

The Nutritional-Toxicological Conflict related to Seafood Consumption

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PhD defence, 4 October 2007



Promoters:

Prof. dr. S. De Henauw

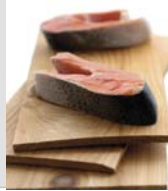
Prof. dr. ir. J. Van Camp

Outline

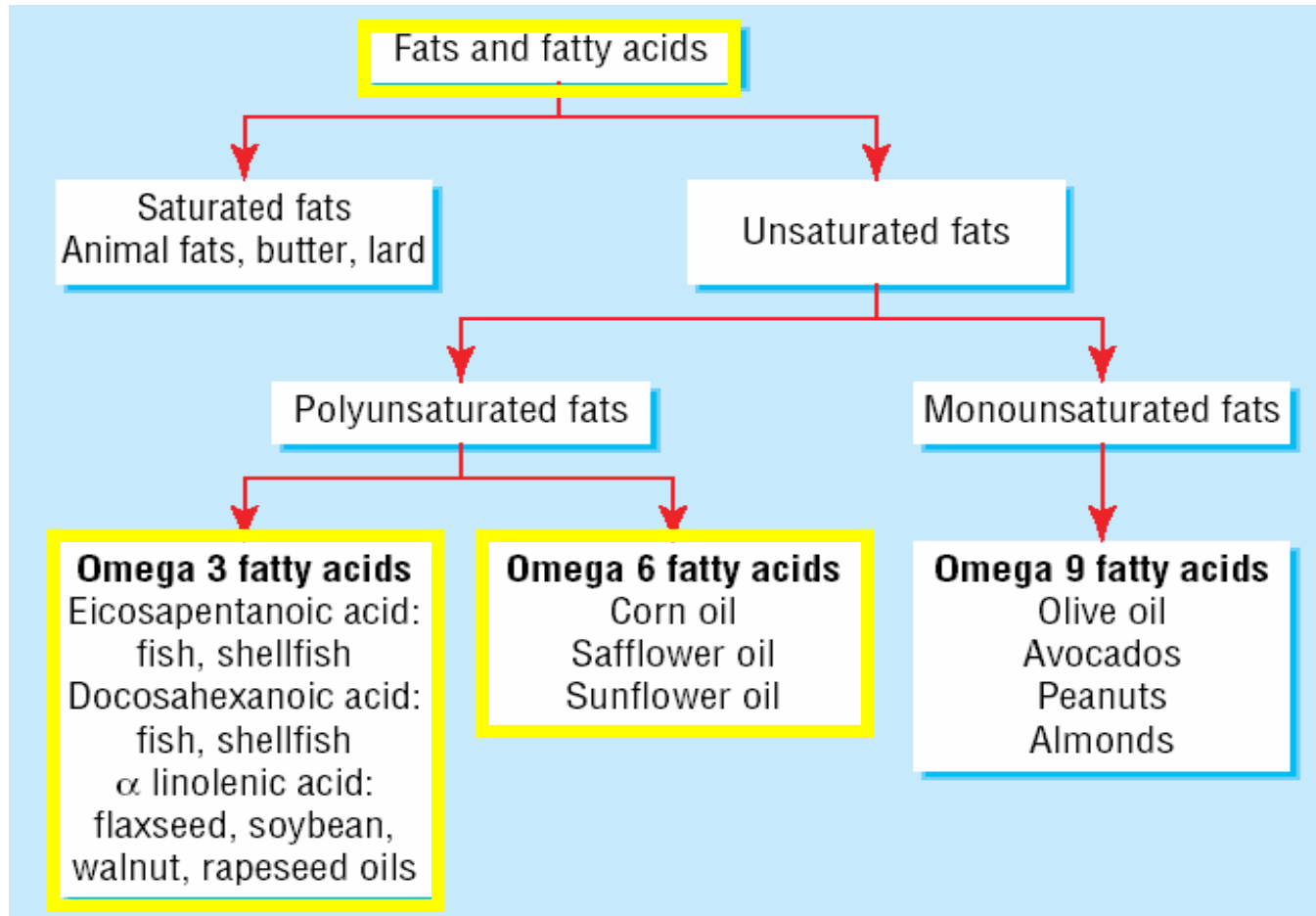


1. **Introduction**: omega-3 fatty acids and the conflict model related to seafood consumption
2. Omega-6 and omega-3 **PUFA intake** of the Belgian population
3. **Methodology** used to study the nutritional-toxicological conflict
4. **Results** of the intake assessment study
5. **Conclusion** and topics of **discussion**

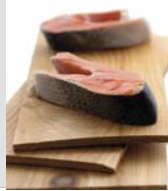
Omega-3 fatty acids: today omnipresent !



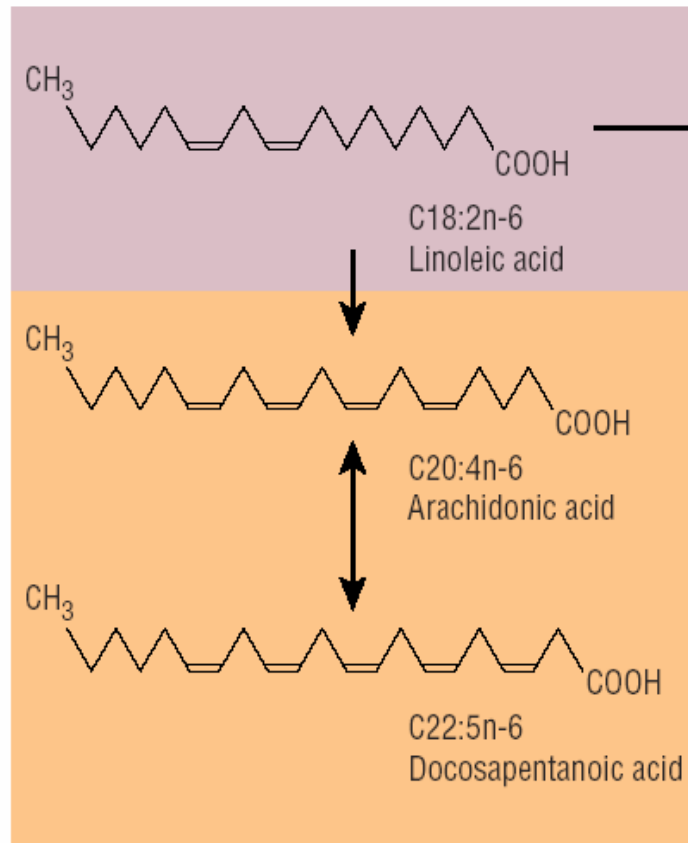
Omega-3 FA: scientific facts



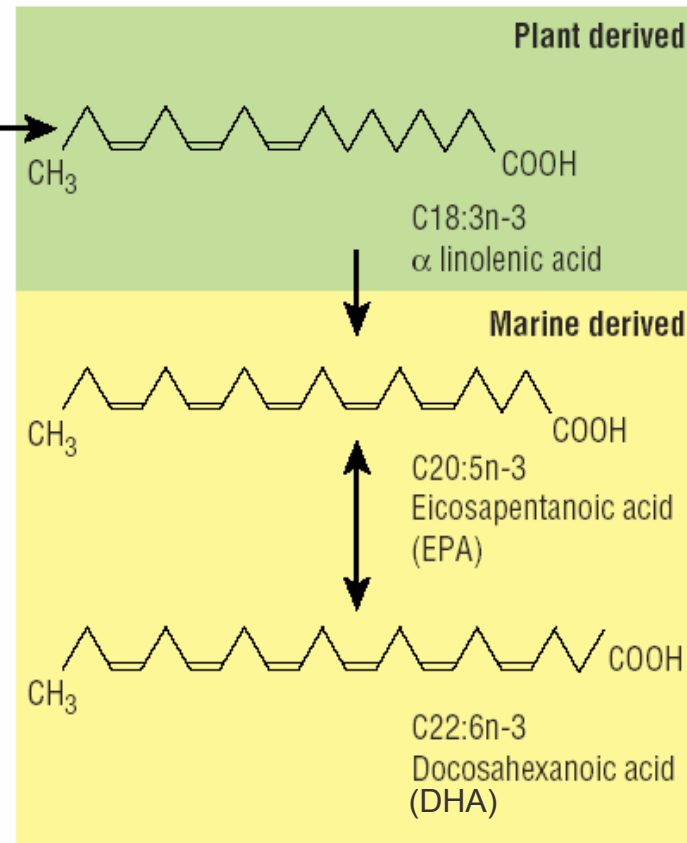
Essential FA and long chain derivatives



Omega 6 fatty acids





Omega 3 fatty acids

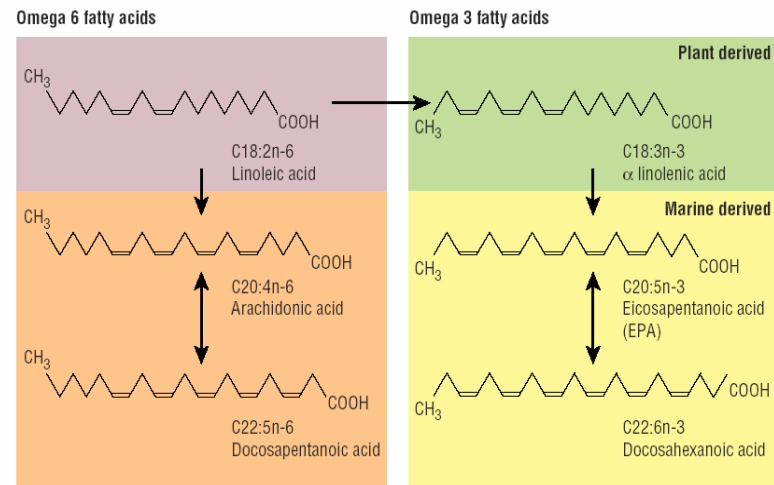


Evolution of omega-3 FA in the diet



Due to agricultural industry and modern food technology

-  omega-3 FA in food products from animal and plant origin
-  use of plant oils rich in omega-6 FA in processed food items



