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Fish fry with yolk sac. Fry are examined under a microscope to ensure intestinal tracts are formed and functioning before the cohort is transferred to rearing ponds.

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Taking stock of state hatcheries

The art and science of raising fish is tricky in a tight economy.

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We use many tools to manage Wisconsin's fisheries. We protect, restore, and enhance aquatic habitat; survey fish populations and set appropriate harvest regulations. We develop and maintain boat launches and access sites. One of our important tools for restoring and enhancing fisheries – particularly those degraded by pollution, habitat loss and overfishing – is our state fish hatchery system.

We call on our fish hatcheries to restock lakes after winterkills or fish kills, to reintroduce native species and to supplement fish populations in waters with poor spawning habitat. We enhance fishing recreation by stocking urban ponds for kids fishing clinics, by maintaining catchable trout in Class 2 and 3 waters, or by surprising southern Wisconsin lake anglers with the occasional bonus musky or walleye. These activities are all crucial in supporting Wisconsin's $2.3 billion sport-fishing industry, including Lake Michigan's $200 million fishery, which is almost entirely dependent on DNR stocking.

We annually invest $5.4 million, more than 25 percent of our fisheries management budget in the 14 hatcheries and rearing stations, three Great Lakes anadromous egg collection weirs, and numerous outlying ponds that comprise our fish hatchery and rearing system.

Hatcheries contribute more than just stocked fish. They are a focal point for visitors, education, and building partnerships. Tens of thousands of people from every state and many foreign countries annually tour our facilities. At many of our hatcheries educational exhibits and displays teach about hatching and raising fish as well as the importance of clean water and good habitat to good fishing. We have also built some outstanding partnerships with conservation and angling groups around our hatcheries. These groups annually contribute cash and in-kind donations to help their favorite hatchery program operate. Sports groups also raise fish through cooperative fish rearing programs.

Right now our state hatchery system is at a crossroads. We have over $32 million in long overdue projects to rebuild and maintain the system. Critical facilities like our Wild Rose hatchery need renovation just to meet state environmental laws. The Natural Resources Board has approved a major development project to meet these needs, and we'll work with the Governor and Legislature to find funding for these projects in future state budgets.

Time to rebuild

The Wild Rose State Hatchery in Waushara County is ready for renovation as soon as budgets allow. The hatchery now produces about a quarter of the trout and salmon, two-thirds of the northern pike and all the lake sturgeon and spotted muskies stocked by DNR fisheries statewide.

Engineering studies funded in the last two years call for a $22.5 million investment to essentially build a new coldwater hatchery for trout and salmon, and a warmwater hatchery for northern, musky, walleye and sturgeon. Many of the existing buildings and fish raceways located on former wetlands would be abandoned and the wetlands restored. A portion of this historic hatchery built by the Civilian Conservation Corps would be preserved as a visitors' center. If approved, crews would construct a new aquaculture water supply to replace the aging artesian wells.

Artesian springs that flowed under natural pressure served the hatchery well for decades and made Wild Rose one of the most economical hatcheries to operate. Now, however, those artesian wells don't comply with current laws. Water quality problems include pathogens, siltation, excess dissolved nitrogen, low dissolved oxygen and storm water runoff that have limited fish production and caused disease problems.

Competing with nearby developments for water

Nevin State Hatchery in Dane County is renowned for raising wild strain brook trout for stocking and wild strain brown trout for stocking and brooding. By raising brood stock, we don't have to remove adult fish from rivers to meet our production goals. Six artesian wells and two springs provide 1,400 gallons of water per minute to the hatchery. We face a challenge in maintaining a buffer around the hatchery to protect the water supply in an area that is quickly being developed. Commercial properties and many subdivisions growing near the hatchery draw water from the same supply.

Encroaching development concerns managers of the Nevin State Fish Hatchery, as private land owners and businesses draw more water from the same aquifer and flows from artesian wells decrease.

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The hatchery would like to run its water supply through a central degassing area to remove excess nitrogen gas and add more dissolved oxygen before water flows to fish batteries and raceways. Hatchery crews also want to upgrade some outside raceways with covers to protect against predation. Other improvements would better handle discharge water, remove sludge more efficiently and, perhaps, recirculate hatchery water if incoming flow rates diminish.

The Osceola Hatchery has produced fish for stocking in Wisconsin since 1860, first as a private hatchery and then as a state hatchery since 1925. The facility adjoins the St. Croix River in western Polk County near the Minnesota-Wisconsin border. CCC crews last rebuilt the hatchery in the early 1930s. Seventy cement-walled raceways with compacted sand bottoms provide 5,800 linear feet of space to raise trout. The raceways are fed by 39 to 40 artesian wells that provide a constant stream of 48° water year-round, under natural flow with no pumping.

