Trends in total human exposure to PCB and dioxins in Sweden

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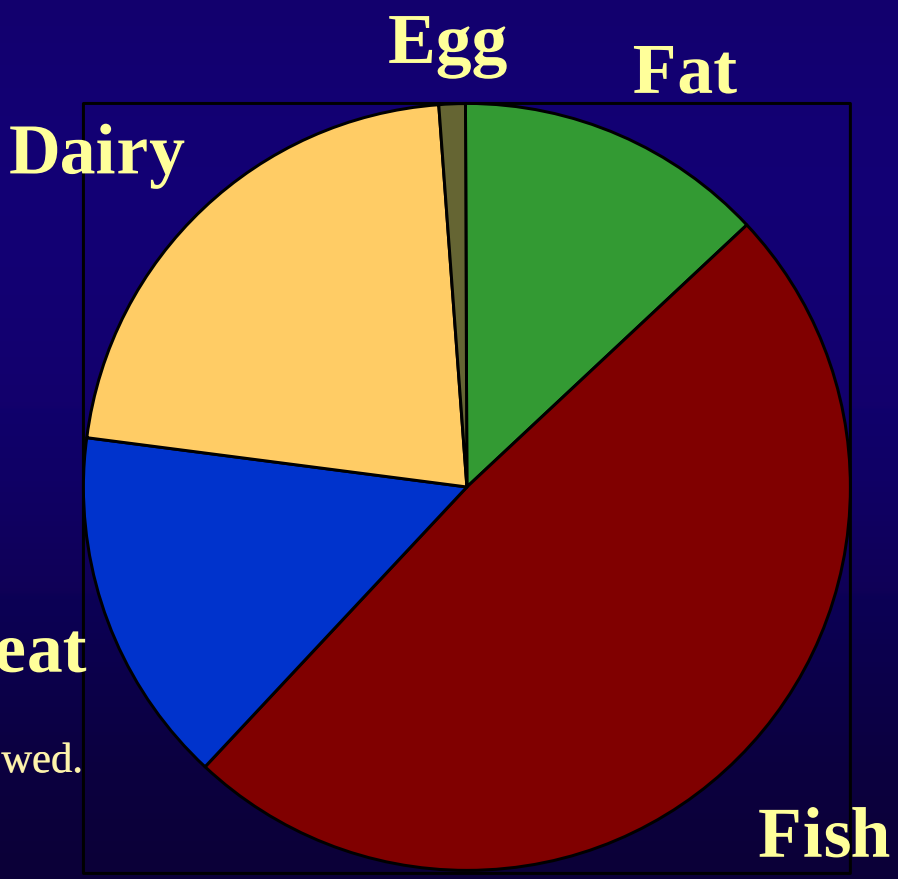
Trends

- **Temporal**
- **Spatial**

- Levels
- Exposure
- Composition
- Sources
- Population
  - Age
  - Sex
  - Habits
- etc.

Contribution of different food groups to intake of dioxins and dioxin-like PCBs

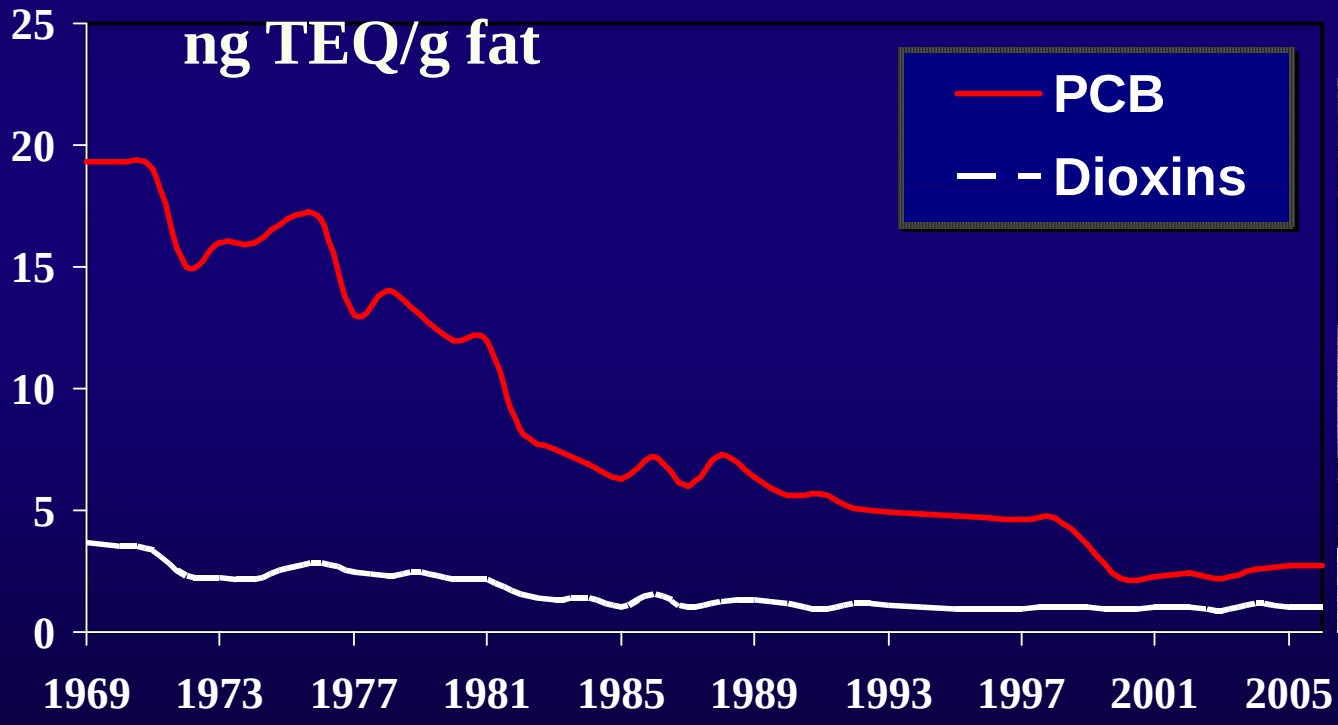


Market Basket Study, Swed. Food Adm. 2005

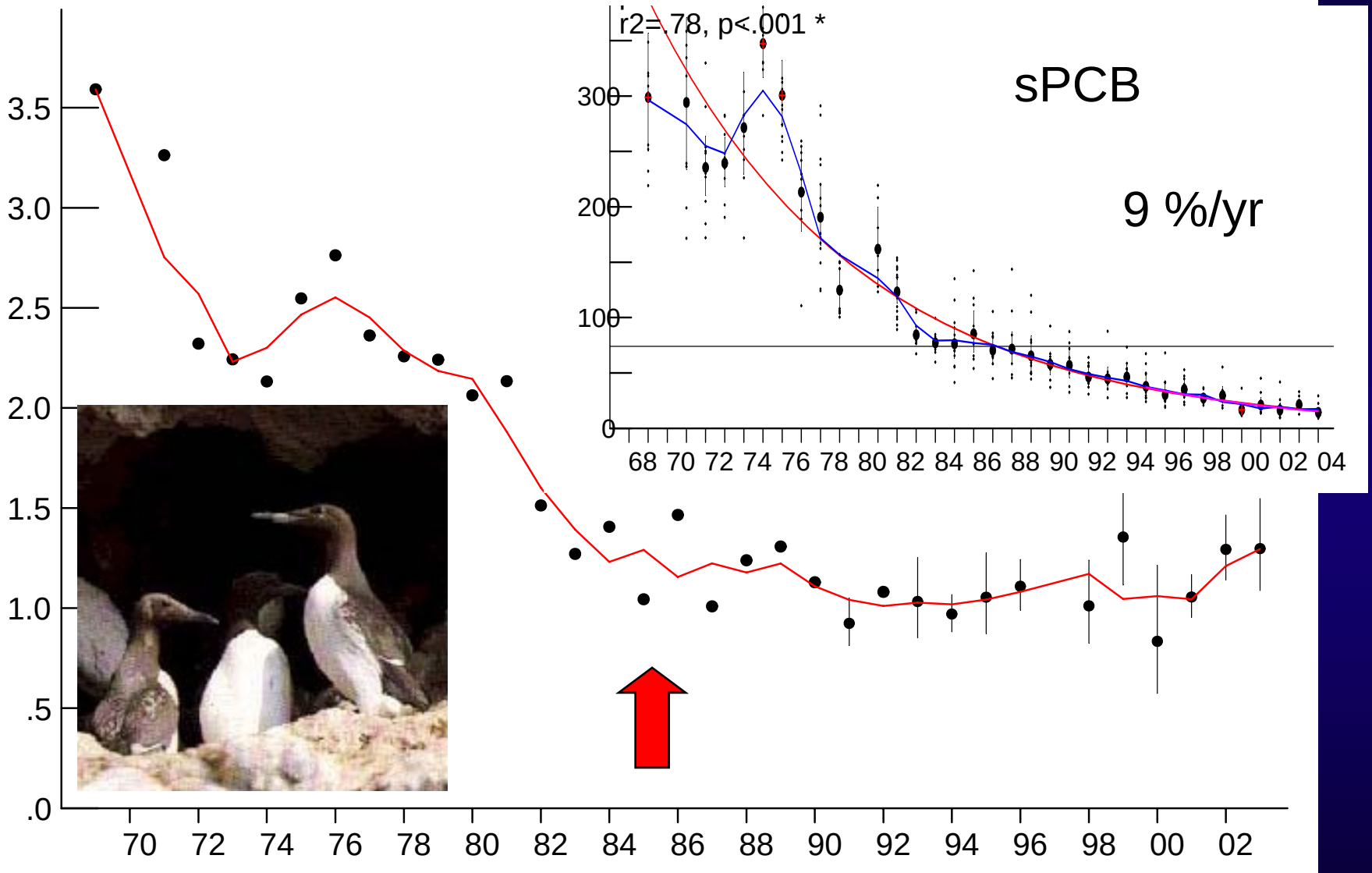
Environmental monitoring
Guillemot eggs

- Monitored since late 1960s
- Representative for Baltic Proper biota in general
- From 1990, some dioxin (PCDD) congener levels have decreased significantly (e.g. 2,3,7,8-TCDD and OCDD)
- Stable or even increasing levels are observed for most other toxic PCDD/F congeners.

