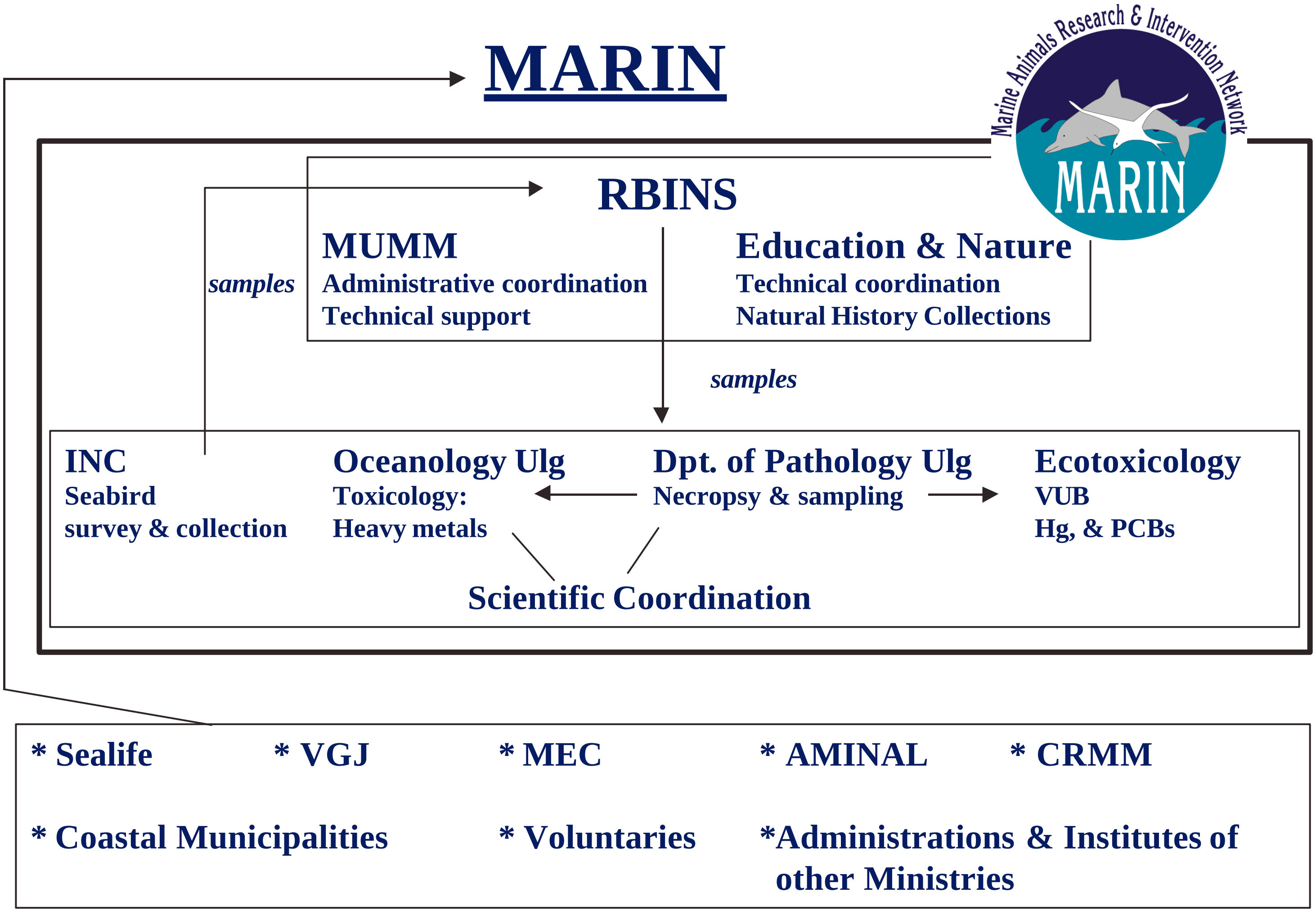
North Sea Seabirds and Marine Mammals: Pathology and Ecotoxicology.


MARIN
RBINS
MUMM
Administrative coordination
Technical support
Education & Nature
Technical coordination
Natural History Collections
samples
samples
INC
Seabird
survey & collection
Oceanology Ulg
Toxicology:
Heavy metals
Dpt. of Pathology Ulg
Necropsy & sampling
Ecotoxicology
VUB
Hg, & PCBs
Scientific Coordination
* Sealife
* VGJ
* MEC
* AMINAL
* CRMM
* Coastal Municipalities
* Voluntaries
*Administrations & Institutes of other Ministries

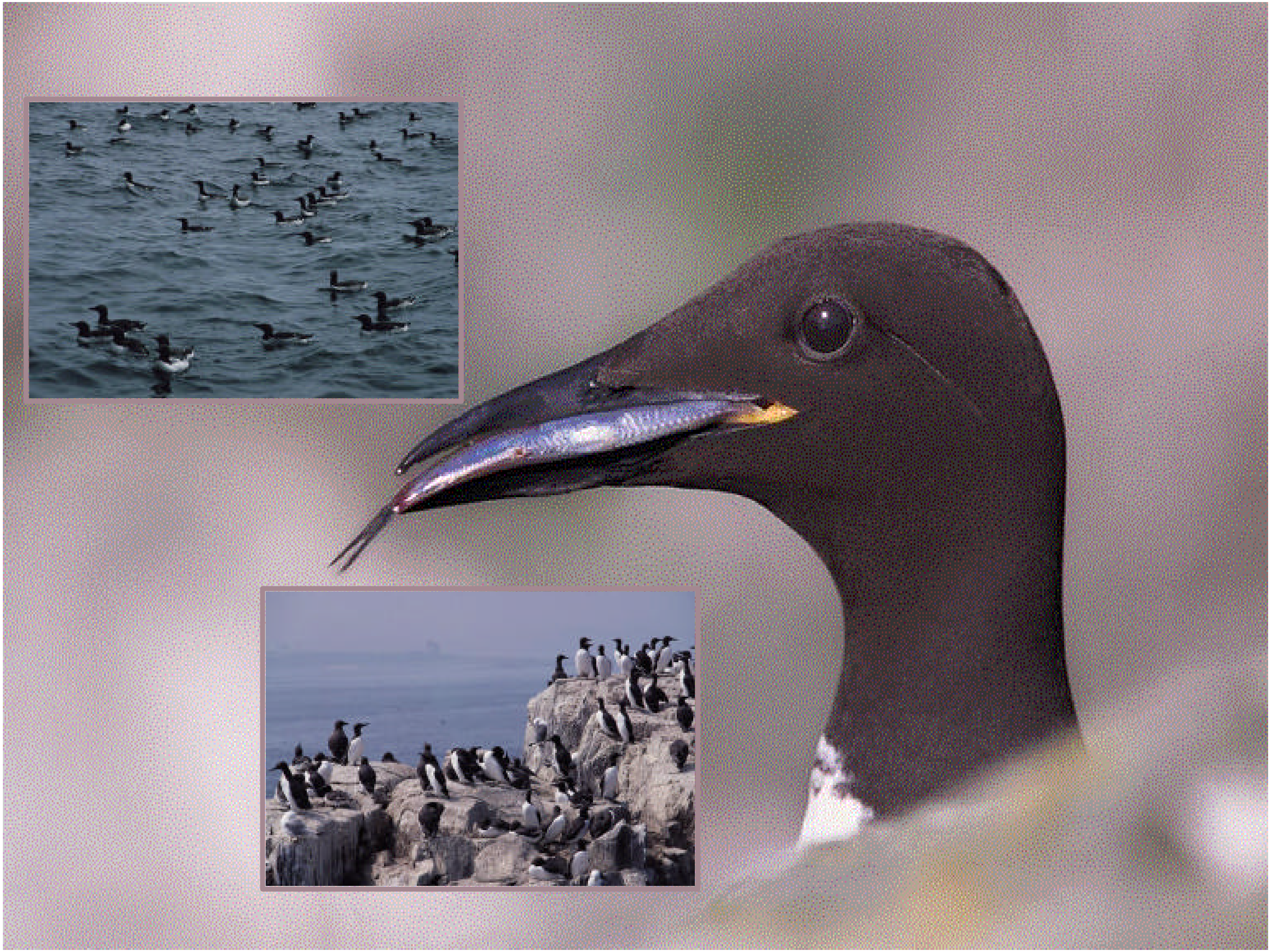
Objective of this study

Evaluating the potential role of contaminants on debilitated specimens.

↓

Pathological + ecotoxicological data.

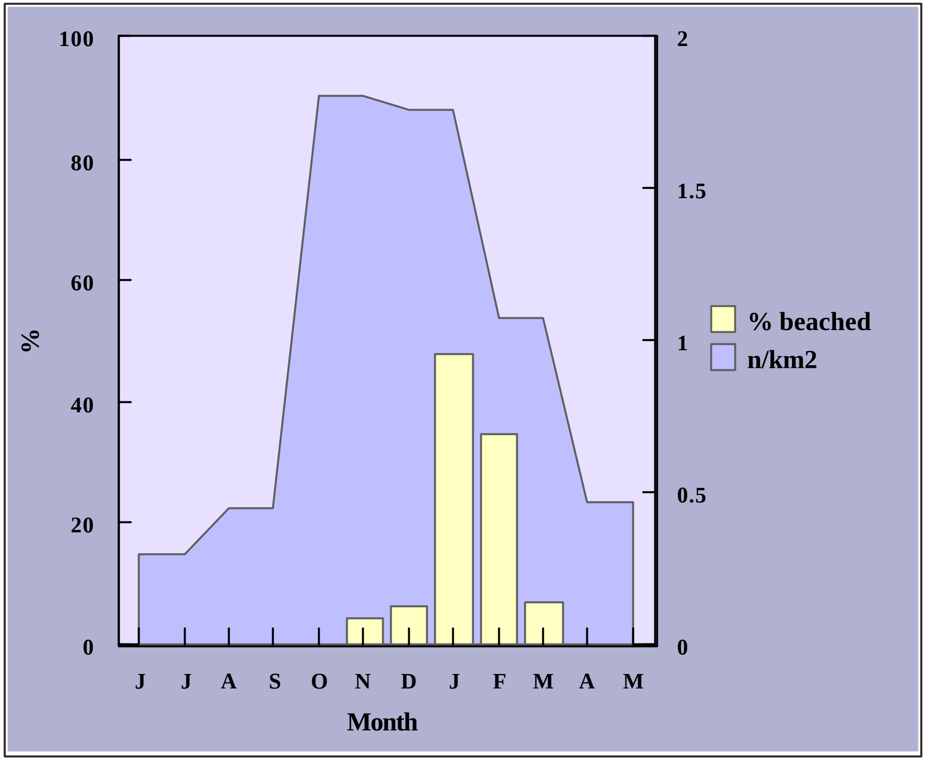
Part I: Seabirds



Beached guillemots at the Belgian coast compared to their densities in the Southern North Sea.

Peak recoveries

- January
- February



Densities: see Camphuysen & Léopold, 1994.

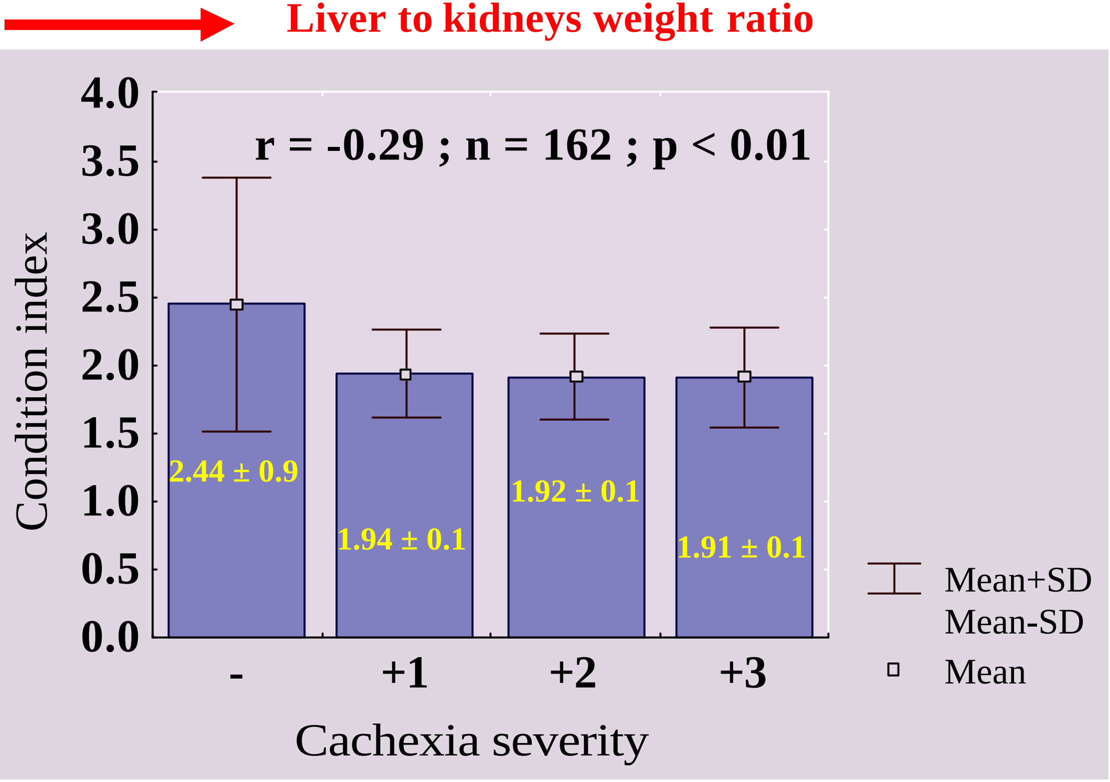
Visual observation at necropsy

Robust ⟶ Cachectic

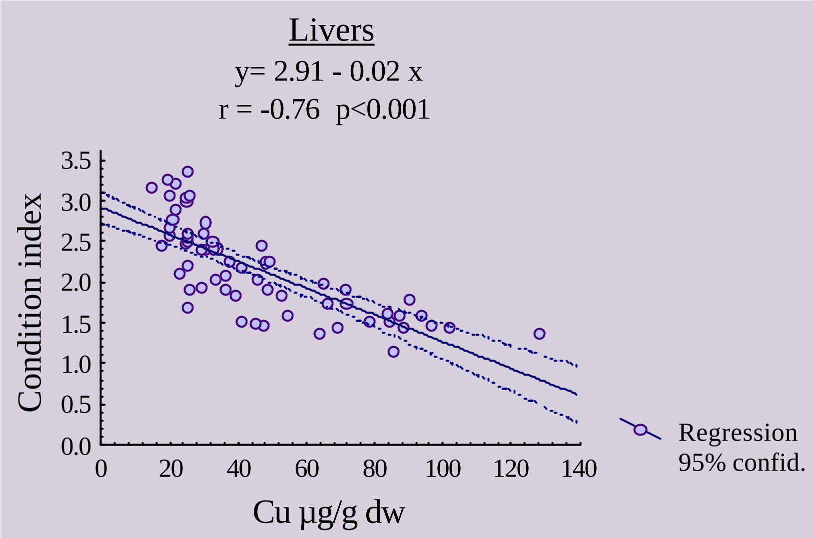
- depleted amounts of subcutnaeous and abdominal fat reserves;
- mild to severe atrophy of the pectoral muscles.

