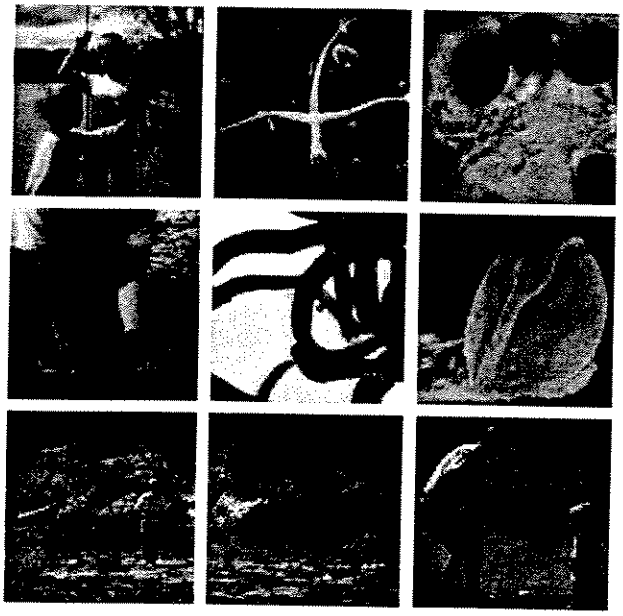


REPORT
and Action Recommendations

Montana Whirling Disease Task Force

May 1999

This report can be downloaded from the Task Force web site at www.whirlingdisease.org

Table of Contents

More information can be obtained concerning the Task Force and whirling disease by contacting Montana Fish, Wildlife and Parks at 1420 East Sixth Avenue, Helena, MT 59620-0701, or by calling: FWP Public Information (444-4041); Task Force Information (444-3186); Fisheries Division (444-2449) or by contacting the Task Force directly at 449-2196. This report was prepared by Policy Resources, Inc. Helena, Montana (406) 449-8838.

Executive Summary

Whirling disease, caused by the parasite *Myxobolus cerebralis* was first found in Montana in December 1994, and at that time was believed to be isolated to the Madison River. Today, with greatly improved techniques for identifying its presence and severity, the disease has been identified in more than 70 locations comprising most of the state's major trout streams. Of the state's major trout streams, only a few including the Bitterroot, Gallatin, Big Horn and Kootenai, remain free of the parasite.

Despite the spread of *M. cerebralis,* fishing remains excellent in Montana, including the Madison River. As yet no crisis has emerged – our fisheries have not been irretrievably decimated. On the Madison, for example, where whirling disease has been present for a number of years, the rainbow trout numbers appear to have stabilized at 500 fish per mile, and the brown trout population is slightly higher than its pre-whirling disease level.

Our state's elected officials, the media and the public must recognize, however, that the disease is in a very early stage on most rivers, and that the potential for severe long-term problems is real. Several examples highlight this point. On the Missouri River, whirling disease has appeared over the last two years, and rainbow trout recruitment from a major spawning tributary has dropped by 90 percent. While long-term consequences cannot be predicted, this may presage significant declines in a world-class rainbow trout fishery. In another recent development, a low-level whirling disease infection has been detected in Depuy's Spring Creek, a spawning tributary to the Yellowstone River. Therefore, based on the available evidence, the Task Force believes that whirling disease remains a very significant threat to wild, naturally reproducing trout populations in our state.

The impact of whirling disease remains uncertain. Many factors appear to influence the extent and severity of infection, including the mix of trout species, trout spawning habits, habitat, oligochaete worm populations, water temperatures, and other factors. Because each drainage across the state has its own personality with respect to these different factors, it is reasonable to expect that the impacts of whirling disease will vary from area to area. A comprehensive research project on the Missouri River should help to sort out some of these issues and improve our ability to predict the impacts of whirling disease on different streams.

The current and potential socio-economic impacts of whirling disease are harder to assess and somewhat more controversial. This is because numerous variables, such as weather, stream flows and negative publicity about Montana in general, can affect fishing, tourism and fishing pressure. Some FWP data suggest that whirling disease has had little effect on total angler use through 1997. Nonresident angler use of the Madison, however, has declined, and this suggests larger impacts on tourism and guiding. Ennis-area guides and businesses believe the impact has been substantial, and also note that the early-season closure of the Madison has had an additional negative economic impact. This is an area presently receiving study.

In the area of scientific research, the Task Force believes that approaches to dealing with whirling disease are an excellent model for the study of other exotic diseases. Whirling disease has greatly increased scientific attention on trout biology and stream ecology. In the last four years, a remarkable amount has been learned. Montana Fish, Wildlife and Parks (FWP) and other Montana fisheries scientists should be recognized for work in this area. The impressive field research by Whirling Disease Research Coordinator Dick Vincent and others in FWP has greatly increased our knowledge and understanding. The National Partnership on the Management of Wild and Native Coldwater Fisheries and the Whirling Disease Foundation have also made extraordinary progress and should be commended for their work.

There are at least four different lines of scientific research that may provide answers to controlling the impacts of whirling disease in our state. They are: (1) assessing the resistance of various strains of trout, (2) controlling worm populations and (3) utilizing life histories of trout, the worm and the parasite to avoid population-threatening infection rates, and (4) analyzing the ecology of streams and rivers in which WD has not been detected to learn why they have remained WD-free.

We believe that the guiding philosophy established by the first Whirling Disease Task Force remains appropriate today – *All actions to address whirling disease should be consistent with protecting, preserving and restoring self-sustaining populations of wild, native and nonnative salmonids.* As stated in earlier Task Force reports, Montana and wild trout are synonymous.

With respect to implementation of previous Task Force recommendations, FWP has done a superior job. However, to date neither FWP nor the Fish & Game Commission have adopted an overall management plan for whirling disease, nor a set of policy/regulatory actions that can be consistently applied to whirling disease-infected waters. The Task Force believes that such a management plan is needed and should be tied to a watershed-by-watershed risk assessment by the Department.

The Task Force also believes that public education remains an important aspect of dealing with whirling disease in our state. There continues to be much misunderstanding, misinformation and speculation about whirling disease. A credible voice, working to educate the public, needs to be a high priority. The Education Subcommittee of the Task Force worked to identify key messages to be communicated about whirling disease. They are (1) basic whirling disease information including the life cycle of the disease, (2) wild trout and their history and importance in Montana, and (3) hope for the future of Montana's fisheries. A matrix of targeted groups and accompanying educational materials was developed.

In conjunction with FWP, the Task Force's Education Subcommittee has been very active. It has reviewed and distributed a "What in the Whirld is Whirling Disease" poster; developed a "Whirling Away on the Life Cycle" teacher activity; developed a brochure on whirling disease and enabled its distribution to thousands of Montana homes statewide; engaged in a radio talk show event; hosted numerous teacher workshops across the state; and completed with FWP assistance a narrated slide show on whirling disease. The Task Force has developed and maintained an Internet site at **www.whirlingdisease.org** which has received several

thousand visits in the last year and generated requests for information from students, sportsmen and other interested individuals around the state and around the globe. That site should be continued under the auspices of the FWP.

In our last report we recommended to the public a series of measures designed to limit the spread of whirling disease. All water recreationists are reminded that we still do not know enough about how whirling disease spreads to rule out many possible vectors. Although we believe that the movement of fish and fish parts is the major source of spreading the disease, it is still possible that fish-eating birds and animals, as well as anglers and other water recreationists can also move the parasite. Consequently, precautions still make sense. This continues to be an area where more research is needed.

Another area of concern is the illegal introduction of infected fish into Montana and the specter of other exotic fish diseases. The proliferation of private ponds coupled with the ease of illegally introducing and transporting fish may create additional and unforeseen problems in the future. As WD spreads, it seems inevitable that some hatcheries within the state will become infected. This greatly increases the probability for spread within state waters and private ponds and poses an unacceptable risk to Montana's fishery resources. MFWP must have adequate funding, staffing and authority to maintain vigilant oversight of state, Federal, tribal and private hatcheries, and to deal expeditiously with any hatchery that becomes infected.

Almost five years after its detection in Montana, whirling disease continues to capture the interest and concern of anglers, business people, conservationists, students and public officials, both in Montana and around the world. It is an indisputable fact that Montana is recognized as the leader in dealing with this problem. The Task Force has attempted to provide an ongoing focus on whirling disease for our state, a focus that should continue in some fashion. We recommend that FWP call together members of the Task Force and others, at least annually, to review the "state of the state" on whirling disease, and to issue reports and recommendations as appropriate.

Finally, it must be remembered that the policies that govern Montana's trout fisheries are unique. Unlike every other state where whirling disease has been identified, Montana relies almost exclusively on self-sustaining wild trout populations. As a result, the evolution of whirling disease and the attendant consequences in Montana will also be unique. Thus, it is unlikely that management approaches contemplated for other states will be appropriate or applicable here.

In short, whirling disease poses very real threats – to native species, to wild nonnative trout, and to recreational fishing. We are still at the dawn of the whirling disease era in Montana, and it will take the skills and resources of our citizens, scientists and public officials to adequately address the threat.

Whirling Disease – The State of the State

"Whirling disease" is a disease of salmonid fish (trout, salmon, whitefish) caused by the microscopic parasite *Myxobolus cerebralis*. It is not harmful to humans. The parasite has a complicated life cycle that involves two hosts – a small oligochaete worm (*Tubifex tubifex*) that lives on the bottom of a stream or other body of water, and trout. Trout become infected after a form of the parasite (the *Triactinomyxon*, or TAM, stage) emerges from the worm and enters the water. The TAM attaches to the fish and penetrates the skin or mucus membranes. The parasite eventually finds its way to the cartilage of the fish where it matures into a spore form. It stays there until the fish dies, releasing spores into the water, which ultimately are ingested by the worms and the life cycle starts all over.

In the fish, the parasite can affect nerves and damage cartilage which results in the symptoms of whirling disease. Whirling disease gets its name from the abnormal whirling, tail-chasing behavior exhibited by some infected fish. This results from damage to the nervous system caused by the disease process. Other signs may include a black tail in younger fish. In older fish, symptoms sometime include skeletal deformities of the head or body. Appendix 2 illustrates the life cycle in detail.

Whirling Disease in Montana

Myxobolus cerebralis, was first detected in Montana in rainbow trout in the Madison River in December 1994. It was discovered during an investigation of a major decline in the rainbow trout population in the river's upper stretches. Prior to December 1994, this parasite had never been detected in any fish in Montana.

The parasite has now been detected in over 70 individual trout waters, mostly in western Montana. A complete listing as of this report is provided in Appendix 3. It is found on both sides of the Continental Divide, in the headwaters of the Missouri and Clark Fork of the Columbia drainages. Recently it has also been found in a remote area of Yellowstone Lake in Yellowstone National Park. This find is of particular concern due to the potential impact on Yellowstone cutthroat trout, a species of special concern, and impacts on the Yellowstone River in Montana.

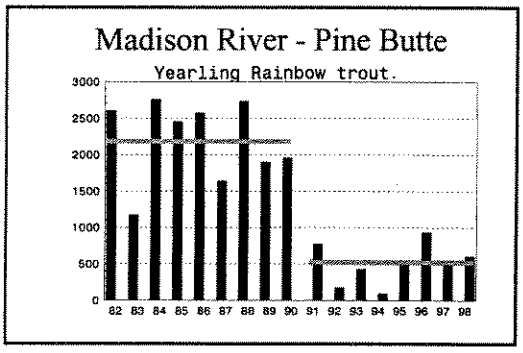
Monitoring of hatchery stocks to test for this parasite had taken place for several years prior to its discovery in the Madison River. These monitoring efforts increased dramatically after the discovery of the parasite and a statewide survey was initiated. Nearly 300 individual waters have been tested. To date, no private, state or federal hatchery facility in Montana has tested positive for whirling disease. Although Montana has strict limits on importation and transport of live fish, it is possible that illegal introductions of infected fish from prohibited sources have occurred in private ponds. Infection could spread from these waters either by vectors or by the escape of fish into public waters.

Some biologists believe that several whirling disease-positive waters had been infected for several years, but went undetected until the statewide survey was initiated. The initial infection of the Madison River most likely occurred in the mid-1980s. This is based on the rainbow trout population trends through the 1980s and 1990s and rainbow trout decline that started in the early 1990s. Although the specific date, location and source of the first infection in Montana are unknown, there is no evidence that activities of FWP were involved in the introduction or spread.

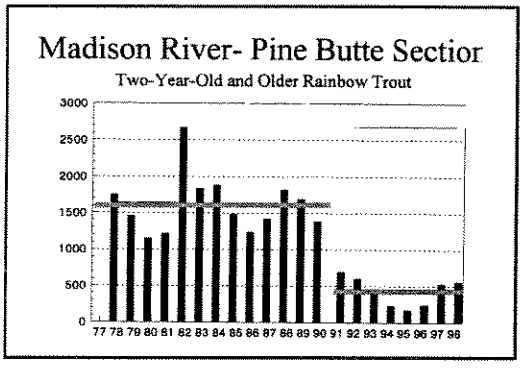
Population Impacts

Population impacts from whirling disease have been most extensively investigated on the Madison River, the Missouri (and its tributaries, e.g. Little Prickly Pear Creek and Dearborn River) and Willow Creek. Population impacts are also being monitored and evaluated on Rock Creek, the Ruby River and DuPuy Spring Creek.

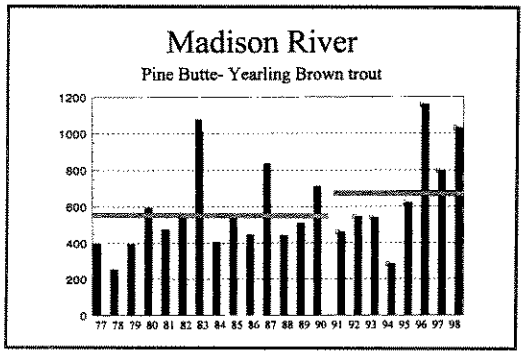
On the Madison River, whirling disease is clearly responsible for a severe decline in rainbow trout in the upper reaches of the river. Alternate hypotheses for the decline have been



In the Pine Butte section of the Madison River, rainbow trout young-of-the-year have dropped from a pre-WD average of 2200 per mile to approximately 500 per mile.



