climate change
RESEARCH INFORMATION NOTE
Note Number 4 2007

Potential effects of climate change on lake trout in Atikokan Area

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Introduction

The Atikokan Area of the Fort Frances District has 570 lakes larger than 25 ha and 99 (17%) of them contain lake trout (*Salvelinus namaycush*) (Fig 1.). These lakes represent over 55% of the lake surface area with sizes ranging from 25 to 8250 ha. Lake trout is a popular sportfish in the area, particularly in the winter and spring. It is the responsibility of the Ontario Ministry of Natural Resources (OMNR) to ensure that fish populations are managed sustainably. This responsibility is exercised through many regulatory and planning processes, including fish harvest regulations and forest management and watershed planning.

Climate change, temperature increases, and longer growing seasons predicted to occur in northwestern Ontario may have two significant and negative effects on lake trout populations. The first is through a reduction in volume of the hypolimnion (i.e., deep, cold zone of water below the thermocline) due to increasing temperatures, changes in productivity, and/or changes in water clarity (Magnuson et al. 1997, Shuter and Lester 2004, Baker et al. in prep.). Lake trout require these temperature and oxygen conditions to survive the summer months. Reductions in the amount of this habitat can result in loss of lake trout populations (Ryan and Marshall 1994).

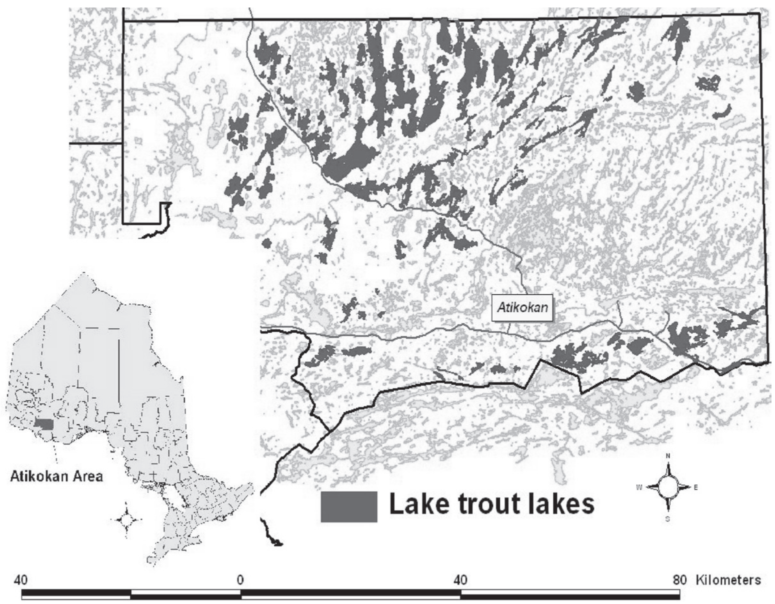

Figure 1. Lakes supporting lake trout populations in the Atikokan Area of Fort Frances District.

The second impact is a change in fish community composition that favours species that negatively affect lake trout. Studies have shown that predators such as smallmouth bass (*Micropterus dolomieu*) and rock bass (*Ambloplites rupestris*) can impact lake trout populations by reducing the number of small fish species that live in the littoral zone (Vander Zanden et al. 2004). These fish can be an important food source for lake trout, particularly in lakes without alternate deepwater prey such as Lake herring (*Coregonus artedii*) or whitefish (*Coregonus clupeaformis*). Rainbow smelt (*Osmerus modax*) also provide an alternate food source but, as an introduced species, may negatively impact trout populations. Both range and abundance of smallmouth bass and rock bass are expected to increase as water temperatures increase (Shuter and Post 1990).

An adaptive management approach involving several stages was proposed at a climate change workshop presented by OMNR Northwest Science and Information staff in 2005 (Racey 2005). The first step is the identification of a problem or concern followed by a risk analysis of key resource values. This note presents a basic analysis of the risk of climate change to Atikokan Area lake trout populations using readily available physical characteristics of lakes and species composition data. In addition, the Atikokan Area lake trout monitoring program is reviewed to determine if high risk situations are being adequately monitored.

