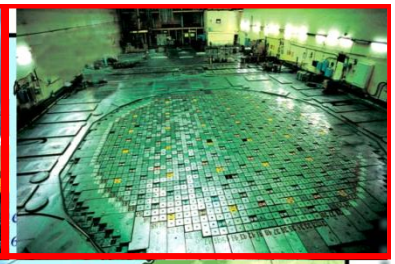
Radioactive contamination issues in the Arctic

Nadezhda Kasatkina

Murmansk Marine Biological Institute, MMBI KSC RAS

Expert workshop on Marine Protected Area networks in the Arctic
21-22 September 2017, Helsinki

Sources and pathways of artificial radionuclides in northern seas



Global Level

- Global fallout of artificial radionuclides as a result of nuclear tests and the Chernobyl accident
- Transoceanic transport

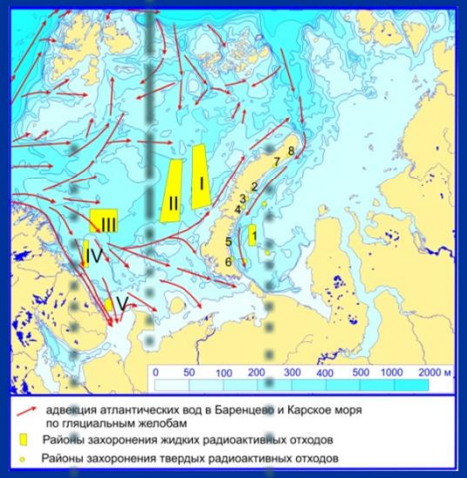
Regional Level

- Transport of nuclear waste from reprocessing factories by Siberian rivers
- Transport of global fallout from river watersheds
- Transfer by glaciers, icebergs of Arctic archipelagoes, pack and seasonal sea ice
- Local sea currents

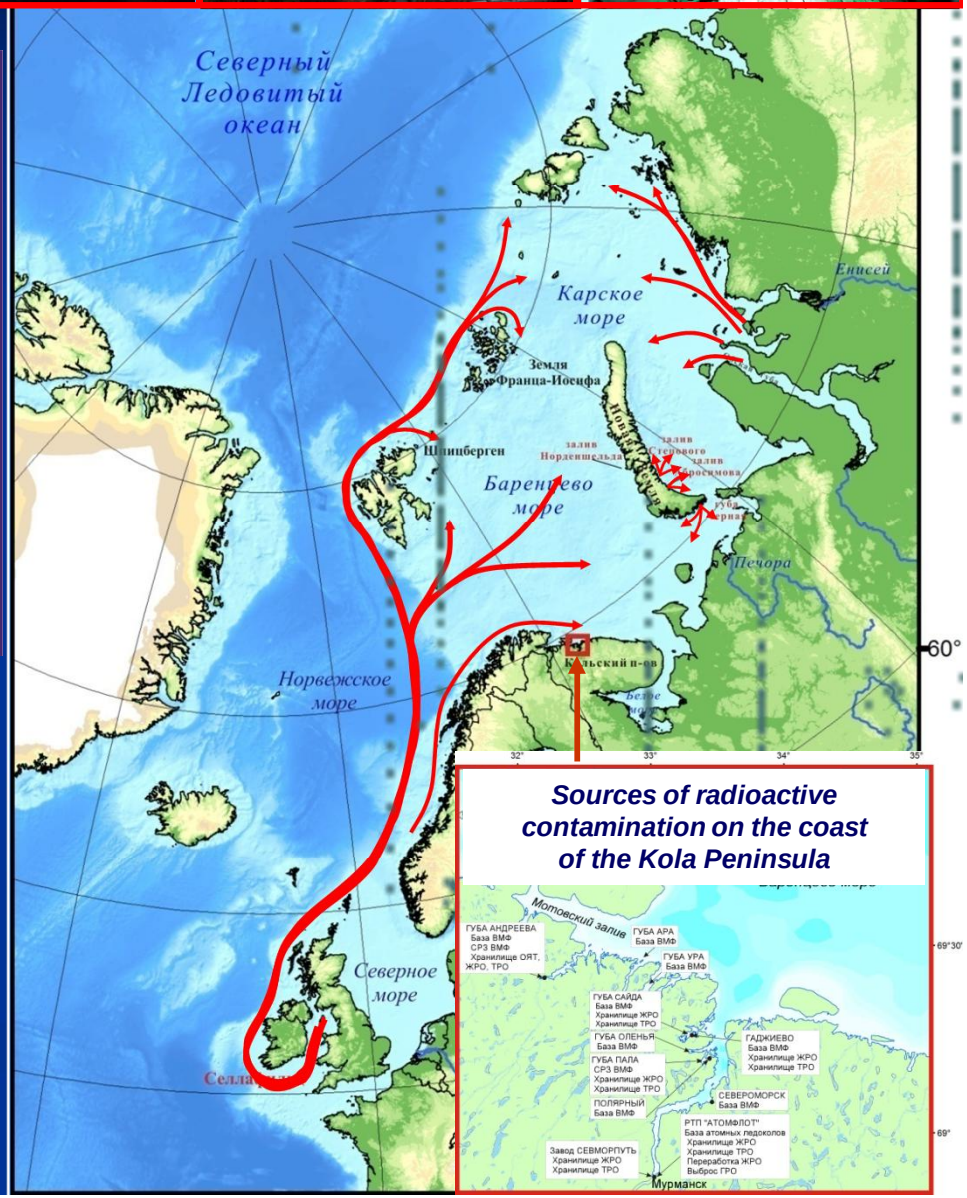
Local Level

- Releases from factories repairing nuclear reactors, ships and vessels
- Releases of liquid radioactive waste from military/industrial nuclear bases
- Dumping of radioactive waste containers
- Releases to groundwater and atmosphere from subterranean nuclear explosions
- Remobilization from organisms accumulated redionuclides (birds, fish, mollusks, macrophytes)
- Remobilization from bottom sediments

