

CONTAMINANT CONCENTRATIONS AND BIOMARKERS IN NORTHERN PIKE AND LONGNOSE SUCKERS COLLECTED FROM THE YUKON RIVER

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Abstract

The Biomonitoring of Environmental Status and Trends (BEST) program measured tissue concentrations of selected contaminants and evaluated biomarker responses in northern pike (*Esox lucius*) and longnose suckers *Catostomus commersoni* from the Yukon River basin, Alaska. Sampling stations covered a distance of 1135 river miles and included the village of Eagle near the eastern border with Canada to the Bering Sea village of Kotik. Organic and inorganic contaminants were measured in whole-body composite fish samples. Selenium in pike and suckers and mercury in pike were the only inorganic contaminant concentrations that exceeded criteria thresholds. Concentrations of Se and Hg were greatest at sites located in tributaries of the Yukon River near Fairbanks. The H4IIE bioassay did not detect dioxin-like activity in any of the samples. Mean microsomal EROD activity ranged from 0.71 to 17.5 pmol/min/mg protein in pike and 3.6 to 10.0 pmol/min/mg protein in suckers. Estradiol levels were elevated in male pike and male sucker from sites in the central region of the Yukon River. Reproductive biomarkers (gonadosomatic index and vitellogenin) were not elevated for pike or suckers. Fish health indicators (external lesions and somatic indices) and immune system indicators (macrophage aggregate parameters) were also evaluated in this study. Previous contaminant studies in this basin have focused on issues concerning subsistence fishing in villages or chemical contamination on national wildlife refuges. The BEST program data will aid in establishing a reference data set for contaminants and biomarkers in fish throughout the Yukon River in Alaska.

Introduction

The BEST large river program measures and assesses contaminants and biomarker responses on selected species and habitats at broad geographic and temporal scales (Figure 1). Sources of contaminants in the Yukon River Basin (YRB) include persistent, bioaccumulative compounds being deposited through atmospheric transport, and sources within the YRB, such as mining and abandoned defense installations. Migrating adult salmon are suspected of transporting bioaccumulated compounds from the ocean into the YRB (Krümmel and others, 2003). However, only limited data exist on contaminant concentrations in salmon, and to a lesser extent, resident fish in the Yukon River, and little or no information on contaminant effects exist.



Figure 1. Yukon River near Eagle, Alaska (301).

Our objectives were to:

- Document contaminants and their effects throughout the YRB
- Compare biomonitoring results from the YRB to other major US river systems
- Establish a reference data set for contaminants and biomarkers in the YRB in Alaska

Materials and Methods

Ten locations within the YRB were sampled in the summer of 2002 (Figure 2). At each sampling station, 40 fish were collected (10 of each gender, 2 species) by hook and line, gill nets, or fyke nets. Target fish species included northern pike and longnose sucker. Burbot (*Lota lota*) were collected as an alternate predator species. Fish were processed soon after capture. The suite of field and laboratory methods selected respond to a wide variety of contaminants (Table 1). A total of 217 fish were collected.

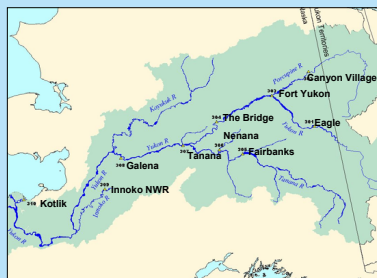


Figure 2. Sampling station locations in the Yukon River Basin, Alaska.

Table 1. Methods incorporated into the Yukon River Basin BEST project.

Method	Description	Tissue(s) examined	Sensitivity
Tissue contaminant concentrations	Contaminant assimilation	Whole fish (composites)	Organochlorine (OCs), inorganic compounds
H4IIE bioassay	Screening tool for planar halogenated compounds	Whole fish (composites)	PCBs, dioxins and furans, PAHs
Ethoxyresorufin O-deethylase (EROD) activity	Induction of cytochrome P450 enzymes	Liver	PCBs, PAHs, dioxins and furans
Vitellogenin (Vtg)	Egg yolk precursor synthesized in the liver	Blood plasma	Endocrine modulating compounds
Hormones (estradiol/11-ketotestosterone)	Reproductive health and status	Blood plasma	Endocrine modulating compounds
Fish health assessment	Visual assessment of external/internal anomalies	All	Overall fish health and contaminants
Histopathology	Microscopic examination for lesions	Gonads, spleen	Overall fish health and contaminants
Macrophage Aggregate (MA) analysis	Cellular-level immune response	Spleen	Contaminants including PAHs, metals
Somatic indices	The relative mass of selected organs	Gonads (GSI), spleen (SSI), liver (LSI)	Overall fish health and contaminants

Results and Discussion

➢ Organochlorine (OC) pesticides, total PCBs, and toxaphene concentrations were below quantification limits or wildlife criteria thresholds. H4IIE rat hepatoma bioassay did not detect dioxin-like activity in any samples.