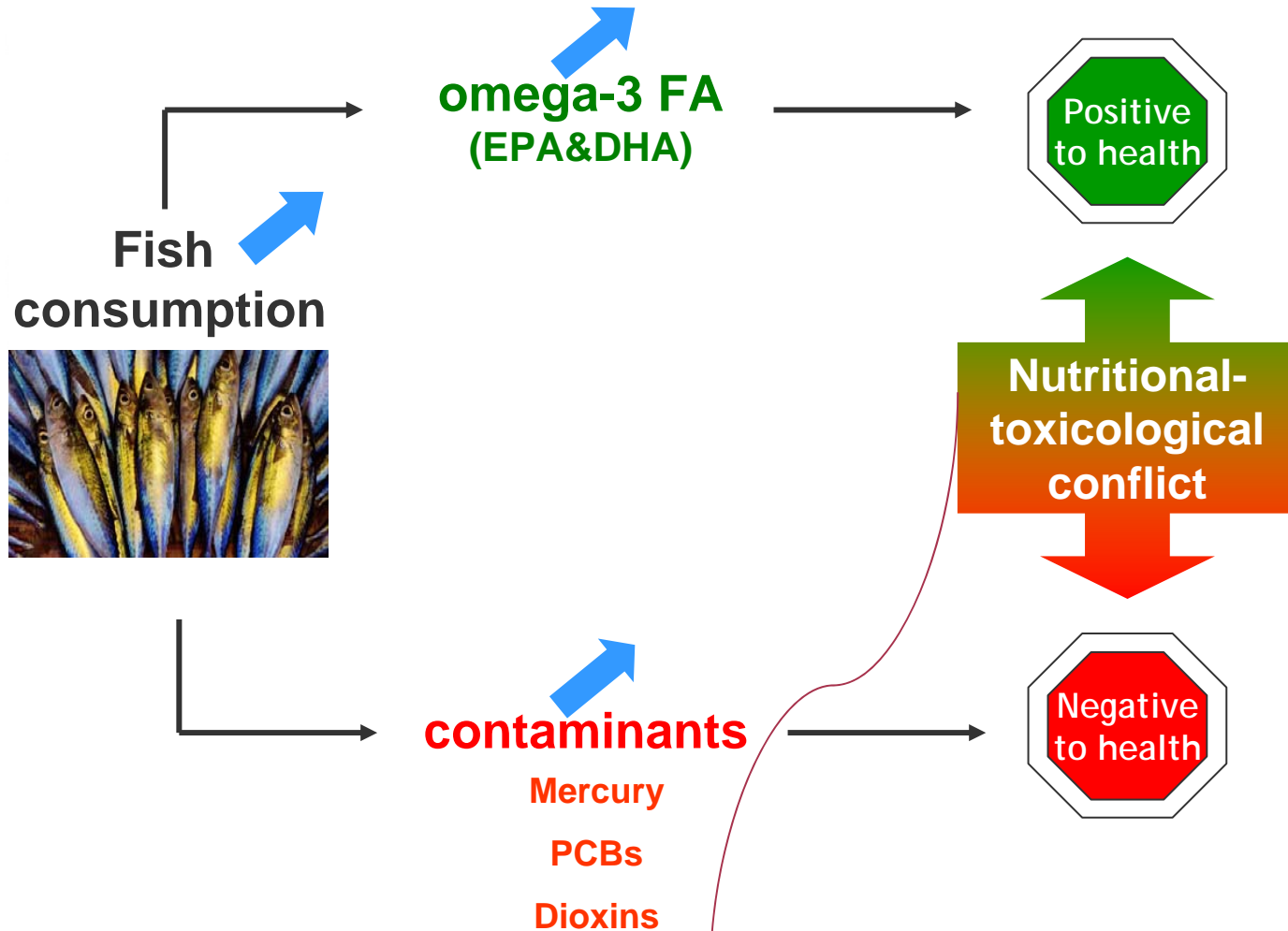
Evolution ratio omega-6/omega-3



Table 1. Omega-6 : omega-3 ratios in various populations

Population	Omega-6 : Omega-3	Reference
Paleolithic	0.79 ^{a,b}	Eaton et al. [15]
Greece prior to 1960	1.00–2.00	Simopoulos [14]
Current United States	16.74	Eaton et al. [15]
United Kingdom and northern Europe	15.00	Sanders et al. [29]
Japan	4.00	Sugano and Hirahana [28]
Belgium	?	

Increasing the omega-3 intake



n-6 and n-3 PUFA intake of the Belgian population



1. Objective:

Intake assessment, food sources and evaluation for individual omega-6 and omega-3 poly-unsaturated fatty acids

2. Methodology:

Combination of consumption data and PUFA concentration data in consumed food items

Belgian recommendations for fatty acids (2007) were used to evaluate the intakes

Consumption data: 3 sub populations



1. Flemish pre-school children (n=661; 2.5-6.5 y; nov02-febr03):
3-day dietary record
British Journal of Nutrition 2007; 98(4): 819-825
2. Adolescents, region Ghent (n=341; 13-18 y; mar-may97):
7-day dietary record
Journal of Human Nutrition and Dietetics 2007; In Press
3. Young women, region Ghent (n=641; 18-39 y; 2002):
2-day dietary record
Lipids 2006; 41(5): 415-422

PUFA concentration data



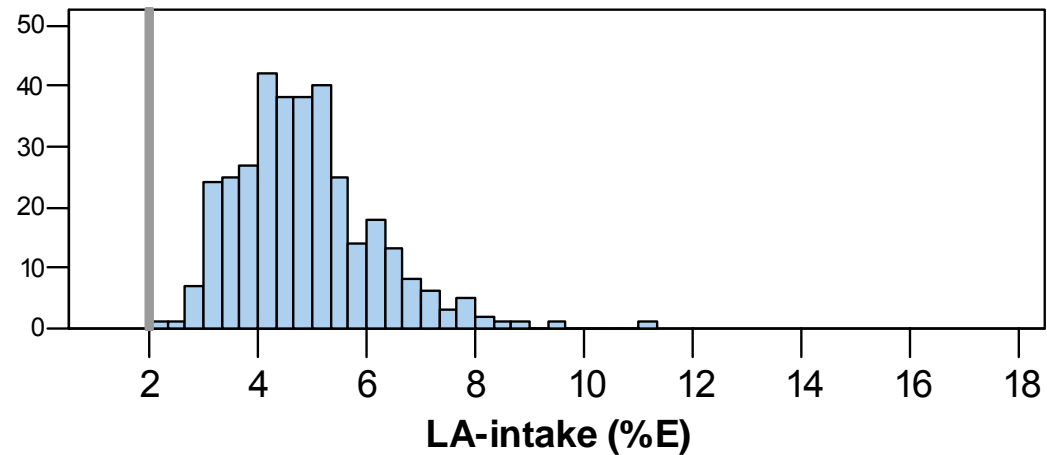
1. Combination of data from 8 international food composition databases:
The Netherlands; France; UK; USA; Finland; Canada; Denmark; Germany
2. Information from industry (margarines, cheese)
3. Calculated concentrations on the basis of recipes

$$\text{PUFA intake} = \text{consumption data} \times \text{PUFA concentration data}$$

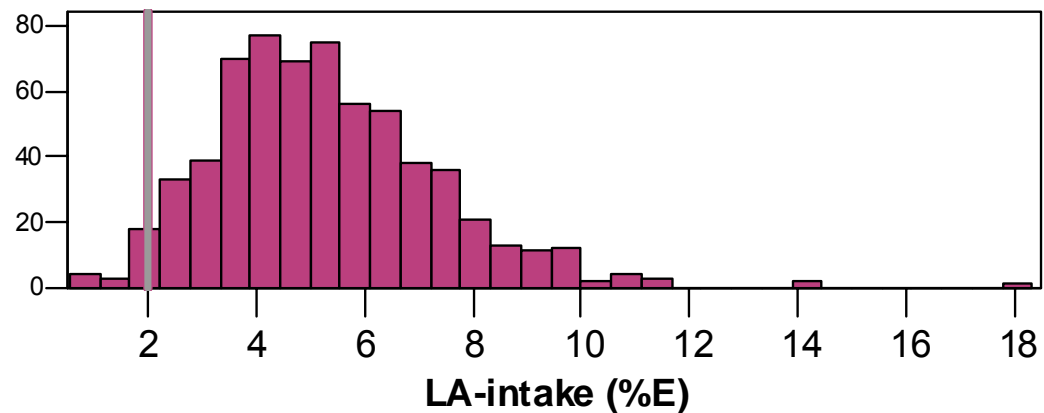
Intake linoleic acid (omega-6)



