Yukon

MR-19-02

Review of the status of Yukon's commercial lake trout and lake whitefish fishing industry

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Government of Yukon
Fish and Wildlife Branch
MR-19-02

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Summary

The Government of Yukon conducted a review of the status of the Yukon commercial fishing industry to determine if current quota allocations are sustainable. This review consisted of multiple aspects including; a historical review of the commercial fishing industry in Yukon; the potential for revenue generation for local and exported markets; the status of lake trout and lake whitefish stocks within commercial fishing locations, in relation to Optimal Sustainable Yields; and a review of recreational fishing trends in Yukon.

Yukon's commercial harvest occurs in freshwater lakes, which are low in primary productivity and are consequently less productive than southern Canadian lakes. Within these systems, fish are slow growing and recover slowly from any form of collapse. Optimal sustainable yields (OSY), when reviewing the commercial industry are currently not exceeded, however current commercial fishing is under utilized. If Yukon's current commercial fishing quotas are fully realized, with the increase of recreational angling seen in Yukon, the OSY for these systems will be exceeded.

Key findings

- Fourteen individual quotas for commercial harvest exist, allotted among four lakes (Atlin, Bennet, Teslin and Kluane) and three rivers (Yukon, Teslin and Six Mile).
- Only three of the quota holders annually renew their licences, of these only two routinely fish.
- The total allocated commercial quota for Yukon is 4,860 kg (4,050 kg lake trout, 760 kg whitefish and 50 kg of cisco) with Yukon's 15-year average commercial harvest at 350 kg, approximately 9% of the current allowable quota.
- Current commercial harvest, although relatively small, when added to known licenced angling harvest, exceeds sustainable levels in two lakes.
- Yukon recreational angling and fishing pressures are increasing and are trending to increase over time, especially if current increases in projected tourism continue.
- The lack of subsistence harvest data and winter angling data may present a significant data gap.

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Introduction

The Government of Yukon conducted this review of the status of Yukon's commercial fishing industry in response to concerns raised by the Taku River Tlingit First Nation (TRTFN) and the Carcross Tagish Renewable Resources Council (C/TRRC). These concerns were regarding the practice of allowing commercial freshwater fishing harvest on Yukon lakes and rivers, which are seeing increased pressure from recreational and subsistence harvest.

Over the past 15 years, resource utilization for Yukon fisheries has been steadily increasing. This growth has largely been driven by greater interest in both summer and winter angling and is rising with the improvement of fishing technology and accessibility. The influence of human activities on Yukon fisheries may not be the only stress on the resource. Temperature change, associated with climate warming will likely transform fish species abundance and distribution throughout the Territory (McKenzie-Grieve and Post 2005).

These increased pressures, coupled with requests from First Nations, prompted the Government of Yukon to review the practice of allowing commercial fishing on Yukon lakes and the allocation of fisheries quotas to the commercial industry. This review is focused on the commercial fishery for lake trout and lake whitefish across Yukon, as the single cisco commercial Licence has been closed.

This review is multifaceted and includes; a historical review of the commercial fishing industry in Yukon; the potential for revenue generation for local and exported markets; the status of lake trout and lake whitefish stocks within commercial fishing locations, in relation to Optimal Sustainable Yields; and a review of the trends of recreational fishing in Yukon. Finally, this review provides recommendations for the management of Yukon's commercial fisheries.

Historical review

To understand the present-day state of the Yukon commercial fishery, a historical perspective is required. Examining past utilization gives us an understanding of the temporal change that has occurred, identifies patterns in resource use, and gives insight into the origins for potential resource competition. This historical review looks at commercial fishing prior to devolution in 1989, post devolution and includes a review of the status of domestic fishing.

Commercial fisheries – pre-devolution

The first commercial fisheries in Yukon began circa 1885 with a shift by First Nations from being solely subsistence-based to using fish as a resource for trade with non-First Nations. The shift was largely driven by the encroachment of fur trappers who required fish as a food source for themselves and their dogs. European contact also initiated industrial-scale fur trade. Through trade and barter, Yukon First Nations improved their ability to access wildlife through the acquisition of rifles, traps and varied fishing equipment (e.g. gill nets, metal hooks) (Siegel and McEwen 1984).

By the late 1800s gold prospectors had inundated Yukon, creating a large commercial market for locally-caught fish. Early entrepreneurs exploited this demand and therein the first large commercial fisheries began. The majority of these commercial fisheries occurred in the Southern Lakes region. In 1898, the first commercial fisheries were initiated on Lake Laberge (lake trout and lake whitefish) and the Yukon River (salmon) (Siegel and McEwen 1984). By 1899, commercial fisheries were formalized, with the

Royal North West Mounted Police (RNWMP) being granted authority for the issuance of freshwater commercial licences in 1899 (RNWMP Correspondence 1899). By 1903 there were 17 commercial harvesting licences sold, with 40 people working directly in the industry (Marine and Fisheries Annual Report 1903).

In a 1902 report, the stated commercial catch for lake whitefish (*Coregonus clupeaformis*) and lake trout (*Salvelinus namaycush*) in Lake Laberge was 45,000 lbs (20,454 kg) (RNWMP 1902). This reported figure is of importance as it greatly exceeds the current estimate for maximum sustainable yield (MSY, the maximum level in which a resource can be harvested and remain sustainable) in Lake Laberge of 29,324 kg (YG unpublished data). This MSY estimate is not solely for lake whitefish and lake trout but for all species. Therefore, it is not surprising that the harvest levels seen in 1902 were not sustainable, which is further evident by the 1908 harvest, which had declined to 26,181 lbs (11,900 kg). Evidence for this decline is also noted in reports from harvesters who fished Lake Laberge and expressed concern that fish populations were being depleted (RNWMP 1902).

