**Scientific name:** *Myxobolus cerebralis*

**Common name:** Whirling disease

### Alaska invasion/introduction history

Whirling disease was first detected in 2006 in rainbow trout at the Elmendorf fish hatchery (Arsan et al. 2007). Salmonid fish (such as rainbow trout) are one of the two obligate hosts that Myxobolus cerebralis alternates between, the other host being an oligochaete worm (*Tubifex tubifex*, certain mitochondrial lineages are more susceptible; Arsan and Bartholomew 2008).

### Ranking Summary

<table>
<thead>
<tr>
<th>Ranking Summary</th>
<th>Potential Max</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>Biological Characteristics</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Ecological Impact</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Feasibility of Control</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>78</strong></td>
</tr>
<tr>
<td><strong>Invasiveness (out of 100)</strong></td>
<td>78</td>
<td>Highly invasive</td>
</tr>
</tbody>
</table>

### Distribution

**Current global distribution (0-10)**

Whirling disease is widespread, with occurrences in North America, South America, Europe, Asia, and island countries, such as Japan and New Zealand (Bartholomew and Reno 2002).

**Extent of the species US range and/or occurrence of formal state or provincial listings (0-10)**

Whirling disease is invasive in 25 states (Bartholomew and Reno 2002).

**Role of anthropogenic and natural disturbance in establishment (0-5)**

Prior to 1990, whirling disease was primarily a problem in hatcheries (Gilbert and Granath 2003); however, whirling disease is now found in natural areas.

**Climatic similarity between site of origin and release (0-5)**

TAM release may be delayed at colder temperatures, but is not reduced in magnitude. In Colorado, TAM release peaks have been documented in the late-fall to early winter in a stream where the primary or sole salmonid host present was brown trout. Myxospores were washed downstream by spring snow-melt in April - June and settled onto sedimanted eddies containing worms in April - June. TAM release can be virtually non-existent during the warm months of summer and early fall, then begins to pick up in late October, early November, peaks during December-January (under ice cover) and then subsides to non-detectible levels in March-April as spring warm-up occurs (B. Nehring pers comm.). Additionally, Nehring (2010) found there is no elevation or thermal barrier prohibiting the establishment of whirling disease in Colorado, with both hosts occurring in cold high elevation streams (Nehring 2010), meaning it could likely establish in Alaska (B. Nehring pers comm.).

**Total for distribution** 27/30

### Biological Characteristics and Dispersal

**Invasive elsewhere (0-5)**

Whirling disease is invasive throughout the United States and in Africa, Asia, New Zealand, Japan, South America, and parts of Europe (Bartholomew and Reno 2002).

**Dietary specialization (0-5)**

Whirling disease alternates between living in two obligate hosts, salmonid fish and oligochaete worms, in two spore stages. The myxospore stage of the life cycle is dependent on an oligochaete worms for nutrients, the worm then releases the triactinomyxon (TAM) stage, which enters the salmonid fish and feeds on the cartilage (El-Matbouli et al. 1995).

**Habitat specialization (0-5)**

Since whirling disease is dependant on two hosts, a salmonid fish and an aquatic oligochaete worm (*Tubifex tubifex*), suitable habitat is where there is spatial temporal overlap of the hosts (Arsan and Bartholomew 2008). Upon initial survey of southeast and southcentral Alaska, the probability of finding areas with abundant oligochaetes of the susceptible lineage and rainbow trout (more susceptible to infection than other salmonids) are low (Bartholomew and Reno 2008). However, the lack of *T. tubifex* worm sampling in Alaska does not mean they do not occur, and if *T. tubifex* worms are present, there is likely an abundant amount of habitat available in salmonid spawning streams.

**Average number of reproductive events per adult female per year (0-5)**

In laboratory experiments, ingestion of 50 myxospores/worm results in 1 million to 20 million TAMs produced over a 200 - 230 day release period.
Scientific name: Myxobolus cerebralis

Common name: Whirling disease

Impact on natural community composition (0-10)
As stated above, the ecological impacts of whirling disease are highly variable. The parasite has the potential to alter fish communities by reducing trout (and other salmonid) abundance, which could in turn alter food chains for species dependent on and preyed upon by those salmonids (Elwell et al. 2009).