Adolescents



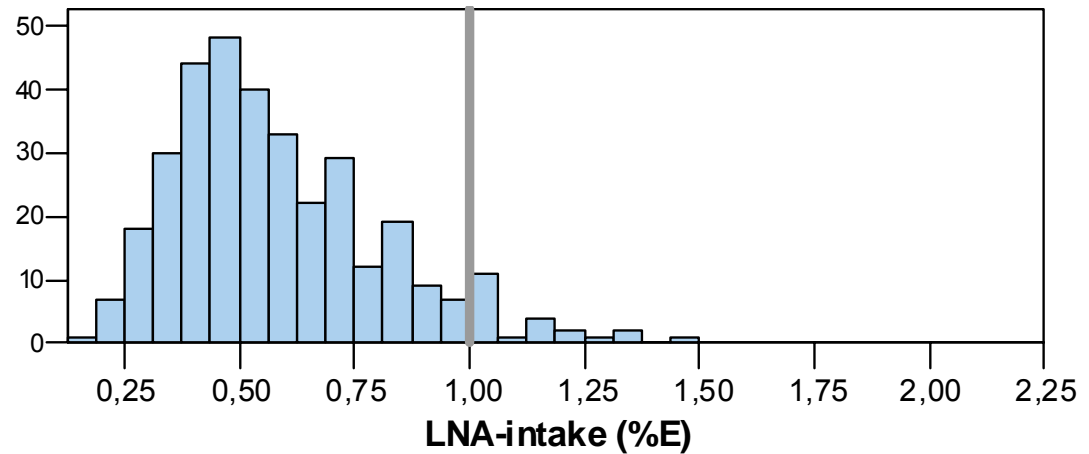
Young
women



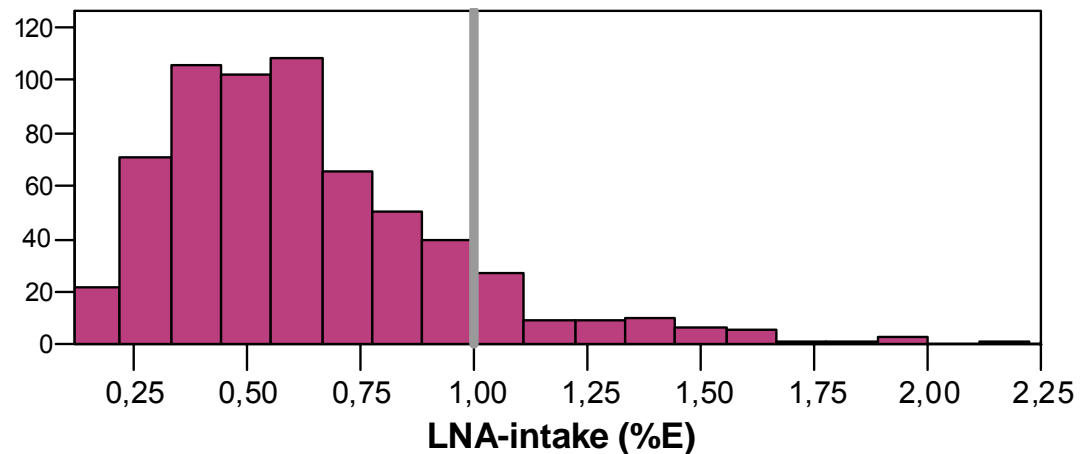
Intake alpha-linolenic acid (omega-3)



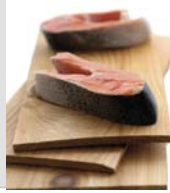
Adolescents



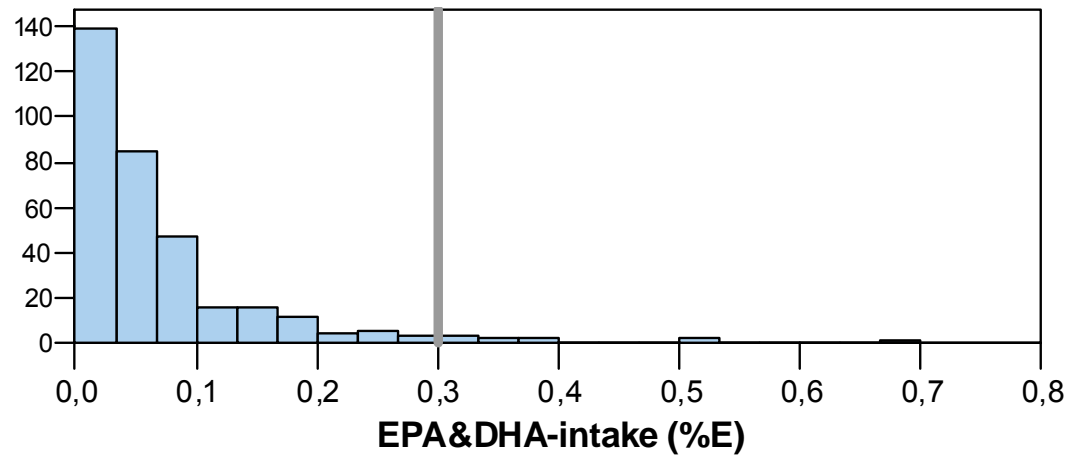
Young
women



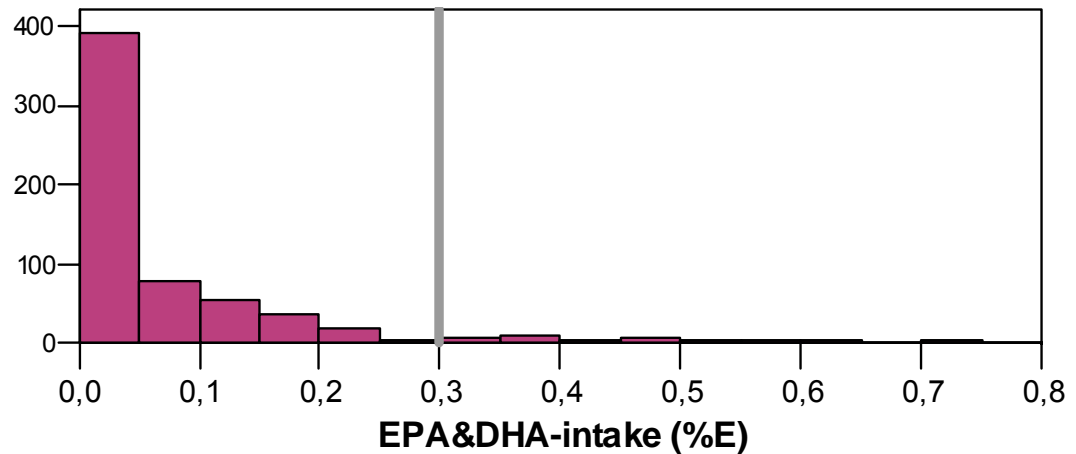
Intake long chain omega-3 PUFAs



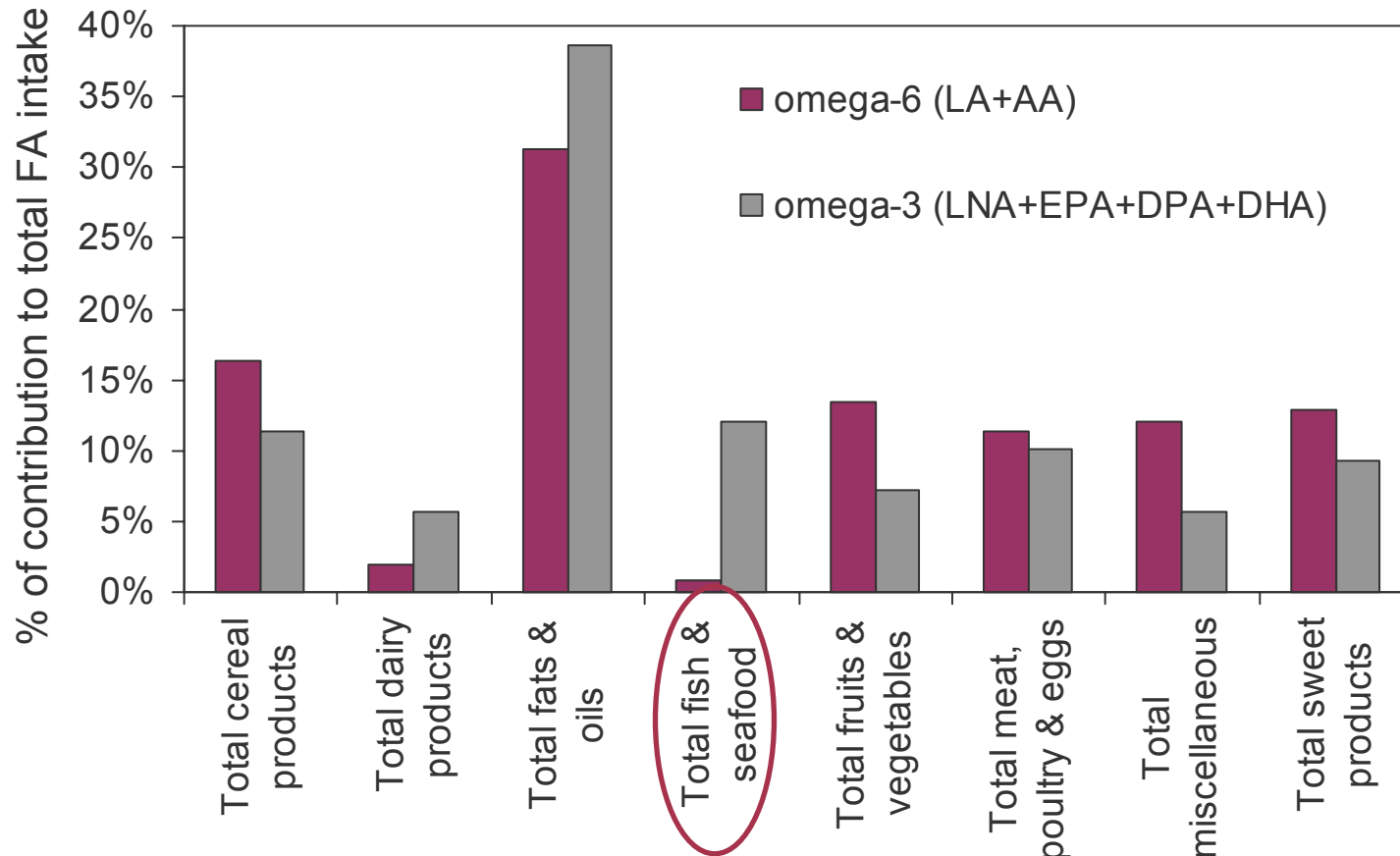
Adolescents



Young
women



Food sources n-6 & n-3 PUFAs (young women)