In that same section, two-year-old and older rainbow trout have dropped from an average of about 1600 per mile to 400 per mile, bottoming out at about 100 per mile in 1995. Although there had been some hope over recovery based on 1996 and 1997 data, 1998 numbers suggest that a rebound to pre-whirling disease numbers is not occurring.



Brown trout are less susceptible to whirling disease, and brown trout populations have remained stable in this section of the river, actually averaging slightly higher post-WD (700 per mile) than pre-WD (550 per mile).

examined and are not credible. Adult rainbow populations on the Madison remain at a stable but depressed level from pre-WD conditions. The 1982-90 (pre-WD) average was 2,200 yearling rainbows per mile; the 1991-98 average is about 500 per mile, or about 75% decline. There is no indication that rainbow numbers are rebounding, as some have speculated. Brown trout numbers, however, have remained stable, increasing slightly post-WD. Some small population increases have been noted in Westslope cutthroat trout, but are a very small part of the river's total wild trout. These trends are illustrated in Figures 1-3, accompanying.

In March, 1999, the presence of whirling disease was reported in DuPuy's Spring Creek, a spawning tributary to the Yellowstone River. The infection was detected by exposure of small rainbow trout in cages (live cars) during the summer of 1998. Subsequent random tests of fish from the spring creek were negative. The level of infection is currently at 1.5- 2.0, a level not expected to have impacts on populations (see next section). This is the only location in the Yellowstone drainage, except in Yellowstone Lake, where infection has been detected. Implications of this finding are uncertain at present.

The results of live car testing from 1998 revealed no detectable infections near Maiden Rock Bridge and trace infections near Melrose on the Big Hole River. Thus, the limited testing on the Big Hole River has revealed only spotty and light infection rates to date.

Infection grading system – FWP researchers in collaboration with other fisheries scientists from the U.S. Fish and Wildlife Service and Washington State University have developed a system for evaluating the severity of whirling disease in a population. The method relies on placing young fish in the stream in cages (live cars) and sampling fish at various times. Research has indicated that it is important to quantify the infection in the trout population, since the degree of infection is the critical factor in whether a population will decline as a result of whirling disease. A grading system has been developed which rates the severity of infection from 0 to 4, where 0 is no infection, 1 is least severe (rarely resulting in the death of a fish), and 4 is the most severe (always resulting in fish mortality). If the infection is averaged for the population, it appears that population infections in the 1 to 2 range are likely to have little impact on the trout population, while infections of grade 3 and 4 are critical and almost certain to result in severe population declines. This grading system is coupled with an assessment of the percentage of fish infected. Other states have not adopted this grading system, but it has proved extremely useful for Montana fisheries scientists.

In the West Fork area of the Madison, in-stream live box studies suggest that the infection level is holding at about 3.5 to 3.6. However, based on field research during 1998, there appears to be a wide variation in infection levels on the Madison throughout its length from the Hebgen Lake dam to Ennis. In one location, the fish infection averaged 3.7, but two miles downstream it was 0.6. This suggests that there may be infection "hot spots" which need to be the focus of additional research. Spawning areas in particular appear prone to be whirling disease hot spots.

On the Missouri River below Holter dam, population impacts have not yet been documented on the mainstem of the river. However, field research during the summer of 1998 indicate that whirling disease infection in Little Prickly Pear Creek, a major spawning tributary, is severe.

Infection rates have increased from less than 1.0 in 1996 (when WD was first discovered there) to 4.0 in 1998. Fish surveys in Little Prickly Pear reveal a 90% decline in the number of young-of-the-year rainbow trout in September 1998, compared to the previous year (722 fish vs. 75 fish).

The prospect of losing Little Prickly Pear as a spawning tributary to the Missouri River is very serious. Nevertheless, it is not clear what if any long-term impact will occur because the Missouri River enjoys other important spawning tributaries, most notably the Dearborn River where WD has not been detected. (See Appendix 4 for an overview of FWP research on the Missouri and other rivers for 1998 and 1999).

In summary, the population impacts of whirling disease are likely to vary significantly, depending upon the ecology of a particular body of water. A few trout populations have already been severely impacted. However, to date brown trout in the Madison, Ruby River and Poindexter Slough appear to be relatively unaffected; and in Rock Creek, tributary spawning may have some mitigating effect for rainbow and cutthroat. In short, each river drainage is likely to be different, and different management responses may be needed. However, an overall management philosophy that considers the presence of whirling disease and continues to support our state's wild trout populations now needs to guide FWP's management actions (see below for further discussion).

Species Susceptibility to Whirling Disease

In Montana, the following species have been found infected with the whirling disease parasite:

- Rainbow Trout – DeSmet, Eagle Lake, Madison River, Missouri River, New York, and Red Band strains have been tested, all were found susceptible
- Cutthroat Trout – Westslope, Upper Snake River and Yellowstone strains have been test and found susceptible
- Rainbow / Cutthroat Trout Hybrids – tested and found susceptible
- Brook Trout – tested and found susceptible
- Brown Trout – tested and found susceptible to infection but resistant to disease impacts
- Kokanee Salmon – tested and found susceptible
- Mountain Whitefish – tests are presently underway.
- Arctic Grayling - of all species tested, grayling appear to be the most resistant. There is no indication that this species produces whirling disease spores.
- Bull Trout – initial testing suggests some measure of resistance. Testing is being repeated.

During 1999, several additional rainbow and cutthroat strains will be tested, along with additional studies on Eastern Brook trout, Bull Trout, Arctic Grayling, Chinook Salmon, Kokanee Salmon, and Cisco (a forage fish).

Whirling Disease Research

Although no solutions to whirling disease have yet been found, current research efforts suggest at least four avenues of investigation. They are:

- *Assess innate resistance of various strains of rainbow and/or cutthroat trout.* Extensive susceptibility testing was done in 1998, and additional testing is planned for 1999. No innately immune strains of rainbow or cutthroat have been identified to date.

- *Attack the parasite through the worm host.* Without the worm host the parasite can't complete its life cycle and there is no whirling disease. Research is underway to determine if *T. tubifex* in streams can be reduced by altering land management practices within whirling disease positive drainages, and if so, whether it reduces the infection rate in trout.

- *Utilize life histories of trout, the worm and the parasite to avoid population-threatening infection rates.* It may be possible to reduce the impact on whirling disease by promoting salmonids that spawn very early so young emerging fry would not be exposed to extremely high levels of infection.

- *Examine stream ecology of streams in which WD has not been detected.* As of early 1999, several drainages (e.g. the Bitterroot and Gallatin Rivers) which are adjacent to infected rivers have remained free of WD. If this situation continues, research should be initiated to determine what characteristics of these river systems have prevented the parasite from gaining a stronghold there.

Montana Fish Wildlife and Parks has several experiments ongoing at its whirling disease research station near Harrison, MT that hold significant promise in these research areas. These studies are setting the standard for field investigations. They are summarized in Appendix 5.

Research Supported by the National Partnership

Additional laboratory and field research is being supported by the National Partnership on the Management of Wild and Native Cold Water Fisheries, a project of the Montana University System Water Resources Center. Two funding cycles have been completed, and 28 projects

and four contracts have been funded totalling nearly $2 million. Research teams include 48 investigators from seven states, focusing on the spread of the disease, fish susceptibility, the parasite and the worm host, and diagnostic techniques. See Appendix 6 for additional details.

Governor Racicot's Executive Order asks the Task Force to evaluate the work of the National Partnership. We are pleased to report that, considering the Partnership started from ground zero only two years ago, remarkable progress has been made. The peer-reviewed grant application process is open and fair, and the Partnership is to be commended for its efforts. The research completed to date is of very high quality and is furthering our understanding of whirling disease. The studies are fully consistent with the Task Force's previous recommendations. Furthermore, the Partnership is a credible process and is a model that could be expanded to address other aquatic issues, in Montana and globally.

Socioeconomic Impacts of Whirling Disease in Montana

Fishing for trout has been estimated to generate nearly $300 million in recreational expenditures in Montana. Therefore, the question of whether whirling disease has had an economic impact on the state is an important one, especially for communities that depend heavily on tourism associated with coldwater angling.

A research project is now underway to investigate this question, funded by the National Partnership. Focusing on the Madison and Missouri Rivers, the researchers are working on a series of statistical models to estimate the extent to which reductions in trout populations change angling pressure and how that in turn impacts the regional economy. During the summer of 1998, angler surveys were conducted on both rivers, and analysis of the data is now underway.

Socioeconomic impacts are particularly difficult to assess given the wide number of variables that can impact anglers' decisions about when and where to fish. Whirling disease is one possible factor, but so are high water flows, weather, insect hatches, media attention to particular waters, and so forth.

One set of data that may some day describe whirling disease impacts on angling pressure is FWP's annual angler use survey. This dataset suggests that whirling disease did not impact *total* angler use through 1997. However, other FWP data indicates that nonresident usage of the Madison has dropped significantly in the most recent years available. The final interpretation of these data is not completed. (see Appendix 7 - Public/Outfitter Fishing Use on 10 Most Popular Montana Rivers).

Representatives of the Ennis Chamber of Commerce feel strongly that whirling disease and the resulting national publicity has had a significant impact on their community and met with the Task Force to discuss this issue. These discussions pointed out that numerous factors impact tourism and non-resident angling pressure. Final analysis and resolution of this situation are unresolved.

Management Issues

Conserving wild salmonid populations and reducing impacts on sport fishing remain important overarching management goals. Task Force members are frequently asked "Can't you just stock more fish?" Many people do not fully appreciate the fact that in the angling world, the state of Montana is unique. We are the only state in the continental U.S. that does virtually no stocking of its rivers and streams. Our trout streams have reached world-class stature by relying exclusively on natural reproduction, and as a result anglers from all over the world make Montana a fishing destination to enjoy our state's wild trout resources.

Stocking fish to maintain or supplement the fishery is not a desirable option. Studies in Montana have shown that stocking hatchery fish on top of wild trout populations does not produce better fisheries. In point of fact, during the time when the Madison River was stocked, prior to the onset of the wild trout policy, rainbow numbers were about what they are now – 500 rainbow trout per mile. Cost is another consideration – it would cost millions of dollars annually to stock fish into Montana's rivers to maintain trout fisheries. And even if cost obstacles could be overcome, Montana does not have the hatchery capacity to raise the fish necessary to maintain these fisheries. Stocking is simply not a viable option.

Controlling the spread of the disease remains an important management goal, despite the fact that whirling disease has spread and is likely to continue to do so. The effectiveness of control measures for whirling disease prevention is uncertain. However, this goal is warranted under the general principles of environmental health and risk reduction. Specifically, there are other water borne diseases and pests that need to be guarded against.

To date, no comprehensive management strategy for WD-infected waters has been developed. The complexity of the whirling disease problem and our general lack of knowledge about the disease have made it impractical to adopt such a plan. In addition, the research conducted to date suggests that there will be no universally applicable policy or regulation change that can be imposed to address whirling disease. Instead, decisions will need to be based on site-specific conditions for individual streams and fisheries.

The Task Force has had extensive discussion about various "triggers" that could be utilized in developing such a management strategy. A subcommittee has had preliminary discussion with the Fish and Game Commission in that regard. We believe that an overall management plan is needed, in conjunction with improved data acquisition and development of an overall risk assessment for all primary trout waters in the state.

Public Education

During the course of its tenure, the Task Force has observed significant misunderstanding and misperception about whirling disease among the public and, at times, the media. One of our primary objectives has been to counter this misinformation with credible, easily accessible public information.

To that end, the Task Force's Education Subcommittee has produced a wide range of materials on whirling disease. We believe it is critically important that the public understand three key messages: (1) basic whirling disease information including the life cycle of the disease, (2) wild trout and their history and importance in Montana, and (3) hope for the future of Montana's fisheries. To that end, a matrix of targeted groups and accompanying educational materials was developed. Matching audiences and communications opportunities, the following was accomplished:

- In conjunction with FWP, the Education Subcommittee reviewed and distributed a "What in the Whirld is Whirling Disease" poster;
- Created a "Whirling Away on the Life Cycle" teacher activity;
- Developed and produced a general public brochure on whirling disease, which - through the Task Force's fundraising efforts - was distributed to thousands of Montana homes statewide; engaged in a radio talk show event;
- Hosted numerous teacher workshops across the state;
- Completed with FWP assistance a narrated slide show on whirling disease;
- Developed and maintained an Internet site (**www.whirlingdisease.org**) which has received several thousand visits in the last year and generated requests for information from students and sportsmen around the state and around the globe. (See Appendix 8) That site should be continued under the auspices of FWP.

We have also responded to numerous requests for additional information generated through the site. Appendix 9 provides an overview of the site.

The Task Force recognizes that FWP has been instrumental in developing and distributing educational materials that present a balanced picture of whirling disease in our state. Excellent articles have appeared in Montana Outdoors and in FWP videos. These materials have been adapted and used by several other states, National Parks and other private non-governmental organizations.

Evaluation: Implementation of Previous Task Force Recommendations

The Governor's Executive Order asks the Task Force to evaluate and update the recommendations that were made by the Task Force in 1996. We are pleased with the extent to which these recommendations have been carried out. A summary is provided below:

1. Scientific Research Needs:

1.1. What is the scope of the whirling disease problem in Montana?

1.1.A. **Recommendation:** Continue sampling around the state to identify sites where there are infected fish.

Status: All of the original sampling for the state has been completed. Sampling continues at the regional level where grab samples are being taken to fill in our knowledge gaps.

1.1.B. **Recommendation:** When a site tests positive, initiate additional testing procedures to determine the severity of infection.

Status: Ongoing. In-stream testing of fish in cages (live car studies) is being conducted in blue-ribbon fisheries that have tested positive for *M. cerebralis* to determine the level of infection. Approximately 200 live cars have been placed in 15-20 water bodies. This method has become the benchmark by which other studies are measured.