Impact on natural ecosystem processes (0-10)
The impacts of whirling disease on ecosystem processes not fully understood, but this species has the potential to change nutrient cycling. In Yellowstone National Park, cutthroat trout populations and spawning runs have been greatly reduced from historical numbers (B. Nehring pers comm.), this in turn can impact nutrient input and cycling in the stream and surrounding areas.

Total for ecological impact 24/30

<table>
<thead>
<tr>
<th>Feasibility of control</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of populations in Alaska (0-3)</td>
<td>1</td>
</tr>
<tr>
<td>Whirling disease has only been detected at the Elmendorf fish hatchery near Anchorage (Arsan et al. 2007).</td>
<td></td>
</tr>
<tr>
<td>Significance of the natural area(s) and native species threatened (0-3)</td>
<td>3</td>
</tr>
<tr>
<td>The impact of whirling disease on salmonids is variable, with the potential to cause declines in native salmonid populations (especially rainbow trout). In Alaska, rainbow trout are a highly valued sport fish, that occur naturally and some regions have supplemental stocking (Dean 1994). Declines in rainbow trout could cause economic loss due to a reduction in anglers and a waste of hatchery effort to raise and stock fish that may become infected. If other salmonid species become infected the economic and conservation loss would be even greater.</td>
<td></td>
</tr>
<tr>
<td>General management difficulty (0-4)</td>
<td>3</td>
</tr>
</tbody>
</table>
| Since whirling disease is not widespread in Alaska, and the single reported case has been in a hatchery, management and prevention of future whirling disease introduction can be accomplished with moderate effort. More sampling is necessary to make sure whirling disease is actually absent for the rest of the state. Improvement to hatchery facilities, such as converting earthen-bottomed ponds and raceways to

once TAM maturation (1,000 degree-days post-ingestion) has occurred. Likewise, a dosage of 100 TAMs (which is very low in the natural environment) for a susceptible salmonid fry will result in a cranial myxospore concentration of 100,000 - 1,000,000 myxospores once the parasite life cycle has run its course (B. Nehring pers comm.).

Potential to be spread by human activities (0-5) 3
Humans can spread whirling disease through importation of frozen fish (speculated pathway for initial introduction into U.S.; Hoffman 1962), use of contaminated fish heads as bait, attachment and transfer on recreational equipment (e.g. waders), and stocking of infected salmonid fish and contaminated water (Arsan and Bartholomew 2008).

Innate potential for long distance dispersal (0-5) 3
Spores can naturally disperse in water, even traveling through interdrainage canals and underground springs (Wilson 2006). Rainbow trout can spread whirling disease; however, trout typically do not migrate long distances (Morrow 1980). Other salmonid fish (including steelhead, the anadromous form of rainbow trout) can be infected, spreading whirling disease greater distances during migration (Arsan and Bartholomew 2008).

Total for biological characteristics 20/30

<table>
<thead>
<tr>
<th>Ecological Impact</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on population dynamics of other species (0-10)</td>
<td>10</td>
</tr>
<tr>
<td>The impacts of whirling disease on other organisms is highly variable, with negligible changes in native salmonid abundance seen in the eastern United States to severe declines in native trout in Colorado, Wyoming, and Montana (Elwell et al. 2009). Whirling disease causes mortality in salmonids (especially young fish) by concentrating in the head and spinal cartilage which causes abnormal swimming behavior, and difficulty feeding and avoiding predators (Elwell et al. 2009). The effect of whirling disease on oligochaete populations is unclear, but possibly detrimental, as infected worms often have circular areas of discoloration in the intestines (Gilbert and Granath 2003).</td>
<td></td>
</tr>
</tbody>
</table>
Scientific name: *Myxobolus cerebralis*

Concrete (Markiw 1992) and switching from a surface water to a groundwater sources, would help prevent whirling disease spread. If the parasite spreads to lakes, stocking of larger fish can reduce spore counts (Ryce et al. 2004). However, prevention of whirling disease spread to natural areas through public education and stocking only disease free fish is often the most cost efficient method to control whirling disease (Elwell et al. 2009).

**Total for feasibility of control** 7 / 10

**References**


**Common name: Whirling disease**


Federal Aid Project F-237R-17, Fort Collins, CO.


**Acknowledgements**

Authors: K. M. Walton and T. A. Gotthardt, Alaska Natural Heritage Program, University of Alaska Anchorage.

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