➢ All inorganic concentrations were below threshold criteria except for Hg and Se (Figure 3).

➢ Pike from The Bridge (304), Fairbanks (305), Nenana (306), Tanana (307), and Galena (308) exceeded 0.3 µg/g, a Hg concentration associated with reproductive impairment in loons (Barr, 1986).

➢ Fish from Eagle (301), Canyon Village (302), and The Bridge (304) had fish with Se concentrations exceeding 0.6 µg/g, which may be toxic to piscivorous wildlife (Lemly, 1996).

➢ Microsomal EROD levels were uninduced at most stations. Vitellogenin concentrations in males and females were not elevated. Other reproductive indicators (GSI and atresia) were normal. No intersexed fish were identified (Table 2).

➢ Estradiol/11ketotestosterone ratios exceeded 1.0 in male fish from The Bridge (304), Nenana (306), Tanana (307), and Galena (308) (Figure 4).

➢ Fish health examinations determined most abnormalities were attributed to lesions on the body surface (Figure 5). Macrophage aggregate (MA) parameters were similar within species among stations.

Table 2. Range of station means for biomarker data collected in the Yukon River Basin, 2002. Means were combined when significant differences (P<0.05) did not exist between genders.

Biomarker	Female Pike	Male Pike	Female Sucker	Male Sucker
EROD (pmol/min/mg protein)	0.71-8.8	3.1-17.5	1.3-8.8	2.6-10.0
Vitellogenin (mg/ml)	0.09-5.3	<0.01-0.10	0.03-0.31	<0.01-0.02
Estradiol/11-ketotestosterone ratio	1.6-6.8	0.11-4.1	1.5-7.5	0.38-5.3
GSI (%)	0.51-11.9	0.3-1.5	1.0-6.4	0.4-1.9
Atresia (%)	0.0-2.9	—	0.0-0.5	—

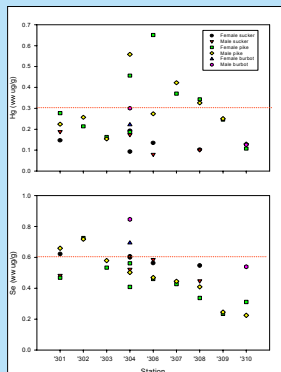


Figure 3. Concentrations of Hg and Se in the Yukon River Basin, 2002.

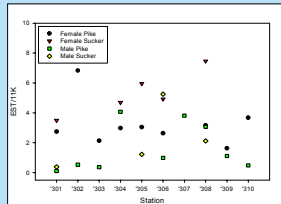


Figure 4. Estradiol/11ketotestosterone ratio in fish from the Yukon River Basin, 2002.

Conclusions

➢ Most OCs and inorganic concentrations are not of concern in the YRB. Hg concentrations were greatest near Fairbanks and surrounding tributaries, and Se concentrations were greatest in the upstream YRB.

➢ Most biomarker results did not indicate exposure to contaminants. Estradiol levels were high in males from stations located near Fairbanks and surrounding tributaries.

➢ Histopathology results will aid in identifying abnormalities described in the fish health assessment.

➢ Most reproductive and immune fish health indicators did not indicate exposure to contaminants.

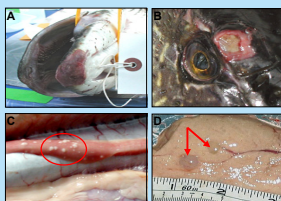


Figure 5. Northern pike fish health examination (A) common lip lesions, (B) common head lesions, (C) nodules on gonads, and (D) nodules on liver.

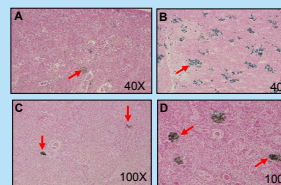


Figure 6. Macrophage aggregates in longnose suckers from (A) Galena, (B) Fairbanks, and northern pike from (C) Tolovana, and (D) Fairbanks.

Citations

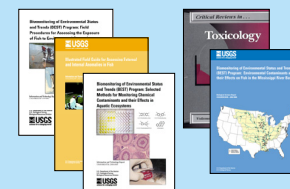
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