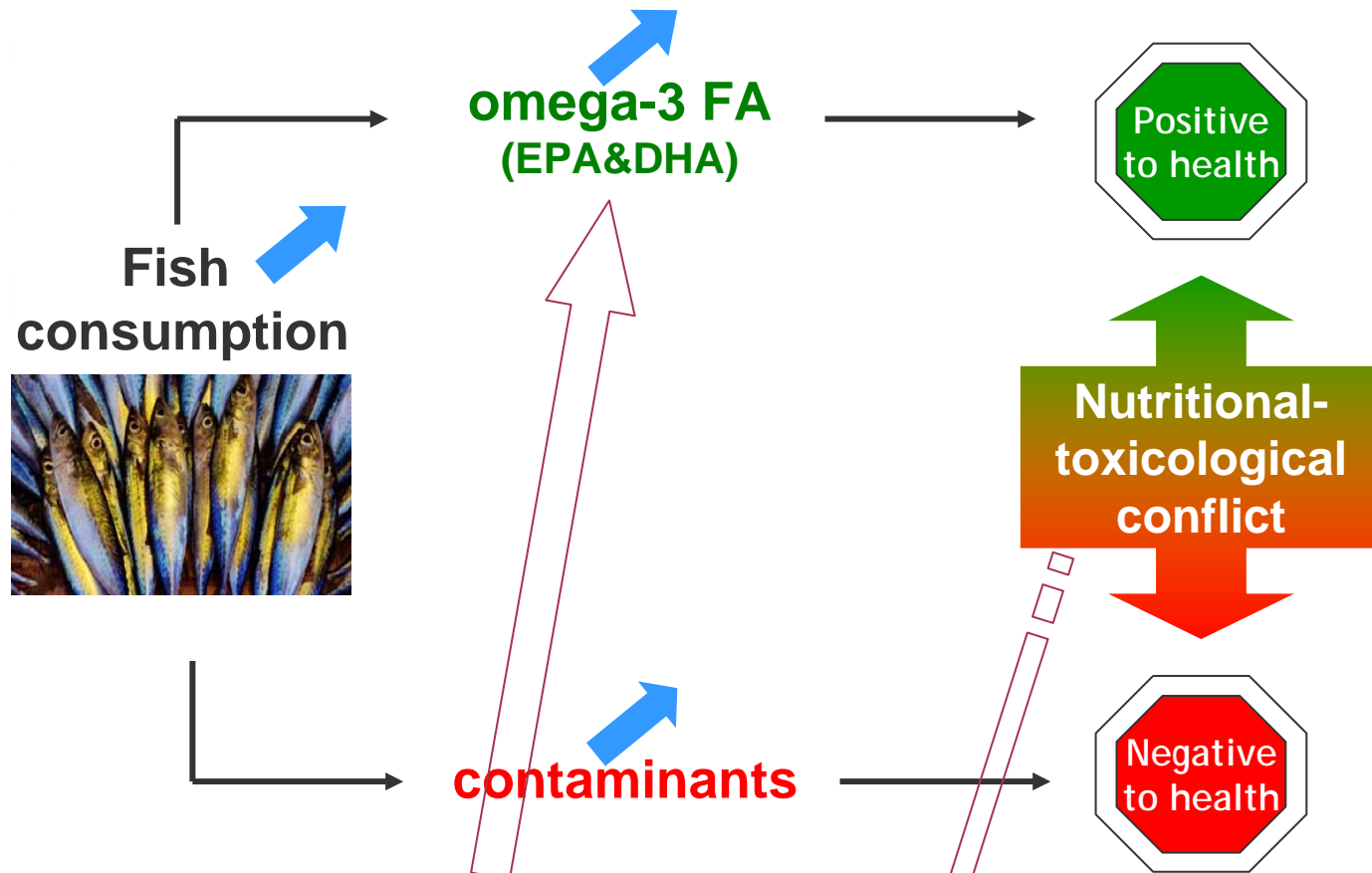


Conclusions of the PUFA intake study



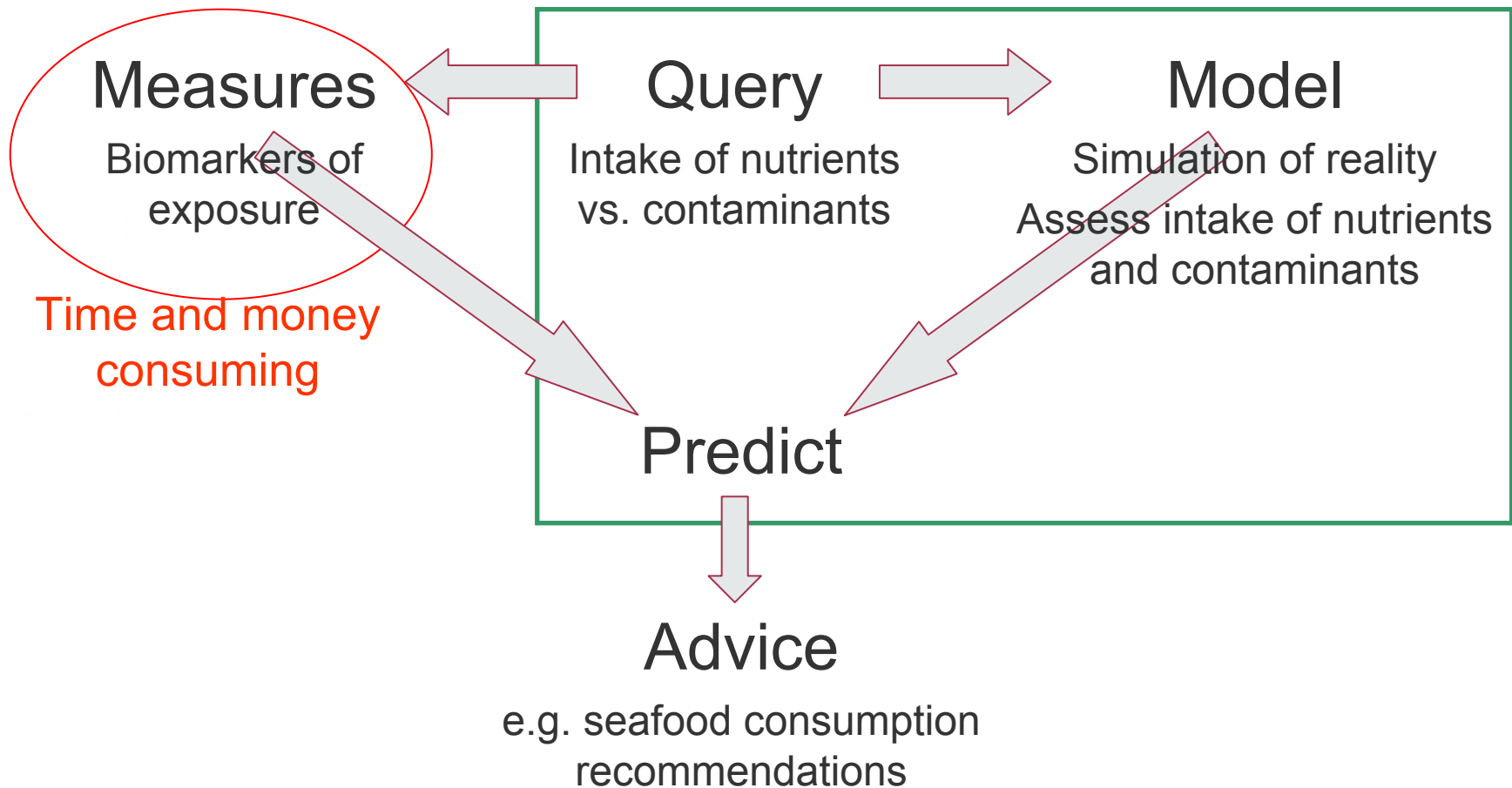
- Intake of essential PUFAs:
 - LA intake (n-6) : reaches the recommendations
 - LNA intake (n-3): very low compared to recommendations
 - high LA/LNA ratio
 - Solution: e.g. increased use of LNA rich oils in food products
- N-6/n-3 ratio in Belgium ≈ 8
- Intake of long chain n-3 PUFAs (EPA&DHA):
 - Depends strongly on seafood consumption
 - Seafood consumption in Belgium very low
 - Recommendations to consume more seafood are a possible solution

Conflict model



1. Introduction – 2. PUFA intake – 3. Methodology – 4. Results – 5. Conclusion

Methodology to study the conflict model



Model for intake assessment



$$Y_i = \sum_v \sum_a \sum_t \left(\frac{b_{v,a} \cdot X_{v,i,t} \cdot C_{v,a}}{BW_i \cdot T} \right)$$