1.1.C. **Recommendation:** Complete the development of a polymerase chain reaction (PCR) assay as a diagnostic tool for detection of the whirling disease parasite in fish, worms and water supplies.

Status: The test has been developed and is presently being evaluated for use as a standard diagnostic test. It will be several years before the test is available for routine use, as it must meet Blue Book standards published by the American Fisheries Society. PCR is the only new diagnostic test developed thus far and is still being used in conjunction with spore counts and histology.

1.1.D. **Recommendation:** Field test the PCR assay to verify its utility as a diagnostic test.

Status: Assay is being field tested but is not yet ready for routine use.

1.1.E. **Recommendation:** Field sampling for *T. tubifex* worms to enable mapping of their distribution in Montana.

Status: Initial presence-absence distribution has been completed by Dr. Dan Gustafson. Drs. Bill Granath and Billie Kerans continue to collect samples for particular research projects or on an as-requested basis.

1.1.F. **Recommendation:** Develop expertise and technology to better distinguish *T. tubifex* from similar oligochaete worms, and to characterize *M. cerebralis* infection in *T. tubifex*.

Status: Work is ongoing. Dr. Granath is characterizing the infection in the worm. Morphology is still the basis for the identification of *T. tubifex*; a molecular method has not yet been developed. Dr. Dee Dee Kathman is developing a guide to provide morphological characteristics for the identification of oligochaetes in the field. Dr. Winton is developing molecular markers to distinguish *T. tubifex* from other oligochaetes.

1.2. Which Montana species are susceptible to the disease, and how will populations be impacted?

1.2.A. **Recommendation:** Support laboratory research in a self-contained wild trout research facility to test species susceptibility under varying conditions (water temperature, spore load, etc.). Experimental research in a controlled laboratory setting is the only way to systematically evaluate the degree of susceptibility of various salmonid and non-salmonid species to whirling disease.

Status: Extensive work is being done in this area in Montana and other states. Field and lab research are being integrated.

1.2.B. **Recommendation:** Field research is also required to assess species susceptibility and disease impacts in the wild. While laboratory research may show that some species are susceptible, the impacts of whirling disease in the wild still need to be determined. Field work is needed to evaluate the impacts of the disease on different strains of fish in a wild setting, where many other variables such as life history, stream gradient, sediment load, habitat and water flows may enter the equation.

Status: Extensive work is being done in this area in Montana and other states. Field and lab research are being integrated.

1.2.B.i. **Recommendation:** Expand live box testing at Willow Creek and the Madison River, focusing on seasonality, tissue damage and quantitative spore production for several fish strains and species.

Status: Ongoing (see Appendix 3)

1.2.B.ii. **Recommendation:** Expand the scope of field research activities: New sites should include the Yellowstone (uninfected); Madison/Pine Butte (infected, ongoing); Madison Norris (imminent infection); Upper Gallatin (high gradient stream); Missouri/Holter (major rainbow fishery); Clark Fork/Milltown (tributary spawners) and the Big Hole River above Melrose. Study elements may include water temperature; general habitat characterization; young of year; annual fish population; seasonal worm density, speciation, infection; fish genetics.

Status: Field research is being conducted in each of these drainages (note, however, that Clark Fork research is above Milltown dam, not below it)

1.2.B.iii. **Recommendation:** Initiate new field research sites on the Ruby River and/or upper Clark Fork focusing on brown trout.

Status: On the Ruby River, initial data analysis has shown little impact to wild brown trout during the two study years 1996-97.

1.2.B.iv. **Recommendation:** Dedicate additional new FTE's to whirling disease. Develop a FWP research position with support similar to the programs in Colorado and Idaho.

Status: FWP requested 2.0 new FTEs and was funded by the 1997 Legislature for 1.5 FTEs. A whirling disease coordinator position was established and filled by Dick Vincent. Beth MacConnell is on a two year leave from the USFWS and is currently working for FWP. The Task Force believes that FWP is adequately staffed and funded at present, given the existing workload. However, if there is a significant increase in the number of sites to be monitored, then FWP will have inadequate resources to do the job. FWP's current level of effort is only adequate due to redirection by FWP.

1.2.B.v. **Recommendation:** Obtain population data to determine impacts on streams other than the Madison River.

Status: Extensive population data are being obtained for the Missouri and Madison Rivers, Willow Creek and Rock Creek (see Appendix 3).

1.3. Are some trout strains naturally resistant?

1.3.A. **Recommendation:** Laboratory testing will be required to evaluate the possibility that some trout strains show a natural resistance to WD which can be transmitted genetically.

Status: Ongoing – current data suggests that arctic grayling and bull trout, both native species, exhibit some degree of resistance to whirling disease

1.3.B. **Recommendation:** The possibility of "behavioral resistance" will require field research to evaluate whether various behaviors (time of spawning, etc.) are related to varying degrees of resistance in whirling disease-susceptible fish.

Status: Research being conducted on Willow Creek, Rock Creek and the Missouri River.

1.4. Are there solutions to whirling disease which focus on the intermediate host (*tubifex* worms) rather than on trout?

1.4.A. **Recommendation:** Compare several common Montana oligochaetes for quantitative ability to become infected and produce the *Triactinomyxon* (TAM) form of the parasite.

Status: In progress. Drs. Billie Kerans (MSU), Jim Winton (NBS) and Willard Granath (UM) and others are conducting research on infectibility. Studies to date indicate that *T. tubifex* is the only oligochaete that can sponsor propagation of *M. cerebralis*.

1.4.B. **Recommendation:** Compare micro habitats and seasonal density of *T. tubifex* in infected and uninfected streams of both high and low gradient.

Status: Quantitative sampling methods are being developed. Pilot studies are being conducted on the Madison, Missouri, Bitterroot and Blackfoot Rivers, Rock Creek and Willow Creek.

1.4.C. **Recommendation:** Compare the genetics of worms that, by external characteristics, are classified as *T. tubifex* in geographically and ecologically different watersheds. If differences are found, test these for infection and numbers of TAMs produced.

Status: Drs. Winton, Kerans and Granath are looking into genetic differences between *T. tubifex* in Rock Creek, the Madison and Missouri Rivers. Genetic markers are being developed.

1.4.D. **Recommendation:** Develop in-state expertise within the University system in ecology, particularly as it relates to whirling disease.

Status: Drs. Granath, Kerans and Gustafson have active research programs underway.

1.5. The need for a dual-track scientific effort

1.5.A. **Recommendation:** Construction of a Wild Trout Research Facility.

Status: Construction has been completed of the laboratory which supports 192 aquaria and five living streams. Five research projects were initiated during 1997-98. In addition, FWP has a laboratory facility at Pony, MT that contains ninety 30 gallon aquaria that provide 180 test lots.

1.5.B. **Recommendation:** Support of Immediate Research Needs.

Status: An appropriate balance was achieved between building infrastructure and funding immediate research needs.

New Research Recommendations of the Task Force: In addition to the research goals and objectives reviewed above, the Task Force recommends three additional objectives be added. They are:

1.6 **Recommendation:** Examination of the relationship between life histories and environmental factors affecting whirling disease infection rates and fish population declines.

1.7 **Recommendation:** Development of a nonlethal diagnostic test.

1.8 **Recommendation:** Research on the mechanisms of transmission of whirling disease.

2. Fisheries Management and Policy

2.1. Conserve populations of wild salmonids (both native and non-native species) that survive within whirling disease-infected waters.

2.1.A. **Recommendation:** To conserve populations of wild salmonids that survive in whirling disease-infected waters, when and where necessary, Montana Fish, Wildlife and Parks and public and private land management agencies should take extra precautions to protect fish habitat.

Status: Tools to protect habitat are limited. FWP is protecting habitat under the Stream Protection Act and Future Fisheries program, and through various stream restoration projects. Additionally, a pilot study is being conducted on Rock Creek by Granath/ Vincent/Kerans/Winton/Gannon to determine whether there is a cause-effect relationship between habitat quality, *T. tubifex* populations and whirling disease infection rates.

2.1.B. **Recommendation:** The Department and Commission of Fish, Wildlife and Parks should continue to monitor the impact of angling on populations of wild trout that survive in whirling disease-infected waters. Where appropriate, special management actions should be taken to conserve surviving populations.

Status: Fish population monitoring and angler creel surveys are being conducted on the Madison and Missouri Rivers (initial wave completed summer 1998). Fishing regulations have been modified on Rock Creek, Hells Canyon Creek, West Fork of the Madison and Willow Springs Creek. In addition, FWP established a draft risk matrix and the Task Force established and presented to the Commission a discussion of "triggers" for management action in WD-positive waters.

2.2. Control the spread of whirling disease.

2.2.A. **Recommendation:** Unless demonstrated to be ineffective, existing management actions to control the spread of whirling disease should be continued. Management actions to control the spread of whirling disease should adapt as new information is gained about the vectors responsible for its spread.

Status: Whirling disease has continued to spread, and vectors are still poorly understood. Aquatic birds, felt waders and frozen fish have been evaluated as possible vectors. However, the relative contribution of one vector versus another is unknown.

2.2.B. **Recommendation:** There is a strong likelihood that earth moving equipment which is used in and around waterways can become contaminated with whirling disease infected mud. The Task Force recommends that all responsible regulatory agencies provide information to contractors concerning the need to clean their machinery and equipment on-site after completing a job in order to avoid inadvertently spreading the disease.

Status: FWP requires all contractors to clean equipment when working around hatcheries. This is a condition that FWP should be putting on 310 permits

2.2C. **Recommendation:** Additional emphasis should be placed on interagency cooperation to prevent the spread of whirling disease. FWP has solicited the cooperation of federal natural resource management agencies in addressing the whirling disease problem. Contacts have been made and agency involvement initiated. However, a number of major issues relating to the inadvertent spread of whirling disease remain unresolved. One foremost issue involves the sources of water that are used in fighting forest fires. Water removed from streams and lakes and transported to other areas to fight fires is a potential means for spreading the disease. Agency policies need to be formulated regarding this and other related issues.

Status: Information has been shared with other states, fish health committees and the federal government. In addition, the National Database has been established by Dan Goodman. A series of interconnected Internet sites is also anticipated.

2.2.C. **Recommendation:** The difficult and politically sensitive issue of fresh or frozen trout imported daily into Montana as food should be addressed. A single trout head may contain as many as 200,000 to 500,000 *Myxobolus* spores without obvious external evidence of deformities. We are advised by sanitary engineers that sewage treatment systems will not kill spores. Thus, a single fish head placed in a kitchen disposal presents a significant hazard if it is spore laden (this holds true, as well, for fish caught in infected waters, where the risk of spread of infection to another watershed is even higher). Idaho now produces most commercial fish. Some of the major facilities are thought to be free of whirling disease, but many smaller operations may well not be clean, and there are no regulations at present, either in Idaho, Montana or other states which ensure that whirling disease will not be further spread by this means. Montana FWP does not have clear authority to promulgate rules in this situation, nor the monies to test the large numbers of fish required to be sure that whirling disease spores are not being introduced in this way. We recommend that the Governor ask the FWP, Health and Commerce Departments to coordinate efforts on this potential problem.

Status: Samples of fish from grocery stores were tested and no whirling disease positive fish were detected. The Northwest Fish Health Committee is not aware of anyone looking at this possible vector of transmission. Other steps taken include a moratorium on the importation of live fish, except if the following protocols are met: (a) disease free egg source; (b) secure, disease free water supply; (c) whirling disease cannot be found in the immediate drainage. Only three private hatcheries are allowed to import trout into Montana and their authorization is reviewed annually.

2.3. **Recommendation:** Minimize the impacts of whirling disease on recreational fishing opportunities.

Status: Guidelines and recommendations were established and published in the Task Force's whirling disease brochure. Management triggers document developed by Task Force and discussion with the Commission.

New Management Recommendations of the Task Force: In addition to the research goals and objectives reviewed above, the Task Force recommends two additional objectives be added. They are:

2.4 **Recommendation:** Develop a comprehensive management strategy on whirling disease infected waters.

2.5 **Recommendation:** Data acquisition and integration – collate field and lab data and use it to assist in guiding management decisions.

2.6 Recommendation: MFWP must have adequate resources to inspect and test hatcheries and to deal with any that become infected with whirling disease.

3. Communication / Education / Outreach

3.1. Activities by Montana Fish, Wildlife and Parks

3.1.A. **Recommendation:** The Department should continue its practice of releasing new information as it is obtained. The Department's credibility depends upon being perceived as an objective information source, and the Task Force believes that both information-gathering and information-dissemination are critically important FWP tasks.

Status: FWP has continued to release new information as it is obtained, as well as having maintained frequent formal and informal contact with the news media, sportsmen's clubs and legislators to keep them informed on the issues and the various research and management projects underway in Montana. Dozens of news stories have been printed and broadcast on whirling disease. Press releases are available on the FWP web site.

3.1.B. **Recommendation:** The Department should continue its distribution of simple communication materials to inform the public about the presence of whirling disease and to provide "Do's and Don'ts" recommendations for containment. This should include distribution of pocket cards to individuals who purchase fishing licenses, whirling disease advisory signs at fishing access sites, and related activities.

Status: Whirling disease "do's and don'ts" are prominently displayed on the back cover of FWP's 1998-99 Fishing Regulations pamphlet. Pocket cards continue to be made available and the posting of advisories is now an ongoing project directed by FWP's regional fisheries managers. In addition, FWP's Internet site provides whirling disease information and links to various whirling disease information sites, include the Task Force's web site.

3.1.C. **Recommendation:** FWP is planning to expand its efforts to educate the public about the value of wild and native trout. The Task Force believes this is an important adjunct to basic communications about whirling disease, underscoring what is at risk.

Status: FWP partnered with the Task Force in development of the brochure "Whirling Disease in Montana." All FWP communications regarding whirling disease emphasize Montana's wild trout imperative. FWP has produced several whirling disease television spots under its "Outdoor Report" banner, as well as in the agency's *Montana Outdoors* magazine. FWP has also created a traveling display (Wild Country, Wild Trout) that highlights the importance of wild and native trout.

