Balancing nutritional benefits, contaminant concerns and environmental sustainability in the seafood debate.

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Omega-3 Polyunsaturated Fatty Acids

- **Essential fatty acids which humans cannot synthesize. There are high concentrations of shorter chain (18 carbons) omega-3s in some oils (canola, flaxseed, soybean) and nuts. Longer chain (20 or 22 carbons) omega-3s are found in seafood.**

- **Omega-3s are concentrated in neurons and in photoreceptors in the eye. Longer chain omega-3 fatty acids comprise about 10-20% of total brain lipids, but only about 1% of blood lipids.**

- **Omega-3 fatty acids are believed to regulate membrane fluidity in all cells.**

Reported Benefits of Omega-3 Fatty Acids

- Reduction of risk of sudden death following a myocardial infarction
- Improved cognitive function in infants
- Reduced psychiatric and memory disorders in adults
- Improved glucose tolerance
- Immunomodulation, anti-inflammatory actions

Problems With Benefits

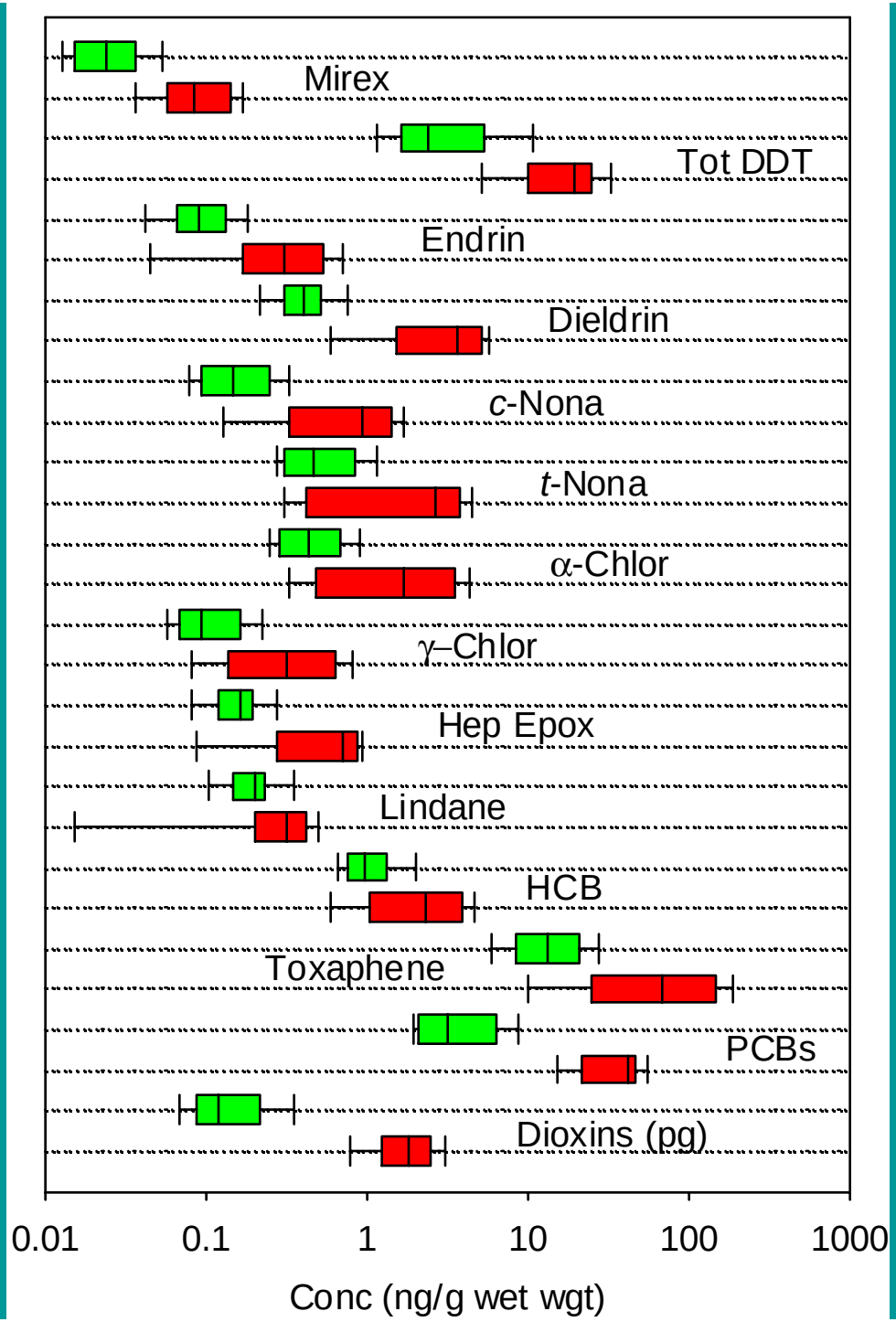
- In spite of recent reports, most of these suggested benefits are still questioned. This is even true for the cardiovascular effects (recent review by Hooper et al., BMJ, 2006). Omega-3 are critical components of neuronal membranes, but there is still debate as to whether supplementation beyond a healthy diet adds benefit.

