A COMPARATIVE STUDY ON 137 Cs UPTAKE FOR TWO CULTURED FRESH WATER FISH: CARP AND EEL

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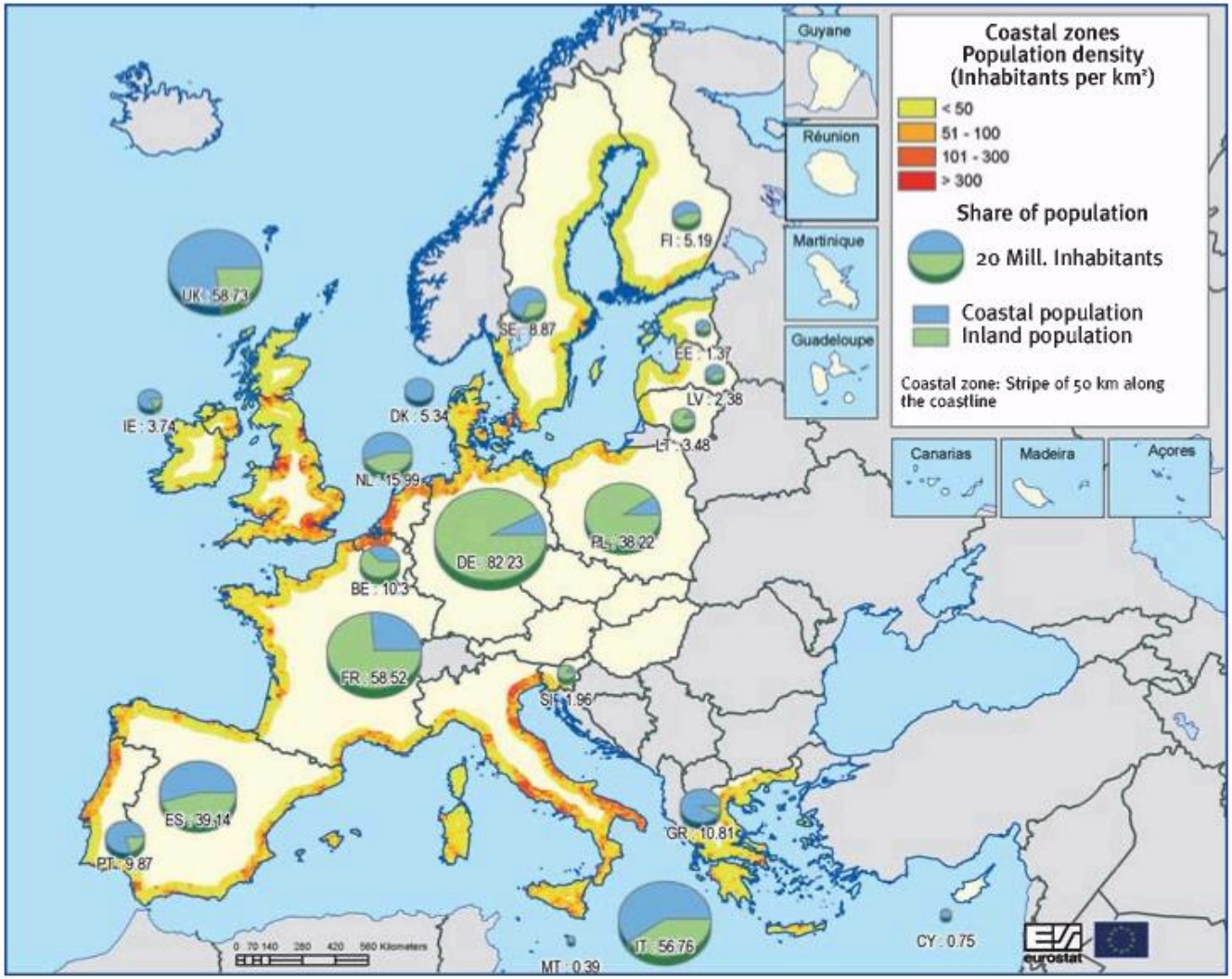
INTRODUCTION TO THE EU MARINE POLLUTION

The European Union has a coastline of 68.000 km - that is over 3 times longer than that of the US and almost 2 times that of Russia.

No European resident lives more than 700 km away from the coast.

Almost half of the Union's population lives less than 50 km from the sea, although the population is concentrated in urban areas along the coast.



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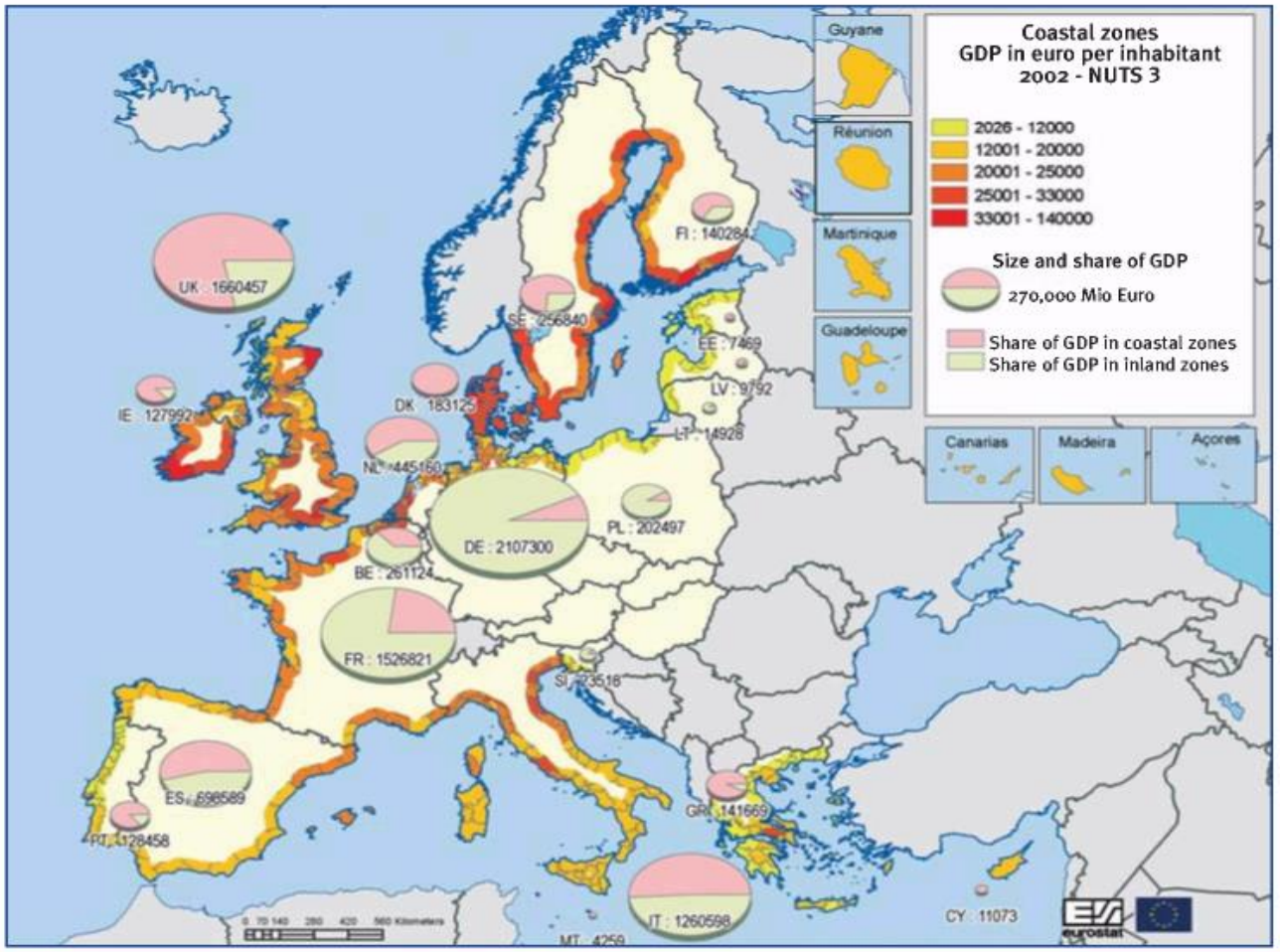
2. THE MARITIME ECONOMY

- Between 3 and 5 % of Europe's Gross Domestic Product (GDP) is estimated to be generated from sea-related industries and services, without including the value of raw materials, such as oil, fish or gas.