3.1.D. **Recommendation:** Expanded monitoring of the mass media to assess how the whirling disease problem in Montana is being characterized by out-of-state publications including the national news media, as well as sporting/fishing and travel publications.

Status: FWP maintains an active whirling disease clipping file on all related news stories.

3.1.E. **Recommendation:** Education is a key communications objective, and the Task Force unanimously recommends increased attention on high school and elementary school children as an important long-term audience. FWP plans to develop a whirling disease curriculum for distribution to schools, and the type of "science day" activities which recently were developed in the Bitterroot area can serve as a useful model. The Task Force should encourage and support educational efforts, particularly hands-on activities in which students and educators can participate.

Status: In addition to the activities discussed in 3.1.B, FWP's Education Bureau has developed a "What in the Whirld is Whirling Disease" poster that has been distributed to Montana schools. It has also placed whirling disease stories in WOW magazine, distributed to Montana fourth graders.

3.1.F. **Recommendation:** Increased attention on internal communications to FWP and other agency employees is also recommended. Ongoing education of staff as to what is known (and not known) about the disease is needed.

Status: Whirling disease updates are frequently delivered at regional meetings and cross-divisional training sessions.

3.1.G. **Recommendation:** Formal evaluation of communications activities is also strongly recommended. Survey research should be conducted to assess who is receiving messages about whirling disease, and the impact of those messages on their intended audiences.

Status: FWP has not established a formal evaluation survey.

3.1.H. **Recommendation:** Publication and distribution of research results by Montana Fish, Wildlife and Parks and other whirling disease investigators should be given high priority.

Status: Through discussion with reporters, FWP's news releases, video "Outdoor Reports" and Montana Outdoors magazine, the department keeps the public abreast of research underway in Montana and early results of that research. The Montana Water System also lists whirling disease research results funded through the National Partnership on its web site.

3.2. Task Force activities

3.2.A. **Recommendation:** Serving as a sounding board for new communications materials. Are the communications messages consistent with our overall understanding of the facts about whirling disease, as new field research and laboratory work is completed? Do communications materials strike an appropriate balance between communicating the seriousness of the issue and the fact that Montana fishing opportunities remain largely unparalleled in the U.S.?

Status: The Task Force has provided this function. However, this role needs to revert to FWP since the Task Force has completed its tenure.

3.2.B. **Recommendation:** The Task Force should monitor legislative activity at the state and federal levels and encourage support of the objectives of the Task Force.

Status: Task Force member Jim Ahrens testified during the 1997 legislature on behalf of the Task Force. The reconvened Task Force included two legislators. Former Task Force

members Tom Anacker and Karl Johnson testified before the Congressional Sportsmen's Caucus. Task Force Chairman Marshall Bloom has met with Congressional delegation and briefed Congressional Staff members of key committees. This function needs to revert to FWP since the Task Force has completed its tenure.

3.2.C. **Recommendation:** Many Task Force members can be used as effective spokespersons for the state and national media. The Task Force includes eminent scientists, well-known sportsmen, and representatives from a number of well-known organizations. Task Force members can increase credibility of outreach to the media by talking as experts, by talking sportsmen-to-sportsmen, and so forth.

Status: The Task Force has provided this function. However, this role needs to revert to FWP since the Task Force has completed its tenure.

3.2.D. **Recommendation:** Some Task Force members have volunteered to assist in other outreach activities. Presentations to local civic organizations and sporting clubs, to school groups, and other audiences are positive ways to inform the public about the whirling disease issue. A slide show similar to the one currently being used by some FWP employees, scripted for Task Force members and other volunteer presenters, should be developed.

Status: The Task Force has provided this function. However, this role needs to revert to FWP since the Task Force has completed its tenure.

3.2.E. **Recommendation:** The Task Force can play a central role in fundraising activities, seeking financial assistance from various private sector organizations and individuals, and through lobbying appropriate lawmakers and agencies. The Task Force believes that significantly increased funding for whirling disease efforts should be sought from the 1997 state legislature, and that all opportunities to increase federal funding should also be taken. In addition to financial support from government, the support of individuals and organization will be needed to achieve the fundraising goals which are set forth in this report, and the Task Force is well-positioned to assist in this regard.

Status: Funding raised for Task Force operations and for the whirling disease brochure and other educational activities has been adequate, but limited.

3.2.F. **Recommendation:** The Task Force also believes it is important to increase communication with other whirling disease organizations, and groups such as Trout Unlimited and other national organizations with a direct interest in this issue. It is important to expand coordination and outreach activities, including increased contacts with other state, national and international groups working on whirling disease, sharing information on the recommendations and activities of the Task Force and seeking information on their goals, objectives and activities.

Status: This has come about largely because of the Whirling Disease Foundation's annual research meeting and the work of the National Partnership. Trout Unlimited and Federation of Fly Fishermen have featured many articles on WD in their periodicals.

3.2.G. **Recommendation:** The Task Force should encourage appropriate sporting goods manufacturers and retailers to include information about native and wild trout and whirling disease in their catalogs and product packaging.

Status: The Task Force has provided this function. However, this role needs to revert to FWP since the Task Force has completed its tenure.

New Recommendations on Communication/Education/Outreach:
In addition to the research goals and objectives reviewed above, the Task Force recommends two additional objectives be added. They are:

3.3 **Recommendation:** Because the Task Force commission from the Governor has expired, MFWP should establish a "key contact" list of individuals and groups that have been involved with WD activities. The "key contacts" should be kept updated and informed about new research findings, press releases, new whirling disease testing results and other WD related information.

3.4 **Recommendation:** MFWP should call together members of the TF and others, at least annually, to review the "state of the state" on whirling disease and to issue reports and recommendations as appropriate.

Conclusion

Almost five years after its detection in Montana, whirling disease continues to capture the interest and concern of anglers, business people, conservationists, students and public officials, both in Montana and around the world. Montana is recognized as the leader in dealing with this problem.

The Task Force appreciates the opportunity to be of service on this very difficult scientific and policy challenge. We encourage the Governor, the Legislature, the media and all Montana citizens to remain engaged on the whirling disease issue. We need continued support for comprehensive scientific research, as well as informed and effective fisheries management decisions to respond effectively to the threats posed by whirling disease.

The members of the Task Force remain prepared to assist on behalf of our wild trout in any way we can.

Appendix 1
Task Force Executive Order

State of Montana
Office of the Governor

Executive Order No. 1-97

EXECUTIVE ORDER CONTINUING THE
GOVERNOR'S WHIRLING DISEASE TASK FORCE

WHEREAS, the presence of *M. cerebralis*, the causative agent for whirling disease, has now been confirmed in 40 water bodies in Montana; and

WHEREAS, the State of Montana is still at the very early stages of this problem, and all indications suggest that it is a problem that will escalate; and

WHEREAS, although extensive research efforts are now underway, it is still the case that there is no known cure for whirling disease once it enters a water body; and

WHEREAS, *M. cerebralis* continues to be detected in water bodies in Montana, and as the social and economic impacts multiply, the public concern over whirling disease will escalate; and

WHEREAS, the Governor's Whirling Disease Task Force and Montana Fish, Wildlife and Parks have emerged as national leaders in the effort to manage wild fish populations infected by whirling disease; and

WHEREAS, the Governor's Whirling Disease Task Force previously promulgated goals and a plan to guide whirling disease research, management, communication and education; and

WHEREAS, the goals and action plan previously developed provide guidance for the Whirling Disease Task Force's continued work.

NOW, THEREFORE, I, MARC RACICOT, Governor of the State of Montana, by virtue of the authority vested in me by 2-15-122, MCA, do hereby continue the Governor's Whirling Disease Task Force.

I. PURPOSE

A. The Whirling Disease Task Force shall:

1. Promote public education on whirling disease by helping to establish educational and information programs and by serving as an ambassador to various constituencies and interest groups to ensure they receive up-to-date information.

2. Prepare an annual status report that:

a. assesses the status of current efforts to implement the Task Force's recommendations;

b. evaluates and updates, as appropriate, the previously established goals and action plan; and

c. reports on research conducted under the auspices of the whirling disease project of the National Partnership on the Management

of Wild and Native Coldwater Fisheries.

3. Provide a forum for the discussion of public policy issues associated with whirling disease in Montana. The Task force maintains a unique position to bring affected parties together to jointly develop a shared understanding of policy options and trade-offs. These efforts should complement the decision-making roles of the Fish, Wildlife and Parks Commission and the Department of Fish, Wildlife and Parks.

4. Evaluate and, as appropriate, develop recommendations to address the socio-economic impacts of whirling disease.

B. The Whirling Disease Task Force may establish subcommittees comprised of individuals with needed technical, scientific, educational or economic expertise to assist the Task Force in making informed decisions.

II. COMPOSITION

The Whirling Disease Task Force shall be composed of not more than 21 members, plus the Director of Montana Fish, Wildlife and Parks who shall serve as an ex-officio member. The names and addresses of members who shall serve at the pleasure of the Governor shall be submitted by separate letter to the Department of Fish, Wildlife and Parks and the Secretary of State.

III. DURATION

This Task Force shall remain in existence until January 1, 1999, unless extended or terminated by subsequent Executive Order.

This Order is effective immediately.

GIVEN under my hand and the GREAT SEAL of the State of Montana, this 7th day of February, 1997.

Marc Racicot

MARC RACICOT, Governor

ATTEST:

Mike Cooney

MIKE COONEY, Secretary of State

by Lois Lee Sill, Deputy

Appendix 1
Roster of Task Force Members

Patrick Graham, Co-chair

Director, Montana Fish, Wildlife & Parks. Fisheries biologist. Helena, MT.

Marshall Bloom, M.D., Chair

Research Medical Officer, Rocky Mountain Lab, National Institutes of Health. Montana Trout Unlimited State Council member (former chairman), National TU Whirling Disease Grassroots Advisor. Whirling Disease Foundation Director. Hamilton, MT.

Jim Ahrens

President of the MT Hospital Association. Active in state and national programs. Currently a member of various health-related boards and committees. Helena, MT.

John Bailey

Owner of Bailey's Fly Shop. Livingston, MT.

Frank Cooper

Immediate past chair, Montana State Council of Trout Unlimited

Robin Cunningham

Executive Director of Fishing Outfitters Association of Montana (FOAM). Licensed fishing outfitter for Headwaters Guide Service. On the Montana Board of Outfitters. Gallatin Gateway, MT.

John Duffield

Research Professor of Economics, University of Montana. Head of Bioeconomics, Inc.

John Etgen

State Coordinator of Project WET Montana, a teacher/youth water education program based at Montana State University.

Willard Granath, Jr.

Professor, Division of Biological Sciences, University of Montana, Missoula, Montana. Currently conducting research on the role of *T. tubifex* in the epidemiology of whirling disease.

Mike Halligan

Senator, Montana State Legislature.

Bud Lilly

Owner, Bud Lilly's Angler Inn. Member of MT Ambassadors. Past National Director for TU; Board Member of MT River Action Network; Served on Greater Yellowstone Coalition Board. Bozeman, MT.

Dud Lutton

Whirling Disease Foundation director. Bozeman, MT.

Roger Nelson

Owner, Nelson's Spring Creek Ranch, Livingston, MT.

Art Neill

Executive Vice President and Director of Montana Power Company, retired. President, Montana Nature Conservancy. Butte, MT.

Karl Ohs

Representative, Montana Legislature

Chris Somers

Haxby & Somers Law Office. Butte, MT.

Rick Stowall

Fisheries Program manager, Region I, U. S. Forest Service. Missoula, MT

Marsha L. (Josh) Turner

Owner, Turner and Associates, a consulting firm specializing in management, public relations, and public policy consulting. Vice president of the Montana Wildlife Federation.

Bill Tietz, DVM, Ph.D.

Member of steering committee of the National Partnership on the Management of Wild and Native Cold Water Fisheries; steering committee Wild Trout Research Lab. Past president Montana State University.

Richard J. Wesnick

Editor, *The Billings Gazette*.

Bob Wiltshire

Director of the Federation of Fly Fishers International Fly Fishing Center, Livingston, Montana.