primary sources | secondary sources | potential sources



Liquid radioactive waste burial sites



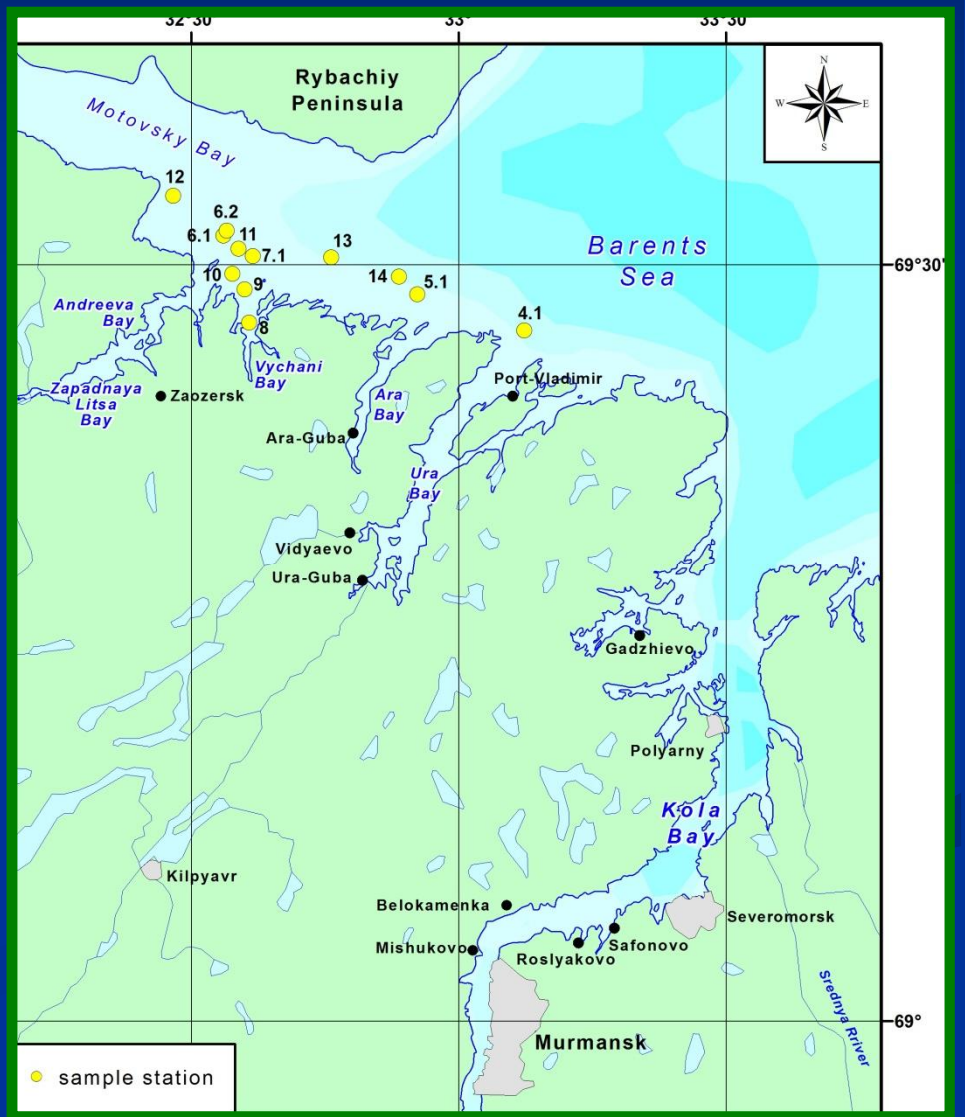
Main scientific directions in the field of marine radioecology

- Sources and pathways of artificial radionuclides in the Barents, Kara and White Seas.
- Current levels of artificial radionuclides in different elements of the marine ecosystems.
- Impact of radioactive contamination on the marine environment.
- Mathematical modellings of hypothetical radiation accidents.
- Development and improvement of radiation monitoring system.

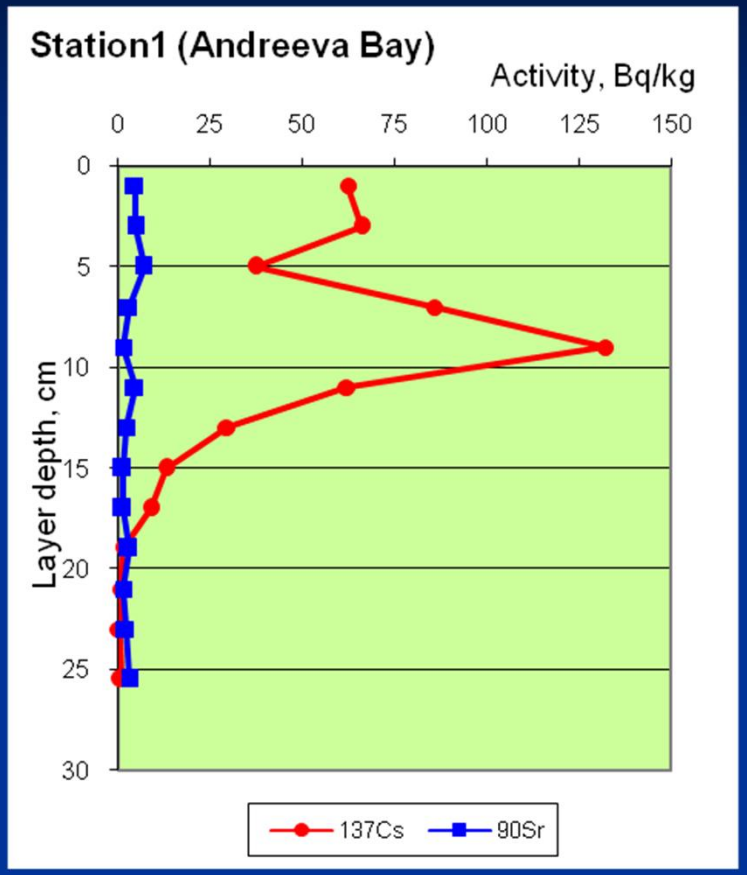
International projects:

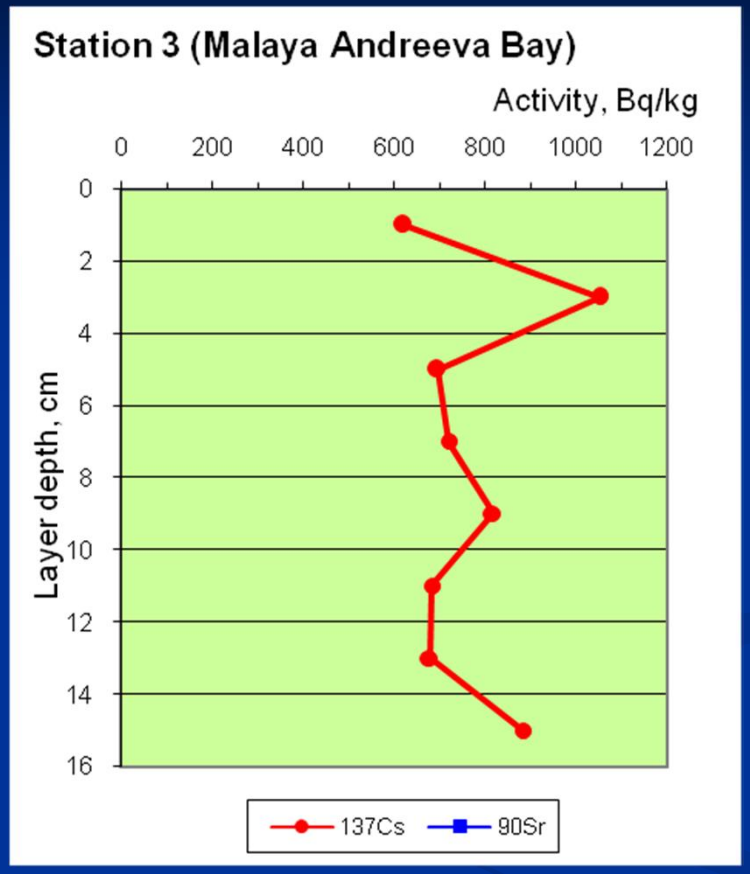
- **CEEPRA:** “Collaboration Network on EuroArctic Environmental Radiation Protection and Research”.
- **CETIA: Coastal Environment, Technology and Innovation in the Arctic**
- **Evaluation of the Present Radio-Ecological Situation in Andreeva Bay and adjacent offshore zones.**
- **MEMO-PRO:** “Development of methods for ecosystem-based monitoring of the coastal zone and continental shelf of the Barents Sea and the High Arctic, methods for scenario modelling of emergency situations related to transport of petroleum products and radioactive waste, accompanied with and innovative technologies for marine environment protection under conditions of the marine periglacial”.

