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A risk-based decision-making framework for Buffalo River Inconnu (*Stenodus leucichthys*) that incorporates the Precautionary Approach

Un cadre décisionnel axé sur les risques pour l'inconnu (*Stenodus leucichthys*) de la rivière Buffalo et intégrant l'approche de précaution

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ABSTRACT

Inconnu (*Stenodus leucichthys*) have been harvested as bycatch in the Great Slave Lake (GSL) commercial Lake Whitefish (*Coregonus clupeaformis*) fishery from 1945 to the present. The Buffalo River stock was heavily targeted at the mouth of this system in the springs of 1978 and 1979. The stock collapsed following this fishing pulse and has not recovered since. Inconnu become vulnerable to the fishery several years prior to maturity and are, therefore, vulnerable to recruitment overfishing. Using the precautionary approach (PA) framework, a PA model for management of GSL Buffalo River Inconnu was tabled at a regional advisory process organized by Fisheries and Oceans Canada (DFO) in Yellowknife, NT, on March 30 and 31, 2010. Catch-per-unit-effort of mature female Inconnu in experimental nets set at the mouth of the Buffalo River in spring between 1976 and 2008 was used as an index of spawning stock biomass (SSB) and biological reference points (BRP) of the PA model. Maximum removal rates were determined from examination of the response of population parameters of this stock to various rates of commercial harvest of Inconnu from the west basin of GSL. Upper and lower limit BRP SSBs were 10 and two mature female Inconnu caught per hour per net respectively. Recommended upper and lower limit removal rates were 40,000 kg and 10,000 kg respectively. Buffalo River Inconnu were assigned to the critical zone of the PA model and had a BRP SSB of 0.6 mature female Inconnu caught per hour per net for the last assessment done in 2008. Following the pulse fishing of 1978 and 1979, BRP SSBs have remained in the critical zone of the PA model, except in a single year. Levels of risk were assigned as moderate for the lower limit removal rate of 10,000 kg and high for all removal rates in excess of this amount. Given the critical status of Buffalo River Inconnu, a low level of risk can only be achieved through a closure of the fishery.

RÉSUMÉ

Depuis 1945, l'inconnu (*Stenodus leucichthys*) est surtout capturé de façon accessoire dans le cadre de la pêche commerciale au grand corégone (*Coregonus clupeaformis*) dans le Grand lac des Esclaves. Aux printemps 1978 et 1979, le stock de la rivière Buffalo a été particulièrement ciblé à l'embouchure de ce système. Le stock s'est effondré à la suite de cette vague de pêche, et il ne s'est jamais rétabli. L'inconnu est devenu vulnérable à la pêche plusieurs années avant d'atteindre sa maturité et, par conséquent, à la surpêche du potentiel reproducteur. Tiré du cadre d'approche de précaution (AP), un modèle d'AP pour la gestion du stock d'inconnus de la rivière Buffalo dans le Grand lac des Esclaves a été présenté lors d'un processus de consultation régionale organisé par Pêches et Océans Canada (MPO) à Yellowknife (T.N.-O.), les 30 et 31 mars 2010. Les prises par unité d'effort de femelles inconnus matures dans des filets expérimentaux installés à l'embouchure de la rivière Buffalo au printemps entre 1976 et 2008 ont servi d'indice de la biomasse du stock reproducteur (BSR) et de points de référence biologiques dans le modèle d'AP. Les taux d'exploitation maximaux ont été déterminés d'après l'étude de la réponse des paramètres de population de ce stock à divers taux de pêche commerciale à l'inconnu dans le bassin ouest du Grand lac des Esclaves. Les limites supérieures et inférieures des points de référence biologiques de la BSR étaient établies respectivement à dix et deux femelles inconnus matures prises par heure et par filet. Les limites supérieures et inférieures recommandées du taux d'exploitation étaient de 40 000 et de 10 000 kg respectivement. Le stock d'inconnus de la rivière Buffalo a été évalué comme se situant dans la zone critique du modèle d'AP et, d'après la dernière évaluation effectuée en 2008, le point de référence biologique de la BSR était de 0,6 femelles inconnus matures prises par heure et par filet. À la suite de la vague de pêche en 1978 et en 1979, les points de référence biologiques de la BSR sont demeurés dans la zone critique du modèle d'AP, sauf une année. On a attribué un niveau de risque modéré à la limite inférieure du taux d'exploitation de 10 000 kg, et un niveau de risque élevé pour tous les taux d'exploitation supérieurs à cette quantité. En raison de l'état critique du stock d'inconnus de la rivière Buffalo, seule la fermeture de la pêche permettrait de de parvenir à un niveau de risque faible.

BACKGROUND

STUDY AREA

Great Slave Lake (GSL) lies in the southwest corner of the District of Mackenzie, Northwest Territories. It is the fifth largest lake in North America, having a surface area of 27,195 km^2 and a drainage area of 985,300 km^2. Stretching 440 km from its extreme east end to the outlet of the Mackenzie River, the lake straddles two physiographic regions. The northeast shore of the north arm and the east arm lie within the Precambrian Shield and have irregular precipitous margins. The western portion of the lake overlies the alluvial plain known as the Mackenzie Lowlands and has few islands and gently sloping shores. The rivers entering the lake from the Shield are cold, clear and rapidly flowing while those entering from the south are slow flowing brown water streams laden with silt during spring and early summer. While the western basin has a maximum depth of about 165 m and mean depth of 42 m, a depth of 625 m has been recorded in the east arm. Physical and biological characteristics of the lake have been described previously in detail by Rawson (1950, 1951, 1953a, b).