Appendix 1
Education Subcommittee Members

John Etgen, Chair
Project WET Montana
Montana State University
Bozeman, MT

Sharon Bitz
Bozeman, MT

Marshall Bloom, MD, Chair
Whirling Disease Task Force
Hamilton, MT

Dorothy Bradley, Director
MUS Water Center
Bozeman, MT

Kurt Cunningham
Project WILD Coordinator
MT Fish, Wildlife & Parks
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Dave Hagengruber
Aquatic Ed. Specialist
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Conservation Education Div.
Helena, MT 59620

Senator Mike Halligan
Missoula, MT

Marilyn Hayes
Helena, MT

Sue Higgins
Whirling Disease Foundation
Bozeman, MT

Josy McLean
CM Russell High School
Great Falls, MT

Art Neil
Montana Power Co.
Butte, MT

John & Mary Nickum
Fish Technology Center
USFWS
Bozeman, MT

Jim Peterson
MT Fish, Wildlife & Parks
Great Falls, MT

Denise Rogers
Hate Free Zone
Bozeman, MT

Jim Schulz
Helena, MT

Paul Sihler
MT Fish, Wildlife & Parks
Helena, MT

Dick Vincent
Whirling Disease Coordinator
MT Fish, Wildlife & Parks
Bozeman, MT

Richard Wesnick, Editor
The Billings Gazette
Billings, MT

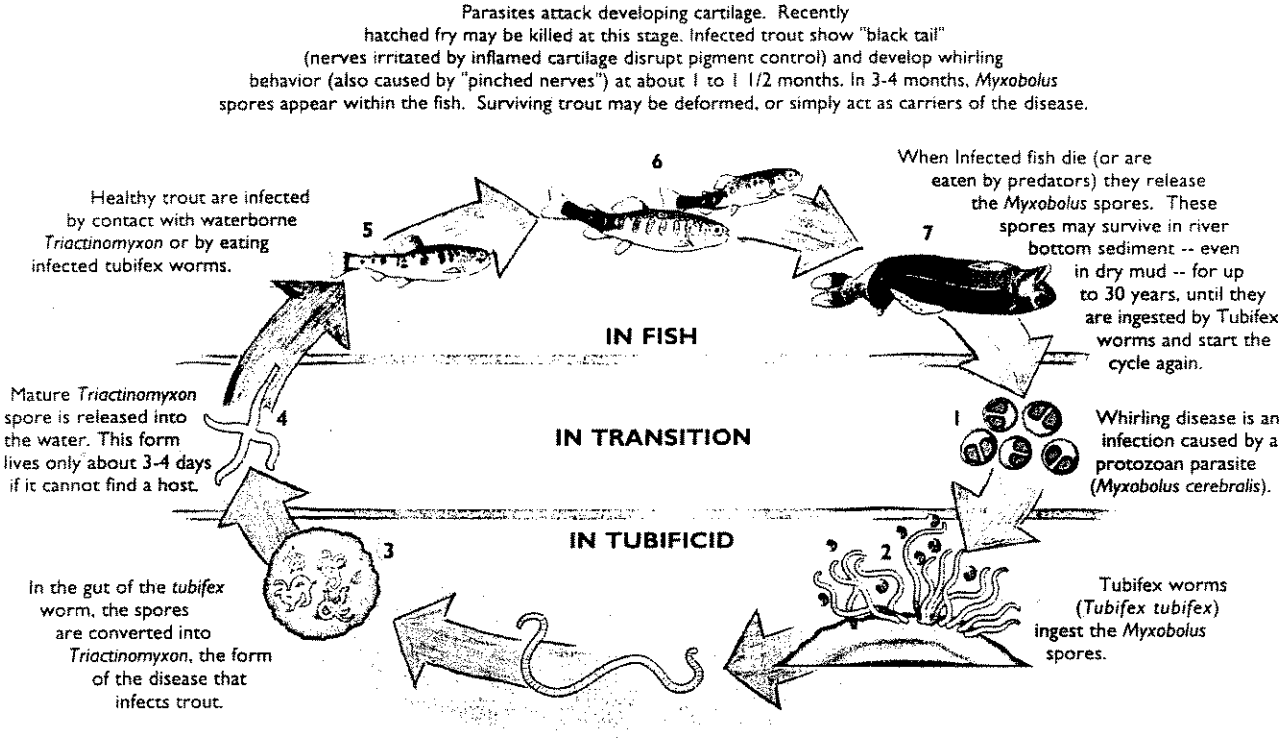
Bob Wiltshire
International Fly Fishing
Center - FFF
Livingston, MT

Appendix 2
Life Cycle of Whirling Disease

Whirling disease is caused by a microscopic, waterborne parasite that attacks the cartilage of young trout. Whirling disease spores (*Myxobolus cerebralis*) are released into the water when infected fish die and decompose, or when they are consumed and excreted by predators or scavengers.

As the chart below illustrates, the parasite has a complex, two-host life cycle that involves the trout and the bottom-dwelling *T. tubifex* worm, which is found in streams, rivers and lakes throughout Montana.

While the parasite may not directly kill a trout, an infected fish's erratic tail chasing makes it extremely vulnerable to predation. The disease also makes feeding difficult for infected fish, which can eventually result in starvation and death.



The Life Cycle of Whirling Disease

(Illustration borrowed from *Trout* magazine, Spring 1995)

Appendix 3
Known Whirling Disease Positive Sites in Montana

The following bodies of water are known to be infected with *Myxobolus cerebralis* (whirling disease). In interpreting this listing, please keep a couple of things in mind:

First, the majority of sites listed below have only light or moderate infections of whirling disease and to date have not experienced any significant degradation in the quality of fishing — the fishing remains world class on many of these streams! Whether more severe population impacts will develop over time is unknown.

Second, this list is constantly changing and should not be taken as "definitive." That means that even if a body of water is not listed here, you should still take proper precautions not to spread whirling disease to it or from it. For more information on precautions you can take, see the FAQ, questions 7 and 8, and the "You Can Help!" page.

This page is under construction and is updated as new information becomes available. Future updates which will include additional information about each infected site.

Code:
RBT= Rainbow Trout
BNT= Brown Trout
BKT= Brook Trout
WCT= Westslope Cutthroat
MWF= Mountain Whitefish
KOK= Kokanee Salmon
RBX= Rainbow/Cutthroat Hybrid

Beaverhead River Drainage

Alder Gulch Creek - BNT
Beaverhead River - BNT
Big Sheep Creek - BNT
Birch Creek Reservoir - RBT
Blacktail Deer Creek - RBT, BKT
Canyon Pond - RBT, BNT
Clark Canyon Reservoir - RBT
Cold Spring Creek - BNT
Culver Pond - RBT
Grasshopper Creek - RBT, BNT
Horse Prairie Creek - BKT
Poindexter Slough - BNT
Red Rock Creek - BKT, RBX
Red Rock River, Springs - RBT, BNT
Ruby Reservoir - RBT
Ruby River - BNT
Silver Springs - BNT

Flathead River Drainage

Goat Creek - BKT
Swan River - RBT
Woodward Creek - BKT

Big Hole River Drainage

Big Hole River - RBT

Blackfoot River Drainage

Blackfoot River - RBT
N. Fork Blackfoot River - RBT, BNT
Cottonwood Creek - RBT
Kleinschmidt Creek - BNT
Lincoln Spring Creek - BNT
Shanley Creek - BKT
Warren Creek - RBT, BNT, BKT

Clark Fork River Drainage

Clark Fork River - RBT
Dempsey Creek - BNT, BKT
East Fork Rock Creek - BNT, BKT, WCT
Flint Creek - RBT, BNT, BKT
Flint Creek, North Fork - RBT, BKT
Georgetown Lake - KOK
Gold Creek - BNT
Little Blackfoot River - BNT
Lost Creek - BNT
Racetrack Creek - BNT, BKT
Rock Creek - RBT, BNT, BKT, RBX
Stuart Mill Creek - BKT
Warm Spring Creek - BNT

Jefferson River Drainage

Boulder River - RBT, BNT, BKT
Hells Canyon Creek - RBT, BNT
Jefferson River - RBT, BNT
South Boulder River - RBT, BNT, BKT
Whitetail Creek - BNT
Willow Creek (above res.) - RBT
Willow Creek, South Fork - RBT
Willow Springs Creek - BNT

Missouri River Drainage

Elk Creek - BNT
Hound Creek - BNT
Little Prickly Pear Creek - RBT
Marsh Creek - RBT
Missouri River - RBT
Sun River - BNT
Tyrell Creek - BKT
Wolf Creek - RBT

Madison River Drainage

Blaine Spring Creek - RBT
Cherry Creek - RBT
Horse Creek - RBT, BNT
Jack Creek - BNT
Madison River - RBT, BNT
Moore Creek - BNT
Moose Creek - BNT
O'Dell Creek - RBT, BNT
Papoose Creek - RBT
Soap Creek - RBT
Squaw Creek - BNT
West Fork Madison River - RBT, BNT
Wolf Creek - RBT

Yellowstone River Drainage

Yellowstone River (above Livingston) - RBT

Depuy's Spring Creek - RBT

Appendix 4
FWP Field Research 1998-99

Whirling Disease Studies Ongoing During 1998-99

1. Missouri River studies
   a. Life History of wild rainbow trout in the Missouri River
   b. Relationship of *Tubifex tubifex* densities to infection intensities in wild rainbow trout.
   c. Infection intensities of WD in three spawning tributaries to the Missouri river (Little Prickly Pear Creek, Wolf Creek, Lyon's Creek, Sheep Creek, and the Dearborn River.
   d. Estimation of wild rainbow and brown trout in three study sections on the Missouri River.

2. Madison River studies
   a. Madison River wild rainbow trout spawning life history study. Determine the water temperature and spatial requirement for wild rainbow trout spawning in the upper Madison River.
   b. Relationship between tubificid populations and infection rates in rainbow trout.

3. Relationship of *Myxobolus cerebralis* infected tubifex worms to infection rates and severity of whirling disease in wild rainbow trout in Rock Creek, Montana.

4. The relationship of tubifex worms population densities to the level *M. cerebralis* infections in wild rainbow trout in the Big Blackfoot and selected tributaries.
   Objective 1 - Through the use of live cages determine the level of infection in six mainstem river sites and in six tributary sites. Exposures will be for a ten day period in late June and early July.
   Objective 2 - Determine if there is a relationship between *T. tubifex* densities and the infection rate in young wild rainbow trout held in live cages below these Tubifex populations.
   Objective 3 - Determine the population level of *T. tubifex* above each live car site and determine if there is a potential to change some land management practices within each selected drainage to alter the densities of the alternate host - *T. tubifex.*

5. Determine the relative infection rates of *Myxobolus cerebralis,* if any, in the Yellowstone River from Livingston to Columbus on the Yellowstone river and in certain selected tributaries.
   Objective 1 - Determine the relative rate of WD infection in caged young (1-2 inch) wild rainbow trout in six sites on the mainstem Yellowstone River. Level and intensity of infection will be determined using the Baldwin-MacConnell histological method.

5. Determine the relative infection rates of *Myxobolus cerebralis,* if any, in the Yellowstone River from Livingston to Columbus on the Yellowstone river and in certain selected tributaries.

   Objective 1 - Determine the relative rate of WD infection in caged young (1-2 inch) wild rainbow trout in six sites on the mainstem Yellowstone River. Level and intensity of infection will be determined using the Baldwin-MacConnell histological method.

   Objective 2 - Using live cages determine relative infection rates of WD in caged young (1-2 inch) wild rainbow trout in six selected tributaries to the Yellowstone River. Level and intensity of infection will be determined using the Baldwin-MacConnell histological method.

6. Life history of the Red Band rainbow trout in the Kootenai River drainage.

   Objective 1 - Determine the spawning life history of this strain of rainbow trout with emphasis on spatial and thermal requirements. Determine if this strain has either some life history attributes or WD resistance which may be utilized in solutions to whirling disease in other Montana streams where rainbow trout are present.

7. Willow Creek studies

   Objective 1. - To determine if the water temperatures encountered during egg incubation determines the spawning temperatures at which rainbow trout begin their spawning activities upon reaching sexually maturity. Previous information from Willow Creek Reservoir has shown that eggs incubated at water temperatures higher than normally found in Willow Creek during the spring spawning egg incubation period (54F, 56F & 58F) has resulted in adults that spawn much later and at higher temperatures than those hatching in the colder stream water. These rainbow trout were hatched and raised to one year of age prior to stocking in Willow Creek Reservoir. The new study will examine hatching eggs in colder water prior to raising them to one year of age and then stocked in the spring of 1999. If the experiment goes as expected, it should provide an early spawning rainbow trout which would allow an earlier emerging fry. Three strains of wild rainbow trout are being used in this experiment (DeSmet, Eagle Lake and Finger Lake, NY.

   Objective 2. - Compare incubation periods (degree days) for five strains of rainbow trout - DeSmet, Eagle lake, Madison River, Missouri River, and Red Band.

   Objective 3. - Determine relative resistance to *M. cerebralis* infections for six strains of rainbow trout and three strains of cutthroat trout. This will be accomplished at the wild trout lab at MSU through controlled doses of infective tams (2000 TAMs/fish/2 hours). Level of infection will be measured through the Baldwin-MacConnell histology technique (with the 0-4 ratings system). Strains of rainbow trout to be used are as follows: DeSmet, Eagle Lake, Missouri River, Madison River, Finger Lake, and Red Band. The strains of cutthroat trout are as follows: Westslope (Washoe Park brood), Yellowstone (McBride) and Upper Snake River (WY).

   Objective 4. Acquired Immunity Study. Determine if light exposures to *M. cerebralis* TAMs (ratings less than 2.0 on the Baldwin/MacConnell histological scale) decreases the level of infection, when later exposed to large concentrations of TAMs. This will be done in Willow Creek with live cage experiments.

Objective 5. Continue to monitor the relationship between water temperatures and *M. cerebralis* infections in young rainbow trout in Willow Creek through the use of live cages.

Objective 6. Determine the level of *M. cerebralis* infections in young-of-the-year mountain whitefish when exposed to 2000 TAMs/fish/2 hours under a laboratory conditions at Pony.

Objective 7. Determine if young rainbow trout just hatched are vulnerable to infection while they are still in the inter-gravel spaces prior to emergence.

8. Statewide survey for presence and intensity of *M. cerebralis* infections.

Objective 1 - Using live cages determine the rate and intensity of *M. cerebralis* infections in at least 10 streams. Initial streams are: Big Hole River - two sites, Jefferson River, Missouri River near Toston, Deep Creek a tributary to the Missouri River, Smith River, Harvey Creek near Missoula, Swan River - 3 sites and Big Horn River.

Objective 2 - Using electrofishing gear, sample wild trout waters as needed on a statewide basis to determine the presence or absence of whirling disease.

Appendix 5
FWP Field Research - Harrison Research Station

Temperature Effects on Whirling Disease and Trout

FWP Whirling Disease Coordinator Dick Vincent in previous research discovered that at cold water temperature (below 50 degree F) whirling disease infection levels in fish are low; as the water warms, infection levels increase, with peak infections in fish occurring at 54-57 degrees F; as the water temperature increases to the low 60's F, infection levels drops off again. As a consequence, Vincent believes that trout fry that emerge at colder water temperatures have a better chance of being exposed to survivable levels of whirling disease infection than fish that emerge at 54-57 degrees F.