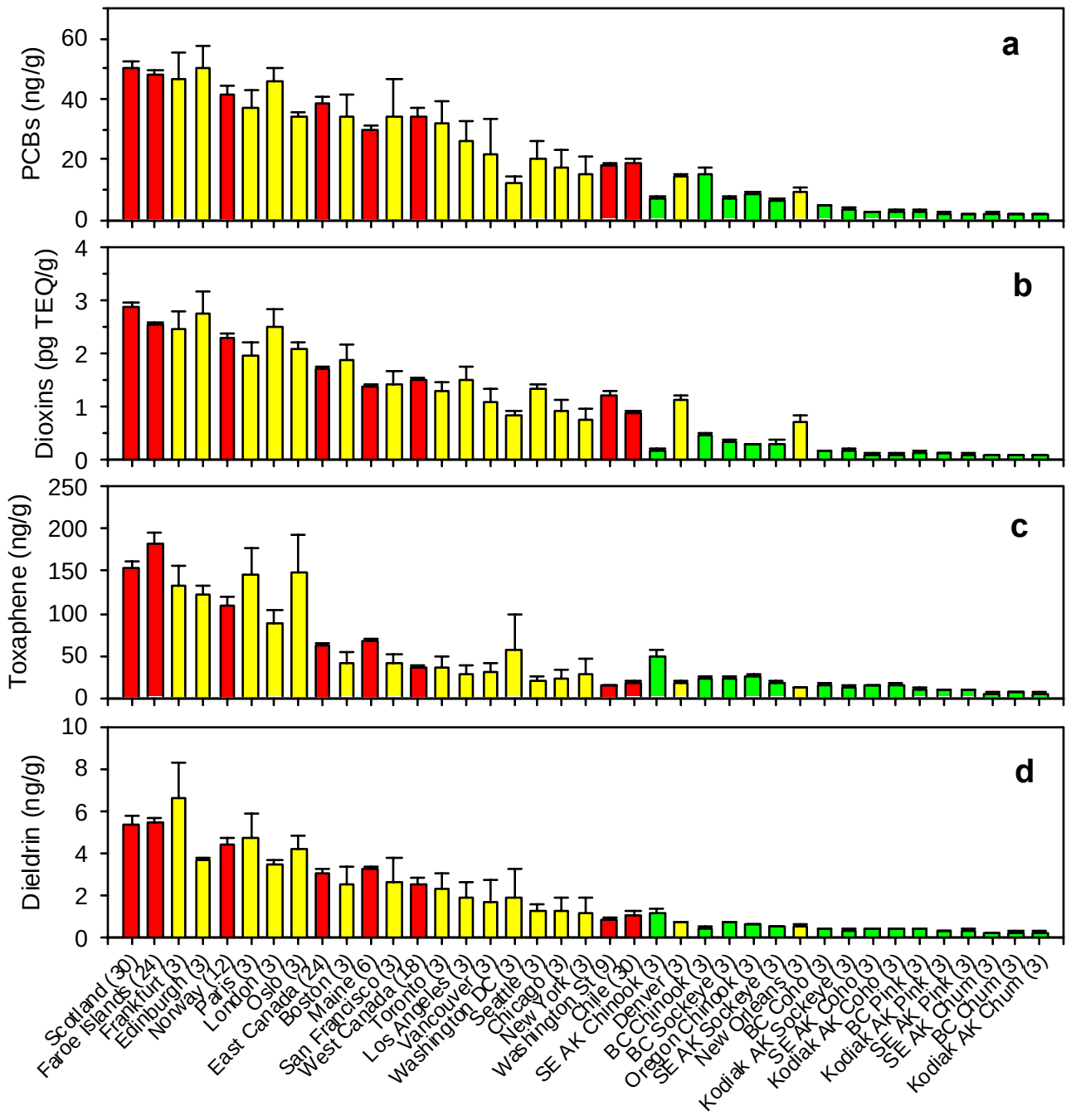
Major Contaminants in Fish

- Organochlorines, including PCBs, dioxins/furans, chlorinated pesticides These are present in fat.
- Methyl mercury, which binds to protein.
- Toxins, microbes, other chemicals.

SALMON

A very popular fish with high levels of omega-3 fatty acids, known to be beneficial in preventing sudden cardiac death. Farming of salmon has grown very rapidly, now at levels of over 1 million tons per year. Farmed salmon are relatively cheap and are available throughout the year.





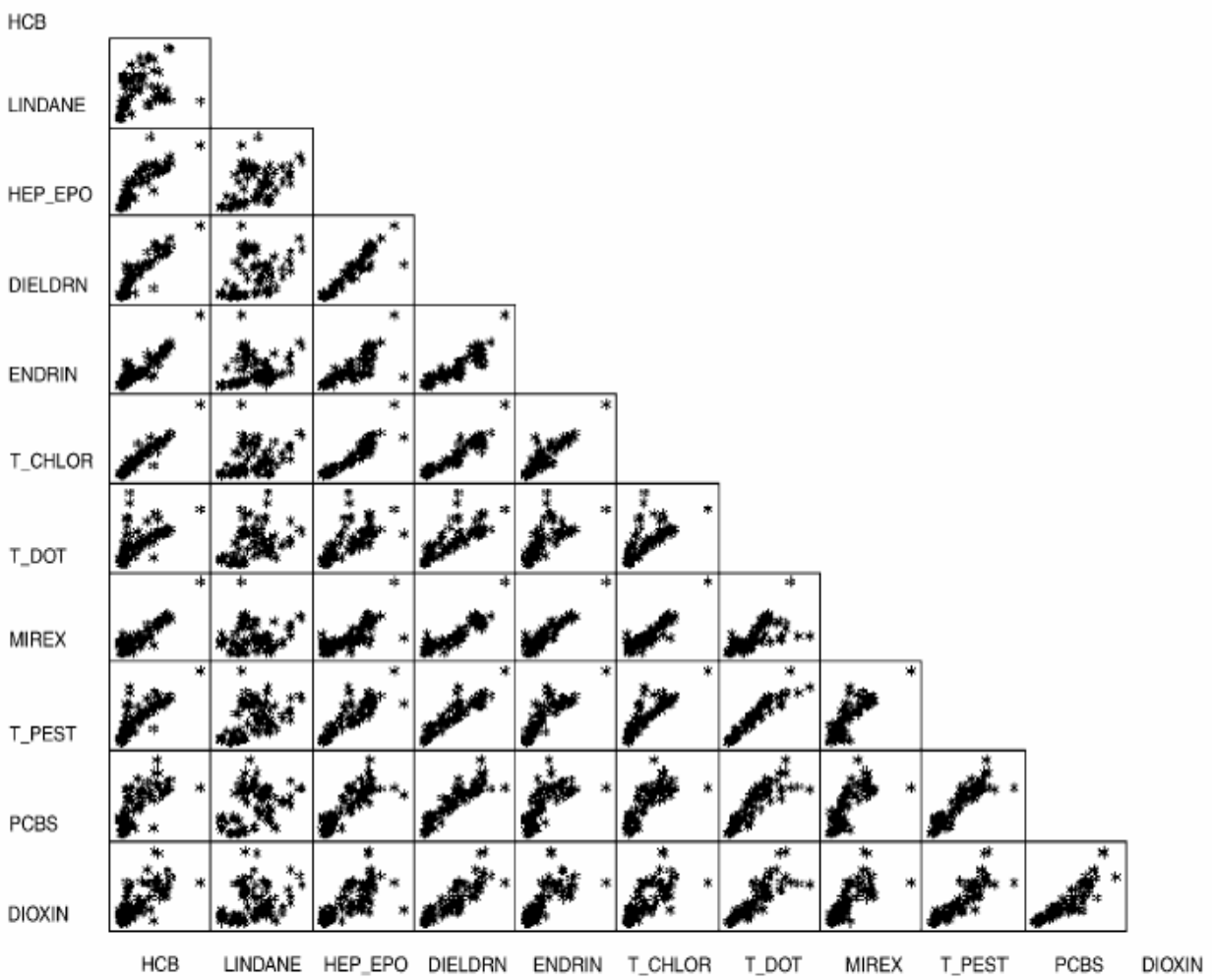


Fig. 4. Scatter-plot matrix for the content of pairs of 10 contaminants and total pesticides measured in salmon samples from various locations where the salmon were produced or purchased. HEP_EPO, heptachlor; T_CHLOR, total chlordane; T_DDT, total DDT; T_PEST, total pesticide.

