

# Eddies

*Reflections on Fisheries Conservation*



*Coltman*

# Eddies

Vol. 1, No. 3

## Publisher

Gary Frazer, Assistant Director  
U.S. Fish and Wildlife Service  
Fisheries and Habitat Conservation

## Editor

Craig Springer

## Contributing writers

Linda Andreasen	Ryck Lydecker
Robert Bakal	Mark Madison
Josh Bradley	Joe Moran
Ann Gannam	T. Edward Nickens
H. Dale Hall	Ken Phillips
Irene James	John Tertuliani
Todd E.A. Larson	Judy Toppins

## Editorial Advisors

Darren Benjamin, U.S. Fish and Wildlife Service  
Richard Christian, U.S. Fish and Wildlife Service  
Stuart Leon, Ph.D., U.S. Fish and Wildlife Service  
Ryck Lydecker, Boat Owners Association of the United States  
Hal Schramm, Ph.D., U.S. Geological Survey  
Michael Smith, U.S. Fish and Wildlife Service (retired)  
Denise Wagner, Wonders of Wildlife Museum

## Assistant Regional Directors – Fisheries

Dan Diggs, Pacific Region  
John Engbring, California and Nevada Region  
Jaime Geiger, Ph.D., Northeast Region  
Linda Kelsey, Southeast Region  
Mike Oetker, Southwest Region  
LaVerne Smith, Alaska Region  
Mike Stempel, Mountain-Prairie Region  
Mike Weimer, Great Lakes–Big Rivers Region

## Contact

For subscription information visit our web site,  
[www.fws.gov/eddies](http://www.fws.gov/eddies), email [craig\\_springer@fws.gov](mailto:craig_springer@fws.gov),  
call 505 248-6867, or write to:  
Eddies  
USFWS Fisheries RM 3118  
500 Gold Ave. SW  
Albuquerque, NM 87103

## Design

Blue Heron Communications

## On the Cover

A northern pike lingers in the shade of lilies in this 1971 Bob Hines painting. Read about it on page 14.



*Departments*    **Headwaters**    **3**  
                          **Watermarks**    **4**  
                          **Pioneers**         **8**

**American Fishes** **10**  
**Meanders**         **30**

## Features



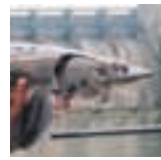
**Cryogenics for Conservation—12**  
*Irene James*



**From Horse Heads to Pellets—22**  
*Dr. Ann Gannam*



**Bob Hines—A Man of Art—14**  
*John Tertuliani*



**Fishingenuity—24**  
*Craig Springer*



**Fighting the Amphibian Fungus—20**  
*Dr. Robert Bakal*



**Diagnosing Disease—28**  
*Ken Phillips*



*U.S. Fish and Wildlife Service artist, Bob Hines, drew this 1956 postage stamp. See more of his work on page 14.*

***The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people.***



# Headwaters

## Science and the Sublime

By Gary Frazer



Some consider art and science mutually exclusive. But both endeavors come from, and create, inspiration.

In this autumn issue of *Eddies* we mix fish art and fisheries science. In every autumn issue in years out, we intend to bring to you more fine fish art to delight your eye and inspire your mind. The late Bob Hines is first up, his biography told by John Tertuliani. Hines was one of ours – the only national artist ever in our employ. He was as talented as he was committed to conservation. His northern pike lurks in the weeds on our cover waiting for a plug to plunk on the water.

We also profile some of the scientific prowess residing within the U.S. Fish and Wildlife Service's Fisheries Program.

Dr. Ann Gannam proffers that fish nutrition isn't what it used to be in her "Horse Head" story. She chronicles how fish diets evolved from the crude and coarse to the refined and complex, based on science, much of it conducted by the U.S. Fish and Wildlife Service.

Irene James tells us about the imperiled pallid sturgeon and how cryogenics, borne of exigency two decades ago, may be the science to carry 20 or more fish species into the future. Freezing and storing sperm cells for conserving fish is science-fact, but with science-fiction patina.

In "Fishingenuity" you will get a snapshot of the conservation genetics work of Drs. Meredith Bartron and Greg Moyer. H. Dale Hall, Director of the U.S.

Fish and Wildlife Service, muses in "Meanders" on how the past made him, and how science makes a future for fisheries conservation.

We have an impressive, thoroughly trained, and highly specialized workforce. We have world-class applied research capabilities in raising fish, nutrition, conservation genetics, fish health, and aquatic animal drug approval, providing service and support to our field stations, state agencies, Indian tribes, the aquaculture industry, and the Food and Drug Administration. We have been developing and applying new knowledge since our inception 137 years ago, and we make this information available through the published scientific literature, the breadth of which is illustrated on the back cover.

The U.S. Fish and Wildlife Service's scientific capabilities have been bolstered in recent years by the leadership of the Office of the Science Advisor to the Director and by the work of the U.S. Fish and Wildlife Service Science Committee. Through their collective efforts to advance science excellence within the U.S. Fish and Wildlife Service, everyone in the U.S. Fish and Wildlife Service, from the Director on down, adheres to a Scientific Code of Professional Conduct; we have vibrant Communities of Practice, such as one recently formed on conservation genetics; we have strong agency support for participation in professional societies; we have re-established U.S. Fish and Wildlife Service publication outlets; and we all have ready access to a large body of scientific literature on-line through our Conservation Library at the National Conservation Training Center in Shepherdstown, West Virginia.

As the adage goes, science isn't a destination; it's a journey. Science is never done, as there will always be something more to learn – it is cumulative. By keeping our technical capabilities sharp, and constantly growing and applying new scientific knowledge, our efforts at fisheries conservation are more effective. That's good for fish and good for people.

Enjoy the art! I hope it helps inspire in each of you, as it does in me, the desire to learn and achieve even more.

---

Gary Frazer is the Assistant Director for Fisheries and Habitat Conservation in Washington, DC

## Florescent fish



Thomas Bell/USFWS

*Bony scutes and other hard parts on this shovelnose sturgeon show calcein stains.*

Fish biologist Jerre Mohler at the Northeast Fishery Center in Lamar, Pennsylvania, first discovered that the non-toxic fluorescent dye, calcein, can efficiently mark fish in large numbers. He reported that in the scientific journal,

the *North American Journal of Fisheries Management* (NAJFM) in 1997, saying of his Atlantic salmon research, “Results suggest that calcein may be a valuable tool for mass-marking larval fish for long-term hatchery product evaluation.”

With the hindsight of history, it seems grossly understated. Calcein is used worldwide to mark fish for population studies. It helps scientists to understand mortality rates and the success of hatchery fish in the wild.

The dye stains fish bones and other hard parts, like scales. In a process that takes about eight minutes, large numbers of small fish are marked via immersion in water mixed with the dye. The mark isn’t visible to the naked eye, so Mohler invented a flashlight that researchers use to read the brilliant marks on fish and assigned the patent to the U.S. Department of the Interior.

Because waste water mixed with calcein can’t be released into streams, Mohler and Kelly Bradley from Lock Haven University researched ways to remove it from the water, and found one. They reported such in August in the NAJFM, thus opening up more uses for the dye with fishes like America shad. ♦ Craig Springer

## Do your best – for the brookies

The Cub Scout motto, “Do Your Best,” was in action in August at the Jordan River National Fish Hatchery. Pack 17 of the Scenic Trails Council, East Jordan, Michigan, made history by being the first entity to exercise provisions of the National Fish Hatchery Volunteer Act of 2006. Congress authorized in the Act the ability for the U.S. Fish and Wildlife Service’s Fisheries Program to accept monetary donations for conservation, and Pack 17 came through in a big way with \$467 in bake sales. The donation bought a rearing tank that will be part of Jordan River’s Baby Brookies program, where fifth- and sixth-graders at Mancelona Public Schools will monitor the growth of brook trout. It’s all

part of Imaginature, an after-school collaboration conceived at the Hatchery. The boys are led by Cubmaster Jon Sumner who is also Vice-President of the Friends of the Jordan River National Fish Hatchery. ♦ Joe Moran



Joan Moore

*Charlie Wooley (l), Deputy Regional Director of the Great Lakes - Big Rivers Region, accepts the check from Pack 17.*

## Urban salmon face storm water foe

Fix the habitat, the fish will come. And they might die, says research into the effects of non-point source pollution on the health of salmon in urban watersheds. Jay Davis, a contaminants specialist from the USFWS’s Western Washington Fish and Wildlife Office, and Nathaniel Scholz of NOAA Fisheries examined the effects of storm water runoff on salmon spawning in streams near Seattle. The work revealed that in 2007, 73 percent of female coho salmon died before spawning in Longfellow Creek where fish habitat had been restored. Davis and Scholz learned there’s more to habitat than pools and riffles. Heavy metals and pesticides wash into the creek and thwart salmon reproduction. ♦ Craig Springer

## Twenty-five years of striped bass conservation

The genetically unique Gulf Coast-strain of striped bass was once common to rivers pouring into the Gulf of Mexico. By the 1960's, its population had declined significantly due to poor water quality and loss of habitat from a wave of dam construction. The last known population of native striped bass survived in low numbers in the Apalachicola-Chattahoochee-Flint (ACF) river system in Florida, Georgia and Alabama.

Twenty-five years ago, these states and the U.S. Fish and Wildlife Service formed a powerful partnership to restore Gulf striped bass in the ACF. Some remarkable achievements have been made. We know more about its life history and its genetic integrity is safeguarded. The partners evaluate each year the stocking success and food availability; a young-of-year index estimates year-class strength; creel surveys

evaluate recreational fishing; and telemetry studies have revealed the waters that provide essential temperatures the fish need. And now many of those coolwater habitats have been protected or rehabilitated. Recreational fishing in these places is carefully managed. Through the partnership, Radium Springs on the Flint River was purchased for habitat protection. Dead Lake Dam on the Chipola River was removed, and the operations at other dams have improved. Biologists have evaluated fish passage problems throughout the basin.

