

Evaluation of Alternatives to Rainbow Trout for Creation of Put-and-Take Fisheries in Alberta



wildlife | fish | habitat

**ACA PROJECT
REPORT**

Evaluation of Alternatives to Rainbow Trout for Creation of Put-and-Take Fisheries in Alberta

Abridged and lightly edited from original content produced by ACA April 2021.

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PREFACE

Preface (2023)

At the request of the Government of Alberta (GOA), Alberta Conservation Association (ACA) evaluated the suitability and availability of commonly stocked sport fish in North America as an alternative to Rainbow Trout for creation of put-and-take fisheries in 2020/21. Following our evaluation, Channel Catfish (*Ictalurus punctatus*) was selected as the most promising alternative, subsequently modified to a Channel Catfish x Blue Catfish (*I. punctatus* x *I. furcatus*) hybrid. Catfish of the genus *Ictalurus* do not currently occur within Alberta so their stocking to provincial waterbodies required careful consideration. To assist in the evaluation, we completed a review of the biology, ecology, management, and culture of catfish in North America. In 2021/22, we continued to gather information in support of the evaluation as requested by provincial managers. The evaluation was completed in 2022/23 and included a detailed assessment of ecological risk, as well as consideration of the management and social implications of stocking catfish. Although the final decision rested with the GOA, ACA participated in the review and was conditionally approved for the introduction of sterile hybrid Channel Catfish to Alberta in August 2022. However, after careful assessment of the logistical and financial challenges associated with meeting the conditions of approval, ACA decided to not proceed with importation. This report summarizes the results of our evaluation of alternatives to Rainbow Trout for creation of put-and-take fisheries which provided the rationale for ACA's proposal to stock catfish in Alberta.

Preface (2021)

Alberta Environment and Parks (AEP) has the mandate and responsibility within the provincial government to oversee the management of fish populations, and advocate for the conservation of fish and fisheries. The Ministry is also solely responsible for regulating and managing the use of Alberta's fisheries resource.

Alberta Conservation Association (ACA) is a non-profit organization, and a registered charity. As a Delegated Administrative Organization, ACA delivers responsibilities as outlined in the *Wildlife Act* and defined in a Memorandum of Understanding with AEP. Every year ACA stocks approximately 60 waterbodies with over 100,000 trout to create put-and-take angling opportunities for Albertans through its Fish Stocking Project. In the 2019/20 fiscal year AEP identified assessment of the viability of different species and strains of sport fish to increase put-and-take angling opportunities for stocked fish as a high priority activity for ACA.

In partial fulfillment of this objective, we assessed a candidate pool of twenty sport fish species and hybrids from five families common to the prairie and parkland region of North America as alternatives to trout for stocking in Alberta. From the initial pool, detailed evaluation of the seven most promising species was completed. Channel Catfish (*Ictalurus punctatus*) was found to have the best combination of habitat requirements, fishery characteristics, culture requirements, and economic considerations of the group. Channel Catfish do not currently occur within Alberta and their introduction to provincial waterbodies requires careful consideration.

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RATIONALE

Roughly one quarter of all fishing effort in Alberta is sustained by fish stocking. Only 800 of Alberta lakes are naturally fish bearing and, with some 300,000 active anglers, demand for recreational angling opportunities in the province is high (Alberta Environment and Sustainable Resource Development 2014). To help meet demand, millions of hatchery-reared trout are stocked into hundreds of Alberta lakes, reservoirs, and ponds, annually (Table 1). Most waterbodies are stocked with catchable-sized trout (i.e., 20 cm) in spring to create put-and-take fisheries, which are open all year with a harvest limit of five trout of any size and bait is allowed. Most of the waterbodies managed as put-and-take fisheries in Alberta are limited by low winter dissolved oxygen and will not consistently overwinter trout (Miller and Thomas 1957) making them unsuitable for creation of put-grow-and-take or trophy fisheries. The 2020 *Alberta Guide to Sportfishing Regulations* identifies 222 lakes, reservoirs, and ponds that are stocked with trout and managed as put-and-take fisheries in the province.

Table 1: Summary of the diversity, number of fish, and waterbodies stocked in Alberta 2017 – 2019.

Year ^a	Brook Trout (<i>Salvelinus fontinalis</i>)	Brown Trout (<i>Salmo trutta</i>)	Cutthroat Trout (<i>Oncorhynchus clarki</i>)	Rainbow Trout (<i>Oncorhynchus mykiss</i>)	Tiger Trout ^b	Total	Number of waterbodies
2017	132,679	55,199	44,102	2,026,770	41,108	2,299,858	224
2018	98,728	32,508	32,350	1,277,862	40,221	1,481,669	234
2019	92,398	55,529	53,786	1,371,325	91,511	1,664,549	219

^aStocking data summarized from Government of Alberta fish stocking reports for 2017, 2018, and 2019. Renovations to the Sam Livingston Fish Hatchery reduced provincial trout production in 2018 and 2019.