Dioxins and coplanar PCB in Guillemot



TCDD equivalents, ng/g fat, Guillemot egg, early laid1969 - 2003



Bignert 2008. **Chemical analyses, Department of Environmental Chemistry, Umeå University**

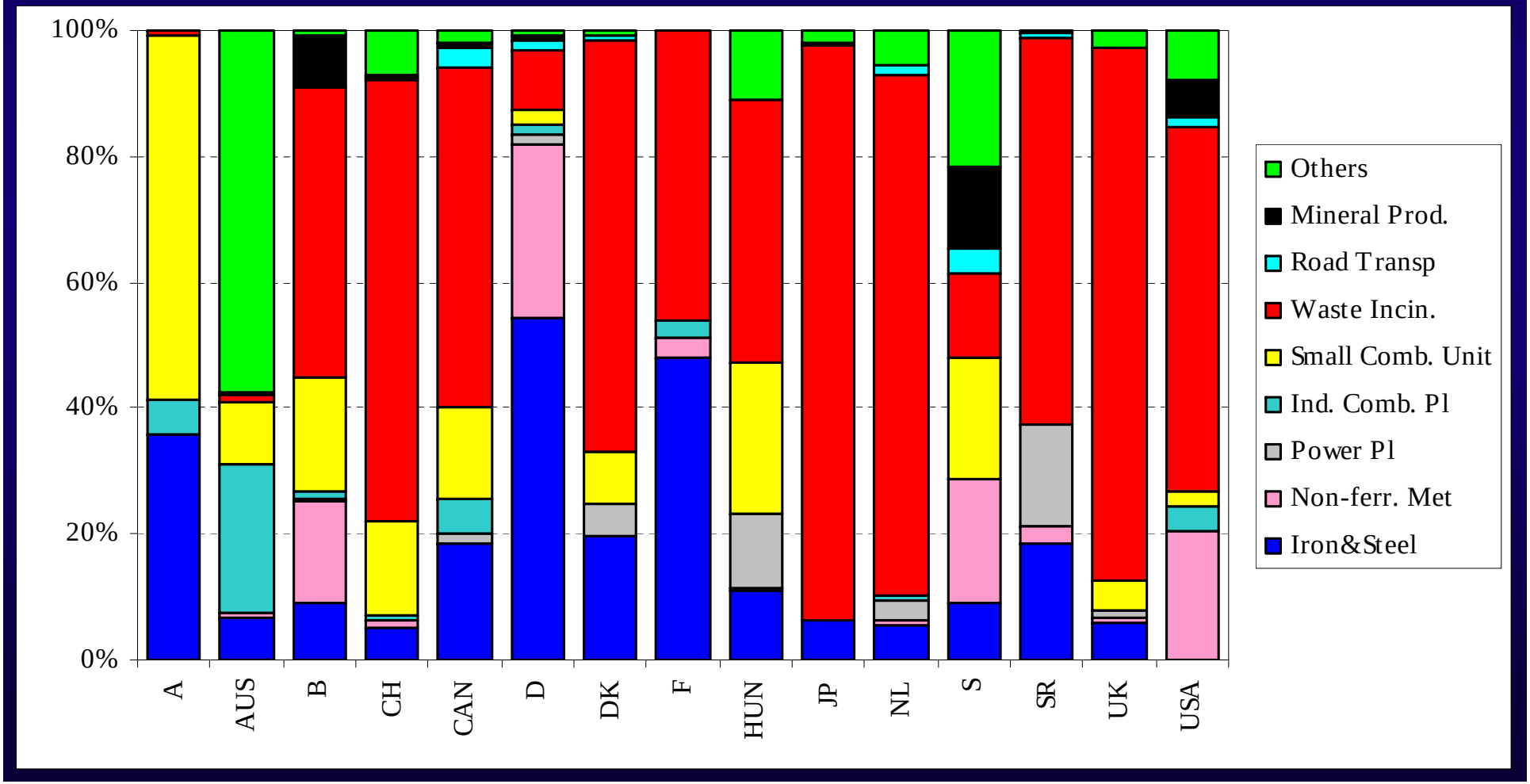
European Dioxin Air Emission Inventory (Quass et al.)

- Considerable emission reduction has been achieved for many industrial sources over the studied period; 10.5 kg (1985), 1.4 kg (2005) (I-TEQ)
- Emissions from non-industrial sources more or less constant since 1995; 3.1 (1985), 1-2.3 (2005)
- Therefore, today or in the near future non-industrial emission sources are likely to exceed those from industrial installations.

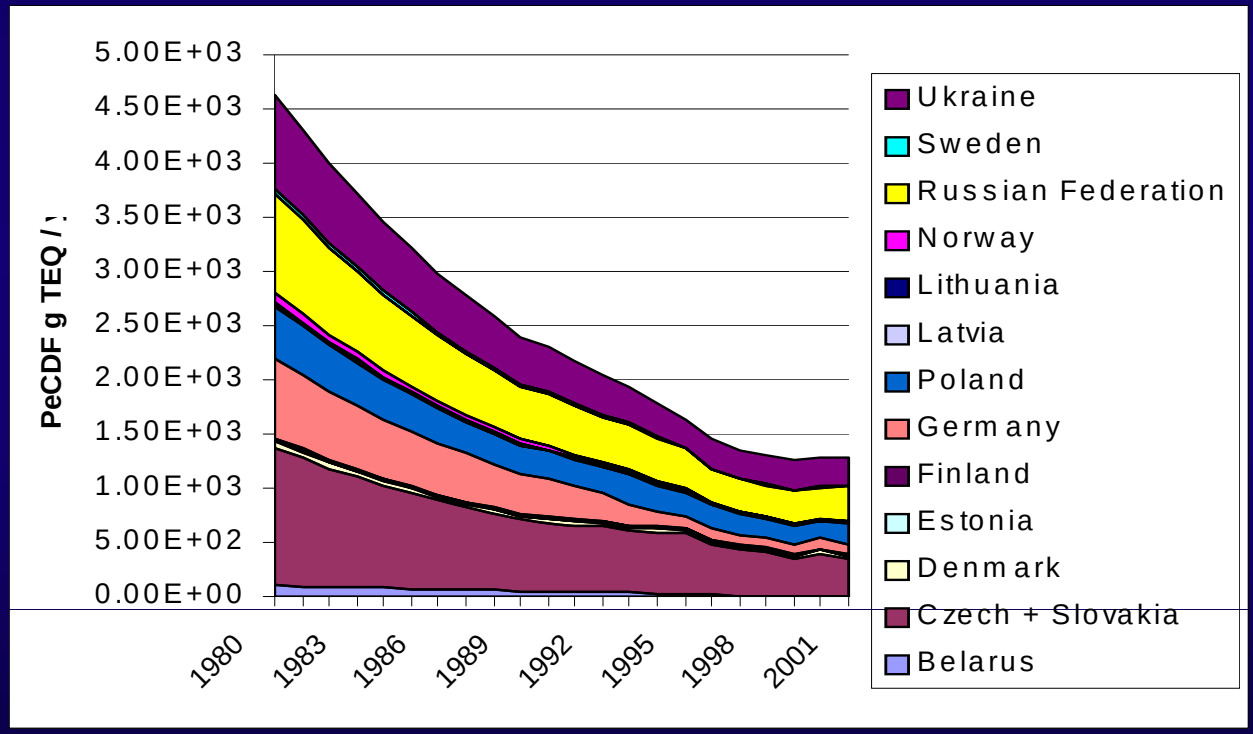
European Dioxin Emission Inventory

- Today, iron ore sintering is believed to be the most important emission source type followed by the former “No. 1”, municipal waste incineration.
- The highest emissions of PCDD/Fs to air in the Baltic Sea area are reported by Germany, Russia and Poland. Together they contribute with more than 95% of the total reported emissions.
- However, data on emissions in the Baltic Sea region are scarce and therefore uncertain

National emissions per industrial sector, 1995



Annual 2,3,4,7,8-PeCDF air emissions in the Baltic region 1980-2001



Annual PCDD/F budget in Sweden

(WHO-TEQ 1998)

- From all industrial sectors: 160-200 g to waste/landfills, 16–84 g to air and 1.9–2.4 g to water and sediments.
- A major part originate from combustion. Among these sources, large scale bio-fuel incineration, backyard burning and combustion of fossil fuels dominate
- Municipal waste incineration is today a minor source
- Ash from municipal waste incineration contain significant amounts of dioxins. This ash is deposited at certified landfills and dioxins could eventually be released to soil water and air

Current or historical emissions?

