



SCIENCE ADVICE FROM A RISK ASSESSMENT OF YELLOW PERCH (*Perca flavescens*) IN BRITISH COLUMBIA



Yellow Perch (Perca flavescens) Image courtesy of the New York State Department of Environmental Conservation, Albany NY.

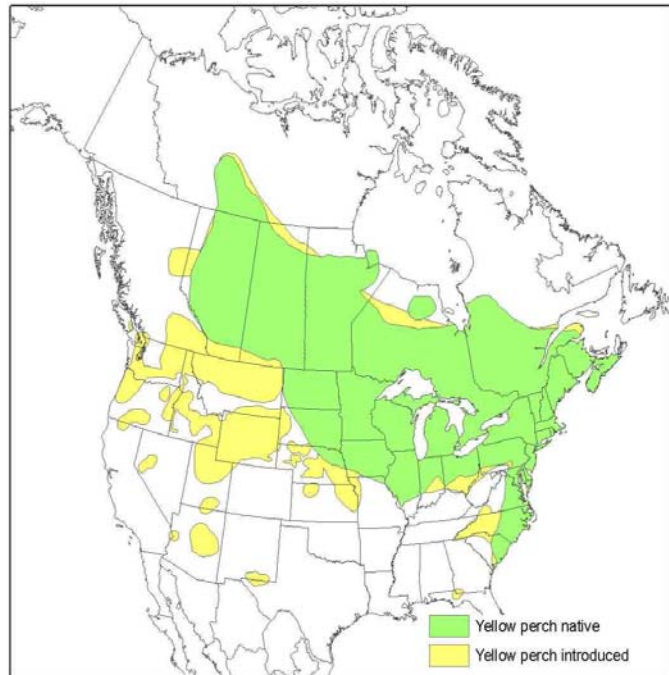


Figure 1. Native and introduced range of Yellow Perch in North America from Brown et al. (2009).

Context :

Yellow Perch is native to the freshwaters of North America but is non-indigenous in British Columbia. Its native range covers most of Alberta and continues east through Nova Scotia (Figure 1). It has been introduced in British Columbia and the states bordering it to the south largely due to unauthorized introductions, but, also through authorized stocking efforts in the past. Yellow Perch is a small- to moderately-sized, shallow water species with a diverse diet that includes zooplankton, benthic invertebrates, and small fishes. It is a highly adaptable species that can utilize a wide range of habitats and concerns have been raised about its impacts on British Columbia's aquatic ecosystems.

The establishment of populations of non-indigenous aquatic species may pose a substantial threat to native fishes and other components of aquatic ecosystems. Concern raised by fisheries managers regarding potential impact of Yellow Perch on salmonid populations in British Columbia initiated a national risk assessment of Yellow Perch in British Columbia. Fisheries and Oceans Canada's (DFO's) Centre of Expertise for Aquatic Risk Assessment (CEARA) coordinated the risk assessment and provided guidance on its completion. The risk assessment provides science-based guidance to resource managers for the development of management options necessary to deal with the expanding range of Yellow Perch.

The assessment was undertaken with the aid of an extensive literature search and the use of

environmental niche modelling to predict the potential range of Yellow Perch in British Columbia. The draft risk assessment research document was peer reviewed March 4-6, 2008 at Richmond, British Columbia according to Canadian Science Advisory Secretariat (CSAS) peer-review guidelines.

SUMMARY

- Yellow Perch is not native to British Columbia. Introduced populations have established in watersheds surrounding British Columbia and Yellow Perch has been found in waterbodies within British Columbia.
- A risk assessment was conducted to estimate the threat posed to British Columbia's aquatic ecosystems by the introduction of Yellow Perch. The risk assessment addressed the likelihood of introduction (arrival, survival, reproduction and spread) as well as the ecological consequences to the native biodiversity and ecosystem functioning should Yellow Perch become established. The risk assessment also assessed the threat posed by Yellow Perch as vectors for diseases and parasites.
- The likelihood of survival, reproduction and spread was considered moderate to very high with a moderate to high uncertainty in all watersheds assessed.
- The ecological impact was considered to be very high with low uncertainty in small waterbodies (<1000 ha) and moderate with high uncertainty in large waterbodies. The risk of genetic consequence was considered very low with low uncertainty.
- The ecological impacts, caused by introduction of parasites and diseases with Yellow Perch, were determined to be low with very high uncertainty.
- The scale of this risk assessment is large. If risk posed to a specific waterbody is required, the details of that waterbody need to be evaluated to determine its specific risk.

