



Monitoring of radioactive contamination of bottom sediments and fish in the Southern Baltic Sea, in 2014

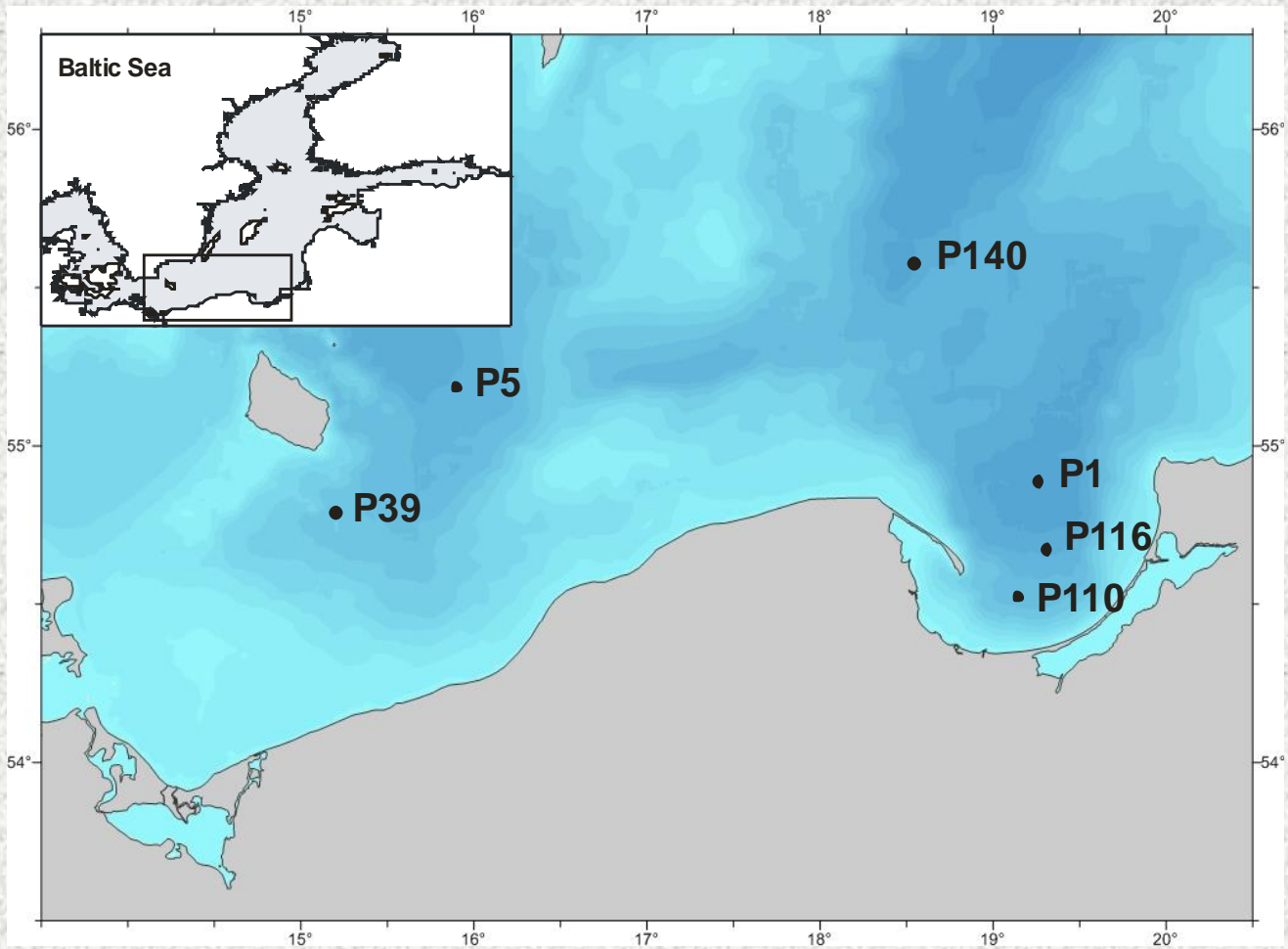
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Bottom sediments