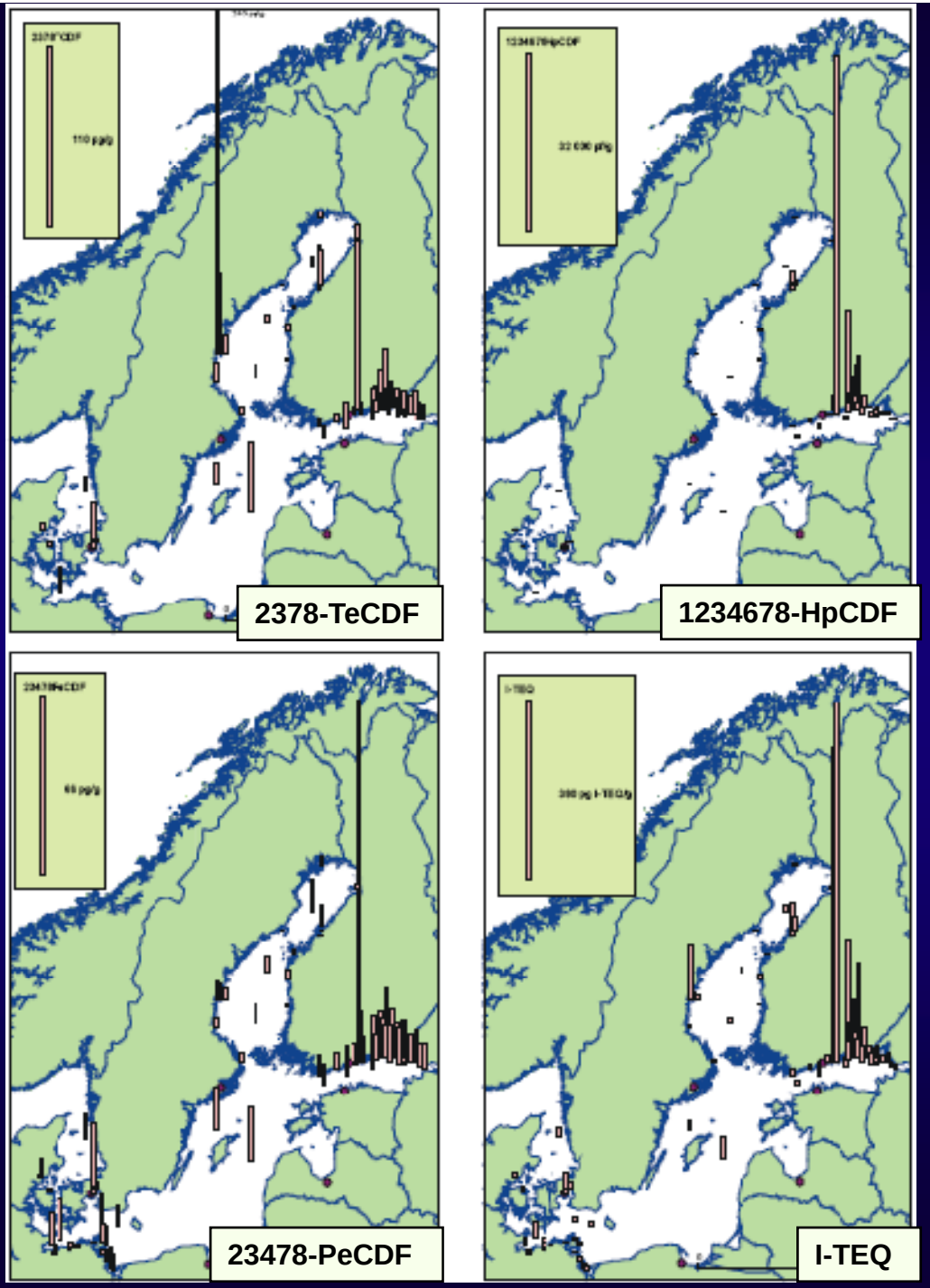
- Dioxins and other POPs in the vicinity of a number of operating and closed pulp and paper plants focused on levels in fish, water and settling particulate matter at sites near and distant from the industrial sites.
- The study suggests that there are some indications of local environmental impacts from a few facilities.

Current or historical emissions?

- The Swedish Forest Industries Federation conducted a dioxin survey at nine mills.
- Waste water, flue gas, air and sludge were analysed and some current PCDD/F emissions were detected.
- The contributions of PCDD/F from the point sources together with tributary inflows to the receiving recipients could roughly explain the differences in PCDD/F levels in fish caught near the industries compared to reference locations.

PCDD/F in sediment

Verta et al. (2004)



Sources and routes of dioxins to the Baltic (g/yr)

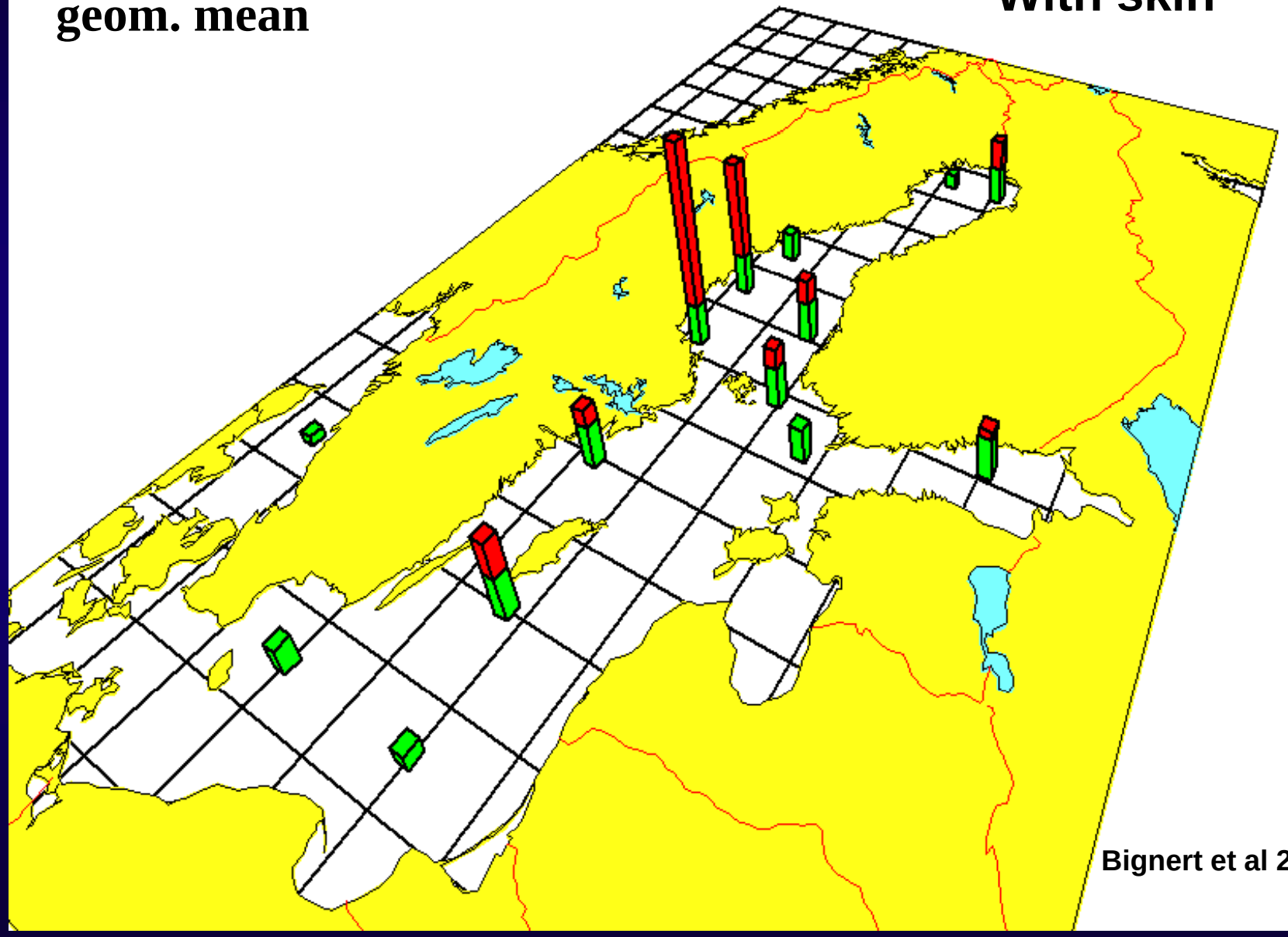
	2,3,7,8 TCDF	2,3,4,7,8 PeCDF	WHO-TEQ
Atmospheric deposition	560	260	680
Via rivers	17	3	40
Pulp and paper industry			
- To air	0,2	0,4	0,5
- To water	0,4	0,03	0,2

Spatial variation

	WHO-TEQ (pg/g f.w.)	Landings (t)
Piteå	6,18	140 (1,5%)
Ångermanälven, Bålsön, Västra Banken	18,52	1800 (20%)
Gotland and Landsort	11,71	3700 (41%)
Utlängan	4,12	3000 (33%)