- Y_i : intake of a contaminant/nutrient of individual i
- $X_{v,i,t}$: seafood consumption (species v) of individual i
- $C_{v,a}$: concentration of a contaminant/nutrient in fish v coming from region a
- $b_{v,a}$: probabilistic factor to express the origin
- BW_i : body weight of individual i
- T : time

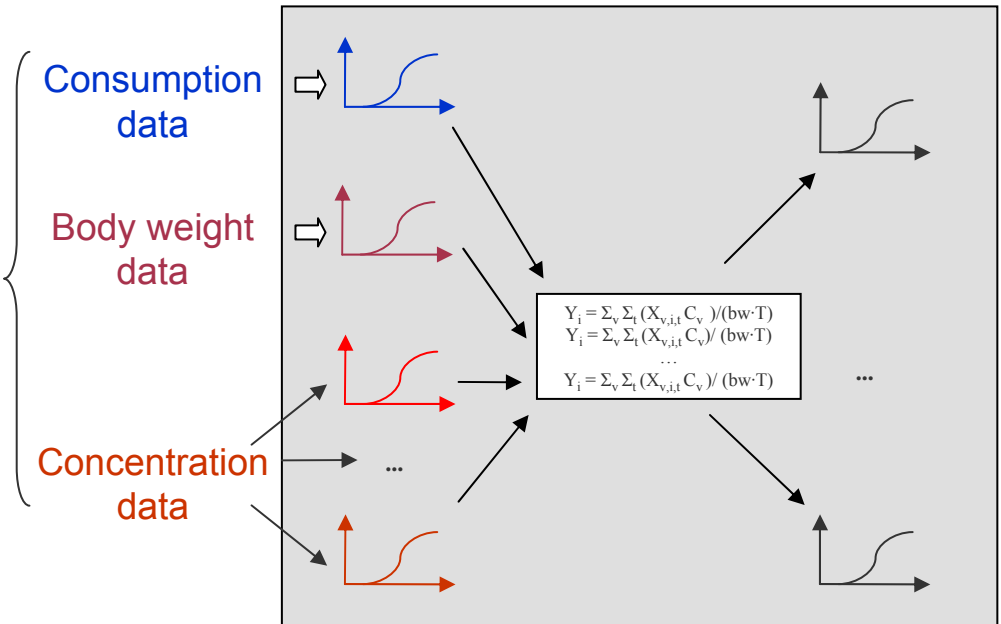
v: fish species
a: origin of the fish
t: time
i: individual

Probabilistic approach



Takes into account **variability** of consumption, body weight and concentration data

Each consumption point is combined with a concentration point of multiple compounds

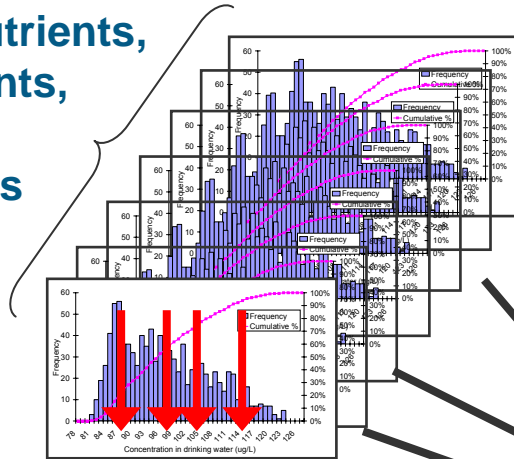


Combined intake assessment, giving information about correlations between the intake of different compounds

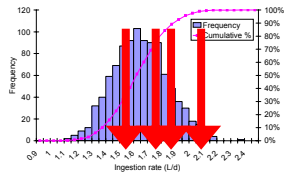
Probabilistic approach in practice



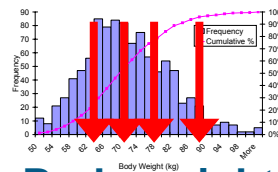
Multiple nutrients,
contaminants,
origins,
fish species



Concentration



Consumption

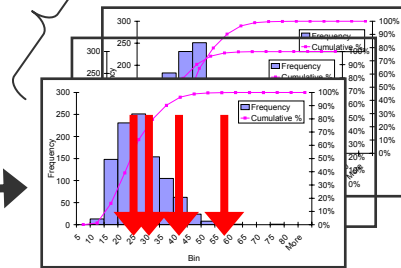


Body weight

MODEL

$$Y_i = \sum_v \sum_a \sum_t \left(\frac{b_{v,a} \cdot X_{v,i,t} \cdot C_{v,a}}{BW_i \cdot T} \right)$$

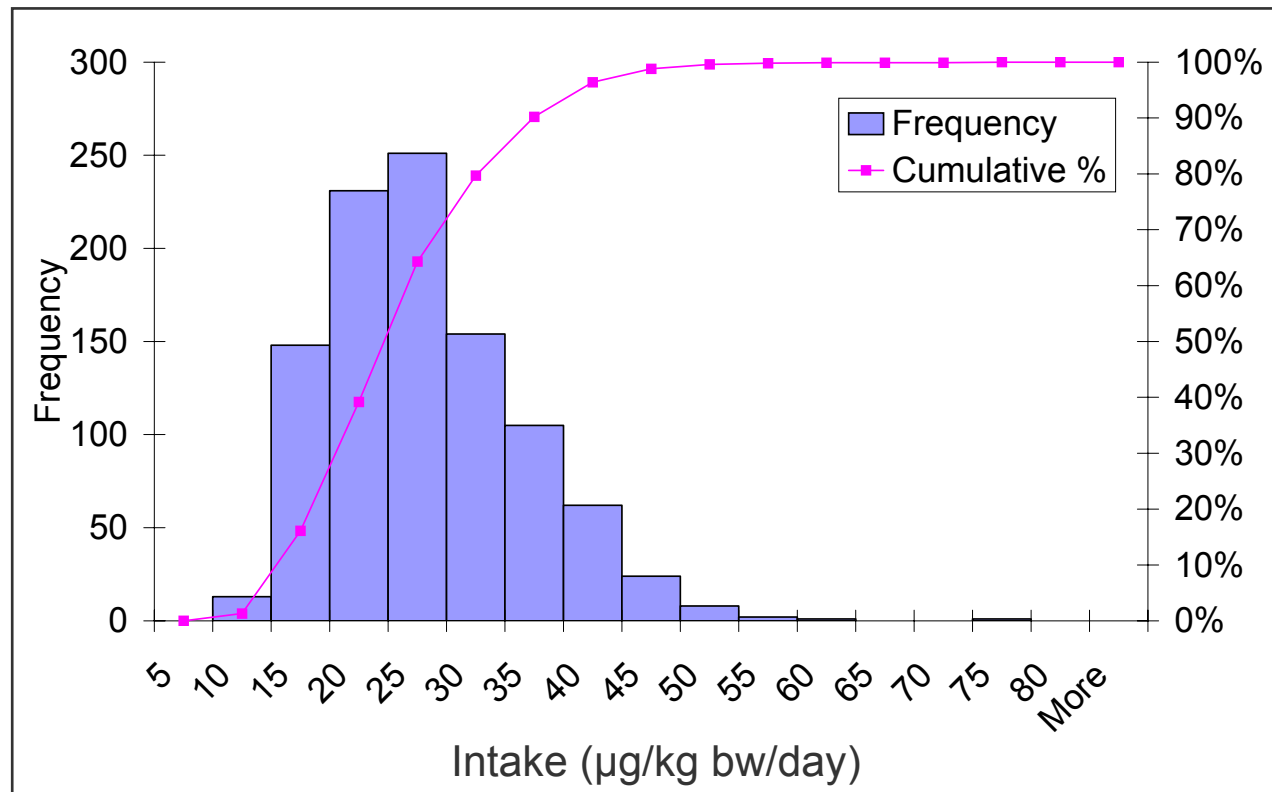
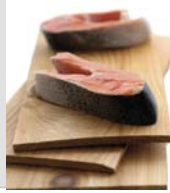
Multiple nutrients,
contaminants



Intake

To perform all these simulations:
a **software module** was
developed: **ProblIntake^{UG}**

Presentation of distributions





Three databases were compiled using literature sources:

1. The origin of seafood on the Belgian market
Preparing for submission to Fisheries Research.
2. A nutrient database, considering EPA+DHA, vitamin D, iodine and total fat
Journal of Food Composition and Analysis 2007; 20(8): 662-670.
3. A contaminant database, considering mercury, PCBs and dioxin-like compounds
Human and Ecological Risk Assessment 2007; 13(3):632-657.

Databases: conclusions



- Hard to find out the origin of the seafood species available on the Belgian market, **traceability** of seafood should be improved
- High **intra-individual variability** in the concentration of nutrients and contaminants in seafood species
- Need to **improve the comparability** of data critical to conduct human intake assessment

Results of the intake assessment



1. **Current situation**, based on REAL consumption data of 341 adolescents (1997) and 821 adults (2004)

Chemosphere. In review.

2. **Scenario studies**: can EPA-DHA recommendation be reached without toxicological concerns?

Public Health Nutrition. In review.