**Sampling stations of bottom sediment in Polish sector of the Baltic Sea,
HELCOM -MORS monitoring programme.**



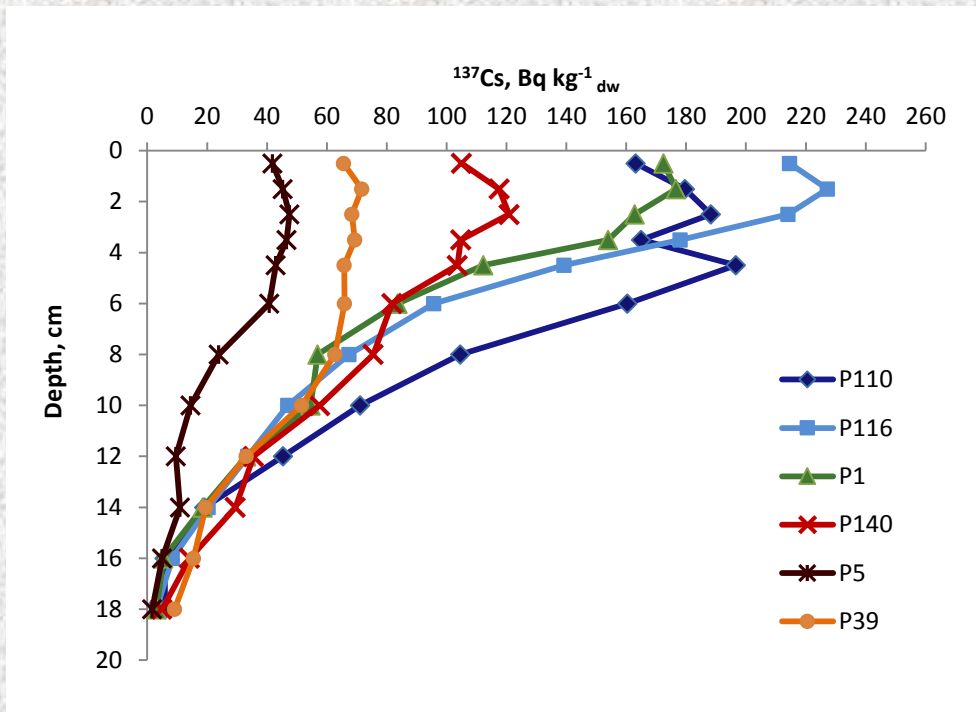
At each location, six core samples were taken and divided into 12 slices: 1cm (to the depth of 5 cm), and 2 cm (from 5cm to 19cm depth).



Methods

1. ^{137}Cs - gamma spectrometry;
2. $^{239,240}\text{Pu}$, ^{238}Pu - radiochemical method, with ^{242}Pu as a tracer, followed by alpha spectrometric measurements.
3. ^{90}Sr - radiochemical method and the ^{90}Y activity concentration measurement after establishing the radioactive equilibration of ^{90}Sr - ^{90}Y .

Vertical distribution of ^{137}Cs in bottom sediments



In the Gulf of Gdansk and Gdansk Deep the average concentrations of ^{137}Cs in layers from 0 to 5 cm were:

P-116 $195 \pm 36 \text{ Bq kg}^{-1}_{\text{dw}}$.

P-110 $177 \pm 17 \text{ Bq kg}^{-1}_{\text{dw}}$.

P-1 $155 \pm 26 \text{ Bq kg}^{-1}_{\text{dw}}$.