During 1998, Vincent is testing a hypothesis that temperature of the water from which fish emerge as fry is the primary factor determining the temperature at which the fish will spawn as adults. If this hypothesis proves to be true, then fish managers may have two new options for managing around whirling disease. First, they may be able to identify and select for strains of wild rainbow trout that spawn at colder water temperature whose offspring would be better suited to surviving in a whirling disease infected stream. These fish could then be established as a wild population in an infected stream. Second, they may be able to shift the spawning temperature of wild fish whose fry currently emerge during the peak TAM release (54-57 degrees F) so that they emerge at a colder water temperature. This would be accomplished by raising the eggs of wild fish in an incubator with water temperatures below 50 degrees and then releasing the fry back into the wild. If the hypothesis is correct that trout seem to imprint on their hatching temperature, those fish as adults would then spawn at colder water temperatures, thereby imparting a greater chance of survival on their offspring.

Vincent has raised fish at colder water temperatures and released them into Willow Creek, a stream whose rainbow population has been devastated by whirling disease. This is an ideal location for a controlled field experiment because the basin is closed by a downstream dam. Beginning in the year 2000 when these rainbow become adults become adults and spawn themselves, Vincent will learn whether his hypothesis is correct.

Trout Species Susceptibility to WD

In another experiment, Vincent is determining the relative susceptibility to whirling disease of three species of cutthroat trout (Snake River, Westslope and McBride) and six species of rainbow trout (Redband, Eagle Lake, DeSmet, Missouri River, Madison River and Finger Lake, which are from New York). This experiment is being conducted in a lab where emergence time can be controlled so that all fish are the same age when exposed to TAMs and so that all fish are exposed to identical doses of TAMs.

The results of this experiment will be significant because several of the fish species being tested are believed to have resistance to whirling disease. Colorado researchers have conducted tests with the Snake River cutthroat and believe them to be highly resistant. Also, the Finger Lake rainbows come from an area in New York where whirling disease is present but does not seem to have the impact on rainbow populations that have been witnessed in some waters in Montana and Colorado. Histological analysis has not yet been completed, but results are expected soon.

Acquired Immunity

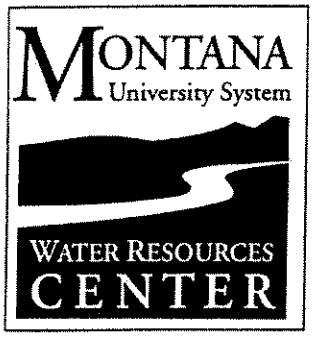
Data from previous field/lab experiments show that fish exposed to a light initial infection of *M. cerebralis* receives some immunity to a later exposure to *M. cerebralis*. In effect, this acts as a partial "vaccine" for the particular fish. Data show fish re-exposed to *M. cerebralis* consistently have a 20-25% lower level of infection when compared to naive fish receiving the same exposure to *M. cerebralis* for the first time. This immunity, however, is NOT passed on to progeny.

In a third experiment initiated in 1998, Vincent is trying to learn if there is variation between different species in the level of "protection" afforded to a fish by receiving a light initial infection of *M. cerebralis*. He will be testing some of the same species of trout that were used in the previous experiment.

Live Car Monitoring

Finally, FWP is conducting live car monitoring in numerous rivers around Montana. This monitoring involves placing fish for ten day periods in a cage in a river, and then raising them to see if they develop signs of whirling disease. This enables the department to determine the rate and severity of whirling disease in the river. Waters being monitored are the Yellowstone, Blackfoot, Missouri and Madison Rivers, and Little Prickly Pear, Willow and Rock Creeks. In addition, spot checks are being conducted on the Big Hole, Smith and Swan Rivers.

Appendix 6
The National Partnership - Report to Congress



NATIONAL PARTNERSHIP
on the Management of
Wild and Native Cold Water Fisheries

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A REPORT TO CONGRESS

1997-1998 Research Findings
Whirling Disease Initiative
November 1, 1998

For further information contact the Steering Committee for the Whirling Disease Initiative at the Montana Water Resources Center, 101 Huffman Building, Montana State University, Bozeman MT 59717 (406) 994-6690.

A REPORT TO CONGRESS

1997-1998 Research Findings
Whirling Disease Initiative
November 1, 1998

BACKGROUND

During the current decade the metazoan parasite *Myxobolus cerebralis*, which causes whirling disease in many salmonid fish species, has been spreading and infecting hundreds of river and stream reaches in the Western United States. A Eurasian native, *M. cerebralis* made its way to North America in the 1950s -- probably through the importation of frozen fish -- and has recently taken a particularly large toll on wild rainbow trout in some of the richest riverine fisheries in the Rocky Mountain States. This microbe is extremely hardy and long-lived, with a life cycle that employs both a fish host and a ubiquitous aquatic worm host known as *Tubifex tubifex*. Once established in a stream, it is there to stay. The parasite cannot be eradicated; nor can its worm host, without significantly damaging the ecosystem.

Until very recently, the body of scientific knowledge relating to whirling disease in riverine environments was slim. While the parasite has entered many government and private hatcheries, managers of these facilities learned techniques to avoid exposing very young fish to the disease. Whirling disease can kill young fish directly, or cause its victims to spin without control, rendering them vulnerable to predators and unable to efficiently capture food. Due to the reduced susceptibility of the older fish, later infections are generally not fatal. However, the stocking of infected hatchery fish in riverine settings increases the *M. cerebralis* parasite load in positive streams, and may provide one more avenue by which the disease is spread into uninfected areas.

In past years it was mistakenly assumed that the disease would not affect wild self-sustaining trout populations. This assumption dramatically toppled when whirling disease was discovered to have caused a greater than 90 percent reduction of wild rainbows in Montana's Madison River in 1994. Similar losses have been documented in four of Colorado's best fisheries. Whirling disease is now reported in 22 states, including both eastern and western drainages of the Rocky Mountains, and obviously has caught the attention of anglers, scientists, and fisheries managers.

THE WHIRLING DISEASE INITIATIVE

In 1997, the Whirling Disease Initiative was established under the Charter of the National Partnership on the Management of Wild and Native Coldwater Fisheries (see *Appendix 1*). The purpose was/is to promote, prioritize, and help fund cooperative research with direct

implications for whirling disease afflicting self-sustaining trout populations. The program is centered at Montana State University-Bozeman, where a Whirling Disease Steering Committee convenes in person or by conference phone (see *Appendix 2*). This broadly based Committee: (1) writes an annual research plan (see *Appendix 3*); (2) issues Requests for Proposals (RFPs) (see *Appendix 3*) based on identified priorities; (3) selects and approves projects for funding following scientific peer review; and, (4) summarizes and makes available research results to all partners and cooperators via mail and an expansive WEB site (see *Appendix 4*). It works closely with the Whirling Disease Foundation which sponsors annual symposia where scientific papers are presented and discussed.

1997 was the first year in which the National Partnership received United States Fish and Wildlife Service funding for whirling disease research. Dr. Ron Hedrick of the University of California Davis, probably America's top whirling disease authority, pointed out recently that the science is still in the "causes" phase, and that "solution" work will come later. This situation may well prevail for the foreseeable future. In the meantime, the research strategy of the Steering Committee is to support a mix of projects representing a balance between short and long term research, and techniques for collection and analysis of data, always seeking potential solutions to the management of the fisheries and the disease. The multiple aspects of inquiry enhance the opportunities for helpful breakthroughs, stress *rapid response* information to assist fish managers, and focus on breaking the life cycle of the disease.

RESEARCH STRATEGY

Parasite Aspects

Research on the production, movement, and identification of the Triactinomyxon, or TAM stage of the parasite (the spores that are released by the worm host); and the possibility of alternative worm hosts.

Worm Aspects

Research on the life cycle, geographic strains, reproduction, and population densities of *T. tubifex.*

Fish Aspects

Research on biological resistance, life history strategies, the development of immunity, effects of stress, and lethal dosage levels.

Ecosystem Aspects

Research on environmental factors that influence worm density and fish vulnerability; and the relationship of stream condition to the development of risk assessments for infection and disease.

RESEARCH SUMMARY

To date, two *Request for Proposal* cycles have been completed, and 28 projects and 4 contracts have been funded for a total of $920,624 in federal dollars, and $886,298 in match. (The second research cycle is only five months in progress.) Research teams include 48 investigators from 7 states (see *Appendix 5*). The Initiative is characterized by excellent cooperation from multiple agencies, continuous assessment of research findings, and a high level of communication, due certainly in part to the annual symposia and field ecology workshops, and current whirling disease WEB site (see *Appendix 6*).

Progress is also due to the successful construction and management of a Wild Trout Research Laboratory on the MSU campus, which was completed in less than a year in spite of sophisticated requirements for maintaining the aquaria, and a specialized waste treatment facility to prevent the spread of infection. No other facility for conducting fish disease research exists in the Rocky Mountain West. The Lab is run and supported by a unique coalition of researchers from MSU, the Montana Department of Fish, Wildlife and Parks, and the U.S. Fish and Wildlife Service.

HIGHLIGHTS OF WHAT WE HAVE LEARNED

Whirling Disease is Fast-Spreading

Whirling Disease is now present in over 70 stream reaches in Montana, almost every major drainage in Colorado, and 20 other states. Where it has *NOT* spread is more perplexing than where it *HAS* spread (e.g., of the three forks of the Missouri River, two are badly infected and the third is clean). We still do not completely understand all of the vectors which transmit the disease from one site to another, or why the intensity of infection varies so much from one river to another.

Susceptible Fish

The impact of whirling disease on trout populations varies depending on the species. Rainbow trout are very susceptible, brown trout show few symptoms, cutthroat are susceptible but may spawn outside the danger zone, grayling appear to be resistant, and school is still out on whitefish and bull trout. Learning about susceptibility of strains and species is still in the early stages. Where some species (rainbow) have been on the decline, other species (brown) may fill in behind them, sometimes retaining the overall "fish biomass" of a river.

The Whirling Disease Parasite is Complicated and Durable

The life cycle and resilience of the parasite, *M. cerebralis,* help explain the rapid spread of whirling disease. The microscopic spores produced in infected fish number up to seven

digits. When a fish dies, spores are released into the water where they can survive for decades before being ingested by the widespread worm host, *T. tubifex.* Inside the worm, they are transformed into TAMs, and ejected back into the water -- sometimes by multiples of thousands per day per worm -- where these shorter-lived spores must find a susceptible salmonid fish within a few days to continue the cycle.

Decreasing Worm Hosts and Separating Fingerlings from the Parasite May be Management Strategies

One hopeful management strategy for decreasing the impact of whirling disease involves modifying the environment to make it less favorable for the worm host. Another involves enhancing life history patterns of trout to prevent exposure at the young age when they are most vulnerable. For example, manipulating spawning locations and/or seasons may allow trout to hatch in a low parasite environment, enabling them to either avoid areas of high infection or acquire sufficient resistance to avoid life-threatening infections. The offspring of rainbow trout spawning earlier in spring have been shown to have a lower infection rate than those that hatch later.

Gains are forthcoming on Diagnostic and Collection Methodologies

A. Improvements are being made on a DNA-based method of measuring the prevalence of spores in infected fish.

B. A manual and training course on protocols for worm collection are available, and a portable system for collecting TAMs from natural waters is showing some success.

C. Progress is being made on techniques for *in vitro* cultivation of salmonid cells that will advance the study of the intracellular development of the parasite.

SUMMARY

While the goal of containment of whirling disease is still out of reach, the Steering Committee of the Whirling Disease Initiative believes the 1997-98 projects laid an excellent foundation for continuing the pursuit of solutions to the whirling disease problem. Competent scientific teams are involved; studies are complementary and well designed; and execution has been exceptional, putting new information on the table, as well as refining useful scientific techniques.

The Committee particularly thanks Montana's Congressional delegation -- Senator Max Baucus, Senator Conrad Burns, and Congressman Rick Hill -- for their advocacy of this research; and the Representatives of the National Partnership for their time and guidance.

Appendix 7
Public/Outfitter Fishing Use
on 10 Most Popular Montana Rivers

River	Year	Angler Days	Client Days	O'fit. Use %	Res. angler use / %	Non-res. angler use / %
Beaverhead	1989	19122	633	3 %	7972 / 42%	11150 / 58%
	1991	11663	1337	11 %	5075 / 44%	6568 / 56%
	1993	16480	1496	9 %	7164 / 43%	9316 / 57%
	1995	17449	1431	8%	6890 / 39%	10559 / 61%
	1997	37630	3085	8%	15319 / 41%	22311 / 59%
Big Hole	1989	35550	1797	5 %	22410 / 63%	13140 / 37%
	1991	44289	2516	6 %	29583 / 67%	14706 / 33%
	1993	54443	2849	5 %	35639 / 65%	18804 / 35%
	1995	69407	5270	7.5%	42802 / 62%	26605 / 38%
	1997	80971	5297	7%	44929 / 55%	36041 / 45%
Bighorn	1989	48164	4595	10 %	15814 / 33%	32350 / 67%
(Dam - B'horn FAS)	1991	41296	5398	13 %	14617 / 35%	26679 / 65%
	1993	42505	8184	19 %	15820 / 37%	26685 / 63%
	1995	54906	8394	15%	21914 / 40%	32992 / 60%
	1997	93181	8462	9%	42574 / 45%	50607 / 55%
Bitterroot	1989	32246	814	2 %	22217 / 69%	10029 / 31%
	1991	36276	680	2 %	24595 / 68%	11681 / 32%
	1993	51450	1422	2 %	36314 / 71%	15136 / 29%
	1995	69951	1754	2%	48763 / 70%	21188 / 30%
	1997	95559	2565	3%	68795 / 72%	26764 / 28%
Gallatin	1989	55711	557	1 %	28342 / 51%	27369 / 49%
	1991	42096	699	2 %	23469 / 56%	18627 / 44%
	1993	50785	1679	3 %	27025 / 53%	23760 / 47%
	1995	67422	1777	3%	37951 / 56%	29471 / 44%
	1997	72839	1676	2%	43218 / 59%	29621 / 41%
Madison	1989	94271	4839	5 %	30779 / 33%	63492 / 67%
	1991	91230	6575	7 %	30231 / 33%	60999 / 67%
	1993	120314	7316	6 %	37067 / 31%	83247 / 69%
	1995	113007	7605	6%	39726 / 35%	73281 / 65%
	1997	114848	5984	5%	45956 / 40%	68892 / 60%
Missouri	1989	54298	935	2 %	41418 / 76%	12880 / 24%
(Holter - Cascade)	1991	49753	1483	3 %	39497 / 79%	10256 / 21%
	1993	54596	2409	4 %	42707 / 78%	11889 / 22%
	1995	75201	2622	3%	56613 / 75%	18588 / 25%
	1997	179018	3001	2%	146835 / 82%	32183 / 18%
Rock Creek	1989	28429	238	1 %	19260 / 68%	9169 / 32%
	1991	20130	296	1 %	14115 / 70%	6015 / 30%
	1993	21364	242	1 %	12308 / 58%	8912 / 42%
	1995	57154	394	.6%	34963 / 61%	22191 / 39%
	1997	31790	109	.3%	16202 / 51%	15588 / 49%
Stillwater	1989	21720	no data	no data	18156 / 84%	3564 / 16%
	1991	16380	no data	no data	13463 / 82%	2917 / 18%
	1993	24564	98	.3 %	20878 / 85%	3686 / 15%
	1995	26702	302	1%	20332 / 76%	6370 / 24%
	1997	36124	146	.4%	30377 / 84%	5747 / 16%
Yellowstone	1989	34086	1963	6 %	20089 / 59%	13997 / 41%
	1991	36789	2288	6 %	23358 / 63%	13431 / 37%
	1993	57007	3315	6 %	37223 / 65%	19784 / 35%
	1995	78784	4442	6 %	50377 / 67%	28407 / 33%
	1997	105637	3255	3%	80858 / 77%	24779 / 23%

Source: '93, '95, '97 FWP Creel Census; '93, '95, '97 MBO outfitter tally sheets

Appendix 8
Sample Whirling Disease Educational Materials

Task Force Whirling Disease Brochure

Incorporating the Whirling Disease Story into Existing Curriculum

Whirling Away on the Life Cycle!