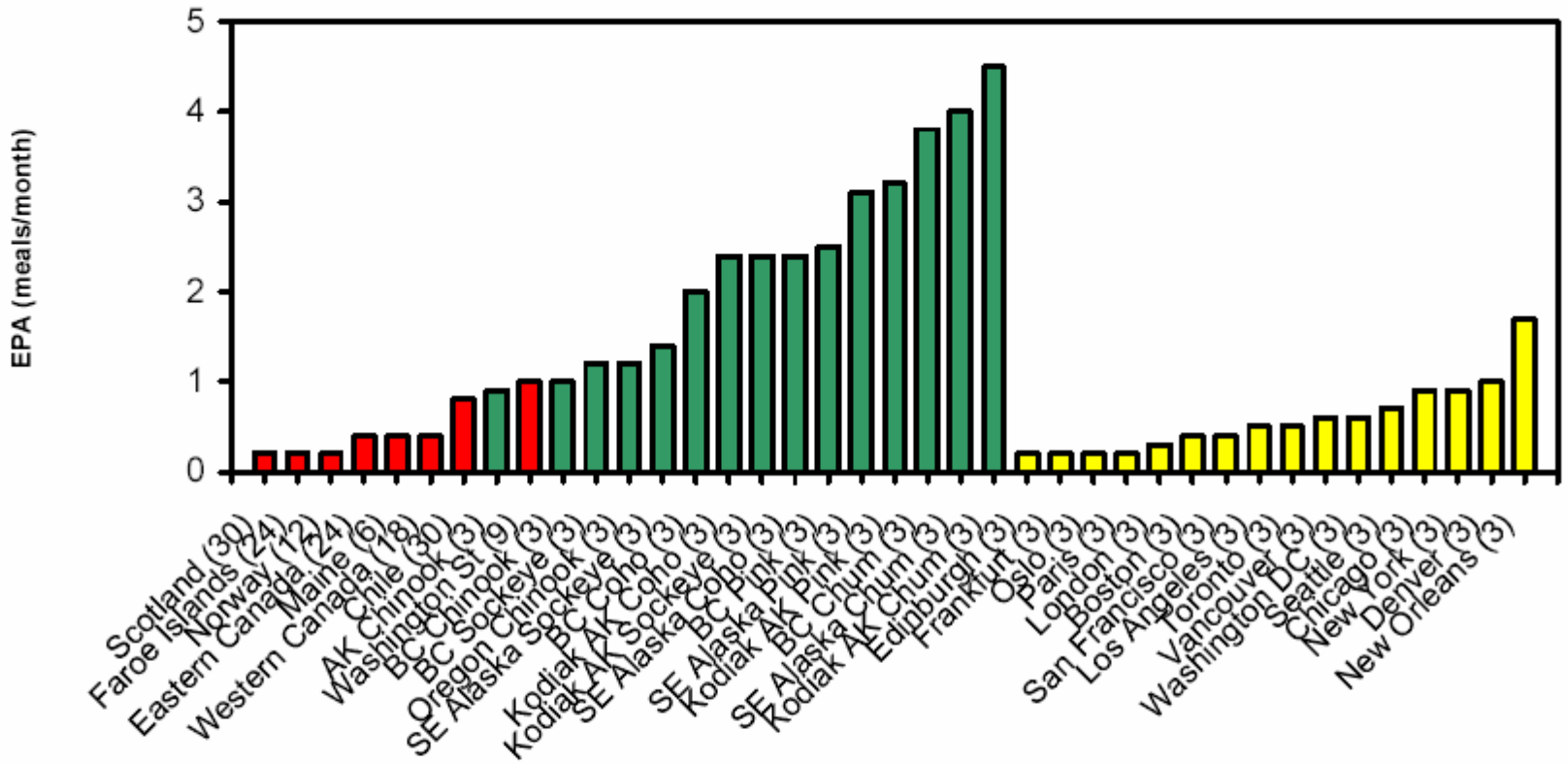


Figure 5. Consumption advisories (in meals per month) based on USEPA cumulative carcinogenic risk assessment methods for total DDT, dieldrin, total chlordane, heptachlor epoxide, lindane, hexachlorobenzene, toxaphene, PCBs and dioxins/furans for farmed salmon (red), wild salmon (green) and for retail market salmon (yellow). The country in which the salmon was produced or the city from which it was purchased is indicated. The numbers in parenthesis are the number of samples analyzed.

Cancer and Contaminants

- There is no convincing evidence that omega-3 fatty acids protect against cancer. Most organochlorines compounds are likely human carcinogens.
- Methyl mercury is not known to be a human carcinogen.

Table 4: Non-Cancer Effects of Chlorinated Pesticides, PCBs and Dioxins

	Immune Suppression	IQ/CNS	Feto-tox	Repro	Musculo Skeletal	Liver	Kidney	CV/ Blood	Endocrine Dys
Chlordane	X	X				X		X	X
DDT/DDE	X	X	X	X		X		X	X
Dieldrin	X	X	X	X	X	X	X	X	X
Dioxin	X	X	X	X	X	X		X	X
Endrin		X		X	X				X
HCB	X	X	X		X	X	X	X	X
Hexachlor		X		X	X	X		X	
Lindane	X	X	X	X		X	X		
Mirex			X	X		X	X	X	X
PCBs	X	X	X	X	X	X	X	X	X
Toxaphene	X	X				X	X		X

IQ/CNS = Decrements in IQ and/or central nervous system effects.
Feto-tox = Fetotoxicity
Repro = Reproductive effects
CV/blood = Cardiovascular or hematological effects
Endocrine Dys = Endocrine Dysfunction.