The decline in Lake Laberge was not the only historical report of the fishery decline. In 1919, the Dawson Daily News reported claims in addition to Lake Laberge that Teslin Lake fish populations were also becoming scarce (Dawson Daily News, 1919; Appendix 1). Reported declines in fish stocks during this time were also reported in Tagish and Marsh Lakes, with records by Superintendent Synder of the RNWMP (RNWMP 1903).

Between 1920 and 1946, Yukon's commercial fishing industry had dramatically declined and interest was stagnant until the construction of the Alaska Highway (1942 to 1947). During this time, the Royal Canadian Mounted Police (RCMP) received approximately 100 enquiries from newcomers who wanted to obtain information and licences to commercially fish in the large lakes along the highway. However, recognizing the vulnerability of Yukon lakes to overfishing, officers were instructed to discourage these individuals in the interests of conservation, and no increase in harvest was documented (RCMP correspondence 1943).

The decline of the commercial fishery harvest continued from 1958 to 1971, from 46,450 lb (21,113 kg) to 7,256 lb (3,298kg). Despite this decline, during the period from 1964 to 1971 commercial licences sales doubled from 33 to a result of 67 (Boland 1973). It is however, unclear whether the reported harvest decline was the result of diminishing fish stocks or declining effort. It has been suggested that the increase of commercial licences during this time was a response by non-First Nation fishers to the cancellation of domestic fishing licences, which were licences which allowed a non-First Nation food fishery (Boland 1973). The procurement of commercial licences during this period was the only way that non-First Nation fishers could utilize nets to acquire fish.

In 1961, concerns regarding overharvesting in small lakes led to a restriction of commercial quotas from all lakes that had a surface area of less than eight square miles. This left 34 lakes that could be fished commercially (Table 1) (Siegel and McEwen 1984). During this period, both Tagish and Marsh Lakes were excluded due to rising public pressure from anglers who feared overuse of the fisheries resource. Between 1961 and 1971, 12 additional lakes were removed from the commercial list due to further concerns related to overharvest (Table 1).

Subsequent to 1971, commercial licence sales continued to dramatically and consistent increase, tripling in number from 56 licences in 1972 to 156 by 1982. This increase in licence sales, however did not translate into an increase in commercial harvest. Between 1973 and 1982, the total yearly average harvest remained relatively consistent, with harvest generated from commercial licences at 18,874lb (8,579 kg), of which 56% (4,804 kg) were whitefish and 44% (3 774 kg) were lake trout (Horler et *al.* 1983).

Table 1. Lakes that remained designated as commercial fishing lakes after 1961. Subsequently 12 additional lakes were removed due to over harvest concerns (Siegel and McEwen 1984).

water body	subsequent closure year	original quota (kg)	1982 quota (kg)
Aishihik	1968	6,800	---
Atlin			1,800
Bennett			4,000
Big Kalzas			1,800
Dezadeash	1964	3,200	---
Drury			1,400
Earn			1,800
Ethel	1967	900	---
Fairweather			1,400
Finlayson			1,400
Fish	1964	450	---
Fortin			1,400
Fox	1964	900	---
Frances			5,400
Hutshi			1,000
Kluane			17,000
Kusawa	1968	6,800	---
Laberge		6,800	9,000
Little Atlin	1964	1,800	---
Little Salmon	1969	2,800	---
Mayo			3,600
McQuesten			1,800
Pelly			1,400
Quiet			2,800
Sekulmun	1968	3,600	---
Simpson	1964	900	---
Tatlmain			1,800
Teslin		5,900	2,200
Tillei			1,400
Tincup	1971	1,800	---
Wellesley	1971	4,000	---
Wolf			3,600

Commercial fisheries – post-devolution

In 1989 the Federal Government devolved freshwater fisheries management to the Government of Yukon. Following this devolution, Yukon reviewed all licensing practices and initiated an index-netting program on all major Yukon lakes. This program was designed to better characterize and understand fisheries resources and to identify locations where fish populations were depleted.

Subsequent to these surveys, Yukon further reduced the number of lakes where commercial fisheries were permissible and reduced quotas on the remaining lakes and rivers: Kluane Lake; Atlin Lake; Bennett Lake; Six-Mile River; Lake Laberge; Yukon River; and Teslin Lake.

Throughout the years, both pre and post-devolution, the commercial fishery has undergone a slow and steady harvest decline (Table 2).

Currently, the total allocated commercial quota for Yukon is 4,860 kg (4,050 kg lake trout, 760 kg whitefish and 50 kg of cisco), spread across six waterbodies. Total harvestable quota is divided into 14 individual quotas, the majority of which are no longer fished. Only four fishers annually renew their commercial licences, and of these, only two routinely report harvest (Table 3).

Since the commencement of this review, the commercial fishery for Cisco on Six-Mile River has been closed.

Domestic fisheries

In addition to the commercial fisheries, there were also licences issued for domestic purposes. Domestic fisheries were only allowed on lakes where commercial fisheries were already in existence. These licences provided a food fishery for non-First Nations beneficiaries, as well as an avenue for providing fish as food for sled dogs, largely through the harvest of whitefish.