The Buffalo River enters GSL 40 km east of Hay River at 60° 53' N, 115° 02' W. It drains an area of 17,638 km^2 with various tributaries originating in the Caribou mountains of northern Alberta that flow into Buffalo Lake. Buffalo Lake is a shallow lake (maximum depth of 2.0 m), 55 km in length and 25 km at its widest point and covers an area of 720 km^2. The lake has a silt bottom with some boulder reefs and islands along the north shore. Wave action disturbs the bottom sediments shortly after spring break-up and the lake remains very silty for the duration of the open water season.

The Buffalo River drains Buffalo Lake from the north-east corner and drops 108 m over 90 km before it drains into GSL. The river is 50 m to 100 m in width and is generally swift and shallow with water depths reaching a maximum of 0.5 m to 2.0 m in the main channel during the spring run off period. Mean discharge during 1977 was 1,860 ft^3/sec (range 0.10 ft^3/sec in March to 4,310 ft^3/sec in August). Due to the influence of Buffalo Lake, the river is turbid even though it flows over a shale and boulder stream bed. It is navigable by a small craft only during peak run off periods. The river often freezes to the bottom in winter and becomes a barrier to fish movement between Buffalo Lake and GSL.

The river has a few current shelters and back eddies located downstream of islands and rapids where gillnet fishing with short sections of net (15 m) is possible, however, the majority of the river's reach is unsuitable for gillnet fishing. The river separates into two channels just before it enters Buffalo Lake which flow on either side of a small island which is approximately 100 m in width.

The Upper Buffalo River, Whitesand River and Yates River are the three major tributaries which flow into Buffalo Lake. These rivers are clear and swift and drop 680 meters between their headwaters in the Caribou Mountains and Buffalo Lake. They assume a brown colour as they meander through the muskeg below the Caribou Mountains. All three rivers have numerous rapids with boulder and course gravel bottoms. The more placid stretches of river generally have silt, sand or organic bottoms.

The Upper Buffalo River is the largest of the tributaries with a drainage area of 5,291 km^2. The lower quarter of the river is 35 m to 60 m in width with depths varying from one to four meters. The river becomes turbid during the spring flood, eroding the silt banks and sweeping down large trees which eventually jam in its estuary at Buffalo Lake. The main channel is completely blocked with logs near the mouth and a new channel has cut northward for 10 km where it enters the main body of the lake.

The Whitesand River is approximately two thirds the width of the Upper Buffalo River and drains an area of 3,427 km^2. The lower quarter of the river is 25 m to 60 m wide and 0.5 m to 3.0 m deep. It is less susceptible to flooding and erosion than is the Upper Buffalo River but also becomes turbid during peak flow periods and has numerous large trees lodged in the shallows of its estuary. The Whitesand divides into two channels a kilometer before it enters the Buffalo Lake.

The Yates River, with a drainage area of 1,764 km^2, is approximately a third the size of the Upper Buffalo River and half the size of the Whitesand River. Its upper reaches form a continuous series of whitewater rapids which flow over shale and boulders through a gorge cut into the north slope of the Caribou Mountains. The mid third of the river is deep and slow flowing and meanders through a flat muskeg area. It is generally narrow (20 m) in this region with mud banks and a silt bottom. The lower third of the river, excluding the final eight kilometers, is fast flowing and shallow. It flows over numerous rapids and has a stream bed composed of boulder and course gravel. The lower eight kilometers of the river are deep and slow and flow through a low swampy area which is characteristic of the south shore of Buffalo Lake. In this region, the stream is 20 m to 40 m wide with a depth of two to three meters. The bottom is composed of organic matter and silt. It is very shallow (0.3 m) where it enters Buffalo Lake.

Several small creeks also drain into the lake. These creeks drain flat swampy areas and are generally slow flowing with organic bottoms. Many are obstructed by beaver dams and become choked with aquatic plants during the summer.

THE GSL COMMERCIAL FISHERY

The commercial fishery has operated on GSL since 1945. Throughout the history of the fishery the lake has been divided into a variety of management areas for which boundaries, nomenclature and quotas have changed. At present there are seven management areas for which the boundaries have remained more or less fixed since 1972, with the exceptions of the creation of Area III in fall of 1978 and the boundary between Areas IV and V which in the spring of 1972 stretched form the point of its present intersection with the south shore to the western side of Yellowknife bay. In the spring of 1974 this boundary was moved eastward (Figure 1).

The management of the GSL commercial fishery is unique in regards to other Canadian commercial fisheries because since its beginning, it has had the production and the biological parameters of the harvested species monitored constantly, has remained relatively unpolluted and has not had introductions of non-native species. The primary source of perturbation in GSL has been commercial exploitation by the use of bottom set gillnets of 140 mm (5 ½ inch) stretched mesh size until 1977 and 133 mm (5 ¼ inch) stretched mesh size from 1977 to 1997. In November of 1997, commercial mesh size was lowered to 127 mm (5 inch) in management Areas IE, II, III and IV. It was lowered to 127 mm in management Area IW in May 2000 and November 2000 in management Area V. Although CPUE of the smaller 127 mm mesh was 45% greater than the 133 mm mesh (Day 2002), fishers found that the disentangling of fish from 127 mm nets took too long. Therefore, it is unlikely that 127 mm nets are used frequently by fishers. At present, harvests are delivered to only one fish plant at Hay River although in the past, other plants operated on the lake (Figure 1).

