PART THREE OF A THREE-PART SERIES

FISH BY THE MILLIONS

Today's hatcheries give a nod to the past, but step straight forward into the future of fish culture and management.

WRITTEN BY JIM WILSON ILLUSTRATED BY TIM LEE

"It goes without saying that a fish hatchery has little excuse for being unless it is making a contribution to the sport of angling."

– Willis King,
N.C. Division of Game and Inland Fisheries, 1947

Although the artificial propagation of fish dates back to 1877 in North Carolina, the rise of the modern hatchery system began nearly 50 years later in 1925 when the N.C. General Assembly appropriated $500,000 to build new hatcheries across the state, with five locations in Waynesville, Marion, Boone, Roaring Gap and Fayetteville.

That lineup proved anything but static. The state leased the Marmon Hatchery in Pineola in the early 1940s and later bought that facility. It also ran the Weldon Hatchery on the Roanoke River for the production of striped bass, and by 1948, less than one year after the N.C. Wildlife Resources Commission was formed, began production at Table Rock Hatchery near Morganton.

Of the original five locations, only Marion, a coldwater facility, remains in the system. The current lineup consists of Table Rock, the lone coolwater hatchery; the Setzer Hatchery near Brevard and Armstrong Hatchery near Marion, both coldwater facilities; and warmwater hatcheries McKinney Lake in Richmond County and Watha Hatchery in Pender County.

Yet despite an interval of 125 years, at its heart the artificial propagation of fish has changed little since Stephen G. Worth, the superintendent of North Carolina's first fish commission, and his workers set out to grow fish to release in waterways all across the state.

The reasons for growing fish are different, the methods are much improved and the role of hatcheries within the Wildlife Commission has changed and continues to evolve, but the basics are still the same.

"The process hasn't changed very much," said David Deaton, fish production supervisor for the commission's hatcheries. "The concepts are pretty simple. You have to fertilize the egg and then maintain specific biological requirements for that particular species for successful reproduction. Our ability to identify and understand the biological requirements has increased over the years. By incorporating sound scientific principles and methods into the 'art of fish culture,' we have been able to produce a wide variety of species successfully and efficiently.

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Of all the fish cultured in the United States, probably none has received more attention than the various species and subspecies of trout. As far back as 1892, William P. Seal, aquarist at Woods Hole, Mass., described trout culture as "the nursery, the kindergarten, and college of fish culture."

Deaton described trout production as "in some ways, like following a cookbook. Trout have been produced for years so the basic ingredients and methods have been identified and put into practice. However, not all hatcheries are the same and production goals change to adapt to fishery management needs. For example the big shift we have made is the production of triploid trout."

Triploidization, the process by which a trout ends up with three sets of chromosomes instead of two, actually can occur in nature. A female trout's eggs possess two sets of chromosomes, the male's sperm have one set. After the eggs are fertilized, the chromosomes recombine, leaving the egg with one set of chromosomes from the female and the one from the male. The third set is rejected from the egg. Occasionally that fails to happen, and the egg is left with three sets of chromosomes, leaving the fish sterile. In all other aspects, the fish acts the same as other members of its species.

Fish biologists discovered that by either introducing the eggs to warm water or applying pressure to them, they could artificially duplicate triploidization. All of the trout stocked by the Wildlife Commission since 2007 are triploids. In 2010, more than 850,000 trout were released in the Mountains. Commission biologists use the pressure shock method for rainbows, brook trout and brown trout. This method has been found to be the most consistent and effective method to induce triploidy.

After trout eggs are collected and fertilized at the hatchery, they are placed inside a stainless-steel hydrostatic pressure chamber. Brook trout and rainbow trout eggs are under a pressure of 9,500 pounds per square inch (PSI) for five minutes; brown trout get 10,000 PSI for six minutes. The eggs are then triploid and sterile.

When the Division of Inland Fisheries decided to stock triploids, hatchery workers studied the available literature on the subject, then began testing. "We took the recipes from various published studies and compared or adjusted them," Deaton said. "We did multiple replicates of small batches with different recipes. We wanted the recipe that would produce the highest percentage of triploids, and had the greatest hatch and survival up to the first feed — 100 percent triploidy means nothing if survival is poor and the fish don't grow."