^bTiger Trout are the hybrid of a female Brown Trout and male Brook Trout cross.

Despite high angler effort, often in excess of 400 hours per hectare, many of the trout stocked die of natural causes by the end of summer at many put-and-take waterbodies (Patterson and Sullivan 2013, Fitzsimmons and Keeling 2016). The poor performance of these fisheries is due, in part, to unsuitable water conditions. The limitations of Alberta’s waterbodies to support a summer trout fishery have long been appreciated. In *Alberta’s ‘pothole’ trout fisheries*, published in 1957, R.B. Miller and R.C. Thomas wrote of Alberta’s trout-stocked lakes:

“...during July to mid-September angling is poor and from 12 to 20 hours are required to catch one fish. This poor fishing is attributed to warm surface waters and low oxygen concentrations in deeper waters.”

The trout regularly stocked in Alberta are coldwater species of the family Salmonidae. In contrast to other popular sport species, salmonids require relatively cool, oxygen-rich environments to thrive (Nelson and Paetz 1992) (Table 2) which become limited in many stocked waterbodies during the summer.

Table 2: Mean temperature and dissolved oxygen requirements of four families containing popular North American sport fish species.

Family	Optimum growth temperature (°C) ^a	Dissolved oxygen requirement (mg O ₂ per litre) ^b
Centrarchidae (bass, sunfish, crappie)	25.5	3.98 (mixed freshwater fish populations with no Salmonids)
Ictaluridae (catfish)	29.8	
Percidae (perch, walleye)	22.1	
Salmonidae (trout, char, salmon)	14.8	6.00

^aTemperature data adapted from Table 3 of Hasnain et al. (2010).

^bOxygen value where the average member of a species in a fish community starts to exhibit symptoms of oxygen distress, from Table 9 of Davis (1975).

High summer water temperature and low dissolved oxygen stresses trout and increases mortality such that some of Alberta’s stocked waterbodies are incapable of supporting trout survival beyond mid-summer (Fitzsimmons and Keeling 2016). An upper water temperature threshold of 21°C and lower dissolved oxygen concentration of 2.5 mg/L are generally recognized as limiting the distribution of Rainbow Trout in lakes and reservoirs (Swales 2006).

Even if these minimum water quality requirements for trout survival are met, summer trout fishing may still be poor. Feed consumption (Myrick and Chech 2000) and angler catch (McMichael and Kaya 1991) of trout decline sharply when water temperature exceeds 19°C, effectively closing the fishery. Cooler waters may exist in deeper waterbodies that thermally stratify, however dissolved oxygen in the hypolimnion of these waterbodies is regularly below 6 mg/L (Fitzsimmons and Keeling 2016, Schmidt 2017), which also negatively impacts angler catch (Weithman and Haas 1984). Approximately 40% of Alberta’s put-and-take waterbodies occur in central and southern Alberta where these water quality issues are most likely to occur.

Ideally only waterbodies with adequate summer temperature and dissolved oxygen conditions would be stocked with trout. However, with less than 3% of its area being water (Nelson and Paetz 1992), Alberta is a relatively dry province and suitable waterbodies are limited. Only three (1%) of the 225 waterbodies evaluated in the past five years by the ACA for development of new put-and-take fisheries met minimum requirements and have been stocked with trout (Alberta Conservation Association 2020). Many marginal waterbodies in central and southern Alberta may soon become unsuitable for trout altogether because of climate change (Table 3).

Table 3: Predicted current and future maximum near surface (i.e., 0 – 2 m) water temperature of Alberta lakes.

Area	Temperature (°C) ^a		
	Current	2050 ^b	Change
Brooks	20.7	22.5	+1.8
Calgary	17.9	19.7	+1.8
Edmonton	19.0	19.4	+0.4
Lethbridge	20.6	22.6	+2.0
Medicine Hat	21.6	23.5	+1.9
Red Deer	18.2	20.1	+1.9

^aJuly 1 maximum surface water temperature predictions based on Sharma et al.'s (2008) four factor multiple-regression model and climate data from Climate Atlas of Canada (2020).

^bAssuming a low carbon (RCP4.5) scenario in which, greenhouse gas emissions increase until 2050 and then rapidly decline. This decline leads to less severe global warming (Climate Atlas of Canada 2020).

Coldwater fish species like trout are considered particularly susceptible to a warming climate and are already being negatively impacted by climate change (Lynch et al. 2016). Climate projections for Alberta (2020s – 2080s) generally predict warmer temperatures and increasing drought, especially in the prairies (Gobena and Gan 2013, PaiMazumder et al. 2013, Jiang et al. 2015). Waterbodies with summer water quality suitable for trout are already limited in the province. To expand or even maintain recreational angling opportunity in Alberta, it is prudent to consider an alternative to trout for stocking into waterbodies with marginal trout habitat.