Although domestic fisheries were on a small scale, they still contributed pressure to fisheries resources. In 1974, 42 freshwater licences were issued, by 1982 the number of licences issued had risen to 159. The average reported harvest over this nine-year period was 3,790 lb (1,720 kg), of which 80% were whitefish.

Domestic fishing licences entitled any licence holder in Yukon to fish on any of the 20 commercially fished lakes, prior to 1990. After 1990, the Government of Yukon began limiting these domestic licences to those individuals who could demonstrate that they lived primarily from the land, in remote and isolated areas. For those individuals who could demonstrate such a lifestyle, individual quotas were established.

This subsequently created a substantial reduction in the number of individuals using domestic licences and therefore a substantial decrease of pressure in regards to domestic fishing licences.

Table 2. Yearly average weight (kg) of commercially harvested lake trout and whitefish (based on ten year intervals) between the periods of 1961 to 2009. 1961 to 1982 averages extrapolated from Siegel and McEwen (1984); 1989 to 2016 from Government of Yukon files.

years	mean lake trout (kg)	mean lake whitefish (kg)	combined
1961 - 1971	7,268	7,817	15,085
1972 - 1982	3,761	4,863	8,624
1989 - 1999	1,959	1,789	3,748
2000 - 2009	409	806	1,215
2010 – 2016	269	875	1,144

Table 3. Lake and individual quotas (kg) for remaining water bodies where commercial harvest still exists. Average fish harvested (kg) by individual fishermen during the last 15 years, when harvest has been reported.

lake/total quota	species	individual quotas (kg)	renewals (2002 to 2016)	mean harvest (kg) (2002 to 2016)
Atlin (450kg)	LT	400	15	177.6
	LT	50	15	0.6
Bennett (550kg)	LT	550	15	165.7
Kluane (3050kg)	LT	75	0	0
	LT	750	3	20.4
	LT	1,250	2	0
	LT	100	4	0
	LT	500	3	5
	LT	100	4	1.5
	LT	274	1	0
Yukon River (500 kg)	LWF	500	3	27
Teslin Lake (125 kg)	LT	125	0	0
Teslin River (260 kg)	LWF	260	1	0
Six-Mile River (50 kg)	Cisco	50	15	188

Potential revenue

To effectively review Yukon commercial fisheries, we must consider the impact of potential economic revenue in relation to market value and current commercial interest. In particular, this impact focuses on lake trout and lake whitefish, the two primary species which are commercially harvested.

Market value

Market demand for lake trout and lake whitefish can be considered relatively small when compared to other salmonids species (i.e. chinook salmon). Reasons for this low demand stem from the perceived quality of the meat in relation to taste preferences, as well as the potential for parasite loads that are often found in lake trout and lake whitefish tissue. In particular, lake whitefish are host to the parasite *Triaenophorus crassus* that resides in the muscle of the fish's dorsal area. This parasite forms cysts and while not harmful to humans, the cysts affect the fish flesh aesthetics and thereby the product's marketability. This results in an increase to processing costs and wastage (Freshwater Fish Marketing Corp.; Middagh pers. comm.).

In addition to these costs, due to Yukon's remote location, distances to markets are considerable and in order to compensate for increased shipping costs, potential buyers would be forced to offer low catch prices, affecting revenue generation.

Market comparison

When comparing market value to a potentially similar market, the Northwest Territories (NWT), the Freshwater Fish Marketing Corporation purchases dressed lake trout (head and guts removed) from NWT for approximately $0.73/kg, with prices of lake whitefish at approximately $1.96/kg (Government of NWT, Maher pers. comm.). Within this jurisdiction, the Government of NWT offers the commercial fishing industry a

subsidy of $0.50/kg to compensate for shipping costs.

When comparing market value to southern jurisdictions, it was noted that the value was slightly higher for lake trout at $0.84/kg in Manitoba from 2001 through 2010 (Manitoba Conservation and Water Stewardship Fisheries Branch 2012). This value was also increased within Ontario, which averaged an export price for lake trout of $1.07/kg from 2008 to 2017 (Ontario Commercial Fisheries Association 2018; www.ocfa.ca).

Yukon commercial interest

Commercial export fishery

Yukon has a current aggregate quota for lake trout of approximately 4,000 kg. Based upon the above comparison of lake trout export markets the total revenue for a Yukon export lake trout commercial fishery would range between $3,650 and $4,280. At this current aggregate total, external export markets for whole fish are not economically attractive to support a commercial export fishery.

Commercial local fishery

The expected market value of lake trout sold directly to local markets as fresh/dressed fish, which include the removal of the head and gut portions, is potentially much greater than an export fishery. This price comparison in NWT is at $4.40/kg for lake trout and ranges from $6.60/kg to $8.80/kg for lake whitefish (Government of NWT; Mike Mayer pers. comm.). This price may be increased if fish are fully processed as boneless and skinless fillets, however that process will increase operator costs.

If we extrapolate these prices for a commercial local fishery in Yukon the aggregate total revenue would range from $26,400 to $35,200. This range however is only attainable at full quota realization. Over the past 15 years, Yukon has an average annual harvest of 350kg of lake trout and lake whitefish, which is equivalent to a range of $2,310 to $3,080 in generated revenue.

This valuation only supports local individual revenue generation, through informal selling to locals.

Current status

The current local market is not recorded as all existing commercial harvesters catch weights and volumes are self-reported and there is no mechanism to ensure their accuracy. The current local market contains only two active harvesters, who sell their catch informally to locals, and do not record revenue generation.