Evaluation of the Present Radio-Ecological Situation in Andreeva Bay and adjacent offshore zones



Vertical distribution of ^{137}Cs and ^{90}Sr in bottom sediments at the littoral of Andreeva and Malaya Andreeva Bays, 2014



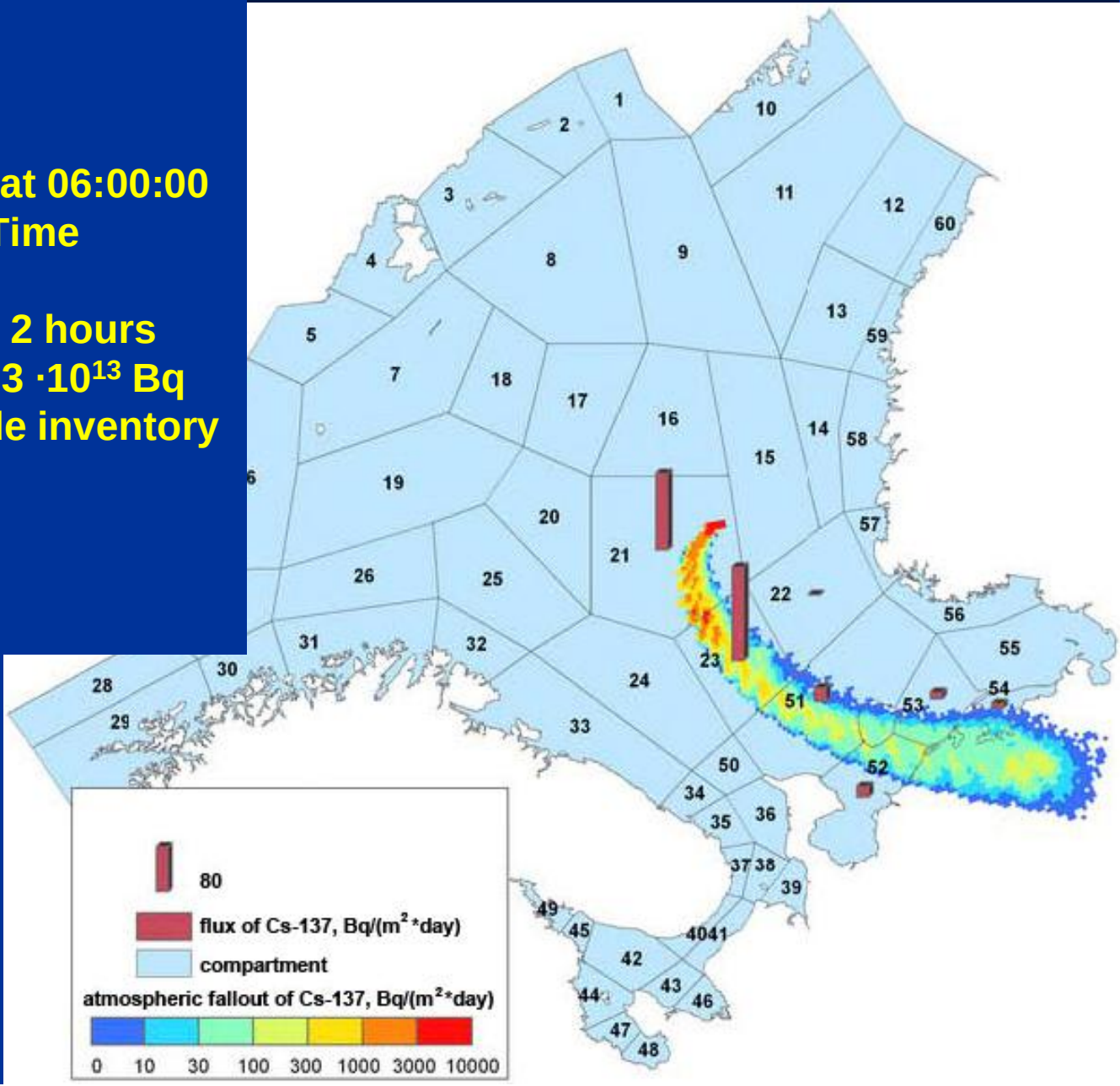


Radionuclide activities in columns of bottom sediment, Bq/kg

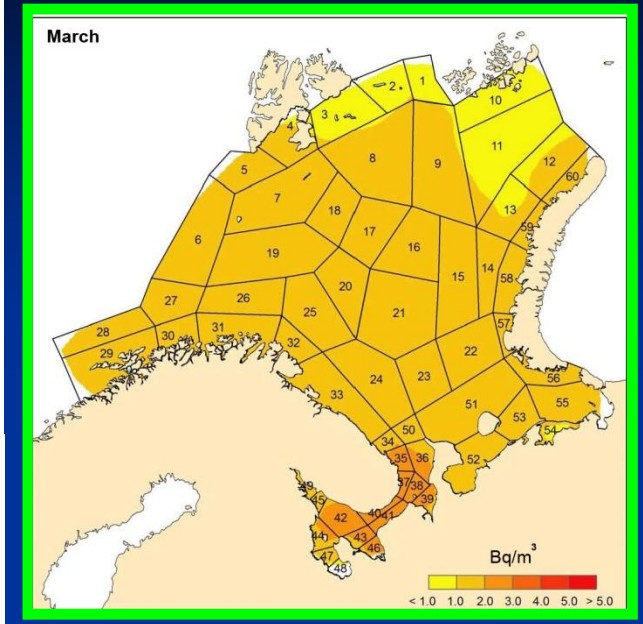
Station	Radionuclide	Minimum	Maximum	Average
1	^{137}Cs	0.37	132.2	38.5
	^{90}Sr	1.2	7.0	3.1
3	^{137}Cs	621.1	1053.4	769.8

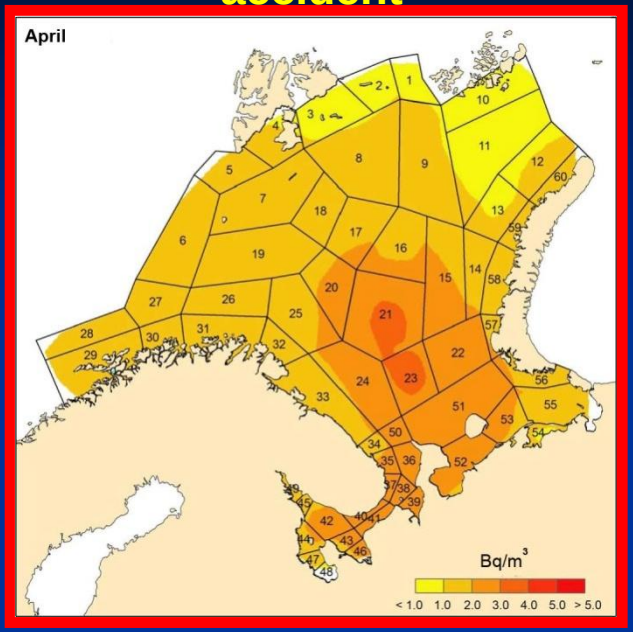
Hypothetical accident at a Floating Nuclear Power Plant in the Barents Sea (Shtokmann gas field, latitude 73 N, longitude 44 E)