Commercial harvest is controlled within each management area by an aggregate quota for Lake Trout *(Salvelinus namaycush)* and Lake Whitefish. Lake Whitefish constitute approximately 80% of the harvest of all species for any given fishing year (November 1 of the starting year to October 31 of the following year). Harvests of other commercial species, which are referred to as bycatch (Walleye, Northern Pike and Inconnu) are, therefore, unregulated since fishing for these species only stops when the Lake Whitefish quota has been caught.

Often, attempts at understanding the effects of exploitation on fish communities have been mired by the confounding effects of pollution, foreign species introductions, changes in lake morphology and/or trophic state, incomplete harvest records, an absence of historical information on the type and amount of fishing effort employed and an absence of historical data on the structure, relative abundance and biological parameters of the fish community. In contrast, the effects of the GSL commercial fishery on the fish community of this lake can be well assessed because there is an abundance of historical data on all commercial species of fish and their harvests and there have been relatively few anthropomorphic perturbations other than the commercial fishery itself. However, in regards to west basin Inconnu populations, the effects of hydro development on the Talston River and mining explorations which have produced sulphur discharge in a small tributary of the Buffalo River are unknown. Therefore, we suggest that the use of harvest control alone is appropriate for management of GSL west basin Inconnu stocks in the context of a Precautionary Approach model.

BIOLOGY OF INCONNU

The Inconnu is a large silvery fish of the whitefish family (subfamily coregoninae) with a wide mouth and projecting lower jaw. Its distribution is in northwestern North America and Eurasian arctic watersheds from the White Sea to Bering Strait and south to northern Kamchatka. In North America they occur south on Bering Sea drainages to the Kuskokwim River and east on Arctic Ocean drainages to the Anderson River. They are found throughout the Yukon River system upstream to its headwaters in the Teslin Lake, B.C., and throughout the Mackenzie River system to GSL, up the Slave River to the rapids at Fort Smith and up the Liard River to Fort Nelson, B.C. (Scott and Crossman 1973, McPhail and Lindsey 1970). They occur most commonly in slow muddy arctic rivers and their associated lakes (McPhail and Lindsey 1970). In non-anadromous populations, such as those in GSL, they are usually found in inshore areas of the main body of the lake except in fall when rivers are ascended for spawning.

Inconnu grow rapidly and reach sizes of 800 mm and 15 kilograms or more in as few as 10 years. They spawn in late September or early October in rivers and their tributaries. The adult Inconnu is piscivorous. In GSL, adult Inconnu diets are composed primarily of small fish, mainly whitefish, and at the mouth of the Buffalo River they have been caught gorged with juvenile Inconnu (Larkin, MS cited in Fuller 1955). Inconnu are not a fish of longevity and in most populations fish older than 12 years of age are uncommon. Inconnu which occur in the Yukon River drainage migrate as far as 1,600 km inland from estuarine feeding areas to spawning areas (Alt 1977).

Early accounts by Melvill (1914) stated that in GSL Inconnu probably ascended most of the rivers flowing in from the north but the fall spawning runs were most pronounced in the south shore drainages of the Buffalo, Slave and Talston Rivers with a smaller run occurring in the MacKenzie River. Scott and Crossman (1973) state that in GSL the most pronounced fall upstream runs occur in the Buffalo and Talston Rivers with smaller runs occurring in the Slave, Hay and Little Buffalo Rivers. Rawson (1947) reported that they were well known for their spawning runs in the Talston and Buffalo Rivers and that moderate numbers were taken in gillnets in summer in the North Arm near Yellowknife and Rae. At present, Inconnu are known to occur in significant numbers in the Slave River only and along the south shore of the west basin of the lake and in a northwest direction as far as the Outpost Islands and Inconnu Channel which both lie at the boundary between the east are and west basin. Inconnu may have been eradicated by overexploitation from other rivers and areas of the lake where they traditionally occurred, and there has been a pronounced decline in relative abundance of Buffalo River Inconnu (VanGerwen-Toyne et al. 2013).

Results from mark-recapture and a fishery-independent gillnet survey have shown that the west basin of GSL is an important area for Buffalo River Inconnu (VanGerwen-Toyne et al. 2013). This is highly relevant to the development of removal reference points for the PA model which were based solely on west basin Inconnu harvests. Howland et al. (2000) reported that existing tag return and radio-tracking data indicate that Inconnu from the Mackenzie River and GSL areas do not mix. Their findings when coupled with tagging results of Day and Low (1993) and VanGerwen-Toyne et al. (2013), that a large proportion of the west basin GSL Inconnu harvests are from the Buffalo River stock, is offered as rationale for choosing west basin harvests to set PA removal reference points for Buffalo River Inconnu.

STOCK DEFINITION

The stock definition of GSL Inconnu is unknown but there is good potential for the existence of several discrete stocks. Yellowknife, Buffalo, Slave, Hay, Talston and Little Buffalo Rivers, and Marion Lake (which is connected to and lies north of GSL) are well separated geographically, are extensive with many tributaries and associated lakes, and are known to have had spawning runs of Inconnu historically. Further, research studies have documented differences between several of these potential stocks (Howland et al. 2000, VanGerwen-Toyne et al. 2013, Fuller 1955).