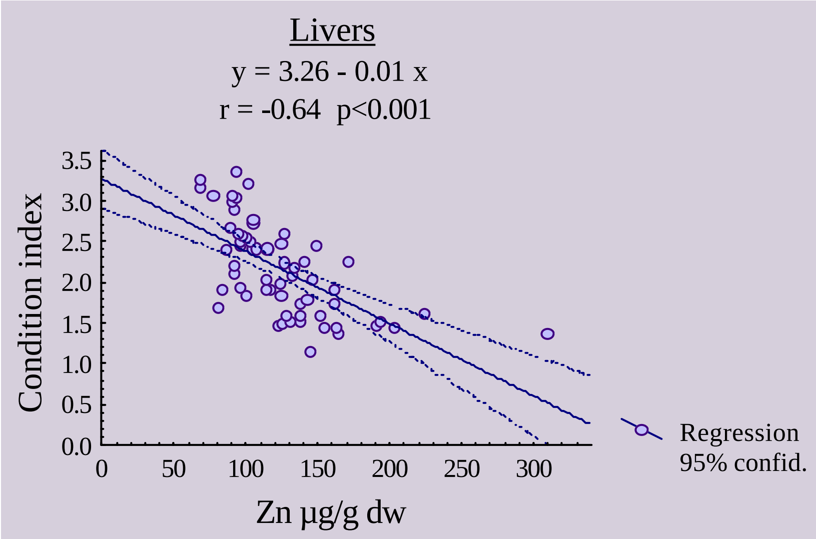
Photos: Dr. T. Jauniaux.

Condition index



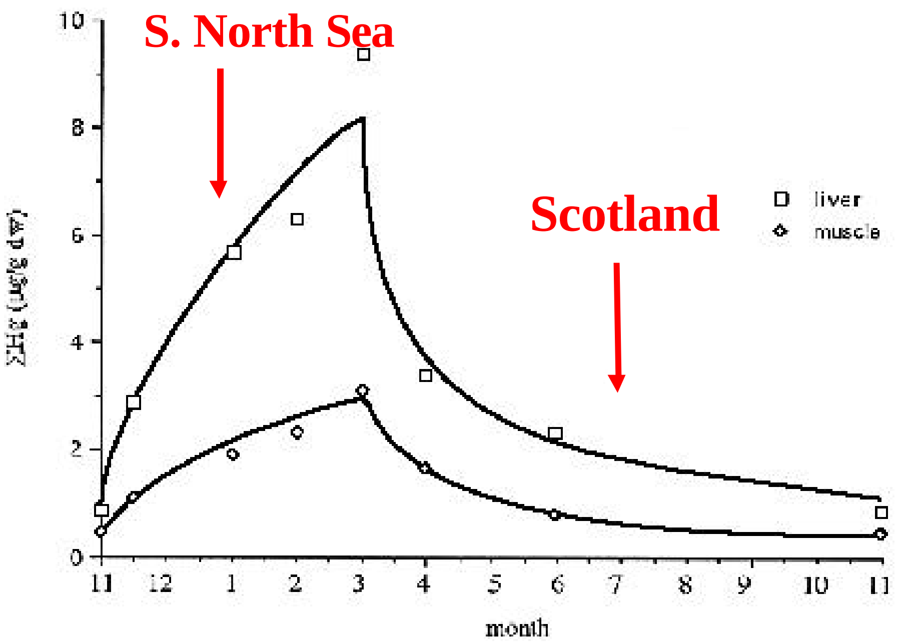
Increased heavy metal levels with decreasing condition index.





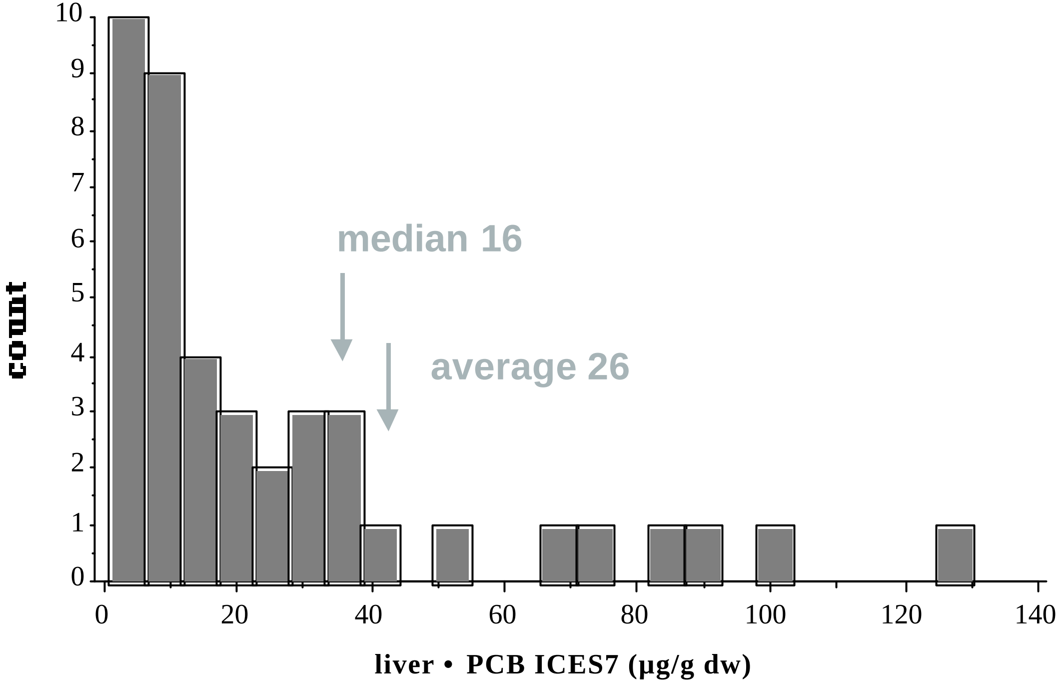
General re-distribution between the organs.

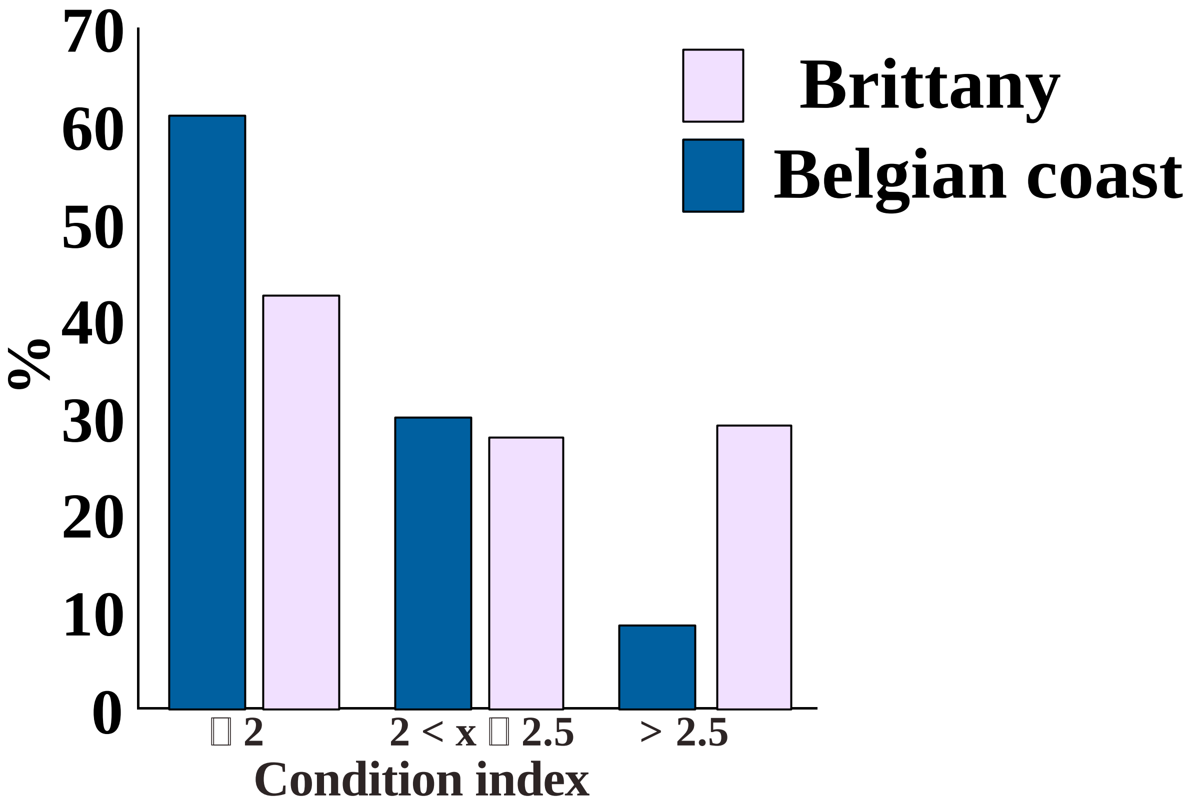
Hg: contamination/decontamination cycle.



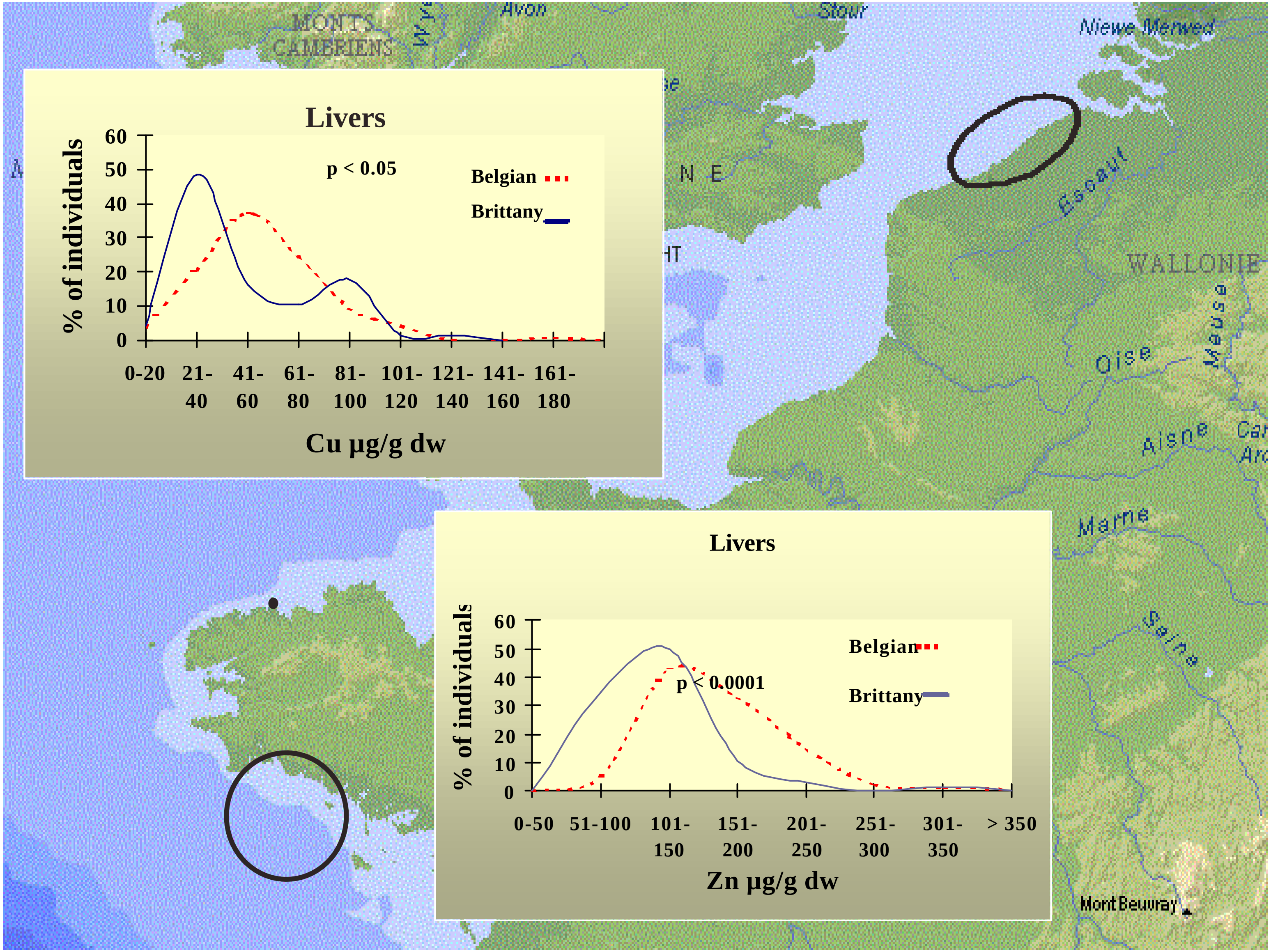
Number Annual cycle of Hg concentration in liver and muscle of the common guillemot. April - November: Stewart *et al.*, 1994; Joiris et al., 2000.