Both Organochlorines and Methyl Mercury Increase Risk of Heart Disease

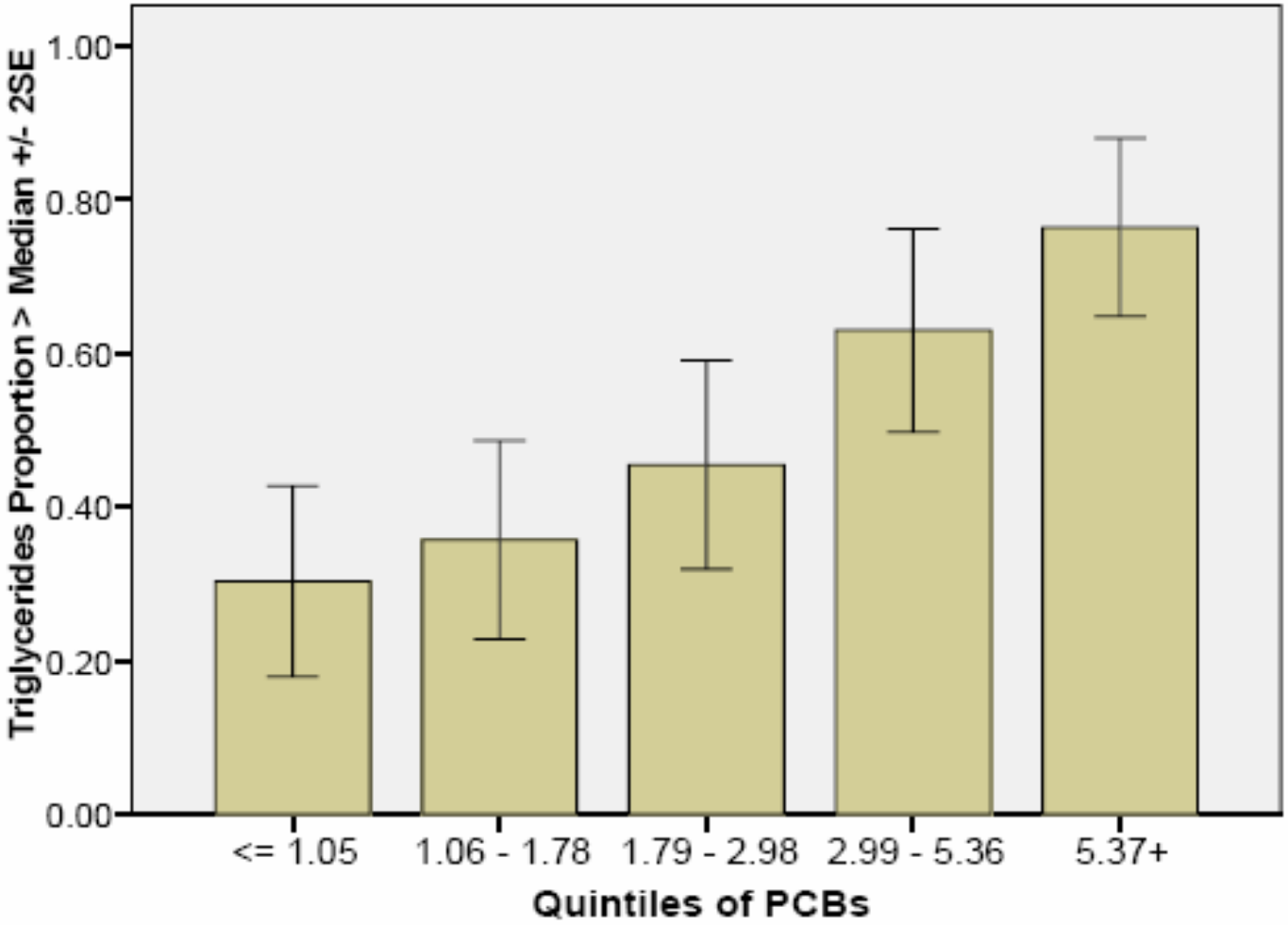
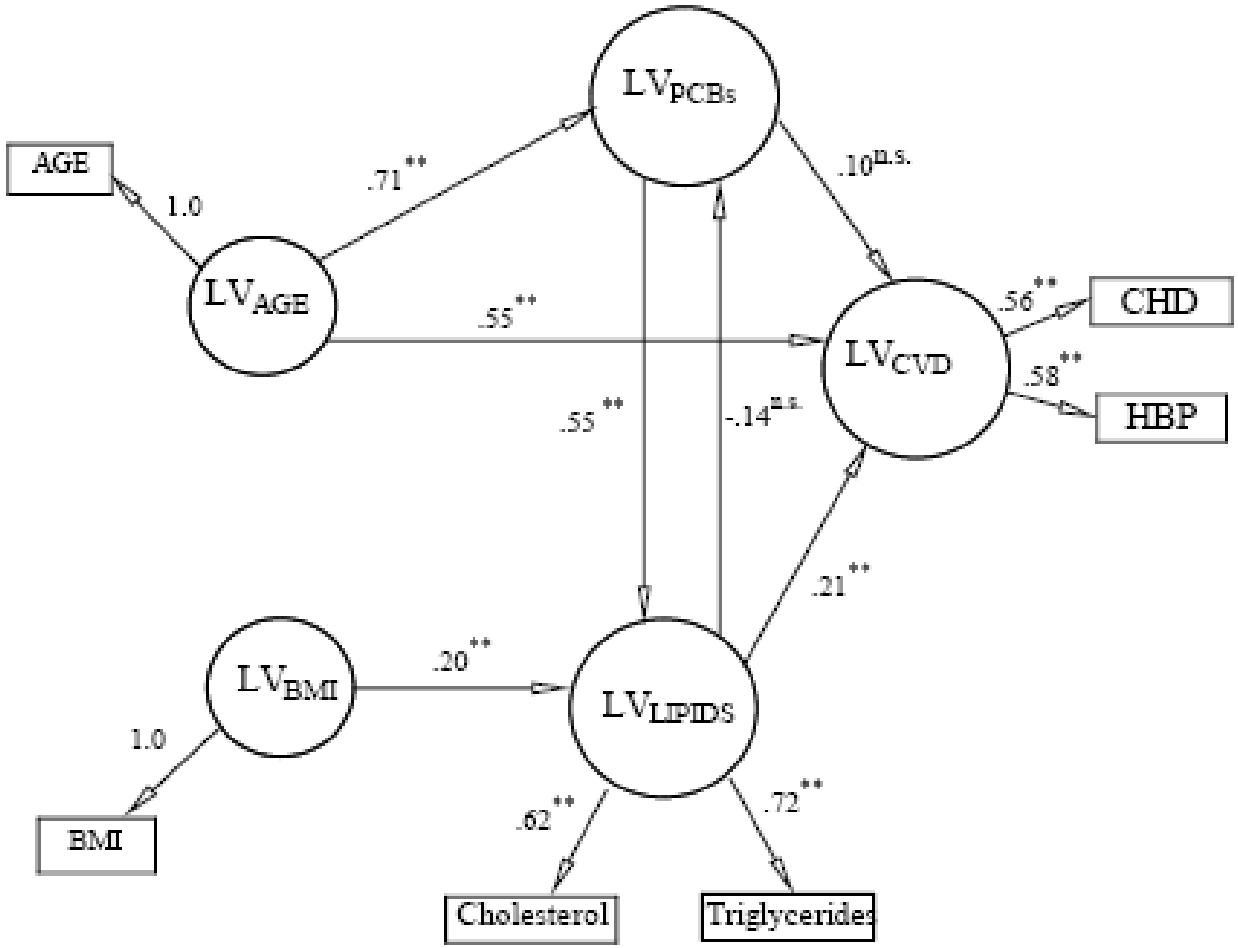
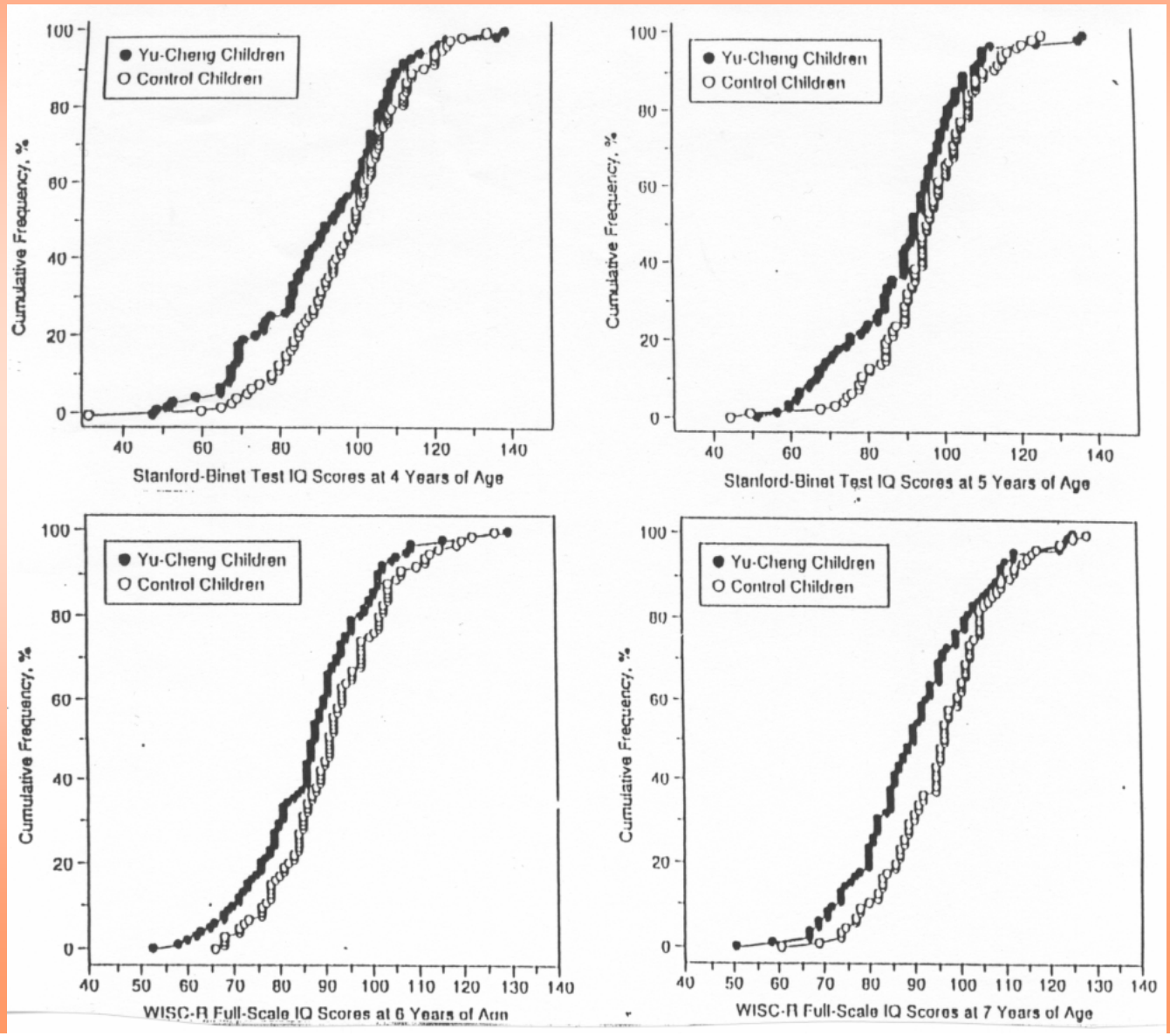


