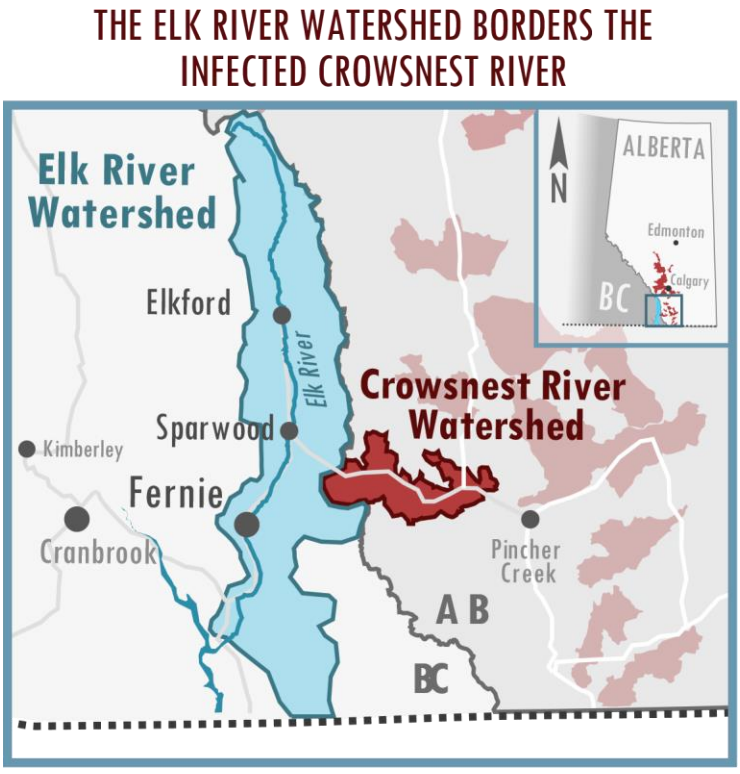
WHAT TO KNOW ABOUT WHIRLING DISEASE

Elk River Alliance 2022

WHAT IS "WHIRLING DISEASE"?

Whirling disease affects salmonid fish (e.g., trout, salmon, whitefish) that get infected by a tiny parasite called *Myxobolus cerebralis*. The parasite relies on two essential intermediate hosts: salmonid fish (like trout), and the "boogie worm" *Tubifex tubifex*. Infected young fish often develop skeletal deformities resulting in a 'kinked' spine that makes the fish swim in a circular "whirling" pattern. While whirling disease does not affect humans, it impacts fish survival rates and leads to significant population declines.

RISK TO THE ELK RIVER WATERSHED



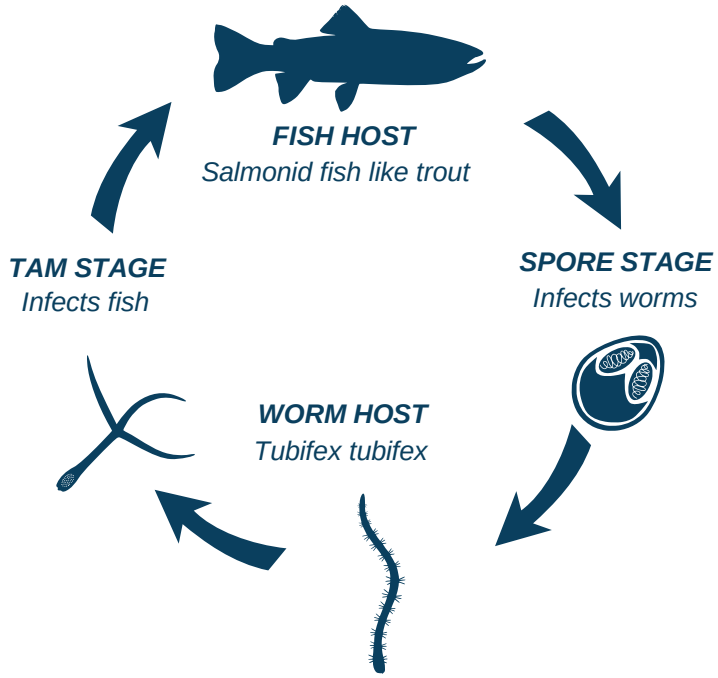
Originally from Europe, *M. cerebralis* was first detected in Pennsylvania (US) in 1958, and in 2016 it was found in Banff National Park's Johnson Lake. Over the following five years infected fish were found in many Albertan watersheds, including the Crowsnest River. Whirling Disease has not yet been detected in British Columbia, but the Crowsnest River is a mere 15-minute drive from the Elk River Watershed in BC; a careless transfer of wet boating, fishing, or wading equipment could easily cause disease transmission. Additionally, in 2020 the Elk River Alliance detected DNA presence of the *Tubifex tubifex* worm in the Elk River Watershed,

meaning both essential *M. cerebralis* hosts are present. Over the next two years the Elk River Alliance will continue monitoring tributary streams for Tubifex worm presence to assess the risk of whirling disease establishment.