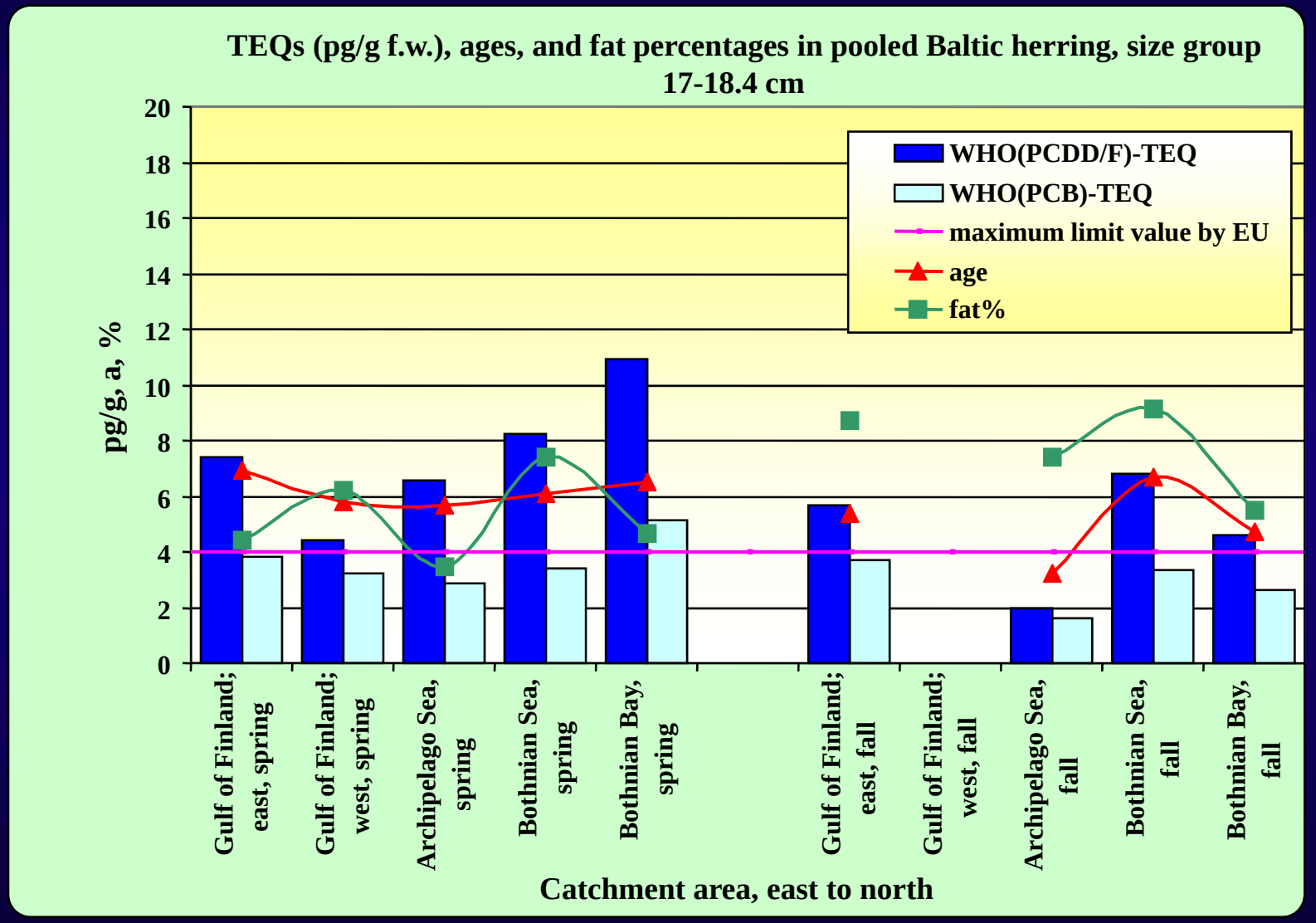
PCDD/F - TEQ Herring, geom. mean

With skin



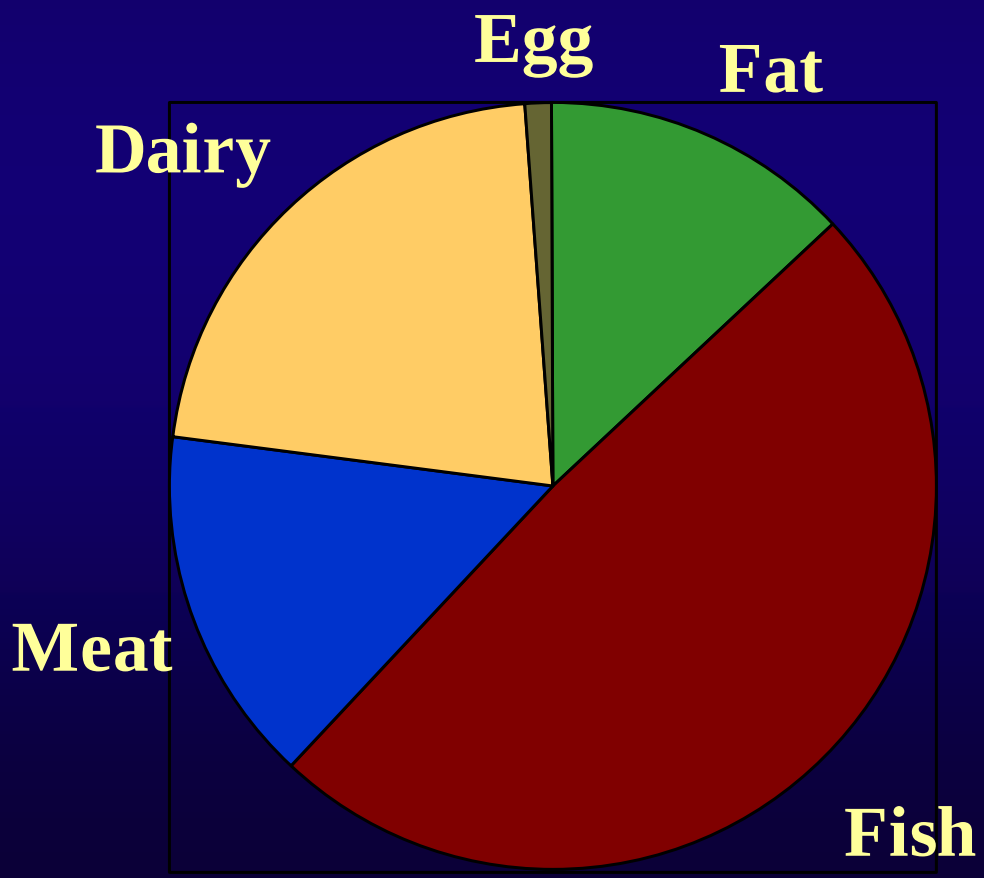
Bignert et al 2008.

Pooled Baltic herring size class III



Verta et al

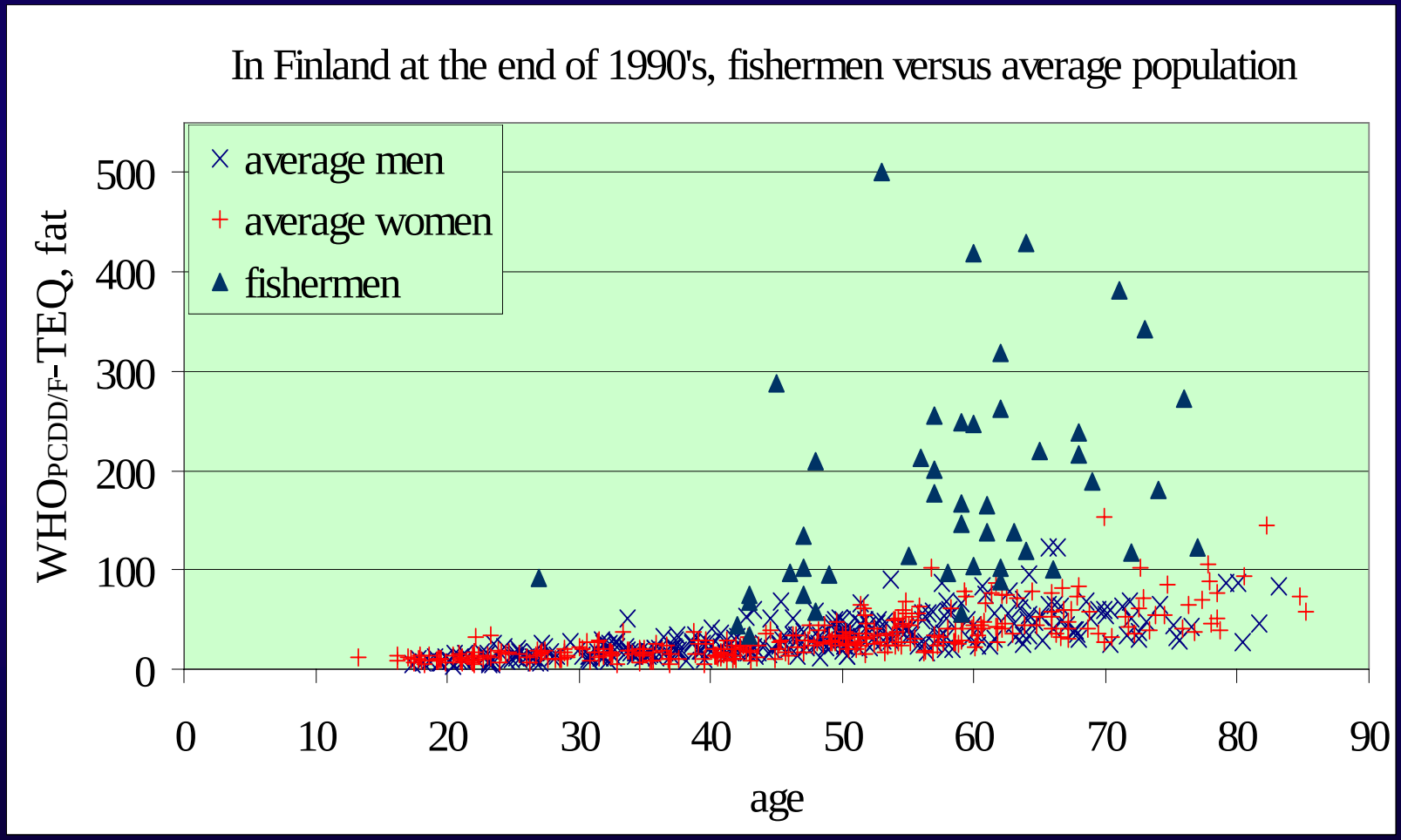
Contribution of different food groups to intake of dioxins and dioxin-like PCBs