Though the artesian water is of excellent quality for raising fish, the water supply has steadily dwindled as nearby land continues to be developed for houses. Hundreds of private homes have been built east of the hatchery within a 1.5-mile radius. In the last 25 years or so, this has reduced water flow in the hatchery's artesian wells from 2,000 gallons a minute to less than 1,200 gallons a minute. Water flow has further decreased following a series of dry years in western Wisconsin. Moreover, well water is now much higher in dissolved nitrogen gas, which must be aerated and removed before it is usable in trout raceways. Greater water flow would also reduce nitrogen, but the prospect of sinking deeper wells in the area might reduce water flow to some private homes that encroach closer and closer to the hatchery each year.

Osceola is home to the state's famous Erwin brood stock, a strain of rainbow trout imported from Montana 15 years ago. These trout are hardy, easy to raise and are readily caught. They are the mainstay of the state's put-and-take trout waters where yearling fish can be stocked just in advance of fishing season's Opening Day, providing angling pleasure to thousands of fishers. More than 300,000 trout fingerlings from the facility are also raised and transferred to other state rearing facilities for stocking. A wild strain of brown trout is also raised at Osceola for stocking in inland Wisconsin streams.

Raceways haven't been rebuilt since they were installed in the 1930s. The facility needs to be overhauled. Suggested improvements include constructing new raceways and taking steps to ensure a reliable water supply with a large, steady flow.

Pumping out iron

Nearly 75 percent of the coho salmon that Wisconsin stocks in Lake Michigan are reared or transferred from the Lake Mills Hatchery in Jefferson County. These fish grow best in cold water (in the low 50° range), and the two high-capacity wells that feed the coho raceways supply 600 to 900 gallons per minute of 52°F water year-round. The uniform temperature and flow through concrete raceways allows DNR to raise approximately 400,000 coho fingerlings in the hatchery at one time.

Historically, the wells at Lake Mills have had an iron bacteria problem. As the iron bacteria grow inside the well and pump, the bacteria narrow the inside pipe diameter consequently decreasing the amount of water that can reach the surface. The pumps clog or break down over time and fail. One solution is to treat wells with chlorine in the fall after the fish rearing season ends. These treatments have been moderately successful, but the wells are quite deep (more than 300 feet) and the bacteria eventually return. Steam injection could also kill iron-reducing bacteria, but we've yet to find contractors who can inject steam deep enough to sterilize such deep wells. Given tight budgets, finding money to either drill a third well or pay for annual/biennial chlorination and well inspection remains a challenge.

Helping plug leaky ponds

DNR hatchery crews at Lake Mills raise small walleye fingerlings in 27 earthen ponds that range in size from 0.5- 1.6 acres. Some of the ponds were dug by hand back in the early 1930s, others in the late 1950s and early 1960s. A quarter of them were renovated in 1961, the rest have outlived their life expectancy.

Compacted clay liners under the ponds and harvest kettles have cracked following years of freeze and thaw cycles. Since the kettles form the low end of each pond, they act as built-in tanks where hatchery workers can collect the small fingerlings as they drain the pond. Harvest kettles eliminate the need to seine small fish out of the ponds, which can stress and kill the young walleyes.

In these old ponds, frost and time have caused cracks, especially at the drains as the cement heaves and settles each spring. For years we had been largely unsuccessful in developing economical repairs for this problem. In the fall of 2001, funds from sportsmen's clubs repaired a pond we hadn't been able to use for nine years. We harvested more than 80,000 small fingerling walleyes from that pond this year. Three other ponds were repaired this fall, thanks in large part to donations from the Lake Koshkonong Recreation Association. Such donations are critical as more ponds begin to fail.

Refining the art of raising fish

Working year in and year out with a live product like fish teaches the observant hatchery crews how tinkering and small changes can lead to big improvements. Here are some changes that have paid off.

At the Art Oehmcke Hatchery in Woodruff, producing strong, healthy muskellunge fingerlings begins when the eggs are collected on the local lakes from wild spawning fish.

Fertilized eggs are brought back to the hatchery to begin two-week incubation . The jars or “batteries” receive a continuous supply of gently flowing clean water that is well oxygenated and temperature controlled. Water drawn into the hatchery from Madeline Lake is disinfected using ultraviolet light just before it enters the incubation jars. The water passes through a six-foot PVC plastic pipe that is lined with UV fluorescent tubes. The UV light kills nearly all of the bacteria and fungi before they can attach to the healthy, developing eggs. The unit sterilizes 90 gallons of water a minute. Fry hatch in 14 days and spend another 14 days in the hatchery jars slowly absorbing their yolk sacs before they are released to rearing ponds.