Standardising the assessed intakes



Nutrients: intakes are divided by

└ dietary reference intakes (DRI)

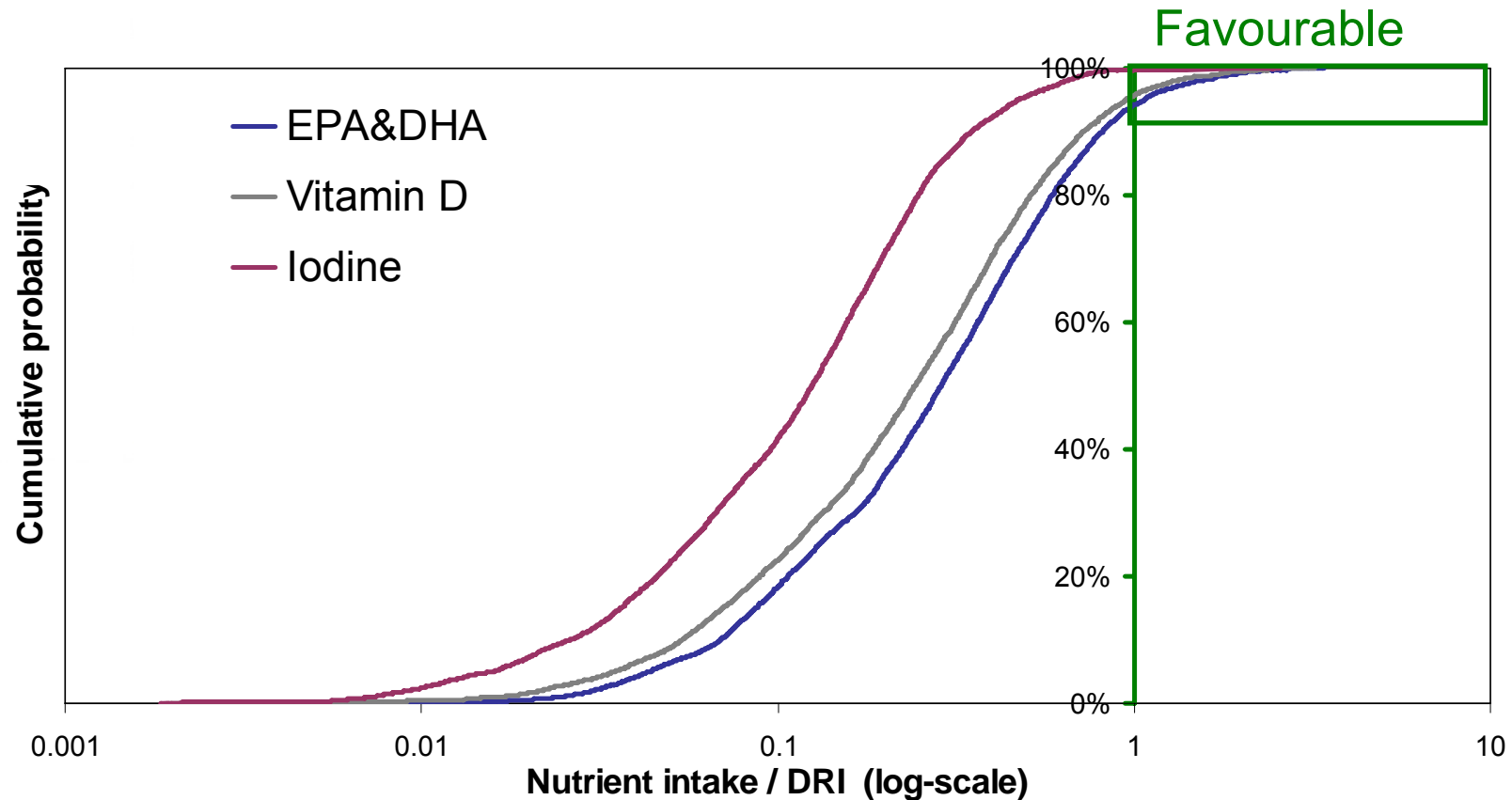
→ Intake > 1 = FAVOURABLE (the recommendation is reached)

Contaminants: intakes are divided by

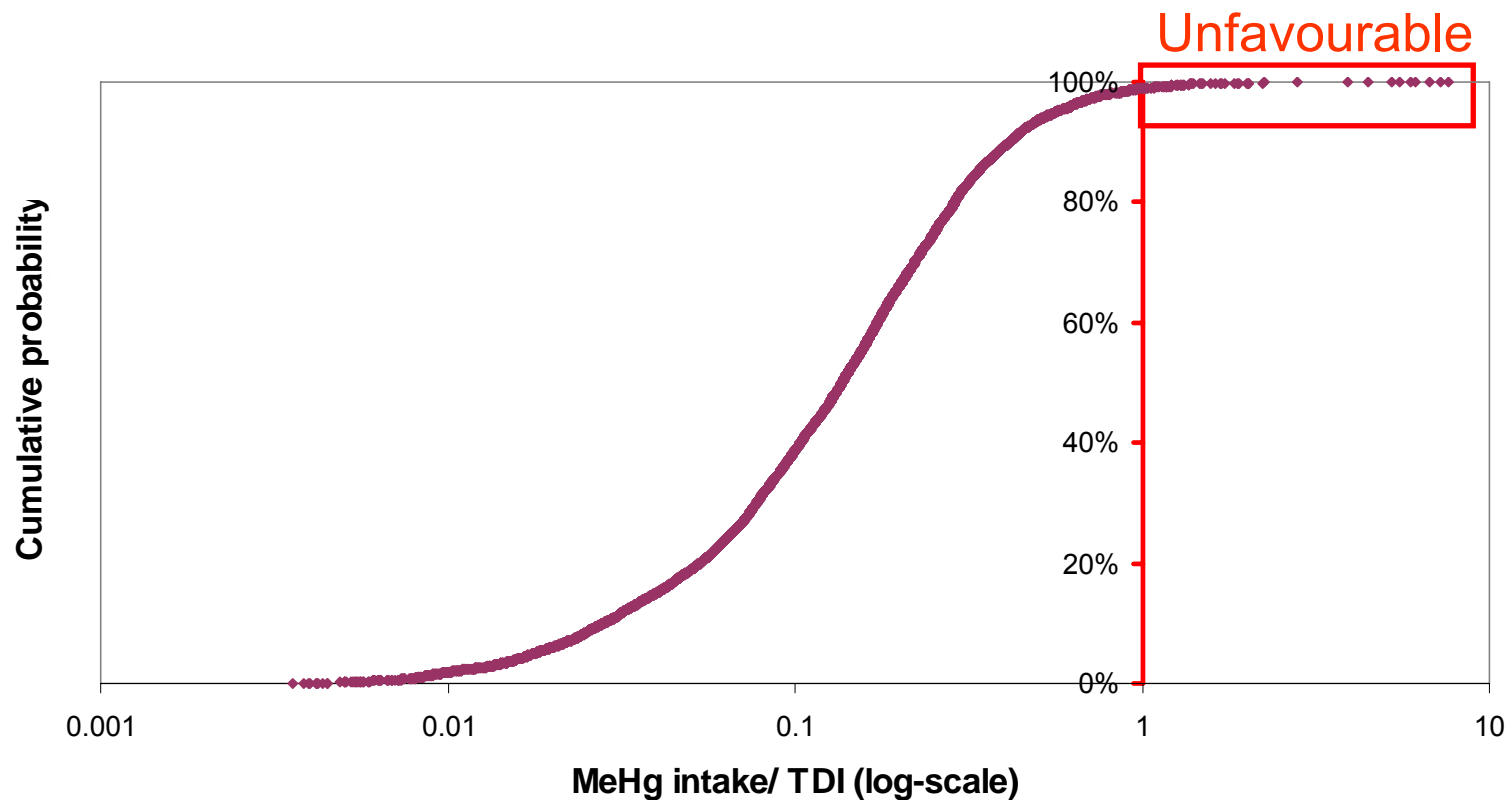
└ tolerable daily intakes (TDI)

→ Intake > 1 = UNFAVOURABLE (the toxicological reference value is exceeded)

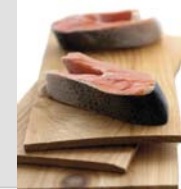
Current nutrient intake via seafood consumption