Figure 5. Nonrecursive Model with Feedback Loop Between LV_{PCBs} and LV_{LIPIDS}.

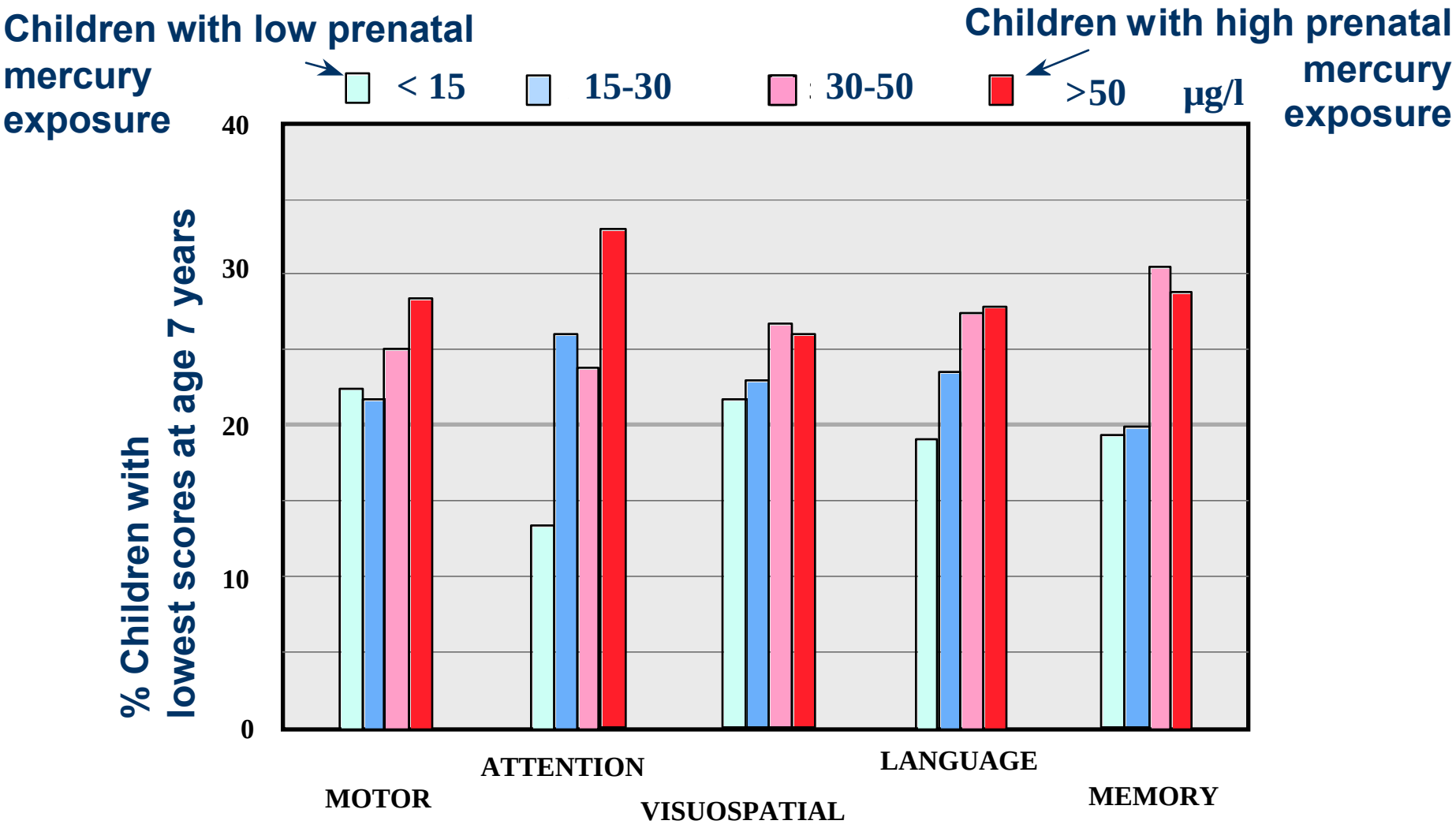
Measured indicators and their loadings on the PCB latent variable are virtually identical to those presented in Figure 4.



Both Organochlorines and Methyl Mercury Cause a Decrease in IQ and Reduced Memory Function.



Mercury
Effects of Low Dose Prenatal Exposure



Source: Grandjean, et. al., "Cognitive Deficit in 7-year-Old Children with Prenatal Exposure to Methylmercury", Neurotoxicology and Teratology, Vol. 19, No. 6, 1997

Figure shows prenatal mercury exposure levels of Faroese children with scores in the lowest quartile after adjustment for cofounders. For each of the five major cognitive functions, one neuropsychological test with a high psychometric validity was selected.