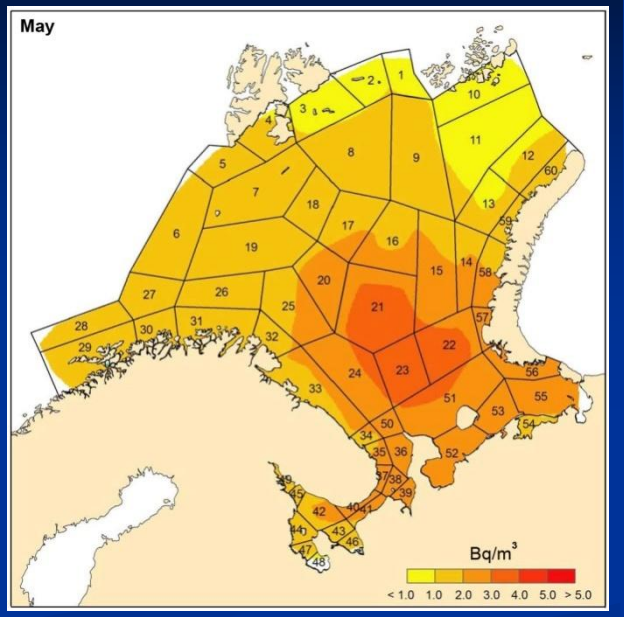
- **Start:** On 3 April 2013, at 06:00:00 Coordinated Universal Time (Greenwich Mean Time)
- **Duration of discharge:** 2 hours
- **Discharge of ^{137}Cs:** 8.83 ·10^{13} Bq or 1% of the radionuclide inventory in the plant.

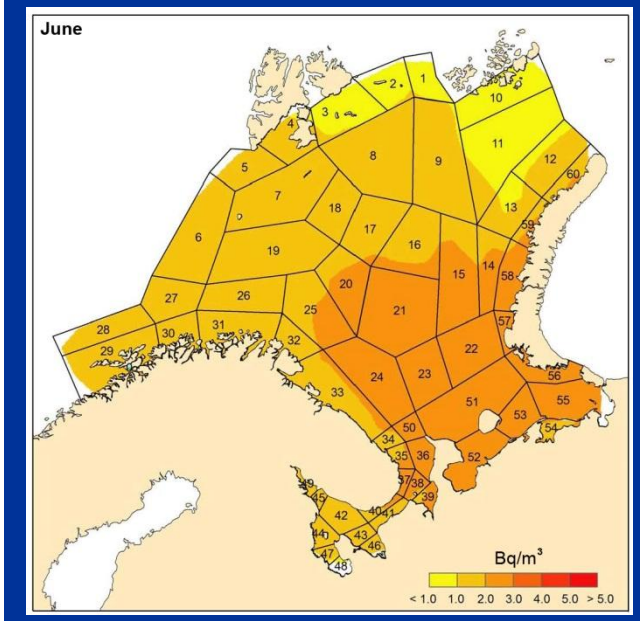


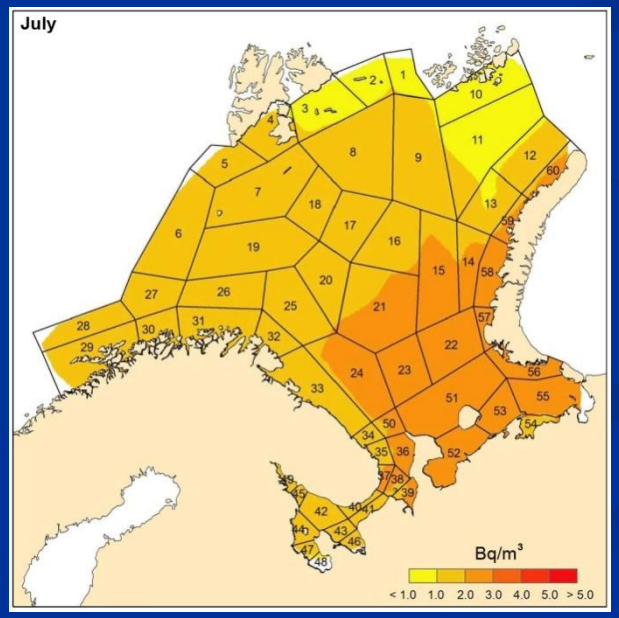
Activity concentrations of ^{137}Cs in the surface layers of the Barents and White Seas before the hypothetical accident at a floating nuclear power plant and after the accident

