Polychlorinated Biphenyls and Mercury in Sediments and Aquatic Biota, Nearshore Juvenile Fish Communities and Aquatic Food Web Structure in the Lower Selenga River, Russia

August 19, 2002

J.R. Sampson[1], E.A. Tarasova[2], E.M. Mamontova[2], A.A. Mamontov[2], S. Chandra[3], G.V. Kalmychkov[2], I.I. Toupitsyn[4]

1. 10,000 Years Institute, P.O. Box 11723, Bainbridge Island, Washington, 98110. USA

to whom correspondence should be addressed.

2. Siberian Branch, Russian Academy of Sciences, Institute of Geochemistry, P.O. Box 4019, Irkutsk-33, 664 033. Russia.

3. University of California, Department of Environmental Science and Policy, Davis, California, 95617. USA

4. Irkutsk State University, Scientific Research Institute of Biology, Lenin Street 3, P.O. Box 24, Irkutsk-3, 664003. Russia.

Abstract

This report describes the results of an investigation of water quality, mercury and total polychlorinated biphenyls (**Σ**PCBs) in sediment and biotic media, juvenile fish community condition, and food web structure in the lower Selenga River, Russia. The Selenga River is the largest tributary to the world's oldest and largest lake, Lake Baikal. Water, sediments, periphyton, invertebrates, juvenile fish, and adult fish were sampled along 35 km of the lower Selenga River at 6 fixed sites. Sites were evenly spaced, beginning at Selenginsk, and extending into the Selenga River delta. Water from each site was analyzed for carbon, silicon, nitrogen and phosphorus compounds, major ions and suspended matter, and temperature was monitored continuously at all sites for the study period. Habitat variables were controlled for fish community samples allowing quantitative between-site comparisons of fish abundances, biomass, and species composition. Adult and juvenile fish tissue and sediments were analyzed for **Σ**PCBs, and all samples were analyzed for mercury and stable isotopes of nitrogen (^{15}N) and carbon (^{13}C). Local fishermen were interviewed to illuminate long term trends in the fishery.

Concentrations of nitrogen compounds, dissolved organic carbon, and suspended matter in water generally increased between July and August. Continuous temperature monitoring indicated that average temperatures were lowest and least variable at the most downstream site. Temperature varied diurnally, with maxima in mid afternoon, and minima a few hours after sunrise.

Fish species richness, juvenile fish biomass and abundances, and adult fish abundances were very low in the study area, particularly near urban areas (Selenginsk and Khabansk). Juvenile fish communities in sampled habitats were dominated by roach (*Rutilus rutilus*)

and Siberian dace (*Leuciscus leuciscus*), with occasional ide (*L. idus*), perch (*Perca fluviatilis*), and rarely stone loach (*Cobitis taenia*). Juvenile fish abundances were significantly lower at the three sites nearest urban areas than at the most downstream site. Differences between sites were the result of significantly ($p < 0.01$) lower numbers of juvenile roach at near-urban sites. Low fish numbers likely reflect cumulative urban impacts, including habitat degradation and heavy subsistence and recreational fishing. Depressed fish communities are not attributable to PCB and mercury exposures.

ΣPCB concentrations in sediments and fish were low relative to concentrations reported for Lake Baikal and areas directly influenced by industry. **Σ**PCB concentrations in sediment ranged from 0.24 to 6.9 µg/kg dry weight (dw), comparable to PCBs in sediments of remote freshwater and marine areas. **Σ**PCB concentrations in fish were 0.091 to 0.92 µg/kg lipid weight (lw). These are at the low end of ranges reported for various fish in Lake Baikal, and similar to **Σ**PCB concentrations in pike (*Esox lucius*) from lakes in non-industrialized areas of Europe and North America.

Mercury concentrations in sediments were 0.011 to 0.056 mg/kg dw, about the same range as for sediment in the nearby Irkutsk reservoir. Mercury concentrations in fish and invertebrates were the highest ever reported in Lake Baikal's watershed. Mercury concentrations in perch were 0.25 to 1.22 mg/kg dw; in pike were 0.51 to 1.54 mg/kg dw; and in catfish (*Parasilurus asotus*) were 1.12 to 2.37 mg/kg dw. On the basis of conservative exposure assumptions, subsistence fishermen may be consuming 5.4 times the U.S. Environmental Protection Agency's non-cancer reference dose (RfD), a no-effects threshold, for mercury. Using worst-case assumptions, the subsistence fisherman may consume up to 17 times the RfD. These exposure levels are generally comparable to the mercury consumption rate of the average U.S. citizen. Mercury in small fish (≤ 11cm) is sufficiently elevated to adversely affect reproduction in piscivorous birds living in the study area.

Patterns of $\delta^{15}N$ in fish indicate that the largest, oldest predatory fish in the study area are not trophically distinct from juvenile roach, dace and perch. This compression of the food web confirms that fish stocks are badly depleted. Over-reliance of large predators on juvenile fish could contribute to poor recruitment of forage fish to spawning stocks, creating a negative feedback loop in the river's fish community. $\delta^{15}N$ is a poor predictor of mercury in biota when data are pooled throughout the area, but is well correlated with mercury at 4 of 6 individual study sites. There was no discernable pattern in $\delta^{13}C$ in the food web.