The stated valuation of potential revenue generation for either a commercial export fishery or a commercial local fishery is not economically viable for commercial harvesters.

Status of lake trout and lake whitefish stock within commercial fishing locations

Currently there are four major water bodies where commercial quotas exist for lake trout or lake whitefish. They include Atlin Lake, Bennett Lake, Teslin Lake and Kluane Lake. With the exclusion of Kluane Lake, the remaining three are in the Southern Lakes district and are considered relatively close to major urban areas.

Lake trout and lake whitefish populations have been assessed for population size by the Government of Yukon using the Summer Profundal Index Netting (SPIN) program (Sandstrom and Lester 2009). The Government of Yukon has also performed Angler Harvest Surveys on these systems to determine fishing effort and harvest levels. Below is a brief synopsis of the status of lake trout and lake whitefish in each of these systems.

This synopsis does not include data on subsistence harvest.

Atlin Lake

Location

Atlin Lake is a very large, deep lake primarily located in northwestern British Columbia (BC), with the small north boundary lying within in the *Traditional Territory* of the Taku River Tlingit First Nation (TRTFN) and the Carcross/Tagish First Nation (CTFN). The lake's northern end extends into Yukon, approximately 100 km southeast of Whitehorse. At approximately 81 km in length, with an area of 588 km^2, Atlin Lake is the largest natural lake in BC and the largest lake in Yukon. The lake sits at an elevation of 670 m above sea level, has a mean depth of 85.6 m, and a maximum depth of 283 m (Foos *et al.* In prep).

Regulation status

The licenced angling fishery in the Yukon portion of Atlin Lake is managed under the Special Management Waters for arctic grayling, with lake trout and lake whitefish being managed under General Waters limits since 1990. British Columbia and Yukon angling regulations have been largely harmonized since 2001. The current catch limit for lake trout is three fish per day, with six in possession. Only one lake trout in possession may be longer than 65 cm total length in Yukon (60 cm fork length in BC). Lake whitefish have a daily catch limit of five, with an allowable 10 fish in possession. In this transboundary water, catch limits do not change, regardless of jurisdiction fished.

Population status

In 2014, the Government of Yukon sampled Atlin Lake in collaboration with British Columbia's Ministry of Natural Resources Operations and the Taku River Tlingit First Nation, whose *Traditional Territory* encompasses Atlin Lake.

During the SPIN survey, 188 lake trout were caught for an average of 1.01 lake trout per net. This result indicated that there was a moderate to high relative density of large-bodied lake trout, consistent with a lake of its productivity, and therefore, the population could be considered healthy (Foos *et al.* In prep).

There were also 11 whitefish captured during the survey, resulting in 0.04 lake whitefish per net. This result, when compared to other Yukon lakes is small, suggesting that the relative density of the whitefish population is low.

In consideration of the angling pressure, two angler harvest surveys have been conducted (2000, 2014). Through these surveys, it was determined that angling effort has been increasing on Atlin Lake, with effort doubling between 2000 and 2014 (Taku River Tlingit Fisheries Department. 2001; Foos *et al.* In prep). Accordingly, the number of fish caught and harvested has also risen.

In 2000 it was estimated that anglers captured 746 lake trout, while in 2014 an estimated 2,193 lake trout were captured. Of the fish captured, approximately 59% were retained in 2000 and 48% were retained in 2014 (Taku River Tlingit Fisheries Department 2001; Foos *et al.* In prep).

The total estimated weight of harvested fish for Atlin in 2014 was 2,480 kg. If we were to add this figure to the established commercial quota it would total 2,880 kg. This figure falls beneath the optimal sustainable yield (OSY = 5,000 kg), (Table 4).

Bennett Lake

Location

Bennett Lake is located in the Southern Lakes region in the *Traditional Territory* of the Carcross/Tagish First Nation. The community of Carcross is at the junction of the South Klondike Highway and the mouth of the Nares River. This is also the northern end of Bennett Lake. The lake

extends south with one arm stretching west and the other continuing south into BC. The lake sits at an elevation of 656 m above sea level. Bennett Lake is approximately 41 km long with an area of 91 km^2. The lake has a mean depth of 62 m and a maximum depth of 123 m (Barker *et al.* 2015).

Regulation status

Bennett Lake is a Yukon-BC transboundary water, where Yukon and BC licences are valid on the entire lake. Within the BC section of the water, all BC fishing regulations must be followed. Length and possession requirements have been harmonized.

Licenced angling on Bennet Lake has been managed under a Conservation Waters regulations since 1994 for lake trout, with lake whitefish limits under the General Waters Regulation. The catch limit for lake trout under these regulations is two fish per day and two in possession. All fish between 65 and 100 cm must be released.

Population status

The 2014 Bennett Lake SPIN survey results captured 128 lake trout, resulting in a lake-wide numerical catch per unit effort (CPUE) of 0.68 lake trout per net, and a lake-wide biomass CPUE of 0.81 kg of lake trout per net (Barker *et al.* 2015).

Angler harvest surveys have been conducted on Bennett Lake on two separate occasions, the first in 1990 and the second in 2009 (Millar *et al.* 2012). Between these periods, angler's catch rates rose from 0.08 fish per hour to 0.13 fish per hour. The amount of effort that anglers spent fishing the lake had dropped by 19% from 1,255 hours in 1990 to 1,020 hours of effort in 2009 (Millar *et al.* 2012). In 2009 the total estimated catch was 128 lake trout, and 74 fish being retained. Release rates have gone up substantially; in 1990, of the 99 fish caught, all were retained. In 2009, 42% were released. The total estimated weight for harvested fish is estimated to be 112 kg.