Differences in composition
as TEQ

- **Herring**
  - **2,3,4,7,8 PeCDF 63%**
  - **1,2,3,7,8,PeCDD 21%**
  - **2,3,7,8 TCDD 6%**
  - **2,3,7,8 TCDF 3%**
- **Humans**
  - **2,3,4,7,8-PeCDF 38%**
  - **1,2,3,7,8 PeCDD 30%**
  - **2,3,7,8 TCDF 0,6%**

Dioxin concentrations in fishermen and in average population in Finland (J. Tuomisto, KTL)



Human monitoring

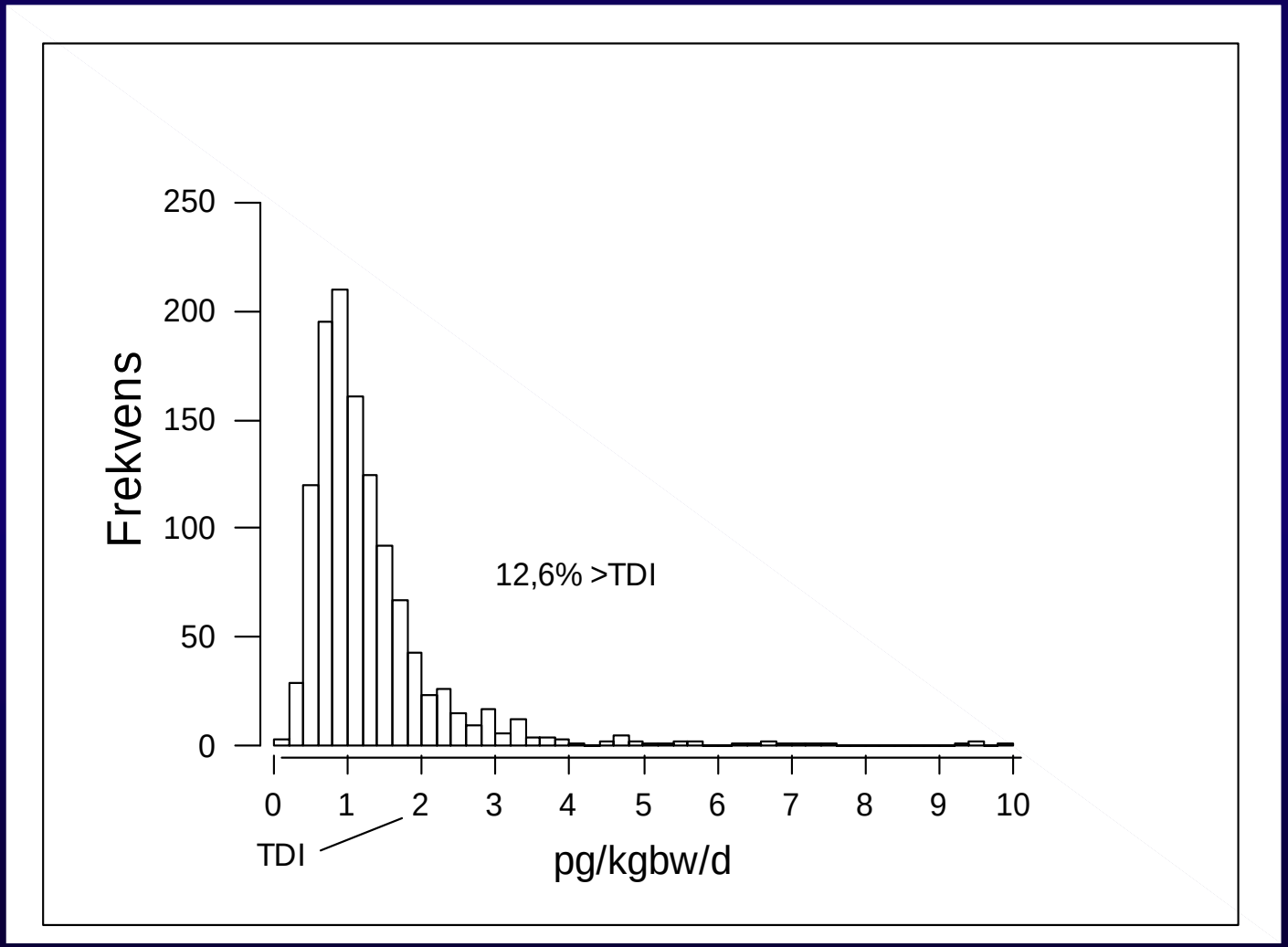
- Decreasing concentrations of PCB has been observed in blood serum from Swedish men during the period 1991– 2001.
- In contrast, no significant changes in TEQ levels were observed in the same population between 1987 and 2001.
- This is mostly attributed to invariable or increasing trends of several of the furan (PCDF) congeners.

Estimated daily intake 2002

- Median intake
  - Women: **1.07 pg/kg bw**
  - Men: **1.02 pg/kg bw**
- 12% of all consumers exceed TDI (2 pg/kg bw).
- 6% of women aged 17-40 years exceed TDI

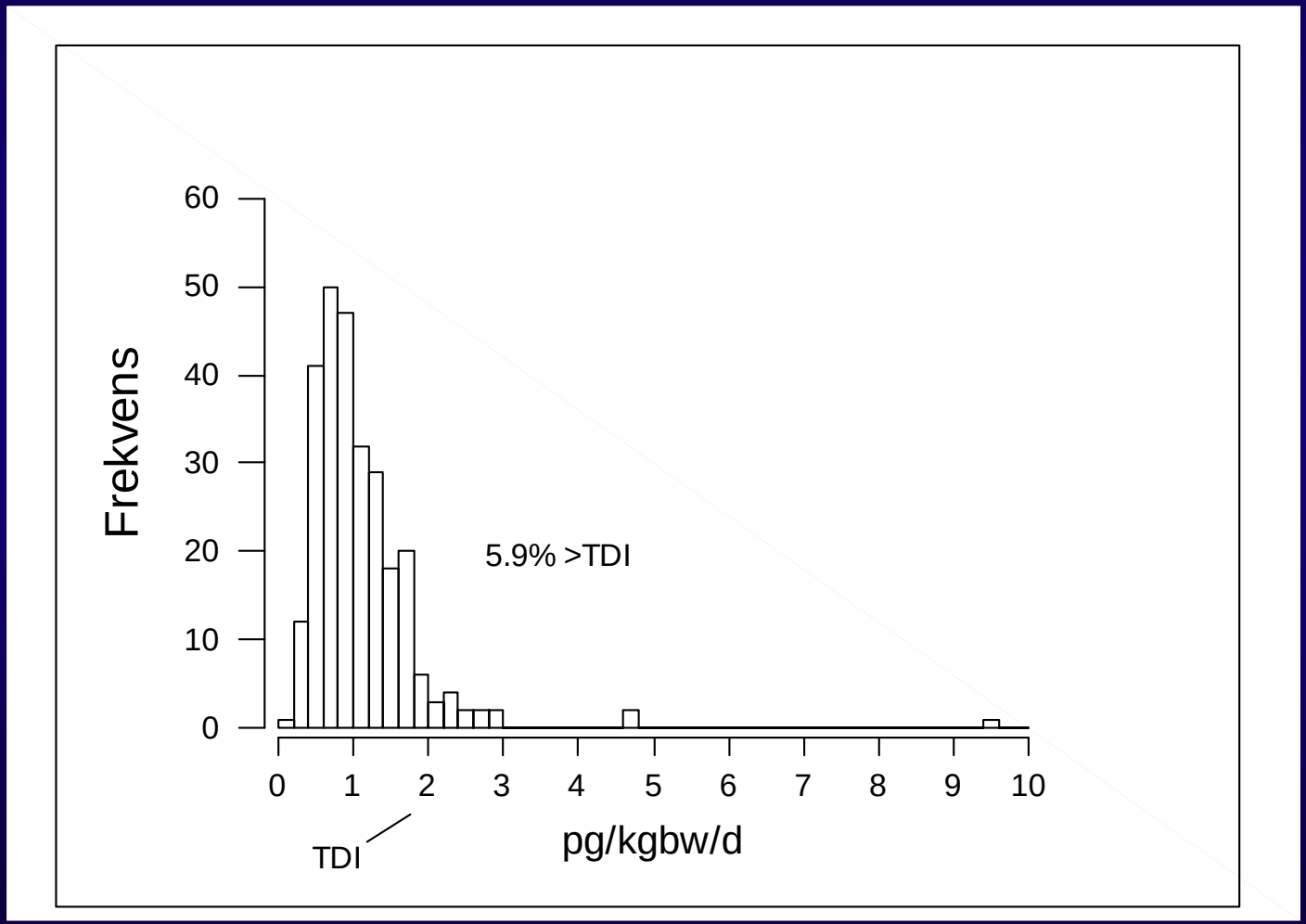
Intake of dioxins

(total-TEQ; n=1195)



