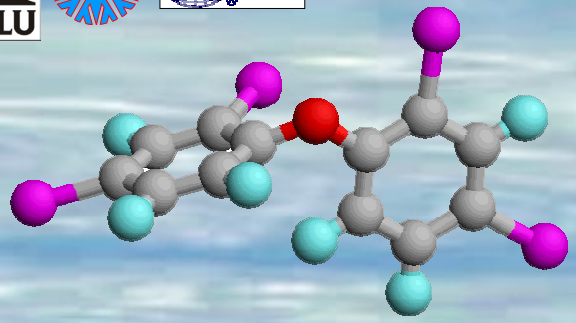


GLOBE Arctic POPs

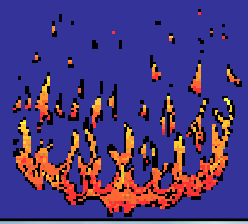
Circumpolar collaboration between schools and NILU

New organic pollutants in Arctic

Outline

- Brominated flame retardants
- GLOBE Arctic POPs
  - Background
  - Objective
  - Protocol
  - Status

What are brominated flame retardants?



Used in plastics, textiles, electronic circuitry etc. to prevent fires

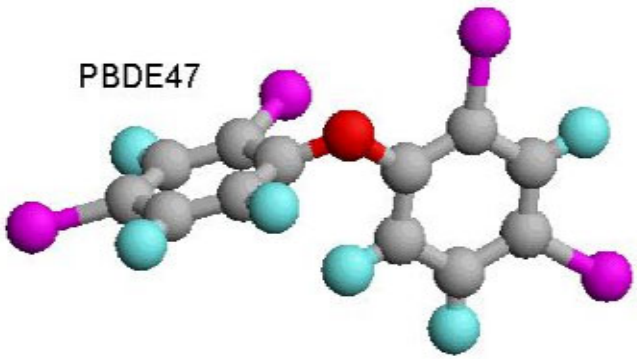
Polybrominated diphenylethers (PBDEs)

Tetrabromobisphenol A (TBBPA)

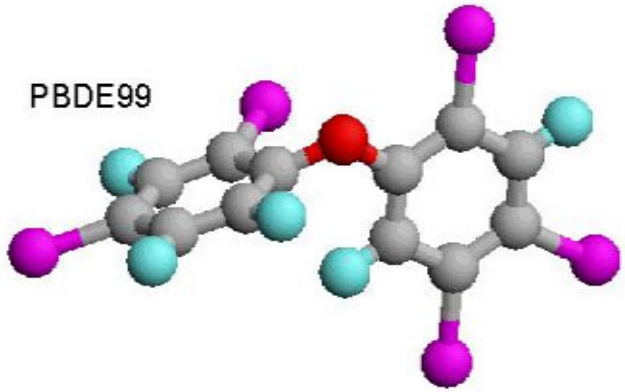
Hexabromocyclododecane (HBCD)

Polybrominated biphenyls (PBBs)

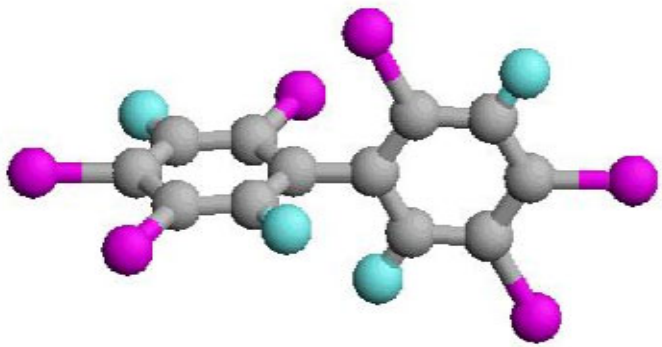
PBDE47



PBDE99



PBB153



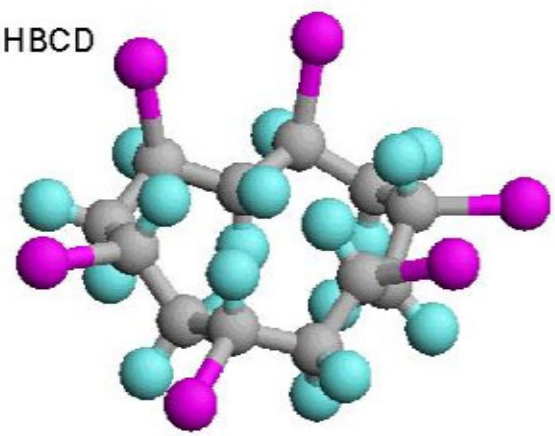
Grey: carbon

Red: oxygen

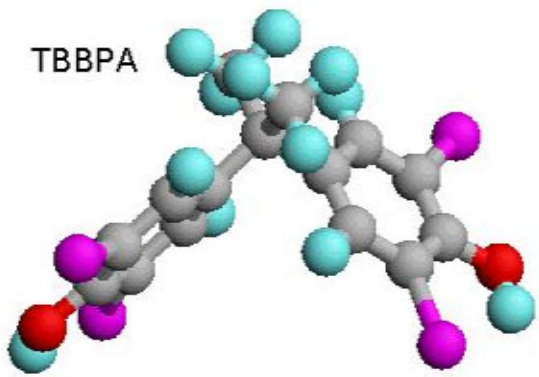
Lilac: bromine

Cyan: hydrogen

HBCD



TBBPA



Some mixed into polymers - not chemically bound to plastics or textiles- leach from surface into environment