in the Eastern Gotland Sea

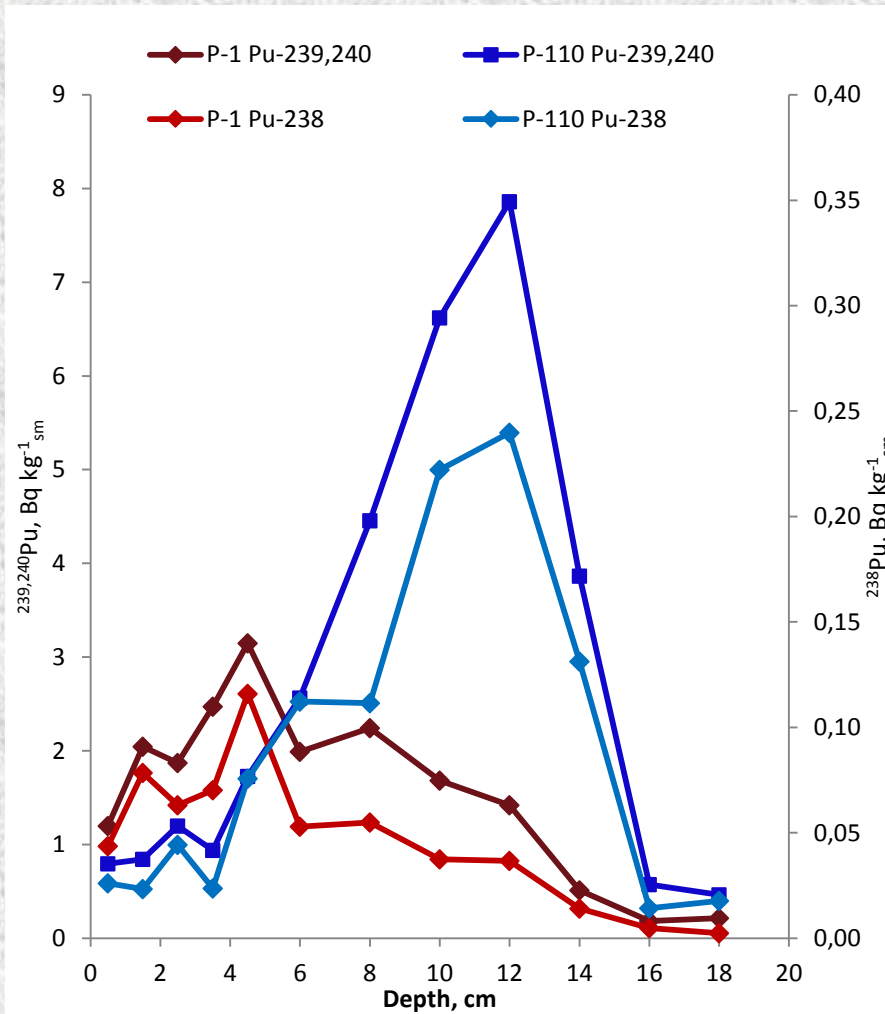
P-140 $110 \pm 8 \text{ Bq kg}^{-1}_{\text{dw}}$.

In the Bornholm Basin

P-39 $68.2 \pm 2.6 \text{ Bq kg}^{-1}_{\text{dw}}$.

P-5 $45.0 \pm 2.1 \text{ Bq kg}^{-1}_{\text{dw}}$.

Activity concentrations of $^{239,240}\text{Pu}$ and ^{238}Pu in bottom sediments from P110 and P1 in a function of depth