Seven state and six federal hatcheries cooperatively stock more than one million Gulf striped bass a year. New recreational fisheries have been created, and anglers have set exciting new records. This work has been a catalyst for striped bass restoration throughout the Gulf region. Today, Louisiana, Texas and Mississippi are



Florida Fish and Wildlife Conservation Commission

*Gulf Coast-strain striped bass are on the comeback thanks to 25 years of conservation work.*

helping this remarkable 25-year-old partnership ensure the success of this unique and important fish across much of its historic range. ♦ Judy Toppins

## FEATURED FACILITY

### Warm Springs Regional Fisheries Center

**Where:** Warm Springs, Georgia  
**When:** As Warm Springs National Fish Hatchery in 1899

**Then:**  
It was 150 years ago that folks first flocked to the waters of Warm Springs for health. The year-round 88-degree waters were thought to have healing properties. President Franklin Roosevelt visited. The “Cold Springs” of Warm Springs feeds the hatchery, providing 63-degree water ideal for rearing fish.

**Now:**  
Warm Springs is still a place for health – fish health. In 1989 a Fish Health Lab was added; a few years later Warm Springs grew to include a Fish Technology Center. The Regional Fisheries Center provides state-of-the-art fish disease diagnostic services. Scientists innovate technology for conservation.



USFWS

*An aerial view of Warm Springs Regional Fisheries Center, Georgia.*

They cooperate with other natural resources agencies on conservation genetics, cryopreservation, fish-strain information, and triploid grass carp certification. Shortnose, lake, and Gulf sturgeons, paddlefish, robust redhorse, and the Gulf Coast-strain striped bass receive the attention of Warm Springs' staff. See [www.fws.gov/warmsprings](http://www.fws.gov/warmsprings) ♦ Judy Toppins

## Flooded Iowa hatcheries get rainbow trout



Gary Siegwarth/Iowa DNR

*Big Spring State Fish Hatchery under water.*

Flood waters covered more than Iowa's corn fields last summer. Two of the Iowa Department of Natural Resources fish hatcheries were inundated and a quarter-million trout were lost. The Manchester Fish Hatchery and Big Spring Fish Hatchery lost some of their brood stocks, and most of their fingerlings and catchable-sized fish. But all is

not lost; Ennis (MT), Garrison Dam (ND), Genoa (WI), Neosho (MO), and White Sulphur Springs (WV) National Fish Hatcheries helped make up the deficit, sending 125,300 fingerling rainbow trout and 178,300 fertilized eggs to Iowa. The stocking program will be on track in 2009-10, noted Iowa DNR supervisor, Mike Mason. "We've always worked closely with the U.S. Fish and Wildlife Service and see them as a vital partner in conserving and enhancing Iowa's natural resources" said Mason. "Anglers to Iowa's 45 put-and-take streams and urban trout lakes will be the beneficiaries of the fish." ♦ Craig Springer



Doug Aloisi/USFWS

*Jim Luoma, Genoa National Fish Hatchery, and Brian Lacey, Iowa DNR (on truck) load trout for Iowa anglers.*



Gary Siegwarth/Iowa DNR

*Big Spring State Fish Hatchery*

## The Ethical Angler

BoatU.S. Chairman and Founder, Richard Schwartz, and U.S. Fish and Wildlife Service Director H. Dale Hall signed an agreement in September to use "The Ethical Angler" creed to remind the public of the great tradition of fishing and its role in conservation. The creed's responsible fishing practices are based on the word "ANGLERS":

**A**void spilling and never dump gasoline, oil or other pollutants - on land or in the water.

**N**ever leave trash behind, including worn line, old hooks and bait, and practice recycling.

**G**ain knowledge about aquatic nuisance species and how to help prevent their spread.

**L**earn and abide by all fishing regulations and boating laws.

**E**ducate fellow anglers and especially new participants about fishing ethics.

**R**espect private property and the rights of other anglers and outdoor recreationists.

**S**ave fish for tomorrow by practicing conservation and learning proper catch-and-release techniques. ♦ Ryck Lydecker



## Short in size—long on data

Passive Integrated Transponders, or “PIT” tags, tell biologists a great deal about individual fish that have been tagged and released, and caught again. The tiny tags come in different data formats from several makers – and that’s a problem we know from science published in the *North American Journal of Fisheries Management*. PIT tags are placed under a fish’s skin, and an electronic reader records the tag’s unique information. Biologists at Bears Bluff National Fish Hatchery in SC tested 20 different transmitters and 11 different readers and learned they don’t all perform well. Their findings reveal the need to use standard equipment in tagging studies of fish that travel long distances over state lines, like sturgeon and paddlefish. Researcher James Henne said without standard gear, fish can go undetected resulting in incorrect estimates of population sizes. ♦ Craig Springer

## A “New Deal” for fish turns 75

In 1933, 30,000 vagrant young men roamed the roads and rails looking for work. Not until the Civilian Conservation Corps and other work programs did they find it.

FDR’s New Deal turned 75 years old this year; labor from the CCC, WPA, and PWA built Chattahoochee Forest (GA), Creston (MT), Dexter (NM), Genoa (WI), Inks Dam (TX), Hagerman (ID), Lamar (PA), Natchitoches (LA), Uvalde (TX) and Welaka (FL) National Fish Hatcheries – all still in operation.

National Fish Hatchery System facilities are on average 64 years old. ♦ Craig Springer



Library of Congress

Posters like this one encouraged young men to find work with the CCC.

## POSTCARDS

### San Marcos National Fish Hatchery



The original San Marcos National Fish Hatchery was established in 1897 near the headwaters of the San Marcos River in Texas. It was the first warmwater hatchery west of the Mississippi River. The hatchery stocked largemouth bass, bluegill and channel catfish. This hatchery also conducted some of the earliest studies on the South African fish, tilapia. The original hatchery was turned over to Southwest Texas State University in 1965. It was replaced in 1978 by the San Marcos National Fish Hatchery and Technology Center. The new Center has a greatly expanded mission of providing refugia for federally threatened or endangered plants, invertebrates, amphibians, and fish. ♦ Mark Madison

By Dr. Todd E.A. Larson

## Dr. James Alexander Henshall



Dr. James Alexander Henshall

Todd E.A. Larson

During his lifetime, Dr. James Alexander Henshall (1836-1925) had many sobriquets, from the “Apostle of the Black Bass” to the “Dean of American Anglers.” He was arguably the first, and undoubtedly became the second. But an aspect of his career that nearly always gets overshadowed is his writings on fish culture. Henshall himself considered these writings among his most important contributions to fishing in America.

The last decades of the nineteenth century were the golden age of fish culture, and Henshall was among the earliest American experts. He was a frequent contributor to both *Forest & Stream* and *The American Angler*, the premier outdoor journals of their day, contributing dozens of full-length articles and hundreds of letters to the editor—many of them on the subject of fish culture.

His name will forever be connected to the bass, in large part because nearly a half million copies of his *magnum opus* — *The Book of the Black Bass* (1881) — have been printed over the years. Yet it was his experience at an Oconomowoc, Wisconsin, brook trout hatchery post-Civil War that would make a most formative event. Henshall served the Union troops as a doctor in Cynthiana, Kentucky, for most of the war. He was “behind enemy lines” when Gen. John Hunt Morgan raided the area, and it is likely he administered to soldiers on both sides. After the war, he headed to Wisconsin.

“I was a frequent visitor at this hatchery,” Henshall wrote in his *Autobiography*, “and became pretty well versed in the method of trout culture.” Beginning in 1868 he took this knowledge and first applied it to the breeding of bass.

Although he is better known today as a promoter and historian of fishing tackle and techniques, much of the last half of his life was spent in earnest study of various fish and their artificial breeding. He wrote on a multiplicity of subjects, from exploding the myth of the “Gogebic Razor-Back,” emaciated smallmouth bass suffering from tapeworms once thought to be a new species, to discourses on the peculiarities of fish eggs. In 1888 he was named secretary of the Ohio Fish Commission and would soon become its president; during this same time he was also an officer of the Cincinnati Society of Natural History and edited this association’s prestigious journal in the 1890s.

Having been an active member of the American Fisheries Society since its founding in 1870, he read important papers at the national conference for many years, and eventually served as president (1891-92). He resigned this position to take charge of the legendary fisheries exhibit at the Columbian Exhibition in 1893. The success of this World’s Fair exhibition further added to Henshall’s fame, and perhaps it was because of this that he was nominated to fill the post of U.S. Fish Commissioner in 1896. Backed by three cabinet members, five governors, and dozens of other political luminaries, it was expected that his nomination would be rubber-stamped by another angler of renown, President Grover Cleveland. The job went instead to Captain John Brice, the cousin of the influential Senator Calvin Brice. Henshall never let on if he was embittered by this event, and recorded in his *Autobiography* that he simply said “*sic transit gloria*, and wrote a letter of congratulations to my friend Captain Brice.”



Laura Dobbins/USFWS

This former home of James Henshall at Private John Allen National Fish Hatchery now houses the Tupelo Garden Club. The building is on the National Register of Historic places.



His disappointment may have been tempered when in late 1896, Brice asked him to rejoin the Fish Commission, now operating under civil service jurisdiction that required Henshall to take a series of exams. He was offered his choice of three new National Fish Hatcheries in Texas, Iowa, or Montana, and perhaps to the surprise of some chose to become Superintendent of the Bozeman, Montana hatchery in January 1897.

It was during his twelve years in Bozeman that Dr. Henshall did significant research on the grayling. With the grayling in Michigan on the verge of extinction, many feared the Montana fish was similarly marked for oblivion. Henshall concentrated his considerable acumen on finding a way to artificially propagate it. He overcame many of the peculiarities of grayling breeding, and when he finally discerned that the only food grayling fry eat are naturally occurring minute crustaceans, he successfully bred the fish.