The current commercial quota for Bennett Lake is 550 kg. The average commercial harvest between 2002 and 2016 was 166 kg. The calculated OSY for Bennet Lake is 535 kg (Table 4).

Teslin Lake

Location

Teslin Lake is a trans-boundary waterbody, which straddles the border between Yukon and BC and is within the *Traditional Territory* of the Teslin Tlingit Council. Teslin Lake is approximately 120 km long, with a mean depth of 53 m and a maximum depth of 232 m. The lake is situated at an elevation of 684 m above sea level and covers an area of 362 km^2, Teslin Lake is one among a series of large lakes that form the southern extent of the Yukon River basin. It has several major inflows including the Teslin, Gladys, Hayes, Jennings, Morley, Swift, and Nisutlin rivers. The lake is drained by the Teslin River to the north, one of the major headwater tributaries of the Yukon River (Lowey *et al.* 2016).

Regulation status

Teslin Lake is managed within the Special Management Waters of the Yukon angling regulations for lake trout and under General Waters limits for lake whitefish. The catch limit for lake trout under these regulations is one fish per day and one in possession. All fish between 65 and 100 cm must be released, with only one lake trout over 100 cm allowed in in catch possession.

Population status

The 2016 Teslin SPIN survey results captured 55 lake trout, resulting in a lake-wide numerical catch per unit effort (CPUE) of 0.25 lake trout per net, and a lake-wide biomass CPUE of 0.36 kg of lake trout per net. The estimated absolute density

of lake trout >300 mm fork length in Teslin Lake was 1.8 lake trout per hectare. Teslin Lake can be considered to have a low relative density of large-bodied lake trout; lower than would be predicted given a lake of its productivity.

Angler surveys have been conducted on Teslin Lake six times (1992, 1997, 2000, 2003, 2008, 2015). Angler effort fluctuated among the sampling events (5,302 hr ± 2013 hr) and without an apparent trend. The number of lake trout caught per hour also fluctuated with no discernable trend (0.268 ± 0.113 fish/hr). Lake trout release rates have increased by approximately 38 % when comparing the last two survey years (2008, 2015) to the first two (1992, 1997) . For example, in 1992 it was estimated that 421 lake trout were caught of which 81 % were retained whereas in 2015 an estimated 1,205 fish were caught but of these only 22% were retained (Mather et *al.* In prep). In 2015, the estimated lake trout harvest was 754 kg, an estimated 75% of the OSY, which is estimated at 1,011 (table 4).

Kluane Lake

Location

Kluane Lake is located approximately 60 km north of Haines Junction. The lake sits at an elevation of 781 m above sea level, is approximately 81 km long and has a surface area of 408 km^2. It is the largest lake that sits entirely within Yukon. Kluane Lake lies within the traditional territories of the Kluane First Nation and the White River First Nation, and adjacent to the *Traditional Territory* of the Champagne and Aishihik First Nations.

Regulation status

Kluane Lake is managed under the Conservation Waters section of the Yukon angling regulations. This allows a catch limit for lake trout under these regulations of two fish per day and two in possession. All fish between 65 and 100 cm must be released, with only one lake trout over 100cm allowed in in catch possession. Lake whitefish are managed under General Waters regulations for Kluane Lake

Population status

The 2013 SPIN results captured 152 lake trout. The catch per unit effort (CPUE) was 1.02 lake trout per net, and a lake wide biomass of 2.01 kg per net. The estimated density of lake trout for Kluane Lake was 4.2 lake trout per hectare (Barker et *al.* 2014). These results indicate that relative to other Yukon lakes, Kluane Lake has a dense population of large-bodied lake trout. In terms of abundance, the lake trout population can be considered very healthy. Results for the 2013 SPIN survey also indicate that there is a high relative density of lake whitefish. In total, 471 lake whitefish were caught, resulting in a lake-wide CPUE of 2.44 fish/net and a biomass of 1.94 kg per net (Barker et *al.* 2014). The population of lake whitefish in Kluane, relative to other sampled water bodies can be considered abundant.

Angler Harvest surveys for Kluane Lake were conducted in 1991, 2000 and 2004. When comparing the results from these three sampling events no visible trend was evident (Foos 2007). Given the large size of Kluane Lake, fishing effort can be considered low. This effort is approximately 2,997 angler hours per year, which is approximately 0.076 hours/ha, with the average catch rate for lake trout was 0.268 fish/hr. ± 0.113 (Foos 2007).

The OSY for lake trout from Kluane Lake is approximately 3,109 kg, with a current commercial quota of 3,050kg. The estimated average harvest (1991, 2000, 2004 results combined) is 1,086 kg, which is approximately 35% of the recommended sustainable harvest (table 4).

Table 4. The optimal sustainable harvest (OSY); Estimated lake trout harvest from the Recreational Angling Fishery (harvest); Total allowable commercial quota (quota); Percent of the sustainable harvest, when commercial quota and angling harvest are combined.

water body	OSY (kg)	harvest (kg)	quota (kg)	percent OSY
Atlin	5,000	2,480	450	41% below
Bennett	535	112	550	15% above
Teslin	1,011	754	125	13% below
Kluane	3,109	1086	3,050	25% above

Recreational fishing trends

When reviewing the commercial fishing industry in Yukon, for lake trout and lake whitefish, a quick review of recreational fishing is needed in order to understand the full demands upon Yukon fisheries. As discussed Yukon lakes are unproductive, when compared to lakes across southern Canada, as such, impacts to population levels stem not only from commercial fishing, but also from recreational fishing.