The Task Force

When Governor Marc Racicot appointed members to the Montana Whirling Disease Task Force, one of his key objectives was to recruit a wide variety of individuals who could bring a diverse set of skills and perspectives to the table. From scientists to sportsmen, fishing guides to government officials, the Task Force is comprised of people dedicated to protecting and preserving Montana's coldwater fisheries against the threat of whirling disease.

You can reach the Task Force at Montana Whirling Disease Task Force • P.O. Box 6517 • Helena, MT • 59604 • 406-449-2916. And for up to the minute information on whirling disease in Montana, be sure to visit our web site at http://www.whirlingdisease.org.

Many thanks to the following organizations who sponsored this brochure

Montana Independent Bankers Association
Montana Chapter of the American Fisheries Society
Bitterroot Chapter of Montana Trout Unlimited
National Trout Unlimited
Fishing Outfitters Association of Montana
The Whirling Disease Foundation
Montana Fish, Wildlife and Parks
U. S. Fish and Wildlife Service

Photographs by Dave Hagengruber. Printed on recycled paper using vegetable inks.

Visit

How You Can Help

Reduce chances of spreading whirling disease to a new area.

Montana's Whirling Disease Task Force believes anglers, boaters, and others can help combat whirling disease and preserve wild trout by following some simple precautions.

- **Never transport live fish from one place to another.** In Montana, it is illegal!
- **Before leaving the stream or lake, be sure to thoroughly check your boating and fishing equipment for mud and aquatic plants.** Mud and aquatic plants could be holding tubifex worms and whirling disease spores, so if you find them clinging to your equipment, wash or scrape them off before departing the water.
- **Don't dispose of fish entrails or skeletal parts in a kitchen disposal.** It is believed that whirling disease spores can survive wastewater treatment systems.
- **Don't collect sculpins (also known as bullheads) or use them as bait.** It is illegal!
- **Don't use trout, whitefish, or salmon parts as cut bait.** It is illegal!

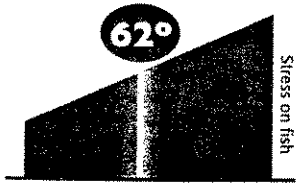
Kids and fishing are a natural combination. Working together, we *can* preserve Montana's fishing heritage for generations to come. And you can help. Please follow the do's and don'ts recommended above.

Preserve the Resource

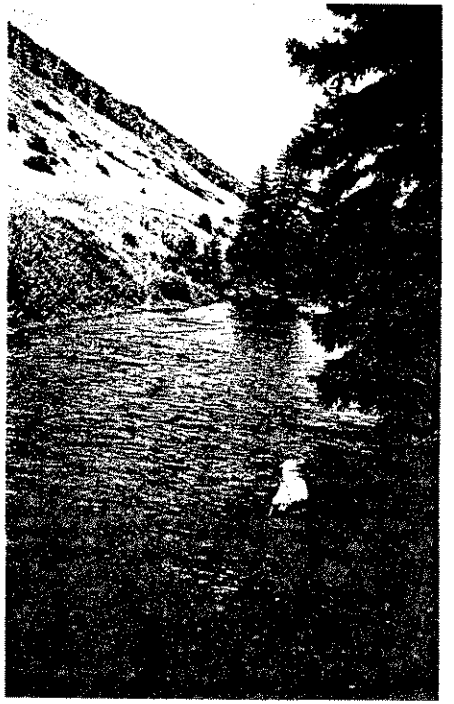
Reduce your impact on Montana's wild trout.

Consider these simple actions you can take to reduce trout mortality when fishing:

- **Don't disturb spawning trout; they are our hope for the future.** Be careful not to disturb fish nests (redds); fish carefully during spawning season so spawning fish are not disturbed; and ask your local Fish, Wildlife, & Parks biologist for tips on recognizing spawning trout.
- **Use particular caution when fishing warmer waters.** Trout become stressed when water temperatures exceed 62 degree Fahrenheit.
- **If you practice catch and release fishing, improve your techniques to reduce stress on fish.** Reduce or eliminate handling by using hook-removal tools and soft, wet gloves, or at least wet your hands if you must handle a trout.
- **Limit your catch, whether you practice catch and release fishing techniques or not.** The quality of your experience doesn't depend on how many fish you catch.



Fishing when water temperatures are above 62° puts severe stress on trout. During summer months, fishing early or later, rather than in the heat of the day, can greatly reduce unintentional fish mortality.



Whirling Disease in Montana

Whirling Disease Brochure

Whirling Disease in Montana

Whirling disease takes its name from an erratic, whirling behavior exhibited by some trout that have been infected by the parasite, *Myxobolus cerebralis*. Whirling disease affects the cartilage of young trout, and severe infections can lead to physical deformities that reduce their ability to feed and avoid predators. Whirling disease has been in the United States since 1956, but it was first discovered in Montana in 1994.

As shown below, the disease-causing parasite has a complex, two-host life cycle – fish and aquatic worms. Today, the Governor's Whirling Disease Task Force considers whirling disease to be the single greatest threat to Montana's wild trout populations.

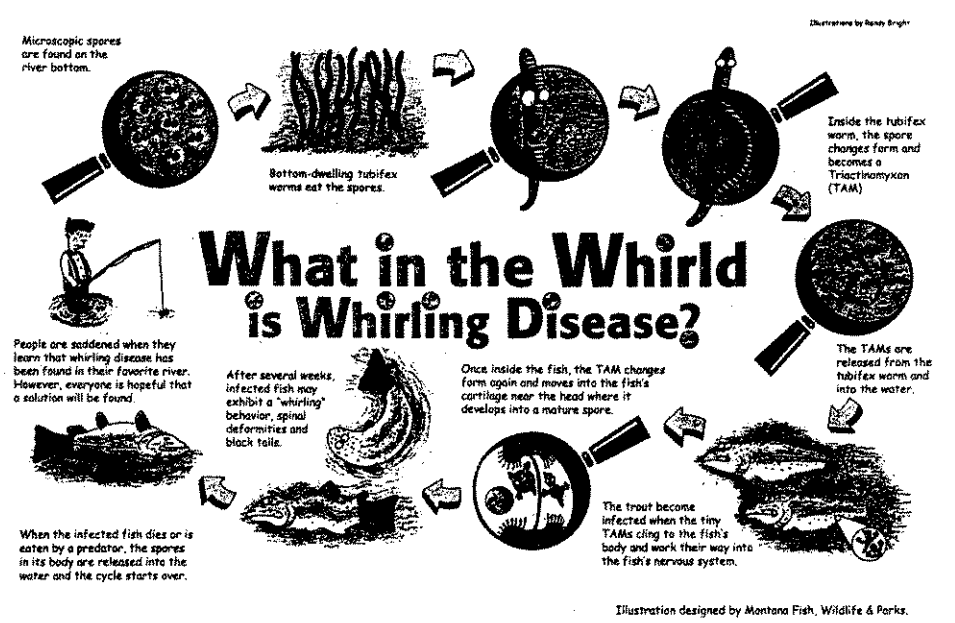


Illustration designed by Montana Fish, Wildlife & Parks.

The Importance of Wild Trout

Wild trout are fish that reproduce naturally and are not stocked into streams from a hatchery. Wild trout spawn, hatch, and grow to spawn again in a self-sustaining natural system.

For more than 25 years Montana has been a leader in wild trout management. Montana relies upon natural reproduction rather than hatcheries to sustain trout in its rivers and streams, season after season.

Wild trout, from the egg stage to adult, provide food for many species of wildlife, in addition to providing untold hours of adventure and recreation. The sudden collapse of wild trout populations could have far-reaching effects within Montana's river ecosystems.

Habitat & Hope

Naturally Promising Solutions

While much has been written about the alleged demise of the Madison River from whirling disease, the truth is that this magnificent river continues to produce about 1,500 catchable wild trout per mile. Because of Montana's commitment to wild trout habitat preservation, the Madison and other streams remain havens where wild trout are the angler's prize.

Not all fish that come in contact with the parasite will die or show deformities. This has led researchers to explore promising solutions, which include:

- Promoting life history patterns of wild trout to keep young trout away from the parasite during the trout's most susceptible stage: from when they first hatch until their cartilage hardens to bone at about 9 months old.
- Finding strains of rainbow and cutthroat trout that may be resistant to *severe* whirling disease infection.
- Reducing the number of worm hosts in a stream to diminish the parasites' potential to cause severe infections.

Dealing with whirling disease will not be easy, but initiatives have been started:

- A national research center has been established in Bozeman, Montana, which is administered by a coalition of researchers from state and federal agencies. The lab houses research facilities for all life stages of the whirling disease parasite and the worm host.
- Montana now has a Whirling Disease Coordinator who directs all field studies in the state.

Hope for scientific breakthroughs is coupled with Montana's protection of naturally reproducing wild trout, careful management, and the preservation of habitat – where wild trout live and reproduce.

Frequently Asked Questions

Is whirling disease dangerous to humans? No! It does not infect humans, only certain species of fish and the tubifex worm which serves as the intermediate host.

Is there a cure? No. Once the parasite is in a stream there is no way to remove it. However, there are things that can be done to reduce the impact of the disease, including the actions outlined in this brochure. The more that is learned about whirling disease, the better researchers, fisheries managers, and Montanans will be able to deal with it.

Is there hope, even though there is no cure? Absolutely! Montana's fisheries managers and researchers are committed to maintaining Montana's wild trout fisheries. The hope lies in the research and our knowledge of the parasite and its life cycle. Researchers are hard at work to answer these important questions.

What species of trout are susceptible to whirling disease? In Montana, the following species have been found infected with the whirling disease parasite: Rainbow, brook, bull, brown and cutthroat trout; rainbow/cutthroat hybrids; kokanee salmon; and mountain whitefish. Rainbow and cutthroat appear to be more susceptible than other trout species. Bull and brown trout appear to be resistent to the disease, but they can spread the parasite. Grayling are very resistant to infection.

Does whirling disease infection in a stream always lead to declines in fish populations? No! The impact of whirling disease has been varied across Montana, with little or no impact observed on some fisheries and moderate to severe impacts measured only in a few areas. Even then, it has not eliminated all of the rainbow trout and brown trout numbers remain unchanged.

How is whirling disease spread? The parasite that causes whirling disease can potentially be spread in several ways. A single fish can be infected with up to a million or more spores! The mature whirling disease spores, once released from the fish, are very hardy and can remain alive in mud for 30 years. Although birds, mud and water are other potential sources of whirling disease, the movement of live infected fish or infected parts of dead fish from one body of water to another remain the biggest source of whirling disease spread.

Whirling Disease Brochure

INCORPORATE THE WHIRLING DISEASE STORY INTO EXISTING CURRICULUM:

By: Josy McLean, CM Russell H.S., Great Falls

I. **Ecology**

A. Define/describe the population involved
   1. native wild trout = not introduced, naturally reproducing
   2. native species = not introduced, need to be stocked
   3. exotic wild = introduced but naturally reproducing
   4. exotic = introduced, must be stocked

--Where do we classify the following sport fish species?
Rainbow, cutthroat, brown, brook, grayling, walleye, n. pike, perch, salmon, etc.

B. Population Dynamics
   1. Mortality and Survivorship
   2. What are the different niches of different trout species?
   3. Realized niche—Where do they live in the wild?
   4. Fundamental niche—Could they live in a larger or less limited area?

--Why is the rainbow more affected than other trout species?
--What is the danger of infecting a hatchery?

C. Speciation—
   1. Biological theoretical definitions = reproduction
   2. Ecological practical definitions = geographical/behavioral isolation
   3. Recombinants between rainbow and cutthroat trout

--Do the recombinants demonstrate same levels of infection?
--What is the value of preserving the native, wild trout species?

D. Coevolution
   1. Are there any defenses present?
   2. Parasite/prey relationship

--Will the trout resolve this disease themselves?
--What will happen to parasite if host vector disappears?

E. Future of Biosphere
   1. Economic impacts
   2. Political pressures
   3. Philosophical Debates in Fisheries Management
   4. Basic Biological Knowledge

II. **Disease Transmission/Control**

A. Life Cycle
   1. poster
   2. multiple hosts/vectors

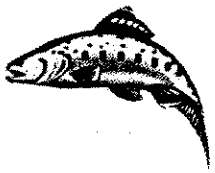
--Where are the resistant and vulnerable states in the life cycle?