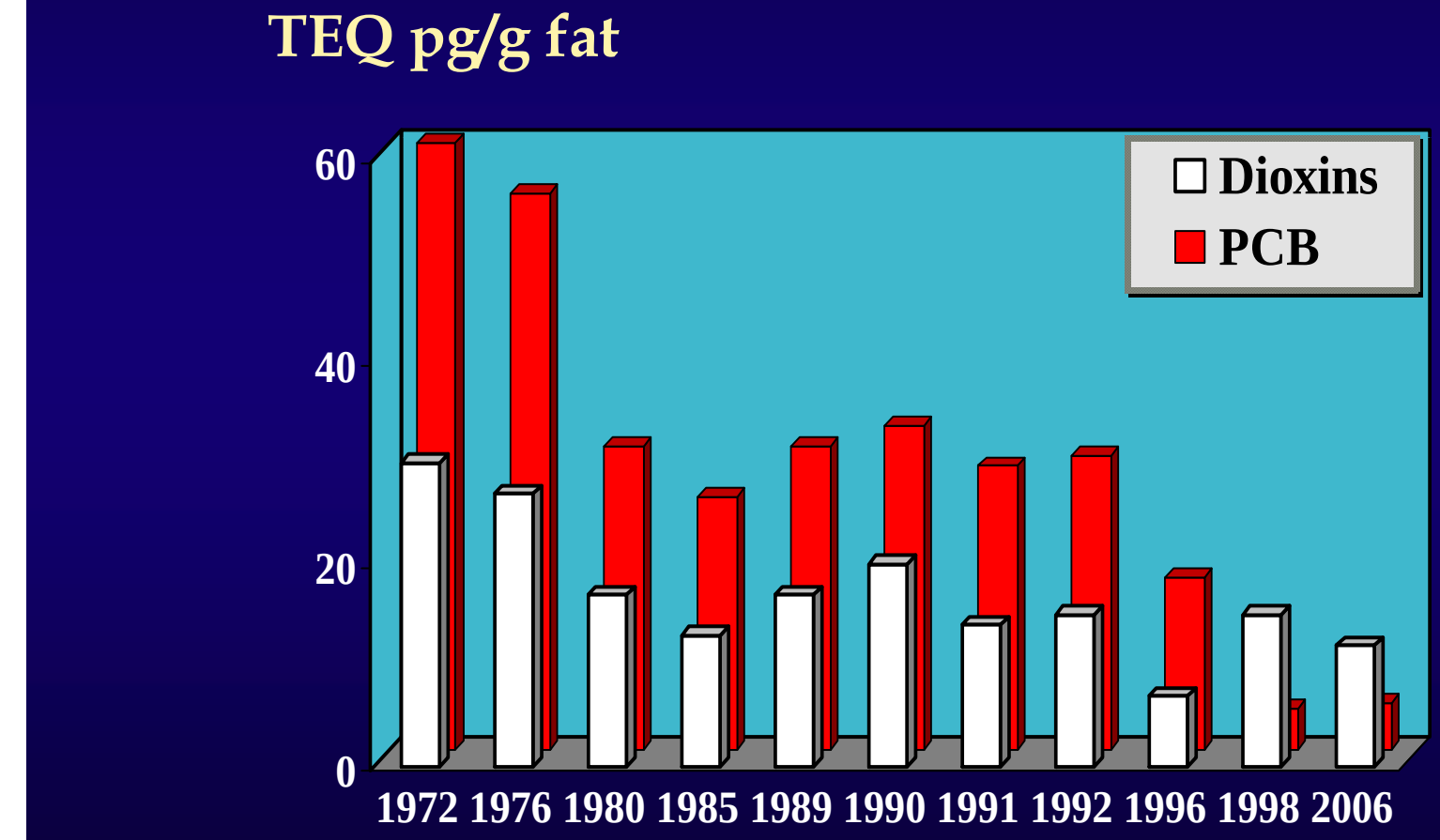
Intake of dioxins

total-TEQ, Women < 40 y (n=272)



Dioxins and PCB in breast milk

1972-1996: Mixed samples from Stockholm
1998-2006: Median levels from primipara women in Uppsala



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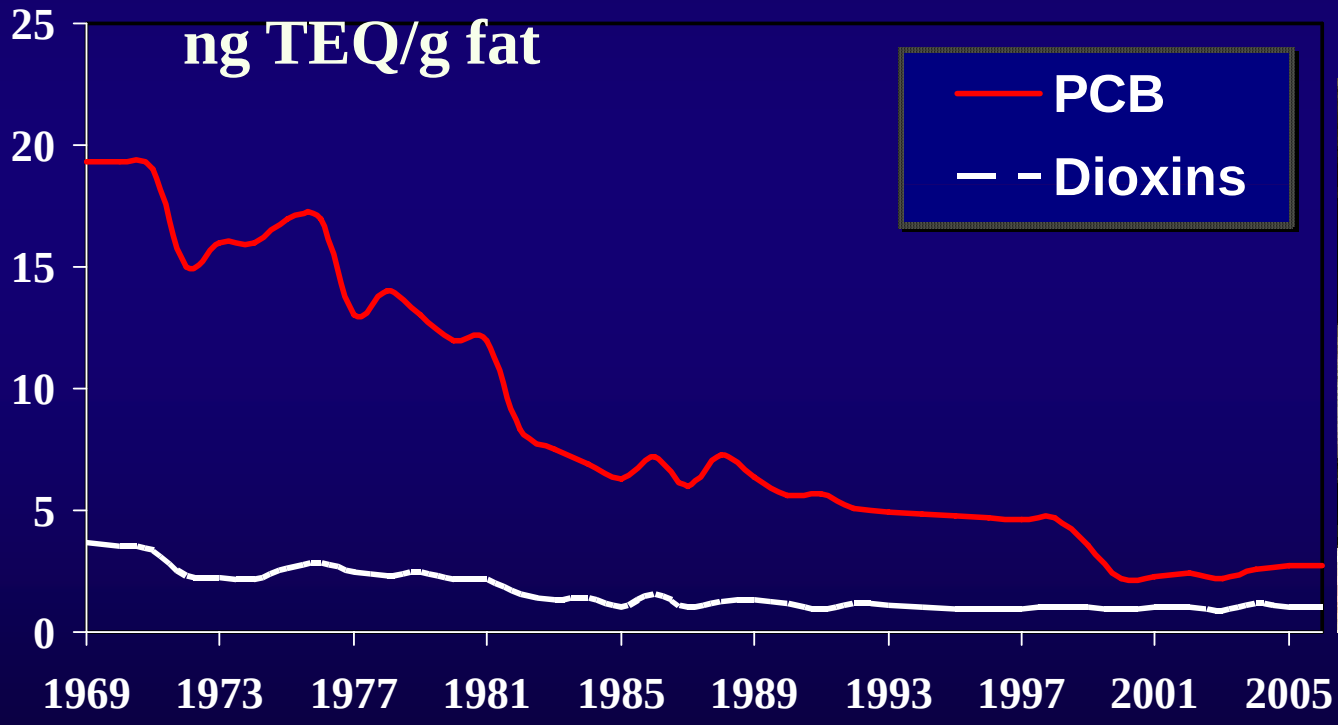

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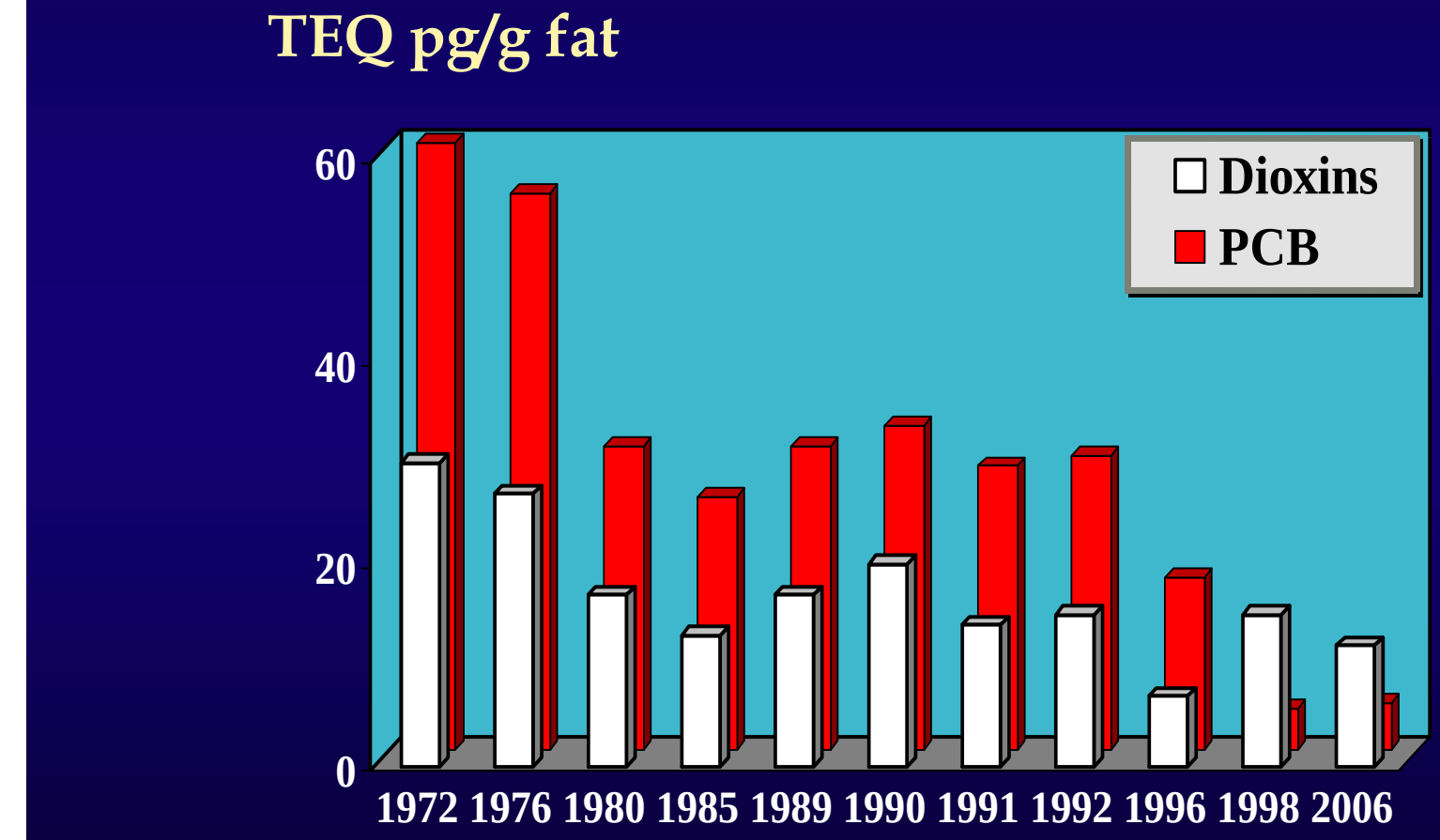


Will dioxin levels in fish decrease?