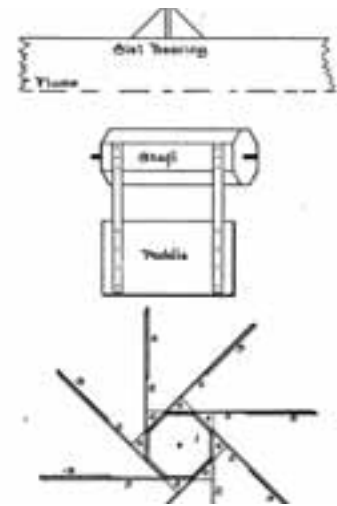
As gratifying as this was—and he was lauded by contemporaries like Theodore Gordon for his work—Dr. Henshall was getting older and the bitterly cold winters took their toll. At age 73, he transferred to the present-day Private John Allen National Fish Hatchery in Tupelo, Mississippi in October 1909, and for the next seven years successfully raised largemouth bass that were shipped throughout the South and as far away as Cuba. Sadly, his eyesight began to fail, and in March 1917 he left the U.S. Fish Commission after nearly a quarter century of service.

Henshall’s theories on fish culture were unpretentious. “The simplest devices give better practical results than those of more elaborate and

complicated structure,” he noted in an address to the American Fisheries Society in 1901. “In fish culture, especially, is this true, and the more we endeavor to follow the methods of nature, and rely on the simplest means to that end, the greater will likely be our success.” He always sought the simplest answer to even the most complicated question, and perhaps this is his legacy in the field of fish culture.

Fittingly, there was one more tag Henshall was given that is as descriptive as any, as it represents his tireless efforts in the field he loved. For the last decade of his life, whenever his name appeared in print it was often followed by the words “the Father of the Grayling.” For a man who spent so much time promoting fish culture, it must have been the most gratifying nickname of all. ♦

Dr. Todd E. A. Larson, is a history professor at Xavier University in Cincinnati, OH, and the owner of the Whitefish Press, publishing books on the history of fishing.



*Henshall unveiled this paddlewheel in the 1911 Bulletin of the University of Montana. He designed it to be used by ranchers at irrigation intakes to keep fish in rivers and not entrained in ditches.*

Todd E.A. Larson



*Dr. Henshall in triplicate: Hunter, Fish Culturist, Angler.*

Todd E.A. Larson

By T. Edward Nickens

## American Shad

“Growing up, I didn’t know what an American shad was,” Pappy Magaro told me one brilliant June afternoon. At the time, this was hard to fathom. We were anchored at the confluence of the Lehigh and Delaware rivers, at Easton, Pennsylvania, with downriggers bent. It’s the precise spot where Magaro, a longtime president of the Delaware River Shad Fisherman’s Association, has fished for more than 30 years.

Once, he said, the river hosted a huge shad migration, but commercial fishing whittled stocks away, dams checked upstream movements, and a massive “pollution plug” in the river between Philadelphia and Wilmington, Delaware, would literally force migrating shad to turn around and swim back to the sea. One day in the mid-1970s, Magaro caught a large fish at the base of the Lehigh River dam. “I called the kids over to look at the size of this huge river chub,” he remembered. “I didn’t find out it was a shad until two years later when a friend asked me to go shad fishing. I said, ‘What’s a shad?’”

Thankfully, anglers and conservationists up and down the East Coast are now much more familiar with this most American of fishes. In recent years, dam removals in Eastern seaboard states and advances in techniques that pass migratory fish around dams have opened up thousands of miles of spawning habitat closed to shad for decades. One of the first dams to fall for shad was the 1998 removal of Quaker Neck Dam on the Neuse River in North Carolina, which opened more than 1,000 miles of migratory fish habitat and attracted national attention.

Since then, shad river dams have fallen or have been outfitted

with fish bypass structures on Pennsylvania’s Lehigh, Delaware, and Susquehanna rivers; on North Carolina’s Little and Cape Fear; on South Carolina’s Pee Dee; and on Virginia’s Rappahannock, among others. On the Schuylkill River alone, in Pennsylvania, seven dams are currently targeted for breaching, removal, or fish passage construction.

Native to rivers from Labrador to Florida, a spawning American shad is 12 to 24 inches of silvery-slick shimmer, its back draped with a green and blue metallic luster that gives way to sides glimmering like liquid opal.

Along the West Coast, the fish aren’t native, but they’ve been there since 1871, when four milk cans of Hudson River juvenile shad were carted by railroad and stagecoach and poured into the headwaters of California’s Sacramento River. In the Columbia River states, American shad populations have quadrupled since 1970 and now support an enormous recreational fishery.

Like all anadromous fish, American shad begin life in fresh waters. As larvae and juveniles, they move downstream to estuaries and sounds, and then spend most of their lives in the open ocean. Early each spring, however, enormous numbers ascend coastal rivers, unseen in the turbid and tannin-stained flows, but heralding the coming season as surely as spring peepers. Streams void of the migrants in January swell with the arrival of hundreds of thousands of fish, seeking spawning grounds that lie in upstream shoals and rapids.

Such seasonal abundance made American shad one of the most important fisheries resources of the young nation. Huge commercial

operations sat astride many coastal rivers. On the North Branch of Pennsylvania’s Susquehanna, in 1881, some 40 seine fisheries each caught up to 10,000 shad per day. Shad bakes and planked shad are an ongoing tradition along rivers such as Virginia’s Rappahannock. It’s a fish worth celebrating: salted shad kept George Washington’s Valley Forge troops alive and kicking as they waited out the winter of 1776.

But their reliance on open migratory corridors through the settled East has hammered American shad populations. Since the dawn of the Industrial Revolution, when untold thousands of small dams were built across Eastern rivers and smaller streams to power mills and factories, to the age of hydroelectric power, when enormous dams corralled major rivers from Maine to Florida, populations of American shad and many other anadromous fish have plummeted.

“Losing American shad from East Coast rivers and the Atlantic Ocean would be an ecological, cultural, and economic catastrophe of Biblical proportions,” says R. Wilson Laney, of the U.S. Fish and Wildlife Service’s South Atlantic Fisheries Coordination Office. “This shouldn’t be allowed to happen.”

Biologists along the Atlantic seaboard are working hard to bring back the fish, from the Waldoboro Shad Hatchery in Maine, to the Watha State Fish Hatchery near Fayetteville, North Carolina. American shad have been raised at North Carolina’s Edenton National Fish Hatchery since the facility opened in 1898, although techniques have changed a bit over the last century. Last year, biologists experimented with an inline heating



Joe Hightower/USGS

*A Roanoke River American shad caught by Mike Waine, a graduate research assistant at North Carolina State University.*

system to heat water in spawning tanks to the required 70-71 degrees F. Previously, each brood fish was individually injected with hormones to initiate spawning, an increasingly expensive option. Fry are immersed in an oxy-tetracycline dip to stain ear bones called otoliths; when biologists recapture marked individuals, microscopic analysis of the otolith stains enable them to determine when and where the fish was stocked, and which hatchery it came from.

In 2008, 3.1 million American shad were stocked from the Edenton hatchery, says hatchery manager Stephen Jackson. It was the highest

figure ever recorded for the hatchery. “And this year, as we were stocking the Roanoke River, fishermen would come up to us and say—‘Whatever you’re doing, keep doing it!’ They love to see those American shad coming back.”

This is easy to understand. Once hooked, the fish puts up a memorable fight, giving them the nickname “poor man’s tarpon.” Yet few anglers keep them, despite the nation’s unmatched heritage of savoring American shad. Instead, they slip the hooks from the shad’s thin, papery mouths, and release the fish into the river’s flow. Once free, American shad tend to hang suspended in the current for

the briefest moment. They gather their wits, sunlight glinting on their pearl-like flanks. Then they orient to the downstream current and are gone in a flash, headed upstream, upriver, heeding the ancient instincts to find swift current over clean rock, where the next generation of American shad will begin life. ♦

---

T. Edward Nickens is an editor-at-large for Field & Stream. He lives in Raleigh, NC.

By Irene James

# Cryogenics for Conservation

The in-vitro fertilization business involves waiting – for the right donor, the right moment, and if all goes according to plan – a baby. Or in this case, lots of babies. The parents-to-be, a handful of mature pallid sturgeon, are gathered in a large fiberglass tank at the Garrison Dam National Fish Hatchery in Riverdale, ND. It's easy to like these friendly fish that crowd like puppies around the wading biologist Bill Bouthillier, who held up a six-foot-long fish for a closer look. The sturgeons didn't arrive at this clinic willingly; they were caught in the wilds of the Missouri River. In the tank, they just keep circling, enjoying regular meals, and waiting for their moment.

This unusual fish, ghostly white, dressed up in bony armor and Fu Manchu whiskers that help it sense food in the muddy Missouri, has been around for 200 million years. Its lifespan rivals ours and its size gives predators second thoughts. But why would these proven fossil-age survivors need our help doing what comes naturally? Quite simply, they are no match for dams and re-channelization

projects that altered the specific environment necessary to survive and reproduce. Pallid sturgeon joined the endangered species list in 1990; the population in its northern range now stands starkly at only a couple hundred, most of them on a stretch of the Missouri River between Fort Peck Reservoir and Lake Sakakawea, including the lower Yellowstone River. Their recovery plan calls for the U.S. Fish and Wildlife Service to help nature along – and that includes freezing fish sperm, or milt. Scientists call it “cryogenics.”

The process begins anew each spring when fish biologists collect both males and females, unite the eggs and milt to produce fry, and later release them throughout the year. The donors are cooperating: one female yielded 243,800 eggs and another some 95,600. But eggs are just one half of the equation. The pallid sturgeon population is so low in the wild, and river conditions so challenging that the hatchery needs to produce not only a lot of fish, but the most adaptable and diverse fish to ensure survival. Consider that it is possible males could go uncaptured in a given year.