Total PCBs distribution in livers of common guillemots.



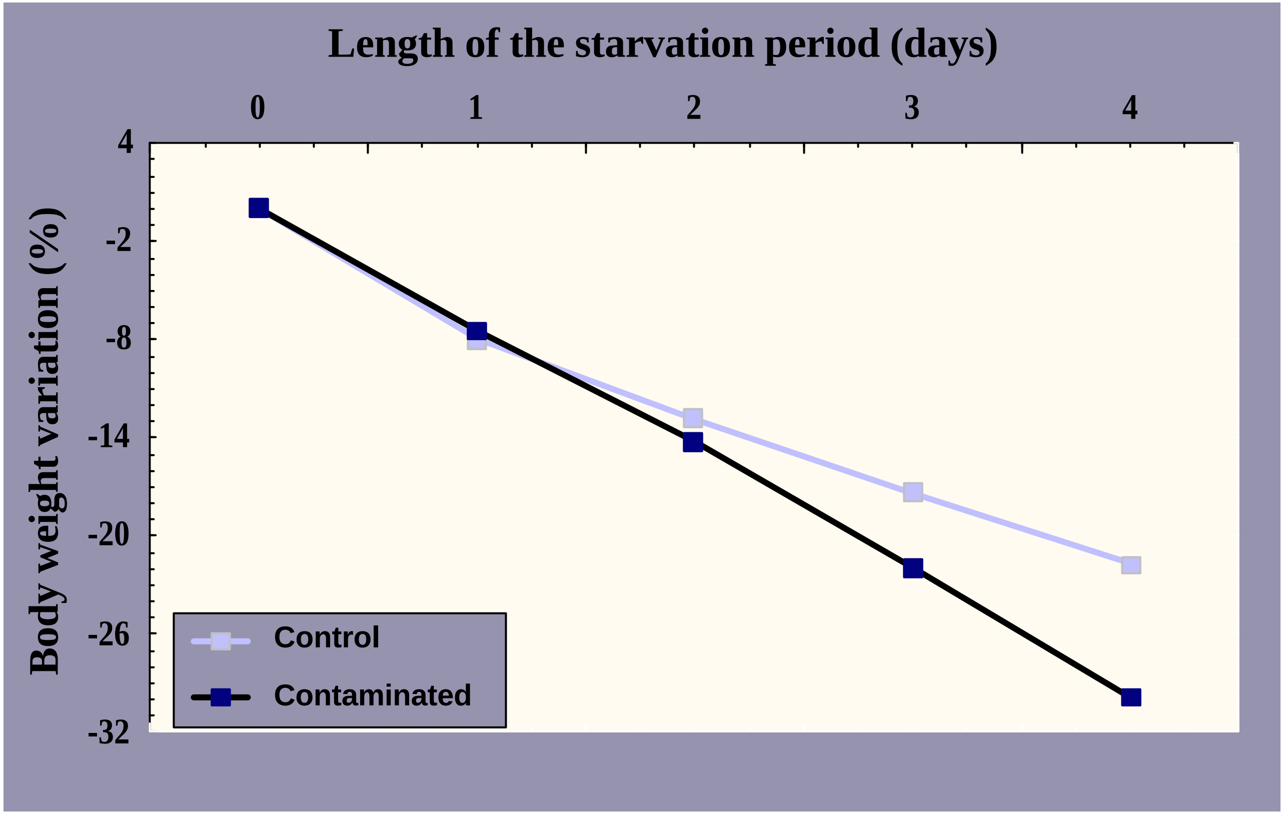


70
60
50
40
30
20
10
0
%
Brittany
Belgian coast
2
2 < x 2.5
> 2.5
Condition index



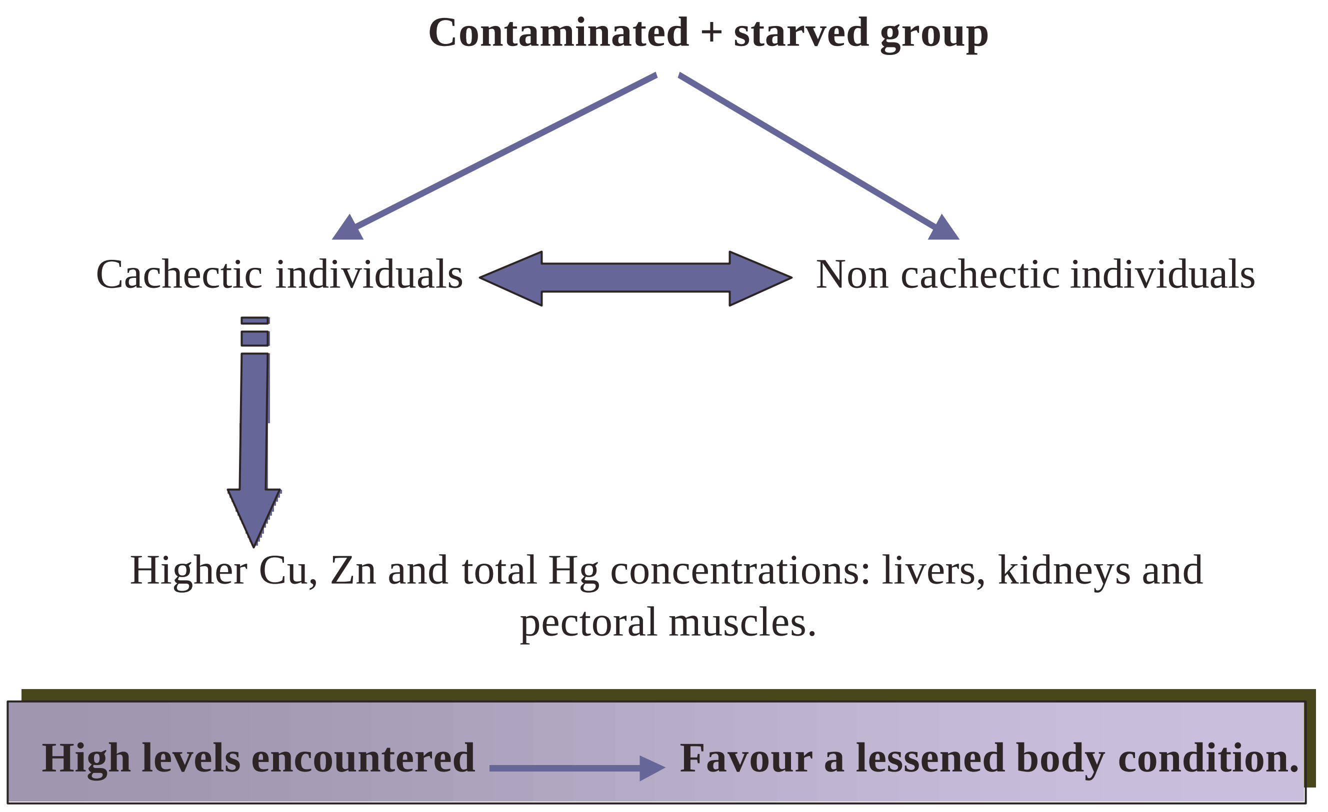
MONTS CAMBRIENS
Avon
Stour
Niewe Merwed
Escaut
WALLONIE
Oise
Meuse
Aisne
Marne
Seine
Mont Beuvray
Livers
% of individuals
p < 0.05
Belgian
Brittany
60
50
40
30
20
10
0
0-20
21-40
41-60
61-80
81-100
101-120
121-140
141-160
161-180
Cu µg/g dw
Livers
% of individuals
p < 0.0001
Belgian
Brittany
60
50
40
30
20
10
0
0-50
51-100
101-150
151-200
201-250
251-300
301-350
> 350
Zn µg/g dw

Experimental contamination and starvation

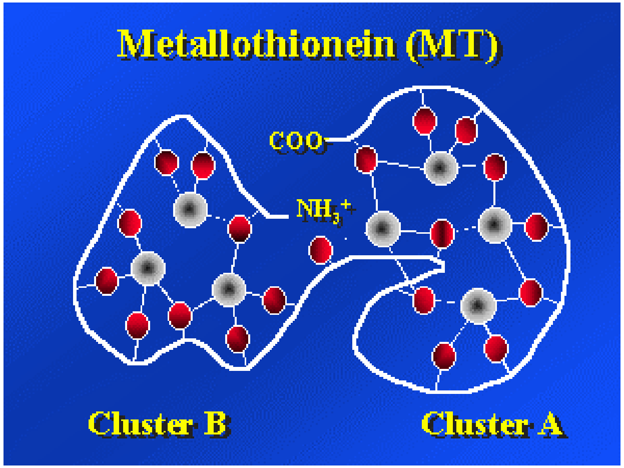


Contaminated and starved group (Cu, Zn and CH_3Hg).							
	Pectoral muscle volume	Subcutaneous fat	Abdominal fat	Cachexia	Subcutaneous oedema	Hepatic fatty degeneration	Other remarks
1	**Severe atrophy**	**no**	**no**	**yes**	yes	no	-
2	normal	no	no	no	yes	no	-
3	**Severe atrophy**	**no**	**no**	**yes**	yes	no	-
4	**Severe atrophy**	**no**	**no**	**yes**	yes	no	-
5	normal	no	no	no	yes	no	-
6	normal	no	no	no	no	no	small testes

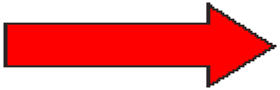
Cachectic individuals are shown in red.


Contaminated + starved group
Cachectic individuals
Non cachectic individuals
Higher Cu, Zn and total Hg concentrations: livers, kidneys and pectoral muscles.
High levels encountered
Favour a lessened body condition.

Metallothioneins



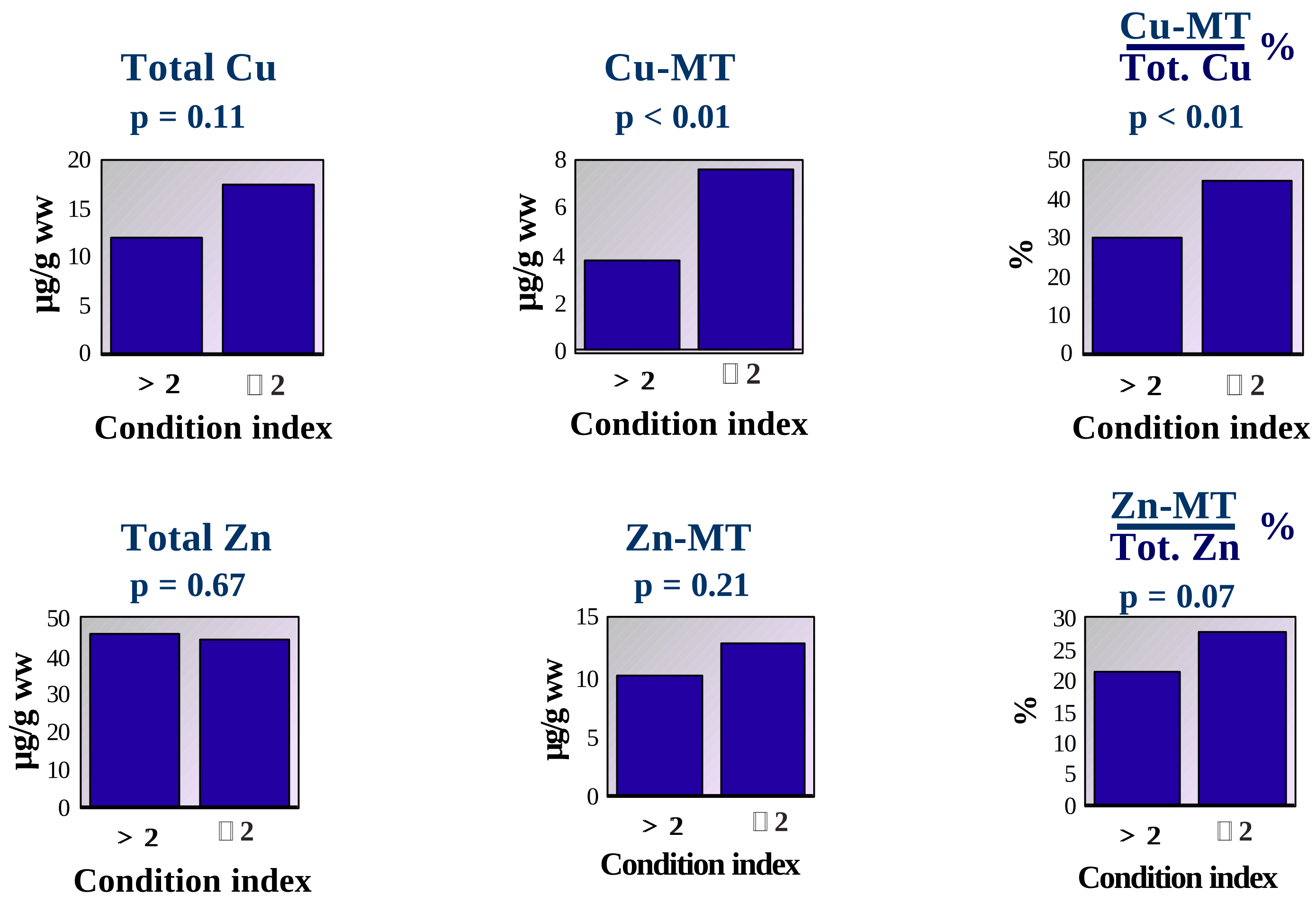
Low molecular weight proteins which are involved in:



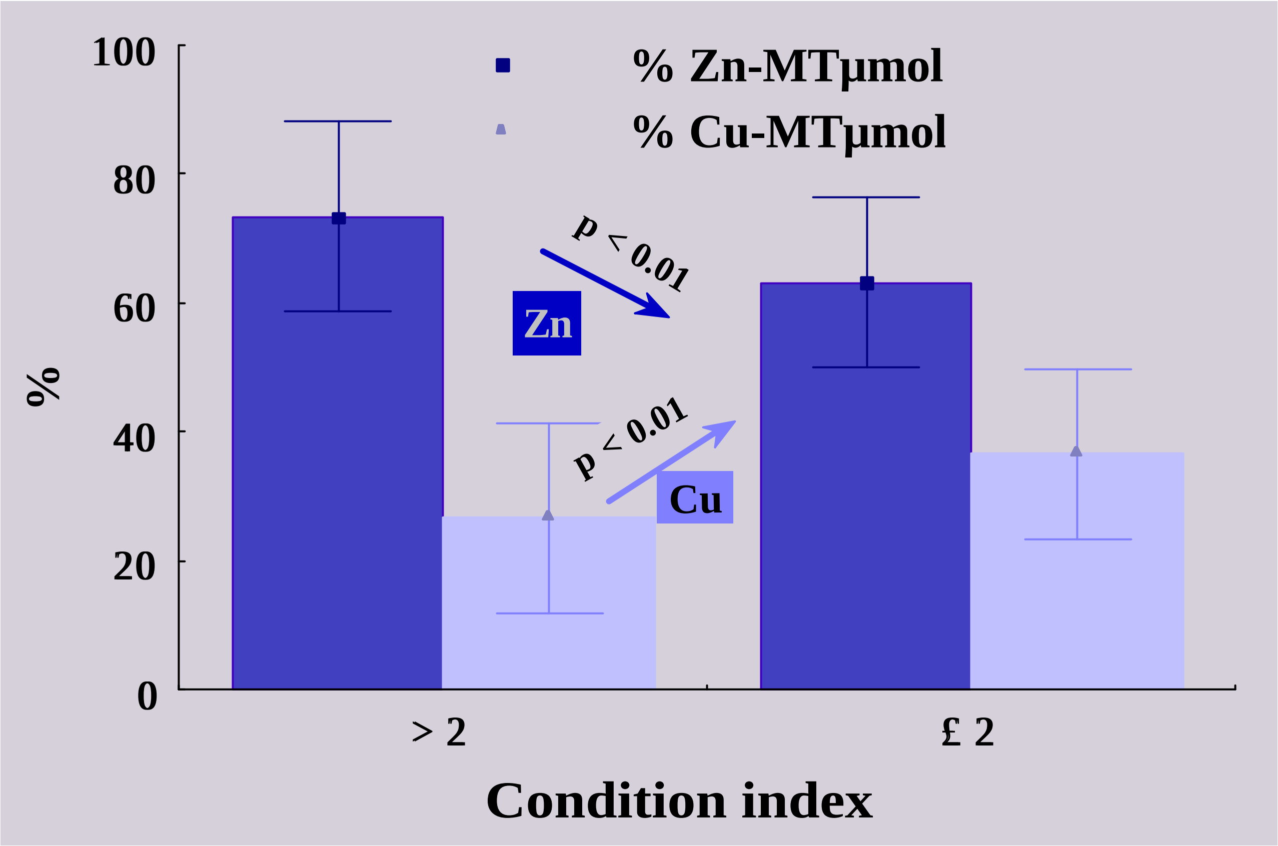
Homeostasy of Zn and Cu

Detoxication of Cd

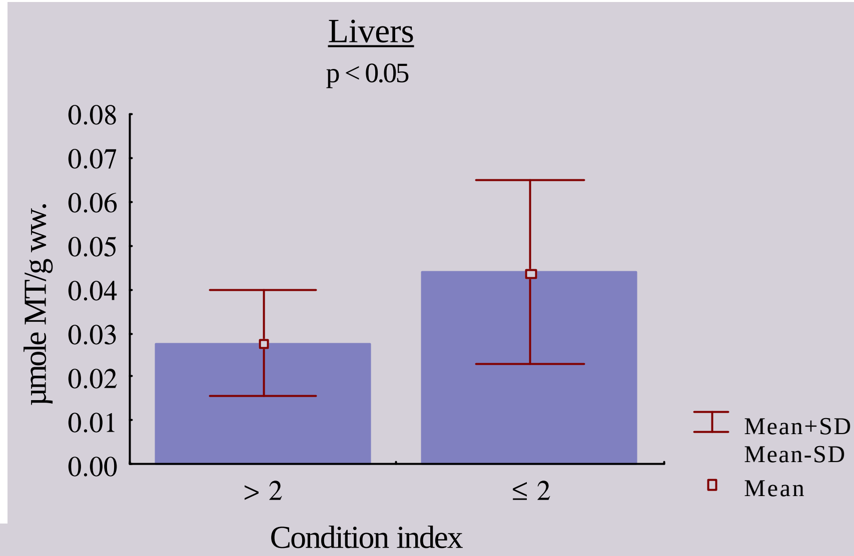
Cu and Zn distribution on metallothioneins in the livers.

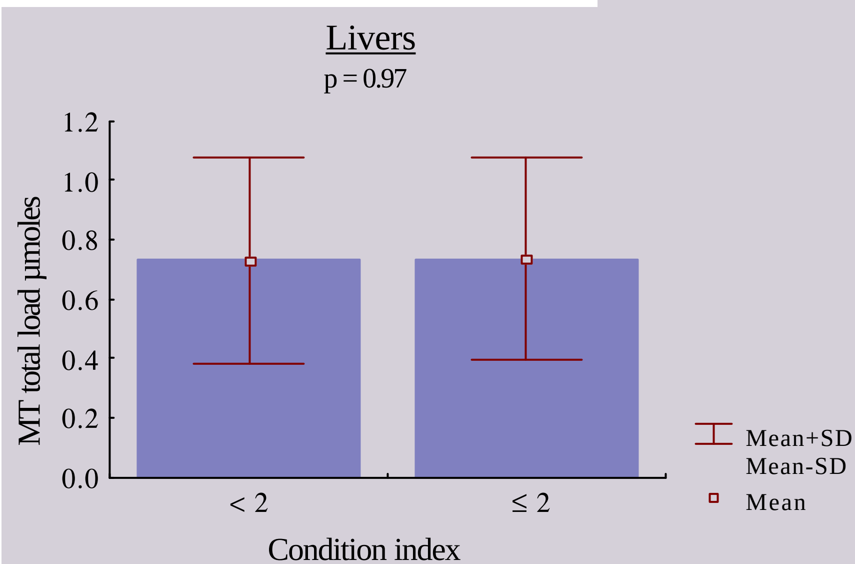


Cu and Zn distribution on MTs



↗ [MT]: ↘ **Condition index**





Total MT load: —

Conclusions

- **re-distribution of the contaminants as an effect of starvation, with increasing levels parallel to increasing cachexia severity;**

- **higher heavy metals levels in the Southern North Sea;**

- **possible role of heavy metals as favouring agents for cachexia;**

- **confirm the potential role of MTs against Cu toxicity.**

Part II: Marine Mammals

Marine mammal biodiversity in the North Sea

Resident

❖Harbour porpoises, *Phocoena phocoena*

❖Harbour seals, *Phoca vitulina*

❖Bottlenose dolphin *Tursiops truncatus*

•**Transient for feeding**

•Whitebeaked dolphins, *Lagenorhynchus albirostris*

• Whitesided dolphins, *Leucopterus acutus*

•Minke whale *Balaenoptera acuturostrata*

Occasional or temporal

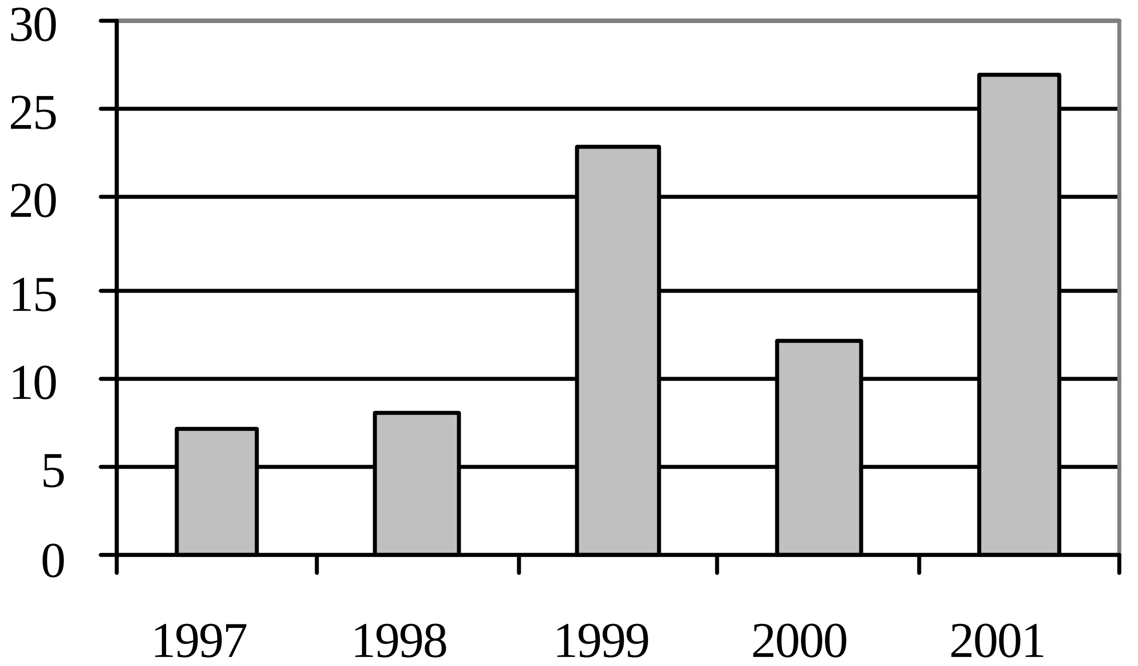
oSperm whales, *Physeter macrocephalus*

oGrey seals, *Halichoerus grypus*

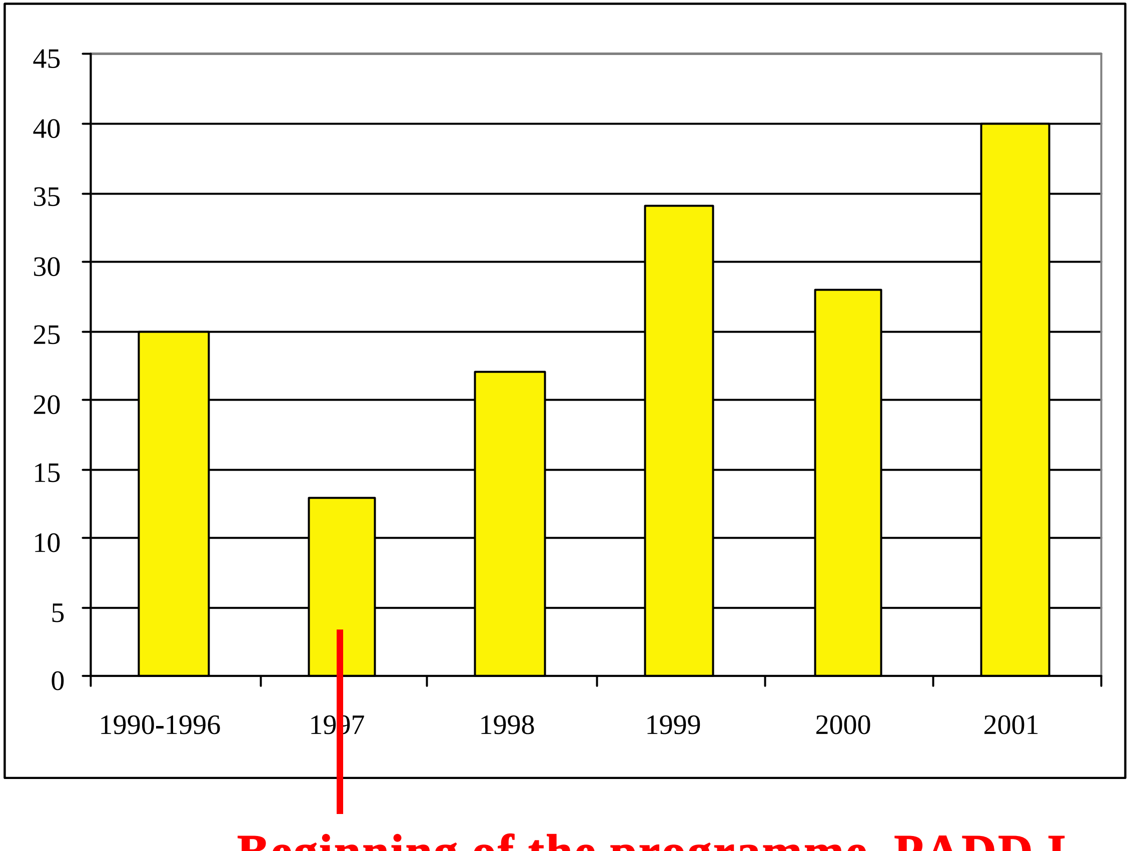
o Hooded seal, *Cystophora cristata*

oOthers species such as killer whales or fin whales

Harbour porpoise stranding frequency along the Belgian and Northern French coastline



Marine mammal stranding frequency (all species)



