ANS
Aquatic Nuisance Species
DIGEST

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FRESHWATER FOUNDATION

Providing current information on monitoring and controlling the spread of harmful nonindigenous species.

Senator Glenn Lauded for Work in Fighting ANS

by Neal Foster, Eric Eckl, and Gordon Helms

Senator John Glenn was recently honored by the national Aquatic Nuisance Species Task Force for his outstanding efforts to prevent and control invasions by nonindigenous species. The award was presented at a July 21st reception by the co-chairs of the task force, Dr. D. James Baker, Under Secretary of Commerce for Oceans and Atmosphere, and Jamie Rappaport Clark, Director of the U.S. Fish and Wildlife Service.

"Senator Glenn has long recognized that invasive alien species such as the zebra mussel and sea lamprey can have a serious impact on our country," said Clark. "The Senator was a moving force behind passage of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 and has worked tirelessly to call public attention to the problem of invasive species."

"Senator Glenn recognized an emerging environmental issue long before many others," said Baker, who praised the Senator's vision on this significant concern. "When it would have been expedient to focus on a single species, such as the invasion of the zebra mussel, he recognized the importance of addressing the overall issue and taking steps to prevent future invasions."

Senator Glenn *continued on page 4*

Members of the ANS Task Force with Senator John Glenn (left to right) Gary Isbell, Sheila Tooze, Comdr. Scott Newsham, Leo Dunn, Bill Wallace, John Dekam, Ed Theriot, Mike Slimak, Senator John Glenn, Gary Edwards, John Kahabka, Faith McGruther, John Christmas, Jim Baker (Under Secretary for Oceans and Atmosphere, U.S. Department of Commerce), and Jamie Rappaport Clark (Director, U.S. Fish and Wildlife Service)

Whirling Disease Threatens Wild Trout in Colorado

by R. Barry Nehring, Kevin G. Thompson, and Sherman Hebein

Whirling disease is an infection of **salmonids*** caused by the microscopic parasite *Myxobolus cerebralis*. *M. cerebralis* spends part of its life cycle as a parasite of a bottom-dwelling aquatic worm, *Tubifex tubifex*. It spends the alternate stage of its life cycle in trout fry, where it actively consumes cartilage, the template for bone formation. In young trout, loss of cartilage can result in abnormal or interrupted bone growth and skeletal deformities that are manifested in pinched nerves. Pinched nerves in turn can cause abnormal pigmentation (blackened tail) and impairment of proper motor function, causing the trout to swim rapidly in one direction in tight circles, hence the name whirling disease (Uspenskaya 1957). Affected trout are unable to forage or evade predators. State and federal management agencies, sportsmen's groups, and businesses dependent on tourism are concerned about the long-term effects of whirling disease on trout populations.

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words in **bold type are defined in the glossary on page 4.*

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Direct questions and comments about *ANS Digest* to: Freshwater Foundation, Gray Freshwater Center, 2500 Shadywood Road, Navarre, MN 55331; (612) 471-9773; e-mail: freshwater@freshwater.org.

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SERC Launches National Ballast Water Information Clearinghouse

by Gregory M. Ruiz, Anson H. Hines, A. Whitman Miller, and Lynn Takata

Overview

The National Invasive Species Act of 1996 (NISA) directed the United States Coast Guard in conjunction with the Smithsonian Environmental Research Center (SERC) to develop a clearinghouse for the synthesis, analysis, and interpretation of national data concerning ballast water management and ballast-mediated introductions. In 1997, the National Ballast Water Information Clearinghouse was established at SERC.

NISA calls for a variety of measures to reduce the risk of nonindigenous species invasions resulting from the release of ballast water by commercial ships. Among these, NISA requests that all ships destined for U.S. ports from outside the 200-mile Exclusive Economic Zone follow voluntary guidelines that call for open-ocean exchange of water in ballast tanks that will be discharged in U.S. waters. This management practice is intended to minimize the spread of nonindigenous species (see sidebar for discussion of ballast water, ballast water management, and relevant legislation).

Effectiveness of voluntary guidelines for ballast water management is a key element of this legislation. The goals of the assessment are to track and measure the level of compliance with voluntary guidelines, the changes in the frequency and patterns of ballast water delivery, and the reduction in the frequency of ballast-mediated invasions. The Clearinghouse was created to synthesize and analyze these data, and to function as a central source of information on ballast water and ballast-mediated invasion. Specific objectives are to:

- track and measure spatial and temporal patterns of ballast water delivery and management;
- track and measure patterns and frequency of marine and estuarine invasions;
- create a directory of ongoing and past research on ballast water and ballast-mediated invasions, and;
- provide general information on a broad range of topics relevant to this issue.

Together, these elements will provide a central information resource, which is currently lacking for ballast water management and ballast-mediated invasions. The Clearinghouse will report on national patterns of ballast water management and invasion as well as databases, which will be made available on the Internet, accessible through SERC's Web site at http://www.serc.si.edu beginning early in 1999. This approach is intended to provide access to a rich source of information for education, management, policy, and research.

The National Ballast Survey

The U.S. Coast Guard and the Clearinghouse are implementing a nationwide program, the National Ballast Survey (NBS), to measure ballast water management and delivery patterns for commercial vessels destined for U.S. ports from outside of the Exclusive Economic Zone (see sidebar). The NBS is designed explicitly to create a national ballast water database that will allow us to:

- measure patterns of ballast water delivery and management, especially ballast water exchange;
- measure changes in ballast water management by vessel type, geographic region, and season;

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- assess the accuracy of data through use of multiple, independent data sources and direct water testing; the details are not yet finalized, but this will likely involve a questionnaires from the International Maritime Organization, data collected by the Maritime Administration, and shipboard inspections carried out by the U.S. Coast Guard.

NBS data will be used to measure the extent of voluntary compliance with guidelines for open-ocean ballast exchange. Extent of ballast water exchange will be estimated for different types of vessels, such as bulk carriers, oil tankers, and container ships, both in terms of the number of vessels that undergo exchange and the percentage of ballast water exchanged. Furthermore, plans have been made to test for differences in locations and times for the rate of exchange and the amount of foreign ballast released to assess the corresponding differences in risks of invasion. Also, the level of contamination — in terms of both numbers of species and types of species — of source water varies seasonally and by location.

The design phase for the NBS is near completion, with some aspects of the program already in place; it will be fully implemented during 1999. The Clearinghouse is responsible for management and analysis of the data collected under this program, and is assisting the U.S. Coast Guard in the development and implementation of data collection techniques.

Data gathered by the NBS will be used to provided a comprehensive analysis and biennial report to the U.S. Congress on the status and risk of ballast water introductions throughout the country. The first report will provide a nationwide baseline on the current status of ballast delivery and management patterns, and subsequent biennial reports will measure trends or changes in ballast water management. Although the Clearinghouse will provide analyses and interpretation of patterns for ballast water management, policy recommendations will be made by the Secretary of Transportation in consultation with the ANS Task Force.

