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Science of the Total Environment 351–352 (2005) 501–522

Science of the Total Environment
An International Journal for Scientific Research into the Environment and its Relationship with Humankind

www.elsevier.com/locate/scitotenv

Temporal trends of organochlorine contaminants in burbot and lake trout from three selected Yukon lakes

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Received 26 April 2004; received in revised form 28 July 2004; accepted 28 August 2004
Available online 6 September 2005

Abstract

Historical studies have demonstrated that organochlorine (OC) concentrations in top predators can vary considerably from lake to lake within a small geographic region but temporal trends of these contaminants have rarely been monitored in a sub-Arctic area for a long period of time. This study examined OC concentrations, including chlordane (CHL), DDT, hexachlorocyclohexane (HCH), toxaphene (CHB), PCB and chlorinated benzenes (CBz) in lake trout and burbot, from three Yukon lakes (Laberge, Kusawa, Quiet), over a span of 11 years (1992–2003). Temporal and spatial differences continue to exist in the OC concentrations of burbot and lake trout between these lakes. There is strong evidence that these contaminants are declining at various rates in lake trout (*Salveninus namaycush*) in Laberge, Kusawa and Quiet Lakes. For example, ΣDDT concentrations have decreased 39%, 85% and 84% in Kusawa, Quiet and Laberge Lakes, respectively. Conversely, no consistent trends were observed in OC concentrations for burbot (*Lota lota*). For example, there is no evidence of a decline in toxaphene concentrations of Kusawa burbot yet a 58% decrease was observed in Laberge samples. Increases were also observed in the ΣHCH levels of Kusawa Lake burbot, as well as increases in all OC groups (except ΣHCH) for the Quiet Lake burbot samples. Decreases in burbot were evident in ΣHCH and ΣCHB for Lake Laberge fish and in ΣCHL for Kusawa Lake samples. Spatial variations in OC levels are quite evident as Lake Laberge trout and burbot continued to maintain the highest levels over the eleven-year period from 1992 to 2003 followed by Kusawa Lake and then Quiet Lake. These differences were related to a variety of factors especially the species morphological characteristics such as log age, log weights and fish lipid content. A decreasing trend in Quiet and Laberge Lake trout lipid content, coupled with fluctuating condition factors and increases in body masses, suggest biotic changes may be occurring within the food webs due to fish population variations related to the cessation of commercial fishing or potentially an increase in lake plankton productivity related to annual climate variation. It is suspected that biotic factors

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doi:10.1016/j.scitotenv.2004.08.022

rather than atmospheric inputs are the primary factors affecting the contaminant concentrations in lake trout and burbot in the study lakes.

Keywords: Arctic; Canadian Arctic; Yukon; Temporal trend; Lake trout; Burbot; Organochlorines

1. Introduction

The Arctic was once considered a pristine environment, however, over the last 20 years, significant levels of organochlorine (OC) pesticides such as toxaphene (chlorobornanes) and hexachlorocyclohexane (HCH) and industrial chemicals such as polychlorinated biphenyls (PCB) have been found in its ecosystem and in the traditional foods eaten by local people (Muir et al., 1992; Lockhart et al., 1992; Van Oostdam et al., 2003). It is well documented that long range atmospheric transport is the primary source of these contaminants to the northern regions (Bidleman, 1999) and that once there, these chemicals bioaccumulate and biomagnify to upper trophic levels of the food web (Barrie et al., 1992; Bidleman et al., 1989). Many monitoring projects have begun to assess the temporal levels of these contaminants in aquatic and terrestrial animals. Since atmospheric levels of some OCs (lower chlorinated PCB, HCH, chlordanes and DDT) seem to have decreased in the Arctic over the past decade (Bidleman et al., 2003; Stern et al., 2005), questions remain as to whether the levels of these compounds are also decreasing in northern aquatic biota.

Temporal studies of OCs in aquatic biota are important in determining the time it takes for abiotic changes in contaminant levels to manifest into changes within the living parts of an ecosystem (Manosa et al., 2003). However, changes in aquatic biota OC concentrations cannot be easily or directly predicted from atmospheric values or geographical location because of a variety of factors that influence tissue OC concentrations in organisms (Kidd et al., 1993; Larsson et al., 1993; Ruus et al., 2002). Population, morphological and biochemical characteristics can be used as predictors of organochlorine contaminant trends in fish and to assess overall ecosystem health. A few of these factors include lake productivity (Larsson et al., 1992), food web trophic structure (Kidd et al., 1995; Vander Zanden and Rasmussen, 1996), growth rates (Hammar et al., 1993; Olsson and Valters, 2000), diet (Manosa et al., 2003) and reproductive transfer/loss (Larsson et al., 1993; Rasmussen et al., 1990). In order to determine the trend of contaminants in fish, biological parameters such as lipid content, size and age must also be assessed (Larsson et al., 1993). Some are significant predictors of OC levels in biota and hence better predictors of OC trends within a specific ecosystem (e.g. a lake) than environmental concentrations. With an increasing number of temporal data points and information on species ecology and morphology, more precise conclusions can be drawn about OC trends and the changes in an ecosystem over time (Bignert et al., 1993).

Kidd et al. (1998) conducted a food web study on Lake Laberge, a sub-Arctic lake in the Yukon Territory. Fish from this lake were found to have considerably higher levels of OC contaminants compared to fish in other regional lakes such as Kusawa and Fox Lakes. This was attributed to the longer food chain length in Lake Laberge and the higher lipid content in the fish. Since 1992, tissues from lake trout (*Salvelinus namaycush*) and burbot (*Lota lota*) have been intermittently measured for OC levels in Laberge, Kusawa and Quiet Lakes (Fig. 1). Lake trout were until recently a commercially exploited fish while burbot livers are prized by local First Nations people as a delicacy. The lake trout and burbot in these three Yukon lakes remain the focus of ongoing research to study the long-term temporal trends of contaminants in northern biota in the lower Yukon region.

In this study we report on the temporal trends of 6 major OC contaminant groups including chlorinated benzenes (CBz), chlorinated bornanes (CHB), chlordanes (CHL), DDT, HCH and PCB in Quiet, Kusawa and Lake Laberge, over a span of 11 years (1992–2003). Lake trout and burbot were selected because of