- Almost 90 % of the EU's external trade and over 40 % of its internal trade are transported by sea.
- Europe's leadership in shipping is beyond any doubt with 40 % of the world fleet.

- Aquaculture accounts for 19 % of the Union's total fisheries production. By 2030, aquaculture will provide more than half of the fish consumed worldwide.



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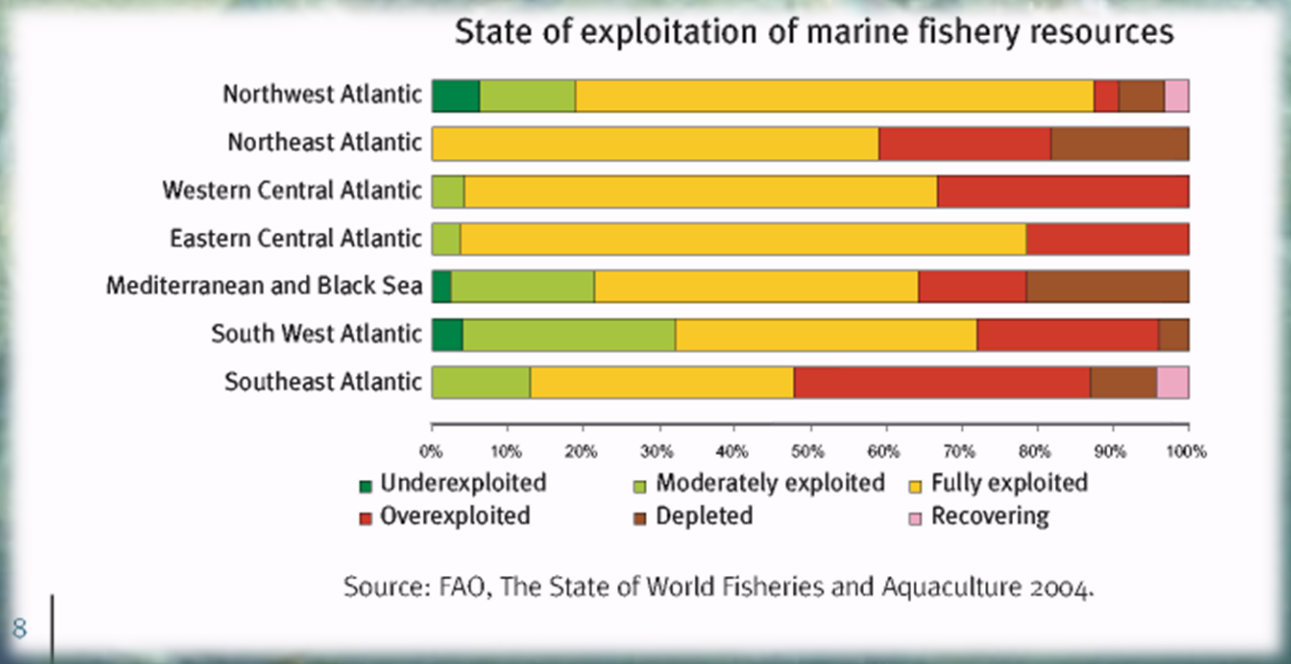
3. THE MARINE ENVIRONMENT

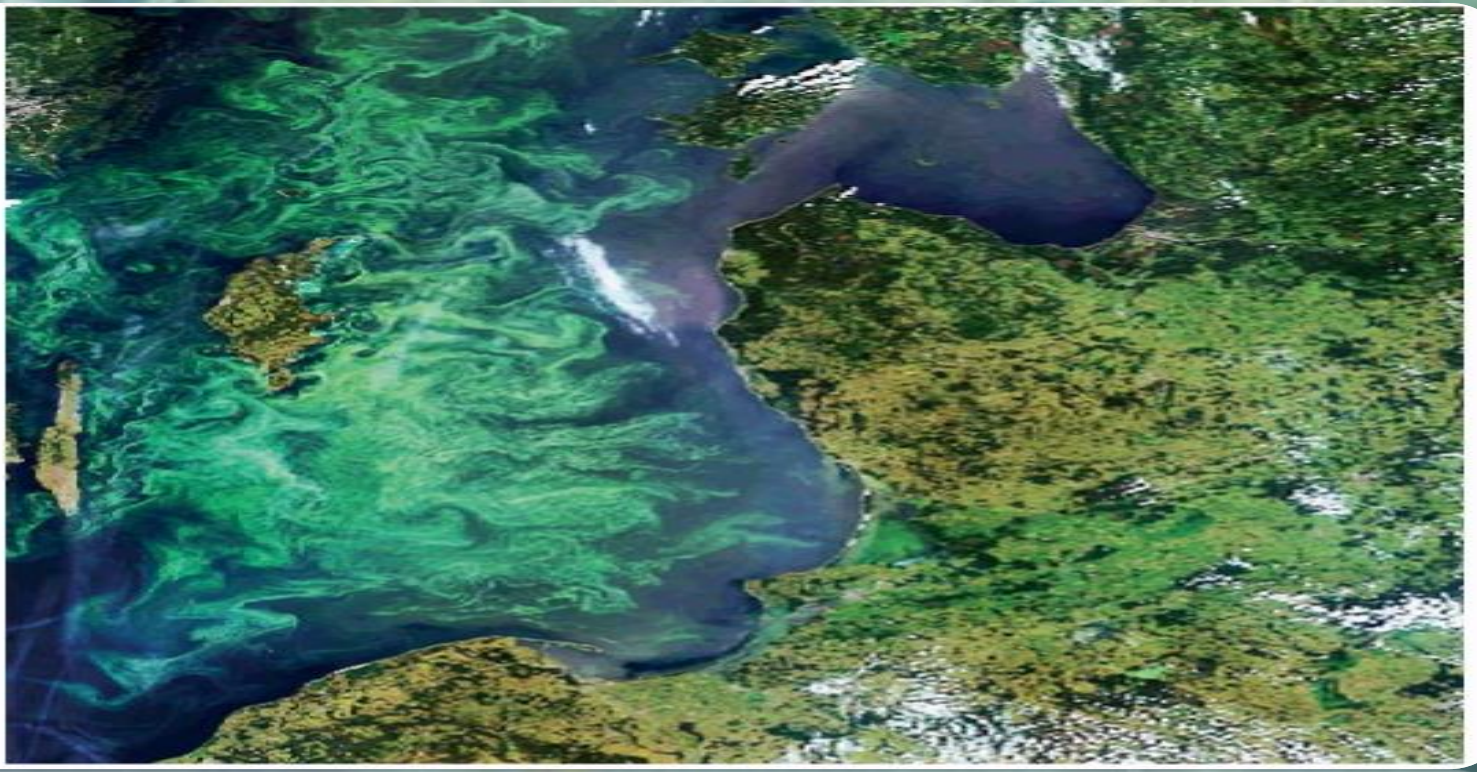
- Over 70 % of the Earth's surface is covered in water, with an estimated volume of around 1.360.000.000 cubic kilometers. Over 97 % of all water is found in oceans.
- As a result of global climate change, mean sea level will rise between 9 cm and 88 cm by 2100 as compared to 2000.
- Half of Europe's wetlands are expected to disappear by 2020.

- On the basis of the latest scientific assessments made by the International Council for the Exploration of the Sea (ICES), Community fish stocks are being fished at between two to five times more than the level that would provide the maximum sustainable yield from those stocks.