Evaluating the Effectiveness

The effectiveness of this management strategy depends upon both the degree of implementation and the relationship between organism supply and invasion rates. Although the NBS will provide a detailed assessment of compliance with NISA's voluntary guidelines for ballast exchange, it is important to recognize the NBS as only one measure of effectiveness. The NBS is designed to measure the extent of implementation of ballast water exchange, but does not measure the actual affect on reducing the rate of invasion. Overall, a reduction due to open-ocean ballast water exchange of the number and frequency of organisms that arrive to our ports in ballast water will result in fewer invasions. However, ballast water exchange is not 100% effective, as not all organisms are removed by exchange (see "Ballast Water Invaders" in *ANS Digest* Vol.1, No. 3).

Measuring the pattern and rate of invasions is essential for evaluating the effectiveness of ballast water exchange, or of any other management strategy, to reduce invasions. For example, as the rate of ballast water exchange increases over time, the supply of ballast-transferred organisms would be expected to decrease. Thus, it is important to link patterns of ballast water delivery to associated patterns of invasion. The Clearinghouse will strive to integrate and to assess patterns of ballast delivery and invasion across the nation.

Gregory M. Ruiz is a Senior Scientist who oversees the design and administration of the National Ballast Water Clearinghouse; A. Whitman Miller is a Project Coordinator, responsible for many design, implementation, and functional aspects of the Clearinghouse; Lynn Takata is a Biological Technician responsible for data handling for the Clearinghouse; and Anson H. Hines is a Senior Scientist and Assistant Director of the Smithsonian Environmental Research Center, P.O. Box 28, Edgewater, MD 21037.

Ballast Water Introductions of ANS and Present Management Strategies

Ballast water is carried by ships to provide necessary stability and trim for steering and propulsion. The use of ballast water varies among vessel types, among port systems, and according to cargo loads and sea conditions. Ballast water often originates from ports and other coastal regions which are rich in fish, invertebrates, and **planktonic** organisms. Ballast water is released at sea, along coastlines, or in port systems. As a result, a diverse mix of organisms is transported and released around the world with the ballast water of ships.

Ballast water appears to be the most significant pathway for marine, **estuarine**, and aquatic species transfer throughout the world. Ballast water discharge has resulted in the unintentional introduction of thousands of freshwater and marine species into the U.S. and other countries. Although the effects of many introductions remain unmeasured, clearly some invaders are causing significant economic and ecological effects as well as human health consequences.

Ballast water exchange is the only recommended management tool to effectively reduce the risk of ballast-mediated invasion. Ballast water exchange involves replacing water taken on in port with open-ocean water during a voyage. This process replaces the coastal organisms in the ballast tanks with oceanic organisms, which have a lower probability of survival in near-shore waters, significantly reducing the number of coastal organisms discharged into a recipient port.

Currently, ballast water exchange is recommended as a voluntary measure by the International Maritime Organization. However, this procedure has two shortcomings. First, the ability to safely conduct ballast water exchange depends upon weather and wave conditions, sometimes making exchange impossible due to safety concerns. Second, this process is only partly effective; some coastal organisms always remain in ballast tanks following exchange.

The National Invasive Species Act (NISA) of 1996 (P.L. 104-332) reauthorized and amended the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. NISA issued mandatory ballast management reporting and voluntary ballast exchange guidelines to all vessels that enter U.S. waters from outside the Exclusive Economic Zone, with the exception of military vessels, crude oil tankers that conduct coastal trade, and some passenger ships that are equipped with ballast treatment systems.

If compliance with the voluntary guidelines is low, NISA authorizes the use of mandatory guidelines for vessels arriving at selected regions or the entire nation. The National Ballast Water Information Clearinghouse will provide analysis to estimate the national patterns of ballast water management. Policy decisions about the adequacy of voluntary guidelines and the acceptable rate of compliance will be based upon criteria and evaluation by a committee of the national Aquatic Nuisance Species Task Force.

Senator John Glenn Lauded for Work in Fighting ANS

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Economic and Ecological Consequences

"Introductions of nonindigenous aquatic species have been extremely costly to our nation, both economically and ecologically," Dr. Baker added. "For example, cities, power plants, and industrial facilities in the Great Lakes region spend more than $30 million each year to prevent zebra mussels from clogging water intake pipes." The U.S. and Canadian governments spend $15 million annually to control another nonindigenous threat, the sea lamprey, which has had a serious effect on sport and commercial fishing, which contribute $5 billion to the regional economy annually.

Clark emphasized the seriousness of environmental effects of aquatic nuisance species. "Aquatic nuisance species are notorious for their ability to devour or crowd out native wildlife. Alien species have upset the ecological balance in many of our waters and have played a role in the depletion of many fish and other aquatic species in the United States."

A Step Toward Prevention and Control

Senator Glenn authored the Nonindigenous Aquatic Nuisance Prevention and Control Act, which established the national Aquatic Nuisance Species Task Force, which coordinates ANS programs among several federal agencies. The Act galvanized federal efforts to detect, prevent, and control invasive aquatic species and earmarked millions of federal dollars for research, outreach, and education needed to support these activities.

The Act addresses ballast water discharge as a pathway for new introductions. "Thanks to Senator Glenn's efforts, all ships [with ballast on board] entering the St. Lawrence Seaway must now exchange their ballast water on the high seas," Clark said. "This greatly reduces the likelihood of another pest like the zebra mussel invading Toledo, Chicago, or Duluth."

Members of the Aquatic Nuisance Species Task Force, established by the Nonindigenous Aquatic Nuisance Prevention and Control Act, include the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Department of Agriculture, U.S. Coast Guard, and the U.S. State Department. There are also several ex-officio members, representing regional organizations, state agencies, tribal governments, and industry.

Upcoming Meetings

National Conference on Marine Bioinvasions
24–27 January 1999
Massachusetts Institute of Technology
Cambridge, MA
Contact: Judith Pederson,
MIT Sea Grant College Program,
292 Main Street E38-300, Cambridge, MA 02139
fax: (617) 252-1615; e-mail: jpederson@mit.edu
http://massbay.mit.edu/exoticspecies/conference.html

9th International Zebra Mussel
and Aquatic Nuisance Species Conference
26–30 April 1999
Duluth Entertainment and Convention Center
Duluth, MN
Contact: Elizabeth Muckle-Jeffs; (800) 868-8776;
fax: (613) 732-3386
http://www.zebraconf.org

5th Annual Whirling Disease Symposium
18–20 February 1999
University of Montana
Missoula, MT
Contact: The Whirling Disease Foundation
PO Box 327, Bozeman, MT 59771-0327
(406) 585-0860; fax: (406) 585-0863;
e-mail: whirling@mcn.net
http://water.montana.edu/docs/whirling/WDsymp.htm

Send meeting announcements to:

Editor, ANS Digest
2500 Shadywood Rd., Navarre, MN 55331
e-mail: freshwater@freshwater.org

Deadline for the next issue is 15 March 1999

Glossary

Estuarine:
Found in an estuary; an estuary being the part of the mouth of a river that meets the sea.

Phylum:
In the system for classifying living organisms, phylum is the subdivision of kingdoms.