Methods

A review of the Atikokan Area lake database, which includes physical characteristics (e.g., area, mean depth, and maximum depth), water chemistry (e.g., total dissolved solids and pH) and species composition was conducted. These data were available for 88 (91%) of the 99 known lake trout lakes in the Area. The following criteria were used to classify the risk to each lake:

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1. Loss of hypolimnion habitat: Shallow lakes, which generally have less hypolimnion habitat than deeper lakes, are at greater risk of losing lake trout populations due to habitat loss than deeper lakes (Ryan and Marshall 1994). A comparison of the maximum depth of lake trout lakes was used to identify high risk lakes. Lake trout were not found in Atikokan Area lakes with a maximum depth of less than 10 m. End of summer thermoclines typically reach 15 m in the Atikokan Area (OMNR Atikokan Area, unpub. data). It was assumed that lakes with maximum depths less than 20 m were at high risk of losing lake trout populations due to hypolimnion habitat loss associated with a warming climate. Lakes with maximum depths less than 25 m were considered at moderate risk of losing lake trout populations.

2. Fish species community changes: Species such as smallmouth bass and rock bass potentially will present the greatest risk to lake trout populations because they are non-native, littoral zone predators that are expected to increase in population size and/or range as temperatures warm. The risk is assumed to be greatest in lakes without deep water prey (i.e., whitefish, herring, or smelt) as the primary forage base for trout. A review of community composition of lake trout lakes was completed to identify lakes at risk. Lakes with smallmouth bass/rock bass present without whitefish, herring or smelt were considered at highest risk of lake trout population declines due to changes in fish community resulting from increasing temperatures. Lakes without smallmouth bass/rock bass and without whitefish, herring or smelt were considered moderately high risk because if bass were introduced into these lakes, they could negatively affect lake trout populations.

Results

Hypolimnion habitat loss

Fourteen of the lakes in the Atikokan Area have maximum depths less than 20 m; of these, 4 have maximum depths less than 15 m (Fig. 2). Thermocline depths in Atikokan Area lakes typically reach the 15 m range by the end of summer suggesting that lake trout in these lakes already face a lack of summer habitat. Table 1 lists the 14 lakes under highest risk from loss of hypolimnion habitat due to climate change. Table 2 lists an additional 18 lakes with maximum depths of 25 m or less, which are at moderately high risk of habitat loss.

Fish species community change

Of the 99 known lake trout lakes in the Atikokan Area, species composition information was available for 88 lakes (91%). A total of 67 fish species are known to live in the Atikokan Area, of which 12 are found in 25% or more of the lakes inhabited by lake trout (Table 3). Other species of note include rainbow smelt, a non-native species found in 4 (5%) of the lake trout lakes. Rock bass, which has been found to negatively impact lake trout populations in other areas, occurs in relatively few lakes in the Atikokan Area and is not known to live in any of the lake trout lakes.

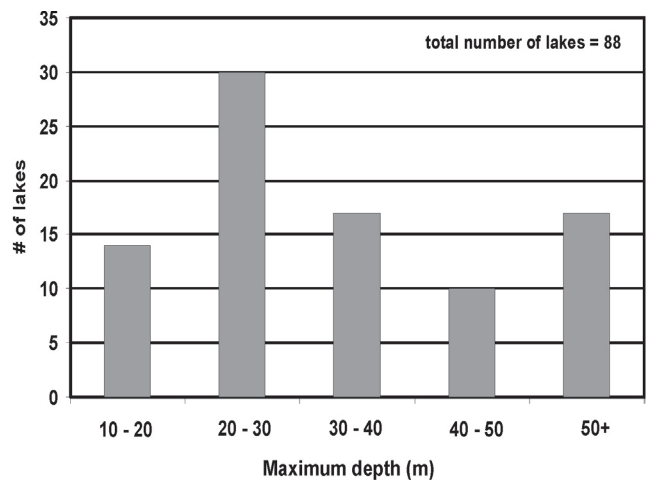

Figure 2. Distribution of Atikokan Area lake trout lakes by maximum depth.

Table 1. Atikokan Area lakes with maximum depths that suggest they are at high risk of habitat loss due to projected changes in climate.