A solution began unfolding in 1993, when biologists borrowed a kitchen in an unused home at the Willow Beach National Fish Hatchery in Arizona. In this unlikelyst of spaces, they experimented with freezing razorback sucker milt. The

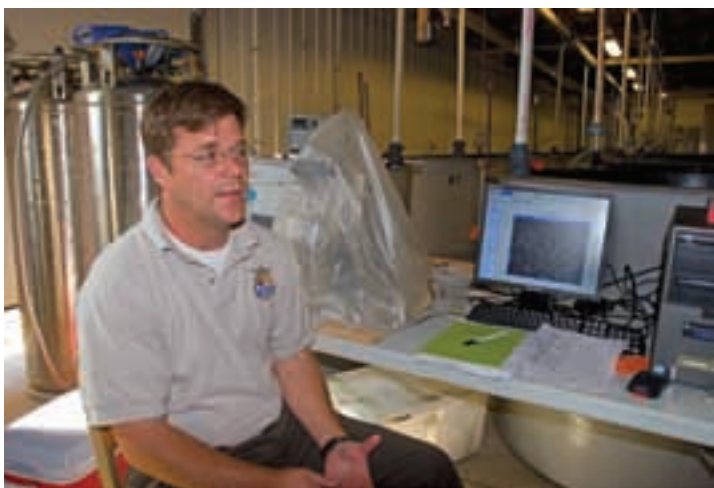
technology had been around for about 40 years, but this marked the first attempt by the U.S. Fish and Wildlife Service to use it for fish conservation.

Louisiana State University professor of aquaculture, Dr. Terry Tiersch, was in the kitchen. He recalled the austere beginnings: “We made it up as we went; we didn't have a laboratory, and started working with Ziploc bags.” Their model, the dairy industry, didn't quite fit the fish work at hand. “Cattle breeders try to minimize genetic variation and diversity. It's very different from conservation,” noted Tiersch.

“The razorback faced looming extinction,” said Dr. Stuart Leon, Chief of the National Fish Hatchery System, who was there, too, those many years ago. “They had declined from 80,000 fish in the 1980s, to an estimated 20,000 fish, and they were old and blind. The youngest we were catching were probably more than 25 years old – they weren't recruiting.”

Tiersch and Leon had good help on hand. It was Dr. Owen Gorman who first thought that cryogenics might work for the razorback. Gorman had recently worked on the evolution of the influenza virus at St. Jude Children's Research Hospital in Memphis, discovering an avian link to the 1918 epidemic, before joining the U.S. Fish and Wildlife Service. Dr. Gary Carmichael, a physiologist, had revolutionized how we haul fish, having researched stress in captive fishes. This “brain trust” saw the incredible and urgent need and took it upon themselves to do the science. “It's rewarding to see how far we've come since then,” notes Leon.

Dr. Bill Wayman, a cryogenics specialist visiting North Dakota from



Jim Foster

*Dr. Bill Wayman discusses the details of freezing and thawing fish sperm. A video on the monitor behind him shows live sperm cells from a pallid sturgeon.*

the Warm Springs Fish Technology Center in Georgia, described early fish cryogenics work as “kind of a test, an adapt-as-you-go philosophy.” The test worked and Wayman is one of many scientists advancing cryogenics in fisheries conservation.

Today, biologists use cryogenics procedures on about 20 fish species, including the pallid sturgeon. Milt is frozen and stored in liquid nitrogen. Its genetic worthiness is tested before it ever meets an egg. At the Garrison Dam hatchery, Wayman scrolled through computer screens of live images of cells, pointing out what they look for, like membrane integrity and how vigorously the cells

move. It’s amazing at how much the specimens look like, well, our own. Wayman paused at a particular pallid sturgeon sample on the screen. It was no gold-medal contender; only about 20 percent of pallid sturgeon sperm cells have what it takes after thawing, not great odds – but enough to get the job done.

Cryopreservation has evolved from humble beginnings into a reliable tool, a savings account for conservation. But freezing milt is no substitute for habitat conservation. Garrison Dam National Fish Hatchery manager, Rob Holm, said it best: "Our mandate is to prevent species from going extinct.

Cryopreservation isn’t the whole answer – we need to restore habitat, which could take 60 to 70 years. But we need to keep the species alive until then."

The Fisheries Program stores milt of endangered fish at the USDA Agriculture Research Service’s National Germplasm Repository in Ft. Collins, CO. It’s a catalog that scientists can draw from to maximize genetic diversity where it is most needed -- in fish populations that are severely depleted. ♦

---

Irene James is a freelance writer in Littleton, CO.



Jim Foster

*Garrison Dam National Fish Hatchery manager, Rob Holm (l), and visiting fish biologist Bill Bouthillier from Warm Springs Fish Technology Center, show off a female pallid sturgeon.*

# Bob Hines –

By John Tertuliani



Bob Hines

*Bonefish on Florida flats – any fish is a good catch.*

# a Man of Art



Bob Hines

*Brook trout – aim for quality.*

The life of an artist can be a tough one. You follow what you love with passion; money plays no role. The hardest part is sticking with it long enough. Common sense pushes you toward a higher paying job – and they all pay more. But art is not a job. An insatiable desire moves you. Heart and soul express how you feel, and you enjoy nothing more than to share your love with anyone who appreciates the same. Bob Hines shared his love of fish and wildlife through an incomparable talent as

a staff artist for the U.S. Fish and Wildlife Service.

Born in 1912, Robert “Bob” Warren Hines enjoyed a typical Midwest childhood in Fremont, Ohio. His family lived near the banks of the Sandusky River, close to where it poured into Lake Erie. From his early years grew a love for the outdoors, hunting, and fishing. He became an Eagle Scout, and a naturalist for several scout camps. The sharp focus with which Hines



USFWS

*Bob Hines paints a drake wood duck.*



*Net return – Golden trout of California.*

viewed nature is patent in what is believed to be his first published illustration, a hunting scene in his 1928 high school yearbook.

Hines' smoldering interest in illustration ignited after learning

about a man who shot a black pheasant, the dark-phase rarely seen. The man left the pheasant where it fell, not knowing what it was. Hines decided to draw wildlife as a way to teach people about wildlife. He would use his experience in taxidermy to

draw a life-like pose on paper. Hines felt the eye was the embodiment of the animal, along with the backbone, the physical support affecting the pose and appearance. These two physical traits were the initial focus of his drawings.

Hines mailed a few of his drawings to the Ohio Department of Conservation; the work so impressed an agency official, that he offered Hines a job as an artist. Hines accepted, but lacking any formal training in art, he crammed four days with his high school art teacher to prepare for using oils.

Hines illustrated the agency periodical, *Ohio Conservation Bulletin*. He also did a weekly feature, "Under Ohio Skies," carried by hundreds of Ohio newspapers. In 1944, Hines entered two drawings in the federal Duck Stamp annual design competition. Both were rejected, but Hines resubmitted his redhead design and it was selected for the 1946-47 Duck Stamp.

Frank Dufresne, then Director of the Alaska Game Commission, asked Hines to illustrate his 1946 book, *Alaska's Animals and Fishes*. Hines fashioned grayling, salmon, Dolly Varden and many others in drawings and watercolors. Dufresne left Alaska to become the Chief of Information of the U.S. Fish and Wildlife Service. Hines came with him to become a staff artist in Washington, DC in 1948.

Bob Hines

He accepted the position, but not with great pleasure after learning that his supervisor would be a woman. His apprehension disappeared in time; he and his new supervisor would become life-long friends.



In his new job, Hines found a wide assortment of opportunities, everything from illustrating common publications to conducting wildlife surveys and scuba diving. His supervisor, a biologist-turned-editor named Rachael Carson, was writing a book on oceans. *The Sea Around Us* was a commercial success to the extent she resigned her position. Carson asked Hines to illustrate her next book on aquatic life living along the Atlantic coast. This proved a challenge for Hines; he was not as familiar with invertebrates. *The Edge of the Sea*, published in 1955, contained Hines' pencil sketches. The book made it to #3 on *The New York Times* bestseller list.

In an effort to raise awareness for wildlife through postage stamps, a Washington attorney and sportsman proposed that Hines paint four images of trout for President Eisenhower. The idea worked, two of the four paintings were presented to Eisenhower in 1955 while he was on a Colorado fishing trip. Eisenhower sent a memo to the Postmaster General with his support for wildlife presented on postage stamps. Hines designed the initial series of four wildlife stamps. In 1956, three-cent stamps were adorned with Hines' king salmon, wild turkey, pronghorn, and a whooping crane.

The late 1960s and early 70s were filled with big events for Hines. The U.S. Fish and Wildlife Service published his monumental, *Ducks at a Distance*. Five private publishers rejected the work before he decided to release the material as public domain. It sold more than two million copies in multiple languages.

On July 4, 1971, the Department of the Interior marked the centennial



Bob Hines

*Striped marlin – a memorable day in the Pacific.*

of the U.S. Fish and Wildlife Service and the Fisheries Program, created as the U.S. Fish Commission, by publishing the book *Sport Fishing U.S.A.* It seems only natural that 21 of Hines' paintings would grace the pages of this authoritarian text

on all aspects of fish and fisheries conservation.