Planktonic:
Minute aquatic organisms that drift with water currents, including the larval stages of many larger organisms.

Salmonids:
Trout and salmon.

Nuisance Notes from the Western Regional Panel on ANS

Western Regional Panel on ANS Meeting in Denver

Members of the Western Regional Panel met in Denver, CO, in September. Agenda items included the Western Governors' Association Resolution on Invasives, member updates on invasive activities, policy and legislative developments, Executive Order on Invasives, Plant Protection Act, proposed rule on ballast water guidelines and regulations, proposed letter from scientific community on pet/aquarium trade, global early warning system for invasive species, l00th Meridian Initiative Control Plan, WA State Plan, Colorado River Basin Regional Plan, ballast water outreach program efforts underway on west coast, purple loosestrife management. The Panel is developing its l999 work plan based on the input of the coastal and inland committees. For more information contact Linda Drees, WRP coordinator, (785) 539-3474, ext. 20 or Linda_Drees@fws.gov.

The 100th Meridian Initiative

Initial findings from boater education stations conducted on interstates crossing the l00th meridian have been provided by state and university researchers participating in l00th Meridian Initiative. Throughout reporting states the following generalizations apply: more boaters pass than stop at stations; boaters have a lack of knowledge regarding invasives; boaters are receptive to message of controlling exotics; no invasives have been found on boats; information collected at lake survey points are useful in assessing movement. Researchers at the University of Texas will be analyzing the data and will be preparing a report on boater movement. For more information contact Bob Pitman, USFWS, (580) 384-5710.

State Updates

Alaska: Researchers from the Smithsonian Environmental Research Center conducted field work in Prince William Sound during summer 1998 looking for NIS and they continue to sample ballast water from arriving tankers. A report will be issued in December. Contact Bob Piorowski (907) 465-6150.

Arizona, Hawaii: AZ contact Joe Janisch (602) 789-3258. HI contact Myron Isherwood (fax) (808) 973-9613.

California: The California Water Commission heard a presentation on mitten crab effects on operations of the Central Valley Project and State Water Project at its November 6th meeting in Visalia. Its December 4th meeting in Palm Springs included a presentation on federal appropriation needs for ANS programs. Contact Randy Brown (916) 227-7531.

Colorado: The Colorado Division of Wildlife will be starting construction on a unique new fish and other aquatic species hatchery in the summer of 1999. The hatchery will be located in the San Luis Valley of southern CO and is designed to maintain and raise native fish, amphibian, and possibly mollusk species. Initial emphasis at the hatchery will be on several species of rare native fish species. Amphibians, such as the state endangered boreal toad, may also be propagated and reared at the facility in the future. Contact Chuck Loeffler (303) 291-7451.

Guam: Brown tree snake control and monitoring program in place. Contact Michael W. Kuhlmann (671) 734-3942.

Idaho: ANS State Plan Workshop held in Boise, ID, on Dec 15–l6. Contact Bill Horton (208) 334-379l.

Kansas: Bighead carp are frequently seen in the Kansas River below Bowersock Dam in Lawrence, KS, and in the Wakarusa River below Clinton Dam, KS. During a recent fish salvage operation at Clinton Dam, approximately 100 bighead totaling 700 lbs. (approximately 1/3 by weight of all species) were removed from the spillway. Young-of-the-year bighead carp have been found in large numbers in frequent fish samples. The ability of these fish to naturally reproduce within the major river systems of the U.S. increases their threat to native species. The feasibility of conducting a multi-state, multi-region study is being explored. Contact Patrick Cassidy, (913) 573-9856 or Tom Mosher (316) 342-0658.

Montana: Results of research conducted on effects of New Zealand Mud Snail in MT were presented at ANSTF meeting in Vicksburg, MS. Contact Tim Gallagher (406) 444-2448.

Nebraska: Ten percent of interviewees at 100th Meridian boater education stations traveled from infested areas. Contact Steve Schainost (402) 471-5443.

Nevada: At its November 19th meeting in Reno, NV the Western States Water Council will hear presentations on mitten crab effects and an overview of WRP activities. Contact Jon Sjoberg (702) 486-5127.

New Mexico: Preliminary findings of decapod survey in SW NM out next month. Contact Brian Lang (505) 827-9904.

North Dakota: PSAs on 100th Meridian Initiative boat checks distributed through radio stations in eastern ND. Letters have been sent to each fishing tournament permit holder informing them they need to check boats for ANS prior to using them in ND water. Contact Terry Steinwand (701) 328-6313.

Oklahoma: Live zebra mussels were found on a trailered boat at Grand Lake. The boat had been transported from Michigan. The marina operator identified the zebra mussels and the exotics were removed prior to launching. Contact Everett Laney (918) 669-7411.

Oregon: The OR Department of Agriculture has proposed rules that would establish a quarantine on all plants on the noxious weed list, including several invasive aquatic plants. The quarantine would prohibit the sale of noxious weeds in the state. Contact Andrew Schaedel, Oregon Department of Environment.

South Dakota: Over 95% of contacts made at l00th Meridian Initiative Lake Francis Case boater education station were from NE, IA, and MN. Risk to SD from infested boats traveling from IA and MN. Contact Dennis Unkenholz (605) 733-6770.

Texas: TPW biologists have confirmed the presence of an exotic species of aquatic plant, *Salvinia molesta*, in the Sabine River watershed. The first occurrences were discovered and confirmed within the last few months. TPW finalized statewide aquatic plant management strategy at the 5 November Parks and Wildlife Commission Hearing. Contact Bill Harvey (512) 389-4394.

Utah: Glen Canyon National Rec Area has been conducting surveys to determine extent of boating traffic from infested states. From 6 April to 30 Septemeber 70 boats from infested areas used Glen Canyon. Contact Randy Radant (801) 538-4812.

Washington: The WA Green Crab and Zebra Mussel Task Force has met and is developing recommendations to address accidental introductions by aquatic plant and animal suppliers as well as ballast water introductions. The green crab has expanded its range north of Willapa Bay to Grays Harbor, but no green crabs have been found in Puget Sound to date. Governor has approved $100,000 from his emergency funds to start a monitoring and control program for green crab. Contact Scott Smith (360) 902-2328.

Wyoming: WY Game and Fish Department plans to submit regional ANS management plan to the Colorado River Fish and Wildlife Directors Council for review in January. This plan will include CO, UT, CA, WY, NV, and NM. Contact Mike Stone (307) 777-4559.

Provincial Updates

Manitoba: Monitoring efforts during 1998 for zebra mussels in Manitoba are complete. No evidence of the mussel was found in waters that are assessed to be high risk to colonization. Efforts continue towards public information and education regarding zebra mussel prevention in the province. Contact Wendy Ralley (204) 934-8146 or Dwight Williamson (204) 945-7030.

Western News on the Web

WZMTF homepage can be accessed at **http://www.usbr.gov/zebra/wzmtf.html.**
WRP on ANS homepage can be accessed at **http://www.wrp-ans.org**

Zebra Mussels "Pulse" in Duluth-Superior Harbor

by Douglas A. Jensen

A surprising increase of thousands of zebra mussels in the Duluth-Superior harbor in September raises concern over potential effects on raw-water-dependent industries and spread by recreational boaters to inland lakes and rivers in Minnesota and Wisconsin.