IDENTIFYING AN ALTERNATIVE TO RAINBOW TROUT

Alberta's put-and-take trout fishery is characterized by its contradictions. Despite relatively low catch rates and high use, most anglers report being satisfied with the quality of their fishing experience (Patterson and Sullivan 2013, Keeling and Fitzsimmons 2016). Even though harvest limits are generous, a surprisingly high percentage of the trout caught by anglers are released (Patterson 2011, Zwickel 2012, Keeling and Fitzsimmons 2016, Rodtka 2018), while anglers appear satisfied with the quality of the trout despite their modest size (Roldtka 2018). Convenience is key to anglers' relatively modest expectations of the fishery. The number one reason anglers give for fishing at a put-and-take waterbody is that it is "close to home" (Patterson and Sullivan 2013, Keeling and Fitzsimmons 2016).

A large majority (>80%) of the trout stocked to create put-and-take fisheries in Alberta are Rainbow Trout. Rainbow Trout are native to western North America, but through widespread introduction now occur on every continent except Antarctica (MacCrimmon 1971). The secret to the Rainbow Trout's success lies in its adaptability, the ease with which it is cultured, and its popularity with anglers. An estimated 50% (by weight) of the fish stocked in the United States (US) by state and federal agencies are Rainbow Trout (Halverson 2008). The ideal alternative to trout for creating put-and-take fishing opportunities in Alberta would share the desirable characteristics of Rainbow Trout but possess a greater resiliency to warm water and low dissolved oxygen. This would allow a wider diversity of waterbodies to be stocked successfully, ensuring these fisheries remain close to home for Alberta's anglers.

Defining a Candidate Pool of Alternative Species

Dozens of sport fish species are cultured and stocked in North America including at least 25 coolwater and warmwater species (Halverson 2008). Not all species are likely to thrive in the summer water conditions typical of Alberta's put-and-take waterbodies, however. By capturing patterns of environmental and ecological variation influencing fish distribution, Abell et al.'s (2008) freshwater ecoregions provide a useful framework for defining a pool of fish species more likely to flourish in Alberta's trout-stocked waterbodies.

Summer water temperature limits trout stocking success most often in central and southern Alberta. The area is characterized by an arid or semi-arid grassland climate, numerous pothole lakes, and recent glaciation leading to a relatively low diversity of fish species (Abell et al. 2008). Three temperate upland river ecoregions encompass the area, which includes the upper reaches of the Saskatchewan and Missouri rivers (Figure 1). The area contains central and southern Alberta, western Saskatchewan, Montana, the Dakotas, and northern Wyoming. Table 4 lists the coolwater and warmwater fish species (including hybrids) for which a general harvest limit was identified in two or more area jurisdictions in 2018.