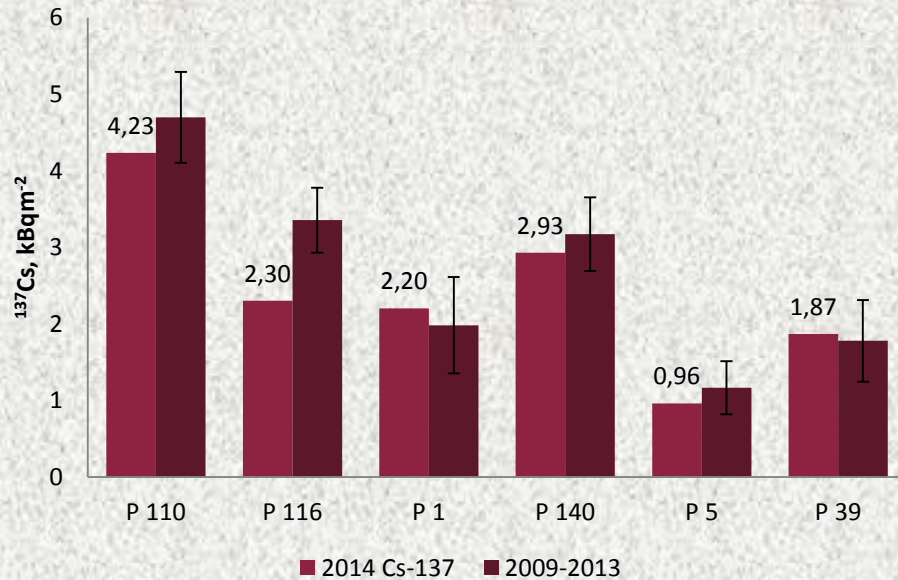
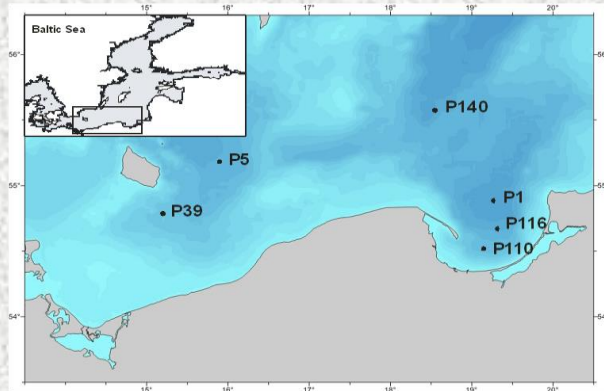
In the Gulf of Gdansk (P110) $^{239,240}\text{Pu}$ concentrations increased from $0.79 \pm 0.05 \text{ Bq kg}^{-1}_{\text{dw}}$ in the first upper layer to the maximum concentration of $7.60 \pm 0.05 \text{ Bq kg}^{-1}_{\text{dw}}$ observed in the 11-13 cm layer. The activity concentration of ^{238}Pu ranged from $0.014 \text{ Bq kg}^{-1}_{\text{dw}}$ to $0.222 \text{ Bq kg}^{-1}_{\text{dw}}$.

In Gdansk Deep (P1) $^{239,240}\text{Pu}$ concentrations increased from 1.20 ± 0.11 in the first layer to $3.15 \pm 0.12 \text{ Bq kg}^{-1}_{\text{dw}}$ in the layer of 4-5cm. Concentration of ^{238}Pu were in the range $0.014 - 0.116 \text{ Bq kg}^{-1}_{\text{dw}}$.

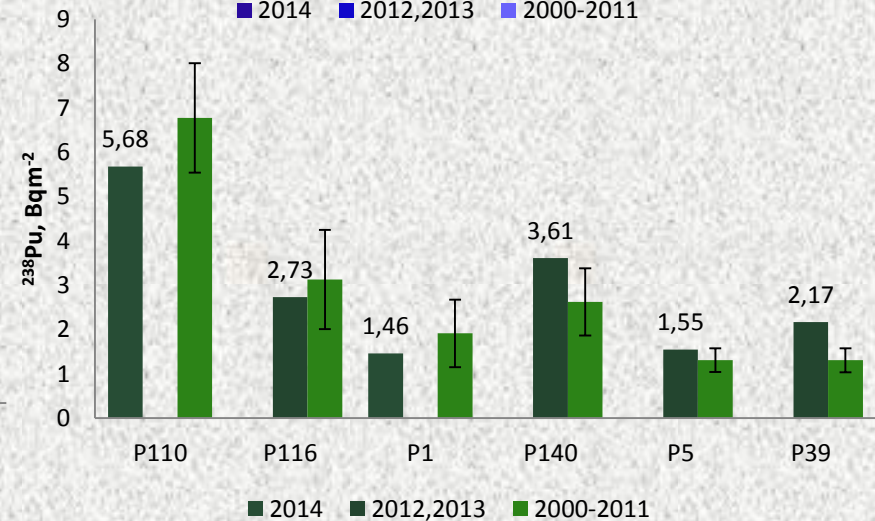
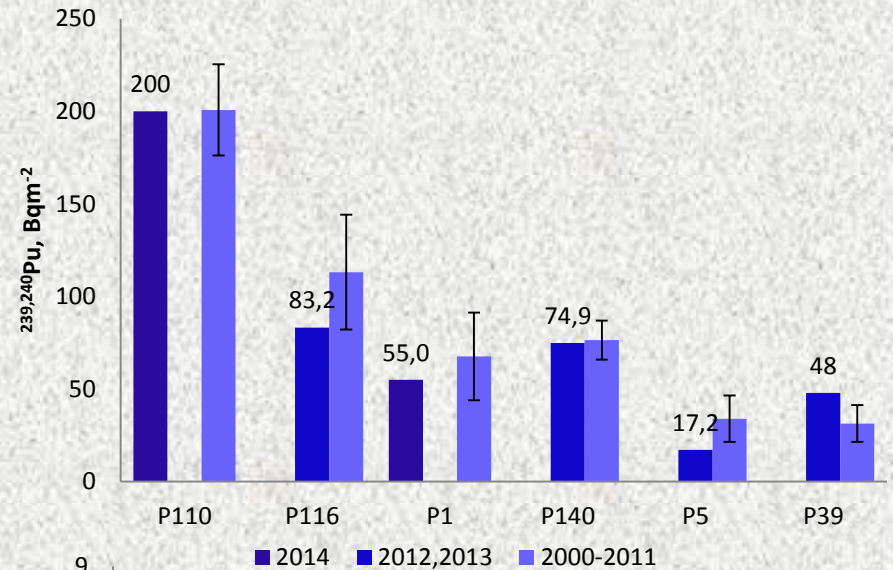
The rate of ^{238}Pu to $^{239,240}\text{Pu}$ in both locations ranged from 0.022 to 0.044 being similar to that determined for the fallout from nuclear weapons tests.

