DIFFERENCES IN LINDANE LEVELS IN PERCH LIVING IN DIFFERENT AREAS OF THE BALTIC SEA (1998-2003)

Lukki T[1], Roots O[2], Järv L[3],Simm M[3]
[1]Tallinn University, Narva road 25, 10 120 Tallinn, Estonia; [2]Estonian Environmental Research Institute, Marja 4D, 10 617, Tallinn, Estonia; [3]Estonian Marine Institute, University of Tartu, Mäealuse 10A, 10 616, Tallinn, Estonia

Introduction
Perch is one of the most abundant fish species in Estonian waters. The Estonian total annual catch (from the Baltic Sea) in the years 1994-1997 was from 300-600t, but shows a decreasing trend [1]. The concentration of lindane in perch of different areas of Estonian coastal sea has been studied since 1998. Differences in lindane concentrations in perch living in different areas (different catches) of the coastal sea could be observed.

Material and Methods
Materials: The main coastal fishing areas are Matsalu Bay, the Väinameri (Moonsund) Archipelago, and Pärnu Bay in the Gulf of Riga. In the period 1998-2003 HCH-isomers concentrations in the Baltic Sea fish from five areas of the Estonian coastal waters were determined. Fish were caught from the western (Dirhami) and eastern (Narva) parts of the Gulf of Finland, Pärnu Bay, Open part of the Baltic Sea (Vilsandi) and the Väinameri (Moonsund) Archipelago. The fish samples were frozen promptly following examination and selection. All organochlorine contaminants have been analyzed in the muscle tissue.
Methods: The Estonian Environmental Research Centre (EERC) is accreditated by German accreditation bureau Deutshes Akkreditieruns-system Prüfwesen GmbH (DAP) (DAP-PL-3131.00 (2008-11-22). All solvents used were of the highest quality commercially available. Ten grams of the fish sample (muscle) were homogenized in a IKA T25 homogenizer from Labassco AB, Pertille, Sweden and extracted according to Jensen et al. [2] and the lipid content was determined by the method in Roots et. al [3-4]. Dissolved lipid (0.1-0.2 g fat) extracts were cleaned up by method – a silica gel column treated with concentrated sulphuric acid. HCH-isomers were analysed on a 90 m capillary column (DB-5) using gas-chromatography (Varian 3380) with electron capture detector (ECD)[3-4].

Results and Discussion
Before beginning an ecological parameters investigation, each scientist must select, what kind of biological parameters to measure in order to measure all the essential parameters simultaneously. The need for adequate fish sampling and biological parameters analyses in ecotoxicological investigations is demonstrated in our earlier works [4,5]. Perch is a fish who feeds actively around a year. In the first summer, when the perch fry is comparatively small, small-size zooplankton, like Rotatoria, was important in perch food. In first autumn and winter the benthic animals: *Chironomidae* larvae, *Gammarus spp.* and *Corophium voluntator,* comprised 40-80% of their total food content. About 70% of immatured perch food content from plankton and benthos (Fig. 1).

For example [4], the concentration of DDT and PCB in the immatured perch (in maturity stage I and II) is low (Fig. 2). In Estonian coastal waters two to four years' old perch becomes to mature. During the maturation of perch the different fish species started to dominate in the ration of perch (Fig. 1) and the DDT and PCB concentration increased in perch muscle (Fig. 2). This increase continue until the first spawning. For this time the concentration of DDT and PCB exceeded over 3 times the concentrations in the immatured perch (Fig 2). During the spawning the content of toxicants rapidly decreased. Probably one part of toxicants has been excreted during the spawning process. As bigger/older the perch growth as more predatory they becomes, but the plankton and benthos still will be very important (altogether about 30%) in they food (Fig. 1).

In Estonia the contents of persistent organic pollutants (POPs) in ecological system of the Baltic Sea have been researched since 1974. In the first period (1974-1991), the aim of the research project was to investigate the mechanisms that determine how organochlorines spread and move around in the environment. Findings on deposition and the concentrations in air and precipitation will be combined with studies of atmospheric transport, seawater processes and cycling between water, plankton, fish algae, molluscs, seals, etc [6].