Hines retired a decade later with 32 years of service. His work for the U.S. Fish and Wildlife Service ran the gamut from line art on paper to



Ohio Department of Natural Resources

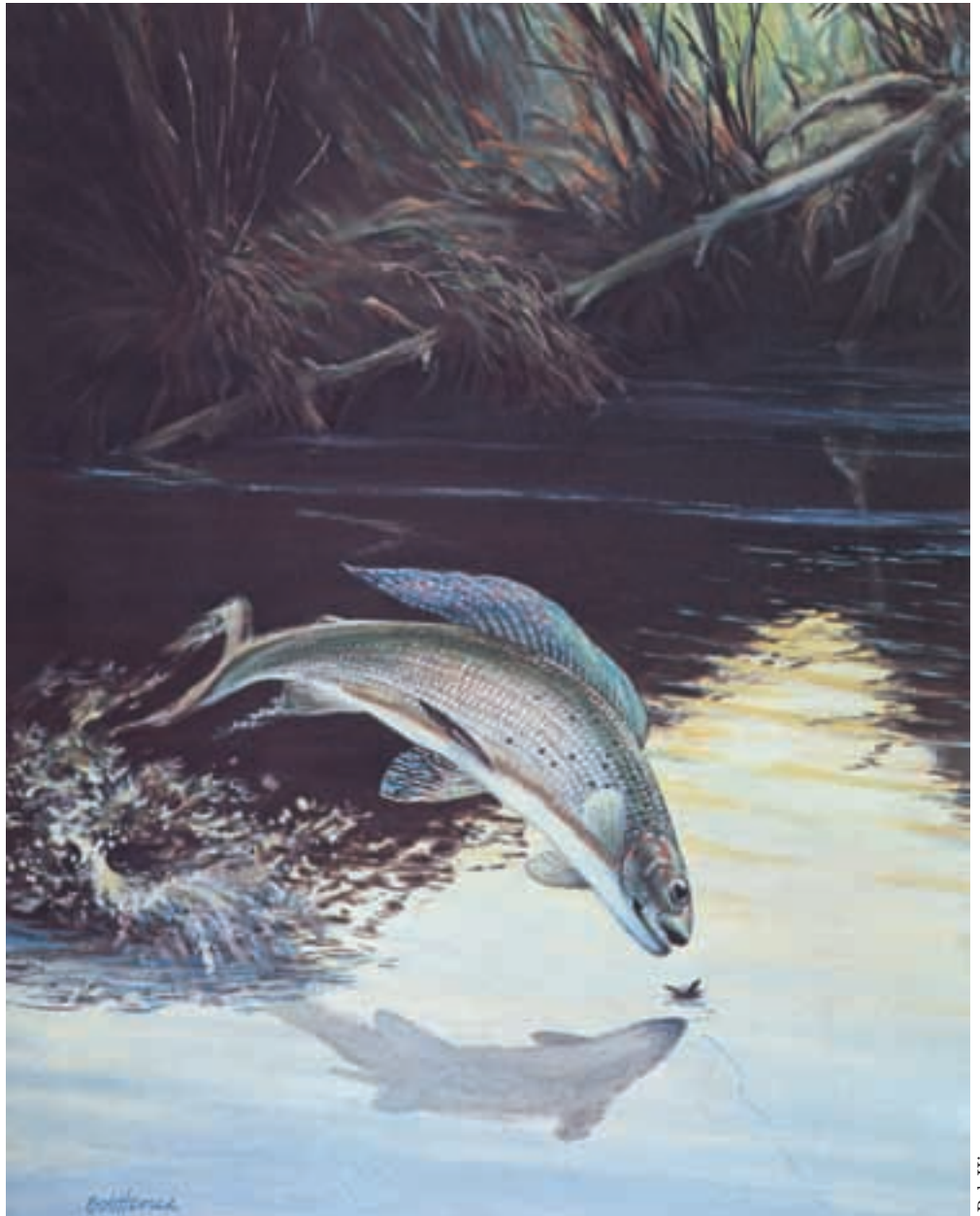
Top: Bob Hines painted fish and wildlife images for the Ohio Department of Conservation and its magazine until 1948. Below: “Under Ohio Skies” appeared weekly in over 200 Ohio newspapers, illustrating the how’s, why’s and what-for’s of conservation, such as in these two 1946 examples.



Ohio Department of Natural Resources



Ohio Department of Natural Resources



Bob Hines

Arctic grayling – natural lakes.

murals on walls. During his lifetime Hines illustrated more than 50 books. His work appeared in *Readers Digest*, *The New Yorker*, *Sports Afield*, and *Natural History*. His last work of note was 1991, the 50th anniversary edition of, *Under the Sea Wind*, by Rachael Carson.

The family of Rachael Carson asked Hines to be an honorary pallbearer at her funeral in 1964. Now it was

his time on November 7, 1994. There was no public service. He left as he arrived, without fanfare, but what he left behind is a canon that will enrich us all for generations to come. ♦

Like Bob Hines, John Tertuliani started his career with the Ohio Division of Wildlife. He’s now a biologist with the U.S. Geological Survey in Columbus, and is the author of two books, *Catching Bluegill*, and *Smallmouth Bass and Streams: Thoughts on Fly Fishing*.



Bob Hines

*Smallmouth bass and rock bass – under the cover of a log.*

By Dr. Robert Bakal

# Fighting the Amphibian Fungus



The results of a chytridiomycosis epidemic in southern mountain yellow-legged frogs in Sixty Lake Basin, Kings Canyon National Park, California.

Amphibians, they are part of our lexicon and our lore. You'll see them in caricature and cartoons and children's books. *Frog and Toad* books in the 1970's were great elemental reads, telling stories about bravery and friendship and growing. But there's another elemental story to tell about frogs and toads, salamanders and newts, and this one has to do with loss.

If you don't recall your textbook definitions, most amphibians spend their early life stages in water as gilled, larval forms known as tadpoles. Later, many change into lung breathing terrestrial adults.

Worldwide, amphibian declines may be the greatest conservation issue the world faces. Since *Frog and Toad* hit the kids' bookshelves in the early 1970's, scientists have witnessed tremendous population declines and outright extinctions of amphibian species. Consider these numbers: nearly 32 percent of amphibian species are threatened with extinction; at least 122 amphibian species have gone extinct since 1980; and, at least 43 percent of all amphibian species are declining in number.

The causes of the declines are many, but habitat destruction and pollution have undoubtedly reduced or eliminated many populations. Other reasons linked with declines include global climate change, invasive species, and one disease in particular – chytridiomycosis. It's a newly recognized disease of amphibians caused by a fungus, *Batrachochytrium dendrobatidis*, or "B.d." for short.

Although the origin of B.d. is not definitively known, the fungus has

Dr. Vance Vredenburg/San Francisco State University

## *“B.d. is now recognized as the worst infectious disease ever recorded among vertebrates...”*

been identified in museum amphibian specimens from Africa collected in the 1930's. It now appears to have spread to many parts of the world, and is now recognized as the worst infectious disease ever recorded among vertebrates because of its impacts to so many species – and its tendency to drive them to extinction.

In September 2005, the nation's capital hosted an Amphibian Conservation Summit, the purposes of which were to design and promote a response to global amphibian declines. This Summit developed an action plan to expand our understanding of B.d. and create strategies to deal with the disease in the field.

To this end, in November 2007, Partners in Amphibian and Reptile Conservation, the U.S. Fish and Wildlife Service, and a host of other federal, state, and non-governmental organizations co-sponsored an international conference on B.d. called *“Amphibian Declines and Chytridiomycosis: Translating Science into Urgent Action.”* Over 200 amphibian authorities from government agencies, universities, zoos and aquaria, and the private sectors from Canada, the U.S., Mexico, the United Kingdom, Denmark, South Africa, Australia, and New Zealand convened in Tempe, Arizona. Participants communicated the scientific information available that in the end enables scientists, educators, policy makers, and concerned citizens to take the urgent actions necessary to protect amphibians from B.d.

The U.S. Fish and Wildlife Service's Fisheries Program is responding to the critical need to address amphibian declines as a result of B.d.

and other causes. Scientists at the Warm Springs Regional Fisheries Center in Georgia are studying the distribution and seasonality of B.d. at the Center and surrounding area. They collect amphibians and other aquatic organisms to determine if they carry B.d. as well. The Center will examine the effects of B.d. on predator-prey interactions, and are developing a procedure for freezing salamander sperm for conservation.

The Dexter National Fish Hatchery and Technology Center in New Mexico held their first workshop on captive amphibian and reptile health issues last year. From “Herpshop 2007,” scientists at Dexter developed an in-house capability to diagnose disease related to B.d. at the molecular level in collaboration with the Zoological Society of San Diego Molecular Diagnostics Laboratory.

Saratoga National Fish Hatchery in Wyoming was first among the 70 National Fish Hatcheries to rear an endangered amphibian, starting in 1997. The Wyoming toad, found only in the Laramie basin of southeast Wyoming, is considered the most endangered amphibian in North America. Although major factors behind the toad's decline include habitat loss and sensitivity to herbicides, chytrid infections have played a large role in suppressing the animal. The hatchery maintains a captive population for breeding, rearing, and refugia. Since 1999, hatchery biologists have released 38,792 toads into the wild. Biologists perform applied research on breeding methods and are undertaking a study of the genetics of the toads to help determine optimal breeding pairs.

The Lamar Fish Health Center in Pennsylvania surveys wild

amphibians for disease-causing pathogens in conjunction with routine population surveys at the Delaware Water Gap Natural Area. Their scientists look for viruses, B.d., and parasites in newts and frogs.

Like canaries in the coal mine, amphibians are showing us that something in our wild places is going terribly wrong. Working together, we can ensure that frogs, toads, and salamanders remain not only vibrant parts of our lexicon and lore, but continue their essential roles in the ecosystems of the world. For more information visit [www.parcplace.org](http://www.parcplace.org). ♦

---

A doctor of veterinary medicine, Robert Bakal is the National Aquatic Animal Health Coordinator for the U.S. Fish and Wildlife Service. He lives in Raleigh, NC.



Manuel Ulibarri/USFWS



Manuel Ulibarri/USFWS

*Renee Martin swabs a Woodhouse toad at Dexter National Fish Hatchery and Technology Center in New Mexico, to test for the presence of B.d.*

By Dr. Ann Gannam

# From Horse Heads to Pellets

## *Fish nutrition has come a long way*

We've all done it, sometimes out of boredom at the table, or walking the aisle at the market with real concern. We pause, turn the box sideways, and read that little white box with black letters and numbers and learn about what we are eating: calories - 250; total fat - 12 g; sodium - 470 mg; vitamin A - 4 percent. Okay, maybe you shouldn't eat so much mac-and-cheese.