Every 5 years, anglers in Yukon are surveyed as part of a larger national recreational survey, to understand how the recreational fishery is changing. Using the results from these surveys allows us to determine indications of how the recreational fishery has trended over the last 25 years (1990 to 2015) in Yukon. In addition, Yukon has been annually collating sales of its recreational angling fishing licences. This information can also provide insights into Yukon's recreational fishing.

Yukon angling licences

Since 2001, Yukon's population has steadily increased, and is projected to have an annual growth rate of 1.3% until 2030 (Yukon Bureau of Statistics). Associated with this growth in population is an increase in the number of Yukon's angling licences, which is illustrating a steady increase (Figure 1).

Between 2000 and 2015, based on resident licence sales, Yukon's recreational fisheries have seen an annual increase of 2.0%, with licence sales increasing by 35%. This same trend can also been seen in licence sales for non-resident Canadians (1.8% annual increase) and First Nations anglers (2.0% annual increase) (Yukon Fisheries files).

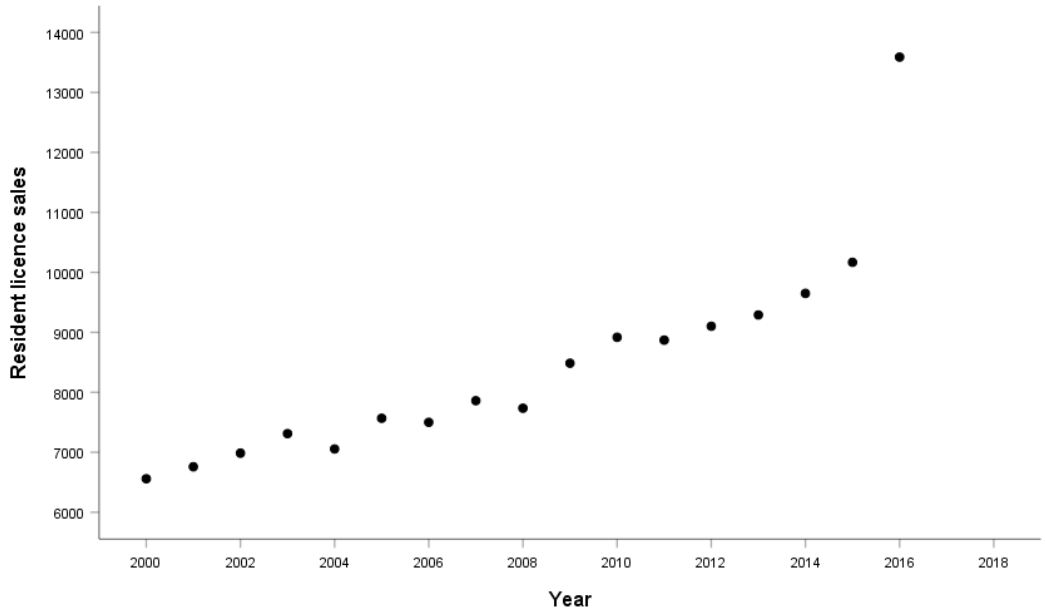

Figure 1. The number of Yukon recreational angling licences sold per year since 2000. Note: online licensing was established in 2016.