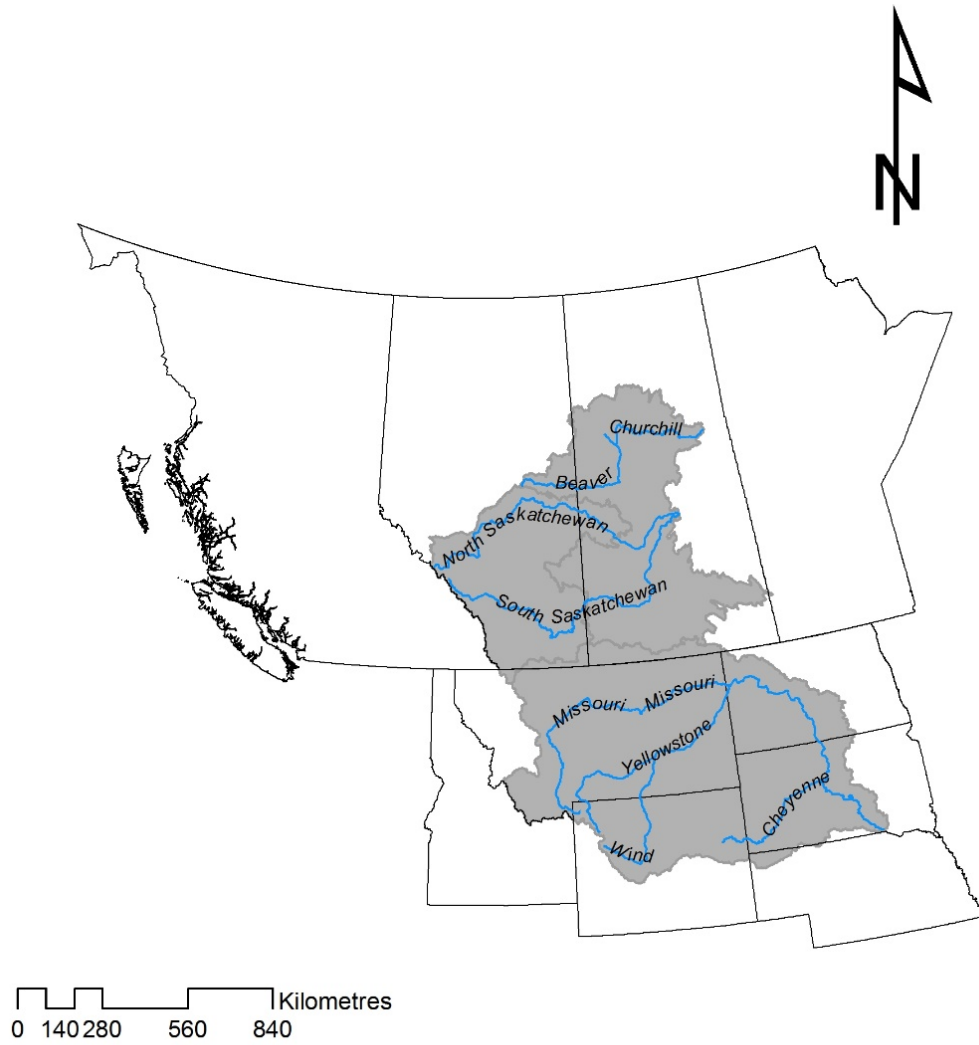


Figure 1: Location of temperate upland aquatic ecoregions and associated large rivers used to define a candidate pool of fish species for consideration as an alternative to Rainbow Trout.

Table 4: Candidate pool of coolwater and warmwater fish species for initial consideration as an alternative for Rainbow Trout in put-and-take fisheries that experience high summer water temperature and low dissolved oxygen.

Family	Common name	Scientific name	Jurisdictions with general harvest regulation	Jurisdiction(s) that frequently stock ^a
Catfish	Black Bullhead	<i>Ameiurus melas</i>	SD, WY	None
	Channel Catfish	<i>Ictalurus punctatus</i>	MT, ND, SD, SK, WY	MT, ND, SD, WY
Mooneye	Goldeye	<i>Hiodon alosoides</i>	AB, SK	None
	Mooneye	<i>Hiodon tergisus</i>	AB, SK	None
Perch	Sauger	<i>Sander canadense</i>	AB, MT, ND, SD, SK, WY	None
	Saugeye	<i>Sander canadense* vitreus</i>	ND, SD, SK	SD
	Walleye	<i>Sander vitreus</i>	AB, MT, ND, SD, SK, WY	MT, ND, SD, SK, WY
	Yellow Perch	<i>Perca flavescens</i>	AB, ND, SD, SK, WY	MT, ND, SD
Pike	Muskellenge	<i>Esox masquinongy</i>	ND, SD,	SD
	Northern Pike	<i>Esox Lucius</i>	AB, MT, ND, SD, SK, WY	MT, ND
	Tiger Musky	<i>Esox Lucius* masquinongy</i>	MT, ND, SD, WY	WY
Sunfish	Black Crappie	<i>Pomoxis nigromaculatus</i>	MT, ND, SD, WY	SD, WY
	Bluegill	<i>Lepomis macrochirus</i>	ND, SD, WY	SD, WY
	Green Sunfish	<i>Lepomis cyanellus</i>	SD, WY	None
	Largemouth Bass	<i>Micropterus salmoides</i>	MT, ND, SD, SK, WY	SD, MT, WY
	Pumpkinseed	<i>Lepomis gibbosus</i>	SD, WY	None
	Rock Bass	<i>Ambloplites rupestris</i>	SD, SK, WY	None
	Smallmouth Bass	<i>Micropterus dolomieu</i>	MT, ND, SD, SK, WY	SD, MT
	White Bass	<i>Morone chrysops</i>	ND, SD,	SD
	White Crappie	<i>Pomoxis annularis</i>	MT, ND, SD, WY	None

^aThousands of fish stocked into multiple waterbodies in the last two or three years for recreational enhancement.

Black Bullhead, Bluegill, Green Sunfish, and Pumpkinseed are classified as invasive species in the *Fisheries (Alberta) Act*, only importation of dead fish of these species is allowed into Alberta, and so are removed from further consideration. Also removed from consideration are those species that are not routinely stocked by more than one jurisdiction in the region including: Goldeye, Mooneye, Sauger, Saugeye, Muskellunge, Tiger Musky, Rock Bass, White Bass, and White Crappie. Although these species may support locally important fisheries, lack of widespread stocking suggests practical limitations to their suitability as an alternative to Rainbow Trout. Every jurisdiction in the region frequently stocks Rainbow Trout.