Nutrition is serious business if you care about your health. Nutrition is also serious business in fisheries conservation, and the science of fish nutrition is steeped in a history of experience. The science has evolved from the crude to the sophisticated in the span of a century.

Culturing fish for food started about 4,000 years ago. Little feed was needed because the culture was extensive and well-fertilized ponds were adequate to support and grow the fish. By the 1870's the U.S. government was setting up fish culture stations to spawn and raise fish to supplement fish stocks in the wild. These culture stations evolved into today's 70 National Fish Hatcheries.

With fish being raised more intensively, supplemental feeding was needed. It was crudely achieved in its earliest form. In some cases, rotting horse flesh was hung over the water to allow fly larvae to drip to fish waiting below. Fly larvae were also cultured in "maggot houses" where fires burned to keep larvae coming in the winter. Horse meat itself was directly rendered into fish feed.

Complete diets that met the fishes' nutritional requirements became necessary. Scientists that did the early work in diet development looked at composition of natural prey

items to determine the appropriate composition – the protein, fats, moisture, and ash of the artificial feed given to fish in the hatcheries. At this time – the early 1900's – the basic nutrient requirements of the fish were not well-considered. Since you are what you eat, these poorly formulated feeds resulted in poor health and poor growth in the fish.

In the 1920's and 1930's wet feeds for use in hatcheries were made based on what was available in close proximity to the hatcheries – that is salmon eggs, fish, oilseed meals, beef and hog liver, spleen, chicken eggs, and horse meat. A feed mixture back then might be comprised of thirds of beef liver, hog liver and salmon guts, chopped and mixed at the hatchery with salt added to thicken the mixture.

The 1940's brought a change to the feed formulations because of the competition for the meat ingredients and by-products used in the wet feeds. More meals were used such as wheat middlings, cottonseed meal and soybean meal. However, in the Rocky Mountain states they must have felt pretty confident their meat supply would be adequate. A Bozeman National Fish Hatchery report from the 1940's stated "There are enough old and worthless horses in Gallatin County to provide fish food for years to come."

Great progress has been made in the development of fish food with landmark feeds coming out in the 1950's, like the Oregon Moist Pellet made at low temperature with a pasta maker. In the 1960s, the Abernathy Dry Diet, a compressed pellet came out, and then the present-day, extruded-feed pellet, one highly efficient for fish.



NCTC Archives/Museum

*Smoke plumes from this historic building, a "fly house" or "maggot house" at Craig Brook National Fish Hatchery, Maine. Rotting flesh kept warm by wood stove produced fly larvae through the winter.*



NCTC Archives/Museum

*H. B. Mailman cuts horse meat to feed fish at a former National Fish Hatchery in Springville, UT.*

The U.S. Fish and Wildlife Service’s Fisheries Program has long been in the diet development business. Its seven Fish Technology Centers around the country today grew from the National Fish Hatcheries where scientists experimented in fish rearing to improve fish culture techniques. At all of these Fish Technology Centers some diet tests have been done now and again, whether to develop new diets or compare commercial diets to find the ones best suited for the fish being reared. National Fish Hatchery employees have contributed greatly to the knowledge of fish nutrition. Dr. John Halver, “The Father of Fish Nutrition,” led the Western Fish Nutrition Laboratory, and was the first to make fish nutrition a science. Roger Burrows and Laurie Fowler, created the Abernathy Dry Diet, named for the Fish Technology Center in Washington state where they worked. It was the forerunner of dry diet formulations used the world over today.

Not all fish species eat the same things. Different fishes need different foods. That creates the need to develop new feeds or test existing feeds. With the volatile commodities market and the real scarcity of some ingredients, such as fish meal and oil, feeds using alternative proteins and oils are coming on the market and need to be tested on the captively raised fish stocks in the National Fish Hatchery System.

Necessity is the mother of invention; imperiled fishes have created another need to apply the science of nutrition. The Bozeman Fish Technology Center has extensively researched fish nutrition, most recently testing diets for pallid sturgeon, Rio Grande silvery minnow, razorback sucker,

June sucker and bonytail – all of them endangered species.

The Applied Research Program in Fish Nutrition at Abernathy Fish Technology Center, where I work, provides quality control of fish feed and diet development, primarily for salmon and steelhead. Our scientists evaluate the quality of commercial fish feeds used at National Fish Hatcheries. We study how nutrition affects young salmon and steelhead through the smolt stage, the point where the young head to sea, and we study the survival and maturation of captive brood stock – something critical for successful captive rearing of fish.

Not only do we want the good stuff on the figurative nutrition label, but we want to keep the bad stuff out. Our scientists seek ways of reducing contaminants in feeds by developing and testing vegetable protein and oils in fish diets.

Future challenges for fish nutritionists will mean dealing with the manufacture of biofuel to feed transportation, which will reduce the availability of plant-based feedstuffs, as well as the increasing cost and decreasing availability of fish meal and fish oil. The need for new diets for new species may not wane. But in the end, regardless of the reason, capable and discerning nutritionists will strive to get all that fishes need on the nutrition label.

---

Ann Gannam, Ph.D. is a Fish Nutritionist at Abernathy Fish Technology Center in Abernathy, WA.



Ron Twibell/USFWS

*Modern pelletized fish food produced at Abernathy Fish Technology Center, WA.*

Nutrition Facts	
<b>Crude Protein</b>	<b>52%</b>
<b>Crude Fat</b>	<b>20%</b>
<b>Crude Fiber</b>	<b>1.0%</b>
<b>Ash</b>	<b>10.0%</b>
<b>Sodium</b>	<b>0.7%</b>
<b>Calcium</b>	<b>2.2%</b>
<b>Selenium</b>	<b>0.1 mg/kg</b>
<b>Phosphorus</b>	<b>1.6%</b>
<b>Vitamin A</b>	<b>10000 IU/kg</b>
<b>Vitamin D3</b>	<b>4000 IU/kg</b>
<b>Vitamin E</b>	<b>350 IU/kg</b>
<b>Vitamin B12</b>	<b>Trace</b>
<b>Folic Acid</b>	<b>Trace</b>
<b>Vitamin K</b>	<b>Trace</b>
<b>Riboflavin</b>	<b>Trace</b>

*Nutritional facts for salmonid feed.*

By Craig Springer

# Fishingenuity

*Science of genetics steers fisheries conservation practices*



University of Georgia

*Dams keep sturgeon from reaching spawning habitats. Conservation genetics help biologists find brood stock populations.*

Science is good for you. Imagine life without a microprocessor, polio vaccine, Velcro, cell phone, a graphite fly rod, or a depth finder and no down-riggers. Science enlightens and informs and its offspring – technology – has made the world a much different place.

The realm of fisheries conservation is no different. Technology, and the science of genetics, have equipped fishery managers to meet conservation challenges in the wild and in the hatchery.

The science of genetics concerns itself with the traits of inheritance, the features that plants and animals and all living things possess that are passed down to them from their ancestors. That genetic information rides in a molecule called DNA, that familiar twirling double-helix form that looks like a spiraling ladder. Inside that DNA are segments called genes and that's what is transmitted to future generations by each parent. Genes are the coded instructions to the fish that tell it how to live its

life. And that's the stuff that fish conservation geneticists, like Greg Moyer at the Warm Springs Fish Technology Center in Georgia, concern themselves with in answering questions in fisheries management.

Moyer holds a Ph.D. in zoology from Southern Illinois University but first earned an undergraduate degree in fisheries biology at Mansfield University in Pennsylvania. The Pennsylvania native melds his academic training in chemistry,



statistics, genetics, evolution, and population ecology in applying high technology to important questions in fisheries conservation. He works in one of five conservation genetics labs of the U.S. Fish and Wildlife Service.

The genetic makeup of an individual fish, or any organism, is like a fingerprint. Everyone's fingerprints are unique, but sharing some commonality in shape and design. In the fine details, that is where the differences lie. And so it is with genetics: Moyer looks at the fine genetic details of fishes at the molecular level. Scientists use sophisticated technology to examine the DNA molecule of fish – the fine details of the fingerprint. By examining the genetic makeup of fish, scientists can answer an array of questions related to conservation.

The Atlantic sturgeon population in the St. Marys River on the Georgia – Florida state line is seriously depleted, if not completely gone. Over-fishing, waters segmented by dams, and loss of habitat affect fish most anywhere. With sturgeon, these problems in managing populations are confounded by the fact that they are very long-lived and are slow to mature to a breeding age. Atlantic sturgeon won't breed until they are about 12 years of age, and then they won't breed every year.

State and federal fishery managers wanted to reintroduce Atlantic sturgeon to the St. Marys River, and they wanted to use the most suitable source of fish. The Altamaha River, the next large river to the north seemed to be a likely source.

But a question needed to be answered, and the tools of genetics



USFWS

*Dr. Greg Moyer loads Atlantic sturgeon DNA samples on an Applied Biosystem 3130 genotype analyzer.*

were a way there. Moyer's job was to determine if the population in the Altamaha River was large enough to warrant taking breeding fish out of the wild population to use as a captive brood stock. For over four years, Moyer examined the genetic makeup of young Atlantic sturgeon caught by scientists from the University of Georgia. He was able to track their parentage, and from the information he learned that there are about 50 breeding Atlantic sturgeon contributing offspring to the Altamaha River every year – a number sufficient enough to allow a small portion to be taken for a brood stock without damaging the population. That brood stock hasn't been established yet. Fishery managers next need to reaffirm that



USFWS

*Paul Christman (l) Maine Department of Marine Resources and Dr. John Sweka from the USFWS Northeast Fishery Center, collect Atlantic salmon parr in the Sheepscot River, Maine.*



Shannon Julian/USFWS

*Dr. Meredith Bartron sorts Atlantic salmon adults collected from the Penobscot River for spawning at Craig Brook National Fish Hatchery, Maine.*

Atlantic sturgeon no longer exist in the St. Marys.

