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Linking contaminant profiles to the diet and breeding location of American dippers using stable isotopes

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4–5 km intervals along the main stem of the Chilliwack River and from seven different Chilliwack tributaries. Aquatic larval invertebrates (*c.* 1 g dry weight) were collected either by kick sampling (disturbing the rocks directly upstream of a Surber sampler (Rickly Hydrological Co., Columbus, OH)) or by turning over rocks by hand. Each sample contained macro-invertebrates, primarily ephemeropteran, plecopteran and tricopteran larvae, that dippers prey upon (Mitchell 1968; Ealey 1977). During invertebrate collections, samples of approxiby gel permeation chromatography, and further cleanup by Florisil (Floridin Co., Quincy, FL, USA) column chromatography. All samples were spiked with internally labelled ^{13}C standards prior to extraction. Each sample extract was injected twice, once for determination of OC and once for PCB. As part of the quality control, blanks and CWS reference material (1989 Lake Ontario Herring Gull QA) were run concurrently. The nominal detection limit for all compounds was 0·0001 g g wet weight^{-1}. Internal standard recoveries were typically between 80% and 110% and residues were not recovery corrected. Egg concentrations are reported on a wet weight basis (Peakall & Gilman 1979) with arithmetic corrections of desiccated samples that deviated by more than 5% from the mean moisture content (78·6%) of freshly collected, undeveloped eggs.

Total Hg and Se were analysed according to CWS method no. MET-CHEM-AA-02E (Neugebauer, Sans Cartier & Wakeford 2000). The sample homogenates were freeze-dried to determine moisture content and analysed for Hg without prior acid digestion on the AMA-254, Advanced Mercury Analyser, which employs direct combustion of the sample in an oxygen-rich atmosphere. Samples for which there was sufficient material remaining were digested in nitric acid according to standard techniques for Se analysis. Se was analysed by graphite furnace atomic absorption spectrometry (GFAAS) using a Perkin Elmer 3030b equipped with a Deuterium background corrector and HGA-300 Graphite furnace. Accuracy of analysis was determined using certified reference materials Dolt-2 and Dorm-2 (National Research Council of Canada, Ottawa, ON, Canada) and blank samples. Recoveries of reference materials were within the certified range (95–121%). Additionally, random egg samples were analysed in duplicate to check precision. All values for Hg and Se are reported on a dry weight basis and detection limits under these conditions were 0·18 g g dry weight^{-1} for Hg and 0·10 g g dry weight^{-1} for Se.

STABLE ISOTOPE ANALYSIS

Invertebrate and fish samples were stored frozen and then freeze-dried for 24–48 h until completely dry before being ground into a fine powder. Three separate subsamples of each of the composites of invertebrates and fish were analysed to ensure homogeneity of the mixture, particularly the invertebrates. Whole blood samples were also stored frozen until preparation for determination of stable isotope ratios. Samples were then freeze-dried for 24 h and homogenized. Feather samples were washed with a 2 : 1 chloroform and methane solution and thoroughly rinsed with distilled deionized water to remove any

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lack of a suitable insectivore reference (i.e. swallows breeding on tributaries). However, river and tributary dippers had significantly different blood isotopic signatures, with river residents more enriched in ^{15}N and ^{13}C (*K*–nearest neighbour randomization test, $P <$ 0·0001; Fig. 3).

According to the mixing model using ^{15}N, the amount of fish in the diets of American dippers ranged widely from 0% to 71% (mean = 33%; Fig. 4). Male and female dippers did not differ in blood ^{15}N values (t_{29} = 0·20, P = 0·8) or diet composition (t_{29} = 0·96, P = 0·4; Table 4). However, resident dippers occupying the river ate a higher percentage of fish (42% 7%) than migrants on tributaries (22% *P*nautarieh rlacknt d1(ants t)13.9(le)31.(aluesri(tion testnt)he ind.9(v)13.iduald)64tion tants J T* -0.0

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ocation between river residents and
nts within the watershed may have fur-
uted to the observed contaminant trends.
exist in watersheds with respect to stream eco-
structure and function (e.g. the river continuum
ncept) that suggest a predictable transition from the
headwaters to higher order reaches (Vannote *et al*. 1980). Changes occur in discharge, chemistry, allochthanous and autochthanous energy sources, species richness and biomass, along with increasing contaminant loads through atmospheric deposition from upstream to do
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prey selection of the individual. Therefore, if trends in contaminant concentrations are to be correctly inferred by indicator species such as the dipper, a sound understanding of the population's structure, migration strategy and diet is crucial. We recommend that results of future contaminant studies on indicator species be interpreted with a more integrative approach that accounts for the spatial variation in breeding sites and relative prey availability.

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