BACKGROUND

Aquatic invasive species (AIS) are non-indigenous species that have an impact on the ecosystems in which they are introduced. These impacts include severe reductions or extirpations of native species, reductions in the abundance or productivity of sport, commercial or culturally important species and habitat alterations. While recent intercontinental introductions have attracted much attention, movements of fish species within the continent have a long history. These introductions have expanded the range of many species and contributed to a trend of homogenization of fish fauna in both the United States and Canada. Beginning in the mid-1800s fishes were transported west to satisfy demands by settlers for fishes that they had become familiar with in the east. Additionally, water development projects in the west created reservoirs that were stocked to provide fishing opportunities. Only in the past 20 years has a more conservative approach to introductions been taken including the outright opposition to any non-indigenous species being introduced.

The Canadian Action Plan to Address the Threat of Aquatic Invasive Species, was approved by the Canadian Council of Fisheries and Aquaculture Ministers in 2004 (CCFAM 2004), and outlines a national approach for managing AIS. One of the strategies developed to address threats posed by potential and existing AIS is risk assessment. Fisheries and Ocean Canada's (DFO's) Centre of Expertise for Aquatic Risk Assessment (CEARA) was created to develop a standardized approach for assessing risk posed by potential AIS. CEARA has developed draft guidelines for a biological risk assessment that include the evaluation of all stages of introduction (arrival, survival, establishment and spread) and the impacts made to the invaded

ecosystem should the evaluated AIS become widely established (Mandrak et al., National Detailed Level Risk Assessment Guidelines: Assessing the Biological Risk of Aquatic Invasive Species. Unpubl. manusc.¹). Completed risk assessments should be used by ecosystem managers to identify potential AIS, focus on species that pose the highest risk, and to develop management strategies that will result in prevention of the greatest harm.

CEARA initiated a risk assessment of Yellow Perch (*Perca flavescens*) in British Columbia at the request of fisheries managers. The draft risk assessment was peer reviewed according to CSAS guidelines at a meeting in Richmond BC, March 4-6, 2008 and discussions from the workshop were published in a proceedings document (DFO 2010). The resulting risk assessment was published by Bradford *et al.* (2008).

RISK ASSESSMENT

Biology

Yellow Perch is a small- to medium-sized member of the Percidae family, often distinguished by its yellow or brassy colour and the dark vertical stripes on the body. Females mature at 3-4 years of age and males at 2-3 years and maximum age is usually 9-10 years. Reproduction occurs once per year in spring when water temperatures rise above 7°C. Yellow Perch spawns in schools using shallow areas with little current; no nest or redd is constructed. Females are very fecund and can produce 20,000 -150,000 eggs that are released into its preferred habitat of aquatic macrophytes and submerged woody vegetation in shallow areas of the lake. Small larvae appear 1-4 weeks after spawning and feed on zooplankton. They switch their diet to benthic invertebrates then to smaller fishes as they grow. Adult Yellow Perch diet is diverse and can include zooplankton, benthic invertebrates and small fishes. Yellow Perch is considered a forage fish as it is a favourite prey item of bass, Walleye and other piscivorous species. It is not a favoured diet item of salmonids, which tend not prey on spiny-rayed fishes.

Habitat

Yellow Perch inhabit both small and large lakes, slow moving rivers and even brackish waters. Abundance is highest in lakes with clear warm waters and Yellow Perch is usually associated with aquatic plants at depths of 1-10 m. Adult movements within a waterbody are generally limited to an apparent home range. Larval perch initially inhabit the offshore waters but move inshore at 2-3 cm length to be near vegetation. Yellow Perch has a wide range of environmental tolerances as indicated by its wide distribution across North America. Upper thermal limits of 25-30°C have been proposed and presence in the northern prairies indicates that it is capable of surviving long winters.

