Ecotoxicology and Environmental Safety 109 (2014) 101–109

Contents lists available at ScienceDirect

Ecotoxicology and Environmental Safety

journal homepage: www.elsevier.com/locate/ecoenv

Contamination of fish in important fishing grounds of the Czech Republic

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ARTICLE INFO

Article history:
Received 10 June 2014
Received in revised form
25 July 2014
Accepted 26 July 2014
Available online 29 August 2014

Keywords:
Mercury
POPs
Fish
Muscle
Health risk

ABSTRACT

The aim of this study was to compare the contamination levels of certain important fishing grounds in the Czech Republic and to assess the health risk of consuming the fish from these localities. The assessment was performed from 2006 to 2010 in 27 fishing grounds. Within this project, 707 fish from 14 different species were sampled. The concentration of selected toxic metals (Hg, Pb, Cd) and persistent organic pollutants (POPs), such as non-dioxin-like polychlorinated biphenyls (NDL-PCBs), hexachlorocyclohexane (HCH) isomers, dichlorodiphenyltrichloroethane (DDT) and its metabolites (o,p´-DDE; p,p´-DDE; o,p´-DDD; p,p´-DDD; o,p´-DDT; p,p´-DDT) and hexachlorobenzene (HCB), were analysed in the muscle tissue of the sampled fish. Atomic absorption spectrometry (AAS) was used for the analysis of toxic metals. All of the POPs were analysed using gas chromatography with an electron capture detector (GC/ECD). Common bream (*Abramis brama*) was chosen as a reference fish species for the comparison of fishing grounds. Mercury was found as a major pollutant in fish flesh at all of the sampling sites. Concentrations in excess of the maximum level (ML) of mercury in the muscle tissue of fish (0.5 mg kg^{-1}) were registered in 32 samples. Concentrations of other monitored toxic metals in fish muscle were low, typically below the limit of quantification (LOQ). From the tested POPs, DDTs and NDL-PCBs were found as major pollutants. ML for NDL-PCBs (ICES-6) in muscle tissue of fish (0.125 mg kg^{-1}) was exceeded in 7 samples. In case of tested pesticides, concentrations in excess of the MRL were not registered.

1. Introduction

Many human activities cause some types of pollution that results in surface or underground water contamination. Certain xenobiotics, such as toxic metals or persistent organic pollutants (POPs), remain in the environment for a very long time because of their poor degradability. These xenobiotics, such as toxic metals, are commonly deposited in the water sediments of aquatic environments, which results in their presence in food chains at localities where there have been no sources of pollution for many years (Abel, 1996; van Hattum et al., 1993).

After being released into the air, mercury returns to the ground through precipitation and enters the aquatic environment; thus, atmospheric deposition is a dominant source of mercury (Lepom et al., 2012). Mercury is neurotoxic in both its organic and inorganic forms (Atchison and Hare, 1994). The commonly encountered form of mercury, methylmercury (MeHg), is the most toxic form affecting aquatic biota (Lasorsa and Allen-Gil, 1995; Maceda-Veiga et al., 2012). MeHg is primarily responsible for bioaccumulation in the muscle tissue of fish with a methylmercury-to-total mercury ratio of 83–90% (Kannan et al., 1998; Kruzikova et al., 2008; Lasorsa and Allen-Gil, 1995; Marsalek et al., 2005).

Cadmium has similar neurotoxic effects as some other heavy metals including mercury, but it has a specific impact on reproductive organs in long-term exposure to even trace concentrations. Several studies (De Conto et al., 1999; Svobodova et al., 2002) show that target organs for accumulation of cadmium are chiefly kidney and liver.

Important source of lead in environment are exhaust gases of vehicles. Lead petrol was restricted to use recently in developed countries, but lead from this source remains in environment and some countries are still using lead petrol. Also lead has neurotoxic effects in living organisms similar to cadmium and mercury (Gupta et al., 2009; Svobodova et al., 2002).

POPs are characterised by a high affinity for adipose tissue and slow biodegradability, which results in their bioaccumulation in

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http://dx.doi.org/10.1016/j.ecoenv.2014.07.034
0147-6513/

various animal species, along the trophic chain, including fish species that are at the top of the food pyramid in an aquatic ecosystem (Bosnir et al., 2007; Marsalek et al., 2004; Siroka et al., 2005). The occurrence of POPs in the environment arouses scientific interest primarily because of their endocrine disrupting effects on animals and humans (Godduhn and Duffy, 2003; Petro et al., 2010; Yang and Xu, 2005).

In the Czech Republic, sport fishing is a traditional recreational activity. Currently, the majority of anglers are organised into two Anglers Unions, which host nearly 320,000 members organised into 585 local units. Nearly 4000 t of various fish species are caught annually by anglers in the Czech Republic. The most stocked fish is common carp (*Cyprinus carpio*), with 3200 t of stocking per year (Adamek et al., 2012).

In the present study, we focused on the detection of toxic metals (mercury, lead, cadmium) and certain POPs (α-, β-, γ-HCH, HCB, DDT and NDL-PCBs; evaluated as a sum of six indicator congeners) in reference fish species (common bream) and fish species that are preferred by anglers in the monitored fishing grounds. Common bream (*Abramis brama*) was chosen as a reference species due to its high abundance in all of the evaluated fishing grounds and because it is not artificially stocked in Czech Republic, so it means that concentrations of pollutants found in its body better reflect the pollution of given locality than in artificially stocked fish species (e.g. carp).