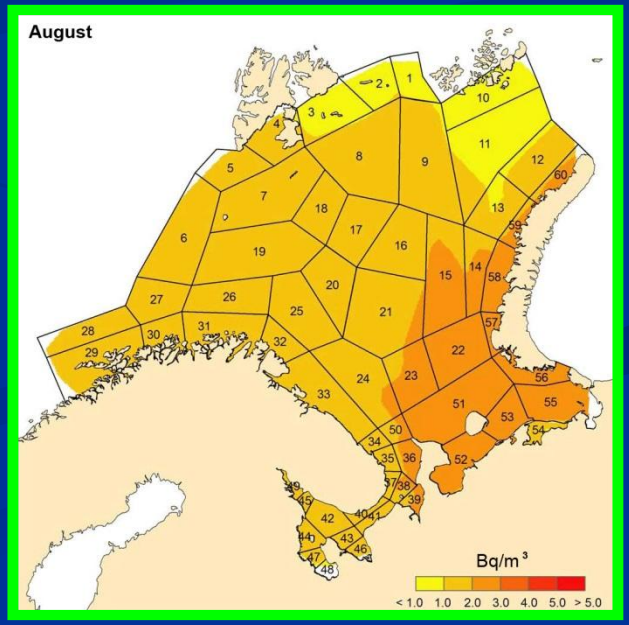






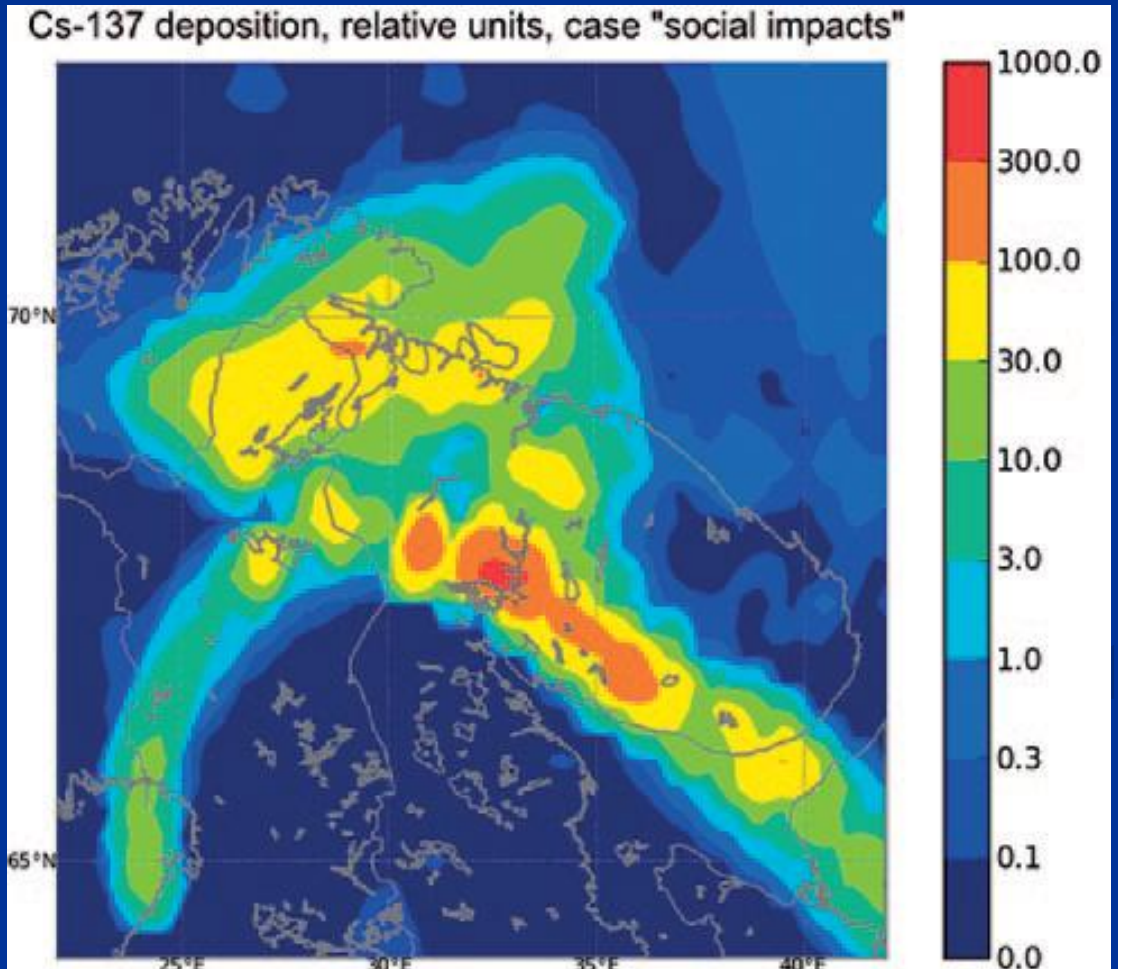






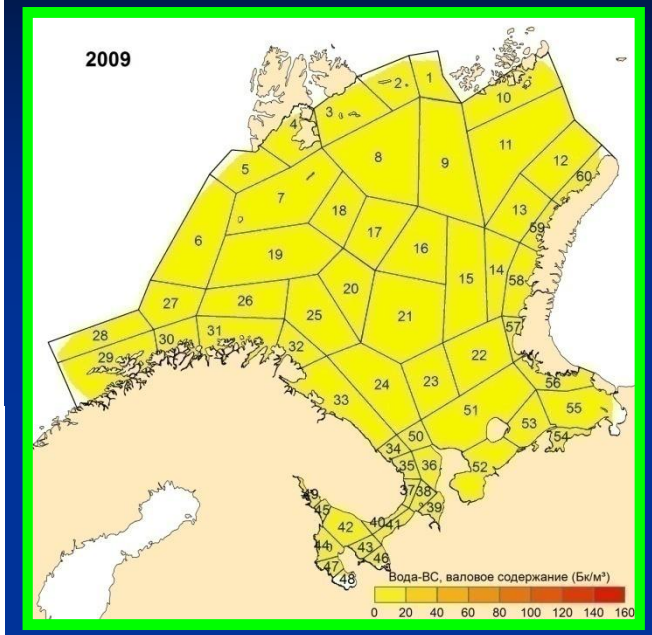
Hypothetical accident at a planned Finnish Nuclear Power Plant (Hanhikivi, latitude 64°32’ N, longitude 24°15’ E)

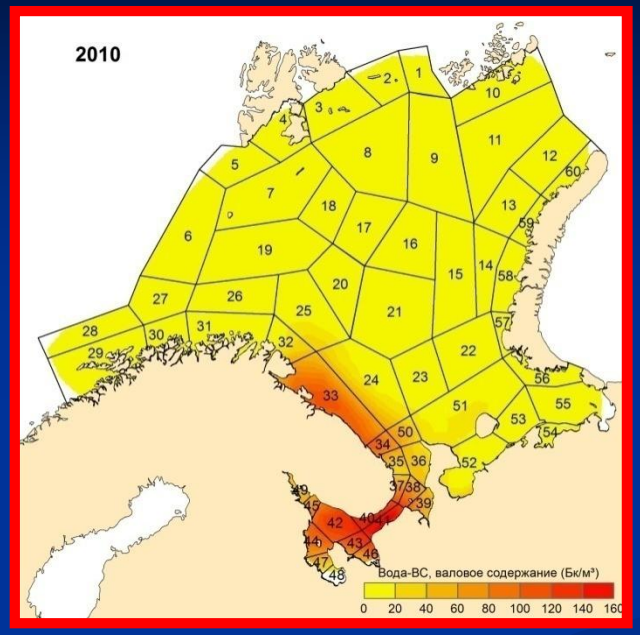
is a nuclear power plant proposed for construction on the Finnish Hanhikivi peninsula, in the municipality of Pyhäjoki. It is to house one Russian-designed VVER-1200 PWR reactor, with a capacity of 1200 MW.