STOCK SIZE, HARVESTS AND CPUE

Stock size cannot be assessed until stock definition is known. However, a pronounced and sustained decline in production of Inconnu from the west basin of GSL suggests that the sizes of all Inconnu stocks of this basin have been markedly reduced (Figure 2). Target fishing for Inconnu was done prior to south shore closures (Figure1) during the fishing years of 1977/1978 and 1978/1979 and yielded exceptionally high catches in Area IE (Figure 3) where the targeting occurred at the mouth of the Buffalo River. Experimental catch-per-unit-effort (CPUE) data for all sex and maturity stages combined from spring samples taken at the mouth of Buffalo River, suggest that the abundance of that part of the Inconnu population which is vulnerable to the fishery (ages four and older) has declined by approximately 85% between the mid-1970s and 2008 (Figure 4). Mean CPUE for mature female Inconnu, the generative component of the population, has declined by approximately 93% for the same time period (Figure 5). Following the high harvests in 1978 and 1979, there was almost complete year class failure for the 1980 to 1985 cohorts (Day and Low 1993, VanGerwen-Toyne et al. 2013).

THE PRECAUTIONARY APPROACH MODEL

Hammill and Stenson (2007) state that the precautionary approach allows resource managers to identify clear management objectives which must address both conservation, economic, and political concerns when establishing harvest levels. However, different weight is given to these concerns for each stock status zone of the model. DFO has published a fishery decision-making framework incorporating the PA which can be found at http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/precaution-eng.htm.

This framework (see below) defines criteria for assignment of stocks to one of three zones (critical, cautious and healthy) and we have used them to assign the present status of Buffalo River Inconnu to the critical zone.

	Stock Status		
	Critical	**Cautious**	**Healthy**
General Approach	Conservation considerations prevail. Management actions cannot be inconsistent with secure recovery	Socio-economic and conservation considerations should be balanced in a manner that reflects location in zone and trajectory	Socio-economic considerations prevail. Conservation measures consistent with sustainable use apply.

The DFO PA framework also suggests harvest strategies (see below) for each of the zones that stocks are assigned to and our conclusion is that the harvest rate of Buffalo River Inconnu from the west basin of GSL (taking into account all sources of removals) must be kept to an absolute minimum.

	Critical	**Cautious**	**Healthy**
Harvest rate strategy	Harvest rate (taking into account all sources of removals) kept to an absolute minimum.	Harvest rate (taking into account all sources of removals) should progressively decrease from the established maximum and should promote stock rebuilding to the Healthy Zone.	Harvest rate (taking into account all sources of removals) not to exceed established maximum.

Data used to develop the PA model for Buffalo River Inconnu were derived from a gillnet study at the mouth of the Buffalo River in spring between 1976 and 2008, as well as historic harvest records (VanGerwen-Toyne et al. 2013).

To set the upper and lower limit reference points for the PA model, the biological reference point (BRP) of relative abundance of the spawning stock biomass (SSB), as shown in the average annual CPUE of mature female Inconnu, was used. Our choice of CPUE of mature female Inconnu as a BRP SSB is supported by a lack of mature females in annual samples and year class failure which occurred immediately after excessive harvests were taken at the mouth of the Buffalo River during the fishing years of 1977-1978 and 1978-1979 (VanGerwen-Toyne et al 2013).

The upper stock status reference point was set at 10 mature female Inconnu per hour per net because this is the mean of this variable for the period prior to high harvests in the late 1970s (Figure 5) and thus represents a healthy stock. The lower stock status reference point was set at two Inconnu per hour per net because it represented a decrease of 80% of the healthy stock and was therefore, qualitatively, deemed as excessive. CPUE of mature females has been less than two since 1983, with one exception; in 2003 CPUE was 2.23 mature females (Figure 5). In 2008, CPUE was 0.70; in the critical zone of the PA model (Figure 6).

Upper and lower removal reference points for SSB are provided in regards to harvests in the west basin of GSL, but with some influence from Area IE because this is where it has been most vulnerable to harvest from the commercial fishery. Removal reference rates for the upper stock status were set at 40,000 kg of Inconnu from the west basin because it was the annual mean harvest (48,500 kg rounded down to 40,000 kg) of Area IE for the fishing years of 1971-1972 to 1977-1978 (prior to abrupt stock decline) and thus represent a healthy stock (Figure 2). This upper value is based on the assumption that all other factors like fish health, habitat status and overall carrying capacity for the stock have remained constant over time (or since the 1970s). The lower removal reference point for SSB was suggested at 10,000 kg from the west basin because when harvests were near this level from 1991-1992 to 2000-2001(annual mean 15,000 kg, Figure 2) CPUE at the mouth of Buffalo River showed signs of improvement and in 2003 rose slightly into the cautious zone of the PA model (Figure 5). However, when west basin harvests were consistently above 10,000 kg from 2001-2002 to 2004-2005 (annual mean of 28,500 kg, Figure 2), the CPUE of Inconnu at the mouth of Buffalo River in 2006 fall back into the critical zone, and has remained there (Figure 5). Although, the model's lower limit removal rate of 10,000 kg may seem conservative given that some recovery occurred in the past at a mean annual west basin harvest rate of 15,000 kg, the recovery was extremely slow and not sustained when harvests increased.

The population is now depleted as is its capacity to recover and is clearly in the Critical Zone therefore, the lower limit removal rate is appropriate and should perhaps even be lower. A moderate level of risk was assigned to the lower limit removal rate of 10,000 kg and a high level of risk to all removal rates in excess of this amount (DFO 2013). DFO (2013) concluded that a low level of risk could only be achieved through a closure of the fishery. In further support of the assignment of this rate, CPUE of mature females has remained in the critical zone from 2006-2007 to 2007-2008 when annual west basin harvest averaged 9,400 kg but exceeded the lower limit removal rate in 2008 by 2,500 kg. We conclude that the model's parameters seem to predict stock decline and recovery and in this sense, it has been tested by historical harvests and observed population response.