Hatchery crews report three tremendous production years since this disinfection system was installed. Production goals have been exceeded and last year almost twice as many fish survived for stocking. A nice aspect of using UV disinfection is there is no carryover and no chemical residues once the water is sterilized. Crews are currently testing this same disinfection system when raising lake trout.

Surfactants and a dash of salt calm fish en route

As we raise fish, we are well aware that hatchery activities can stress young fish in ways that cause direct or premature mortality. Hatchery fish are especially vulnerable when they are old enough to be harvested and transported by truck for stocking in a lake, river or stream. This is when they are handled most by people, jostled in a truck and released to a new environment where they must fend for themselves.

We’ve learned handling techniques that can minimize stress. As we transport the fish, we maintain the same comfortable water temperatures, oxygen levels and pH levels that helped these fish thrive in the hatchery. We don’t feed the fish for a while before they travel and we minimize human contact. We also add set amounts of common table salt and anti-foaming agents to the holding tank waters.

A short lesson in fish physiology will explain why this makes sense. Just like people, when fish become stressed their metabolism speeds up and they respire much more quickly. They use up their energy reserves and excrete waste by-products. If the stress is great enough or lasts long enough, fish can die. Even if fish don’t die during transport, they can get weak enough that they die later or their immune systems are suppressed and they become abnormally susceptible to disease. Weak fish are also easy targets for predators in their new environment.

The most common by-products fish excrete are also the most threatening: carbon dioxide ($CO2$) and ammonia ($NH3$). While either can be lethal to fish, in combination they are very lethal. These chemicals can only be removed from a fish’s environment in two ways, either through a thorough flushing with fresh water or through diffusion to the atmosphere. Under suitable water conditions, these toxicants may be converted to non-lethal compounds by reacting with chemical ions in the water. Unfortunately, when fish are being transported it is normally under highly crowded conditions in closed, confined tanks where water exchange is non-existent and exposure to the atmosphere is limited. It is critical to use every available method to alleviate problems.

Adding table salt (sodium chloride) at a concentration of 0.5 – 1 percent (approximately 4 – 8 lbs. of salt /100 gallons of water) provides two useful benefits when transporting fish. First, salt serves as a source of ions to replenish the electrolytes fish expend when stressed. These ions remove ammonia from their rapidly respiring cells. Second, salt may kill parasites and bacteria, thus, assisting the fishes' immune systems. Stressed fish secrete mucus rapidly from their skin and gills. The salt helps strip the mucus away from their gills and skin, removing bacteria that might infect the fish.

Adding surfactants (anti-foaming agents) serves another purpose. As fish move in tankers from hatchery to pond, their mucus secretions float and form a slimy impenetrable barrier on the water's surface. Respired gases can't escape to the atmosphere. If foam builds up on the water surface, environmental conditions in the tank deteriorate rapidly. Anti-foaming agents made of food-grade silicone eliminate surface foam by breaking down the proteins in the fish mucus. The ammonia and carbon dioxide gases can be more easily stripped away from the hauling water.

Salt and surfactants are just two of many tools and techniques hatchery crews use to keep operations efficient in our aim to raise, transport and stock quality fish.

Liquid food for thought

Before we can raise several hundred thousand walleye fry for stocking, we have to have food on hand to feed them. Like all youngsters, walleyes are hungry, but unlike people, walleyes will cannibalize each other if the groceries run short.

For years, hatchery technicians would fertilize the ponds two weeks before the three-day-old walleyes arrived. Technicians added tons of organic fertilizers (soybean meal, alfalfa meal and torula yeast) to stimulate blooms of single-celled green algae (not the filamentous, matted type). These algae feed zooplankton (tiny microscopic animals) that are a vital food source for larval fish. It's very important to stretch algal and zooplankton blooms across each rearing pond to provide abundant food for the quickly growing walleyes.

We found the organic fertilizers produced inconsistent results. Sometimes the grain meals took two weeks to break down. Sometimes they caused filamentous algal blooms late in the rearing process, and that got in the way when 1.5- to 2-inch walleye were ready for harvest 40-50 days after stocking.

After renovating one of the rearing ponds at Lake Mills in 1992, we raised 700,000 walleye fingerlings, a dramatic improvement from our 400,000 average year. Unfortunately, the numbers dropped again from 1993 to 1997. We just couldn't duplicate that success even though we used the same fertilizer, rates and rearing ponds.

In winter of 1998, we met Dr. David Culver (Ohio State University) who had been experimenting with inorganic fertilizers (liquid phosphorus and nitrogen) in Ohio DNR's walleye rearing ponds. Dr. Culver explained that keeping the ratio of nitrogen to phosphorus at 20:1 was critical for getting the best growth of the algae we wanted. By testing the ponds on a weekly basis and spraying just ounces of liquid fertilizers, we could control algal growth – too little or too much fertilizer would stimulate growth of the less desirable filamentous algae.