Lake	Maximum depth (m)	Lake trout populations monitored now
OWL	10.2	No
MYSTERY (Lake 80)	13.0	No
BELOW BOW (s.e. basin)	13.4	No
NARROW	15.0	No
BOW (UPPER BOW)	16.8	No
JACKFISH (east of White Otter)	17.0	No
LAKE 42	17.0	Part of CNFER[1] study lakes
LITTLE BOW	17.4	No
LAKE 103	18.0	No
EYE	18.3	No
EAST HARDTACK	18.9	No
DRAGON	19.0	No
NEVISON	19.0	No
NIOBE	19.5	Part of QMLFAU[2] study lakes

[1] Centre for Northern Forest Ecosystem Research
[2] Quetico Mille Lacs Fisheries Assessment Unit

Table 2. Atikokan Area lakes with maximum depths that suggest they are at moderately high risk of habitat loss due to projected changes in climate.

Lake	Maximum depth (m)	Lake trout populations monitored now
TURTLE	20.1	No
MILLER (WOLF)	20.7	No
JIM	21.0	No
RUTTER	21.4	Atikokan Area monitoring
BOULDER	22.0	No
SPARKLE	22.0	No
CAMPUS	22.1	No
COLE	22.1	No
GARGOYLE	22.9	No
LAKE 39	23.0	Part of CNFER[1] study lakes
VAN NOSTRAND	23.8	No
CROOK	24.0	Atikokan Area monitoring
WASP	24.1	No
ROUGHSTONE	24.2	No
COMO	24.3	No
HERB	24.9	No
BETHUNE	25.0	No
PETTIT	25.0	No

[1] Centre for Northern Forest Ecosystem Research

Most lake trout lakes (69%) in the Atikokan Area are inhabited by deep water prey species such as lake whitefish, lake herring, or smelt (Table 3). Assuming these species are the primary forage species for lake trout when present, these lakes should be at lower risk of loss of littoral zone prey species due to increases or introductions of smallmouth bass. Of the 30 lakes that do not have deep water prey species, 2 are inhabited by smallmouth bass and are considered at highest risk of fish species community changes (Table 4). The remaining 28 lakes without smallmouth bass are considered at moderately high risk.

Table 3. Species known to be found in at least 25% of the Atikokan Area lake trout lakes.

Species	Occurrence in lake trout lakes (#)	(%)
White sucker (*Catostomus commersoni)*	86	98
Yellow perch (*Perca flavescens)*	67	76
Northern pike (*Esox lucius)*	67	76
Iowa darter (*Etheostoma exile)*	52	59
Lake whitefish (*Coregonus clupeaformis)*	50	57
Burbot (*Lota lota)*	44	50
Blacknose shiner (*Notropis heterolepis)*	41	47
Lake herring (ciscoe) (*Coregonus artedii)*	34	39
Smallmouth bass (*Micropterus dolomieu)*	32	36
Pearl dace (*Margariscus margarita)*	32	36
Walleye (*Sander vitreus)*	31	35
Longnose dace (*Rhinichthys cataractae)*	24	27

Conclusion

A number of Atikokan Area lakes have lake trout populations that may be at risk as a result of the changing climate of northwestern Ontario. Particularly at risk are lakes susceptible to both habitat and fish community change (Table 5).

Table 4. Atikokan Area lakes where lake trout populations are under high or moderately high risk due to fish community changes.

Lake	Bass present	Lake trout populations monitored
BETHUNE	No	No
BOULDER	No	No
CAVE TROUT	No	No
CRAYFISH	No	No
CROOK	No	Atikokan Area monitoring
EAST HARDTACK	No	No
FLORA	No	No
FORSBERG	No	No
GAMBLE	Yes (high risk)	No
GARGOYLE	No	No
HARDTACK	No	No
HERB	No	No
HEUSTON	No	No
JACKFISH (east of White Otter)	No	No
LAKE 103	No	No
LAKE 20	No	Part of CNFER[1] study lakes
LAKE 26	No	Part of CNFER study lakes
LAKE 39	No	Part of CNFER study lakes
LAKE 42	No	Part of CNFER study lakes
LITTLE CRAYFISH	No	No
MILK	No	No
NIVEN	No	No
NORWAY	No	No
RIVERVIEW	No	No
SERPENT	No	No
SILVERTIP	Yes (high risk)	No
SOUTH PETERSON	No	No
TENT	No	No
UNNAMED (northwest of Serpent)	No	No
WALT	No	No

[1] Centre for Northern Forest Ecosystem Research

Use of this information

While OMNR district level actions will not alter the course of climate change in the near future, it is the responsibility of the OMNR to manage fish populations sustainably considering potential effects of climate change. A first step is to identify populations at greatest risk by conducting a risk analysis and then monitoring them to determine whether predictions are accurate. Predictions that are followed by monitoring, evaluation and management actions represent a basis for adaptive management. OMNR districts could pursue an adaptive strategy in response to a changing climate in several ways:

Table 5. Atikokan Area lake trout populations at moderately high to high risk from both habitat loss and community change as a result of changing climate.