Electronics & Electrical: 56 %
Building/Construction: 31%
Textile/other: 6 %, Transportation: 7 %

Estimated world market demand for PBDEs, TBBPA and HBCD in 1999 (de Wit, 2002; www.bsef.com)

in metric tons	PeBDE	OcBDE	DeBDE	TBBPA	HBCD
Americas	8290	1375	24300	21600	3100
Europe	210	450	7500	13800	8900
Asia	0	2000	23000	85900	3900
Total	8500	3825	54800	121300	15900

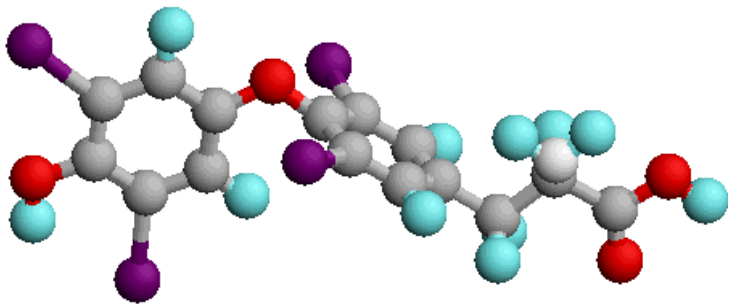
Humans and PBDEs: Exponential increase in breast milk

(Lennart Nilsson)