B. Fish Biology
   1. health
   2. pathology
   3. disease transmission
   4. disease control

--How is fish health assessed?
--How is fish pathology diagnosed?
--How might anglers contribute to spread or control of whirling disease?

C. Fish Genetics
   1. molecular biology PCR tests

D. Water Quality



Whirling Away on the Life Cycle!

Project WET Montana

Whirling Disease Life Cycle Activity

MONTANA Wet Water Education for Teachers

Objectives:

- To demonstrate how fish can become infected with Whirling Disease.
- To demonstrate the transmittal and the effects of TAMs (infective stage of Whirling Disease) on different species of salmonids.
- To demonstrate the seasonal variations in the amount of TAMs in a river.
- To illustrate how infectious spores can be transferred to and accumulated in salmonid predators.
- To demonstrate how salmonid predators can act as vectors for spore transmission.

Grade Levels:

This activity is designed for grades 6–12. Activities for lower grades that could serve as a prerequisite to this activity include Montana fish identification, aquatic food chains, and the how diseases are transmitted.

Materials:

Montana Fish species cards
(laminated pictures of different salmonids)
Costumes for predators:
beak for osprey/eagle, bill for waterfowl, large jaws and fin for larger fish, etc.
Playing field or gym
(cones can help delineate boundaries)
TAM cards – at least 100
(can be pieces of paper, tape, velcro tags, etc.)

Background:

It is recommended that instructors use a slide series, video, posters, or guest speaker to give in-depth background on the Whirling Disease Life Cycle before engaging the students in this activity.

(Overview of Whirling Disease Life Cycle):

- Microscopic spores are found in the sediments of the river bottom.
- Bottom-dwelling Tubifex tubifex worms eat the spores.
- Within the worm, the spore becomes a Triactinomyxon (TAM).
- The TAMs are released from the worm into the water.
- Fish become infected when the microscopic TAMs cling to the fish and penetrate through pores in the skin into the nervous system of the fish.
- Inside the fish, the TAMs change form again and move into the fish's cartilage near the head where it develops into a mature spore.
- After several weeks, infected fish may have cartilage damage that causes them to exhibit a "whirling" behavior, black tails, or spinal and cranial deformities.
- When the infected fish dies and decomposes, or is eaten by a predator, the spores in its body are released into the water and the cycle starts over.

Setting the Stage:

Explain to the students that they will become different species of salmonids that are trying to survive a year in a local river. Pretend (or not) that Whirling Disease was discovered in this river and now the fish living there (students) have to survive the potential infection from the disease. To demonstrate this, the students will engage in an active learning game where they will play fish that become infected by TAMs.

ACTIVITY:

1. **Set up a 40' x 80' or larger playing field** on grass or in the gym. If playing outside, please choose a safe playing area and inspect for holes, sticks or rocks. This playing field represents a section of river that the fish live in.

2. **Give students a fish card** or assign each student to represent a fish according to the species composition of your local river or use the Upper Madison example.

NOTE:

There are two ways to delineate the number of each species to assign:

I. Follow the actual population numbers from the Upper Madison River in the Pine Butte Section that was hardest hit by Whirling Disease: To do this, simply make 75% of your students Rainbow Trout, 25% Brown Trout, and one student a Cutthroat Trout.

Pre-Whirling Disease (1990)	
Rainbow Trout	75% of fish pop.
Brown Trout	25%
Cutthroat Trout	<1%

Post-Whirling Disease (1996)	
Rainbow Trout	43%
Brown Trout	57%
Cutthroat Trout	<1%

II. Research the species of salmonid in your local river to determine the species populations and adjust your activity accordingly. This may involve including other salmonid species like Bull Trout, Lake Trout, Kokanee, Whitefish, or Grayling. The Montana Department of Fish, Wildlife, and Parks has information on fish species composition and Whirling Disease for your local river.

3. **Choose 5 students** to represent TAMs that are floating around in the "river" (the playing field between the cones) after being released from the T. tubifex worms. These TAMs will try and tag the fish as the fish are moving by in the river.

4. **Have the fish line up** on one end of the river and prepare to move to the other end and back without being tagged by the TAMs. The TAMs remain in the river and try to tag the fish. When tagged, the fish receives a small card from the TAM and keeps it throughout the game—this represents the accumulation of TAMs that have infected that fish. Instead of cards, TAMs could place tape or velcro on the fish to give a more realistic representation of how TAMs attach to fish.

5. **Play 4 rounds**, stopping between each one. Each round represents a season of the year. The TAM concentration in the water varies throughout the year, with a peak in the spring. Show this by adjusting the number of TAMs in the river as follows:

Round 1:	Spring	4 TAM students tagging the fish
Round 2:	Summer	2 TAM students
Round 3:	Fall	1 TAM student
Round 4:	Winter	4 TAM students

6. **After four rounds**, have the fish count the number of TAMs that they have collected. Different fish species have different tolerances to Whirling Disease infections. Show this by using the following chart.

   If a fish has at least the number of TAMs indicated below, then that fish has been infected with Whirling Disease. These are relative tolerances according to what is known at this time. These tolerances may change as more research is conducted...

- *Rainbow Trout*
  1 TAM or more and the student has Whirling Disease
- *Cutthroat Trout*
  3 TAMs
- *Brown Trout*
  7 TAMs
- *Kokanee*
  7 TAMs

- *Whitefish*
  7 TAMs
- *Bull Trout*
  Not found susceptible at this time: infinite # of TAMs
- *Grayling*
  Not found susceptible at this time: infinite # of TAMs
- *Lake Trout*
  Not found susceptible at this time: infinite # of TAMs

7. **Prepare to play one final round.** Explain that the fish who have been infected with Whirling Disease must follow the instructions for limitations below during this final round. Fish that are not infected (have not received the minimum number of TAMs), do not have to show the following limitations.

   In the final round, simulate an infected fish and its possible symptoms by:

a. **Lesser infection:** *Hop on 1 foot* if your fish has enough TAMs to become infected according to the previous fish species chart; *but less than 10 total TAMs.*

b. **Acute infection:** *Whirl continuously* if you have more than 10 TAMs and your fish species is susceptible to whirling disease according to the previous fish species chart.

   Final round: introduce salmonid predators (osprey, eagle, otter, larger fish, merganser, etc.) Have the TAMs become the predators, and give them costumes so they can act out their parts. These predators will prey on the fish as the fish move from one end of the river and back. When the predator tags a fish, the predator inherits the TAM cards and continues to collect them from all of the fish that the predator kills. **These TAMs have matured into spores inside the cartilage of the fish, so the predator is accumulating Whirling Disease spores.**

   Have the killed fish stand off to the side after they are tagged by a predator. **Remember that the fish who are infected with Whirling Disease must "hop" or "whirl" as they move through the river!**

Adaptations and Extensions:

1. To show how fish can adapt to whirling disease through "life history" adaptations (some species emerge in early spring, some in late spring, summer, etc), have the:

   Rainbows start in the spring round
   Cutthroats start in the summer
   Browns start in the late winter (spawn in fall)

2. To simulate the lessening vulnerability to whirling disease as fish grow and cartilage hardens into bone (ossifies):

   Choose a few students to be fish that fit in many age classes: 1 year; 5 years; 7 years. These fish (older than 9 months) can carry whirling disease spores, but usually do not show symptoms of infection because their cartilage has ossified into bone.

3. Infected fish still need to eat, so have the students pick up food tokens in the final round, while predators are trying to eat them, or remove the predators altogether.

4. A strong stream current *may* be a factor in infected fish mortality, simulate this by having the students run through a jumprope as it twirls in the final round. Those fish that are touched by the rope are dead. This should eliminate most of the infected fish.

Assessment & Summary Questions

1. ***Ask how many of the preyed-upon fish were "whirling".***

   In reality, whirling fish do not live long as they are easy prey and are rarely seen in the wild, so most of the infected fish should have been preyed upon.

a. *Which fish species was most susceptible to Whirling Disease?*

b. *Which was least susceptible?*

c. *If you used the example of the Upper Madison, did your final surviving population numbers coincide with the actual population numbers after the Whirling Disease outbreak?*

2. Have the predators count the number of Spore (formerly TAM) cards they have collected from the infected fish.

   a. *What happens to the spores once they enter the predator?*

      (predators can act as a vector to help spread the disease via feces, carrying the bones to another river, or possibly becoming infected themselves in the case of a predacious fish.)

   b. *How can these predators transmit Whirling Disease?*

   c. *Explain the life cycle of the Whirling Disease parasite.*

   d. *What other information is needed to fully understand Whirling Disease?*

   e. *How can you help stop the spread of Whirling Disease?*

3. *Is this activity an accurate representation of how Whirling Disease infection occurs and how it can be spread?*

   (Generally yes, with a few exceptions:)

   a. TAMs are floating freely and not actively pursuing fish to attach to;

   b. Rarely are "whirling" fish seen in the wild as they are preyed upon so readily. A better representation of infected wild fish would be fish with black tails or deformities;

   c. Little is known about the actual "tolerance" of some salmonid species to TAM infection, so these relative tolerances are an estimate based upon early research.

   d. There is much that researchers do not know about Whirling Disease, but many research projects are underway. As new information becomes available, some of the assumptions in this activity may be invalidated.

FOR MORE INFORMATION ON WHIRLING DISEASE, PLEASE CONTACT THE FOLLOWING:

- Your local **Montana Fish, Wildlife and Parks** office,
- **The Whirling Disease Task Force** (406) 449-2196 or visit their web site at www.whirlingdisease.org
- **The Whirling Disease Foundation** (406) 585-0686.
- For information on educational activities and materials for teaching about Whirling Disease, please contact John Etgen, **Project WET Montana** Coordinator, (406) 994-6425 or email: jetgen@montana.campus.mci.net

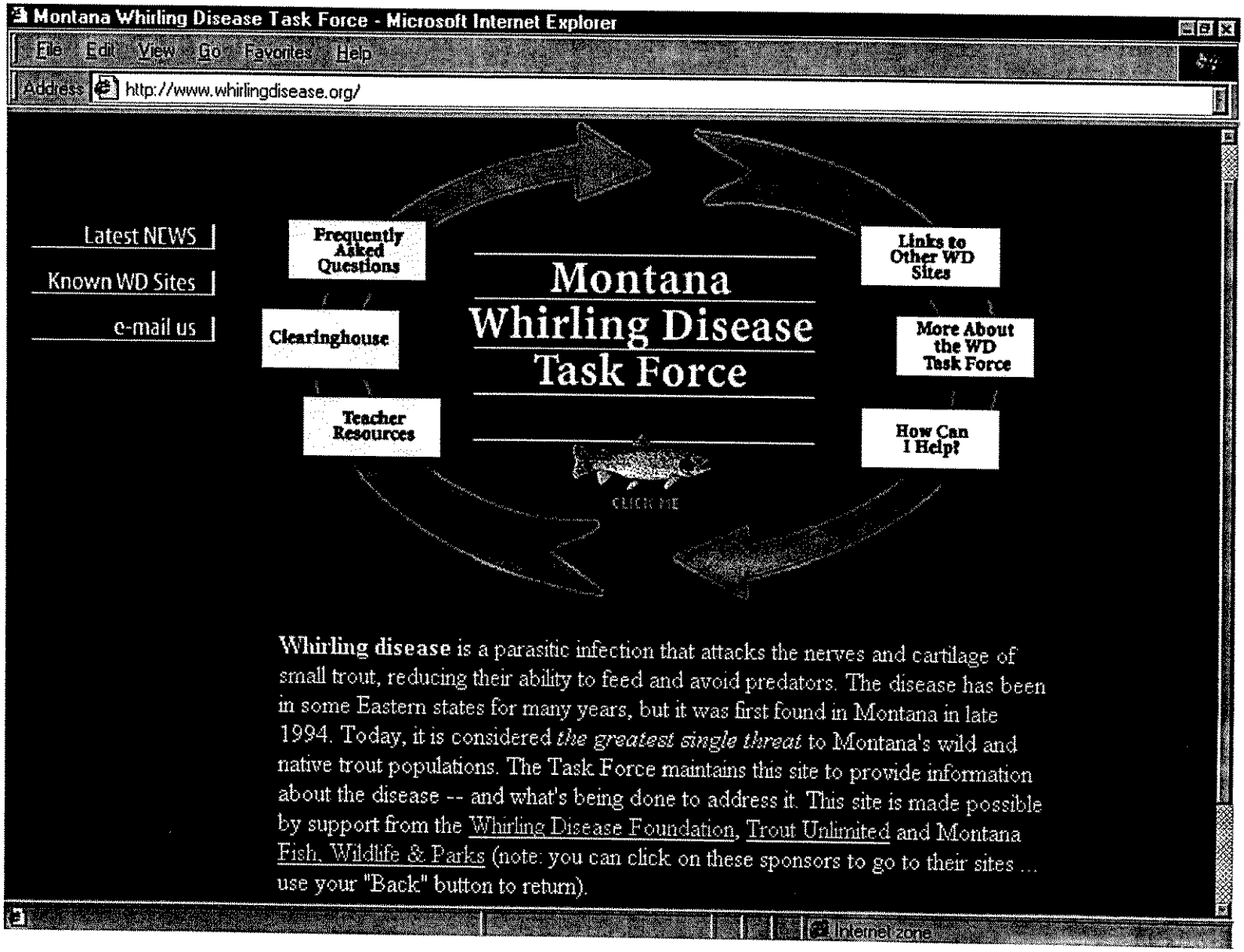
This activity was developed in April, 1997 by John Etgen, Coordinator of Project WET Montana of the Montana Watercourse, with the help of members of the Whirling Disease Task Force Education Subcommittee.

Appendix 9
Task Force Internet Site

The Task Force's web site is available on the Internet at

http://www.whirlingdisease.org

The opening screen of the website is shown on the following page.



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