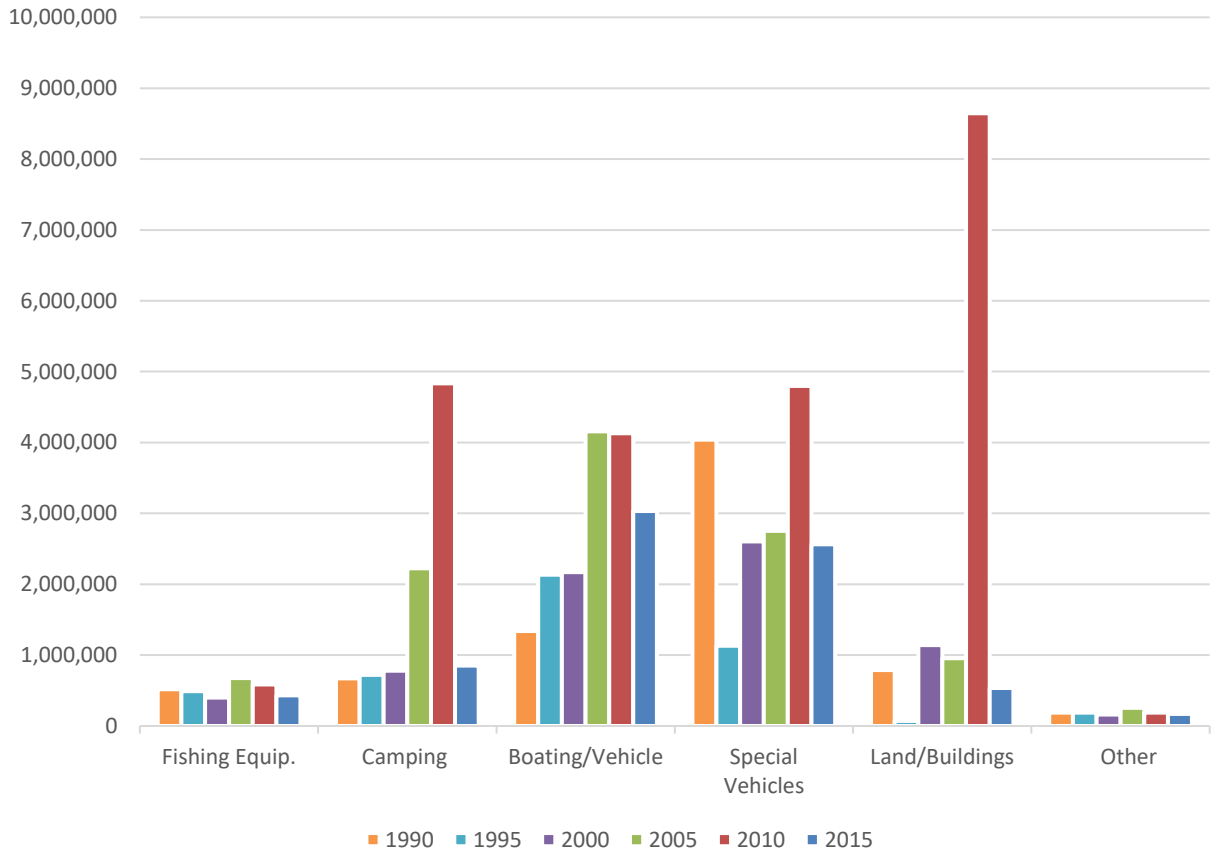

Figure 2. Expenses related to the Yukon recreational fishing industry from 1990 through 2015 (DFO 1995, 2000, 2005, 2010, 2015).

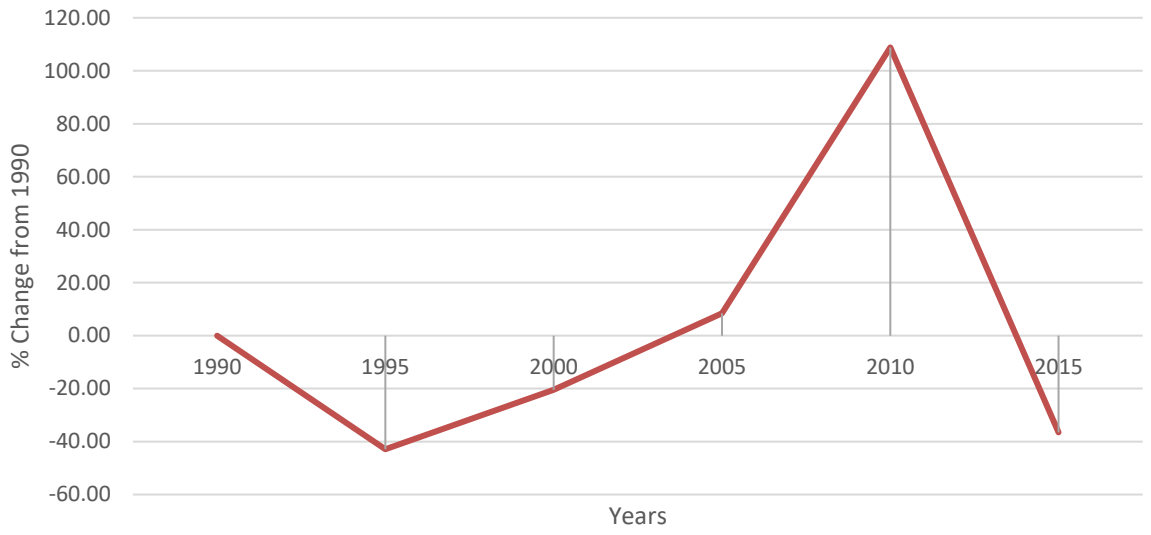

Figure 3. Comparison of Yukon recreational fishing costs from 1990 through 2015, as illustrated in percentage changes from 1990. All costs are adjusted for inflation to illustrate costs in 1990 Canadian dollars.

Yukon recreational angling expenses

In addition to increased participation, recreational anglers appear to be directing greater revenue in the pursuit of angling. To determine changes since this survey was created, in 1990, a comparison was made between each survey year in relation to expenses related to recreational fishing, including: fishing equipment; boating and vehicle expenses; camping expenses; specialty vehicles; land and building costs; and other expenses (Figure 2).

When adjusted for inflation to 1990 Canadian dollars, this shows a variable trend over these years, with a significant increase from 2000 through 2010, now showing a decrease in the 2015 data (Figure 3). This trend is influenced by the significantly higher costs attributed to land/building purchases that were observed in 2010.

Yukon recreational angling harvest

The harvest of both lake trout and lake whitefish within Yukon, in the recreational angling industry has been relatively stable, with a moderate decline since 2010 (Figure 4).

Although lake whitefish are routinely caught throughout Yukon, lake trout are the primary fish species that is harvested by recreational anglers. These values are critical in understanding the potential role that a commercial fishing industry for lake trout and lake whitefish has upon Yukon fish stock levels.