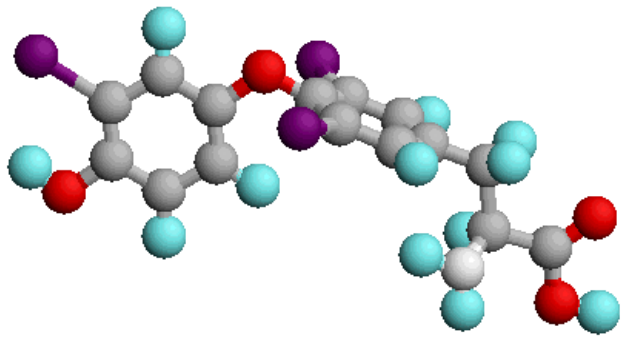
T4, T3, OH-PBDE, TBPPA

Structure similarities

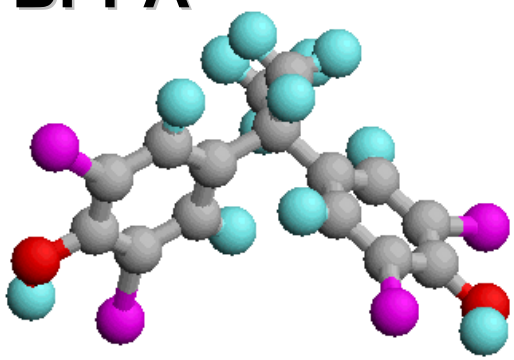
T4



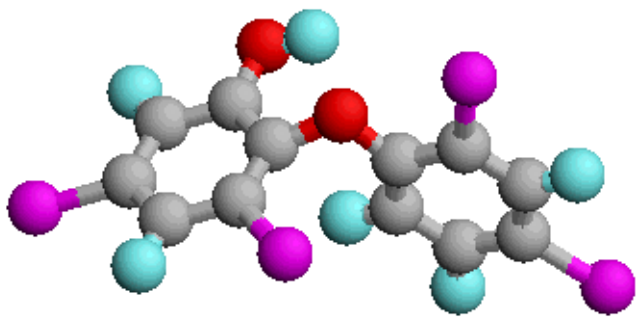
T3



TBPPA

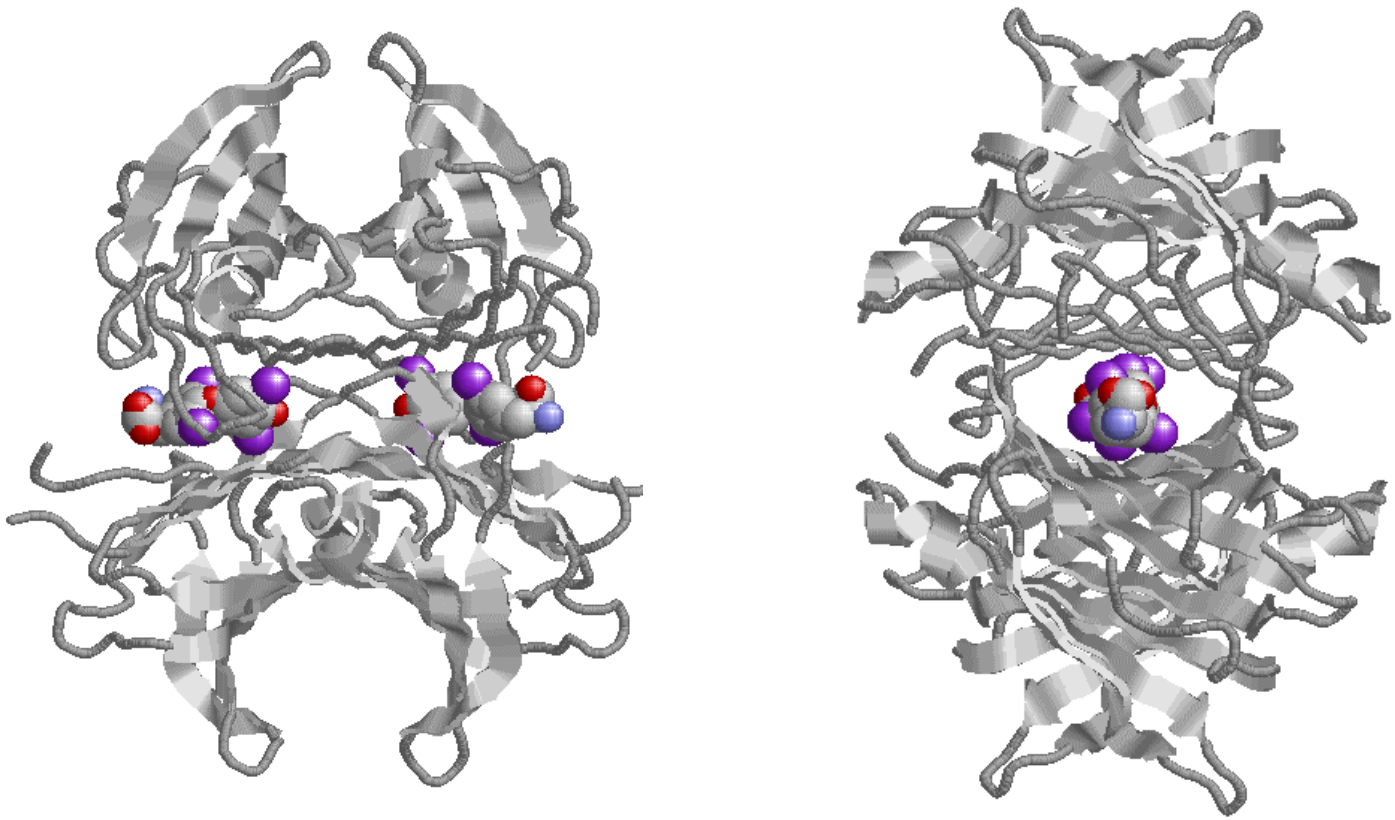


OH-BDE47



Rat Transthyretin Complex With Thyroxine (T4)

Important transport protein for the growth hormone



Outline

- Brominated flame retardants
- GLOBE Arctic POPs
  - Background, objective, status
- Results from fall 2001 sampling

Background

- GLOBE – ”Hands on”
  - Global Learning and Observations to Benefit the Environment- www.globe.gov
- Norwegian GLOBE initiative
  - Arctic project
- NILU contact – 1999/2000
- New protocol: New POPs in Arctic

What is The GLOBE Program?

GLOBE is a worldwide hands-on, primary and secondary school-based education and science program.

For Students, GLOBE provides the opportunity to learn by:

- Taking scientifically valid measurements in the fields of atmosphere, hydrology, soils, and land cover/phenology - depending upon their local curricula
- Reporting their data through the Internet
- Creating maps and graphs on the free interactive Web site to analyze data sets
- Collaborating with scientists and other GLOBE students around the world

For Teachers, GLOBE provides assistance through:

- Training at professional development workshops
- Teacher's guides, "how-to" videos, and other materials
- Continuing support from a Help Desk, scientists, and partners
- Contact with other teachers, students, and scientists worldwide.

For International and U.S. Partners, GLOBE provides:

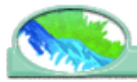
- Train-the-Trainer workshops
- Guidance and support for mentoring teachers

What is the Value of GLOBE?

"GLOBE is the quintessentially ideal program for involving kids in science," - Nobel laureate

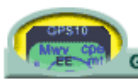
Atmosphere/Climate

- Protocols:
  - Air Temperature (pdf)
  - Clouds (pdf)
  - Precipitation (pdf)
  - Aerosol (pdf)
  - Surface Ozone (pdf)
  - Relative Humidity (pdf)
  - Barometric Pressure (pdf)
  - Automated Air Temperature Monitoring (pdf)
  - Digital Multi-Day Max/Min/Current Air and Soil Temperatures (pdf)
- Protocol Videos
- Instrument Specifications (pdf)



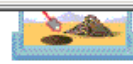
Hydrology

- Protocols:
  - Transparency
  - Water Temperature
  - Dissolved Oxygen
  - pH
  - Electrical Conductivity
  - Salinity
  - Alkalinity
  - Nitrate
- Protocol Videos
- Instrument Specifications (pdf)