Mercury Exposures

Current exposures

- >10% of women of reproductive age exceed Reference Dose (RfD)
- 50% of women who eat fish exceed RfD on any given day
- Higher risk: Subsistence fishers, immigrants, Native Americans

Organochlorine Compounds Increase Risks of Diabetes

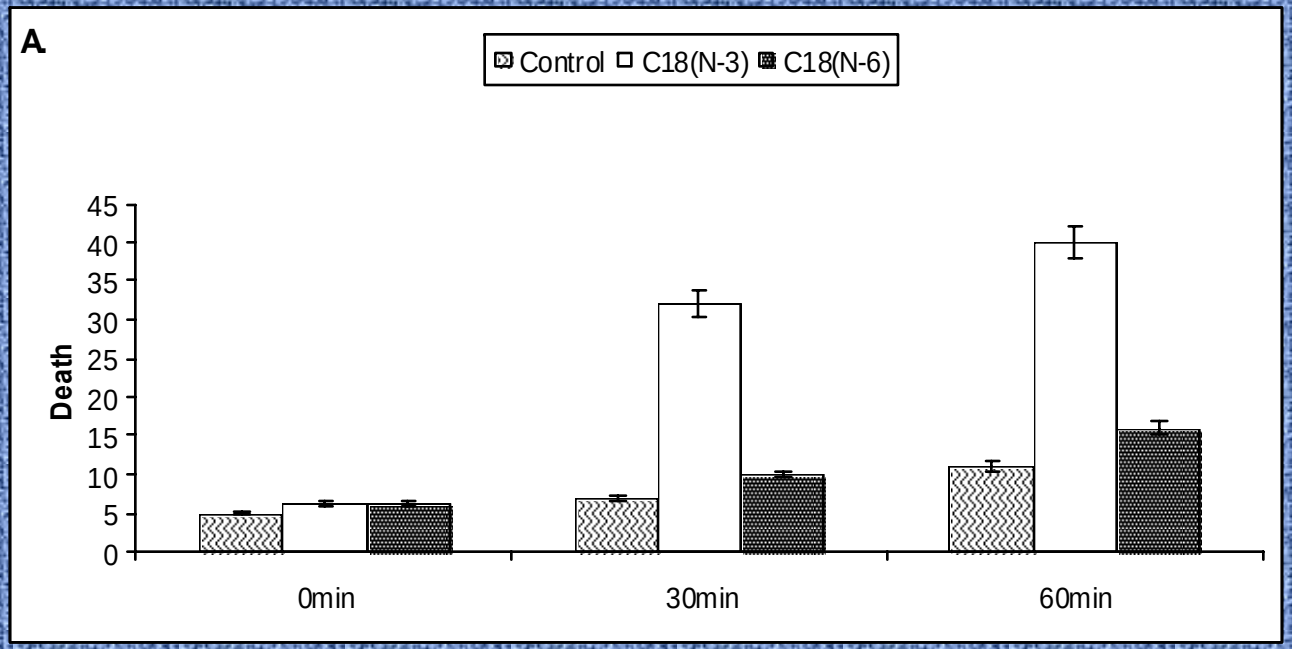
Table 4. Association between diabetes and serum concentrations of total PCBs, PCB-153, PCB-74, mirex, HCB, and DDE, adjusted for certain diabetes risk factors.[a]

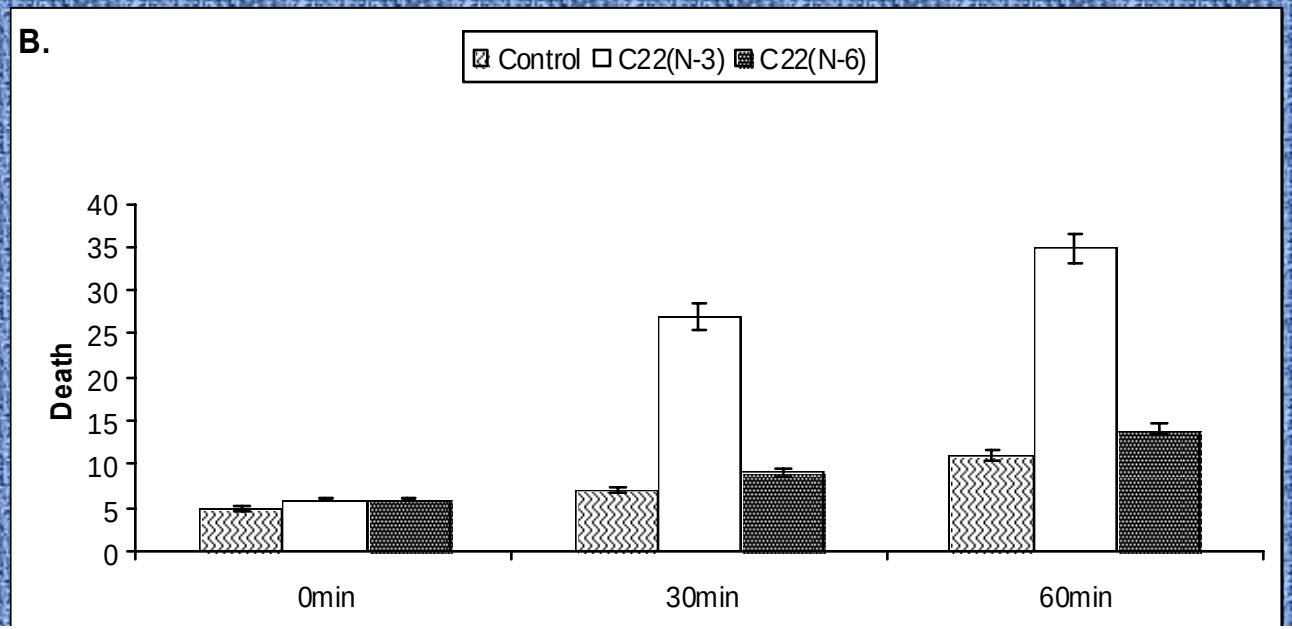
Analyte	Wet-weight measurement		Lipid-standardized measurement	
	Unadjusted for the other analytes[b] OR (95%CI)	Concurrent adjustment for the other analytes[b] OR (95%CI)	Unadjusted for the other analytes[b] OR (95%CI)	Concurrent adjustment for the other analytes[b] OR (95%CI)
Total PCBs (ppb)				
Medium tertile	2.2 (0.8–5.9)	1.8 (0.6–5.5)	1.8 (0.8–4.3)	1.5 (0.6–4.0)
Highest tertile	3.9 (1.5–10.6)	2.8 (0.7–10.8)	3.2 (1.4–7.5)	2.6 (0.8–8.1)
Mirex (ppb)				
Medium tertile	1.2 (0.5–2.7)	0.7 (0.3–1.7)	0.8 (0.3–2.0)	0.6 (0.3–1.4)
Highest tertile	1.0 (0.4–2.2)	0.3 (0.1–0.8)	0.9 (0.4–2.2)	0.3 (0.1–0.9)
DDE (ppb)				
Medium tertile	1.8 (0.6–5.2)	1.4 (0.4–4.3)	2.4 (0.7–8.3)	1.6 (0.5–4.8)
Highest tertile	6.4 (2.2–18.4)	2.6 (0.8–8.8)	6.2 (1.8–21.9)	2.4 (0.7–8.3)
HCB (ppb)				
Medium tertile	0.9 (0.3–2.7)	0.9 (0.3–2.6)	2.7 (0.9–8.0)	2.5 (0.9–6.8)
Highest tertile	6.2 (2.3–16.9)	4.5 (1.4–14.3)	6.8 (2.3–20.3)	4.8 (1.7–13.9)
PCB-153 (ppb)				
Medium tertile	1.0 (0.4–2.5)	0.8 (0.2–2.4)	1.0 (0.4–2.3)	0.6 (0.2–1.6)
Highest tertile	3.2 (1.3–8.2)	3.0 (0.7–12.8)	2.4 (1.0–5.6)	1.4 (0.4–4.8)
PCB-74 (ppb)				
Medium tertile	1.3 (0.4–3.7)	1.3 (0.4–4.4)	1.3 (0.3–4.7)	0.9 (0.3–3.0)
Highest tertile	4.9 (1.7–13.7)	3.6 (1.0–13.4)	4.5 (1.3–15.6)	2.9 (0.8–10.5)

CI, confidence interval.