Benchmark removal rates presented in the Buffalo River GSL west basin PA model for Inconnu must not be exceeded if this stock is to recover. Buffalo River Inconnu are presently in the Critical Zone with the CPUE of mature females being 0.7 which lies well below the lower limit reference point of two. This situation highlights the difficult position managers are in because the DFO PA framework states that conservation considerations must prevail when stocks are in the critical zone. We propose that the PA model is a reliable tool for Inconnu management in the west basin of GSL because it was developed from a long time series of information on stock relative abundance and population parameters (see VanGerwen-Toyne et al. 2013) which were derived from experimental sampling which took place both before and after stock collapse and year class failure. The almost complete absence of mature females for samples taken one to five years after the collapse and consequent year class failure are textbook examples of overharvest. These observations imply that our annual samples are representative of the dynamics of these stocks. We believe that uncertainty in our data is very low.

Stephenson (1999) states that an emphasis on stock complexity is necessary if a PA is to be used for the management of fisheries. This suggests that there is a need for future stock delineation research on GSL Inconnu.

CONCLUSION

A historical review of Inconnu presence throughout GSL strongly suggests that this species is vulnerable to recruitment overfishing. Abundant Inconnu runs were once reported for the Hay, Talston, Yellowknife, and Little Buffalo rivers (Day and Low 1993) but are presently rare in these locations. The same fate was documented for Lake Trout in the west basin of GSL by Kelleher (1972). Both species become vulnerable to the fishery at ages several years before they mature. Therefore, their opportunity to produce recruits is very limited in a temporal sense. These observations underscore our choice of mature female CPUE for assigning biological limit reference points for the PA model. The last year of relatively good recruitment occurred in 1979 immediately after excessive harvests occurred in 1978 and 1979 and was followed by five successive years of recruitment failure and slow recovery in regards to relative abundance. In coincidence with a 2002 to 2005 pulse in west basin harvests which greatly exceeded the model's lower limit removal rate, the slow recovery stopped in 2003. In conclusion, the historical loss of many stocks of GSL Inconnu and Lake Trout, trends in Buffalo River Inconnu population parameters and the PA model, all firmly place the status of Buffalo River Inconnu as being critical.

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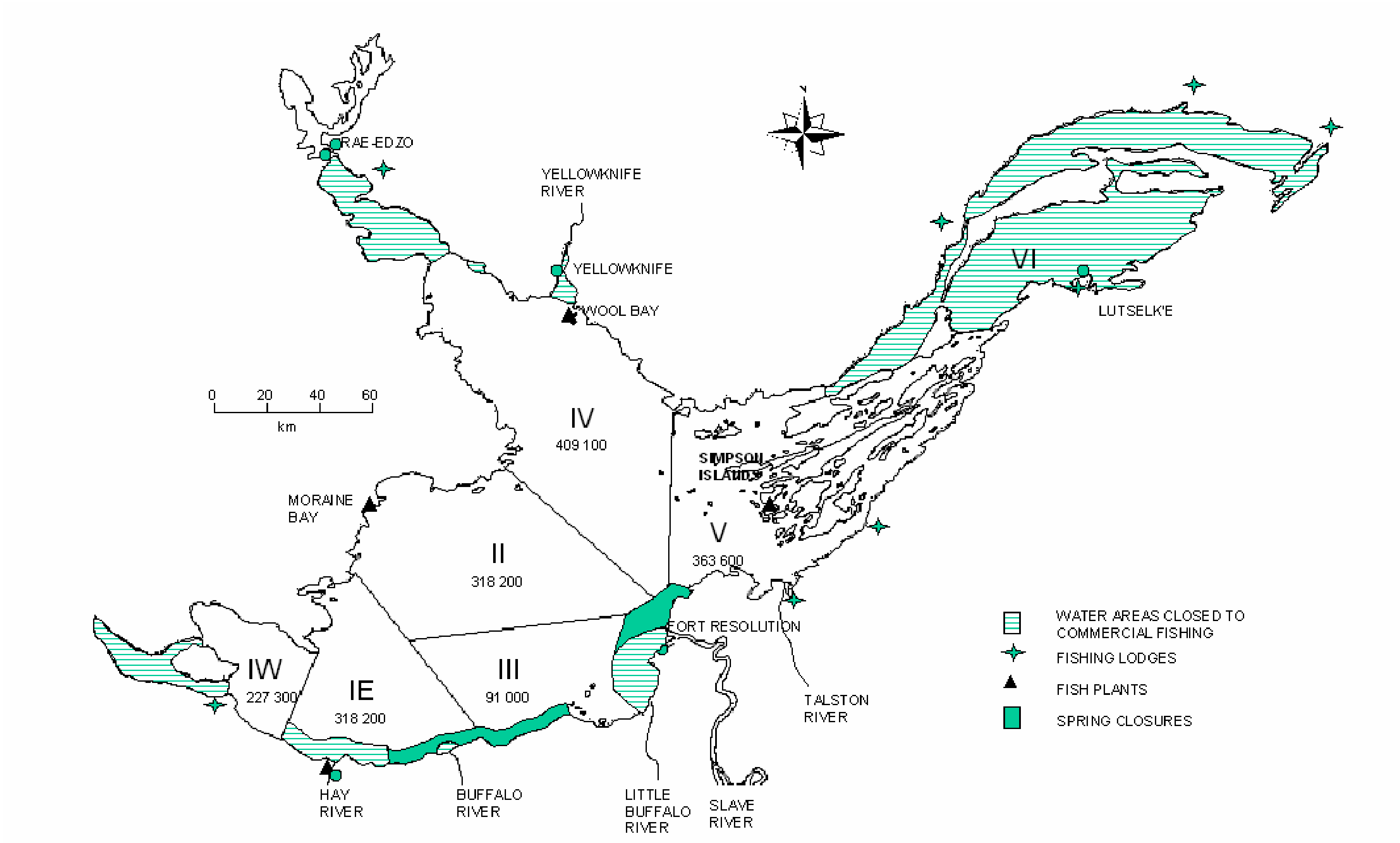