Lake name	Risk of habitat loss	Risk from community change	Monitored
BETHUNE	Moderately High	Moderately High	No
BOULDER	Moderately High	Moderately High	No
CROOK	Moderately High	Moderately High	Atikokan Area monitoring
EAST HARDTACK	High	Moderately High	No
GARGOYLE	Moderately High	Moderately High	No
HERB	Moderately High	Moderately High	No
JACKFISH (east of White Otter)	High	Moderately High	No
LAKE 39	Moderately High	Moderately High	Part of CNFER[1] study lakes
LAKE 42	High	Moderately High	Part of CNFER study lakes
LAKE 103	High	Moderately High	No

[1] Centre for Northern Forest Ecosystem Research

1. By monitoring and assessing changes in some of these populations, they could be used as advance warning of changes that may become more widespread as temperatures increase. Only two of these lakes (Crook Lake and Rutter Lake) are part of the current Atikokan lake trout monitoring program. Although lack of accessibility to many of the lakes listed in Table 5 makes it difficult to monitor them at low cost, at least one other high risk lake (East Hardtack Lake) could be readily accessed and included in the monitoring plan.

Other lakes of concern have been monitored in the past by groups other than Atikokan Area staff. The Centre for Northern Forest Ecosystem (CNFER) located in Thunder Bay has included several of these lakes (i.e., lakes 42, 39, 20, and 26) in their Cold Water Lakes study. These lakes have been closed to angling since 1994 because of this study. Although the study has ended, these lakes provide an excellent opportunity to examine the effects of habitat loss due to climate change. The Quetico Milles Lacs Fisheries Assessment Unit (QMLFAU) has also conducted studies on the trout populations in Niobe Lake. Continued periodic sampling could provide valuable information on climate change effects.

2. The results of the risk analysis and monitoring can assist in determining the appropriate level of caution to use in making management decisions for these lakes. Because we are predicting that trout populations in these lakes have the highest risk of being affected by climate change, resource mangers should ensure that controllable stresses are minimized. These lakes represent populations where increases in harvest pressure or impacts on habitat from development (e.g., increased nutrient inputs) may compromise our ability to maintain sustainable populations.

3. Action taken by the OMNR and communicated to the public through planning processes and public involvement can enhance public awareness and concern over the future of resources under a changing climate. Public involvement and awareness is essential to receiving stakeholder cooperation in funding and implementing new management actions.

Recommendations

1. Consider adding East Hardtack Lake to the list of lake trout populations monitored by the Atikokan Area.
2. Explore research opportunities in the Cold Water Lakes study (Lakes 42, 39, 20, and 26) focused on climate change effects on lake trout.
3. Request that QMLFAU continue to monitor Niobe Lake to study effects of climate change on lake trout.
4. For the lakes identified in tables 1, 2, 4 and 5, apply extra caution in land use management and disposition decisions so that no increases in trout harvest and/or nutrient inputs occur.

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Effets possibles des changements climatiques sur le touladi de la région d’Atikokan

Le touladi (*Salvelinus namaycush*) est considéré comme une espèce vulnérable aux effets néfastes qu’entraîneraient les changements prévus du climat. Sont deux effets possibles : (a) l’appauvrissement de l’habitat d’été du touladi dans l’hypolimnion; (b) la diminution du nombre de proies du touladi, causée par l’introduction ou la prolifération d’espèces d’eaux chaudes non indigènes, tel l’achigan à petite bouche. Une analyse de risque a été réalisée au moyen des données facilement accessibles relativement au touladi présent dans les lacs de la région d’Atikokan. L’analyse a permis de repérer les lacs où les risques de tels effets sont élevés ou moyennement élevés. Des recommandations sont proposées quant aux façons dont les résultats de l’analyse pourraient aider à gérer écologiquement ces populations dans le contexte des changements climatiques prévus.

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