Evaluating the Pool of Candidate Species

Brader (2008) identifies four basic requirements for success of a stocked species in an intensive put-and-take fishery:

1. Fish species selected should be suitable for available habitat.
2. Fish species selected should be large enough to attract anglers and be easily caught using relatively simple tackle.
3. Fish species selected should be relatively easy to culture.
4. Fish stocking should be affordable.

These criteria can be used to evaluate the pool of candidate species as an alternative to Rainbow Trout. A fifth criterion is added to broadly assess candidate species' potential for negative ecological impact.

1. Fish species selected should be suitable for available habitat.

The lakes, reservoirs, and ponds that comprise Alberta's put-and-take trout fishery are typically small (0.5 – 40 ha), shallow (2 – 2.5 m mean depth) waterbodies that maintain their levels by surface drainage. In summer, the waterbodies provide coolwater (19 – 25°C) habitat and rarely maintain a distinct thermocline. Dissolved oxygen often drops below 3 mg/L in deeper water over the summer and throughout the water column in winter (Miller and Thomas 1957, Meding and Jackson 2003, Schmidt 2017). These waterbodies are often highly productive with total phosphorous greater than 0.4 mg/L (Schmidt 2017). Although bottom fauna may be impacted by oxygen depletion, littoral areas often contain a rich diversity of invertebrates and plankton are abundant (Miller and Thomas 1957). Many waterbodies are naturally fishless, those capable of overwintering fish are dominated by species tolerant of low dissolved oxygen like Fathead Minnow (*Pimephales promelas*), Brook Stickleback (*Culaea inconstans*), or less commonly, Yellow Perch and Northern Pike (Nelson and Paetz 1992). For a more comprehensive list of the vertebrate, invertebrate, aquatic algae, and plants that commonly occur in Alberta's trout-stocked waterbodies see Appendix 1. The ideal alternative to Rainbow Trout for stocking into these waterbodies would be a coolwater generalist, tolerant of degraded water quality, and low dissolved oxygen (Table 5).

Table 5: Water temperature preference, habitat and foraging specificity, tolerance to degraded water quality, and sensitivity to low dissolved oxygen of seven candidate species considered as an alternative to Rainbow Trout. Rainbow Trout information included for comparison^a.

Species	Coolwater	Generalist	Tolerant ^b	Low DO tolerant
Channel Catfish	No	No	Yes	Yes
Walleye	Yes	Yes	No	No
Yellow Perch	Yes	Yes	No	Yes
Northern Pike	Yes	No	No	Yes
Black Crappie	Yes	Yes	Yes	Yes
Largemouth Bass	No	Yes	Yes	No
Smallmouth Bass	Yes	Yes	No	No
Rainbow Trout	No	Yes	No	No

^aFrom Eakins (2020).

^bTolerant species are defined as species that are insensitive or adaptive to environmental or anthropogenic stresses (Eakins 2020).

Only Black Crappie meets all habitat criteria. Channel Catfish and Largemouth Bass are warmwater species (i.e., prefer temperatures > 25°C). Although Channel Catfish have a broad, omnivorous diet they are considered a benthic specialist, while Northern Pike are highly piscivorous. Only Channel Catfish, Largemouth Bass, and Black Crappie are considered tolerant of environmental and anthropogenic stresses (Eakins 2020).

2. Fish species selected should be large enough to attract anglers and be easily caught using relatively simple tackle.

Rainbow Trout are an attractive species for Alberta’s put-and-take fishery because they appeal to both sport- and harvest-oriented anglers. Sport fish with a stock size (i.e., the minimum length at which a species is thought to have recreational value) much lower than the 20 cm minimum length of catchable trout stocked in Alberta currently are less likely to provide the sport desired by catch-and-release anglers. Panfish, edible species that do not usually outgrow the size of a frying pan, are an extreme example. These species are an uneconomical option for a put-and-take fishery because panfish anglers are consumption oriented, select for old, large fish that are expensive to produce, and expect generous harvest limits (Lyons et al. 2017) (Table 6).

Table 6: Stock length, if the species is a panfish or not, and harvest limit statistics of seven candidate species considered as an alternative to Rainbow Trout. Rainbow Trout information included for comparison.

Species	Stock length (cm) ^a	Panfish species	Median regional general harvest limit (range) ^b
Channel Catfish	28	No	6 (2 – 20)
Walleye	25	No	7 (3 – 10)
Yellow Perch	13	Yes	30 (15 – 50)
Northern Pike	35	No	10 (3 – 12)
Black Crappie	13	Yes	25 (15 – 50)
Largemouth Bass	20	No	6 (2 – 10)
Smallmouth Bass	18	No	6 (0 – 10)
Rainbow Trout	25	No	6 (5 – 10)

^aFrom Neumann et al. (2012).