The data have shown that many organochlorine substances which have never been used in Estonia have been carried to the Estonian coast by air or surface currents. Preliminary investigations described the results of large-scale environmental monitoring of the hazardous substances in Estonian coastal water ecosystems.
At the beginning of nineties it became evident that every catch (or fish population) of fish (Baltic herring) is unique, so the parameters of different catches (or populations) cannot be described as a single array [7].

In the period 1998-2003 lindane concentrations in the 119 samples of perch, from five areas of the Baltic Sea, were determined. Instead of measured fish quantities X_i as length [*mm*], weight [*g*], age [*year*], maturity, and lindane [*microgram/kg*] we use modified values X_i', where

$X_i' = (X_i - \text{average } X_i)/\text{standard deviation } X_i$.

Using Monte-Carlo method are searched for set of constants C_i in linear form

$Z = C_{\text{length}} * \text{length}' + C_{\text{weight}} * \text{weight}' + C_{\text{age}} * \text{age}' + C_{\text{maturity}} * \text{maturity}$

prerequisite linear correlation constant R to be maximum between Z and lindane. Supplementary condition is maximum stability of R regarding to changes of constants C_i. On that conditions we can interpret values of C_i as relative importance for factors i in establishing lindane values in linear model.

				Set of constants C				
Area	Year	Number of samples	Maturity	C_{length}	C_{weight}	C_{age}	C_{maturity}	R_{max}
All	1998 - 2003	119	2; 3; 4	0,50	-0,60	0,25	-1,00	0,4175

				Set of constants C				
Area	Year	Number of samples	Maturity	C_{length}	C_{weight}	C_{age}	C_{maturity}	R_{max}
Dirhami	2001	14	2; 3	-0,31	0,63	0,88	-1,00	0,5521
Pärnu	2000	6	2	-0,92	0,08	1,00	0,00	0,6457
Pärnu	2002	11	2	1,00	-0,96	-0,67	0,00	0,4595
Narva	2000	15	2; 3; 4	-0,69	0,07	1,00	0,32	0,5789
Vilsandi	1998	10	3	0,29	1,00	-0,17	0,00	0,4344
Väinameri	1998	33	3	-1,00	-0,25	0,38	0,00	0,4062
Väinameri	1999	20	2; 3	-0,11	1,00	-1,00	-0,53	0,5462
Väinameri	2003	10	3	-0,60	1,00	-0,30	0,00	0,4597

				Set of constants C				
Maturity		Number of samples		C_{length}	C_{weight}	C_{age}		R_{max}
2		28		1,00	0,09	-1,00		0,3556
3		86		0,20	-1,00	0,64		0,2746
4		4		-0,83	0,00	1,00		0,9998

At the beginning of nineties it became evident that every catch (or fish population) of Baltic herring is unique, so the parameters of different catches (or populations) cannot be described as a single array [7].

Following the results, since 1998, we consider whether maturity may appear as the main factor in linear model for lindane. Still there are relatively strong arguments regarding uniqueness of the individual catches. There are incomparable sets of factors determining lindane in each area and year.

References:

1. Järv, L. 2000. Estonia. Proc. Estonian Acad. Sci. Ecol., 2000; 49: 270.
2. Jensen, S., Reuthergardh, L., Jansson, B. 1983. Analytical methods for measuring organochlorines and methyl mercury by gas chromatography. Analysis of metals and organochlorines in fish. FAO Fish Tech. Paper, Rome, 1983; 212: 21.
3. Roots, O. 2001.Chemosphere, 2001: 43: 623.
4. Roots, O., Järv, L., Simm, M. Fresenius Environmental Bulletin, 2004; 13: 620.
5. Roots, O., Lukki, T. J. Ecological Chemistry, Theza, St-Petersburg, 1994; 3:181-183 (in Russian, summary in English).
6. Roots, O. Toxic chlororganic compounds in the ecosystem of the Baltic Sea - Tallinn, Estonian Environment Information Centre, 1996: 144 p. (ISBN 9985-9072-0-5).
7. Roots, O., Lukki, T. Proc. XVII Conference of the Baltic Oceanographers, Norköping, 1990: 443.