Source: FAO, The State of World Fisheries and Aquaculture 2004.

- In 2003 there were 4 116 registered Marine Protected Areas (MPAs) covering over 1.6 million square kms all over the world. This represents less than 0.5 % of the seas and oceans.
- A deterioration of the marine environment is leading to widespread algal blooms in the Baltic.



Satellite Picture of Algal Bloom in the Baltic-June 2005

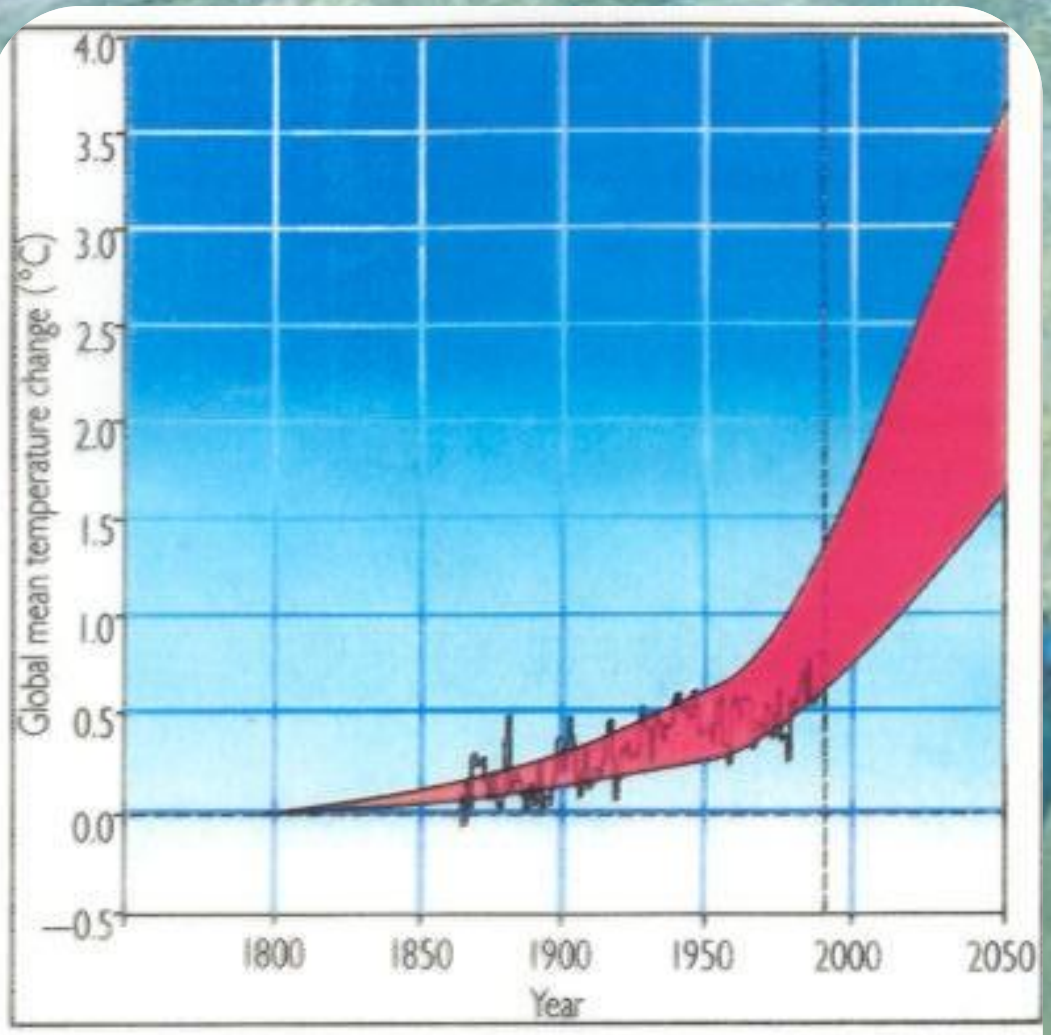
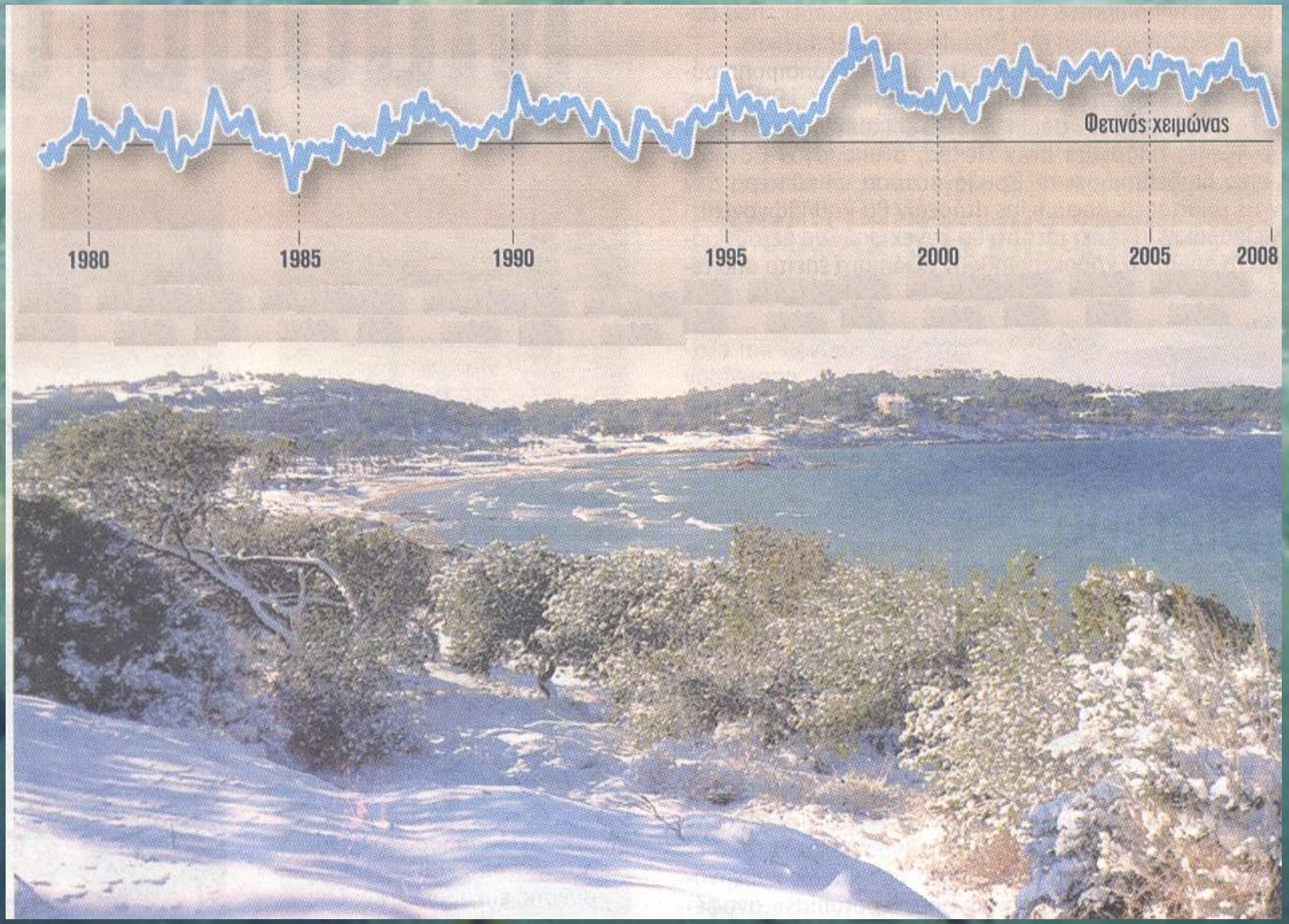