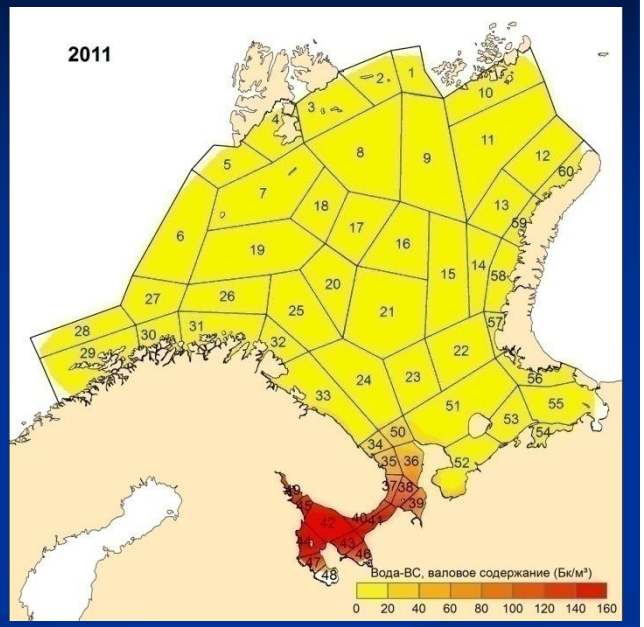


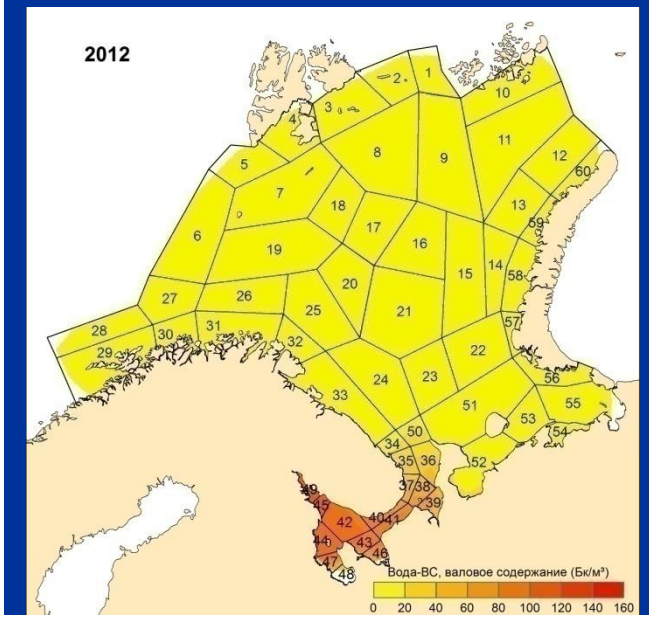
- **Start:** On 03 July 2010, at 00:00:00 Coordinated Universal Time (Greenwich Mean Time)
- **Duration of discharge:** Instant release after shutdown
- **Effective release height:** 200 m above sea level
- **Discharge of ^{137}Cs:** $1.04 \cdot 10^{16}$ Bq or 2% of the radionuclide inventory at the reactor.

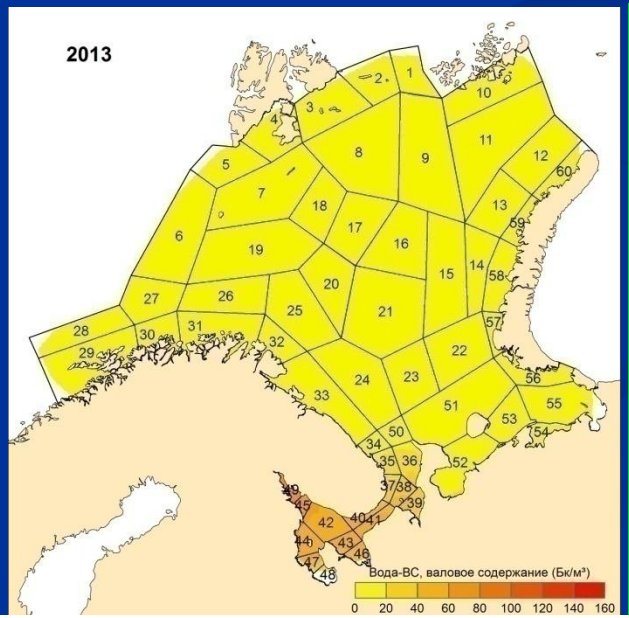
Activity concentrations of ^{137}Cs in the surface layers of the Barents and White Seas before the hypothetical accident at Hanhikivi nuclear power plant and after the accident

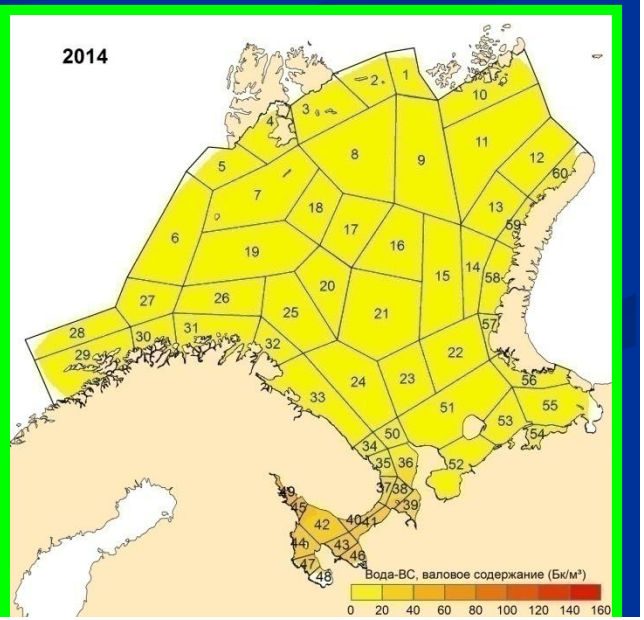












Algae-based bioremediation. Application of biofilter plantation in the Arctic coastal waters

Laminaria saccharina – объект симбиотической ассоциации плантации-биофильтра

Fucus vesiculosus – объект симбиотической ассоциации плантации-биофильтра

Экологически чистые районы побережья Баренцева моря.

Загрязненные районы Баренцева моря

Нефтеокисляющие бактерии – объект симбиотической ассоциации – плантации биофильтра. Бактерии на поверхности таллома водорослей. Увел. 6000

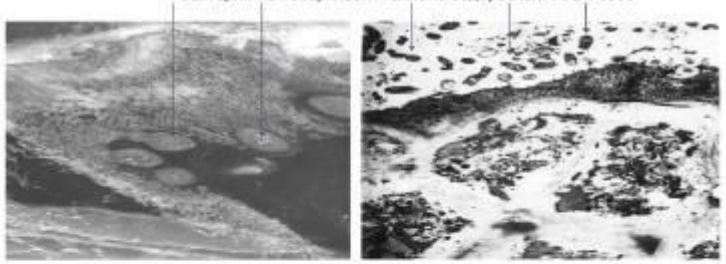
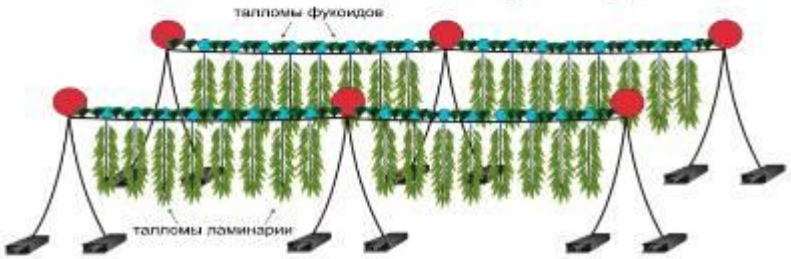