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The reason for stocking triploids primarily was to preserve the genetics of the North Carolina's only native salmonid, Southern Appalachian strain brook trout. "Although we do not stock in waters with native brook trout populations, we do not want northern strain brook trout from the hatchery to have the opportunity to mix with native brook trout," Deaton said.

Other advances in technology have benefited fish production among all species the commission grows. "As technology has evolved, we are now able to manipulate water temperatures, better monitor water quality, and utilize various chemicals to treat sick fish or aid in spawning.," Deaton said. "There are hormones we can inject fish with to synchronize the spawning process, such as carp pituitary for muskies. Technology has given us a more efficient way to produce fish."

A better understanding of fish themselves has aided production, also. For example, North Carolina's first fish commission struggled to produce and grow striped bass. On the Albemarle Sound, Worth once stripped the eggs from a female striped bass but did not have enough milt from males to fertilize his last container of eggs. He took several American shad bucks and squeezed sperm from them, mixed with sound water, onto the striped bass eggs. The combination bore little fruit, a 6-percent fertilization rate, and that only because there must have been striped bass sperm in the sound water.

Biologists now know that part of the problem with striper fertilization is that simply because a female is ripe with eggs does not mean those eggs are ready for fertilization.

"They were pulling fish right off the river, in various stages of development," Deaton said of the 19th century efforts. "Our understanding of striped bass egg development has evolved over time, and we know that there is a short time frame when those eggs can be spawned successfully. We observe spawning behavior in the tanks, and Jeff [Evans, Watha superintendent] will take a sample of eggs from each female and look at them under a microscope. The samples can be compared to pictures of eggs in various stages of development and a precise time for when each female should be spawned successfully can be predicted. There's a short window of time when ripe eggs can be successfully fertilized by the sperm to become viable eggs."

The other major change in hatchery operations that has allowed better production and survival is the advent of commercial diets for fish. "The technology involved in feeding now is pretty extensive," Deaton said. "Fish need water and they need food. Back then they fed what they had available. Today, we can purchase feeds for all life stages of most fish. These feeds are nutritionally balanced and efficiently grow fish with little waste. This results in improved growth and better water quality.

It wasn't even all that many years ago that fish were fed a diet of scrap meat, leaving a foul mess at the bottom of ponds or raceways. Some hatcheries even suspended the heads of cattle over the water to attract flies. The flies laid eggs that produced maggots, which fell into the water to feed fish. At Armstrong Hatchery, the doors to the feed room obviously are those of a meat locker.

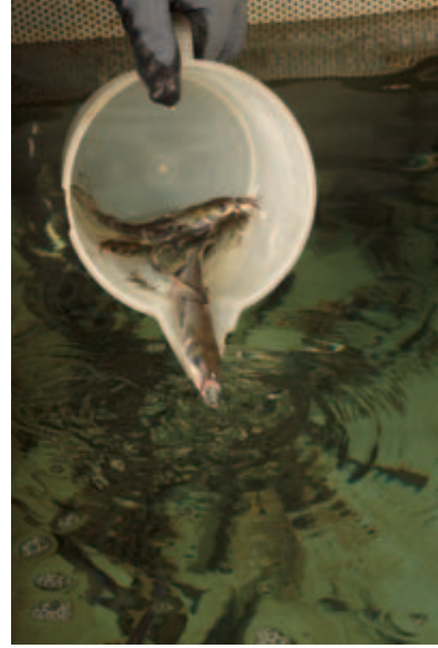
"I still have moist diet recipes in my files," Deaton said. "That was one guy's job. He'd come in the morning and start grinding meat. They'd take so many pounds of meat, so many livers, so many hearts, run it through the grinder to a certain size. They'd add bags of fish meal and make a paste or chunks out of it."

These days feed is composed primarily of fish meal, fish oil and vegetable material.

The commission's hatchery program is crucial to the Division of Inland Fisheries, affecting any number of programs, from trout and muskies to striped bass, American shad, channel catfish and numerous other species. The warmwater hatcheries provide all the catfish for the agency's Community Fishing Program. Last year that total approached 180,000 catchable catfish. The warmwater facilities in 2010 also produced 4.1 million American shad fry and 1.2 million striped bass of two sizes.

