanding. Then the management becomes a little more problematic.

I wanted to talk now about current management recommendations because they're going to vary based on the water body that you're talking about and the part of the country that you're talking about.

Generally we think about stocking grass carp in small impoundments managed for quote balance. Another category would be most reservoirs are usually Piedmont but I'm thinking about reservoirs that are not in the coastal plain of the - of our country. They often are used for hydropower or flood control or maybe just cooling water or a combination. Generally they've got a lot of fluctuation. There got a lot of turbidity and wave action. They don't have a lot of submerged vegetation.

Another category are water bodies in Florida. And then lastly I'd like to talk a little bit about the Santee Cooper system. It's the system that we studied now for 20 years. And it's a little bit better, different from the other categories of reservoirs. So let me talk about how we might go about managing them.

These are generally we stock ten to 20 fish per vegetative acre and that's about it. These impoundments are almost always managed without vegetation because you're fertilizing the water for fish production. Grass carp are stocked therefore to prevent any aquatic vegetation. The stocking rate is generally going to depend upon the location in the country and the length of the growing season. And this management strategy has been in place probably since the late 1960s. And that was one of the reasons that the grass carp was brought to this country was to - was for control in small impoundments.

Grass carp were not considered a, really as a prime management tool for reservoirs and hydrilla infestations until the development of the triploid or the sterile grass carp. And just as an aside about 30 years ago when I started my small impoundments research at Auburn my major professor insisted that I stock ten grass carp per vegetative acre just to ensure that we would not have problems with aquatic vegetation. So the approach on small impoundments and the management strategy has been around for quite a long time.

Most reservoirs -- and I'm talking particularly about the Piedmont reservoirs that I talked earlier about, these systems usually have sparse or paltry submerged aquatic vegetation. These systems as I mentioned you want to detect hydrilla early and suppress with registered herbicides applied by the label. Stock grass carp at about 20 fish per vegetative acre. Remember that you should be able to achieve control of hydrilla very early in the infestation if you do this. And lastly there needs to be some institutional memory here. You're going to have to keep grass carp in the system for at least ten to 20 years.

And I would just remind you that hydrilla has come back in Lake Conroe Texas after about a 20 year period of control and it came back with a vengeance. So those tubers, those reproductive propagules goals in the bottom mud are going to make hydrilla a really long term problem in reservoirs.

In Florida we've got issues. And now this is an area for really long term research. Hydrilla is a big problem there. It's in a lot of their reservoirs. They've used primarily herbicides and they've use the herbicide Floradone to the extent that they're developing resistance, hydrilla is developing resistance to the herbicide and the costs are getting just astronomical. Grass carp has not usually been satisfactory there. They've been tried a lot but they have a problem with the grass carp surviving for very long periods of time and long term depletions of all vegetation. And they've just not been able to work around this. That's why there I think there's a lot of hope for the development of a lifespan limitation devised for the triploid grass carp that would give them some more management options.

Then the Santee Cooper system, this has responded in some ways very differently than we've thought. It's sort of a hybrid system between Florida and most of the Piedmont reservoirs. It's truly a coastal plain reservoir. It's shallow. It's had a long history. It was impounded just prior to World War II but it's had a long history with nuisance aquatic vegetation. Hydrilla was introduced or was found about 1982 and millions and millions of dollars worth of herbicides were applied but hydrilla continued to expand. Grass carp were stocked beginning in 1989 and between 1989 and '96 about 3/4 of 1 million grass carp were stocked. But by then hydrilla had already taken off. And as hydrilla was controlled by grass carp it spread to other areas of the reservoir and eventually invested about 48,000 surface acres or about 1/4 of the reservoir. By 1996 and 97 the grass carp finally were able to eliminate the hydrilla. And they also eliminated most of the submerged aquatic vegetation.

They did not eliminate the floating vegetation nor some of the emergent vegetation but nevertheless the - there was a lot of pushback by the public. And it was not a good situation. But very quickly the grass carp numbers declined. And as the grass carp numbers declined just a little bit that was all that was needed for submerged vegetation primarily and it's desirable submerged vegetation like eelgrass to really take off. And before very long there were about 16,000 acres of submerged aquatic vegetation and very desirable vegetation. So this was a case where grass carp worked just about perfectly. They were able to eliminate the hydrilla but not to cause problems for the desirable vegetation. And based on our tracking studies and population estimates we determined that about one fish per every eight surface acres of the reservoir was just about right to control hydrilla but to allow the native species to flourish. However over time the grass carp densities declined. In about 2005 hydrilla came back and it's rapidly expanding. About 140,000 triploid grass carp have been stocked in the last couple of years. And it doesn't look like they're going to be sufficient.

So the hydrillas, the Santee Cooper systems are a little bit different but we're still seeing that cycle that hydrilla once it's controlled needs to be controlled for a very, very long period of time.

Well that pretty much wraps up what we've done and where we've worked over the last 30 years.

Just thinking in terms of our current work and future directions we're continuing to perform long term survival studies on a series of reservoirs. And actually we have fish that are at a - that are - have ages between ten to 22 or 23 years so we're able to track these populations for a very long time.

We understand that they are going to be very different regional responses in terms of the way the grass carp will work to control hydrilla. And as a team we would like to explore opportunities to work in some different regions that have hydrilla problems in the reservoirs.

We think that there might really be an opportunity to look at this strategy of early detection of hydrilla and integrated use of herbicides and grass carp. And of course they're going to have to be different stocking rates and perhaps some different strategies. But there may be opportunities to tackle hydrilla in other parts of the country and repeat some of the successes that we've had in the North Carolina reservoirs.

And with that I think I've got a little bit of time and I'd be glad to answer questions if there's time Courtney.

Courtney Chambers: Yes. We're going to take a little bit more time since we ate into your time at the beginning. So please do if you have any questions remember to take your phone off of mute before speaking or feel free to utilize the Chat feature and send your question to everyone.

Dr. Phil Kirk: Well Courtney if there is no questions I guess that about concludes this Webinar.

Courtney Chambers: Well okay. I try not to rush everybody but it was pretty quiet there. I will begin wrapping up. If you all want to go ahead and ask a question to the Chat feature you're welcome to.

Again I apologize for the complications today. That's not how we like our Web meetings to go. But thank you for persevering with us and it was a great presentation Phil. Thanks for sharing all of you all's information.

And I did record the meeting. And so what we will do is send an announcement through the Gateway Learning Exchange to our normal attendees so that anybody that had a difficult time accessing the meeting today can have access to the recorded presentation.

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