Parasites

Yellow Perch can be infected with a wide variety of parasites including broad tapeworm which can be transmitted to humans through ingestion of raw fish flesh. In the Great Lakes, it is also a

¹ June 3-5, 2008 national advisory meeting on National Guidelines for Assessing the Biological Risk of Aquatic Invasive Species.

host for a non-indigenous microspoidian (*Heterosporis* sp.). *Heterosporis* has no effect on humans but degrades quality of fish flesh. Another exotic parasite, *Neoergasilus japonicus*, was found on Yellow Perch in Lake Huron in 1994. This parasite can swim well, survive on a number of host species and appears to have dispersed across Europe in 20 years and into North America in 10 years. The ecological effects of *N. japonicus* are currently unknown, but it appears to reduce growth in some species of fish.

Distribution

Yellow Perch is native to North America and covers a wide region of the continent (Figure 1). It has been introduced to waterbodies in the western United States adjacent to the British Columbia border. It is present in 78 waterbodies in five of eight regions in British Columbia (Figure 2).

A Genetic Algorithm for Rule-set Predictions (GARP) ecosystem model was used to determine the potential range available for expansion based on current known distribution (Figure 3).

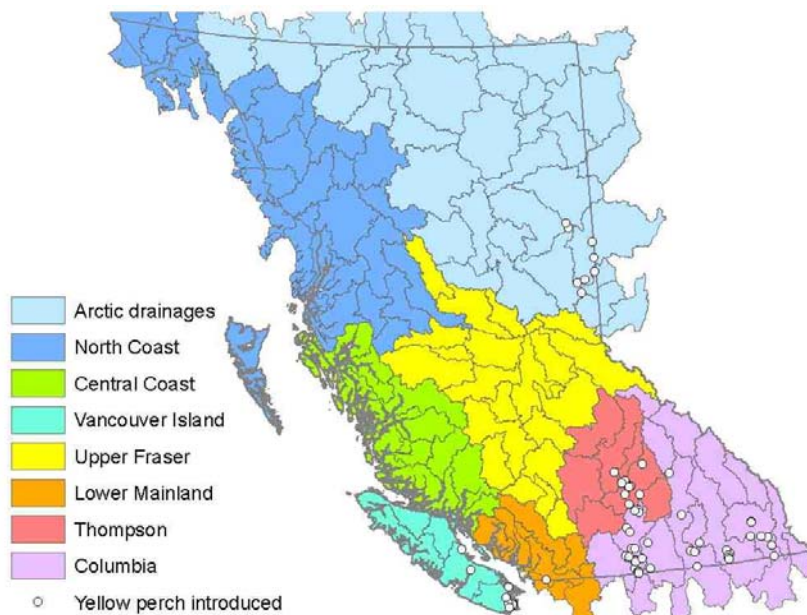


Figure 2. Distribution of known (confirmed) occurrences of Yellow Perch in British Columbia in the regions evaluated (from Bradford et al. 2008).

Potential Vectors of Spread

Yellow Perch is located in five regions of British Columbia and can spread by natural means through connecting waterways. Adults are not migratory, although migratory behaviour has been seen in some populations. Upstream movements have been observed in cases where conditions permitted. Downstream spread may be the result of drift of larvae or small juveniles from an upstream source population. The main expansion of range in North America was through deliberate human introductions. Although authorized introductions have ceased, unauthorized releases are still likely.