Figure 1: *Observed and predicted temperature change*

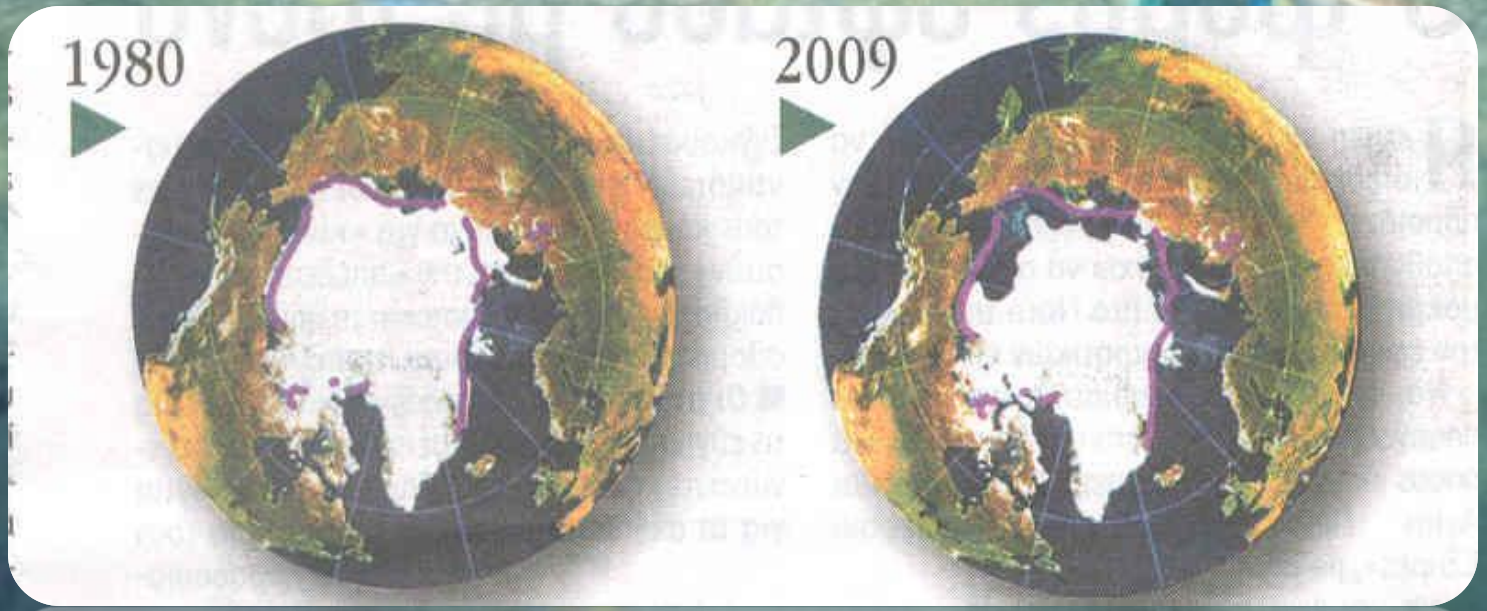
Footnote: *We expect global temperature in the future to lie within the coloured band. So far observation (the jagged line) and predictions have spread fairly well*

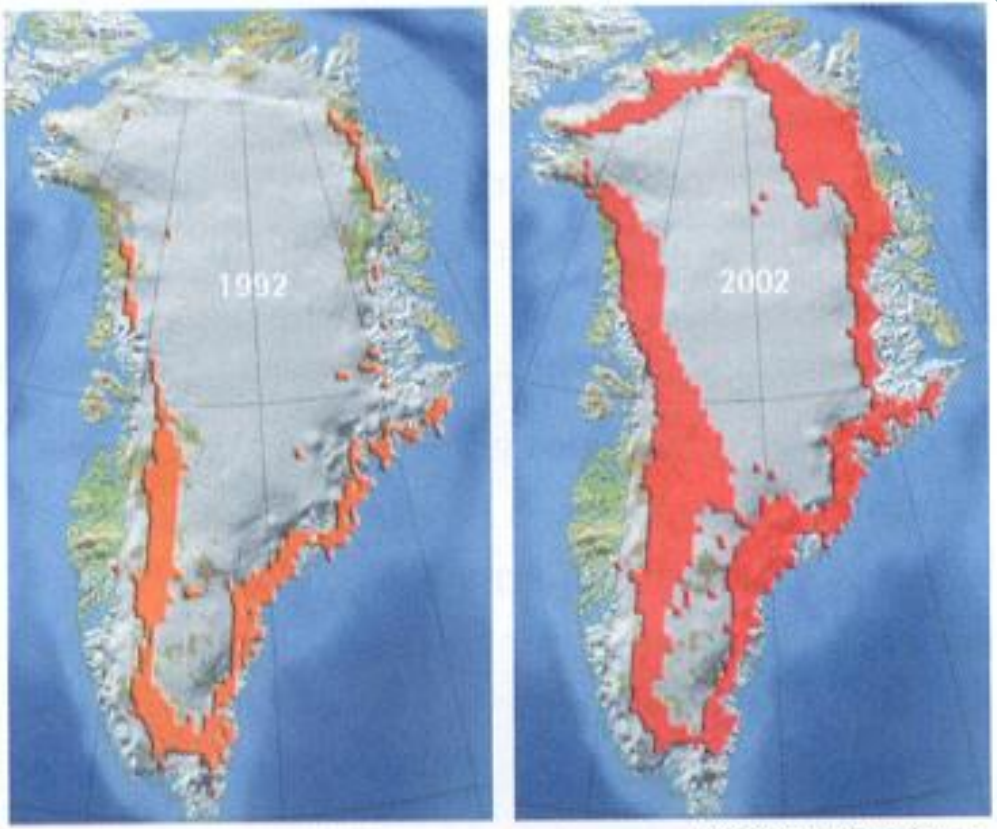
Monthly Global temperature abnormality



The ice in Arctic is reduced

According to NASA the arctic ice lost more than 18 million thickness per year during 2004-2008 and the total area has been reduced by 42%