Beginning of the programme PADD I

Main Lesions

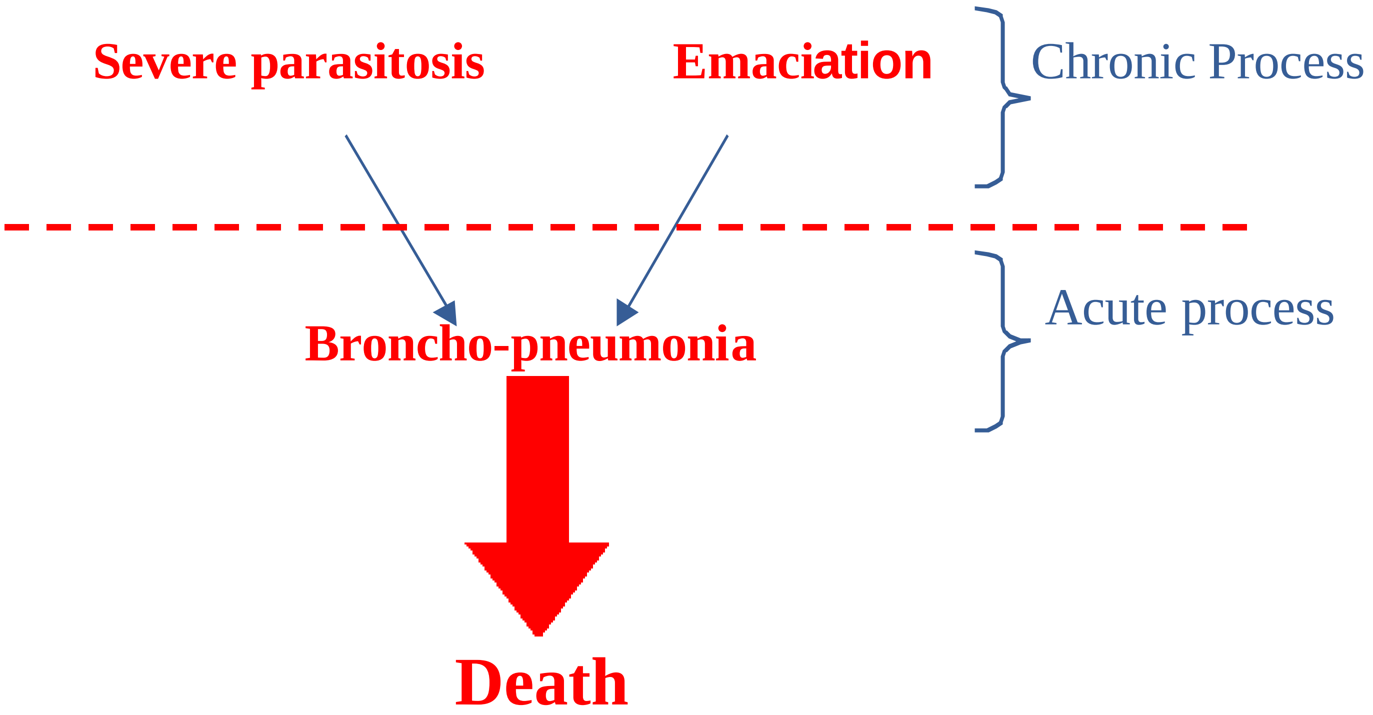
Emaciation: 60%

Broncho-pneumonia:51%

Nematods

Parasitosis: 49%

Harbour Porpoises Major Death Mechanisms



Pinnipeds : Harbour Seals (n=36) with 24 individuals completely necropsied

Emaciation 65%

Morbillivirus* 50% (7 in 1998 et 5 afterwards)

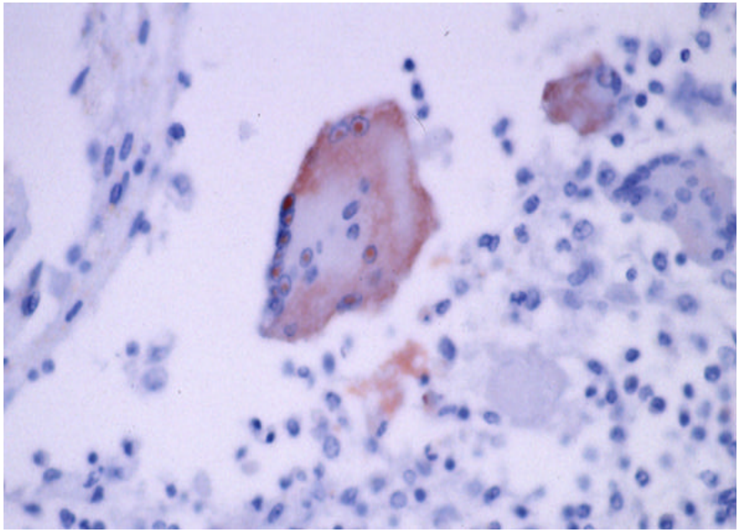
Broncho-pneumonia 30%

Traumatic (by-catch, collision) 30%

***: morbillivirus: responsible in 1988 of the death of 18.000 seals in the North Sea (population: 25.000)**

This is the first outbreak since 1988.

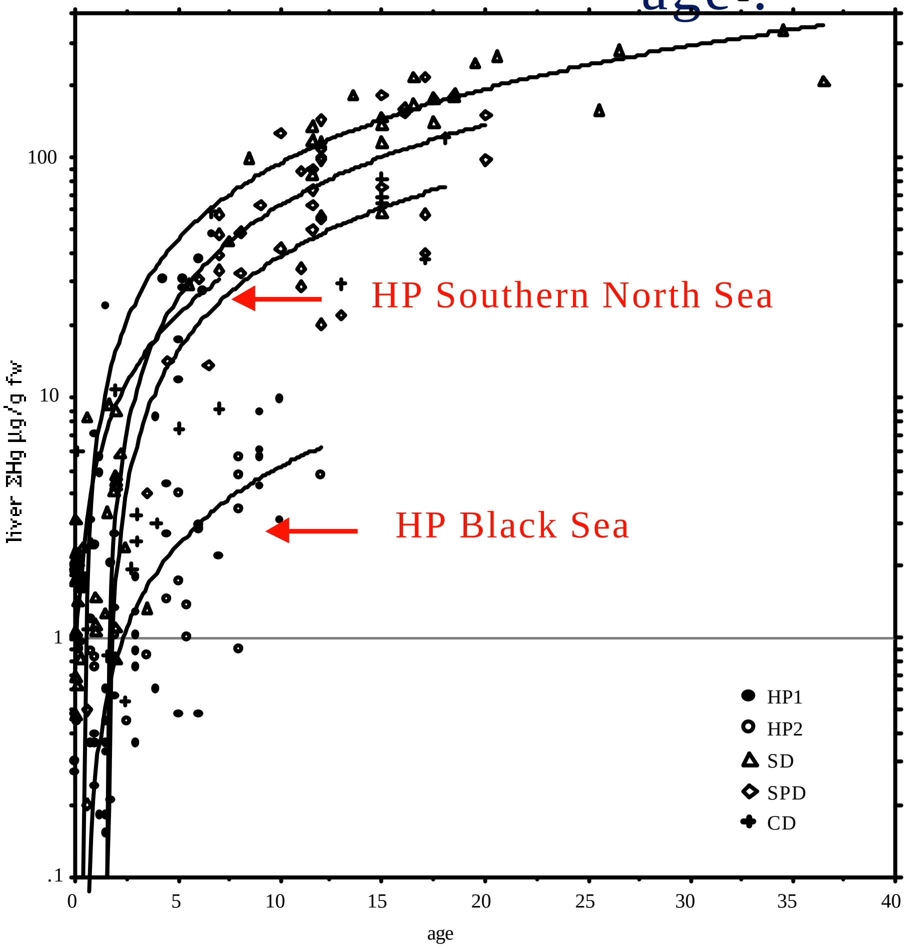
Fin whales infected by morbillivirus



Evidence of morbillivirus by immunohistochemistry observed in 2 out of 4 individuals

→ First description of morbillivirus among baleen whales

Hg species differences marine mammals: age !



Total Hg (µg/g fw) as a function of age in liver

* Harbour porpoise1 Southern North Sea

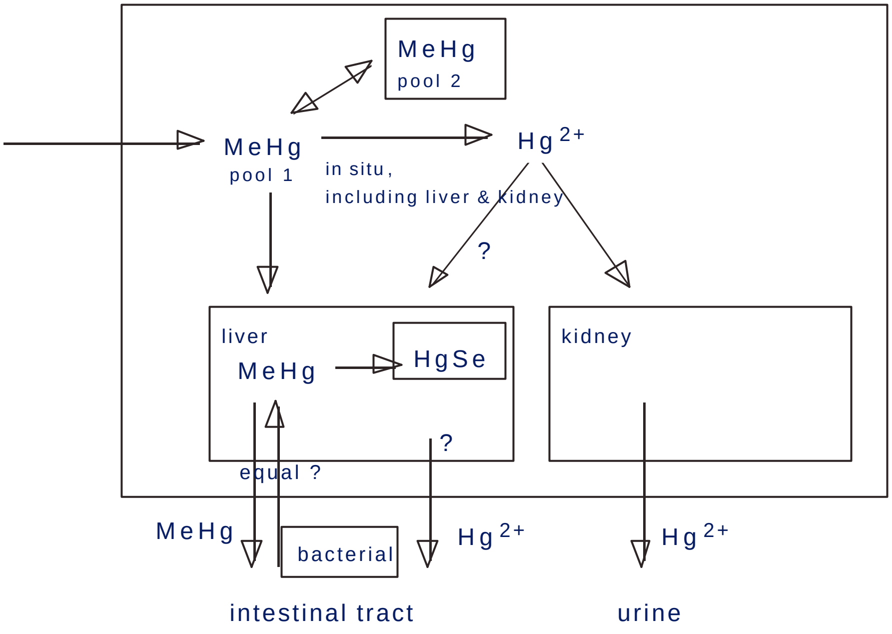
* Harbour porpoise 2 Black Sea

* SD striped dolphin NE Atlantic and partial after Itano *et al.* (1983a&b),

* SPD Pantropical spotted dolphin (André *et al.*, 1990) and

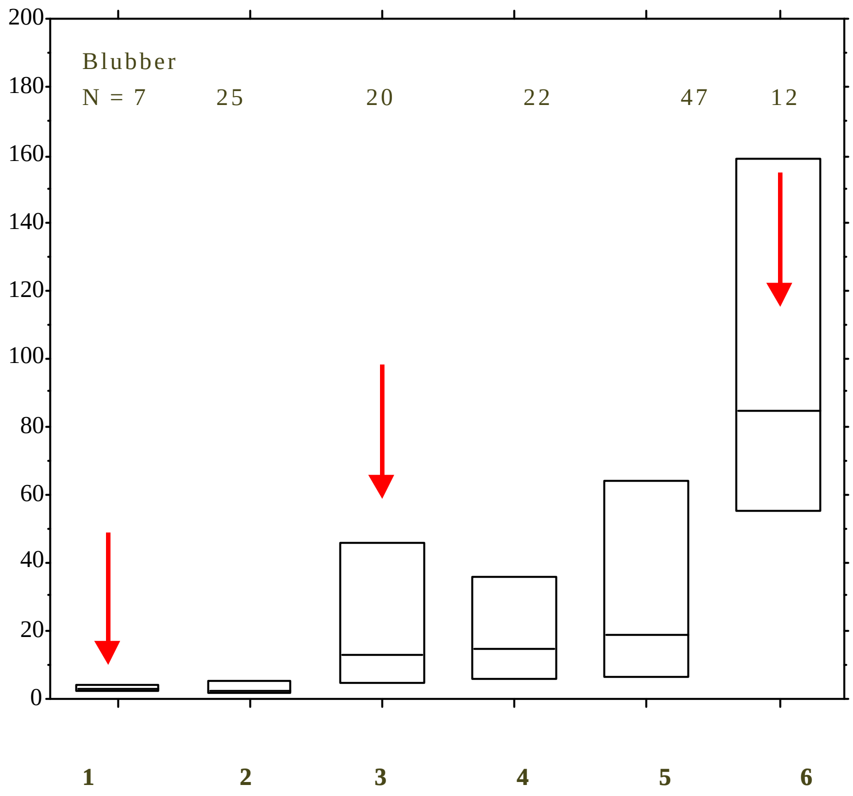
* CD common dolphin NE Atlantic and French Atlantic coast (Holsbeek *et al.*, 1998).

Uptake-excretion model II, three compartments and parent compound only



MeHg biological half-life: recalculated from 500/1000 days to 50 days
T1/2 50 days = T1/2 in man

PCBs in marine mammal blubber (µg/g fw): median, min-Max



Stenella
Mediterranean

Average
Male > 400
Female > 200

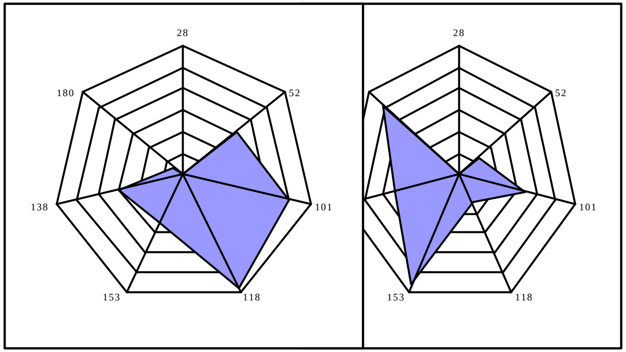
Aguilar & Borrell, 1994
Borrell et al., 1996

differences Ecosystem load diet & age

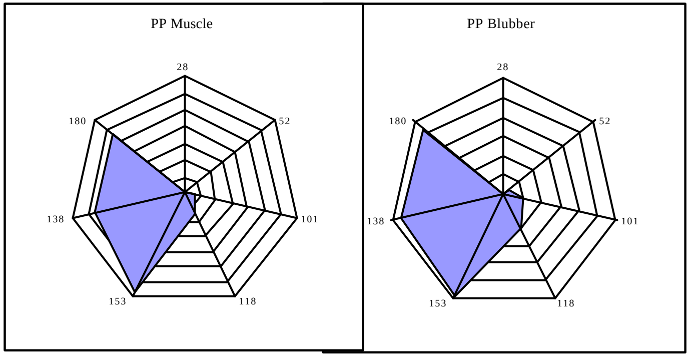
1 sperm whale S North Sea (DWTC)
2 harbour porpoise Black Sea (Holsbeek et al in prep)
3 harbour porpoise S North Sea (DWTC
4 harbour porpoise S North Sea (van Scheppingen, 1999)
5 harbour seal St. Lauren (Benke et al., 1999)
6 dolphins stranded S North Sea (DWTC)