- Deposition 40 g - 600 g I-TEQ per year (30-400 g PeCDF) high enough to explain PeCDF in fish (Assmuth et al. 2005)
- Atmospheric deposition major source to dioxins found in fish (Swedish EPA 2009)
- Total fish biomass: 10 g PeCDF
- Estimated emissions to air 2005, 2-3.7 kg
- Estimate of deposition on the Baltic 2005, 200 g I-TEQ (Gusev et al. 2008)
  - whereof 100-120 g PeCDF

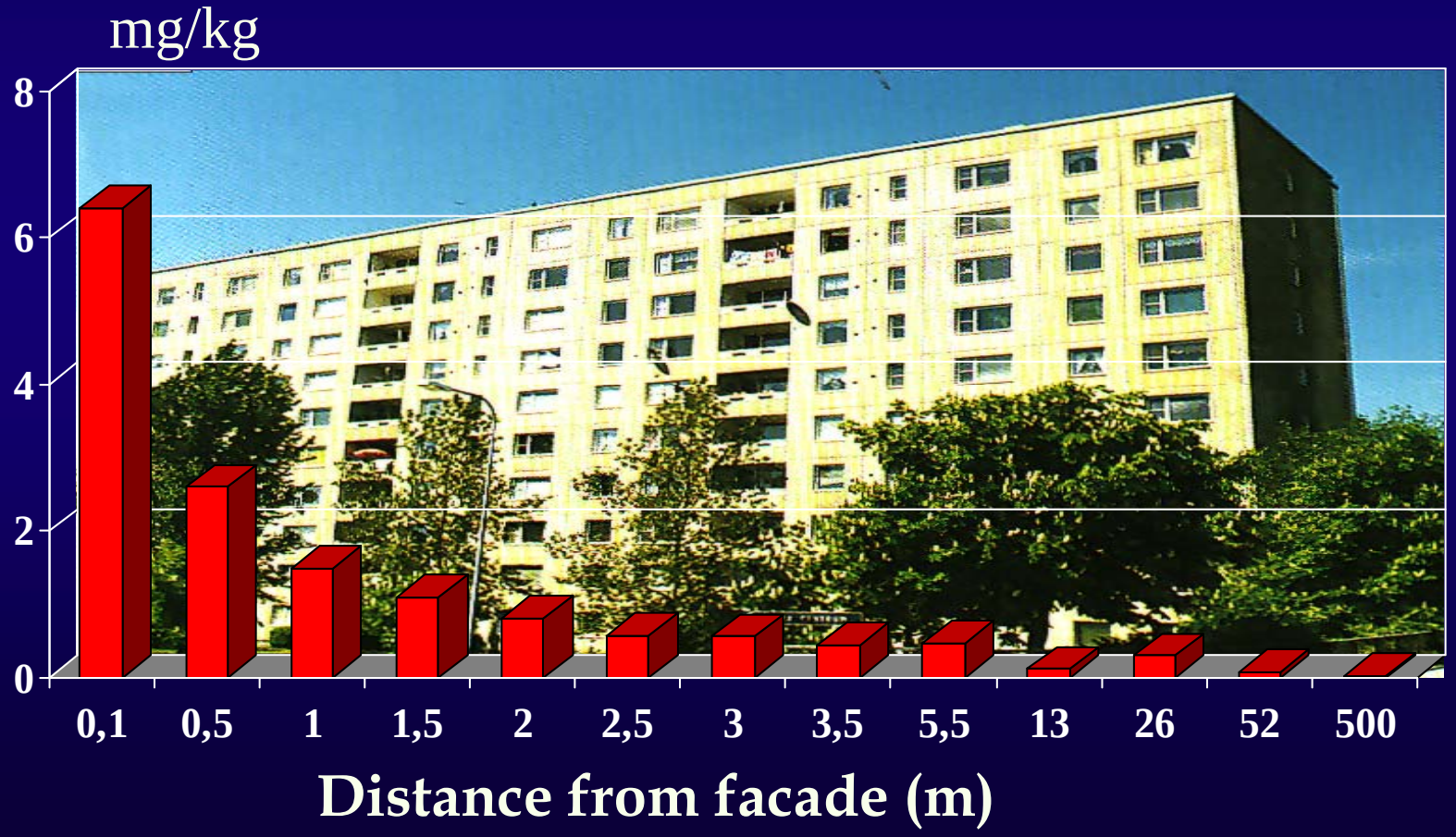
Dietary recommendations Baltic fatty fish

- Girls and women in child-bearing ages
  - Do not eat more than one meal per month of Baltic herring, wild-caught salmon and trout from the Baltic Sea, and of salmon and trout from Lake Vänern and Vättern, and arctic char from Lake Vättern
  - Do not eat liver from cod and burbot
- For other consumer groups the advice is one meal per week of the specified fishes, and not more than occasional servings of cod and burbot liver

The PCB story in Sweden

- 1966: Identified in the environment
- 1971: First legislation on PCB
- 1973: Use in open applications banned
- 1978: ”New” use in closed applications banned
- 1988: Stepwise reduction of use in closed systems
- 1995: All use banned
- 2007: Law on mandatory inventories of PCB in buildings and subsequent decontamination

PCB-level in soil at different distances from a “PCB building”

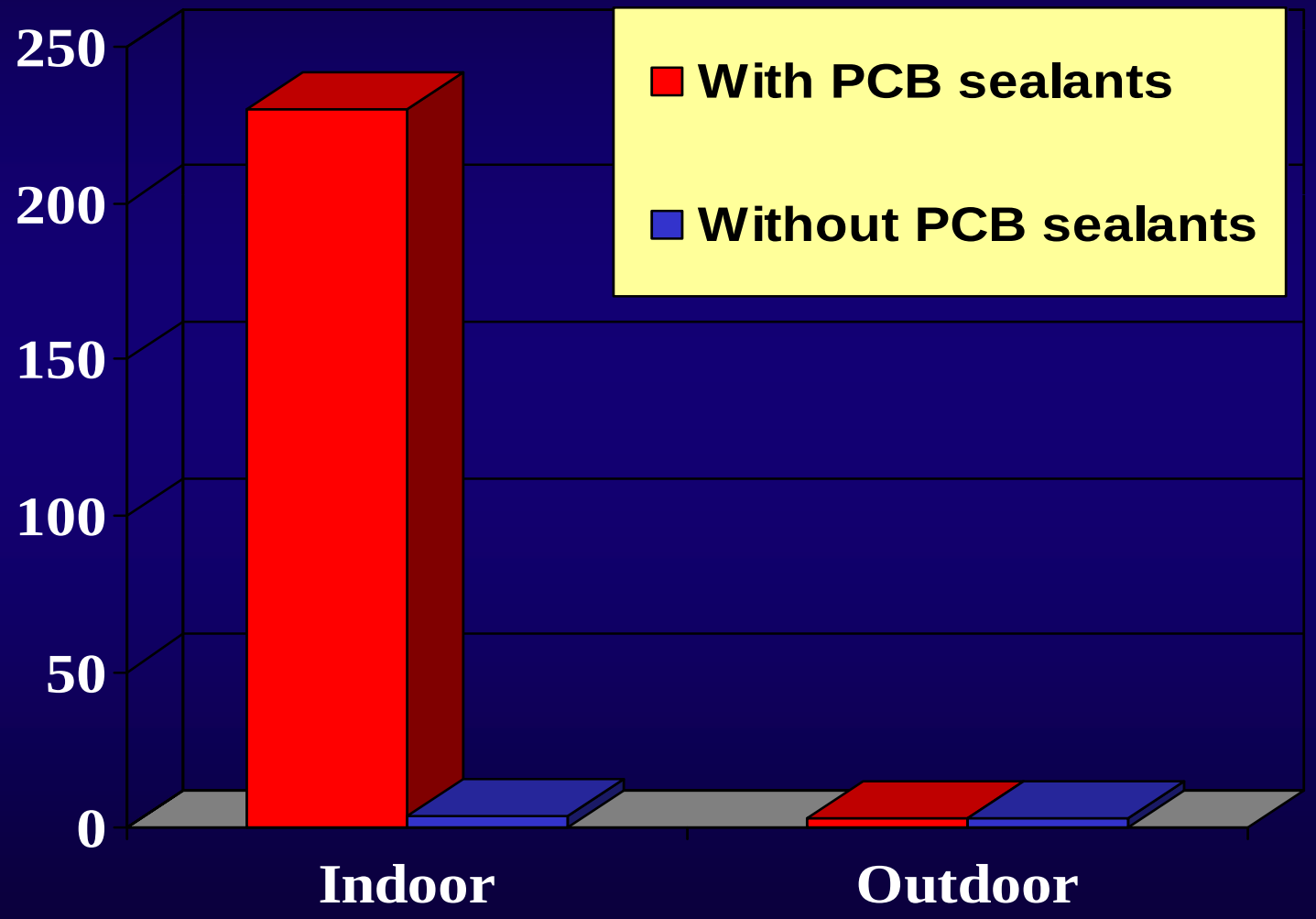


”Are we living in a poisonous building?”