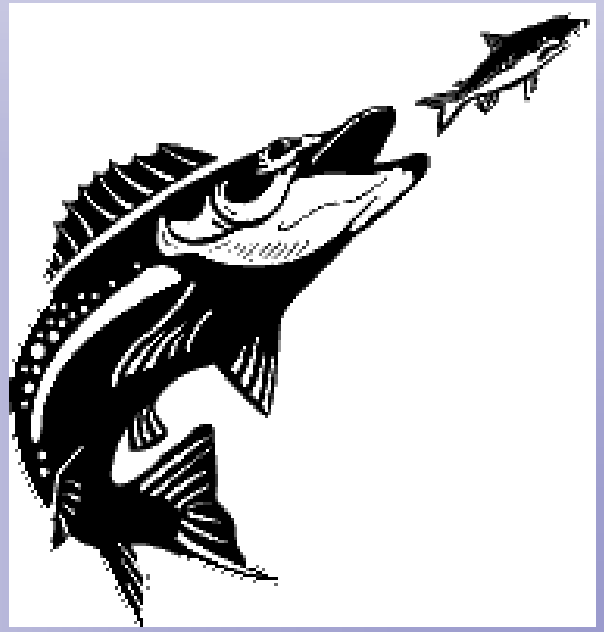
[a]All ORs were adjusted for sex, age category, BMI category, and lifetime smoking status; in addition, wet-weight values were adjusted for estimated total lipid concentration. [b]Other analytes included serum concentrations of DDE, HCB, and mirex for total PCBs, PCB-153, and PCB-74; total PCBs, DDE, and HCB for mirex; total PCBs, mirex, and HCB for DDE; and total PCBs, mirex, and DDE for HCB.