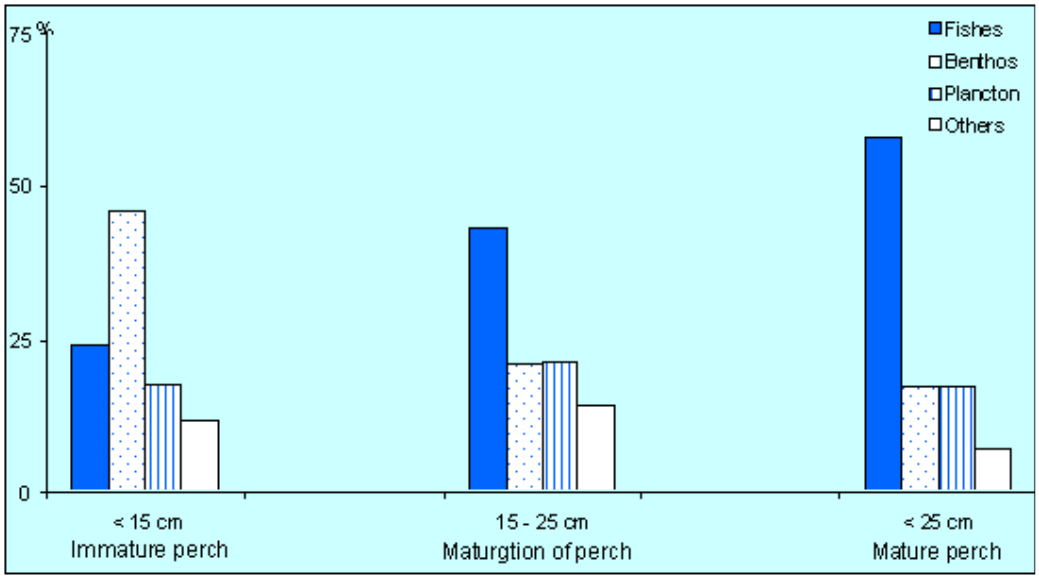

Fig 1. The food composition in different length groups of perch.

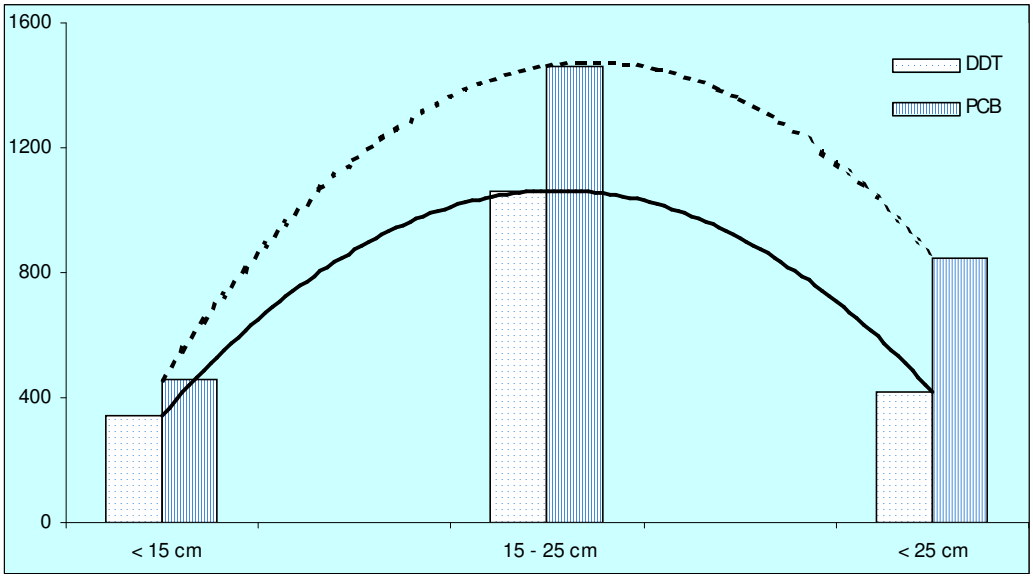

Fig 2. The average concentration (µg/kg per lipids) of toxicants in different length groups of perch.