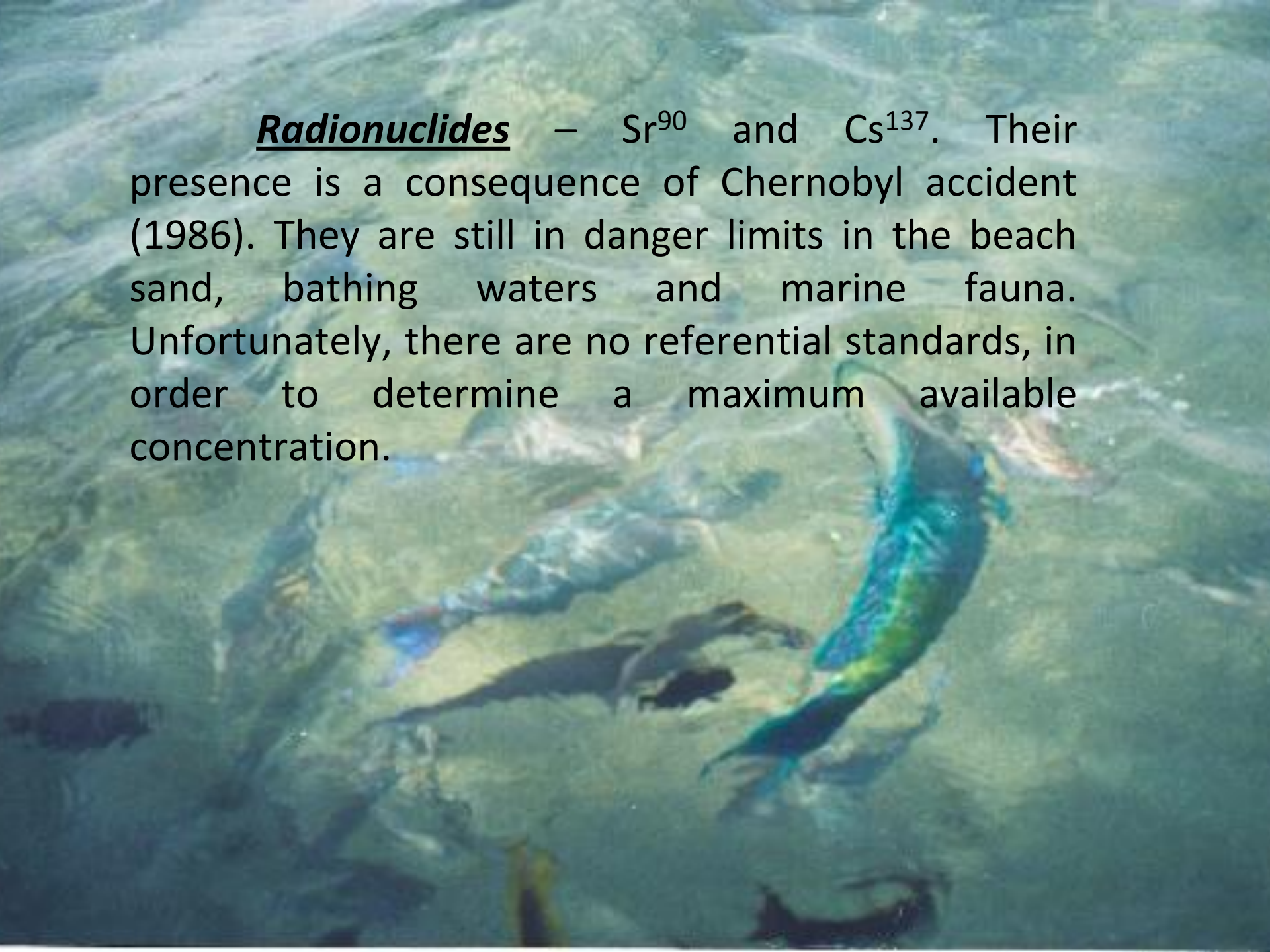




Satellite images, available since 1979, have shown an increasing trend in seasonal surface melt extension of the Greenland Ice Sheet at the height of summer.


KEY:
Landmass 2100
Desert Areas 2100
Landmass Today
Land Lost to the Sea 2100
Is this how the world will look in 2100?


Alaska
24/03/1989
"Exxon Valdez"
40.000 t. arg.
Griland
21/01/1960
Drop of American
B52 with four
bombs of ploutonium
Irland
08/01/1979
"Bentegeuse"
40.000 t. arg.
Britain
18/03/1967
"Torrey Canyon"
121.000 t. arg
15/02/1996
"Sea Empress"
70.000 t. arg.
12/01/1993
"Braer"
85.000 t. arg.
Magxi
10.000 t.
radioactives wastes
Norway
07/04/1989
"Komsomolets"
Soviet Nuclear
submarine
Sweden
20/03/1970
"Othello"
60.000-100.000
t. arg.
Mourmansk
Dissolution of
old Soviet
nuclear
submarines
Sea kara
Nuclear reactor
of Soviet
iceboat "Lenin"
Kamstatka
06/1983
Unknown
Soviet
submarine
with nuclear
arms
Black Sea
09/1974
Soviet martial boat
with nuclear
arms
Italy
10/01/1970
Unknown Soviet
submarine
11/04/1991
"Haven"
144.000 t. arg.
Hawai
11/04/1968
Unknown Soviet
nuclear submarin
Pacific
Depletion of nuclear
waste outside from
the coasts of California
Cape Kod
10/04/1963
American submarine
SSN593 with nuclear arms
Vermoudes
4/010/1986
Unknown soviet
submarine with
nuclear arms
Trinidad &
Tobago
19/07/1979
"Altantic Empress"
"Aegean Captain"
287.000 t. arg
Atlantic
13 regions
with radioactives
Azores
21/05/1968
American submarine
SSN589 with nuclear
Maroco
19/12/1989
"Khank-5"
70.000 t. arg.
Spain
12/05/1976
"Urqiola"
100.000 t. arg.
31/12/1978
"Andros Patria"
60.000 t. arg.
03/12/1992
"Aegean Sea"
70.000 t. arg.
"Prestige"
64.000 t. firings
France
12/12/1999
"Erika"
31.000 t. petrolium
21/01/2006
"Ece"
10.000 t.
phosphorics
Persian Bay
19/12/1972
"Sea Star"
100.000 t.
arg.
India
Dissolution of boats
without precautions
South Africa
21/09/1972
"Texanita"
"Oswego Guardian"
100.000 t. arg.
05/08/1983
"Castillo de Belver"
255.000 t. arg.
Baglantes
Dissolution of boats
without
precautions
Malakka
07/06/1975
"Showa Maru"
237.000 t. arg.
Figi
11/04/1970
Nuclear reacto
from the famous
"Apollon 13"
Nuclear
Pollution
Pollution
of petroleum
other
pollut



Radionuclides – Sr^{90} and Cs^{137}. Their presence is a consequence of Chernobyl accident (1986). They are still in danger limits in the beach sand, bathing waters and marine fauna. Unfortunately, there are no referential standards, in order to determine a maximum available concentration.