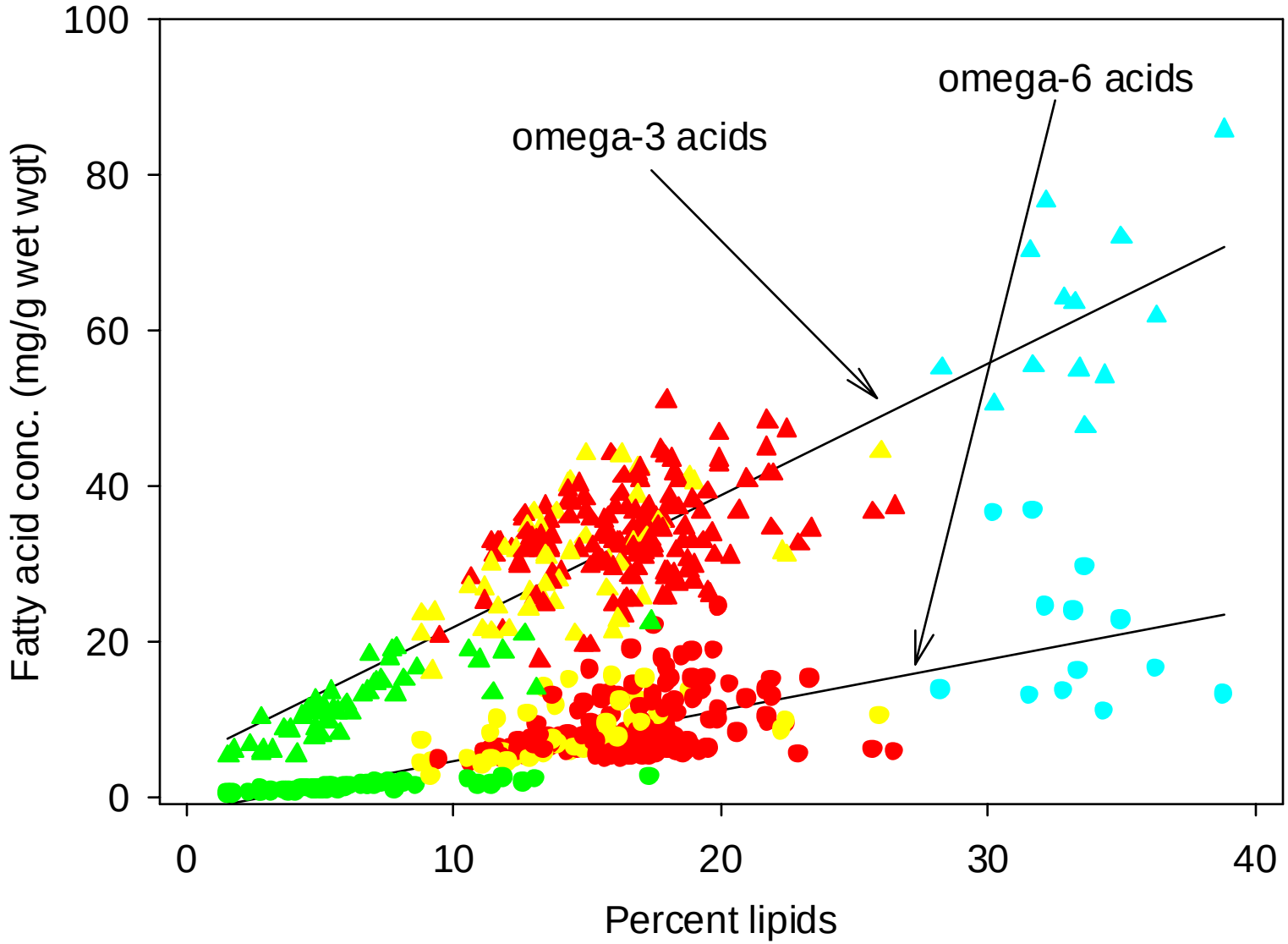
PCBs Kill Thymocytes



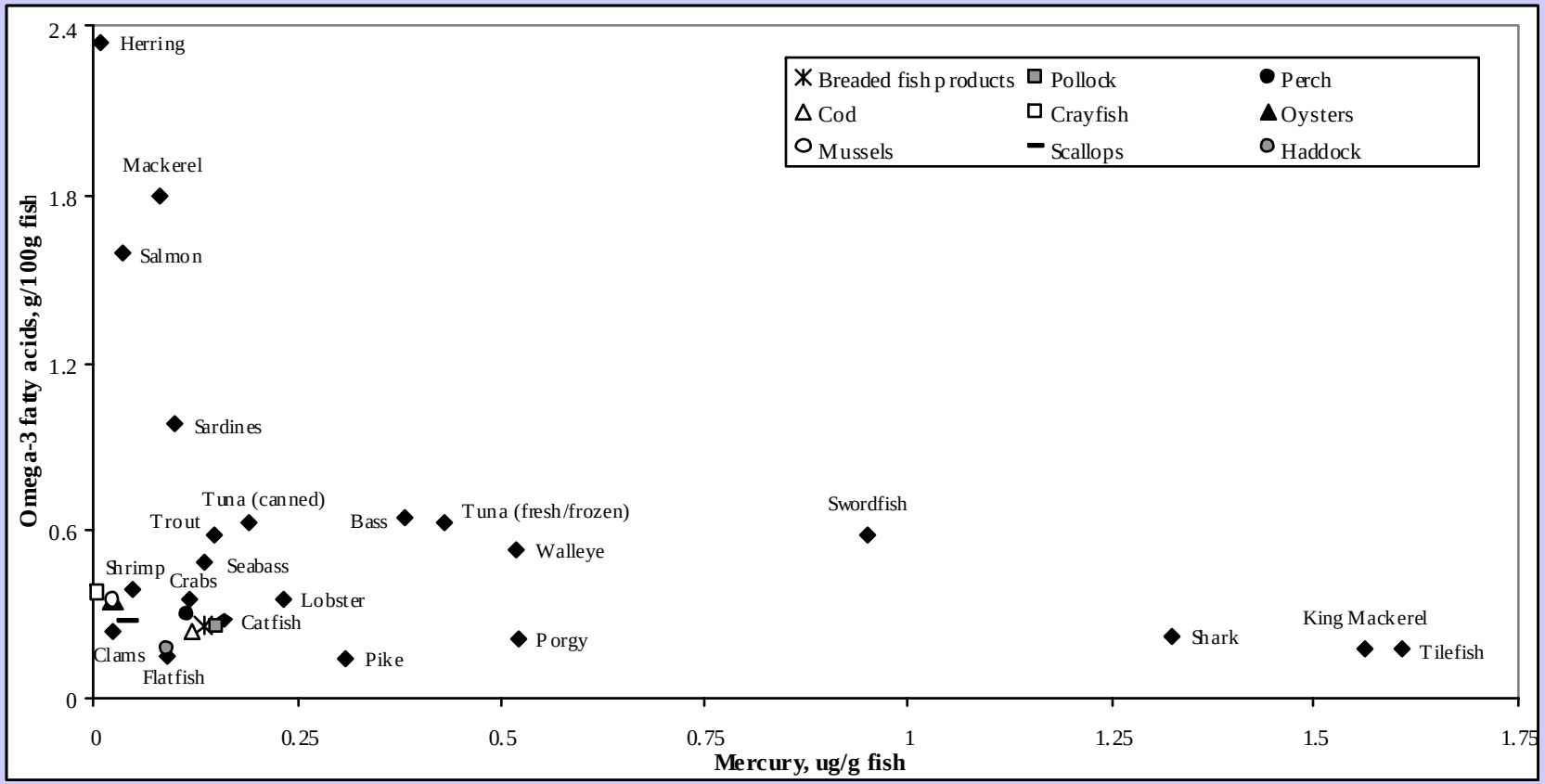


- There is another problem with salmon aqua culture. It takes 3-5 pounds of wild fish to make the fish meal/fish oil to generate 1 pound of salmon. This is not sustainable – we are depleting the oceans of the small fish that feed other fish.





Concentration of mercury and omega-3 fatty acids (EPA + DHA) in selected fish and shellfish species. (Mahaffey et al., 2007)



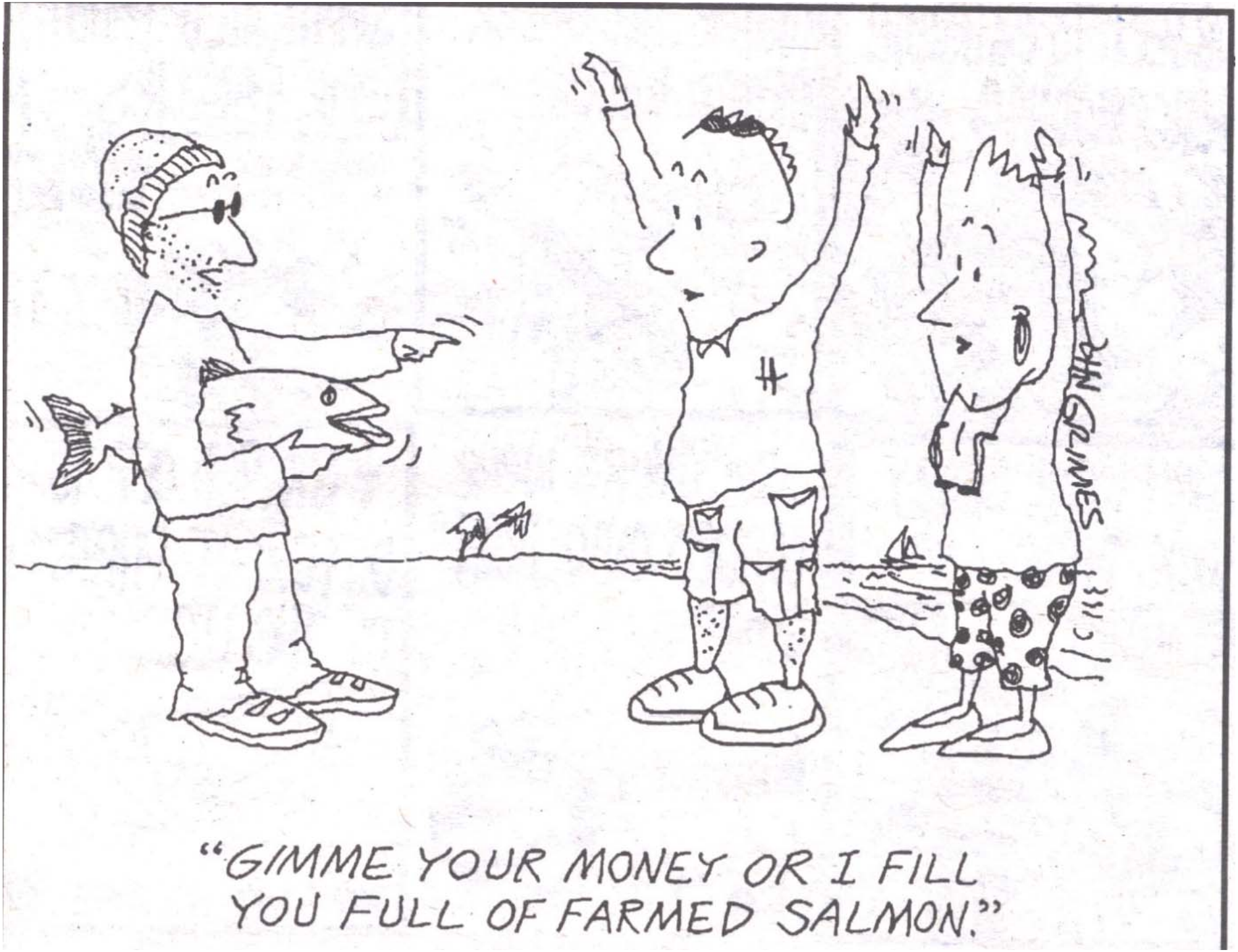
→Fish that is not contaminated is a very healthy food.

→ Fish that is contaminated is a very dangerous food.

→ Unfortunately, when you purchase fish, you don't know whether or not it is contaminated.

→ Most people know about the benefits , but not the risks of eating fish.

→ We all – the public health community, the press and the government – need to do a better job at communicating to the public the risks vs. the benefits of eating fish.



"Cancel the salmon.
We'll just have the mice"