Nearly a decade after their initial discovery, zebra mussels had not become much of a problem in Lake Superior — in contrast to serious effects on the other Great Lakes, the Mississippi, and other waters. Until now zebra mussels were very difficult to find in Duluth-Superior harbor, except in areas where contaminated ballast water is being discharged.

Discovery of the infestations on the hulls of two recreational boats was the beginning of the most significant finding of zebra mussels so far. Other reports of fouling on boat lifts, piers, shoreline, and on native mussels suggest that the infestation is expanding in the harbor. Minnesota Sea Grant is collaborating with Dr. Mary Balcer, University of Wisconsin-Superior, to assess the extent of the infestation and to determine if the young will successfully overwinter in the harbor. Results of preliminary dives by Dr. Balcer show that for the first time there are thousands of young zebra mussels on piers, as well as on rocks along the waterfront. Survival of the young will not be known until next spring.

While the infestation is not necessarily cause for alarm, Sea Grant has issued letters to dozens of raw-water industries and operations on the waterfront to raise awareness of the growing problem and to urge operators to take action to mitigate potential problems.

Minnesota Sea Grant is also stepping up awareness efforts to prevent boaters, anglers, and other water users from moving zebra mussels from the harbor to inland waters. Boaters are urged to inspect their boats and remove and zebra mussels and aquatic plants before leaving a water accesses. Minnesota regulations prohibit carrying zebra mussels or aquatic plants on a public road, and boat owners are required to clean their boats and empty water from live wells and bait buckets before leaving infested waters.

Precautions taken by boaters can work; further spread of zebra mussels is not inevitable. Zebra mussels have been in Lake Pepin on the Mississippi River for the last seven years but have not spread to any nearby lakes or rivers, and they have not been found in any other waterways in Minnesota or northern Wisconsin.

Douglas Jensen is the coordinator for the exotic species information center at the University of Minnesota Sea Grant Program, 2305 East 5th Street, Duluth, MN 55812-1445; (218) 726-8712; fax: (218) 726-6556; e-mail: djensen1@d.umn.edu. He is also co-chair of the upcoming 9th International Zebra Mussel and Aquatic Nuisance Species Conference, to be held in April of 1999.

• •NEW• • Print and Electronic Publications

NEW PRINT PUBLICATIONS

Ships' Ballast Water and the Introduction of Exotic Organisms in San Francisco Estuary: Current Status of the Problem and Options for Management by by Andrew N. Cohen, available from the San Francisco Estuary Institute, 1325 South 46th Street, Richmond, CA 948004; (510) 231-9539.

Life Out of Bounds—Bioinvasion in a Borderless World by Chris Bright, available from the Worldwatch Environmental Alert Series. Call (800) 555-2028.

NEW ELECTRONIC PUBLICATIONS

New CD-ROM version of the Sea Grant Nonindigenous Species (sgnis) Web site. Provides comprehensive information on zebra mussels, Eurasion ruffe, round gobies, and other ANS. Cost: $14, orders over twenty $10 per CD. Contact: Minnesota Sea Grant (218) 726-6191.

WANTED

Bighead and Silver Carp Data

Hypopthalmichthys nobilis and *H. molitrix*

Length and Weight Measurements Needed from the Mississippi River Basin

Originally introduced to the U.S. in the 1970s, bighead and silver carp populations are thought to be increasing rapidly in large Midwestern river systems. Fishery scientists are concerned about the effects of these species on big-river ecology, biodiversity, and native fishes. The Columbia Fishery Resources Office would like to begin compiling available data on these and other Mississippi River basin exotic fishes. This information will be used to fill data gaps with an objective of ultimately developing a compendium of biological and ecological information on these species. As a starting point we would like to develop a relative (Wr) equation for bighead and silver carp within the Mississippi River basin. Length-weight data on wild and cultured fish of these species throughout the Mississippi basin are needed. Your contribution will be fully acknowledged or cited in any reports or documents which may result from this effort. If you or your organization is willing to particiapate in the development of a relative weight condition index (Wr) on these genera or can provide information relative to black carp *(Mylopharyngodon piceus)* or grass carp *(Ctenopharyngodon idella)*, please contact Jeff Finley at (573) 876-1911 ext. 111; e-mail jeff_finely@mail.fws.gov; or:

U.S. Fish and Wildlife Service, Columbia Fisheries Resource Office
Attn: Jeff M. Finley, 608 E. Cherry St. Rm 200, Columbia, MO 65201

News from the Great Lakes Panel on Aquatic Nuisance Species

ANS UPDATE

Summer/Fall 1998 *Volume 4, Nos. 3 and 4*

Dramatic changes in benthic macroinvertebrate populations in southern Lake Michigan

By Thomas Nalepa, Biologist, Great Lakes Environmental Research Laboratory, NOAA

Major population changes of benthic macroinvertebrate populations in southern Lake Michigan have been detected with routine monitoring, conducted by NOAA's Great Lakes Environmental Research Laboratory (GLERL). Between 1980 and 1993, the population density of three dominant macroinvertebrate groups -the amphipod *Diporeia*, oligochaete worms, and fingernail clams *(genus Pisidium)* - declined 58 percent at sites with a water depth of less than 50 meters. This trend initially was interpreted solely as a response to phosphorus control measures. Phosphorus reduction leads to a decline in algal productivity and, subsequently, a decline in the amount of organic matter available as food for these macroinvertebrates. However, further analysis revealed changes that could not be entirely attributed to phosphorus load reductions. For instance, both oligochaete worms and fingernail clams declined uniformly over the whole study area and steadily over the entire study period. In contrast, the decline in *Diporeia* was focused in the far south/southeastern portion of the lake, and occurred mostly in the later portion of the study period (late 1980s/early 1990s).

The decline in population density of *Diporeia* occurred mostly at sites from Chicago, Ill., to St. Joseph, Mich.; the average decline was 82 percent at specific sites in this area. At some sites, *Diporeia* declined from 10,000 per square meter in 1980 to less than 100 per square meter in 1993. More recent sampling in the spring of 1998 indicated that the area of reduced *Diporeia* has expanded greatly since 1993. A preliminary analysis of the data shows that *Diporeia* is now completely gone from about one third of the southern basin, with population densities reduced to zero at sites with a water depth of about 70 meters or less.

Data collected by GLERL researchers suggests that lower food availability resulting from the introduction and rapid spread of the zebra mussel *(Dreissena polymorpha)* in southern Lake Michigan is having an adverse impact on the *Diporeia*. Zebra mussels first were found in the southern portion of the lake in 1989 and reached high abundances by 1993. *Diporeia*, a shrimp-like organism, relies almost entirely on freshly-sedimented organic matter as a food source (i.e., mostly diatoms, an energy-rich algae group), while the zebra mussel is a filter-feeder that intercepts this material before it actually settles to the bottom. The other two macroinvertebrate groups, oligochaetes and fingernail clams, are not as dependent on fresh material as a nutrition source and may actually be utilizing zebra mussel biodeposits directly or indirectly (through bacteria) as a source of food. Preliminary results of recent laboratory studies on *Diporeia* feeding and sediment toxicity seem to confirm that lack of food is the likely cause of the decline.