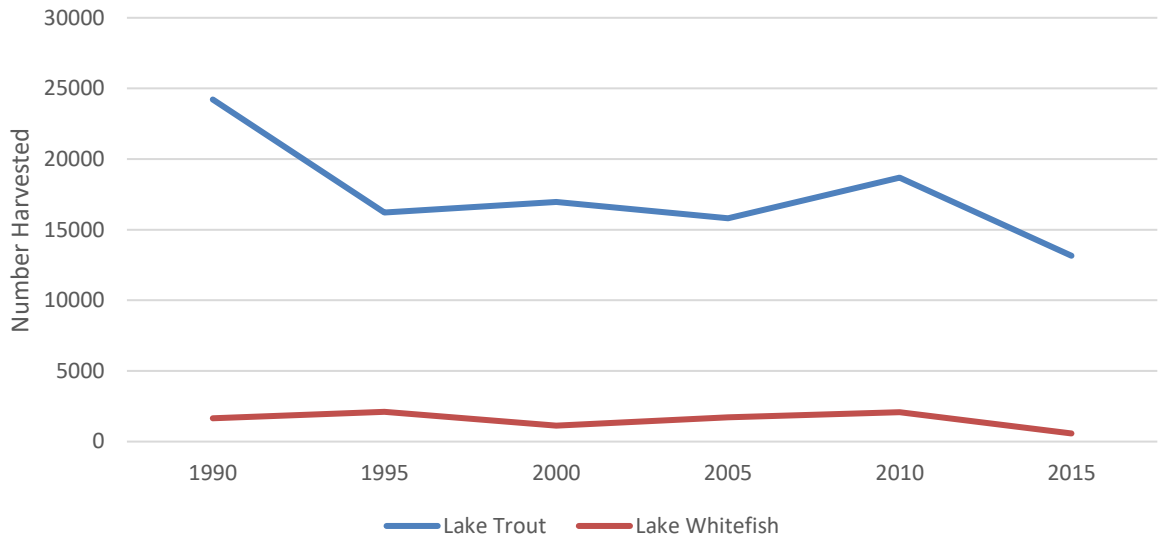

Figure 4. Yukon recreational angling harvest of lake trout and lake whitefish (DFO 1990, 1995, 2000, 2007, 2012, 2019).

Recreational fishing trends review

When reviewing the trends in recreational angling licences, as well as the trends associated with Yukon recreational angling expenses and harvest rates, we can see that recreational fishing in Yukon is increasing in popularity. However, this increase in popularity is not evident through a review of expenditures with the exception of the 2010 survey (Figure 3). This popularity is also trending to illustrate a decrease in harvest levels of lake trout (Figure 4). This trend may be relative to a decrease in catch per unit effort and is indicative of a fish stock level that is receiving additional recreational pressures and which has the potential to show vulnerability to harvest rates.

Discussion

This review focuses on the status of the Commercial Fishing Industry in Yukon, as it relates to a perception of an increased recreational fishery, along with continued subsistence harvest. We reviewed the historical and current status of the industry, potential revenue, fish population levels and the status of the recreational angling industry.

The historical review illustrated a short-lived lake trout and lake whitefish industry, which coincided with the increase in Yukon non-First Nation population as influenced by the Klondike Gold Rush, at the turn of the 20th century. This commercial fishery focused on the large, accessible lakes, predominately in the Southern-Lakes area of Yukon. This industry saw immediate success, followed by immediate collapse due to overharvest and a lack of knowledge about Yukon fisheries sustainability.

The Yukon commercial fishery continued to see a decline in harvest, despite an increase in permit allocation. Since devolution, this industry has declined to a current total of 14 quota's measuring a total harvest of 4,860kg. From a review of potential revenue that the current quota could sustain, as compared to similar jurisdictions, it was determined that the valuation of this industry is not economically viable for commercial harvest.

Since the collapse of the first commercial fishery and post-devolution, the Government of Yukon has continued a lake stock assessment program across Yukon, in relation to lake trout and lake whitefish population levels. With the introduction of fisheries management across Yukon it has been determined that Yukon lakes are low in productivity, when compared to southern Canadian lakes. This results in lower optimal sustainable yields of harvest levels across Yukon and as such Yukon lakes are unable to support similar fishing pressures as southern Canadian lakes.

The current lakes in which commercial harvest quotas are set, which are also surveyed by the Government of Yukon, show relatively stable populations. However, in both Bennett Lake and Kluane Lake, commercial harvest quotas are currently set at levels which would exceed the OSY of each lake, when considering the current harvest levels of recreational fishing in these lakes.

The final portion of this review was aimed at looking at trends in recreational angling. This was performed to assist in determining levels of fishing pressure across Yukon. This review illustrated an increase in recreational angling, with relatively stable expenses and a slightly declining harvest. As the Yukon population continues to grow and the tourism industry becomes an increasing economic focus, the Yukon Tourism Development Strategy has created a target in which the desired goal is to double revenue attributable to tourism by 2028 ($525 million; Yukon Tourism 2018). As recreational angling is an important economic focus, all indications for the foreseeable future show Yukon's licenced angling harvest will continue to grow.

This growth will challenge fisheries management to maintain harvest levels below OSY.

Recommendations

The primary focus of fisheries management is the ability to provide sustainable fisheries and harvest levels. Yukon lakes are seeing an increase in recreational fishing pressure, which has the potential to add both economic revenue as well as strain on the resource.

The following recommendations are based on the information and trends identified in this review:

- Reduction of commercial fishing harvest quotas to meet OSY in all established current lakes that support commercial licences;
- Retirement of currently unused licences, with automatic closure after 2 years of non-use;
- Cessation of new licence allocations; and
- Increased monitoring of lake population stocks in established commercial fishing lakes, with potential adjustment of quotas in order to maintain OSY.

Conclusion

Yukon lakes are low in productivity and slow to recover from declined populations. In order to maintain fisheries sustainability increased scrutiny of the commercial harvest quota is required.

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