Back in Moyer's home state, Meredith Bartron works in genetics at the U.S. Fish and Wildlife Service's conservation genetics lab inside the Northeast Fishery Center in the town of Lamar. Bartron is a Seattle native. She earned a Ph.D. at Michigan State in fisheries biology before landing in the Keystone State. She's an avid angler and two trout streams, Fishing

Creek and Spring Creek, course nearby her lab. Her occupation and avocation mix beautifully when it comes to conserving the only trout native to New England: the brook trout.

Bartron is engaged in a project in northern New Hampshire's Nash Stream. The New Hampshire Fish and Game Department is interested to know more about the populations of brook trout inhabiting the Nash proper and the tributaries that feed it. Brook trout in these streams are separated from one another by distance, by log jams, and by road culverts that may block their movements.

Examining the genetic character of these populations in Bartron's lab should reveal their genetic structure, and complement a concurrent tagging study on the colorful trout. The data should show if these tributary populations are artificially dissimilar, caused by the culverts and log jams. The genetic data and movement data from tagged fish will help fishery managers to decide where best to spend time and money in removing barriers to fish passage. Brook trout populations that are connected to one another should be most robust and best suited to sustain themselves. The USGS Conte Lab and the Connecticut River Coordinator's Office are partners on this project.

When not working on brook trout, Bartron helps manage the brood stocks of Atlantic salmon at eight National Fish Hatcheries in New England. Six brood stocks are considered endangered. Because their numbers are so few, it is paramount that the hatcheries maintain the genetic diversity of the

salmon over time, and ensure that hatchery management practices help achieve that diversity.

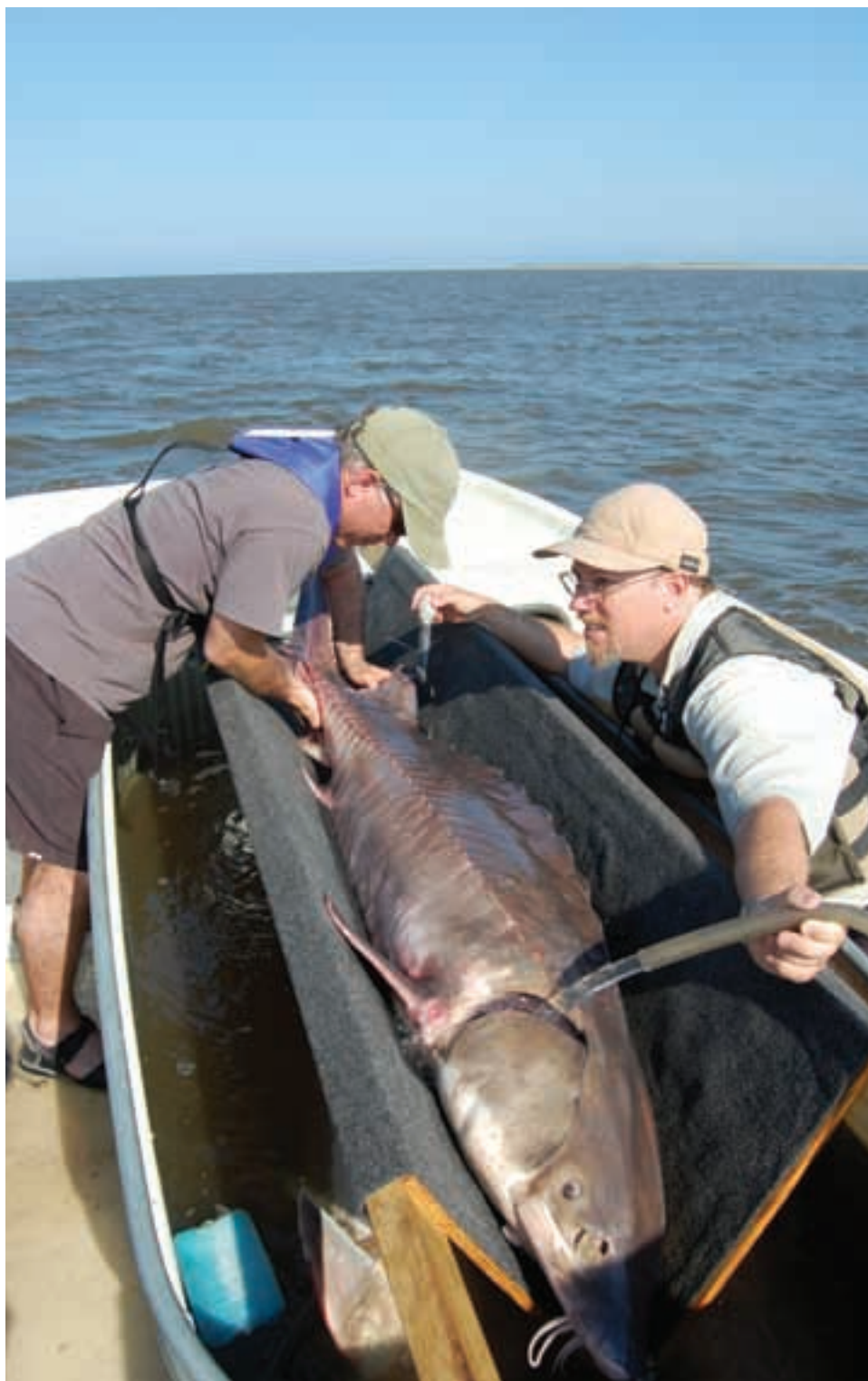
The main thing is to maintain genetic diversity in fishes, that's the principal purpose in using the tool of genetics in conservation. Moyer points out that it is a good thing to have that diversity in the wild – the more diverse that a population is, the better equipped it will be to sustain itself in the face of changes in its environment, and that becomes profoundly important when fish populations are precariously small.

Science is good for you and it's good for fishes. Technology has opened the field of conservation genetics. Aside from where Moyer and Bartron ply the science, three other genetics labs in Alaska, New Mexico, and Washington also use sophisticated technology working on everything from salmon and steelhead to rare desert fishes. All five labs employ 25 people nationwide, and you can learn more by visiting [www.fws.gov/ConservationGeneticsCOP](http://www.fws.gov/ConservationGeneticsCOP). ♦



Meredith Bartron/USFWS

*Brook trout ready for fin clipping.*



University of Georgia

*University of Georgia researchers take great care of this giant Atlantic sturgeon while placing a radio transmitter about its dorsal fin.*

By Ken Phillips

# Diagnosing Diseases

*The National Wild Fish Health Survey plots the occurrence of disease*

Set in Missoula, Montana during the 1920's and 30's the film "A River Runs Through It" brought the grace and art of fly fishing to the forefront. Well before the 1992 movie, western states like Colorado and Montana were considered the fly-fishing Mecca. Many of their streams were known to have rainbow and cutthroat trout populations that numbered in the thousands of fish per mile of stream.

By the mid-1990's, things took a downward turn. Trout populations in Montana's Madison River plummeted. In other streams, young trout were virtually absent. Biologists traced the losses to whirling disease, a deadly fish disease caused by a microscopic parasite called only by its scientific name, *Myxobolus cerebralis*. Spores of the parasite target cartilage in the head, resulting in bone and nerve damage that cause infected fish to swim in a spiral, or "whirling" pattern that greatly reduces their ability to swim away from predators, or to capture prey of their own. Eventually, severely infected fish die.

Prior to the outbreak of whirling disease, little was known about the distribution of agents or pathogens of fish disease in the wild. While it is not possible to eliminate pathogens such as *Myxobolus cerebralis* from the wild, knowing where they exist is a valuable tool to limit the spread of deadly disease pathogens. Fishery biologists could use the information when making decisions on moving wild fish stocks, collection of fish tissues from wild fish, or stocking fish.



*Ken Phillips of the La Crosse Fish Health Center samples Lake Erie walleye with Ohio Division of Wildlife personnel.*

USFWS

To address the need to gather this information, the U.S. Fish and Wildlife Service developed the National Wild Fish Health Survey (NWFHS), and naturally nested it in our nine Fish Health Centers across the nation. The Centers already performed fish health inspections at National Fish Hatcheries, giving it a national scope with internationally recognized expertise. The NWFHS launched in 1997.

The Fish Health Centers use standardized protocols to determine the distribution of 11 different viral, bacteriological, and parasitic pathogens on a national scale. They also look for additional pathogens of local importance, like infectious salmon anemia in the Northeast, or

salmonid ceratmyxosis in the Pacific Northwest.

The Fish Health Centers partner with other federal, state, tribal and non-governmental organization biologists to determine areas to be sampled. Often the Fish Health Centers "piggy-back" sampling efforts with partners to make efficient use of time and money. Results from NWFHS have been used by biologists at all levels to make fishery management decisions.

What Robert Redford's movie did for fly fishing, Steve McQueen's B-movie "The Blob" might come close to portraying Viral Hemorrhagic Septicemia (VHS) in the Great Lakes. VHS does to fish flesh what Ebola

viruses do to the human body. VHS causes internal hemorrhaging and fish bleed to death.

In the spring of 2005, a significant kill of freshwater drum occurred in Lake Ontario's Bay of Quinte in Ontario, Canada. The Ontario Ministry of Natural Resources identified the cause as VHS, considered by many disease pathologists as the most feared fish pathogen in the world. This was the first report of VHS in the Great Lakes region. Later in 2005, VHS was found in muskellunge in Lake St. Clair, Michigan. First reported as a disease of European rainbow trout in 1938, it was not until 1963 that VHS was determined as the responsible pathogen.

The NWFHS has been an important tool in responding to emerging aquatic conservation issues such as the outbreak of VHS in the Great Lakes. In spring 2006 fish kills occurred throughout the lower Great Lakes, including Lake St. Clair, Lake Ontario, Lake Erie, and the St. Lawrence River. Freshwater drum and yellow perch died in Lake Erie. The La Crosse Fish Health Center in Wisconsin, where I work, teamed with the Ohio Division of Wildlife and sampled numerous fish species from Lake Erie to determine the distribution of VHS.