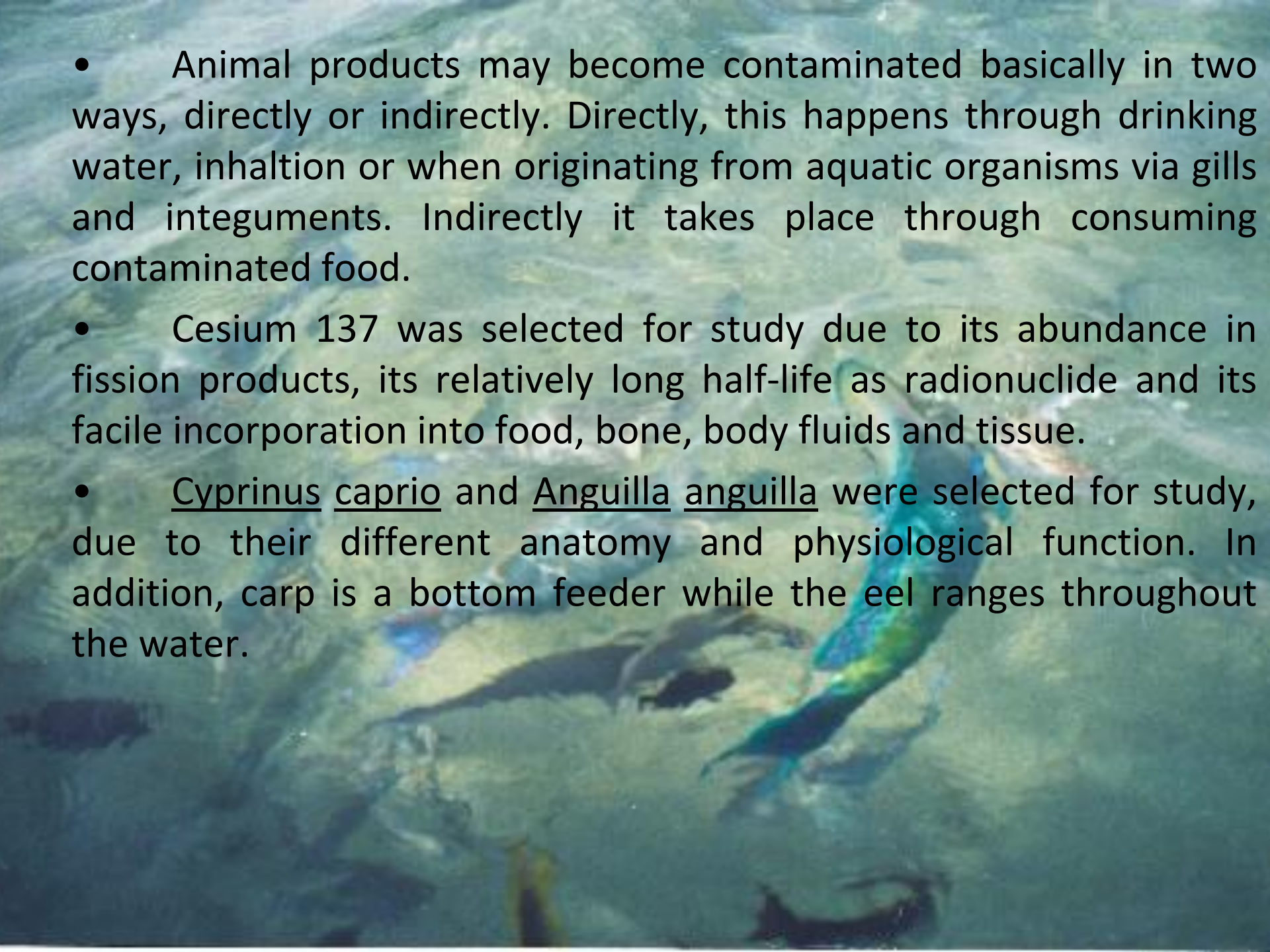
THE RADIOACTIVITY IMPACT TO FISH

1. INTRODUCTION

• Comparative studies were carried out in two cultured fresh-water fish, Cyprinus caprio and Anguilla anguilla, to determine their tolerance in the uptake of ^{137}Cs (3000 Bq/l).

• The histological studies were concentrated in muscular tissues livers, kidneys and gills. The symptoms observed include hyperemia, hydropsy, anaemia and degeneration of liver and kidney tissues.

• Food is a major route by which environmental radiocontaminants reach man. Even with strict controls and containment, releases of radioactive fission products from nuclear power plants are likely to occur.



- Animal products may become contaminated basically in two ways, directly or indirectly. Directly, this happens through drinking water, inhaltion or when originating from aquatic organisms via gills and integuments. Indirectly it takes place through consuming contaminated food.
- Cesium 137 was selected for study due to its abundance in fission products, its relatively long half-life as radionuclide and its facile incorporation into food, bone, body fluids and tissue.
- Cyprinus caprio and Anguilla anguilla were selected for study, due to their different anatomy and physiological function. In addition, carp is a bottom feeder while the eel ranges throughout the water.

2. MATERIALS AND METHODS

- The experiment was conducted in fresh-water fish A.-anguilla and C.caprio cultured in small water tanks artificially contaminated with radioactive ^{137}Cs. The fish A.-anguilla were collected from artificial ponds two days before the experiment started. The fish C.caprio were collected from a local lake. They were kept in a 200L tap water dechlorinated by active carbon. The fish acclimatized well to the aquarium conditions, behave well and no diseases occurred. The dimensions of the water tanks used were 79cm in length, 35cm in width, 50cm in height.
- The fish were sacrificed every one or two weeks, weighed, their length was measured, and the overall conditions of the fish were compared with the control.

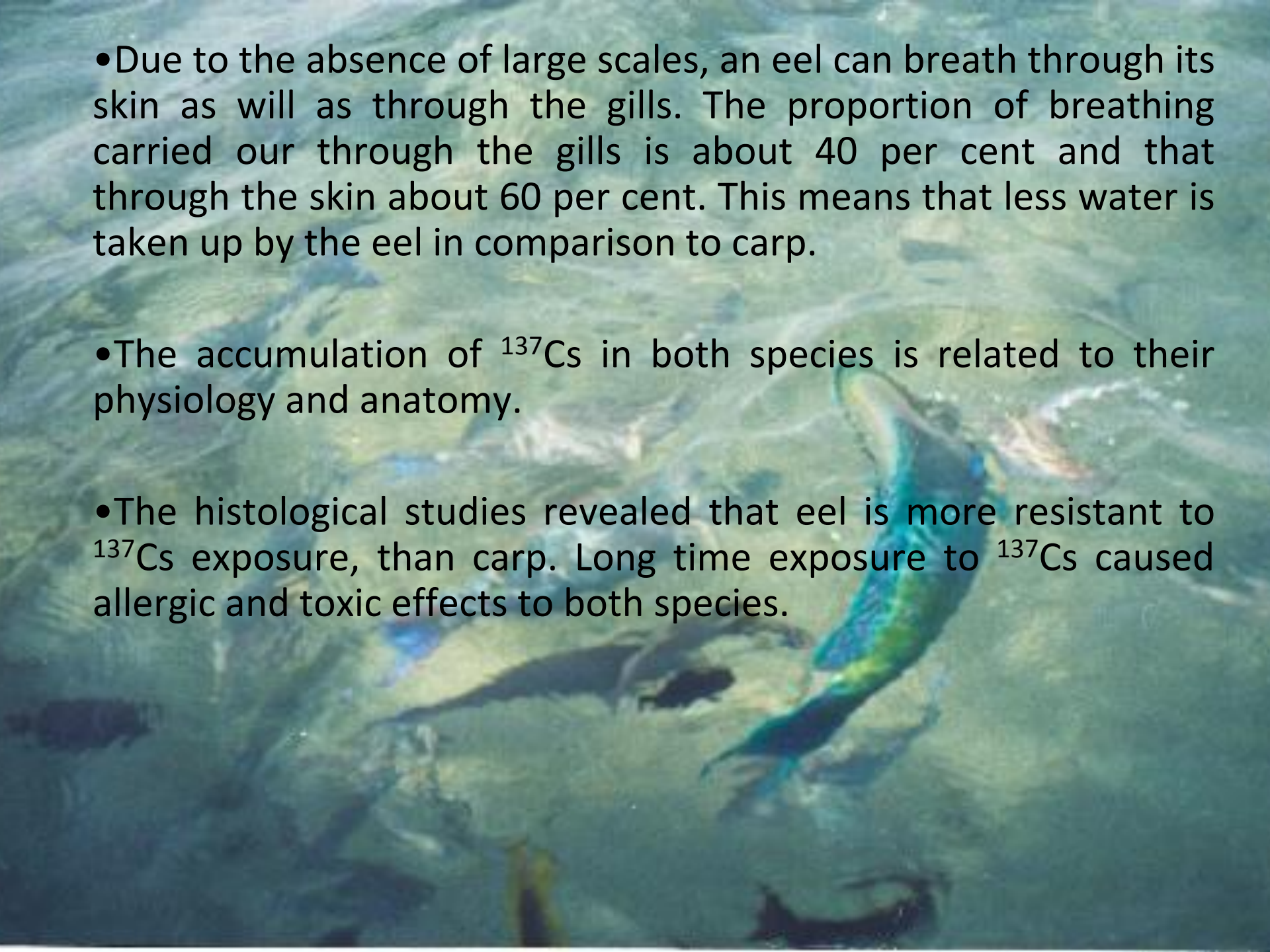
3. RESULTS AN DISCUSSION

• The results indicated that the amount of ^{137}Cs was more in the muscular tissues of carp than the eel.