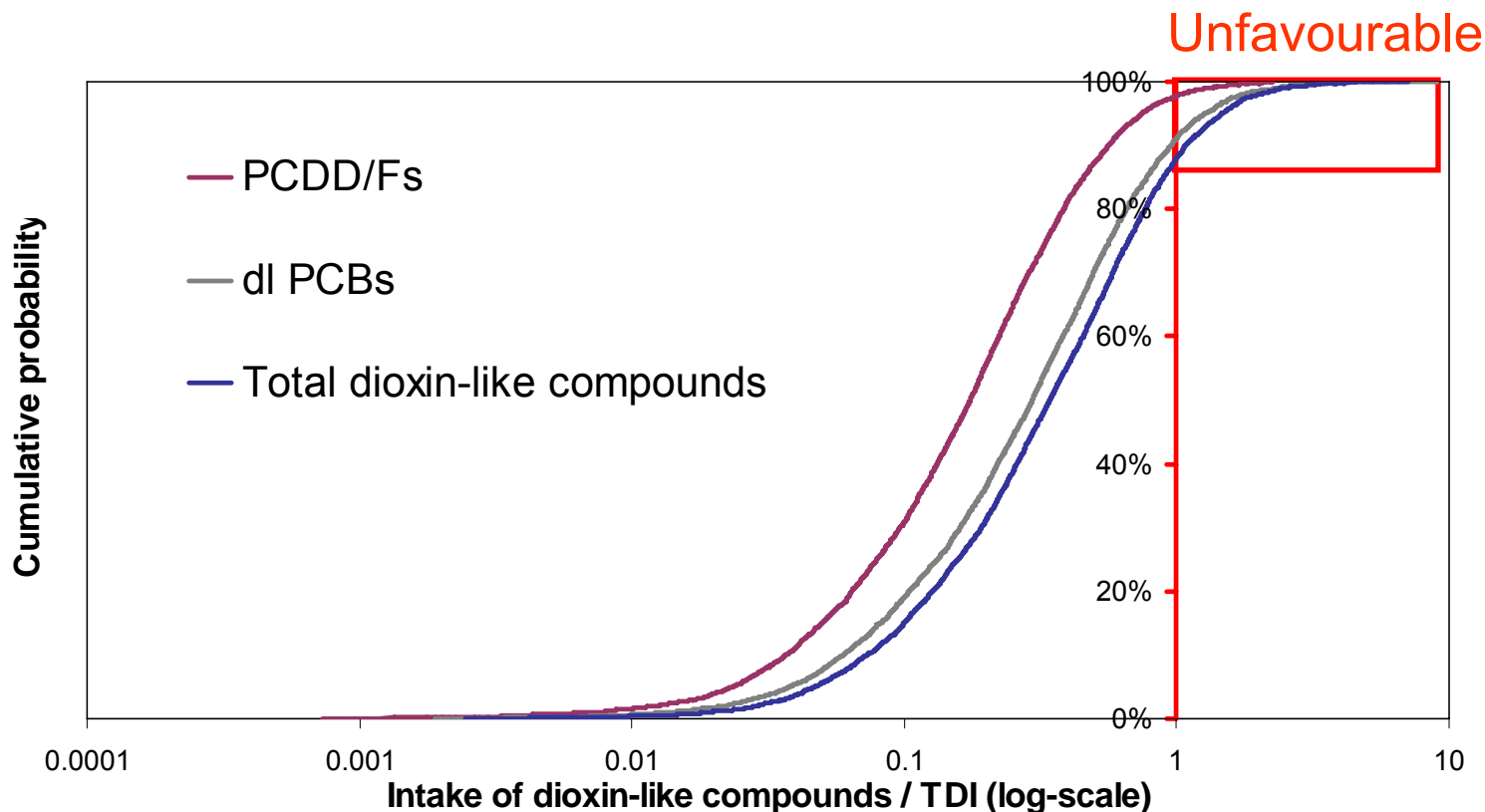
Current methyl mercury intake via seafood



Intake of dioxin-like compounds via seafood *



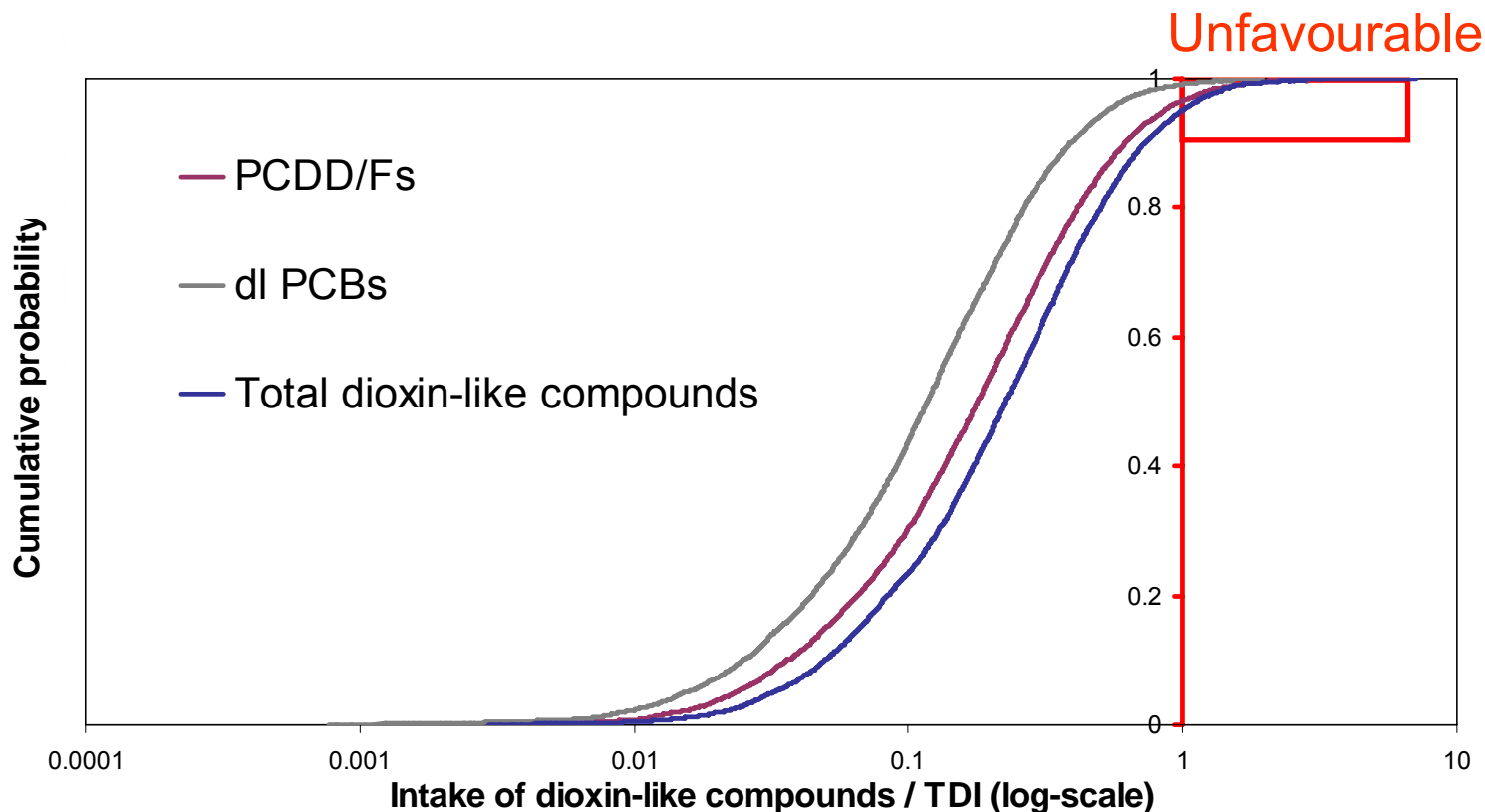
* Including salmon and herring from the Baltic Sea



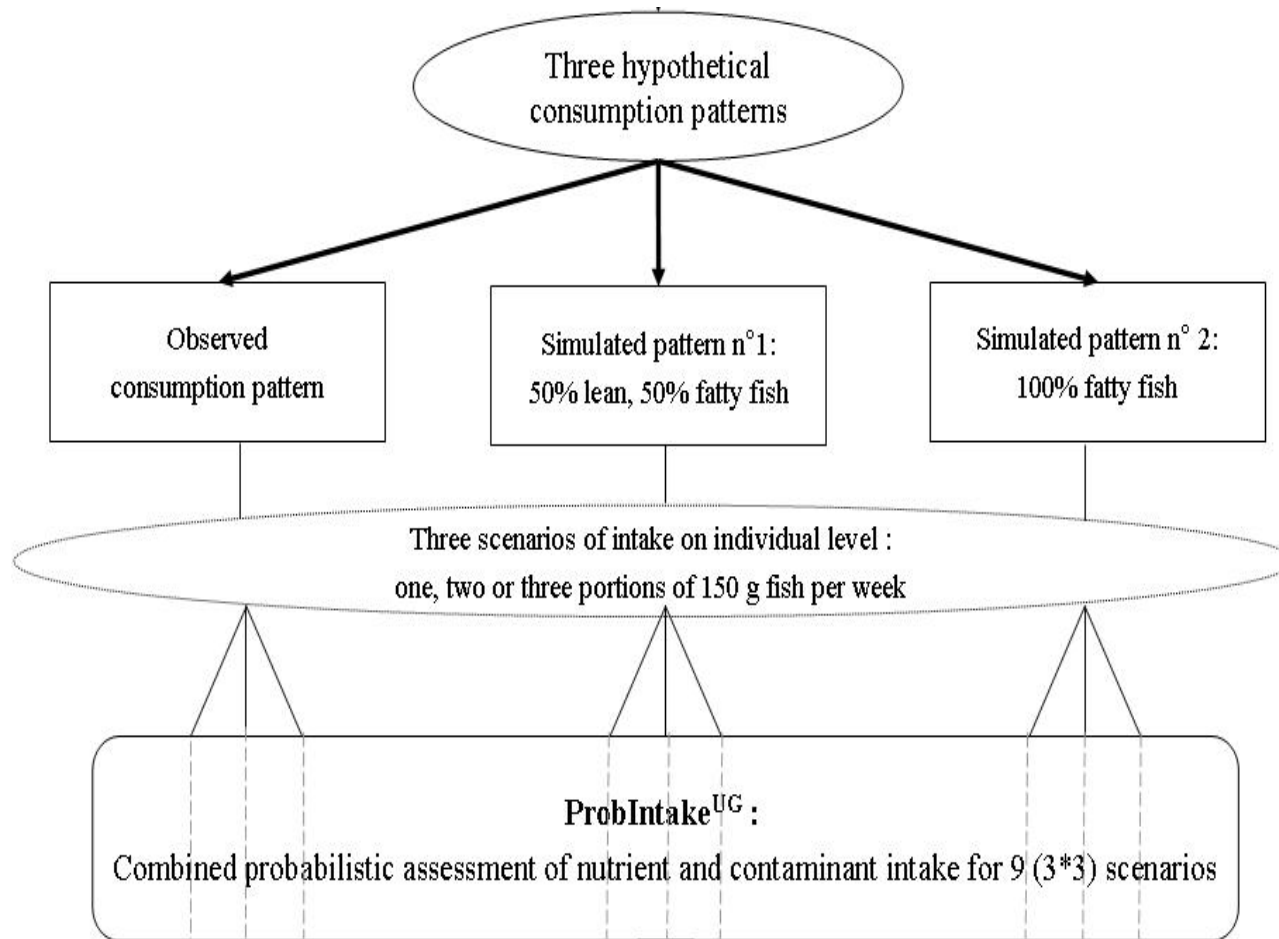
Intake of dioxin-like compounds via seafood *