Figure 1. Map of Great Slave Lake showing the management areas and quotas (kg), areas closed to commercial fishing and location of the fish plants and fishing lodges.

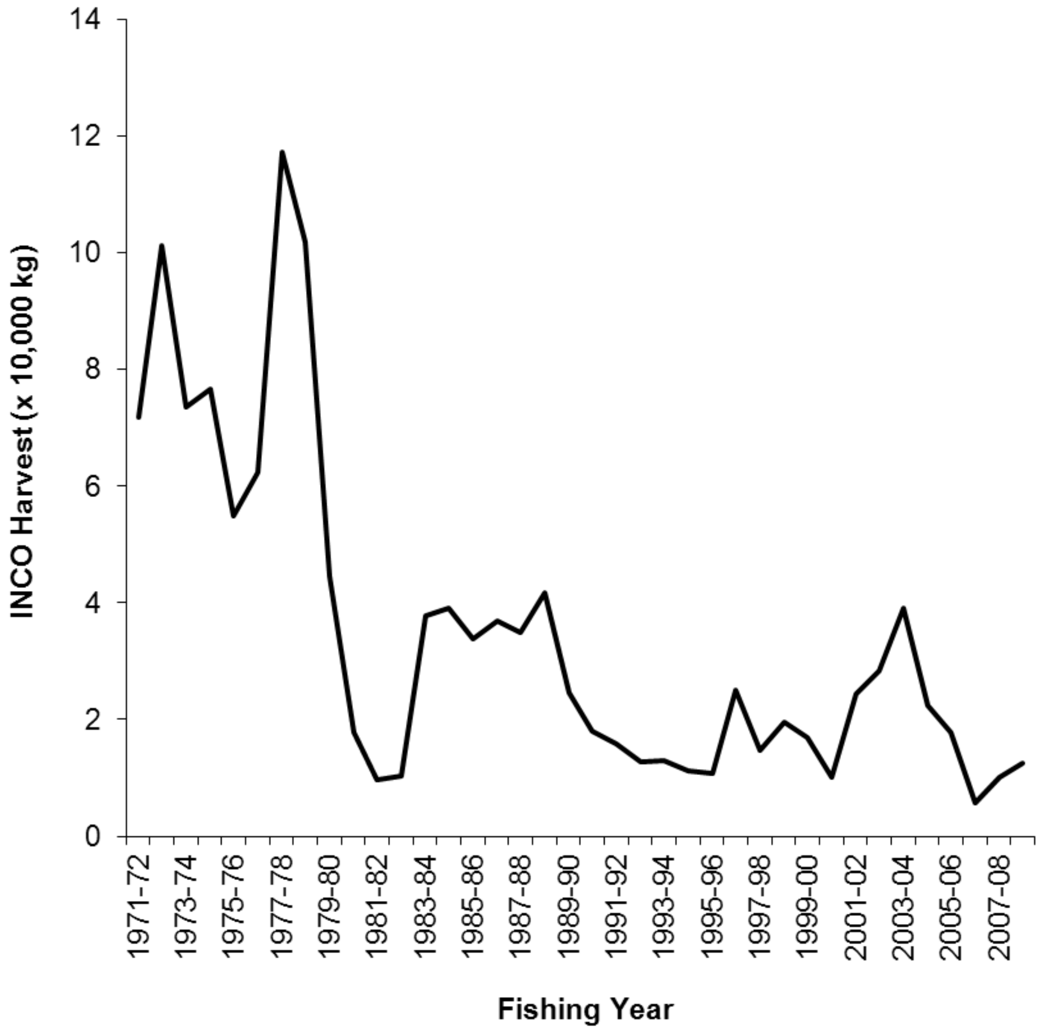

Figure 2. Commercial harvests of Inconnu from the west basin of Great Slave Lake (after VanGerwen-Toyne et al. 2013).