Diporeia is the dominant benthic macroinvertebrate in offshore waters of Lake Michigan and is considered a keystone species in the lake's food web structure. This organism is a component in the diet of most species of fish (during at least some stage in their life cycle) including yellow perch, an important sport fish, and species such as bloater, alewife and sculpin, which serve as prey for the larger piscivores such as trout and salmon. With an increase in zebra mussels and a corresponding decline in *Diporeia*, it appears that energy used to support *Diporeia* growth is now being turned into zebra mussel tissue. As the zebra mussel continues to expand its range in Lake Michigan, *Diporeia* populations will likely continue to decline. Detailed studies are needed to examine how fish are responding to a loss of a major diet item. For further information, refer to the manuscript to be published in the *Canadian Journal of Fisheries and Aquatic Sciences*. **Contact**: Tom Nalepa, GLERL, 734-741-2285, nalepa@glerl.noaa.gov.

Great Lakes Panel Update

The Panel will convene for its winter meeting Jan. 28-29, 1999, in Ann Arbor, Mich. The meeting will focus on the development of the Great Lakes Action Plan for the Prevention and Control of Aquatic Nuisance Species. A workshop, Ballast Water Management and Aquatic Nuisance Species: Setting the Research Agenda, originally scheduled to be held in conjunction with the January Panel meeting will now be conducted April 28-29 in Duluth, Minn. in conjunction with the Ninth International Zebra Mussel and Aquatic Nuisance Species Conference.

The Model State Guidance for Nonindigenous Aquatic Nuisance Species Prevention and Control: Legislative, Regulatory and Policy Approaches for the Great Lakes Region will be released in January. Contact Kathe Glassner-Shwayder, Great Lakes Commission, 734-665-9135, shwayder@glc.org.

Washington Watch

With the closing of the appropriations cycle in late October, three appropriations bills containing items of importance to ANS prevention and control were rolled into the Omnibus Appropriations bill (P.L.105-277): Commerce, Justice, State and the Judiciary; Interior; and Transportation.

The Omnibus bill included compromise positions between the House and Senate Commerce, Justice, State and Judiciary Appropriations bills for most National Oceanic and Atmospheric Administration (NOAA) programs. The National Sea Grant College Program was funded at $57.5 million with report language indicating that Sea Grant should continue its zebra mussel research program, and advocating a study of the human health risks from pathogens in ballast. Congress provided $1.65 million for NOAA activities to implement the National Invasive Species Act (NISA). Report language directs that $850,000 of this amount be used for ballast water technology demonstrations. Sea lamprey control by the Great Lakes Fishery Commission was funded at the Administration budget request level of $8.35 million.

Programs in the Department of Interior were generally level funded. With a few exceptions, U.S. Geological Survey (Biological Resources Division) programs were funded at the House allocation level in the Omnibus bill. Additional funding for ANS programs of the U.S. Fish and Wildlife Service sought by Sen. John Glenn and others from around the country was not included in the Omnibus package. The Omnibus bill included $3 million in funding for U.S. Coast Guard activities to implement NISA, including funds for the Ballast Water Guidelines and Prevention Program.

The Energy and Water Appropriations bill was passed separately and signed by the President in early October (P.L. 105-245). A floor amendment by Sen. Carl Levin for sea lamprey barrier construction, which was included in the Senate-passed bill, was not included in the final House-Senate conference. The conference report provided $300,000 for continuation of the dispersal barrier demonstration at the Chicago Shipping and Sanitary Canal and $3 million for aquatic nuisance plant control research. In a surprise move, the conferees cut the zebra mussel research program in half (both House and Senate passed bills had recommended the Administration request of $1.5 million be provided). **Contact**: Rochelle Sturtevant, Senate Great Lakes Task Force, 202-224-4229, rochelle_sturtevant@glenn.senate.gov.

Full copies of the *ANS Upda*te, a quarterly newsletter prepared by the Great Lakes Panel on Aquatic Nuisance Species, are available upon request from the Great Lakes Commission. The feature article of this issue (Vol. 4, No. 3) is authored by Thomas Nalepa, Biologist, Great Lakes Environmental Research Laboratory, NOAA and is titled, *Dramatic changes in benthic macroinvertebrate populations in southern Lake Michigan.* **Contact:** Kathe Glassner-Shwayder, Great Lakes Commission, 734-665-9135, shwayder@glc.org.

Whirling Disease Threatens Wild Trout in Colorado

continued from page 1

Originally endemic to Europe — *M. cerebralis* was first described in Germany in the early 1900s (Plehn 1904) — it is considered an exotic species in North America. This destructive parasite, belonging to the **phylum** Myxozoa, has been intensively studied throughout the twentieth century. Halliday (1976) listed more than 140 scientific publications with information about the biology of the organism. Hoffman (1991) suggested that the organism was inadvertently introduced into the United States in frozen trout fillets from Denmark, where the disease is present. It is believed that some of these frozen fillets were used as food for farm-reared fish, where the *M. cerebralis* spores were ingested by *T. tubifex* worms, beginning the cycle. The parasite was first identified in North America in 1956, at the Benner Spring Fish Research Station in Pennsylvania (Hoffman et al. 1962). Public records indicate that it arrived to Colorado in shipments of commercially-reared live rainbow trout *(Oncorhynchus mykiss)* from Idaho in the mid-1980s (Obmascik 1995). It was first isolated in rainbow trout at aquaculture facilities in central and north-central Colorado in November and December of 1987 (Walker and Nehring 1995).

Brown trout *(Salmo trutta)* is a species of European origin, as is *M. cerebralis*. Brown trout have great innate resistance to the parasite and rarely develop clinical whirling disease. Rainbow trout, a North American species only recently exposed to *M. cerebralis*, can suffer severe effects when exposed to the parasite as very young trout (Markiw 1991).

At an emergency conference held in April 1988 in Denver, Colorado, most fish pathologists and fish health specialists in attendance believed this parasite — which had been intensively studied in fish culture and laboratory settings — was a nuisance that would not interfere with the aquaculture industry, and that it posed little risk to wild trout populations (FHS 1988). Within a year, tests on more than 25,000 trout detected the parasite at 11 aquaculture facilities and in 40 wild trout populations. However, no population declines were observed in wild trout during the 1980s.

The parasite was first detected in spawning adult rainbow trout in the upper Colorado River during an annual disease inspection in April 1992. In October 1993 research biologists studying the upper Colorado River noticed that two year-classes of juvenile rainbow trout were missing from the wild population, although adult fish ranging from 12 to 22 inches (30 to 55 cm) in size were present. Further investigation revealed that a large cohort of rainbow trout fry, present in September, had nearly vanished from the river by mid-November. In contrast, brown trout fry were abundant in September and November, and seven year-classes were represented in the wild brown trout population. An intensive research investigation during 1994 was the first documented study suggesting that whirling disease was linked to dramatic declines in wild trout (Walker and Nehring 1995).