Determinations of plutonium in bottom sediments are carried out every three years.

Geographical distribution of ^{137}Cs , $^{239,240}\text{Pu}$ and ^{238}Pu in bottom sediments



Total amount of ^{137}Cs in bottom sediments in six locations of Baltic Sea, in 2014 and their averages in 2009-2013



Total amount of $^{239,240}\text{Pu}$ and ^{238}Pu in bottom sediments in years 2012-2014 and their averages in 2000-2011

Strontium-90

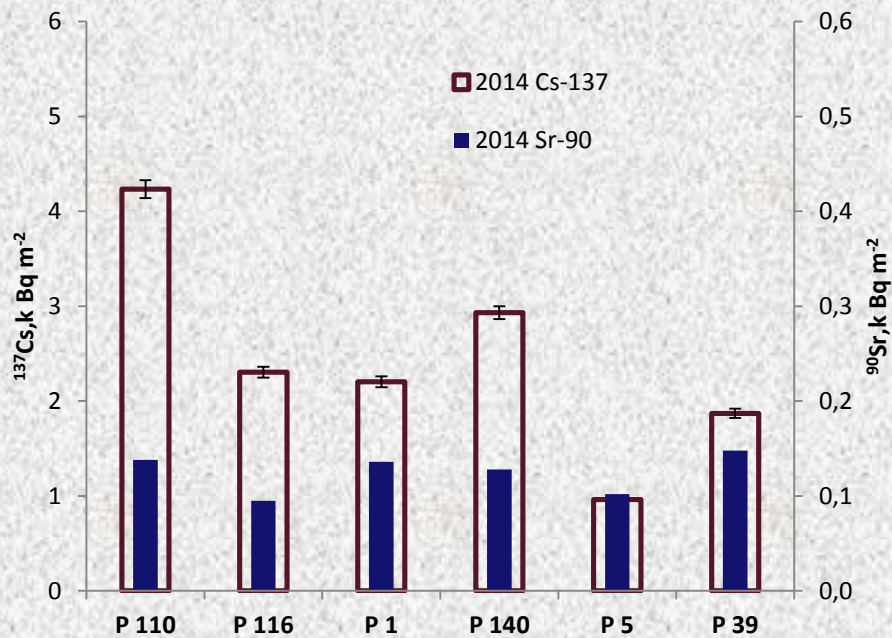
In 2014 the permanent monitoring had been extended to the determination of ^{90}Sr .