All told, the hatcheries produced 5.7 million fish last year, plus another 850,000 brook, rainbow and brown trout.

And to what end are those fish grown and released? In the 19th century, the focus of North Carolina's fish commission was entirely on food fish. Recreational fishing was not



PHOTOGRAPHS BY MELISSA McGAW/NCWRC

(Clockwise from top left) Matthew Turpin (left) and Landon Beaver weigh channel catfish fingerlings. The fish are carefully counted prior to transfer. Barry Midgette pours a bucket of catfish into a hatchery truck. David Deaton, fish production supervisor for the commission, cleans mussels at the Marion Hatchery.

PHOTOGRAPHS BY MELISSA McGAW/NCWRC

considered. The goal was to bring fish to the people. The commission stocked millions of American shad, an important food fish at the time, and also introduced common carp to the state. The thinking was that carp would become an important food fish.

Today, much of the work of the Wildlife Commission's hatcheries involves sport fish, although the agency has begun growing some endangered and threatened mussel species, an endangered fish — the spotfin chub — and the magnificent ramshorn snail. Even though various species of fish may be designated as sport fish, there are different reasons for culturing them.

American shad, stocked as fry, are part of an effort to help restore the species, whose populations have been in a long decline. Shad stocking has been ongoing in North Carolina since the 1870s, and was a major effort by that first state fish commission and the U.S. Fish Commission, which stocked hundreds of millions of them as fry in the Albemarle Sound.

Channel catfish, on the other hand, are intended to be caught, as are all the trout. And that brings up a longstanding misconception about the hatchery program in general and trout in particular.

"By far the biggest misconception about the trout stocking program is that it is to establish or restore populations of trout," said Doug Besler, coldwater research coordinator for the commission. "In the '80s we made a pretty clear distinction when we started our new trout management plan and said that if that a stream had wild, reproducing trout species in it, whether they be rainbow, brook or brown, then we shouldn't be stocking those streams at all. We would leave such populations to be wild, and they are in and of themselves unique resources.

"We decided we should put our stocking efforts into those locations that either couldn't sustain a year-round fishery either because the water temperature got too warm or the habitat, through sediment or some other human-induced impact, made it impossible for the stream to support trout year-round. We don't add streams to our stocking program that have a wild trout population. That misperception has persisted."

What anglers need to understand, Besler said, is that wild populations of fish are much more resilient than people give them credit for. As an example, he cited a devastating flood that occurred in Curtis Creek.

"It was amazing how much debris moved through that creek," Besler said. "There were oak logs 30 feet up in trees. The creek was scoured to bedrock and rubble. You would look at that stream and say there was nothing alive in there. We were up there two weeks after and found rainbow trout adults. Not many of them, but you would find an adult rainbow trout sitting in an area that had been blasted out. It was amazing those animals had survived that sort of turbulence. The next spawning class, you could tell no difference in the creek if you didn't know."

The commission's hatcheries are just as important in other regions of the state as they are in the Mountains. "The hatcheries play an integral role in how we do business here on the coast," said Kevin Dockendorf, the commission's coastal research coordinator. "That role will become even greater in the next decade as we get more and more into genetic analysis of fish."

Genetic analysis, which can be accomplished merely by clipping a piece of a fin for study, might replace the current marking method of using oxytetracycline (OTC), a common antibiotic, to stain a fish's otolith, a bone located in the ear. This marking allows biologist to determine hatchery or wild origins of fish. And while Dockendorf said that both methods have their limitations, genetic analysis does have a distinct advantage. "When we capture fish to check for the OTC marking, we have to sacrifice that animal to study the otolith. Its use is over at that point. We have to grind the otoliths to reveal the OTC marking. We don't have to sacrifice the fish with genetic analysis."

In the Coastal Plain, the commission is beginning to stock rivers with fish specific to that waterway. It is thought that the genetic adaptations in specific populations of fish will allow those stocked fish to better survive and grow in the wild. For example, last year the commission, and the Edenton National Fish Hatchery, stocked striped bass in the Cape Fear River grown from brood fish taken from that river and only that river. In 2011, American shad stocked into the Roanoke River system have come only from shad of Roanoke origins.