Field Detection Surveys

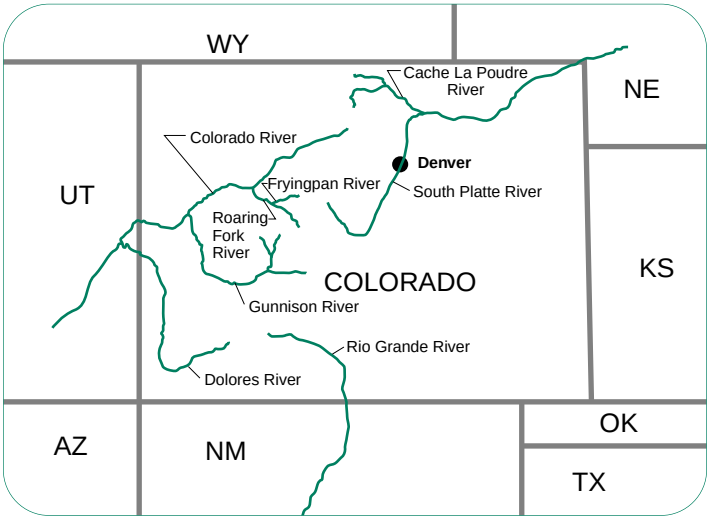
Populations of juvenile and adult trout have been surveyed annually on many trout streams in Colorado for almost two decades. Between 1994 and 1997, numerous sentinel fish tests were conducted in the Colorado River to document the severity of the effect of the parasite on several species and strains of salmonids, including brown trout, brook trout *(Salvelinus fontinalis)*, four strains or subspecies of cutthroat trout *(Oncorhynchus clarki* spp.*)*, and rainbow trout. Sentinel fish are fish held in live cages in rivers infected with whirling disease, and are exposed to everything wild trout are exposed to except inter- and intra-specific competition. Sentinel fish are observed from 16 to 18 months to document the development and severity of whirling disease.

Sentinel fish and wild young-of-the-year (YOY) rainbow and brown trout were collected, preserved, and examined for evidence of tissue damage characteristic of that caused by *M. cerebralis*. This technique is useful in documenting the presence of the disease during the first two or three months after infection (Thoesen 1994). Among free-ranging trout and sentinel fish that had been exposed to the parasite for eight to 16 months, the quantity of *M. cerebralis* spores in the cranium was used to measure the severity of the infection (Markiw and Wolf 1974).

Effects on Trout Populations

At the end of 1997 population-level declines among wild rainbow trout linked to the effects of whirling disease were documented on segments of eight major trout streams in Colorado, including the Cache la Poudre, Colorado, Dolores, Fryingpan, Gunnison, Rio Grande, Roaring Fork, and South Platte rivers (see map). The *M. cerebralis* parasite was confirmed in wild rainbow and brown trout in all eight streams.

Comparative baseline studies done before *M. cerebralis* became established in the Colorado, Gunnison, and South Platte rivers showed that within one or two years after initial exposure to the parasite there were dramatic declines in the number of juvenile rainbow trout seven to 11 inches (19 to 28 cm) in length. With the loss of each additional year-class of young rainbow trout, the number of adult trout decreased (Figures 1, 2, and 3).



Map of Colorado showing the trout streams in this study.

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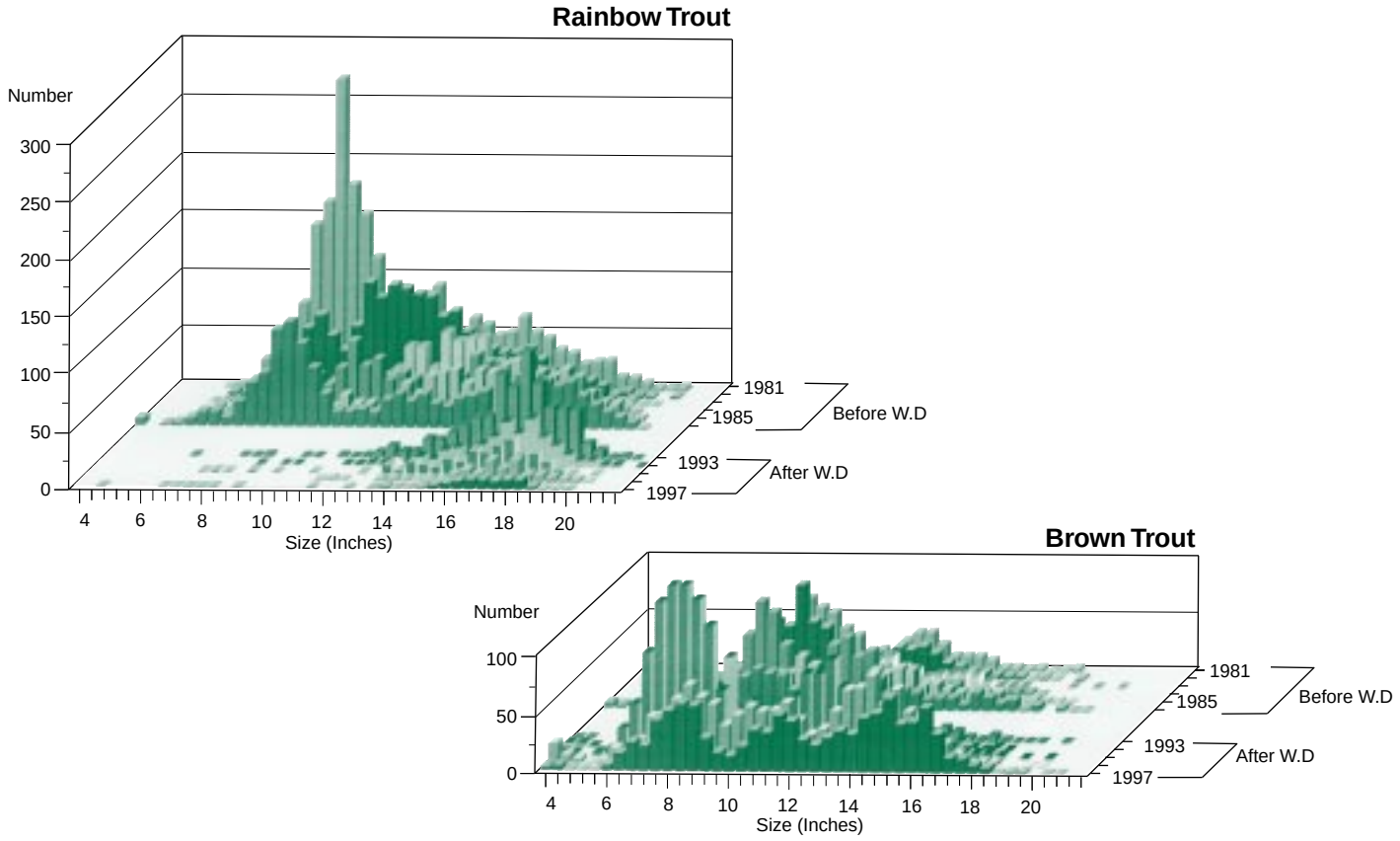

Figure 1. Length frequency distribution of juvenile and adult rainbow trout (top) and brown trout (bottom) collected by electrofishing a two mile (3.2 km) reach of the Colorado River before whirling disease (October 1981–1986) and after whirling disease (October 1993–1997).