PCB fingerprints

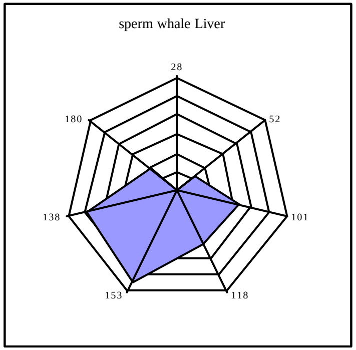
ICES7: CB 28,52,101,118,153,138,180



Aroclor 1254 1260



Harbour porpoise
blubbers and livers



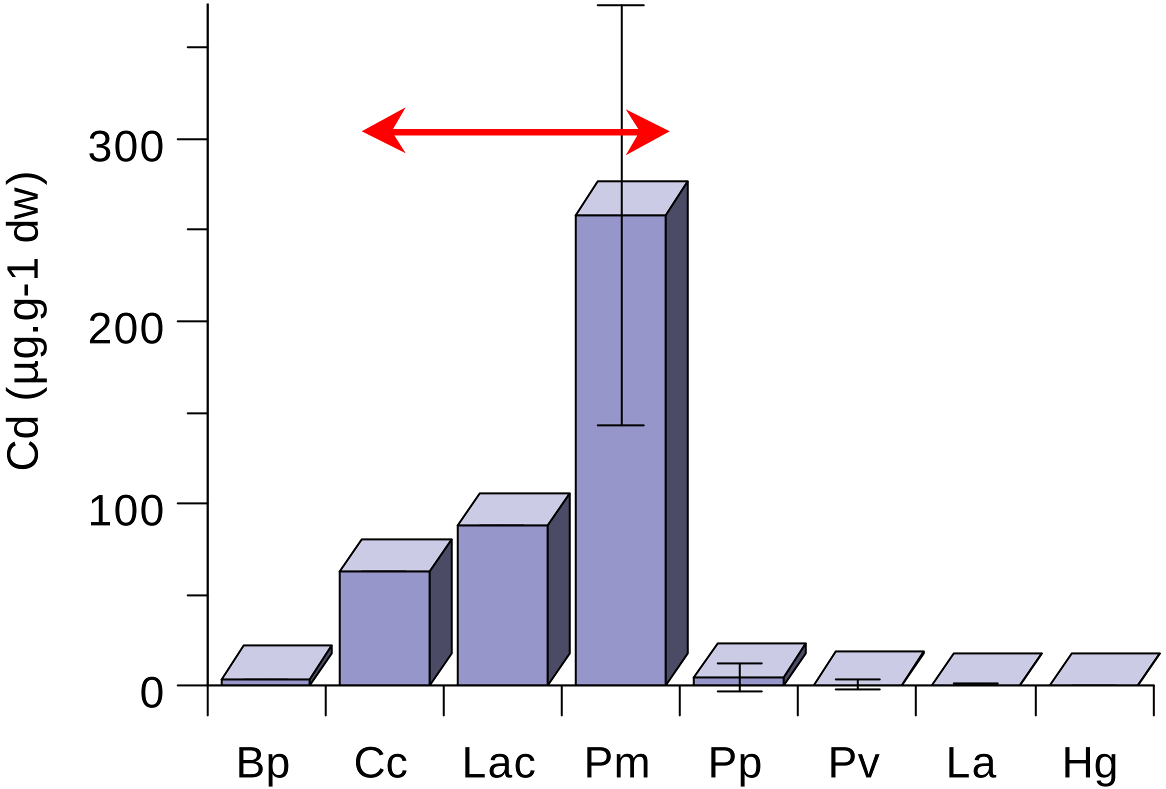
Sperm whale livers
different, ‘open ocean’ pattern
in none of the cases resemblence to Aroclors

Marine mammals collected along the Belgian and Northern French coastline since 1993

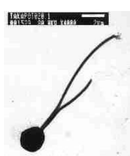
- 57 Harbour porpoises, *Phocoena phocoena* (Pp)
- 27 Harbour seals, *Phoca vitulina* (Pv)
- 8 Whitebeaked dolphins, *Lagenorhynchus albirostris* (La)
- 2 Whitesided dolphins, *Leucopterus acutus* (Lac)
- 7 Sperm whales, *Physeter macrocephalus* (Pm)
- 6 Grey seals, *Halichoerus grypus* (Hg)
- 1 Hooded seal, *Cystophora cristata* (Cc)

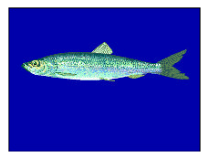
Interspecific variations

Renal Cd



C^{13} et N^{15}isotope=diet tracers

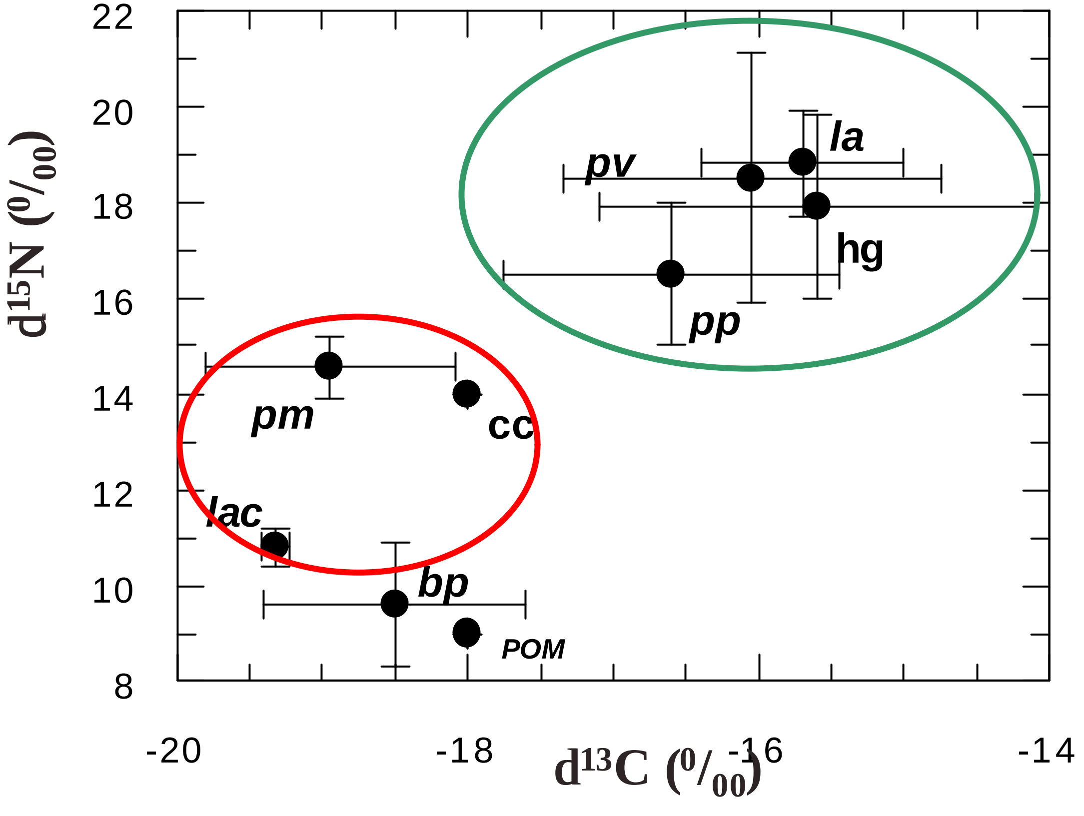




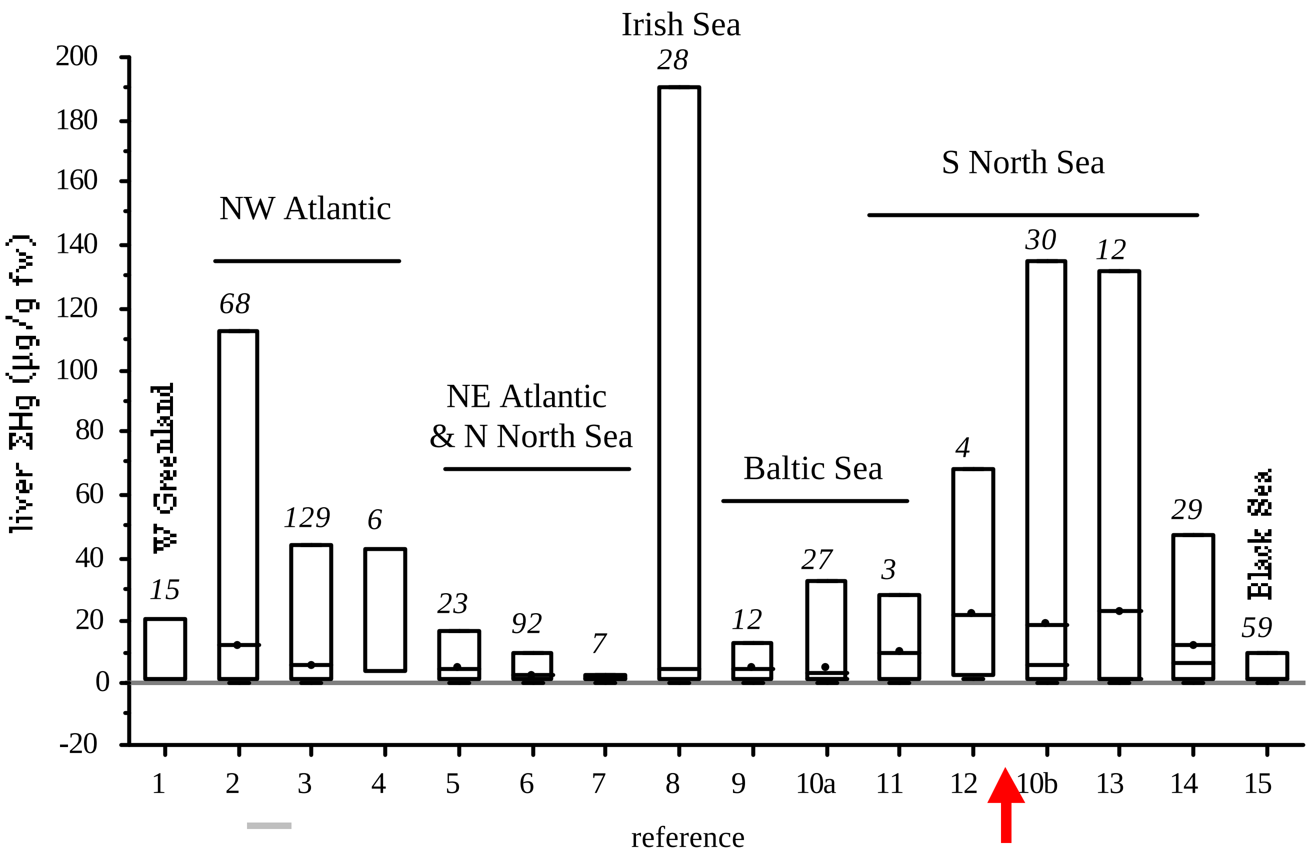
d^{13}C: +1$^{0}/_{00}$

d^{15}N: +3$^{0}/_{00}$

Trophic position of marine mammals



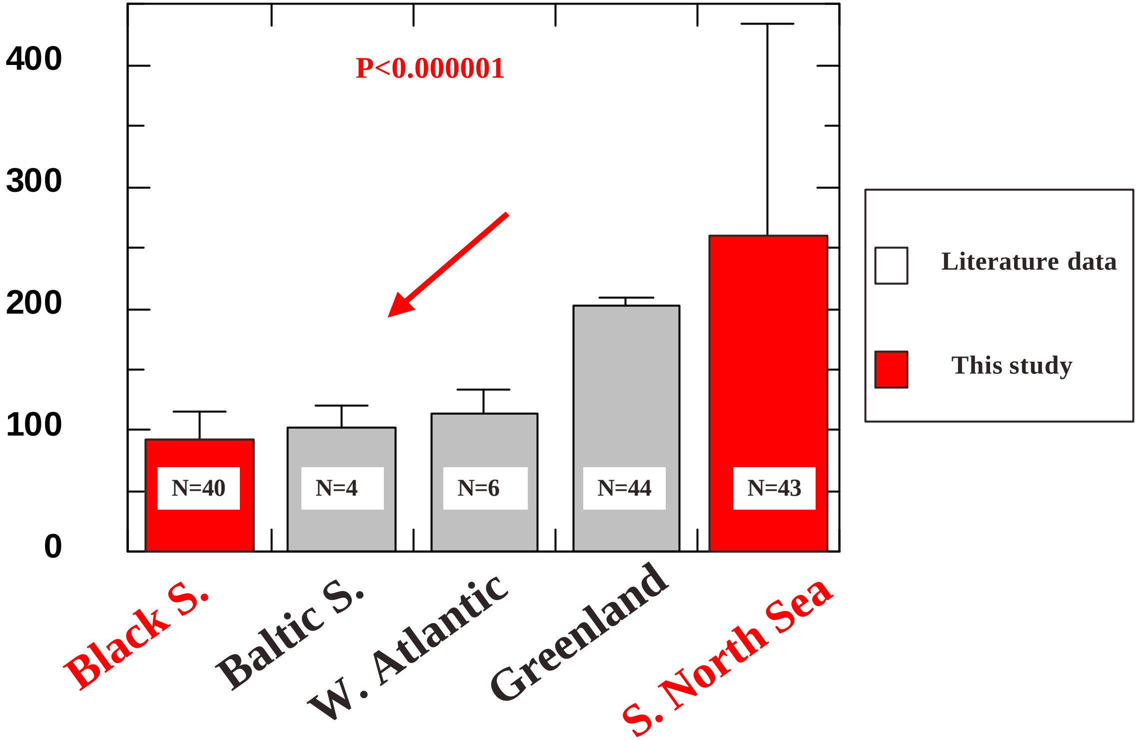
Hg Regional differences: Harbour porpoise