General Information

- Instrument Suppliers
- Earth As a System Videos



Soil

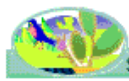
- Protocols:
  - Soil Characterization Field Measurements
  - Soil Characterization Lab Analysis
  - Gravimetric Soil Moisture
  - Soil Moisture and Temperature
  - Soil Moisture Sensor
  - Soil Infiltration
  - Automated Soil Temperature Monitoring (pdf)
  - Digital Multi-Day Max/Min/Current Air and Soil Temperatures (pdf)
- Protocol Videos
- Instrument specifications (pdf)

Land Cover/Biology

- Protocols:
  - Qualitative Land Cover
  - Quantitative Land Cover
  - Biometry
- Protocol Videos
- Instrument Specifications (pdf)

Phenology

- Protocols:
  - Green-up / Green-down (pdf)
  - Ruby-throated Hummingbird



Special Measurements

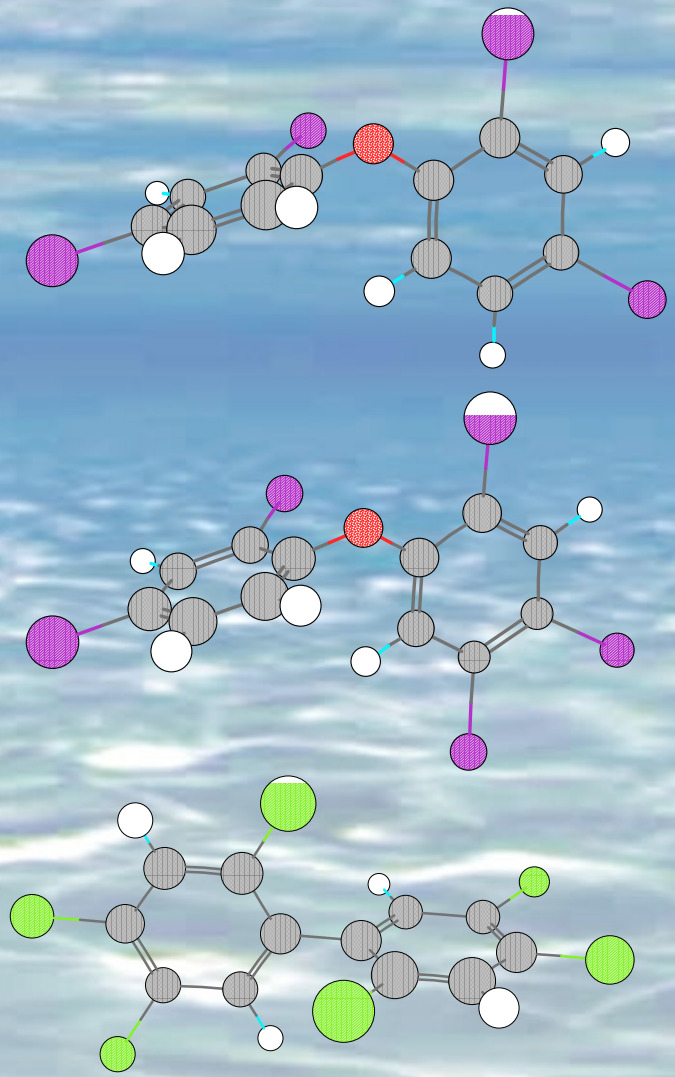
Measurements:

- Budburst

Background

- GLOBE – ”Hands on”
  - Global Learning and Observations to Benefit the Environment- www.globe.gov
- Norwegian GLOBE initiative
  - Arctic project
- NILU contact – 1999/2000
- New protocol: New POPs in Arctic

Objective



- ***Investigate*** **the distribution and level of new selected POPs in the Arctic region**
- ***Increase the knowledge*** **of POPs and general environmental science in the involved schools**
- ***Contribute to the documentation*** **of new POPs in the Arctic, needed for international political processes**

Protocol 2001/2002

- **Scientific correct sampling of fish tissue**
  - liver from cod
  - fillets from salmonids
- **Written protocol by NILU**
  - Precleaned and burned equipment from NILU
- **Biological parameters**
  - length, weight, maturity, otoliths and scales
- **Preparing datasheets**
  - marking and packing in a correct way and shipping to NILU
- **Documentation with camera**
- **Reporting via internet portal**
  - www.nilu.no/web/arcticpops