Based upon these studies, the decline of rainbow trout in the Colorado, Gunnison, and South Platte rivers cannot be attributed to inadequate spawning, hatch, or poor survivorship of fry through the first few months of life. Indeed, in two of the three streams (the South Platte and Gunnison rivers) where trout fry abundance was monitored before and after the onset of whirling disease, abundance of brown and rainbow trout fry has been higher during the post-whirling disease years (Table 1 and Figure 3).

While environmental perturbations such as late spring flooding (due to snow melt) have been shown to drastically reduce survivorship of trout fry in Colorado (Nehring and Anderson 1993), and while year-class failures for two or three years in succession in wild trout populations were not uncommon during the five years of unusually high run-off between 1983 and 1987, the effects of unusually high levels of run-off were always manifested in reduced numbers of both rainbow and brown trout. In contrast, the effects of this disease are much more severely manifested on an immunologically naive species such as rainbow trout than in brown trout, which are highly resistant to the detrimental effects of *M. cerebralis*. It was this sudden disappearance of YOY and age 1 rainbow trout with no parallel decline in abundance of YOY and age 1 brown trout in several of Colorado's best trout streams that alerted biologists and ultimately led to the hypothesis that whirling disease might be the culprit.

Sentinel Fish Testing

Once it had been established that whirling disease was strongly implicated, and possibly the decisive factor responsible for the dramatic decline in wild rainbow trout of the upper Colorado river (Walker and Nehring 1995), the vulnerability of other species of wild native trout was tested. Of particular concern was the susceptibility to the parasite of the three subspecies of cutthroat trout native to Colorado: the greenback cutthroat *(Oncorhynchus clarki stomias)*; the Rio Grande cutthroat *(O. c. virginalis)*; and the Colorado River cutthroat trout *(O. c. pleuriticus)*. To evaluate the relative vulnerability of these three subspecies of cutthroat trout and several other salmonids, we conducted extensive sentinel fish tests in the upper Colorado River between 1994 and 1997. Survivorship and numbers of *M. cerebralis* spores in the head were used as measures of susceptibility or resistance to the parasite.

Results clearly demonstrated that brook trout and Colorado's three subspecies of native cutthroat trout were highly vulnerable to the ambient levels of the parasite occurring in the Colorado River. All four of these treatment groups suffered higher mortality than wild rainbow trout. Among eight species and strains of salmonids tested, only the brown trout demonstrated very strong resistance to the detrimental effects of the parasite. Very few brown trout died during

Whirling Disease *continued on next page*

Whirling Disease *continued from previous page*

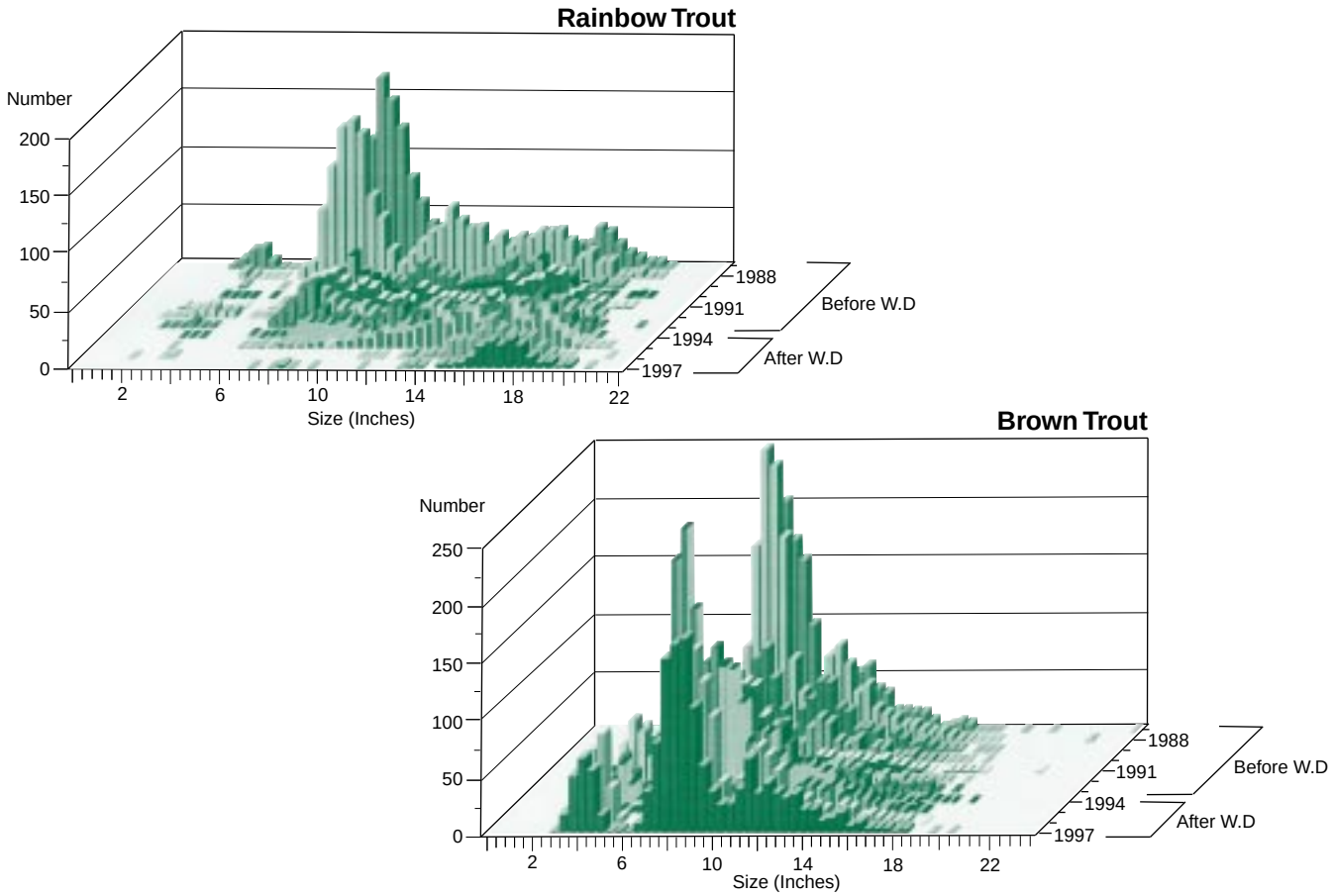

Figure 2. Length frequency distribution of juvenile and adult rainbow trout (top) and brown trout (bottom) collected by electrofishing a two mile (3.2 km) reach of the Gunnison River gorge before whirling disease (September 1987–1993) and after whirling disease (September 1994–1997).

exposures lasting up to 15 months and they had the lowest levels of *M. cerebralis* spores in the cranium at the end of the tests. Rainbow trout consistently carried the highest burden of spores in the cranium of any test group, but they survived at significantly higher levels than did the brook trout and the three native subspecies of cutthroat trout. Interestingly, Snake River cutthroat trout *(O. c. bouvieri)*, a subspecies of cutthroat trout native to the Snake River in Wyoming, demonstrated significant resistance to the effects of the parasite. It survived as well as the rainbow trout and carried the second lowest level of spores in the cranium of the eight salmonid treatment groups tested, only brown trout had lower levels.