^bFrom provincial and state 2020 editions of the sportfishing regulations.

All species support popular North American recreational fisheries, but both Yellow Perch and Black Crappie are panfish species and therefore unlikely to perform as well in a put-and-take fishery. Catch and harvest data from Alberta support the contention that the Yellow Perch fishery is consumption oriented. In 2010, Alberta anglers harvested 35% of their Yellow Perch catch, but only 17% of their Rainbow Trout catch, and 9% of their Northern Pike and Walleye catches (Zwickel 2012).

3. Fish species selected should be relatively easy to culture.

Put-and-take fishery creation depends upon reliable production of relatively large stock. Species stocked in many jurisdictions for recreational enhancement are more likely to have well established culture methods and straightforward production requirements. Those stocked at a larger mean weight are more likely to be suitable for production of catchables (Table 7).

Table 7: Number of states that stock, and mean weight at stocking, of seven candidate species considered as an alternative to Rainbow Trout. Rainbow Trout information included for comparison^a.

Species	Number of states	Mean weight at stocking (g)
Channel Catfish	38	50.0
Walleye	34	0.1
Yellow Perch	12	15.5
Northern Pike	16	1.1
Black Crappie	18	5.0
Largemouth Bass	35	3.6
Smallmouth Bass	22	6.6
Rainbow Trout	45	109.8

^aFrom Halverson (2008).

Of the candidate species that are widely stocked in North America, only Walleye are cultured for recreational enhancement by provincial governments (data in Table 7 are from the US only). However, rearing large numbers of Walleye beyond the fry stage in captivity is generally considered uneconomical

due to issues with feed training and cannibalism (Trushenski et al. 2010). Only Channel Catfish and Rainbow Trout are widely stocked as catchables in North America (Brader 2008).

4. Fish stocking should be affordable.

Since they require stocking large fish, put-and-take fisheries are relatively expensive to maintain. However, the cost to produce a catchable fish varies by species and is reflected in their purchase price with Rainbow Trout being one of the most affordable (Figure 2).

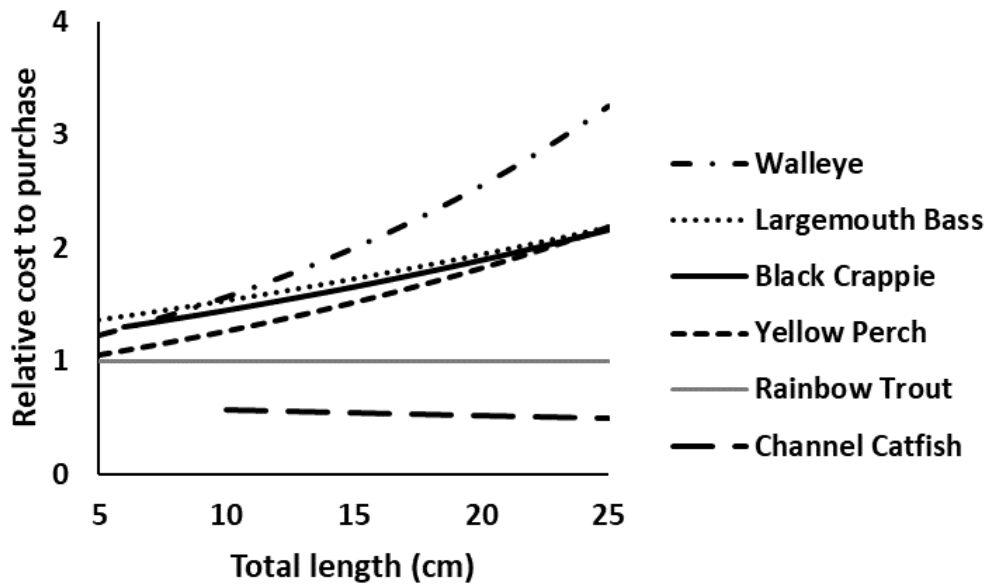


Figure 2: Relative cost to purchase five sport fish species compared to the cost of purchasing a Rainbow Trout of the same size. Smallmouth Bass and Northern Pike (not shown) are over three times the cost to purchase as a similarly sized Rainbow Trout. Relative cost is based on a review of retail prices advertised online by US growers (n = 16) that service the recreational (pond stocking) market, June 2020.

All else being equal, only the purchase cost of Channel Catfish compares favourably to that of Rainbow Trout at all sizes. Cost to purchase a 20 cm Largemouth Bass, Black Crappie, or Yellow Perch is approximately twice the cost of Rainbow Trout. Walleye, Smallmouth Bass, and Northern Pike are even more expensive.

