MERCURY IN FISH IN THE SMALLWOOD RESERVOIR, LABRADOR, TWENTY ONE YEARS AFTER IMPOUNDMENT

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The elevated mercury (Hg) levels in fish flesh found after impoundment of a reservoir, are predicted to decline as the reservoir ages. The length of time required for a return to background levels is dependent on among other things, the trophic status of the fish. Predictions for omnivorous species range between 15 and 20 years while for piscivorous species they vary from 20 to 30 years. Fish in the Smallwood Reservoir, Labrador, Canada, were sampled 6 years after impoundment when hg levels were found to be elevated in most species. Selected of the sites were re-sampled after 16 years and again after 21 years. Mercury in the flesh of omnivorous species such as lake whitefish (*Coregonus clupeaformis*) had returned to background levels after 16 years as predicted. However, hg in the flesh of piscivores such as northern pike (*Esox lucius*) and lake trout (*Salvelinus namaycush*) remained elevated even 21 years after impoundment. While the levels in lake trout have declined somewhat in that time, there is no evidence of decline in the northern pike either within the reservoir or at downstream stations. Models predicting decline in hg levels in piscivorous fish in reservoirs must be re-evaluated in light of this extended data set.

1. Introduction

The accumulation of mercury (Hg) in the flesh of fish found in recently impounded reservoirs has been known for twenty years (Smith *et al.,* 1974). Because of the health risks to human consumers of these fish, it is important to determine how long after impoundment this will continue to occur. Fish from reservoirs in insular Newfoundland can return to background levels after 7 to 12 years (Scruton *et al.*, 1994). Theoretical models developed by Messier *et al.* (1985) predict returns at 20 years for lake whitefish and 30 years for northern pike. Data collected 16 years after impoundment of the Smallwood Reservoir showed that the Hg levels in flesh of non-piscivores was similar to background while piscivores were still elevated above unimpounded lakes although concentrations in all species except northern pike had declined from the levels observed after 6 years.

The Smallwood Reservoir and sites downstream from the impoundment were revisited in 1992 and the fish from these sites were analyzed to determine Hg levels 21 years after impoundment. Results of this study for three characteristic species (*Esox lucius,* northern pike; *Salvelinus namaycush,* lake trout; *Coregonus clupeaformis*, lake whitefish) are presented here.

2. Materials and Methods

The Smallwood Reservoir in western Labrador, was initially flooded in 1971. It covers an area of 6650 km^2 (Bruce and Spencer, 1979) and traverses a number of geological bedrock types (Scruton, 1984). In 1992, fish were sampled from two sites in the reservoir (Sandgirt and Lobstick) and two sites downstream in the Churchill River (Winokapau Lake and Gull Lake) at locations sampled in 1977 and 1987 (Fig. 1).

The fish were taken in gill nets, sized (fork length), weighed and a sample of dorsal flesh frozen pending analysis. Samples were analyzed for Hg using cold vapor atomic

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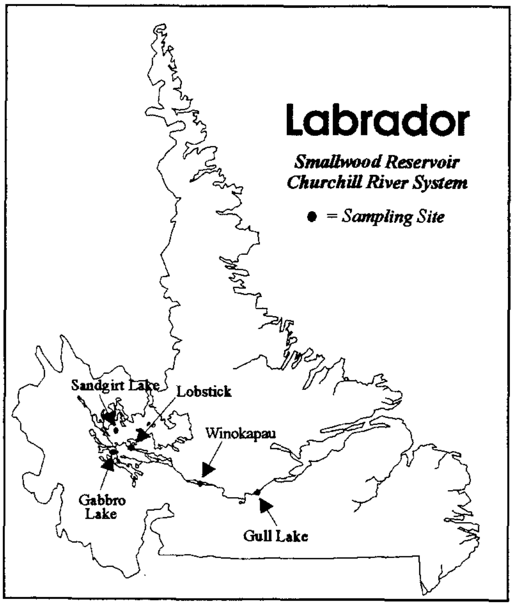

Fig. 1. Map of the Smallwood Reservoir, Labrador showing sites sampled in 1992.

absorbtion (Envir. Can, 1979; Uthe *et al.,* 1970).

Hg concentrations (in µg/g wet weight) in fish from the study sites were compared to those from previous years (1977 and 1987) and to background levels obtained from a survey of fish in 95 unimpounded lakes with minimal anthropogenic influence scattered throughout Labrador (Scruton, 1984). This latter study was selected as a control because it included samples from all of the geological types covered by the Smallwood Reservoir.

The data were log transformed to remove heteroscedasticity. Significant differences in Hg-weight relationships from background and between years were tested using regression analysis. Typically these types of comparison have been made using a standard length fish (e.g. Brouard *et al.* 1990). However, this approach is only valid if the slopes of both the control and the impounded site relationships are the same. If the slopes differ significantly then not only will information be lost using only a single point comparison but also, incorrect conclusions can be drawn particularly concerning larger, older fish. Other problems with the use of standard size in this context have been raised recently by Somers and Jackson (1993).