TABLE 1:

Uptake of 137Cs in cultured fresh water fish: Cyprinus caprio and Anguilla anguilla

Time of killing days	Concentration of ^{137}Cs (Bq/Kg) in muscular tissue		
	Carp		Eel
	(1500 Bq/1)	3000 Bq/1)	(3000 Bq/1)
15	980	1.150	1.170
30	2.980	6.437	1.000
45	3.550	8.023	2.500
60	-	10.460	4.000
90	4.985	12.141	4.400
120	10.850	18.959	4.900

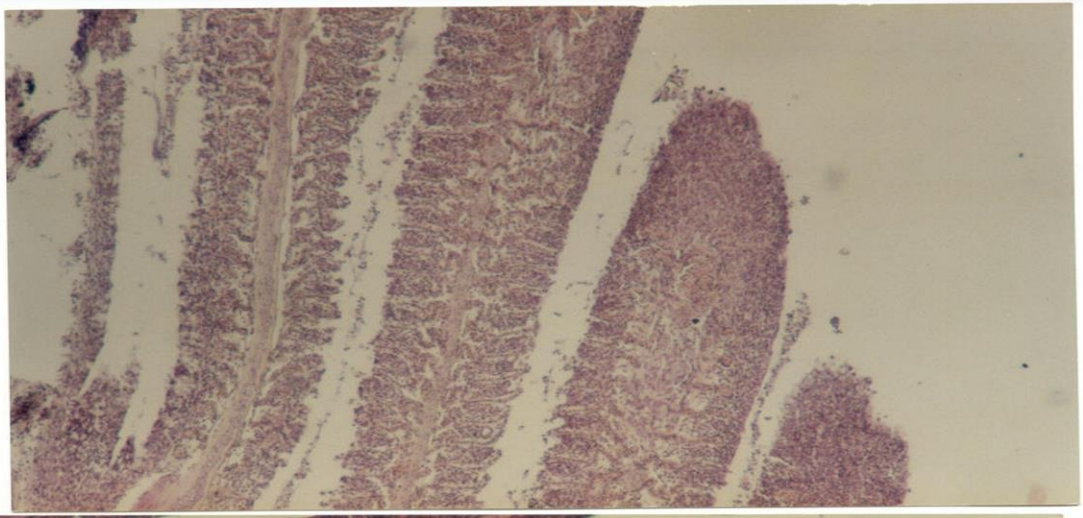


- Due to the absence of large scales, an eel can breath through its skin as will as through the gills. The proportion of breathing carried our through the gills is about 40 per cent and that through the skin about 60 per cent. This means that less water is taken up by the eel in comparison to carp.

- The accumulation of ^{137}Cs in both species is related to their physiology and anatomy.

- The histological studies revealed that eel is more resistant to ^{137}Cs exposure, than carp. Long time exposure to ^{137}Cs caused allergic and toxic effects to both species.

A.



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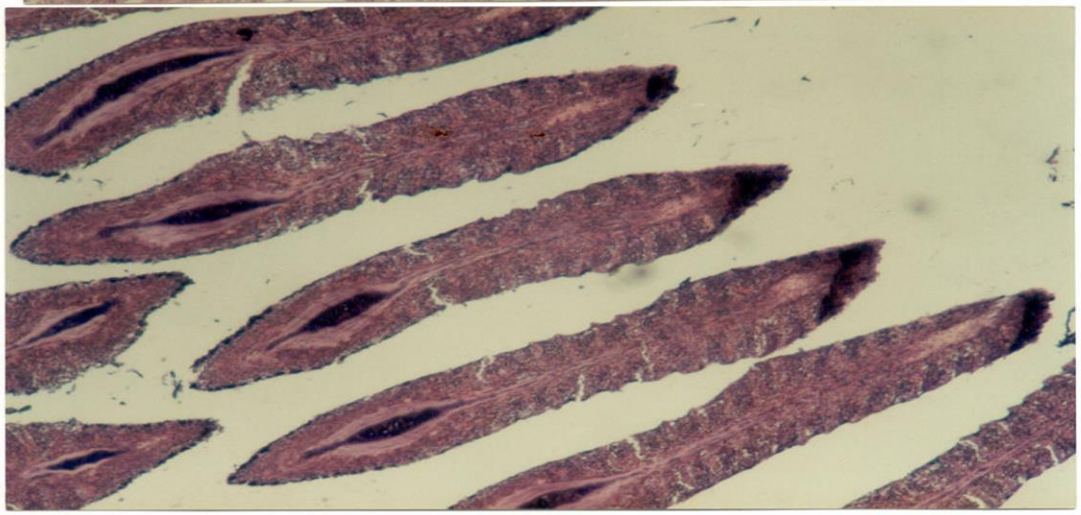
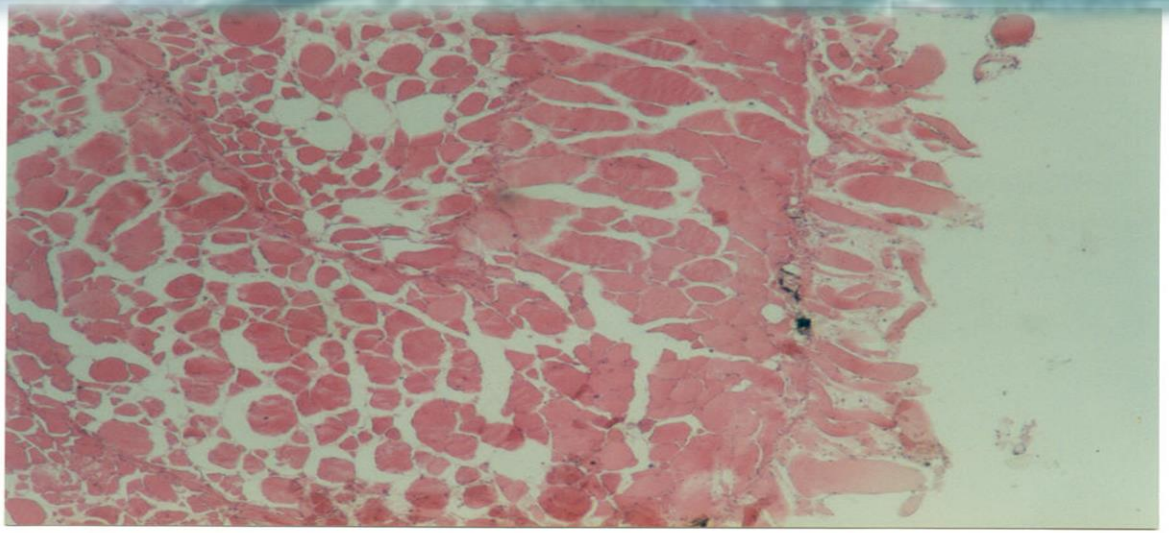


Fig.1. Remarkable epithelial hyperplasia and fusion of some secondary lamellae in the gills. Final stage. A. Carp (x250). B. Eel (x100).

A.