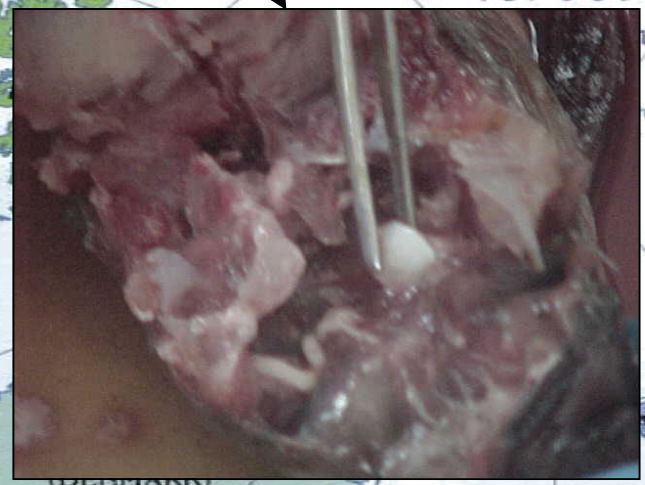
Project status

- **7 countries and 15 schools**

- **Alaska: Anchorage, Kodiak**
- **Canada: Inuvik, Old Crow, Pangnirtung**
- **Russia: Apatity, Murmansk**
- **Iceland: Akureyri, Vestmannaeyjar**
- **Norway: Leknes, Vannareid, Kjøllefjord**
- **Sweden: Kiruna, Pajala**
- **Finland: Tornio**


15 schools
Kodiak
Anchorage
Old Crow
Inuvik
Pangnirtung
Akureyri
Vestmanneyjar
Kjøllefjord
Vannareid
Leknes
Kiruna
Pajala
Tornio
Apatity
Murmansk

Kick-off



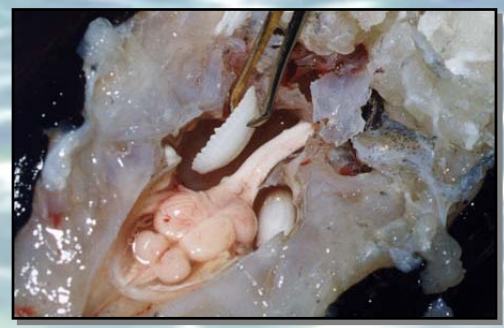
Ocean
Kodiak
Bethel
Gulf of Alaska
Anchorage
Valdez
Bering Strait
Nome
UNITED STATES
Fairbanks
Juneau
Whitehorse
Chukchi Sea
Dawson
Watson
Prudhoe Bay
Barrow
Beaufort Sea
Banks Island
Arctic
SEVERNAYA ZEMLYA
Repulse Bay
Hudson Bay
Baffin Island
Baffin Bay
Iqaluit (Frobisher Bay)
Dikson
Kara Sea
FRANZ JOSEF LAND
NOVAYA ZEMLYA
Svalbard (NORWAY)
Davis Strait
Barents Sea
Kangerlussuaq (Søndre Strømfjord)
Greenland Sea
Bjørnøya (NORWAY)
Nuuk (Godthåb)
Paamiut (Frederikshåb)
Itseqqortoormiit (Scoresbysund)
Tasiilaq (Ammassalik)
Jan Mayen (NORWAY)
Murmansk
Tromsø
Labrador Sea
Narsarsuaq
Norwegian Sea
Denmark Strait
Arctic Circle
ICELAND
Reykjavík
NORWAY
FINLAND

Fish Sampling

- *Liver from lean fish*
  - cod, burbot

- *Fillets from salmonids*
  - salmon, trout, char

- Physiological data
  - Weight, length
  - Gender, maturity
  - Otoliths or scales



Filleting

Maturity

Packing

Project status (cont.)

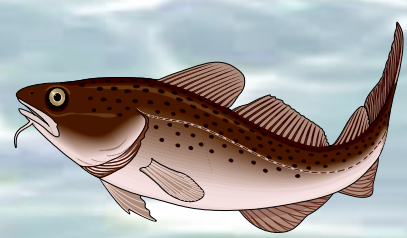
- **Fall 2001 sampling (results)**
  - **Workshop Akureyri, Iceland August 2002**
- **Spring 2002 samples**
  - **Analyses now**
- **Fall 2002 sampling now**

Results
Fish types Autumn 2001

COD

• Norway	VND	cod
	VVO	cod
	KFD	cod
• Iceland	VMA	cod
	BVA	haddock
• Alaska	KHS	cod

- 12 cod samples



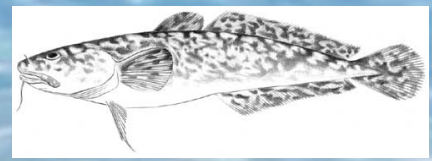
Salmon, char, trout

• Sweden	LAE	salmon
	HJS	trout
• Alaska	POK	salmon
• Canada	ATT	char

8 samples of salmon, char and trout

Other fish types

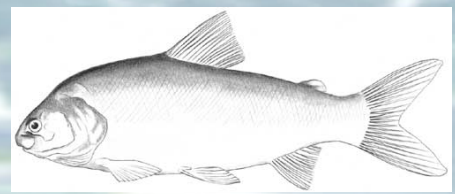
- **Finland** PUS Whitefish fillet
- **Russia** GYM Coregonus liver
- **Canada** SHH Loche liver