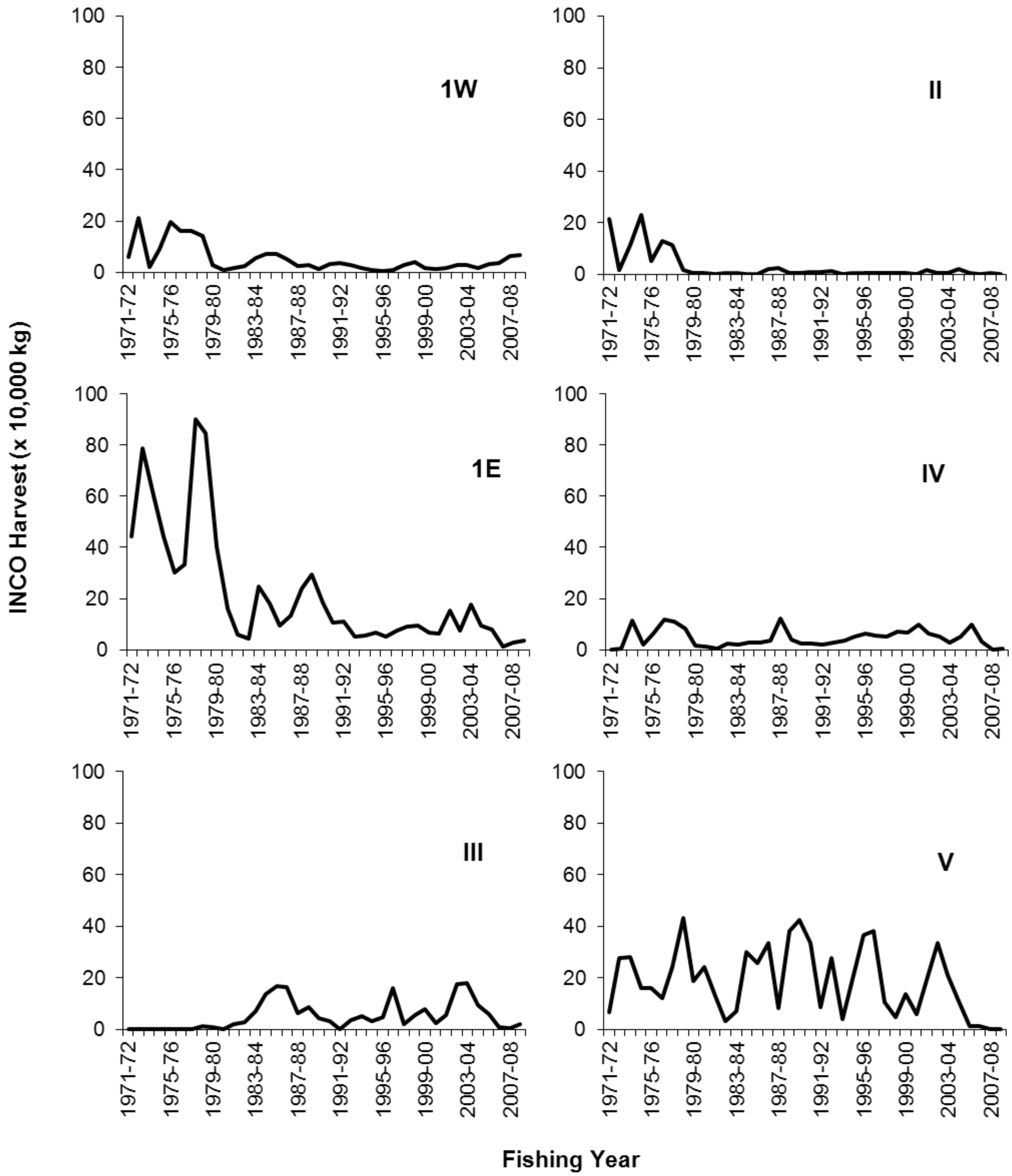

Figure 3. Commercial harvests of Inconnu from six management areas of Great Slave Lake (after VanGerwen-Toyne et al. 2013).

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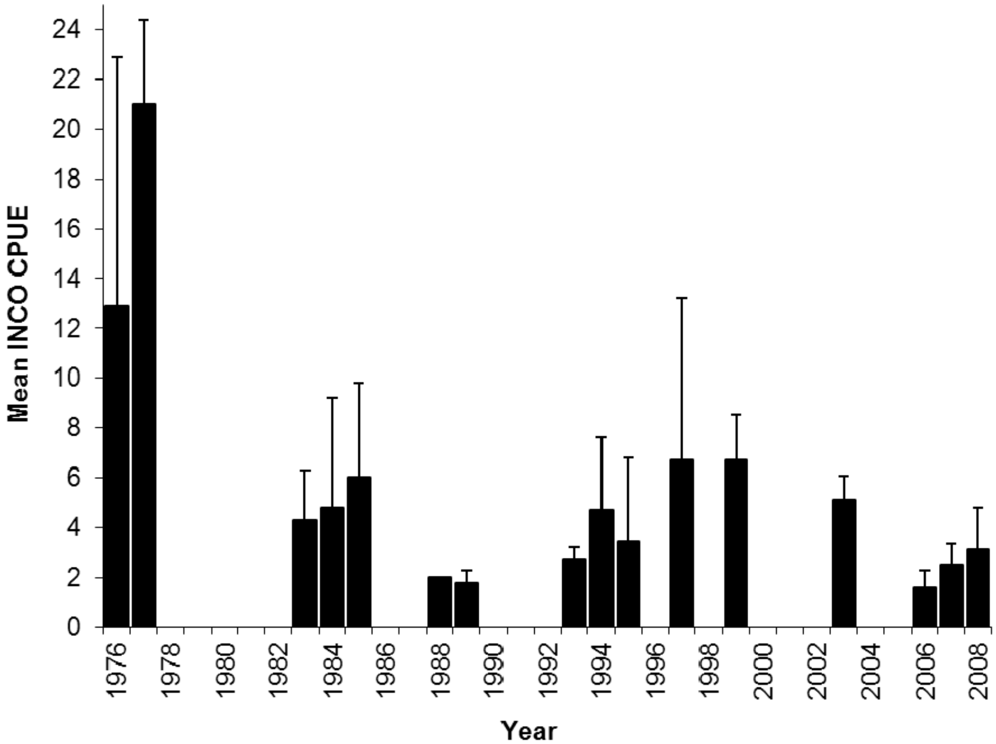

Figure 4. Mean CPUE for all sex and maturity stages of Inconnu caught in 50 m of gillnet (2m deep) per hour (± 1 Standard Deviation) set at the mouth of the Buffalo River, GSL (after VanGerwen-Toyne et al. 2013).