We set up water quality tests with George Bowman at the State Lab of Hygiene to analyze pond samples every week in the ponds receiving liquid fertilizers. In 1998, we produced 700,000 small walleye fingerlings using these techniques. In fact, for the last three years (2000 to 2002) we have produced over 1.1 million small walleye fingerlings annually with the new fertilization program.

This last year, when the State Lab was too busy to handle our samples within the 24-hour turnaround we needed, lab personnel lent us some portable testing equipment and trained hatchery personnel to do the tests onsite. The results were good. We raised more than 1.7 million walleyes, a new Lake Mills record. We're still working out some bugs, but the new technique is a real success.

Bottlenecks to production

Hatchery work has always required a blend of art, science and careful observation to raise as many fry as possible to stocking size, notes Al Kaas, DNR's statewide hatchery coordinator.

"Attending to the bottlenecks for young fry can mean the difference between zero return and 99 percent return from our ponds," Kaas says. "You've got to get through the hurdles one by one because you can't make more fish once they've died. We look at where our biggest losses are and then work back to try and prevent them."

For instance, in recent years, roller coaster spring weather – warm temperatures, followed by a plunge back to snow and cold, then a quick warm-up – meant the temperature of river water that fed the hatchery incubators was too cold compared to the water temperature in the rearing ponds. Colder water during incubation can trigger slower cell division that can cause a lot of birth defects like fish with extra vertebra or other deformities. Incubation water temperature is more of an issue for warmwater fish, rather than trout and salmon.

Renovations at the hatcheries in Spooner and Woodruff during the last five to seven years allows hatchery crews to add heated water or colder water to the incoming water supply to approximate the temperature in the rearing ponds where the fry would be transferred after they absorbed their yolk sacs.

"The trick is guessing what the weather's going to be like ahead of time and matching the temperatures in the incoming water and the rearing ponds," Kaas says. "We're trying to mimic nature as much as possible, but without the drawbacks you might encounter in nature, like cold spells."

Once eggs hatch, crews try to keep together fish that hatched within one to three days of each other.

"Same age fry means there's very little difference in their size – it doesn't take a lot of difference in size before these fish start eyeballing each other as food if there's not enough plankton in the rearing pond," Kaas says

"Then we look at the fry to see how the yolk sac is being absorbed and the gut is closing," he says. "We used to rely solely on the number of days after hatch. Now we look at them under a microscope. That way, we can look for a number of problems. If we find bubbles, that could mean nitrogen gas has supersaturated the water."

Protein in the yolk sac can coagulate and clog up the developing intestinal tract, preventing it from "buttoning up" so that food can pass through. We've learned it's safer to handle fry after the gut has closed up and place them into the rearing ponds at that point.

Once the fish have been transferred to the rearing ponds, the staff regularly observe and carefully examine fish. They measure the ponds daily for dissolved oxygen and clarity. Weekly, crews sample fish to monitor growth rates and look for signs of trouble. Fish with sunken bellies may not be getting enough food; fish cruising the shore of the rearing pond could mean the same.

Choosing when to stock fish can also cause a bottleneck. Hatcheries used to believe in growing walleye fingerlings as big as they could before stocking. Now, we've discovered it's best to stock walleye while they're still feeding on zooplankton so they can make an easier transition to lakes and won't need to eat other fish immediately to survive. By dropping the stocking size from 2 ½ to 1 ½ inches, the fish are in better shape and survival has increased significantly.

DNR research scientists and fisheries biologists are also evaluating the survival rate if walleye are stocked in the fall rather than in spring. Thus far, the costs of feeding young walleye forage fish for a long time has been prohibitive.

Musky managers, on the other hand, learned the importance of stocking larger muskies to increase their chances of survival.

Staff observations and careful examination are the keys to reducing bottlenecks and meeting the goal of stocking fish that stand a better chance of surviving long enough to interest anglers. Experienced, educated and astute staff keeps the state hatcheries as productive as aging facilities will allow, Kaas says. Most hatchery personnel have either a four-year degree in biology or a two-year aquaculture degree from technical schools, and are longtime employees. Staff also get the opportunity for additional training through U.S. Fish and Wildlife Service classes.

“We tend to hire people who are naturally curious and problem solvers, Kaas says. “Given the challenge of producing live products in aging facilities and tightening budgets, our staff need to stay inventive and observant.”

DNR Hatchery Coordinator Al Kaas; Bureau Director Mike Staggs; hatchery managers Steve Fajfer, John Komassa, Lee Haass, Gary Lindenberger, Bob Fahey, Bruce Underwood, and writer Lisa Gaumnitz contributed to this story.