In 2007, we expanded NWFHS efforts in the Midwest, and worked

with state and tribal partners looking for agents of disease in the Ohio and Mississippi rivers, lakes Michigan and Superior, and numerous smaller inland lakes. Typically, partner agencies would collect and ship fish on ice to the La Crosse Fish Health Center, where we screened them for VHS and other pathogens.

The Ohio Division of Wildlife and La Crosse Fish Health Center isolated VHS as part of routine spawning of muskellunge from eastern Ohio's Clear Fork Reservoir in April, the first detection of VHS outside of the Great Lakes basin. We assisted the Ohio Division of Wildlife with follow-up work in the Mohican and Muskingum Rivers and found no VHS, but we did detect spring viremia of carp virus from bluegill and largemouth bass, the first detection in a non-minnow species in the U.S.

All living things can suffer from disease and fish are no exception. Diseases kill fish in hatcheries, and in the wild. With the nasty nature of VHS and debilitating whirling disease, knowing the location of your enemy is extremely valuable, and so is the NWFHS. For more information visit [www.fws.gov/wildfishsurvey](http://www.fws.gov/wildfishsurvey). ♦

Ken Phillips is a microbiologist at the LaCrosse Fish Health Center in LaCrosse, WI.

*“VHS does to fish flesh what Ebola viruses do to the human body. VHS causes internal hemorrhaging and fish bleed to death.”*



Cornell University

*Dr. Paul Bowser, professor of aquatic animal medicine at Cornell University, holds a trophy muskellunge killed by VHS.*



## *A Measure of Experience*

By H. Dale Hall

Kentucky Department of Tourism

*An autumn morning mist shrouds the Cumberland River in southeast Kentucky.*

Thirty years as a fish biologist gives me a reason to think about the past. I often drift back to the days when I was young and free to regularly get wet in the Cumberland River. I was fortunate to be born in the bosom of the Cumberland Plateau of the Appalachian Mountains, deep in southeastern Kentucky. My summers were filled with hours upon hours on the river and walking through the woods that are right now colored in autumn foliage. Naturally, the past makes me think about the challenges that lay ahead of us in the field of fisheries management.

I didn't go fishing and hunting because it was a means of recreation, unless one interprets recreation in its truest form: to *re-create* one's self. Each time I waded into the riffles,

and turned over rocks I became more adept at backing a crayfish into my hand, or finding a juicy "grampus." That was our name for hellgrammite, the pincer-headed Dobson fly larva I used for bait. On occasion I secured the services of an abandoned car top that worked perfectly as a boat with a one-by-six board as the oar. I realized that I was connected with the water as surely as I was Herb and Frances Hall's son. I was as much a part of the river's family as I was theirs. When I reached adulthood and had to choose a profession, Fisheries Management seemed as natural as going home.

Over the years, I witnessed the deterioration of that stretch of river and, when I returned many years later, found it to be a stagnant oxbow

cut off as the Corps of Engineers had re-routed the river to control flash flooding in the bottoms so prevalent in the hills of home. A couple of years ago as I visited my old home place, I was struck by the smell of rotten eggs and dead blooms of algae that had replaced the smell of a clean mountain river. That experience made me feel all the more committed to rectifying the harm that has been done as my generation pursued security from all of nature's wrath – seldom thinking of the cost.

I believe it is our responsibility to do whatever we can in the U.S. Fish and Wildlife Service to instill the understanding that all natural resources belong to the people, and we in government have the privilege of holding those resources in "trust"

for everyone. To accomplish this, we're going to have to engage every tool in our toolbox, take risks calculated by science and be honest about what we're doing. All the while we must educate the public about their responsibilities to be meaningfully involved in the efforts. These precious jewels belong to all of us.

Science is the cornerstone of any plan we may choose. Reality dictates that we will almost never have "enough" science to be confident that the actions we take will lead to certainty. After all, the only thing that is certain in nature is that nothing is certain in nature. However, we hold these resources in trust for the American people, and we will not fail.

We need to actively pursue cryogenics to ensure we have adequate populations of fishes into the future. Preserved fish milt is our bank account – a reserve capable of replenishing depleted stocks. We need to constantly improve our knowledge of population genetics so that as many of the "parts" as is possible can be conserved. We need to continually work with our state fish and game agencies and Tribal partners to understand the current health of fish populations. And we need to continue the efforts we have begun with our partners to remove those obstructions to fish passage, including levees that block access of fish to the floodplain, as well as the removal of dams that have attained the status of liability, rather than asset.

The pursuit of science is the pursuit of truth. Scientists must let no other agenda or objective deter them from that quest. They must be straightforward regarding the true level of understanding. We

must always accept that in the quest for knowledge we are continually learning which issues truly need our attention and what vacuums of data need filled. The greatest mistake a scientist can make is to lead others to believe he or she has the data to support a position when, in fact, the position is based on emotion or speculation. The U.S. Fish and Wildlife Service owns a 137-year-old reputation of being honest scientists in our various pursuits. We must never do anything to tarnish that reputation.

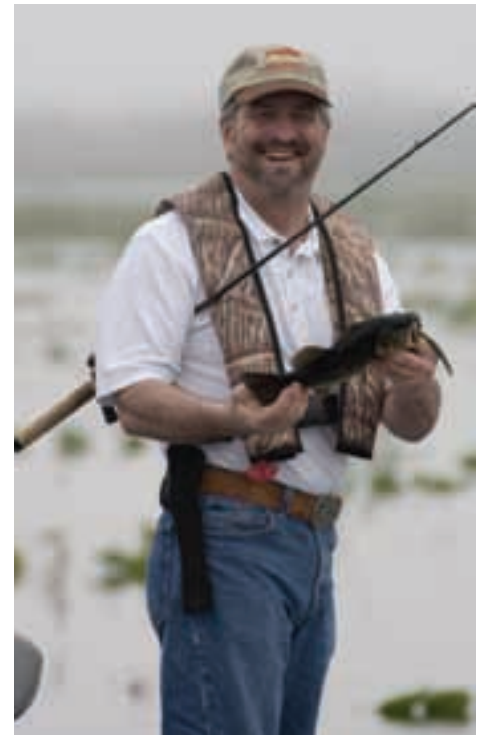
I believe there is a bright future awaiting the aquatic resources of this country because of the dedicated employees of the U.S. Fish and Wildlife Service, as well as those professionals in the States, Tribes and non-governmental organizations. Somewhere today there is a child walking along a stagnant reach of water, but one day that child will re-visit home to find the sweet smell of a healthy, living river.

Let us never forget why we do what we do, nor our commitment to never give up. ♦

---

H. Dale Hall is the Director of the U.S. Fish and Wildlife Service in Washington, DC

*"I didn't go fishing and hunting because it was a means of recreation, unless one interprets recreation in its truest form: to re-create one's self."*



*H. Dale Hall, Director of the U.S. Fish and Wildlife Service, beams over a largemouth bass.*

LaVanda Walton/USFWS

**U.S. Fish & Wildlife Service**  
<http://www.fws.gov/eddies>

Fall 2008



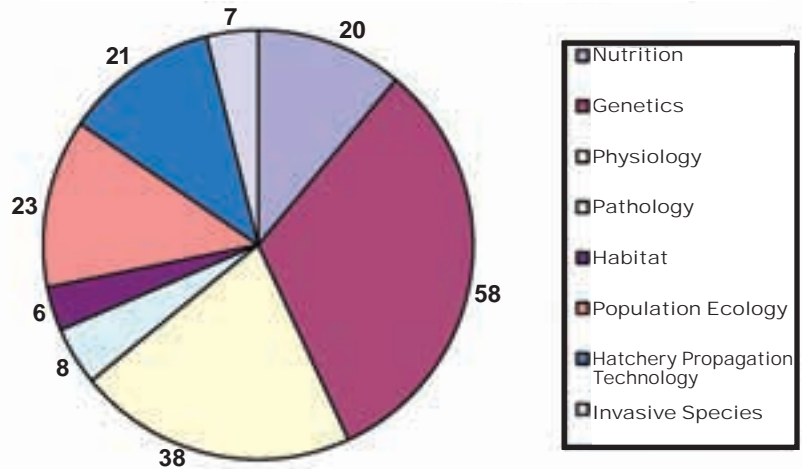
## Sharing Knowledge

What's in your waters? The National Wild Fish Health Survey collects data on disease-causing pathogens in free-ranging fish. The Survey is maintained by the USFWS's nine Fish Health Centers. Over 35 percent of the nation's 2,262 watersheds have been sampled by the Survey. Fish health pathologists have analyzed 125,000 fish of 224 species from 3,000 sites in 49 states and found 19 disease-causing pathogens. Visit [www.fws.gov/wildfishsurvey](http://www.fws.gov/wildfishsurvey) to learn more. Josh Bradley

The USFWS shares scientific information with aquatic resource managers and scientists worldwide via peer-reviewed journals. From 2002 to the present, our Fish Technology Centers, Conservation Genetics Laboratory, and Aquatic Animal Drug Approval Partnership have contributed nearly 200 papers to journals such as *Molecular Ecology*, *Transactions of the American Fisheries Society*, *Journal of Comparative Physiology*, *Journal of Applied Ichthyology*, *North American Journal of Fisheries Management*, *Aquaculture*, and *Conservation Biology*. Linda Andreasen



### Fish Technology Center Publications



# Eddies

*Reflections on Fisheries Conservation*

**U.S. Fish and Wildlife Service— Fisheries**  
**MS ARLSQ 720**  
**4401 North Fairfax Drive**  
**Arlington, VA 22203**

STANDARD PRESORT  
 POSTAGE AND FEES

**PAID**

U.S. DEPARTMENT  
 OF THE INTERIOR  
 PERMIT G-77