Once established, getting rid of Whirling Disease is impossible as there are no known treatments. The Westslope Cutthroat Trout and Mountain Whitefish, two target fish that support a thriving $30M fishing tourism industry in the Elk Valley, have a high risk of being infected and suffering population declines. All downstream watersheds, such as the Kootenay River and Columbia River, will have a higher risk of transmission. *It is up to all users of the Elk River Watershed to ensure transmission is prevented.*

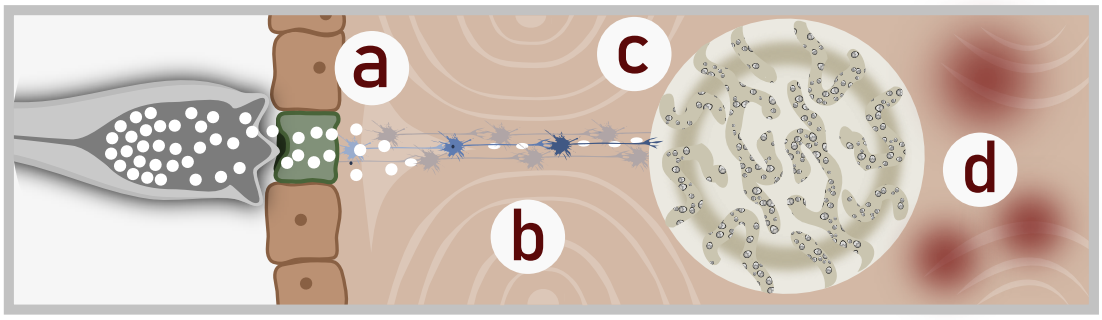
BIOLOGY AND LIFECYCLE OF *M. CEREBRALIS*

M. cerebralis is a relative of corals, anemones, and jellyfish (Phylum: Cnidaria). It has two life stages: the **spore stage** and the **triactinomyxon (TAM)** stage. These stages switch between infecting the *Tubifex tubifex* worm and salmonid fish. While TAMs are fairly fragile, myxospores can survive adverse environmental conditions such as high temperatures, low pH, digestive enzymes, and freezing.



Lifecycle stages:

1. Tiny 0.009 mm *M. cerebralis* spores in the water column get eaten by the *Tubifex tubifex* worm
2. The spores open in the worm gut, and release cells that develop into a 0.2 mm Triactinomyxon (TAM)
3. The TAMs exit the worm along with faecal matter, and float in the water column



4. TAMs attach to the skin of salmonid fish (a), and within one minute inject a sporoplasm (a sac-like structure containing 64 cells) into the fish skin through fish mucous cells.
5. Over the next two weeks, the cells migrate along the nervous system to the cartilage along the skeletal system (b)
6. Over the next 80 days, the parasite develops and feeds on the cartilage of the fish (c), inducing inflammation (d). This degrades and deforms the fish skeletal system, which causes the whirling behaviour. Additionally, inflammation of nerves that are responsible for pigment deposition causes a blackened tail.
7. The parasites mature into myxospores and are released into the water column when the fish dies.

KNOWING THE SIGNS: SYMPTOMS OF WHIRLING DISEASE

While not all fish develop symptoms, the most severe cases lead to a kinked spine, blackened tail, a whirling behaviour, skeletal deformities, and death.

Skeletal deformity | A kinked tail and truncated misshapen skull are key indicators of whirling disease infection. As *M. cerebralis* develops within salmonid fish, it feeds on cartilaginous tissue. This not only deforms and weakens the cartilage but induces an inflammatory response from the fish immune system. The inflammation causes constriction of the spinal cord, which results in a bent tail shape.

Whirling Behaviour | The namesake of “whirling” disease comes from the erratic swimming behaviour fish develop after infection. Deformities in the spine and brainstem of the fish prevent it from controlling the swimming direction. This behaviour not only exhausts the fish but makes it more visible to predators and less capable of escape.

Black Tail | Inflammation of the tissues surrounding cartilage puts pressure on the nervous cells responsible for pigmentation of fish skin, inducing high pigmentation and a black tail.

Death | Fish can die directly from whirling disease degrading their body, or by incidental consequences of whirling disease. Because of the weakened and deformed skeletal system, infected fish have a decreased ability to find food and escape predators. This greatly decreases their chance of survival.

DETERMINANTS OF DISEASE SEVERITY

Although *M. cerebralis* presence or even infection does not mean fish will show symptomatic signs, in some cases infection results in 90% mortality of young fish. Infection severity is determined by: fish age, fish species, temperature, and the extent of *M. cerebralis* TAM exposure.