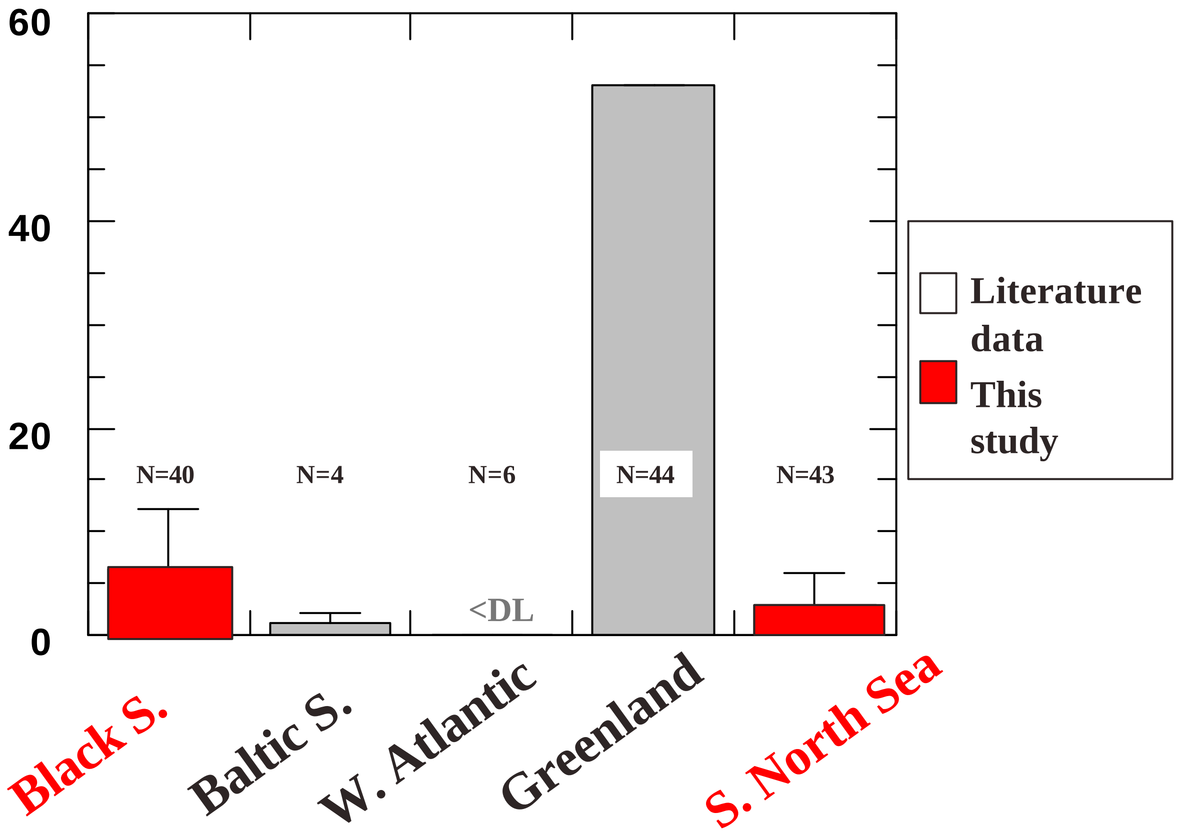
" Hg liver concentrations in harbour porpoise from different regions

Median (bar simple) values when available, average (bar with dot), minimum and maximum values

Mean Hepatic Zn (µg.g^{-1} dw) Concentration in Harbour Porpoises is High in the Southern North Sea



Mean Renal Cd ($\mu g.g^{-1}$ dw) Concentration in Harbour Porpoises is High in Greenland areas



North Sea porpoises have higher hepatic

- **Hg, Zn and Cu**

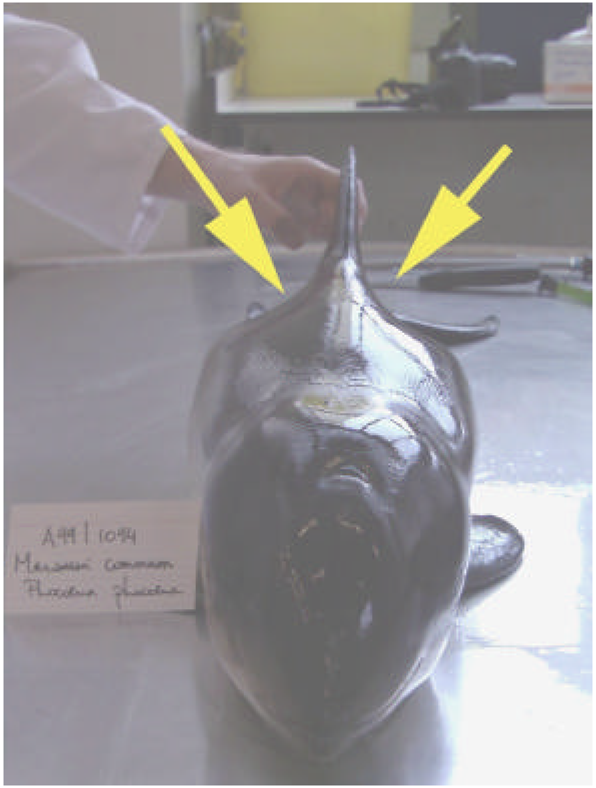
Compared to porpoises from the Black Sea

→

Anthropogenic inputs

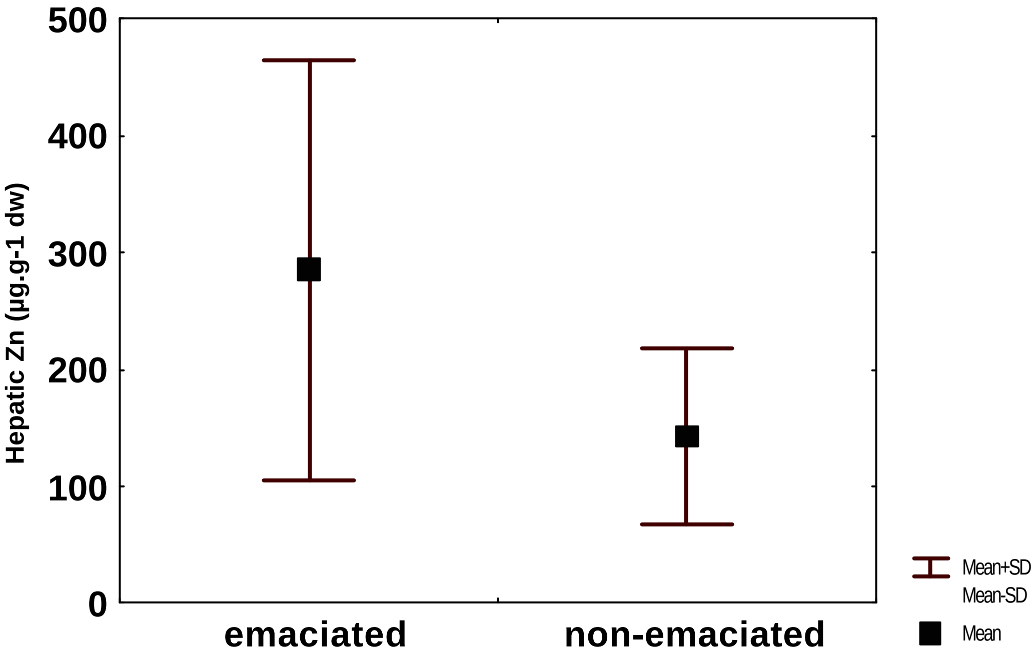
Oceanographic conditions

Emaciated porpoises

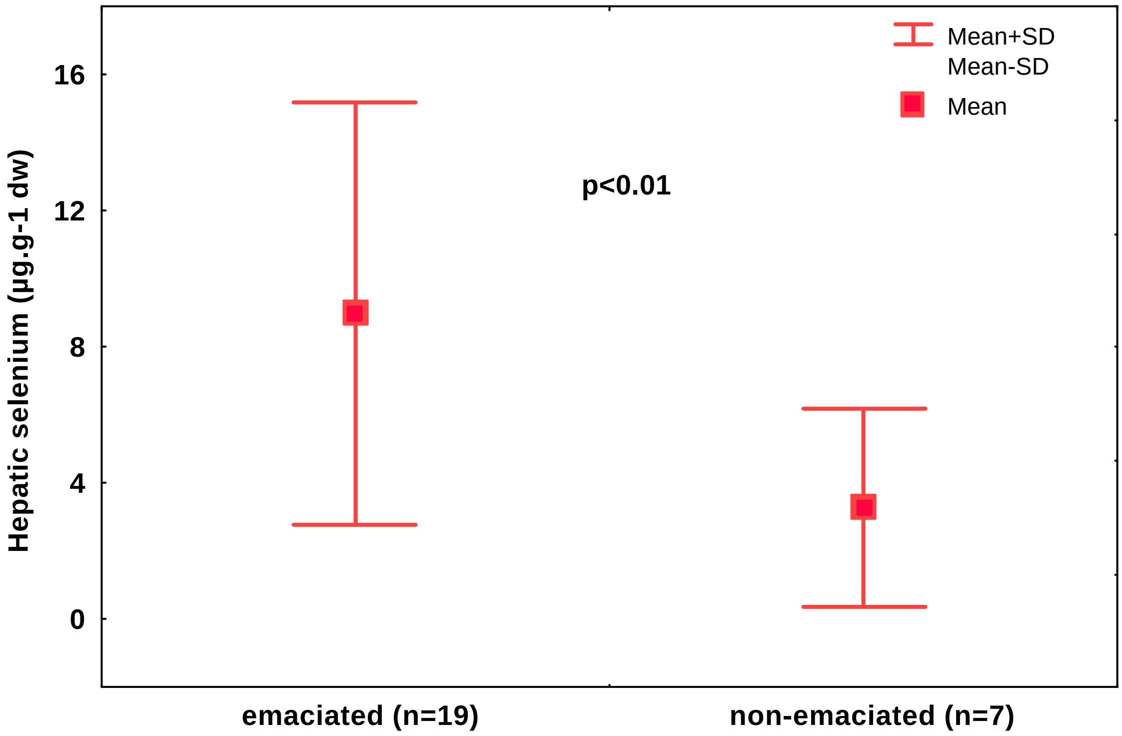


Non-Emaciated porpoises

Hepatic zinc concentrations are higher in emaciated juveniles compared to non-emaciated juveniles



Hepatic selenium concentrations are higher in emaciated juveniles compared to non-emaciated juvenile



Question:

- *High metal levels lead to emaciation?*
- *Emaciation disrupts metal homeostasy and lead to high concentrations?*

Hypothesis

- ***Food deprivation without contamination***

Rat :

- ↗ Zn and MTs

- Loss of liver and body mass

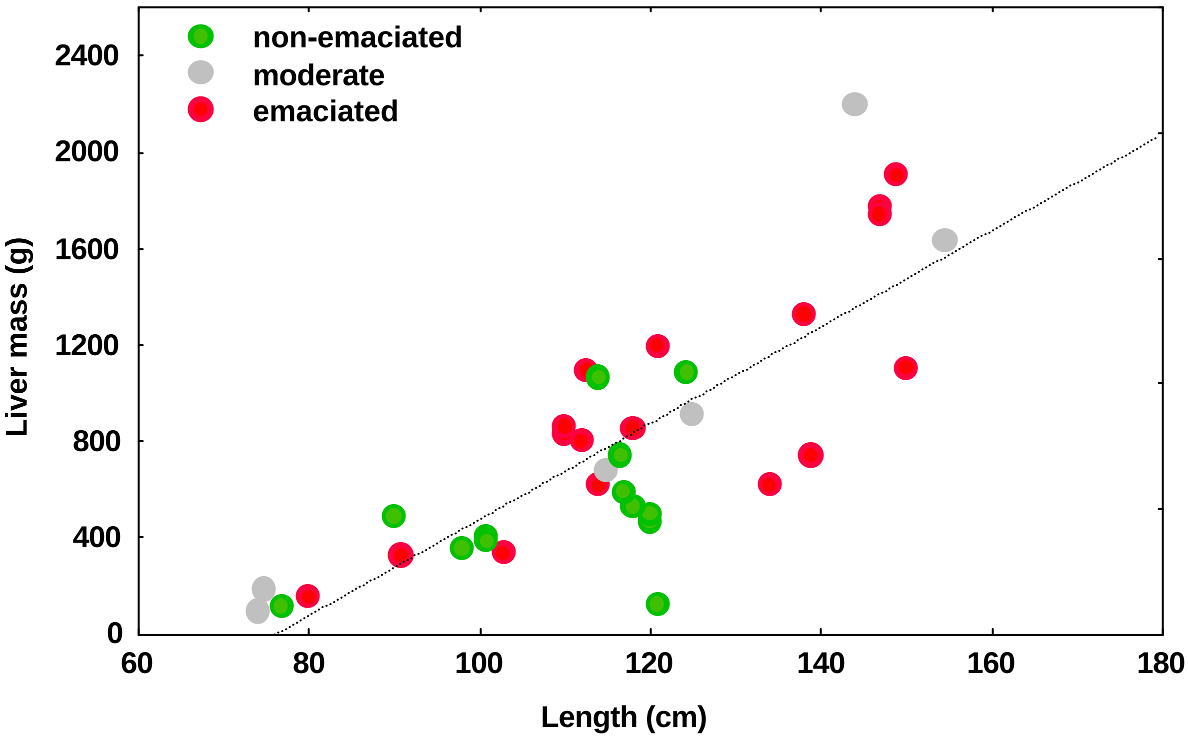
- ***<u>Zinc contamination via the diet</u>***

Rat or ferret:

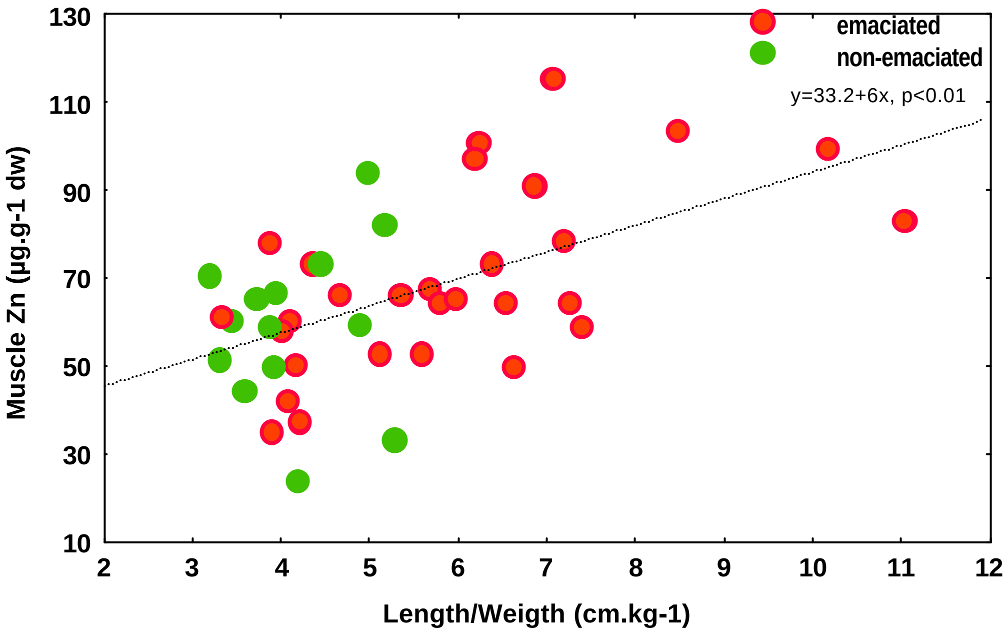
- Loss of body mass

- Homeostasy and physiological problems

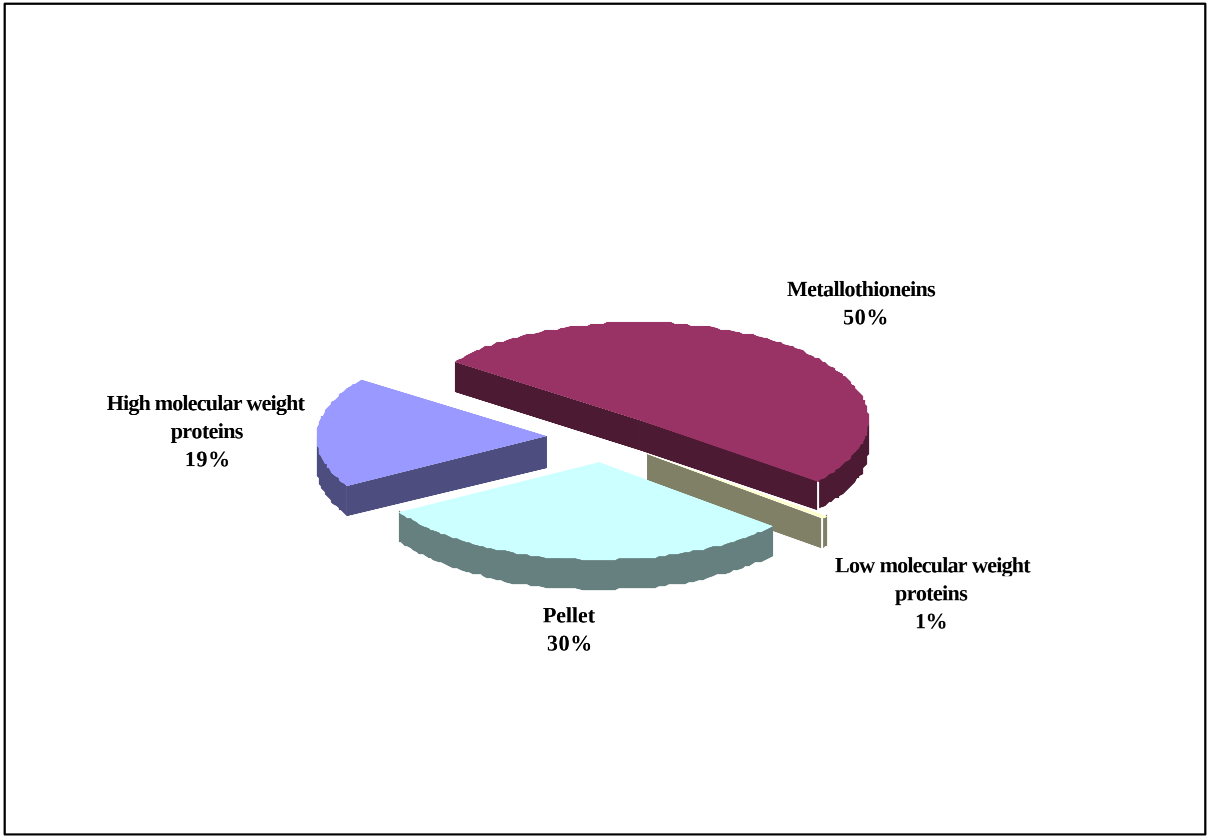
No loss of liver mass due to emaciation



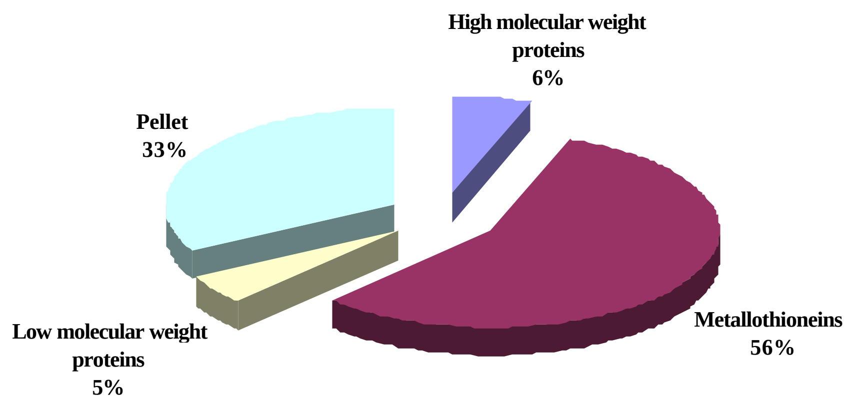
Relationship between the length/weight ratio and zinc in muscles



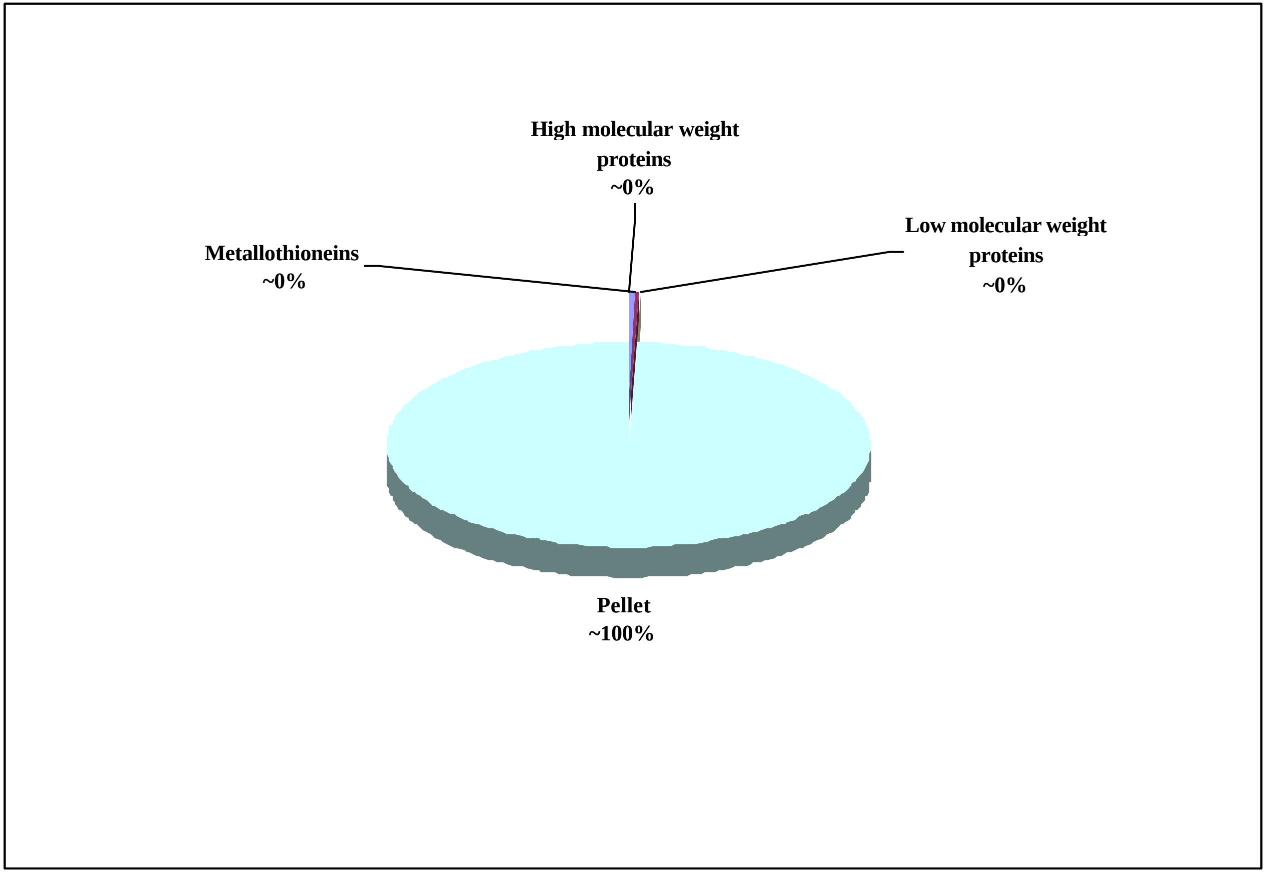
Zinc distribution in the porpoise livers



Cadmium distribution in porpoise kidneys



Mercury distribution in porpoise livers

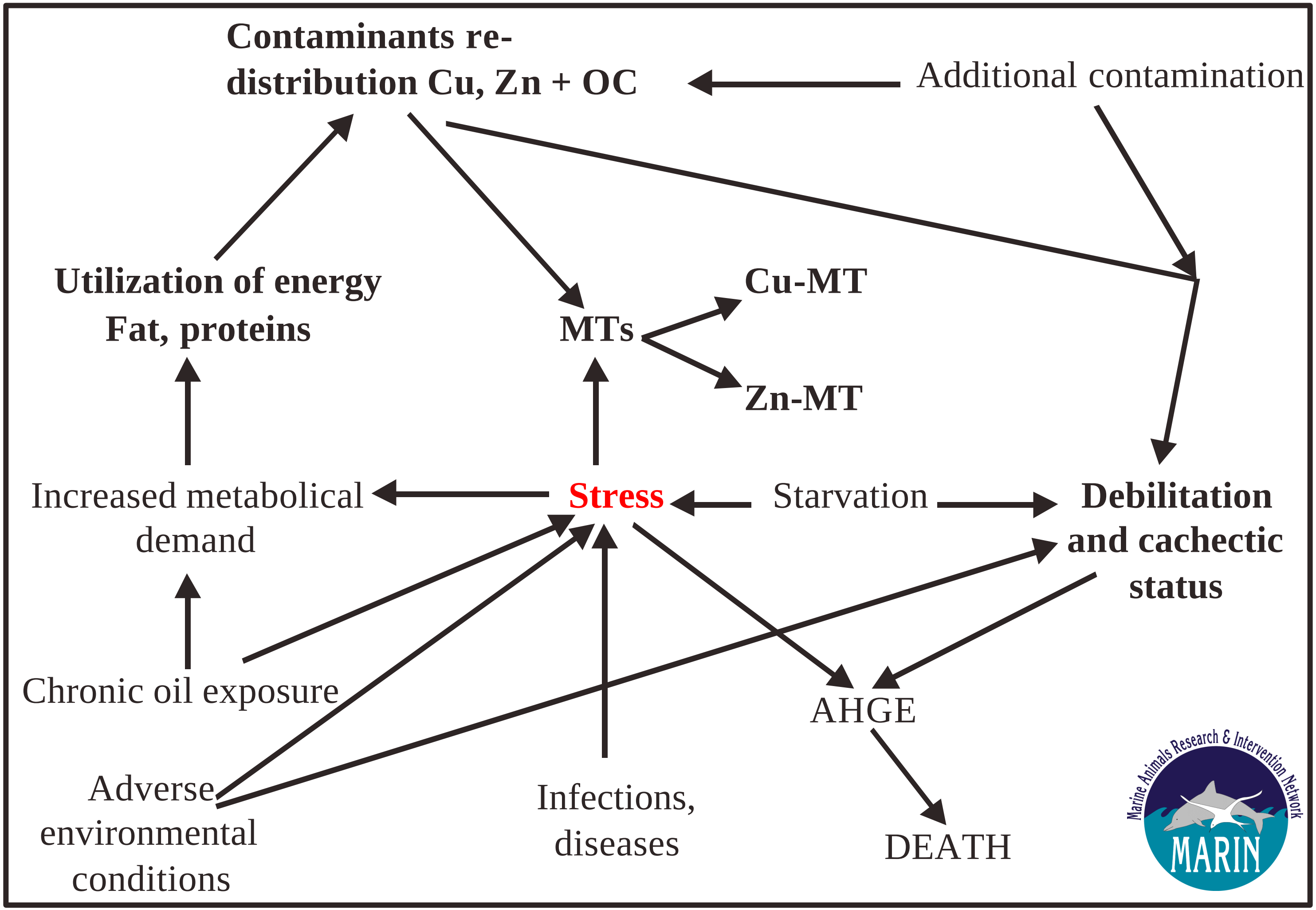


Metallothionein function in North Sea harbour porpoises

- *Variation in MTs concentrations*
- *Zinc and Copper homeostasy*
- *Detoxication of hepatic and renal cadmium*
- *Weak involvment in Hg detoxication*

Preliminary Conclusions

- *High Zn, Cu,and Hg concentrations are found in S.North Sea porpoises*
- *Juvenile emaciated porpoises can display high Zn and Se concentrations*
- *MTs appear to have a key role in Zn and Cu homeostasy and Cd detoxication*
- *Health Status of North Sea harbour porpoises?*


Contaminants re-distribution Cu, Zn + OC
Additional contamination
Utilization of energy
Fat, proteins
MTs
Cu-MT
Zn-MT
Increased metabolical demand
Stress
Starvation
Debilitation and cachectic status
Chronic oil exposure
AHGE
Adverse environmental conditions
Infections, diseases
DEATH
Marine Animals Research & Intervention Network
MARIN

EUROPEAN CETACEAN SOCIETY

LIEGE APRIL 2002

The University of Liege will host the 16th annual conference of the European Cetacean Society

Marine mammal health : from individuals to populations

Who: Laboratory of Oceanology and Department of Veterinary Pathology

Where: Amphithéâtres de l'Europe and Veterinary Faculty

When: 7-11th April 2002