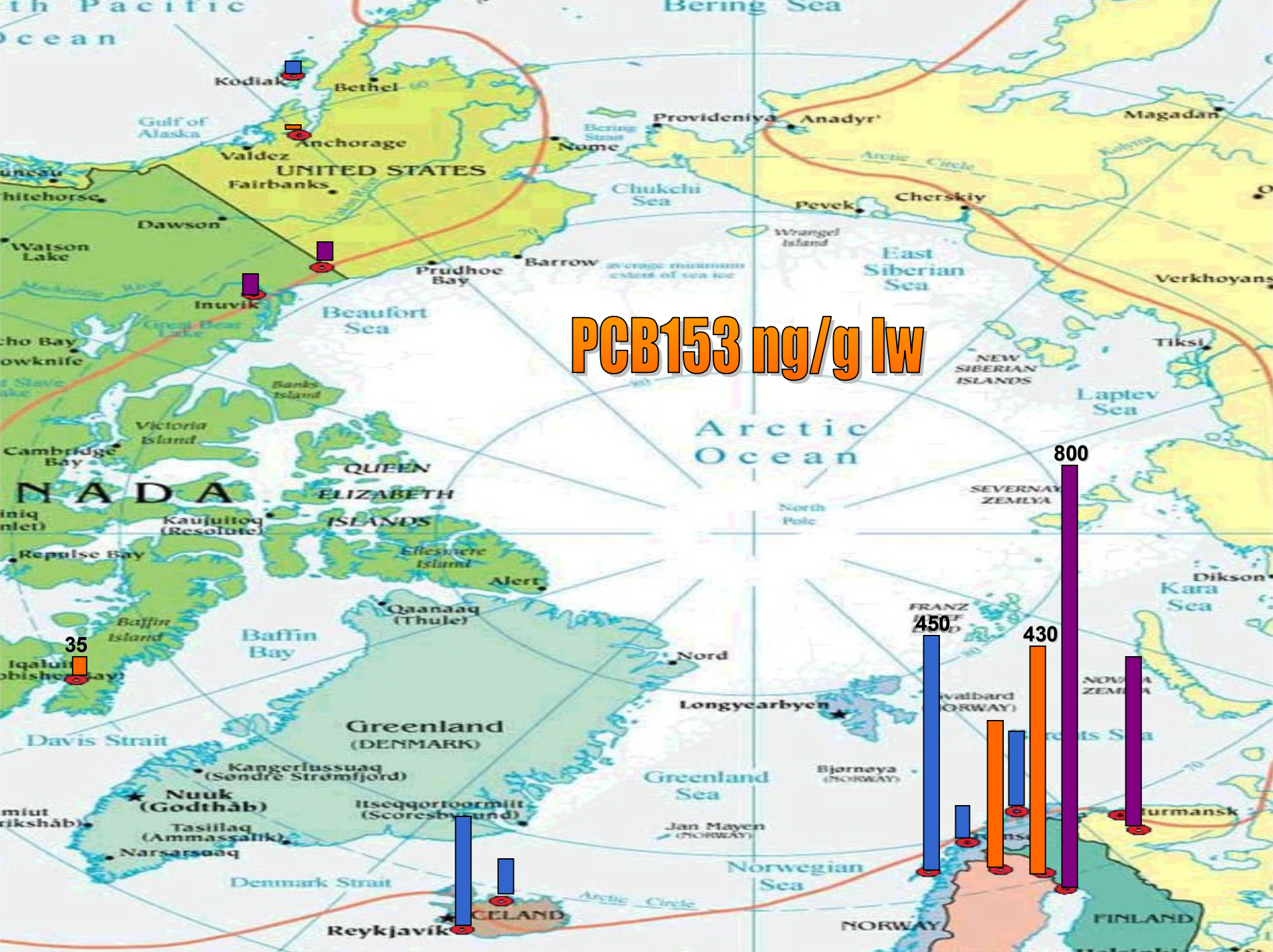


CZG Lake whitefish liver

CZG Broad whitefish liver

- **8 samples**




PCB153 ng/g lw
35
450
430
800
Kodiak
Bethel
Anchorage
Valdez
UNITED STATES
Fairbanks
Dawson
Watson Lake
Inuvik
Prudhoe Bay
Barrow
Beaufort Sea
Gulf of Alaska
Bering Sea
Provideniya
Anadyr'
Nome
Magadan
Chukchi Sea
Pevek
Cherskiy
Wrangel Island
East Siberian Sea
Verkhoyansk
Tiksi
NEW SIBERIAN ISLANDS
Laptev Sea
Arctic Ocean
North Pole
Banks Island
Victoria Island
Cambridge Bay