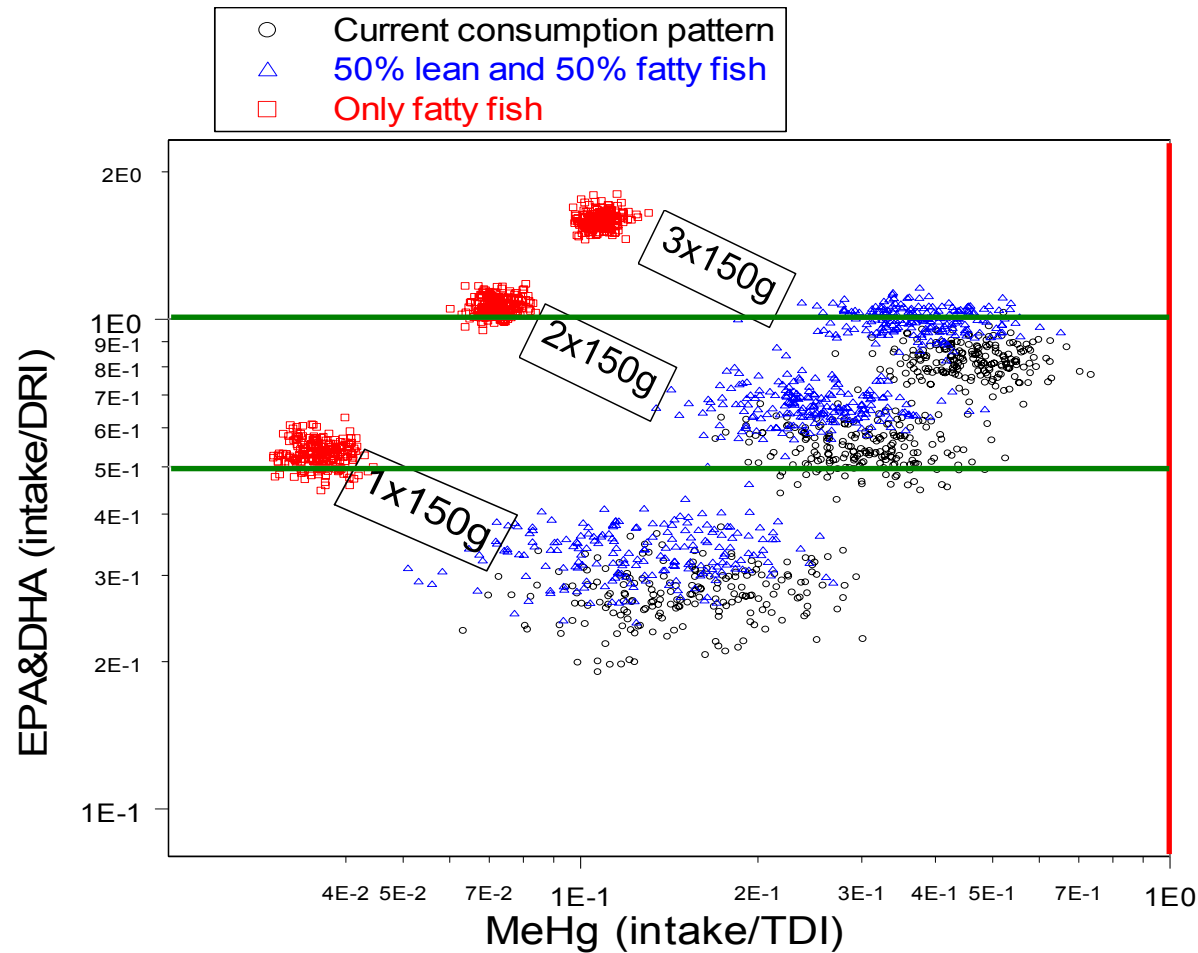
* EXcluding salmon and herring from the Baltic Sea



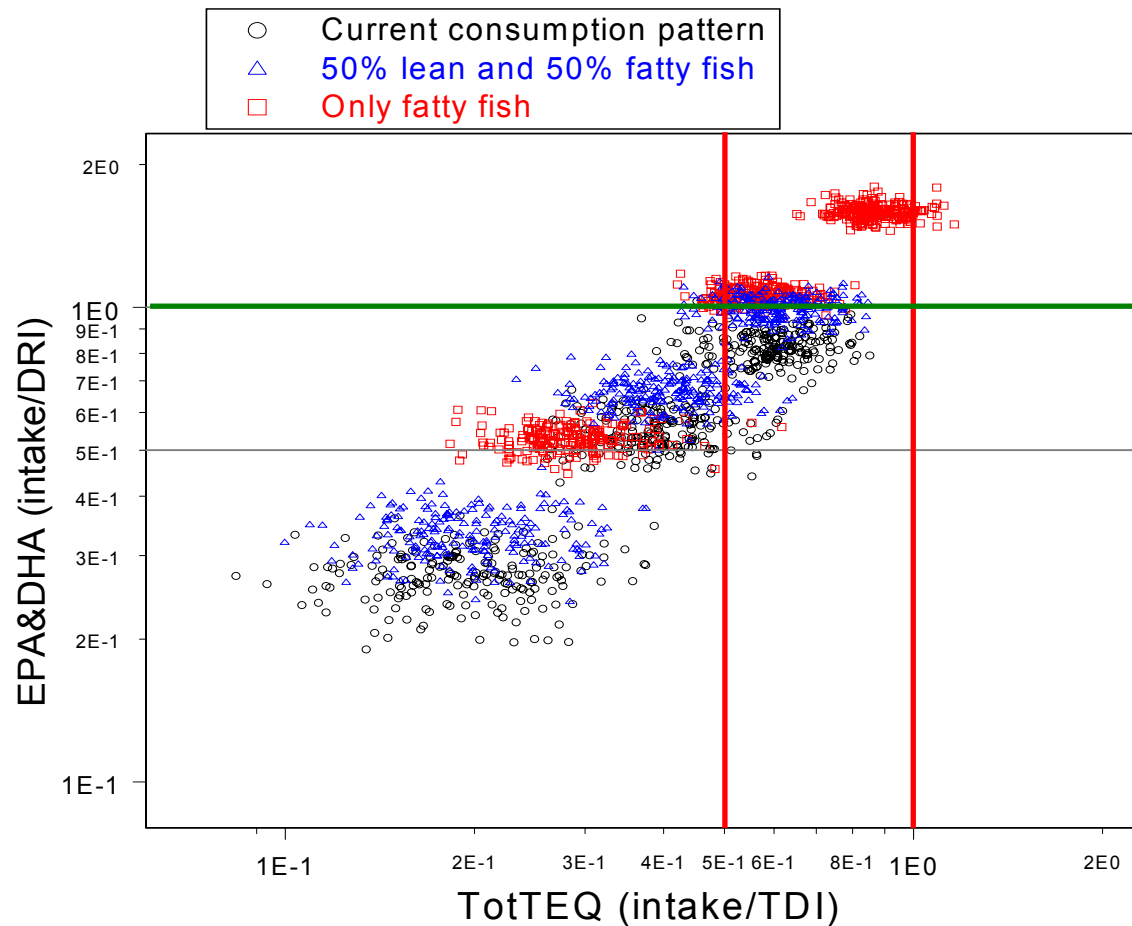
Three times three scenarios



Scenario: MeHg versus EPA&DHA



Dioxin-like compounds versus EPA&DHA



Conclusions (1)



Current situation as far as **only seafood** is concerned:

- General population does not reach adequate intake of the considered **nutrients**
- **Methyl mercury** contamination: not an issue of toxicological concern in Belgium
- Heavy seafood consumers can be at risk for a too high intake of **dioxin-like compounds**
- Exclusion of seafood from highly **contaminated regions** is needed

Conclusions (2)



Scenario studies, independently from other food sources:

- EPA&DHA recommendation can be reached by consuming
 - twice a week fatty fish
 - three times a week a combination of lean and fatty fish
- Three times a week fatty fish can lead to intake of dioxin-like compounds above the toxicological reference value
- Positive conclusion conditional upon compliance of strict rules and regulations

Topics of discussion



1. Other sources were not taken into account, intake assessment via **total diet** is needed
2. **Consumer perception**: nutrition education is crucial when aiming to convince consumers
3. **Sustainability** aspects:
 - Depletion of fish stocks
 - Is aquaculture a valuable alternative?
 - Single cell oils or metabolic engineering to create new omega-3 sources?

Thank you for your attention



If you need tips for recipes to increase your seafood consumption:

- <http://www.vis.vlam.be/>
 - <http://www.tijdvoorvis.nl/>
 - <http://www.goedevis.be/>
-