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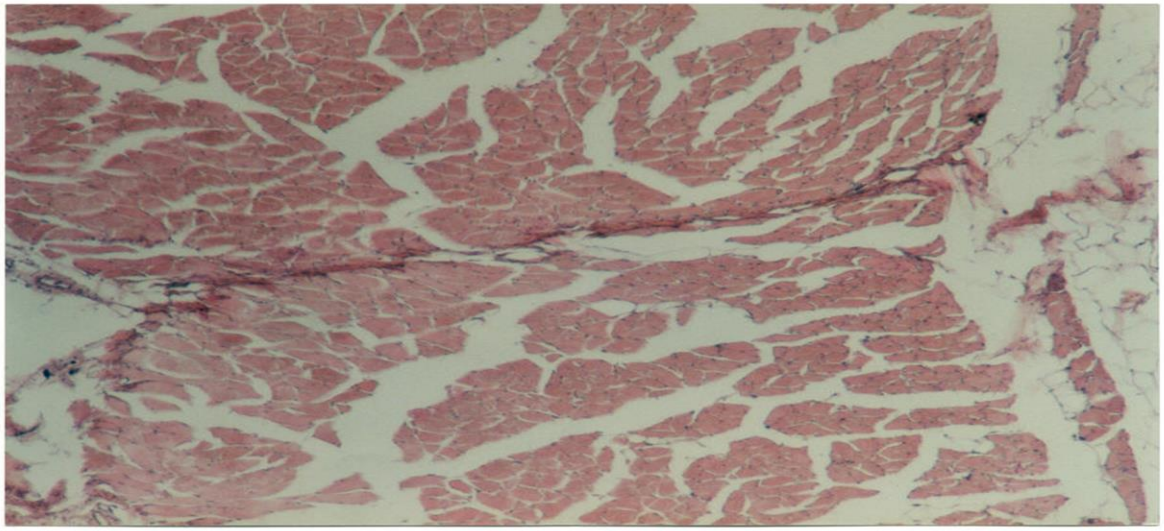
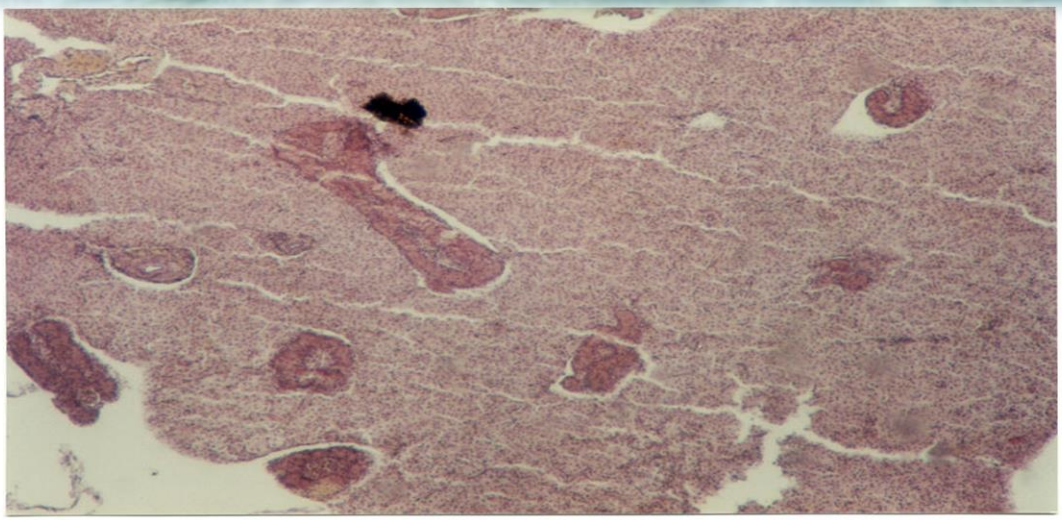


Fig.2. Degeneration of muscles fibers. Final stage. A. Carp (x100), B. Eel (x100).

A.



B.

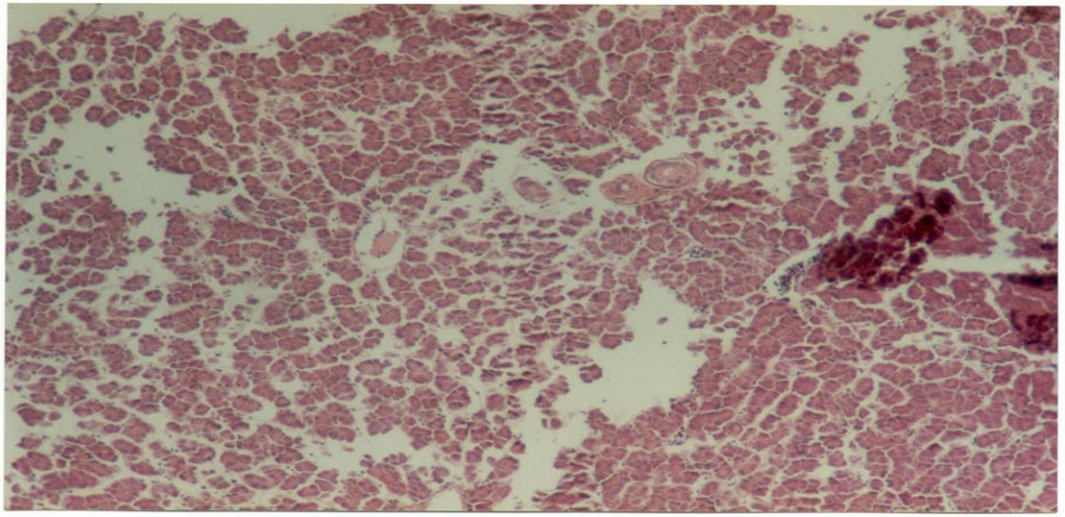
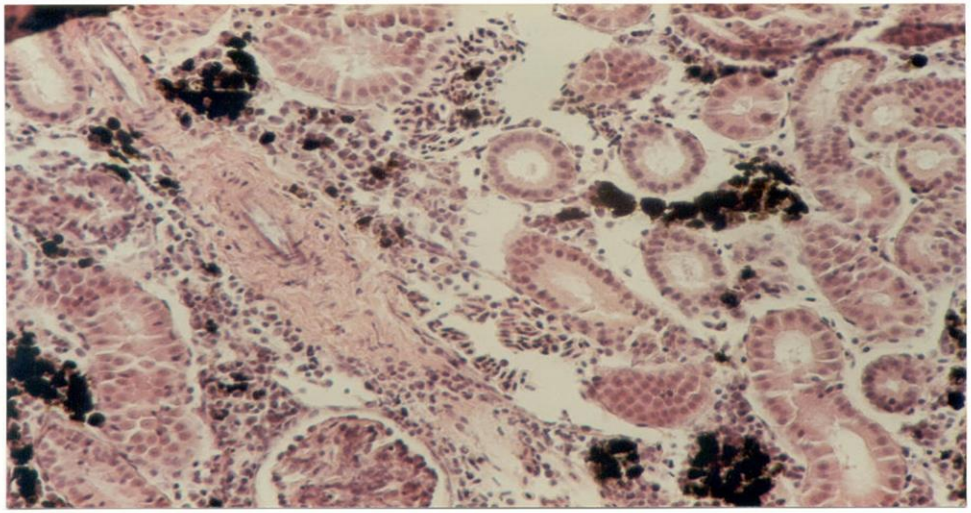


Fig.3. Degeneration of hepatic cells. Final stage. A. Carp (x100), B. Eel (x100).

A.



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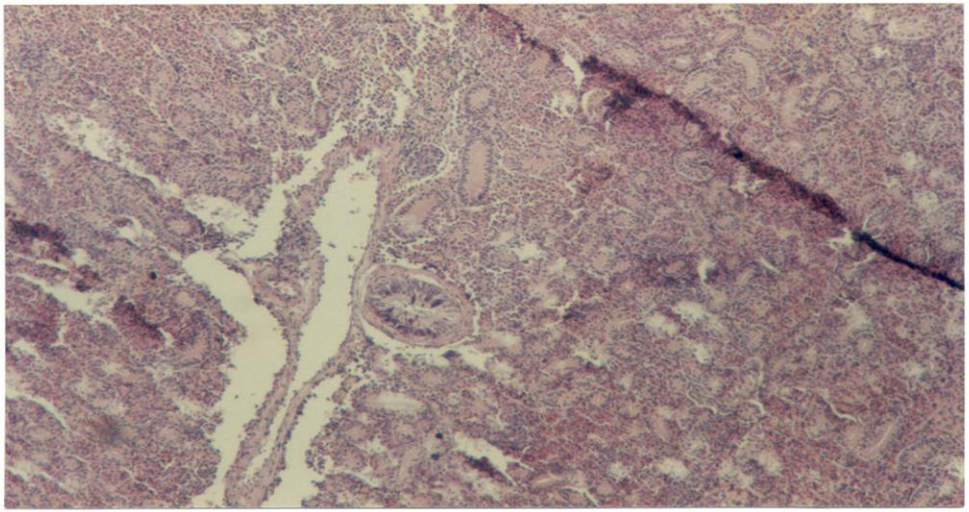

Fig.4. Degeneration of Kidney parenchymal cells and hydeopsy of re nal tubules. Final stage. A. Carp (x100), B. Eel (x100).

4. CONCLUSIONS

The presence of 137Cs, causes allergic and toxic effects. The ability of both species to concentrate 137Cs to a high degree make them valuable as biological indicators of radioactivity. The present work intensifies the necessity to look after more aquatic species investigating their sensitivity to 137Cs in order to plan an emergency action, in case of a nuclear accident and subsequent release of radionuclides in the environment.