QUEEN ELIZABETH ISLANDS
Kaujuitoq (Resolute)
Repulse Bay
Ellesmere Island
Alert
Qaanaaq (Thule)
Baffin Island
Baffin Bay
Nord
Longyearbyen
Svalbard (NORWAY)
SEVERNAYA ZEMLYA
FRANZ JOSEF LAND
Dikson
Kara Sea
Greenland (DENMARK)
Davis Strait
Kangerlussuaq (Søndre Strømfjord)
Nuuk (Godthåb)
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Norwegian Sea
Arctic Circle
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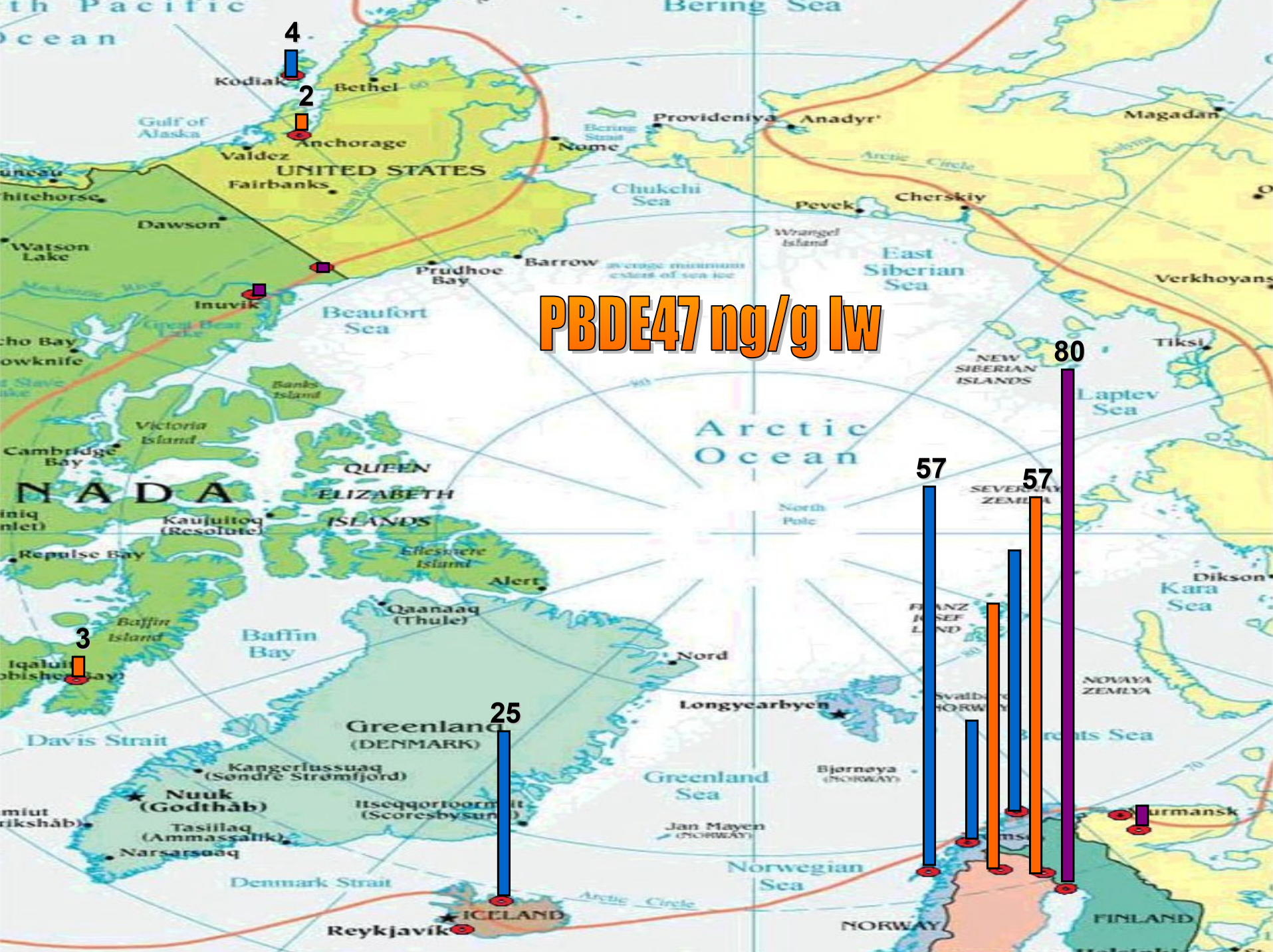
Reykjavík
NORWAY
FINLAND