5. Potential for negative ecological impact.

Maintenance of the natural biological diversity of Alberta’s fish fauna is a guiding principle of fisheries management in Alberta (Alberta Environment and Sustainable Resource Development 2014). Candidate species with high potential for negative ecological impact may pose an unacceptable risk to Alberta’s aquatic ecosystems. The trophic position of an introduced fish species is a strong predictor of its potential for negative ecological impact, with top-level consumers being most impactful (Howeth et al. 2016, Mollot et al. 2017). Species not native to Alberta are also more likely to pose a novel threat to Alberta’s aquatic ecosystems (Table 8).

Table 8: Trophic position and status within Alberta of seven candidate species considered as an alternative to Rainbow Trout.

Species	Top-level consumer ^a	Native to Alberta
Channel Catfish	No	No
Walleye	Yes	Yes
Yellow Perch	No	Yes
Northern Pike	Yes	Yes
Black Crappie	No	No
Largemouth Bass	Yes	No
Smallmouth Bass	Yes	No

^aPrimarily piscivorous after the first year of life (Stewart and Watkinson 2004).

Although all the candidates eat fish opportunistically, Walleye, Northern Pike, Smallmouth Bass, and Largemouth Bass are primarily piscivorous after their first year. Walleye and Northern Pike are native to Alberta and widely distributed across the province, whereas both bass species are not native. The introduction of bass in other jurisdictions has led to large declines in native species richness (Mollet et al. 2017). Although Channel Catfish and Black Crappie are also non-native, they are also not top-level consumers, and their introduction is less likely to drastically impact Alberta’s aquatic ecosystems.

Summary

Table 9 summarizes how each species satisfies the basic requirements of a put-and-take fishery and its potential for negative impact to Alberta’s aquatic ecosystems. Although no candidate species is without shortcomings, only Channel Catfish passes or is neutrally scored on all criteria. Based on the evaluation, Channel Catfish has the greatest potential to succeed as an alternative to Rainbow Trout in Alberta.

Table 9: Summary scoring of seven candidate species on five criteria assessing their suitability as an alternative to Rainbow Trout in Alberta’s put-and-take fishery.

Species	Habitat requirements	Fishery characteristics	Ease of culture	Affordability	Ecological impact
Channel Catfish	Neutral	Pass	Pass	Pass	Neutral
Walleye	Neutral	Pass	Neutral	Fail	Neutral
Yellow Perch	Pass	Fail	Neutral	Neutral	Pass
Northern Pike	Neutral	Neutral	Fail	Fail	Neutral
Black Crappie	Pass	Fail	Fail	Neutral	Neutral
Largemouth Bass	Neutral	Pass	Neutral	Neutral	Fail
Smallmouth Bass	Neutral	Pass	Fail	Fail	Fail

Although the five criteria have been given equal consideration, affordable acquisition of fish is likely to be of overriding importance if ecological impacts can be mitigated. Creation of even a modest put-and-take fishery in the province will require thousands of fish annually and even small savings on their price becomes significant when volumes are high. For much of North America, Channel Catfish have proven to be one of the most affordable options, but this remains an open question for Alberta.

A factor not considered in this evaluation is novelty. Species unfamiliar to Alberta anglers are likely to generate interest independent of their other qualities, native species will not. New species are also less likely to be burdened with angler preconceptions of the fishery, affording greater latitude in its development and management. While it is impossible to know for certain, the novelty of Channel Catfish to most Alberta anglers may be one of its strongest selling points.

Demand for recreational angling opportunity in Alberta is high, fish stocking is necessary to help meet this demand. An overreliance on coldwater species, a limited number of waterbodies, and a warming climate place the future of Alberta's stocking program in jeopardy. Since creating more stocked fisheries and maintaining angler participation and satisfaction at existing fisheries are priorities for the Alberta Government an alternative to trout for recreational enhancement stocking is required.

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APPENDICES

Appendix 1: List of aquatic vertebrates (Table 1), invertebrates (Table 2), algae and plants (Table 3) commonly encountered in small, shallow, natural, and artificial lentic waterbodies in Alberta.

Table 1.