In Colorado, whirling disease poses a very serious threat to the wild trout resources of the state. Over the next five years, the Colorado Division of Wildlife will expend up to $20 million to modernize and secure fish hatchery and rearing unit water supplies. By eliminating the use of surface water supplies, where feasible discontinuing use of earthen-bottom rearing ponds which can harbor *T. tubifex* worms, and investing in water treatment technologies, Colorado hopes to dramatically reduce, if not eliminate, the pathogen from state operated cold-water fish rearing facilities.

Whirling Disease *continued on next page*

	BROWN TROUT FRY		RAINBOW TROUT FRY	
Year	**August**	**September**	**August**	**September**
	Before Whirling Disease Effects			
1992	3,532	9,000	8,313	6,790
1993	3,369	4,647	4,073	4,339
	After Whirling Disease Effects			
1994	8,766	11,408	15,982	1,848
1995	11,376	4,679	2,245	532
1996	12,277	9,885	18,339	2,984
1997	16,257	11,003	38,640	3,195

Table 1. Estimates of young-of-the-year rainbow and brown trout abundance (numbers/mile) during August and September for the Gunnison River gorge before whirling disease (1992 and 1993) and after whirling disease (1994 through 1997)

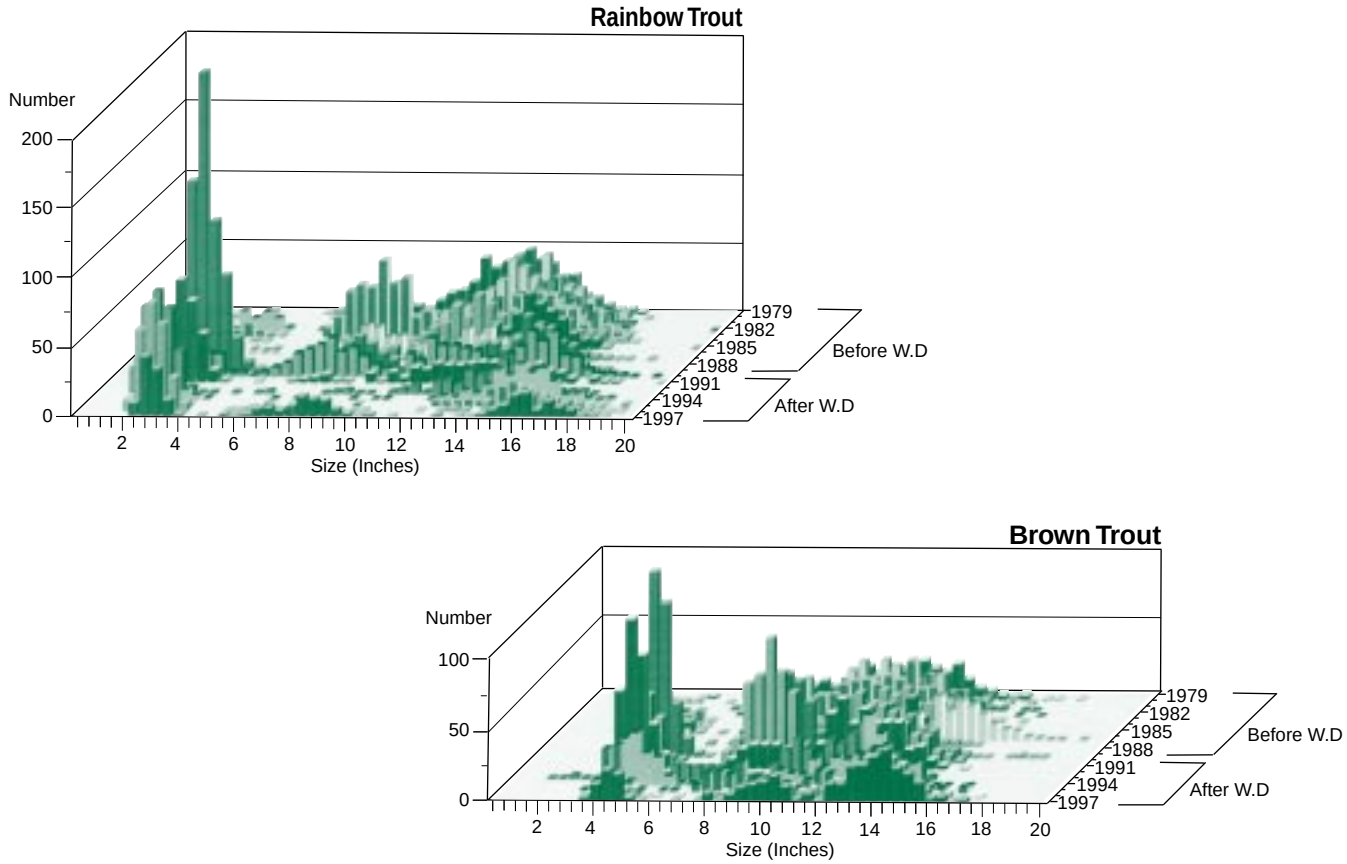

Figure 3. Length frequency distribution of young-of-the year, juvenile, and adult rainbow trout (top) and brown trout (bottom) collected by electrofishing a 750 foot (229 m) reach of the South Platte River before whirling disease (fall 1979–1988) and after whirling disease (fall 1990–1997).

The field studies in Colorado strongly indicate that brown trout will remain reservoirs for *M. cerebralis*, even if the parasite completely eradicates rainbow trout in an infected drainage. Continuing intensive research is needed to fully understand the environmental factors that influence the severity of whirling disease outbreaks. *M. cerebralis* now occurs on both sides of the Continental Divide in Colorado, Wyoming, and Montana. Recent discoveries of the parasite in cutthroat trout native to Yellowstone Lake in Yellowstone National Park may well have serious consequences for that ecosystem. Eradication of the parasite is an impossible task, but containment and control, particularly in aquaculture facilities, remain plausible management strategies.

R. Barry Nehring, Kevin G. Thompson, and Sherman Hebein are Fisheries Research Biologists with the Colorado Division of Wildlife, 2300 S. Townsend Avenue, Montrose, CO 81401. *This article is a condensation of a paper presented by Barry Nehring at the 63rd North American Wildlife and Natural Resources Conference, held in Orlando, FL, in March of 1998. The complete paper is published in the Transactions of the conference, available from the Wildlife Management Institute, (202) 371-1808.*

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