Contrary to fish from the markets of EU countries where hygienic quality is continuously controlled, there is no detailed evidence about contamination of fish from rivers and other water bodies. These data could provide important information about the contamination of fish to anglers, who commonly consume the fish from rivers and water reservoirs. By comparing with provisional tolerable weekly intake (PTWI) and provisional tolerable monthly intake (PTMI) for MeHg and Cd respectively and provisional tolerable daily intake (PTDI) for DDT, suggested by FAO/WHO (WHO, 2004, 2011; FAO, 2001), the potential health risk for consumers was evaluated.

2. Materials and methods

2.1. Monitored sites

From 2006 to 2010, samples were obtained from 27 of the most popular fishing grounds in the Czech Republic, as shown in Fig. 1. Fishing grounds with the highest attendance were chosen in cooperation with the Czech Angler´s Union as indicated by the preferences of anglers. Several industrial areas or sites with a higher level of another type of pollution were also included. A list of the sampling sites with specific characteristics is shown in the Supporting Information (Table S1).

2.2. Fish sampling

Fish were caught by electrofishing, gillnets and angling. Common bream (*Abramis brama*) was chosen as a reference species due to its high abundance in all of the evaluated fishing grounds. Bream is a typical benthic feeder and is not artificially stocked in the Czech Republic. Characteristics of reference species caught at monitored sites are given in Table 1. In addition to bream, fish species typical for each locality, such as asp (*Aspius aspius*) or perch (*Perca fluviatilis*), were sampled as well as those that are preferred by anglers, such as carp (*Cyprinus carpio*), zander (*Sander lucioperca*) pike (*Esox Lucius*) eel (*Anguilla anguilla*) and catfish (*Silurus glanis*).

All of the sampled fish were measured and weighed, and scales were removed for age determination. Muscle tissue from the dorsal side of the body was obtained for all analyses, because it is a common consumable part of fish body by anglers. Samples of reference fish species (bream) for toxic metal analyses were obtained individually at all of the monitored sites. Samples of bream for POPs analyses and samples of other fish species were obtained as single-species pooled samples at each sampling site. The same amount of muscle tissue was taken from each individual to make these pooled samples. Samples were packed into plastic bags, labelled and transported to the laboratory in thermo-boxes filled with ice. Samples were then stored at −18 °C until analyses.

Experimental animals were handled in accordance with the national and institutional guidelines for the protection of human subjects and animal welfare.

2.3. Chemical analyses

Analyses of the target pollutants were performed in the laboratory of the State Veterinary Institute in Prague, which is accredited for the range of analytes of interest in accordance with EN ISO/IEC 17025: 2005. Concentrations of all target

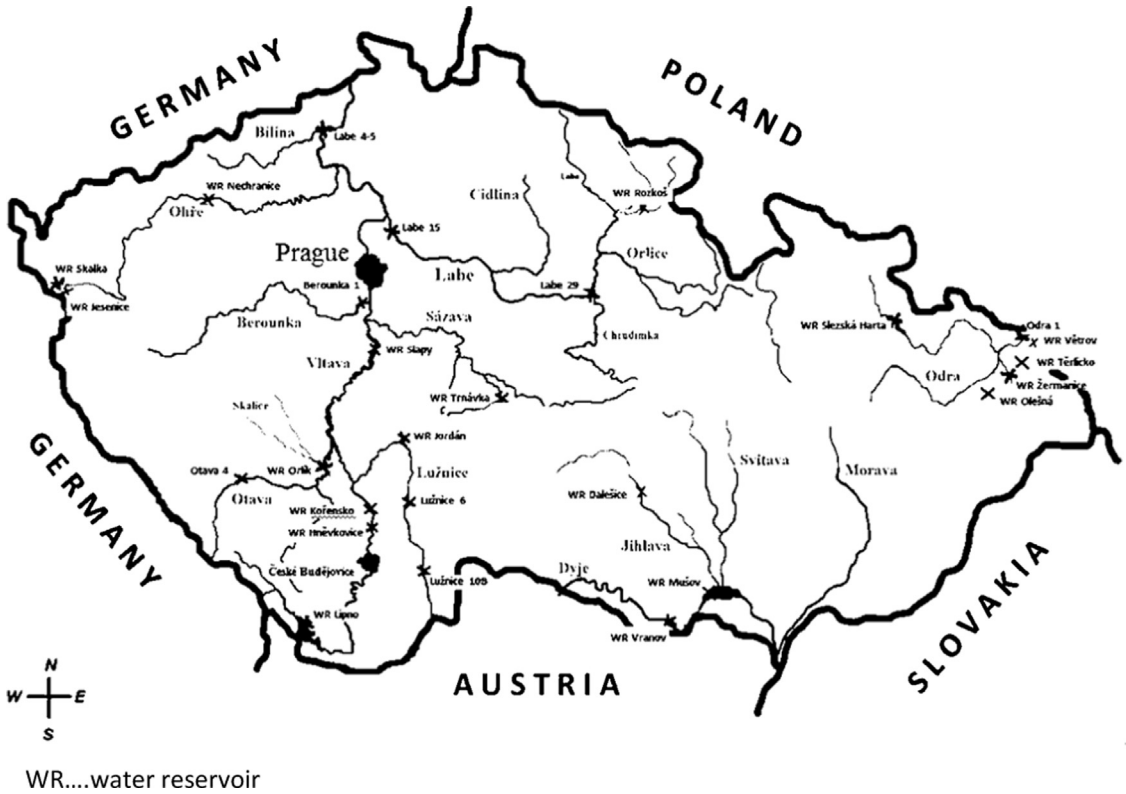

Fig. 1. Map of the Czech Republic with sampling sites.