Схема плантации-биофильтра



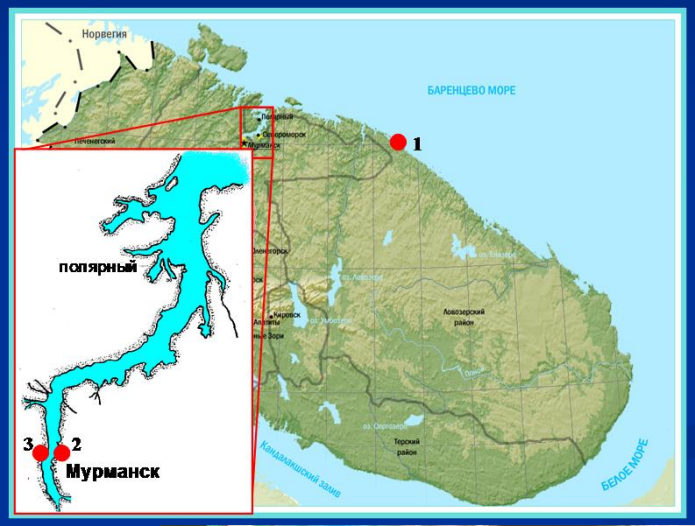
Действующая экспериментальная плантация

Исследования окружающей среды и биоты в районе плантации

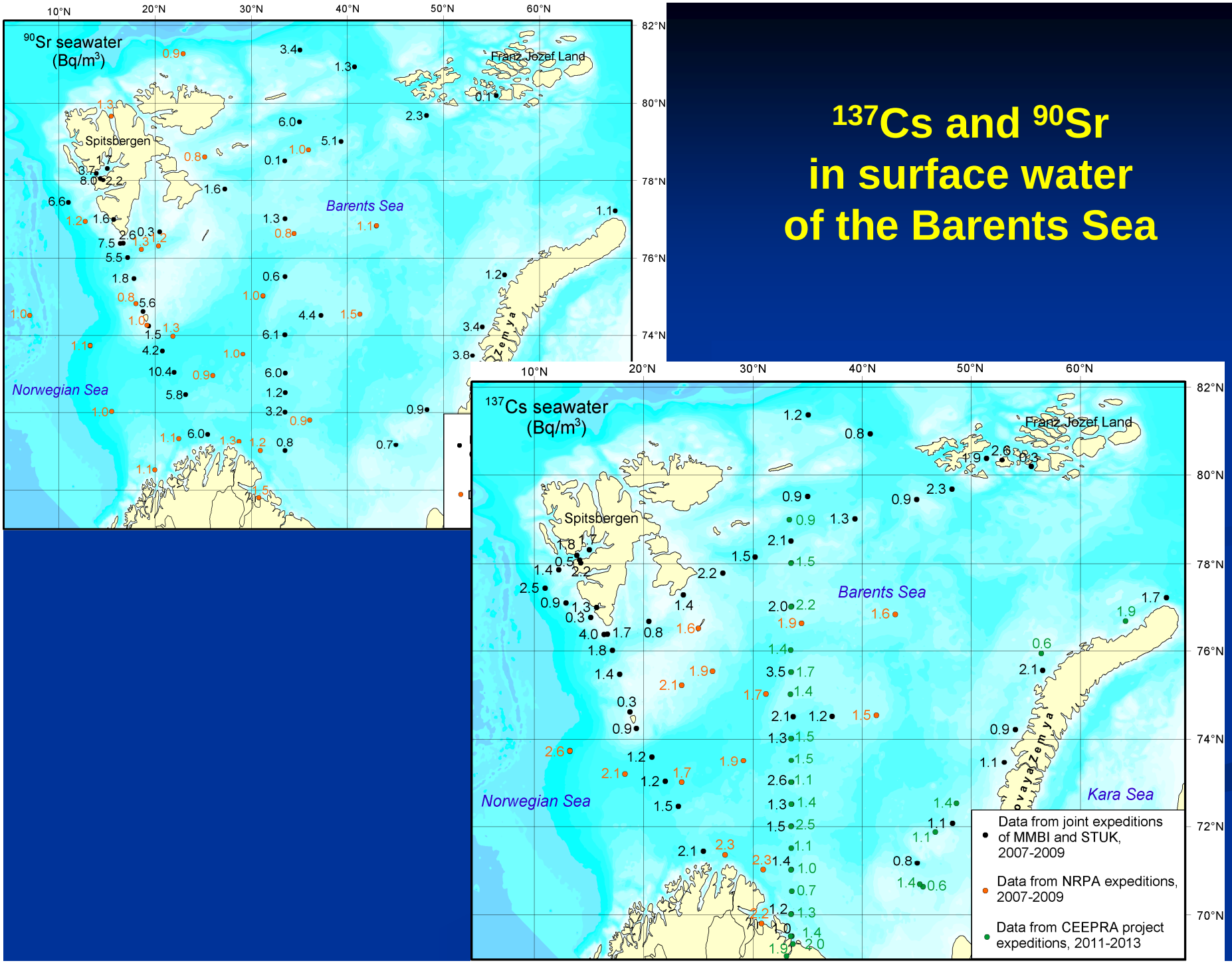
Россия, 183019, г. Мурманск, ул. Владимирская,17. Телефон: (8152) 253-963; факс: (8152) 253-999. E-mail: grvosk@mail.ru

Bioaccumulation of gamma emitting radionuclides in rockweed *(Fucus vesiculosus)* from the Barents Sea under laboratory condition

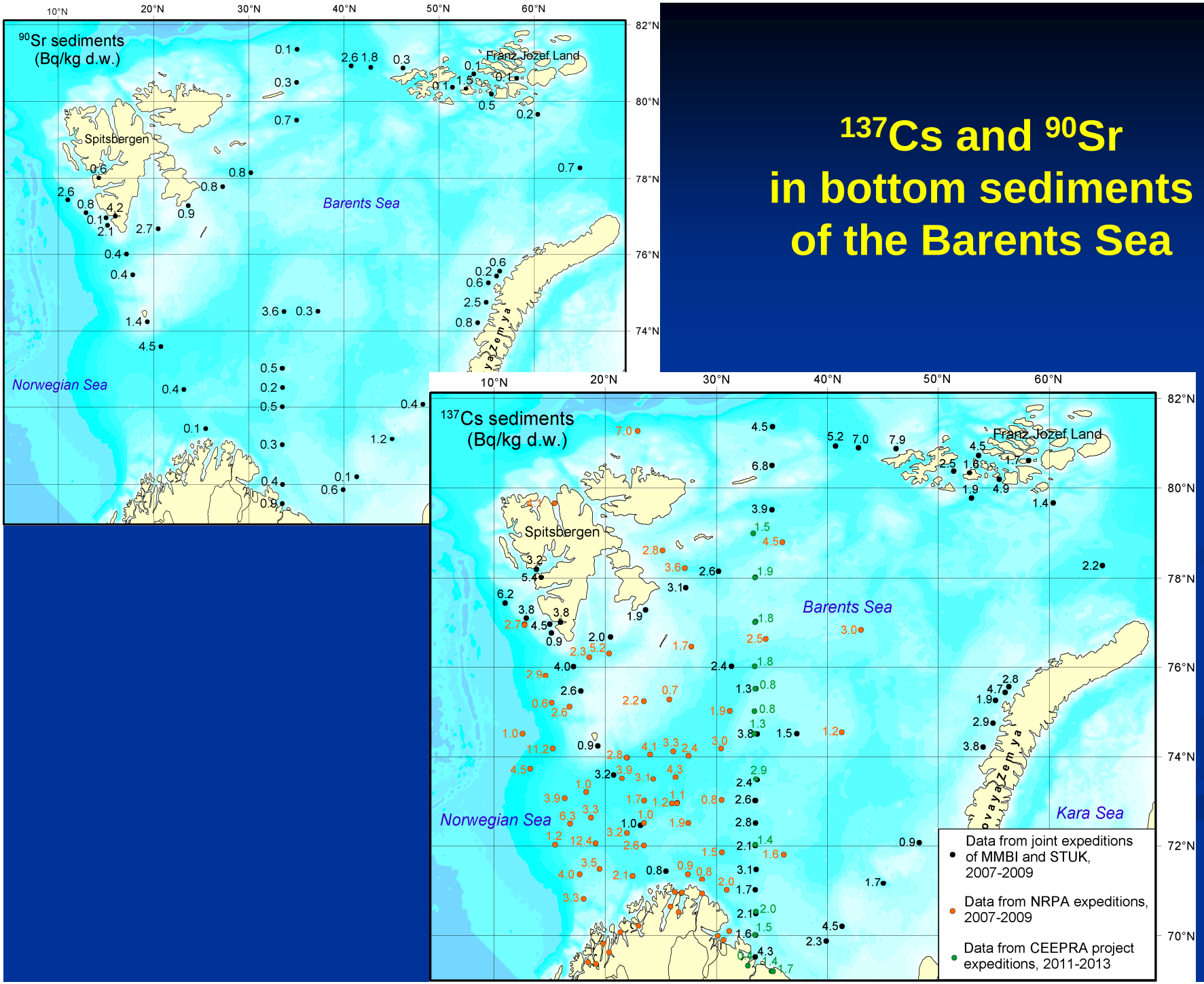
The bioaccumulation ability of radionuclides ^{54}Mn, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{109}Cd, ^{137}Cs , ^{152}Eu and ^{241}Am in rockweed species from the southern Barents Sea - *Fucus vesiculosus* - was determined.