- Study areas from the early seventies
- Two sections; one built before ban of PCB
- Sealant between outer wall and balconies
- Balconies furnished with windows
- Indoor air samples and blood samples collected
- Analysis of some 20 PCB congeners

Air Sampler With Semi-permeable Membrane

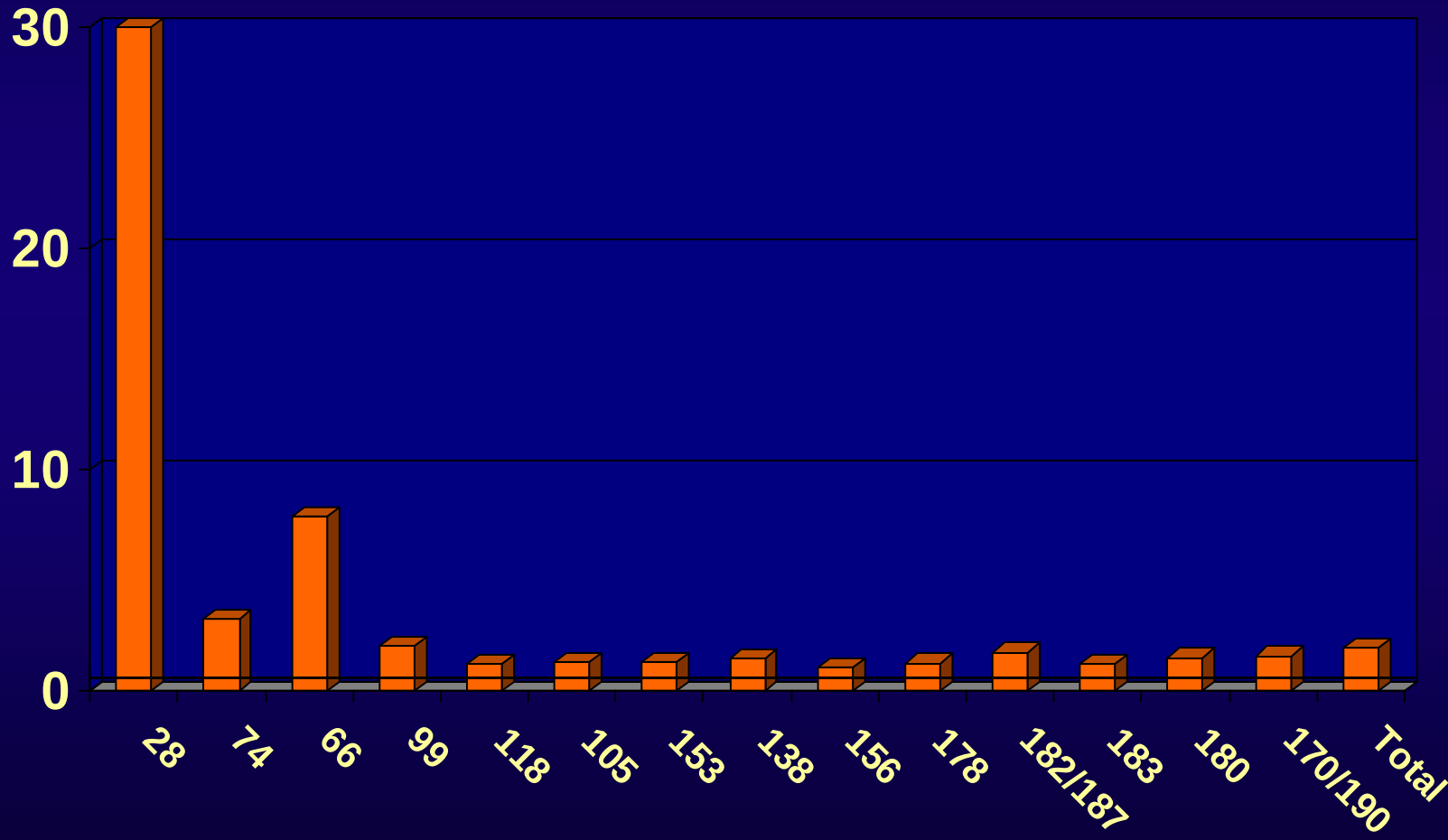
PCB in Indoor and Outdoor Air (*Relative Units*)



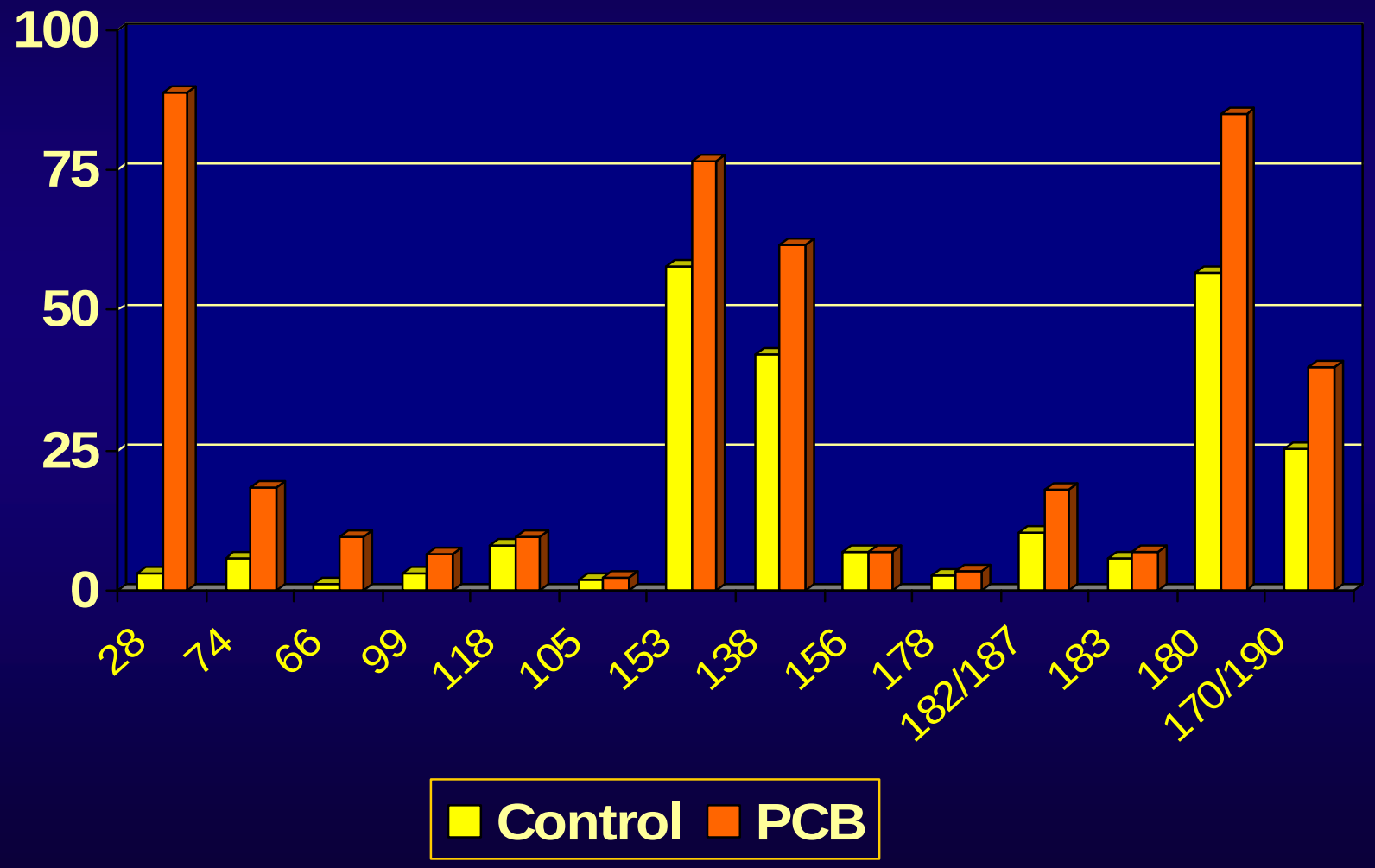
Median PCB concentration in blood

Congener	Control	PCB	p
28	2.92	88.91	<0.001
74	5.75	18.48	<0.001
66	1.21	9.50	<0.001
99	3.2	6.48	0.007
SUM [30]	225.9	434.1	0.005

Ratio PCB/Control group



PCB levels in blood of residents (ng/g lipid)



Levels in blood

- **Levels of PCB 28, 52 and 101 in blood independent of all ”exposure variables” recorded in personal questionnaire**
- **PCB 118, 138, 153 and 180 correlated to age.**

So …

- **PCB is leaking from sealants into the environment**
- **PCB levels in indoor air can be up to 100 times higher in buildings with ”PCB-sealant”**
- **Particles in indoor air contain negligible amounts of PCB (<1%)**

Conclusions

- **Individuals living in buildings containing PCB in sealant have elevated median PCB levels in blood compared to controls**
- **The difference is most pronounced for a few low-chlorinated congeners, but also for total PCB [sum of 30]**
- **Levels of dioxin-like congeners showed no significant difference**

Revised order on PCBs etc.

issued 2007

Who?

- *Anyone who owns a building with joint-sealing compounds or anti-skid flooring compounds erected or renovated 1956 to 1973 shall investigate whether a PCB product is present in the building*

What?

- *The owner shall provide the supervisory authority with a report of the inventory and specify what action is planned*

Decontamination in practice

When?

- *Industrial buildings containing more than 0.050% by weight of PCB … shall ensure that the PCB product is removed not later than 30 June 2013.*
- *For other buildings in which joint-sealing or flooring compounds are found: not later than 30 June 2011.*
- *However, if the joint-sealing or flooring compound have been used indoors it must be removed not later than 30 June 2013.*

Thank you for your attention!

Gotland (Fårö), an island in the Baltic