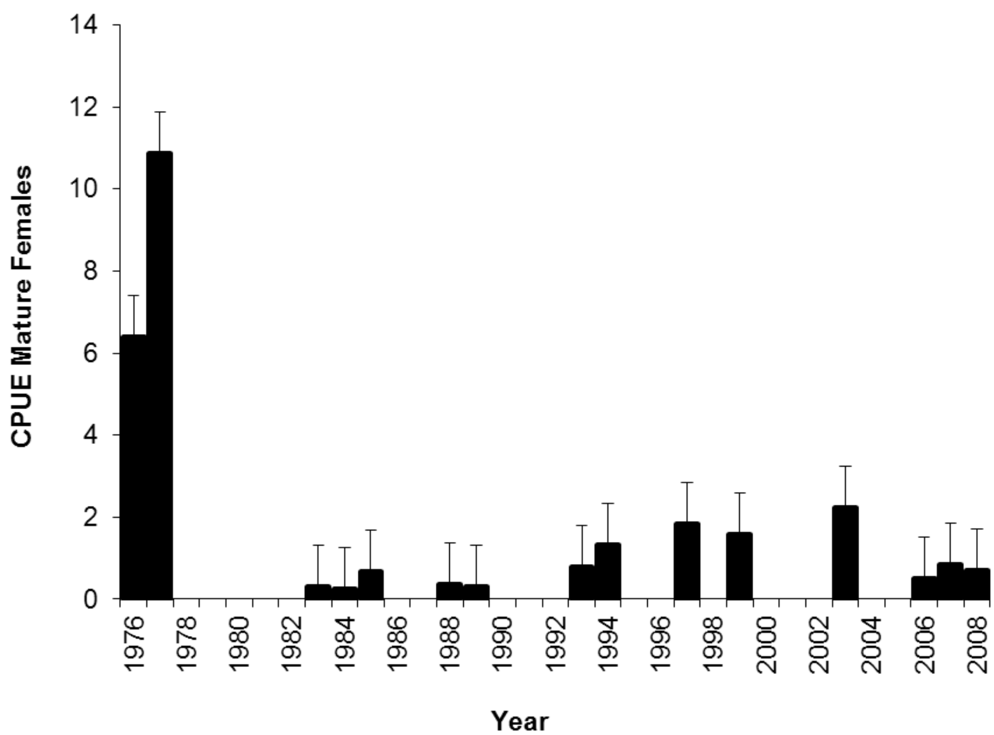

Figure 5. Mean CPUE for mature female Inconnu caught in 50 m of gillnet (2m deep) per hour (± 1 Standard Deviation) set at the mouth of the Buffalo River, GSL.

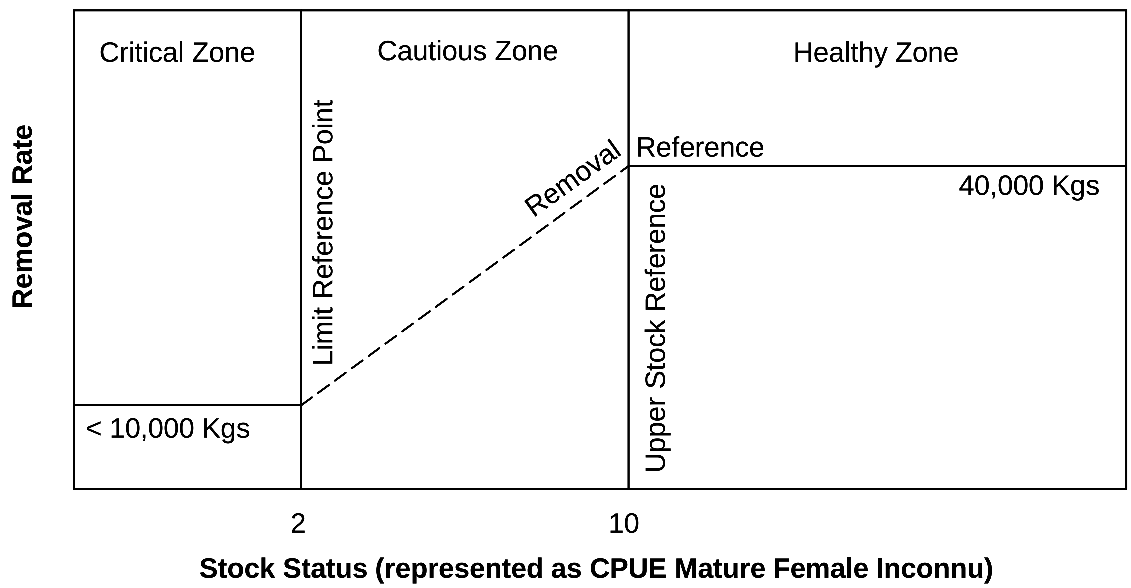

Figure 6. Precautionary approach model for Buffalo River Inconnu harvested in the west basin of the Great Slave Lake commercial fishery. Catch-per-unit-effort (CPUE) of mature female Inconnu equals the number caught per hour per net (50 m long, 2m deep, 133 mm mesh)