Table 1. Activity concentration of ^{90}Sr , in the layer 0-19 cm of bottom sediments and activity concentration of ^{137}Cs calculated for this layer

Sampling station	^{90}Sr [Bq kg⁻¹_{dw}]	^{137}Cs [Bq kg⁻¹_{dw}]
P 110	2.15 ± 0.28	65.8 ± 1.5
P 116	2.39 ± 0.32	57.7 ± 3.5
P 1	3.23 ± 0.47	54.5 ± 2.7
P 140	2.31 ± 0.32	53.0 ± 2.4
P 5	2.24 ± 0.28	21.2 ± 0.9
P 39	3.30 ± 0.32	41.3 ± 2.8

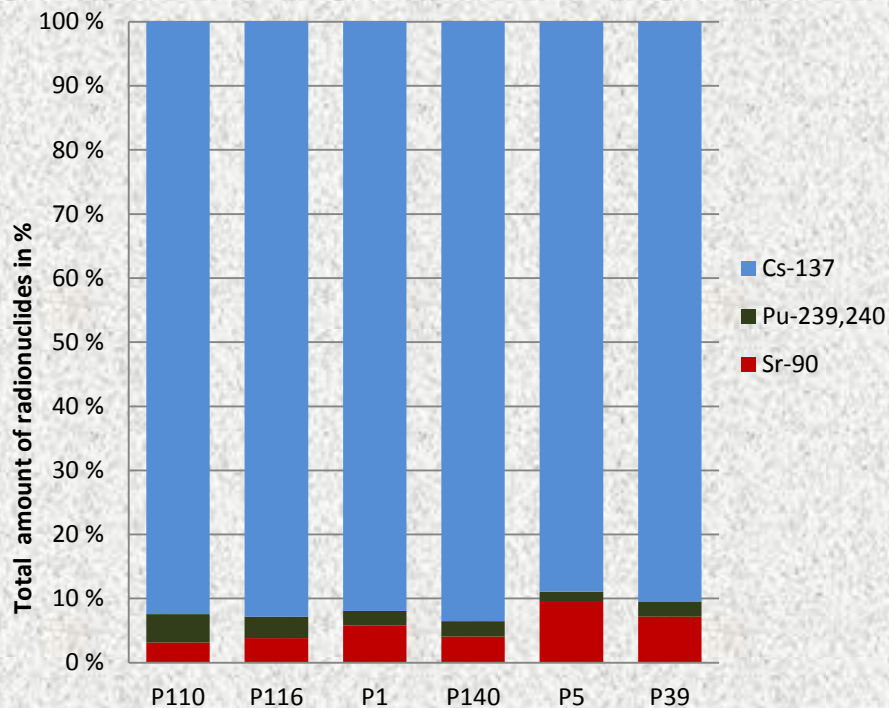
Concentrations of ^{90}Sr ranged from 2.15 Bq kg⁻¹_{dw} at P110 to 3.30 Bq kg⁻¹_{dw} at P 39, being 10-30 times lower than ^{137}Cs concentrations calculated for the same layer.

Total amount of ^{137}Cs and ^{90}Sr in sub-regions of Baltic Sea



Total amounts of ^{90}Sr in bottom sediments were in the range from $94.9 \pm 13 \text{ Bq m}^{-2}$ in P116, to $148 \pm 14 \text{ Bq m}^{-2}$ in P39, and less differ in sub-regions comparing with ^{137}Cs

Total amount of ^{137}Cs , $^{239,240}\text{Pu}$ and ^{90}Sr in sub-regions of Southern Baltic Sea



The anthropogenic radioactivity in the Baltic Sea bottom sediments is connected with the ^{137}Cs presence

The average concentrations of ^{137}Cs and ^{226}Ra in Baltic Sea fish flesh in 2014

Species (number of samples)	Number of fish, total	Fish length cm	^{137}Cs [Bq kg ⁻¹ _{ww}]	^{40}K [Bq kg ⁻¹ _{ww}]	^{226}Ra [Bq kg ⁻¹ _{ww}]
Cod (6)	23	25-38	4.89 ± 0.77*	118 ± 11	0.091 ± 0.007
Herring (6)	122	16-25	3.14 ± 0.54	110 ± 16	0.027 ± 0.002
Sprat ** (5)	243	7-13	3.39 ± 0.26	108 ± 3	0.062 ± 0.003
Plaice (5)	38	22-28	3.48 ± 0.11	101 ± 7	0.053 ± 0.006