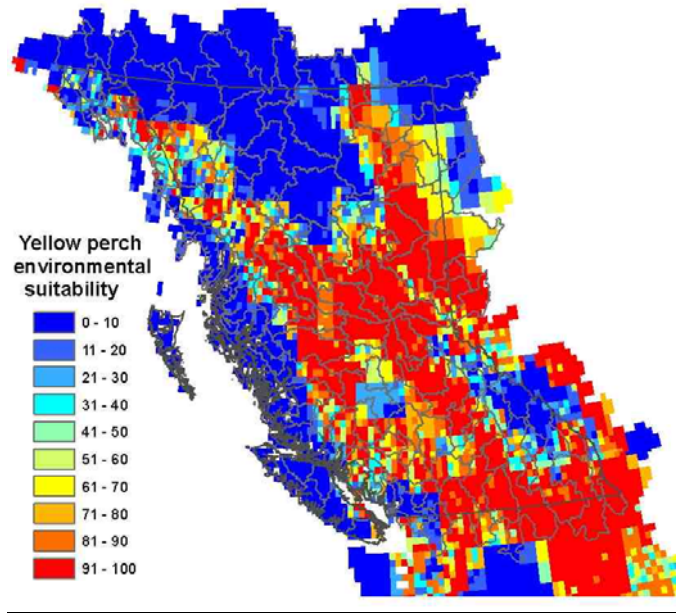


Figure 3. Environmental niche modeling results for the Yellow Perch in British Columbia. Areas with higher scores have environmental conditions predicted to be more suitable for Yellow Perch populations. (from Bradford et al. 2008).

Risk Posed to Watersheds of British Columbia

Based on the biology of Yellow Perch and its potential vectors of introduction, a risk assessment was undertaken. The risk assessment evaluated the likelihood of arrival, survival, establishment, and spread of Yellow Perch in British Columbia. Next, ecological consequences of widespread introduction were predicted. The risk assessment is summarized using a risk matrix, which combines the probability of establishment with ecological consequences. Resulting estimates of overall levels of risk are given below. Ecological risk is given in Table 1, genetic risk is given in Table 2, and risk posed by pathogens, parasites and fellow travellers is summarized in Table 3.

Table 1. Matrix for determining overall ecological risk posed by Yellow Perch, where green indicates low risk, yellow indicates moderate risk, and red represents the conditions for a high risk designation, with regions of similar risk grouped together. Dashed lines are for small waterbodies, solid lines are for large lakes and rivers (from Bradford et al. 2008).

Ecological Consequences	Very High			AR	VI, LM, FR, CO, CC, NC	TH
	High					
	Medium			AR	VI, LM, FR, CO, CC, NC	TH
	Low					
	Very Low					
		Rare	Low	Moderate	High	Very High
Probability of Widespread Establishment						

*AR-Arctic Region, VI-Vancouver Island, FR-Fraser River, LM-Lower Mainland, CO-Columbia River, TH-Thompson River, CC- Central Coast, NC – North Coast

Table 2: Similar to Table 1, except for genetic risk (from Bradford et al. 2008).

Genetic Consequences	Very High					
	High					
	Medium					
	Low					
	Very Low			AR	VI, LM, FR, CO, CN	TH
		Rare	Low	Moderate	High	Very High
Probability of Widespread Establishment						

Table 3: Matrix for determining overall risk posed by pathogens, parasites and fellow travelers of Yellow Perch. The ellipse represents the overall risk associated with the combined effects of establishment and genetic and ecological consequences (from Bradford et al. 2008).

Consequences of parasites or pathogens	Very High					
	High					
	Medium					
	Low					
	Very Low				All regions	
		Rare	Low	Moderate	High	Very High
Probability of widespread establishment						

Considerations Regarding Arrival, Survival and Establishment

- Yellow Perch populations are confirmed in 78 waterbodies in five of eight regions in British Columbia.
- GARP modeling predicted suitable habitat in over 50% of the province based on environmental characteristics of locations with existing populations (Figure 3).
- Yellow Perch introductions are usually successful and records of failed introductions are difficult to find.
- Yellow Perch diet is varied and it can spawn over a variety of substrates; this increases the likelihood of introduced fish finding food and suitable habitat in new locations.

Considerations Regarding Spread

- Yellow Perch is able to disperse within a watershed by the passive downstream dispersal of larva.
- As some populations exhibit migratory behavior, natural upstream movement is possible if suitable conditions exist.
- Unauthorized introductions by anglers hoping to improve fishing opportunities (either for Yellow Perch itself or to provide forage fish) is a suspected method of introduction and unauthorized release is expected to continue.
- Established populations can act as sources for unauthorized introductions in unconnected lakes. Probability of unauthorized introduction is difficult to predict as it could be carried out on a large scale by relatively few individuals.