"For years we used striped bass brood fish taken from the Roanoke River," Dockendorf said. "And that's probably OK for reservoirs that receive an annual supplemental stocking. Looking at the genetic strains, however, there might be enough differences between the Cape Fear and the Roanoke to make a difference."

Overall, the hatchery system is operating close to its maximum production, but Dockendorf said the workers at those facilities often find ways to tweak production without increasing spending. "Hatcheries always look for better ways to produce the most fish they can from the brood stock they receive," he said. "They look for ways to minimize costs. For a long time, we used hormones to make shad spawn at varying water temperatures. But we found if you maintain the water temperature, you don't need the hormones. We've had American shad spawn for 60 days with no enhancement.

"These guys at the hatcheries, they're an amazing group of individuals who can grow all these animals for our mission. We have a great system, and working here on the coast, I can't speak more highly of the Watha Hatchery."

In short, the hatchery functions as a management tool for the Division of Inland Fisheries, whether it is to provide angling opportunities, help restore endangered species or help supplement dwindling populations of fish such as American shad. "Wherever there's a need to grow aquatic animals, that's where the hatcheries come into play," Deaton said. ◆

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A TROUT HATCHERY AND THE INDY 500

The Marmon Fish Hatchery at Pineola in Avery County is little more than a fading memory now. A number of folks can point out where it used to be, but its bones are gone, lost in the shuffle of time and people.

In its day, however, the hatchery was considered technologically cutting edge, especially for a privately built facility in a tiny Mountain town. And that's exactly what you might expect, given that the facility was built by a mechanical engineer and pioneer luxury automobile manufacturer who designed the race car that won the first Indianapolis 500 in 1911. Howard C. Marmon's triumphant car, the Wasp, named for its pointed rear end and bright yellow color, averaged 74.6 miles an hour in the race that took 6 hours and 42 minutes to run.

Marmon, of Richmond, Ind., developed a love for western North Carolina as a child when he spent summers in Linville with his parents in the late 1800s. Upon his retirement, he and his wife returned to the mountains and built an estate, Hemlock Hedges, in Pineola near the site of the present-day Linville Land Harbor. Marmon apparently was creating an idyllic life there. In addition to the main house, Marmon constructed a servants' house, a nursery to provide plants for his estate and the hatchery to supplement existing trout populations. He also constructed a dam on the Linville River at Pineola to form a small lake.

A story in the October 1943 edition of *Wildlife in North Carolina* announcing the leasing of the facility by the Division of Game and Inland Fisheries described the hatchery as being "unique in character. There are six long raceways averaging about twelve feet in width and as much as two hundred feet in length for holding trout fingerlings."

Each raceway had one concrete side, but the other side and the bottom were earthen, which was thought to be the best way to grow normal-colored trout in a hatchery.

The state had sold its hatchery at Boone in 1943, and replaced it by leasing the Pineola hatchery after Marmon's death the same year.

By 1947, when the modern Wildlife Commission was formed and subsequently purchased the Marmon Hatchery and 243 acres east of U.S. 221, the facility was producing almost 27,000 trout each year, at first primarily brown trout for stocking in the Linville and Elk rivers. The hatchery obtained water from a couple of sources, including Avery Creek, and could pump water into the raceways from either end. Its water was too cold in the winter for hatching trout, but was ideal the remainder of the year, which was the opposite situation from the Marion Hatchery. Thus the two facilities worked in combination, with Marion hatching the eggs and Marmon taking over the growing out of the fish to 7 inches in length.

That arrangement worked well until the mid-1960s when the commission decided to combine the work of the two hatcheries at the Marion facility.

The Marmon estate served as the Moose Club lodge for a number of years, but now stands empty and crumbling. But a vanished hatchery and decaying manor home are not the final legacy of Marmon. During his lifetime, he contributed much of the money used to build the little Presbyterian Church in Pineola, and his heir, Robert Morrison, upon his death, left funds to establish the Morrison Library in Newland, and trust funds to Garrett Memorial Hospital in Crossnore and Cannon Memorial Hospital in Banner Elk.

(Clockwise from top left) Fisheries technician Greg Dietzler puts male brown trout in a stunning solution prior to stripping milt from the fish. Gary Gouge releases some of the hatchery trout into an Ashe County stream. Trout eggs are poured into a hydrostatic pressure chamber where pressure will render the fertilized eggs sterile.