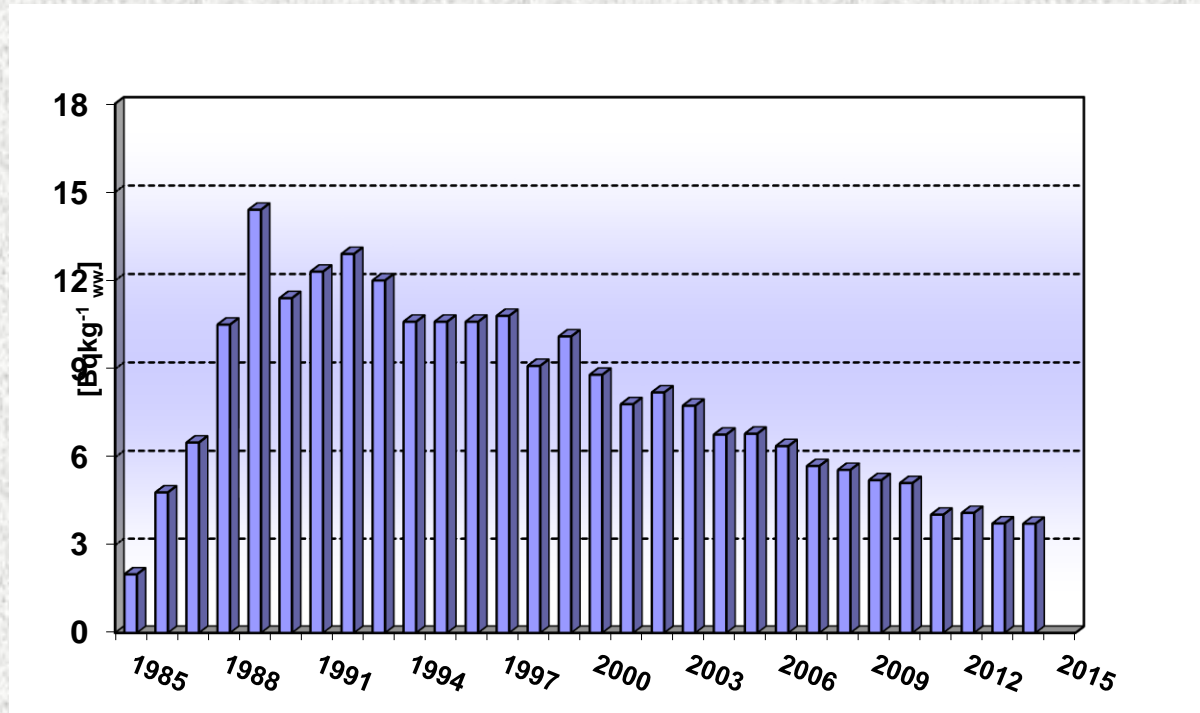
* standard deviation

** whole fish without a head

The highest average activity concentration of ^{137}Cs was found in cod – 4.89 Bq kg⁻¹_{ww}
For the other fish species these concentrations were similar with the average - 3.34 ± 0.17 Bq kg⁻¹_{ww}

Activity concentrations of ^{226}Ra ranged from 27 mBq kg⁻¹_{ww} in herring
to 91 mBq kg⁻¹_{ww} in cod

The average activity concentration of ^{137}Cs in Baltic Sea fish in years 1985-2014



The average concentrations of ^{137}Cs calculated for the four species of the Baltic Sea in 2014 is $3.73 \pm 0.79 \text{ Bq kg}^{-1}_{\text{ww}}$.

Activity concentration of ^{137}Cs in the Baltic sea fish has decreased in years, but it is still almost two times higher than before the Chernobyl accident

The effective half-life ($T_{1/2 \text{ eff}}$) of ^{137}Cs in fish depends on the fish species being equal to about 12.4 years for herring (planktonophagous) and 15.4 years for cod (predator)



Thank you for your attention