Considerations Regarding Ecological Impacts

- The ecological niche of Yellow Perch is well known in its native range, however, little is known in introduced regions. Risks to native species are largely inferred from observations of habits in the native range.
- Yellow Perch is very prolific and populations build to very high levels in small lakes with no predators.
- Yellow Perch is capable of significantly reducing food resources within its foraging area.

- Significant reductions in zooplankton can cause an increase in phytoplankton and a decrease in water clarity.
- Food items consumed depend on lake conditions; in shallow eutrophic lakes Yellow Perch chooses zooplankton and benthos; in more oligotrophic lakes, piscivory, including cannibalism, is observed.
- Salmonids are not good competitors with Yellow Perch. Survival and growth rates of stocked salmonids in lakes with established Yellow Perch are very low. Decreases in salmonid growth and survival were observed in several small BC lakes after Yellow Perch were introduced.
- Impacts of Yellow Perch on larger lake ecosystems are less clear and may be related to the role that predatory fishes have on perch behaviour and survival. In lakes with predators, densities of Yellow Perch are reduced but growth rate and overall adult size can be greater.
- A diet study of Yellow Perch in western Washington found that diet was dominated by benthic invertebrates with only one Coho Salmon being recorded. Yellow Perch were observed to eat Chinook Salmon smolts during migration but diet before and after the migration was dominated by benthic invertebrates.
- Observations of diet of native British Columbia piscivores indicate that Yellow Perch is not a diet item and that native piscivores are not effective predators of Yellow Perch.
- Walleye is the only native Percidae in British Columbia and hybrids of Walleye and Yellow Perch are inviable. It is unlikely that Yellow Perch would interbreed with other native species and produce viable hybrids.
- Future introductions will likely result from illegal movements of fish. It is unlikely that people moving fish illegally will treat them for parasites or diseases.
- Effects of Yellow Perch parasites in the introduced region are undocumented.

Sources of Uncertainty

The key uncertainties associated with this risk assessment are the likelihood of spread in the Fraser watershed, the impact on large lakes and the risk posed by fellow travelers.

- There is less published information on the impact of introduction of Yellow Perch into large lakes than in small lakes and greater uncertainty about the potential impacts of Yellow Perch on those large lakes.
- As with most species introduced by illegal introduction and subsequent natural spread, there is almost nothing known about pathogens, parasites and fellow travelers of Yellow Perch in British Columbia. It is not known which of the wide variety of parasites associated with Yellow Perch may be introduced along with them, nor, are the impacts of those parasites on native fauna of British Columbia known.

CONCLUSIONS

Yellow Perch represents a significant risk to native biota in British Columbia. Given its widespread environmental tolerances and high reproductive potential along with the possibility of spread by natural movement and human activities, there is a significant likelihood of Yellow Perch becoming widespread in British Columbia. Yellow Perch is known to have large impacts on native biota when introduced into small lakes and is thus considered high risk. Its impacts on large lakes may be less than in small lakes and limited to the nearshore areas resulting in localized effects. There is considerable uncertainty about its impacts on large lakes.

OTHER CONSIDERATIONS

This risk assessment was conducted using the time frame for ecological consequences of 10 years. This time frame may not be sufficient for dispersal, natural or otherwise, to allow Yellow Perch populations to achieve widespread establishment as several generations are likely needed for a population to become established and an ecological impact become noticeable to scientific observers.

SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, regional advisory meeting of March 4-6, 2008 on Risk assessment of spiny-rayed fishes (six species). Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at <http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm>.

Bradford, M.J., Tovey, C.P. and Herborg, L.-M. 2008. Biological Risk Assessment for Yellow Perch (*Perca flavescens*) in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2008/073.

Brown, T.G., Runciman, B., Bradford, M.J., and Pollard, S. 2009. A Biological Synopsis of Yellow Perch (*Perca flavescens*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2883: v + 28 p.

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