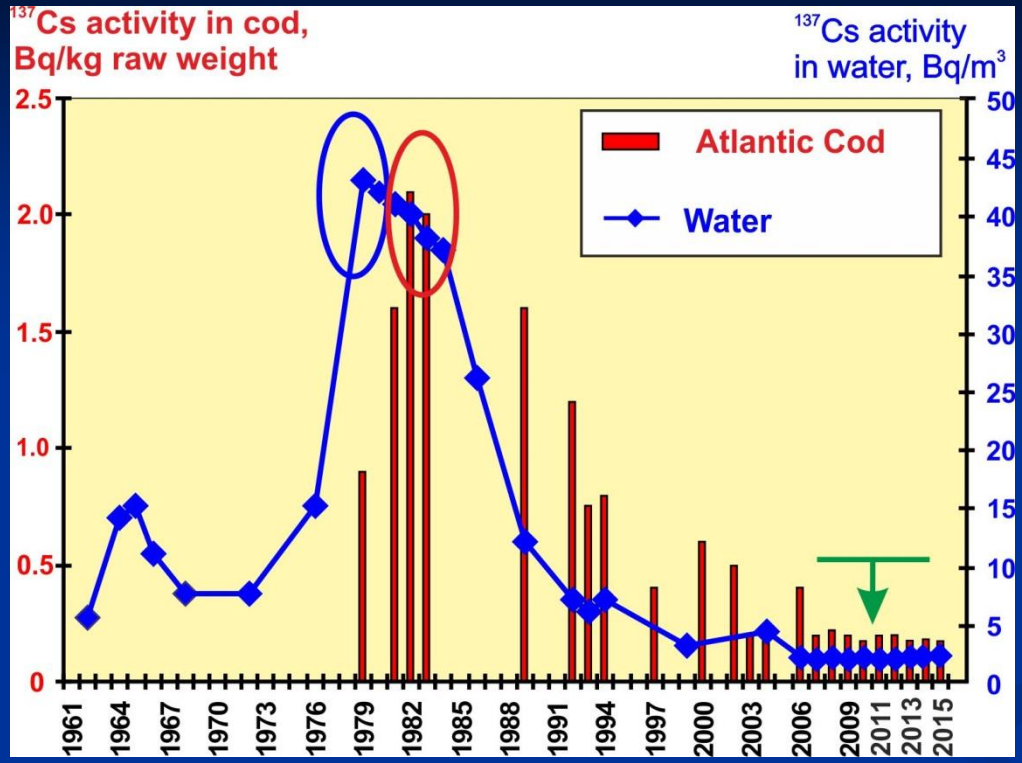
^{137}Cs and ^{90}Sr in surface water of the Barents Sea



^{137}Cs and ^{90}Sr in bottom sediments of the Barents Sea



Average ^{137}Cs concentration in water and in Atlantic Cod from the Barents Sea



Maximum ^{137}Cs discharges from Sellafield (United Kingdom)

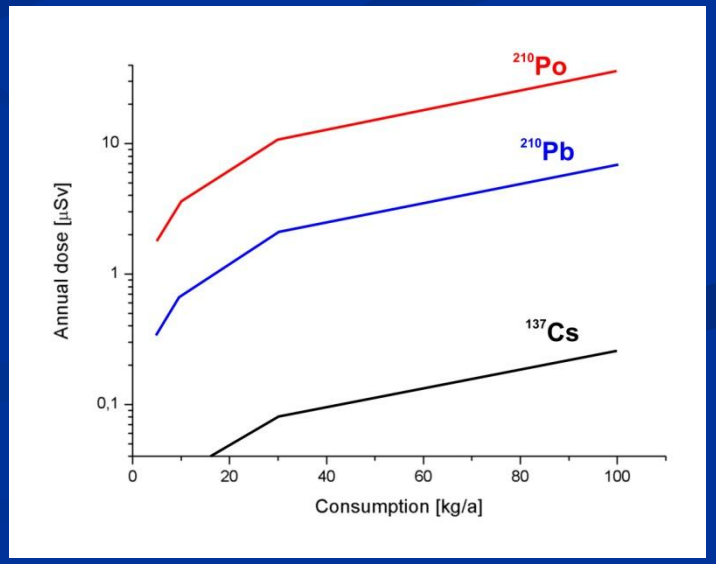
5 years

Maximum ^{137}Cs concentration in Barents Sea water

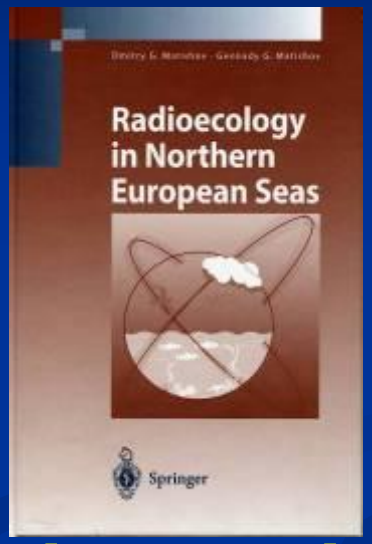
3 years

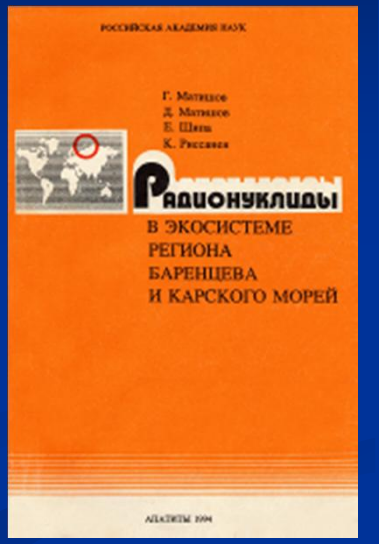
Maximum ^{137}Cs concentration in Atlantic Cod from the Barents Sea

Estimation of the internal dose when eating Barents Sea fish



Books and peer-reviewed articles of MMBI in the field of marine radioecology





Thank you for your kind attention!