Common name	Scientific name	Origin	Comment
Boreal chorus frog	<i>Pseudocris maculata</i>	Native	aquatic larvae
Brook Stickleback	<i>Culaea inconstans</i>	Native	tolerant of low dissolved oxygen
Brook Trout	<i>Salvelinus fontinalis</i>	Introduced	stocked for recreational enhancement
Brown Trout	<i>Salmo trutta</i>	Introduced	stocked for recreational enhancement
Canadian toad	<i>Lithobates sylvaticus</i>	Native	aquatic larvae
Common goldfish	<i>Carassius auratus</i>	Invasive	illegal introduction through pet trade, tolerant of low dissolved oxygen
Fathead Minnow	<i>Pimephales promelas</i>	Native	tolerant of low dissolved oxygen
Finescale Dace	<i>Chrosomus neogaeus</i>	Native	
Koi	<i>Cyprinus carpio</i>	Invasive	illegal introduction through pet trade, tolerant of low dissolved oxygen
Longnose Sucker	<i>Catostomus catostomus</i>	Native	
Northern Pike	<i>Esox lucius</i>	Native	
Prussian Carp	<i>Carassius gibelio</i>	Invasive	illegal introduction, tolerant of low dissolved oxygen
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Native	stocked for recreational enhancement
Tiger salamander	<i>Ambystoma mavortium</i>	Native	aquatic larvae
Yellow Perch	<i>Perca flavescens</i>	Native	often a result of illegal transfer
Western painted turtle	<i>Chrysemys picta</i>	Native and Introduced	native to southeastern Alberta; widely transferred, illegal introduction through pet trade of other turtle species also possibility
White Sucker	<i>Catostomus commersonii</i>	Native	
Wood frog	<i>Lithobates sylvaticus</i>	Native	aquatic larvae

Table 2.

Common name	Grouping	Origin	Comment
Aquatic earthworms	Oligochaeta	Native	diverse group
Beetles	Coleoptera	Native	includes predacious water beetles (Dytiscidae)
Caddisflies	Trichoptera	Native	primarily Hydroptilidae, Limnephilidae, Phryganeidae, and Polycentropodidae
Copepods	Copepoda	Native	diverse group
Crayfish	Astacidea	Invasive (?)	<i>Oregonectes virilis</i> native to northeast Alberta; illegal introduction through pet trade or transfer
Dragonflies and damselflies	Odonata	Native	diverse group
Flies	Diptera	Native	larval form aquatic, includes midges, mosquitoes, crane flies, and Chaoboridae
Freshwater sponge	Porifera	Native	e.g., <i>Ephydatia fluviatilis</i> , <i>Spongilla lacustris</i>
Gastrotricha	gastrotricha	Native	Chaetonotidae, Neogosseidae, Dasydytidae
Horsehair worms	Nematomorpha	Native	Gordiidae and Chordodidae
Hydras	Hydrzoa	Native	e.g., <i>Hydra canadensis</i> , <i>Hydra carnea</i>
Leeches	Hirudinea	Native	diverse group
Mayflies	Ephemeroptera	Native	diverse group
Microflatworms	Microtubellaria	Native	both free-living and parasitic species
Moss animals	Bryozoa	Native	e.g., <i>Cristatella mucedo</i> , <i>Fredericella sultana</i>
Rotifers	Rotifera	Native	diverse group
Roundworms	Nematoda	Native	both free-living and parasitic species
Scuds	Amphipoda	Native	e.g., <i>Gammarus lacustris</i> , <i>Hyalella azteca</i>
Seed shrimp	Ostracoda	Native	diverse group
Snails	Gastropoda	Native	diverse group
True bugs	Hemiptera	Native	includes water boatmen, water striders, and back swimmers
Water fleas	Cladocera	Native	e.g., <i>Daphnia</i> spp.
Water mites	Hydrachnidia	Native	diverse group
Water spiders	Araneae	Native	e.g., <i>Dolomedes triton</i>

Table 3.

Common name	Scientific name	Origin	Comment
Arrowhead	<i>Sagittaria cuneata</i>	Native	
Bladderwort	<i>Utricularia</i> spp.	Native	
Bulrush	<i>Scirpus</i> spp.	Native	
Canada waterweed	<i>Elodea canadensis</i>	Native	
Common cattail	<i>Typha latifolia</i>	Native	
Coontail	<i>Ceratophyllum demersum</i>	Native	
Duckweed	<i>Lemna</i> spp.	Native	common, ivy leaved
Filamentous algae	various, e.g. <i>Cladophora</i> spp., <i>Spirogyra</i> spp.	Native	
Giant bur-reed	<i>Sparganium eurycarpum</i>	Native	
Mare's tail	<i>Hippurus vulgaris</i>	Native	
Macrophytic algae	<i>Chara</i> spp.	Native	stoneworts
Milfoil	<i>Myriophyllum</i> spp.	Native/Invasive	northern, Eurasian
Narrow-leafed water plantain	<i>Alisma gramineum</i>	Native	southern Alberta only
Planktonic algae	various, e.g., <i>Aphanizomenon</i> spp., <i>Microcystis</i> spp.	Native	green, blue-green, and brown
Pondweed	<i>Potamogeton</i> spp., <i>Stuckenia</i> spp.	Native/Invasive	sheathed, sago, Richardson's, curly leaf, etc.
Rush	<i>Juncus</i> spp.	Native	
Yellow water lily	<i>Nuphar variegatum</i>	Native	

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