Age | Age is perhaps the most important factor when determining salmonid disease risk. While fish eggs are not susceptible to infection, immediately after hatching fish are at very high risk of serious infection. In one experiment, a group of 2-day old alevin that were exposed to 100 TAMs contained over 40,000 spores two months later and suffered a 91% mortality rate. Even 7-week-old juvenile Rainbow trout (one of the most susceptible species) exposed to TAMs showed clinical signs of infection and increased mortality rate. One of the reasons young fish are thought to be more prone to infection is that a greater proportion of their skeleton is made of cartilage, rather than bone. Older fish, despite not showing symptoms, may still act as a disease carriers.

Species | So far, only salmonid fish are known to be susceptible to whirling disease infection, and not all salmonids are equally at risk. Some salmonid fish have not yet been recorded to develop symptoms and are thus considered more resistant to whirling disease. Conversely, rainbow trout/steelhead salmon (*Oncorhynchus mykiss*) are highly susceptible and readily show clinical signs of infection even when exposed to a low parasite load. What determines each species’ susceptibility to whirling disease is so far not known, but genetic differences in an ability to mount an effective immune response seems to be a likely factor. This effect can even be seen within different strains of the same species. German rainbow trout, for instance, are considerably more resistant to infection than US rainbow trout because they have had over a century of exposure to whirling disease.

Temperature | Studies show that temperature is a key determinant of *M. cerebralis* development. Within *Tubifex tubifex*, temperatures of 10-15C result in the highest production of TAMs, and salmon infected at 10-12C develop the most severe symptoms. Unfortunately, these are similar temperatures to those the Elk River Alliance measures in key salmonid spawning habitat during early summer, when salmon eggs hatch into alevins and are most susceptible to severe infection.

Parasite load | As with many diseases, more infective agents result in a greater risk of symptomatic infection. While as few as 10 TAMs can cause symptomatic disease in some species, high TAM numbers can cause infection of juvenile fish even in less susceptible species. Because of this, a *slowed* introduction of whirling disease could be effective in preventing extreme fish population decline.

WIDE SCALE EFFECTS OF WHIRLING DISEASE

Drastic population declines of trout species have been attributed to whirling disease in many streams. In some rivers in Colorado, trout declines exceeded 90% of the population in less than two decades since disease detection. Since not all trout species are equally susceptible to infection, the disproportionate impact on one trout species could result in a change of the species present in rivers. Of fish found in the Elk River, the partially resistant Bull Trout could be less impacted than the susceptible Westslope Cutthroat Trout and Mountain Whitefish (see Sarker et al., 2015). Additionally, cumulative effects from many factors acting in combination with whirling disease could increase the chance of population declines. In the Elk Valley, various land uses and recreation activities already impact fish habitat, so the addition of whirling disease could act as “the straw that breaks the trout’s back”. Fish hatcheries are also concerned as infection can require fish quarantine and spread necessitates discarding entire hatchery stocks.

CAUSES OF SPREAD AND PREVENTION MEASURES

Although whirling disease can spread naturally through fish movement or bird faeces, a major cause of spread is human activity. Because there are known treatments for whirling disease, the main preventative method is not exposing fish to *M. cerebralis* in the first place. A single fish can contain thousands of spores, so it is essential that live fish or fish parts do not get transferred between streams. As recreational river users move from one stream to another, there is a considerable risk of picking up *M. cerebralis* spores and transferring them on boats or fishing equipment. To prevent “hitchhiker” invasions, the best-practice method recommended by the Province of British Columbia is to **Clean, Drain, and Dry** all your equipment. Studies have shown that drying even the resilient spore stage significantly reduces the infectious ability of *M. cerebralis*.

Recommendation from the BC Government:

CLEAN | thoroughly inspect boat (hull, drive units, trim plates, transducers), trailer and components (rollers, bunk boards, axles, etc.), equipment (i.e., water pumps, hatchery

equipment, siphons, nets, ropes, traps, etc.) and remove any mud, dirt, plants or aquatic species. Some aquatic invasive species are very small such as New Zealand mud snails and can be found in small amounts of mud or dirt. Pay attention to hidden, hard to reach areas, gaps, crevices, holes and other inconspicuous places (i.e., around the motor housing, trim tabs, and water intake screens, or pump fittings).

DRAIN | whenever possible, areas that hold water should be drained so there is no standing water. Eliminate water from any conceivable item before you leave the visiting area. This includes live wells, bilges, cargo areas, pipes, water pumps, etc.

DRY | dry all areas of the vessel that may have gotten wet. Drying boats, gear and equipment will help to minimize risk of contamination.

To learn more about Government of BC clean drain dry please visit
https://www2.gov.bc.ca/gov/content/invasive-mussels/what-can-you-do

IF YOU FIND A FISH YOU SUSPECT OF WHIRLING DISEASE INFECTION

Report it to the Elk River Alliance. Include a photo, your location, and the fish species (if you can)

info@elkriveralliance.ca

PROJECT FUNDERS

Columbia Basin trust

Freshwater Fisheries Society of BC

Further Reading

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