3. Results and Discussion

Preliminary analyses indicated that there was no significant difference among sites either in the reservoir or downstream for any of the species examined. Therefore, for each species, data from all sites were pooled for analysis. This means that while in some species, Hg levels are elevated above background down stream of the reservoir, there is no evidence of a gradient with distance from the reservoir as was seen in 1977 and 1987 (Brouard *et al.*, 1990).

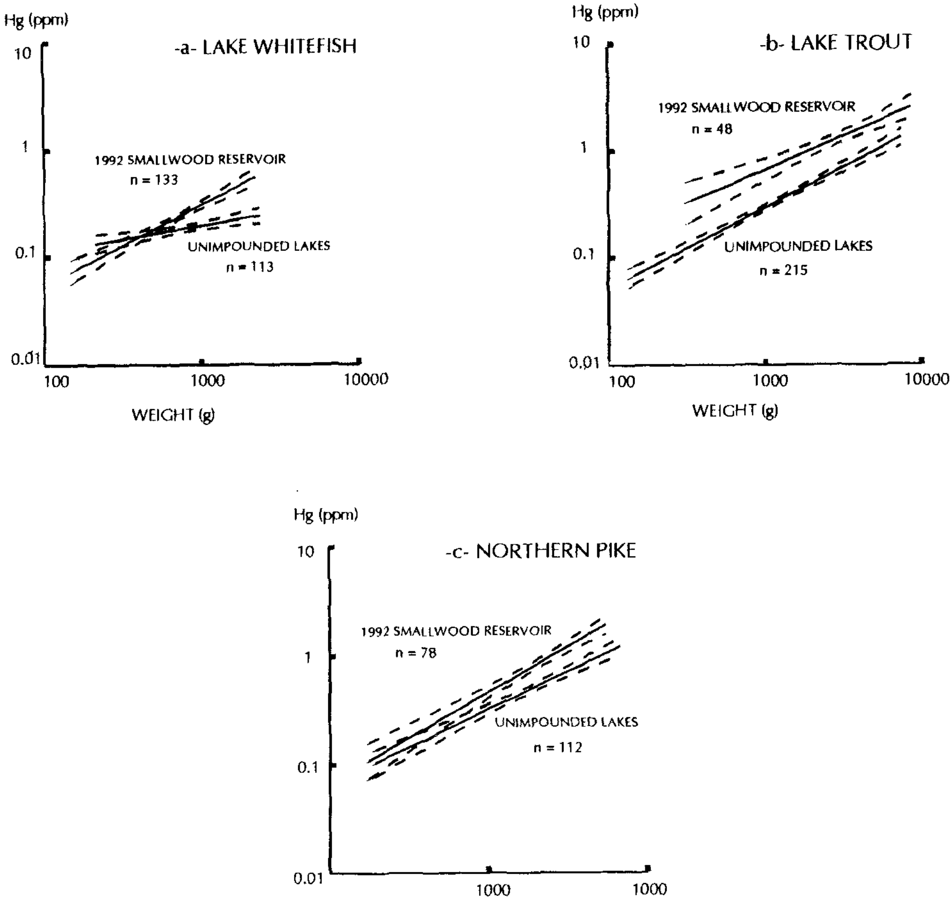

Figure 2. Predicted changes in Hg concentration (µg/g) as a function of weight (g) for lake whitefish (a), lake trout (b) and northern pike (c) in unimpounded lakes and in the Smallwood Reservoir system in 1992. Dashed lines indicate the 95% confidence intervals.

Data from unimpounded lakes of Labrador indicate that even without human influence, Hg concentration increases with body size. In non-piscivores, concentrations are still very low (e.g. 0.05 - 0.45 µg/g for lake whitefish) but in lake trout and northern pike, the concentration of Hg exceeds the 0.5 ppm Canadian Regulatory limit in many of the larger fish. This is particularly true for lakes in western Labrador. Here again, comparisons solely among fish of a standard size may not adequately reflect the situation.

Sixteen years after impoundment, the Hg concentration of a standard length lake whitefish from the reservoir was not different from background levels (Brouard *et al.*, 1990). However, regression analysis comparing 1992 to the unimpounded lakes (Fig. 1. a) shows a significant difference in slopes ($P \leq 0.001$) between the two relationships, indicating that the larger older fish may still be carrying high body burdens.

Hg levels in lake trout were still significantly elevated ($P \leq 0.001$) over background in 1992 (Fig. 1. b) although they had declined slightly from 1987. The slopes of the two relationships are not significantly different (Fig. 2. b). This means that even the youngest lake trout in the reservoir still have elevated body burdens of Hg.

Even after 21 years, northern pike is not showing any significant decline in Hg levels. There is no significant difference between pike sampled in 1987 and in 1992 and they are still significantly higher ($P \leq 0.001$) than background levels (Fig. 1. c).

4. Conclusions

Hg levels of lake whitefish from the Smallwood Reservoir have returned to normal with the exception of some of the largest fish that have slightly elevated Hg concentrations as compared to background populations. This supports the predictions of Messier *et al.* (1985) of a twenty year return to normal.

Piscivorous fish such as lake trout and northern pike continue to contain more hg than fish from unimpounded sites. Levels in lake trout have begun to decline for fish of all sizes while northern pike show no indication of a return to background.

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