PBDE47 ng/g lw
4
2
3
25
57
57
80
Kodiak
Bethel
Gulf of Alaska
Anchorage
Valdez
UNITED STATES
Fairbanks
Dawson
Watson Lake
Inuvik
Beaufort Sea
Prudhoe Bay
Barrow
Provideniya
Anadyr'
Nome
Magadan
Chukchi Sea
Pevek
Cherskiy
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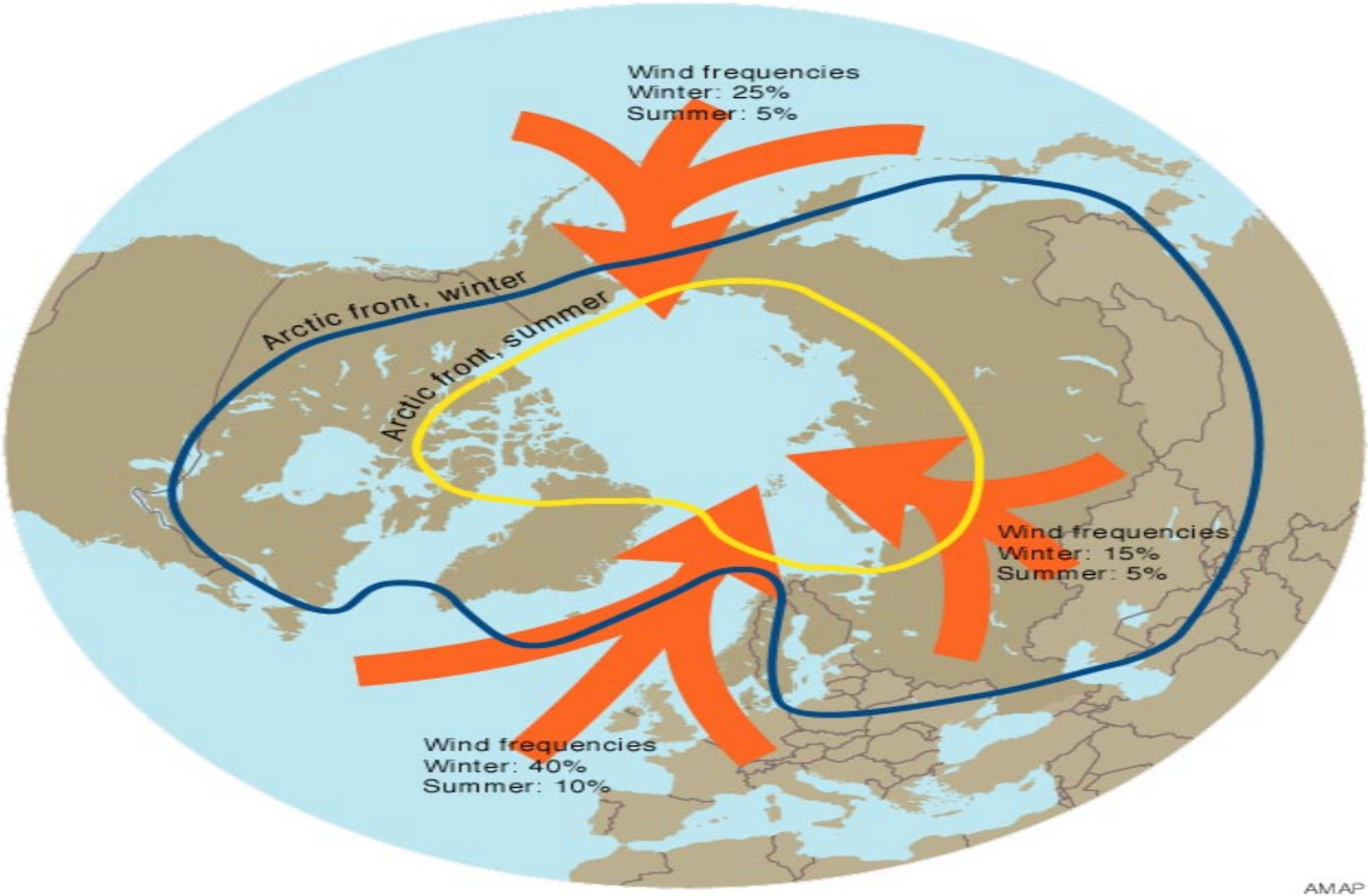
Greenland Sea
Bjørnøya (NORWAY)
Jan Mayen (NORWAY)
Murmansk
Norwegian Sea
Denmark Strait
Arctic Circle
ICELAND
Reykjavík
NORWAY
FINLAND

The position of the Arctic front influences contaminant transport in the atmosphere. The figure shows the mean position of Arctic air mass in January and July and the winter and summer frequencies of winds driving the major south-to-north transport routes.

Arctic Monitoring and Assessment Programme

Arctic Pollution Issues: A State of the Arctic Environment Report, Chapter 3, Figure p.22/1



Results 2001 sampling

PBDEs found of all over the Arctic

Lower levels in Arctic than in south

Industrialised part of Europe and America

European Arctic > American/Canadian Arctic

Spatial trend: confirm AMAP results

Wind direction differences, river outlets,
distance form source, different food webs (diets) etc

ng/g lipid weight-*Ref. De Wit, 2002*

Fish species	Location	PBDE47	PBDE99	PCB153
Salmon	Umeå river SE	167 57	52 18	 LAE
Salmon	Dalalven Baltic, SE	200	54	1100
Arctic char	Lake Vattern, SE	400 3	64 2-3	 ATT
Trout	Dalsland Canal SE	120-460 40	64-590 24	 HJS
Trout (whole fish)	Lake Ontario	267	64	
Trout (whole fish	Lake Erie	70	9	
Whitefish (muscle)	Lake Storvindeln	15 2	7.2 1	 SHH (liver)
Cod (liver)	North Sea	170 57	 19	 VVO

Project web site

GLOBE project: Arctic POPs

First page

About the project:
- General
- Scientific background
- Results
- Reports

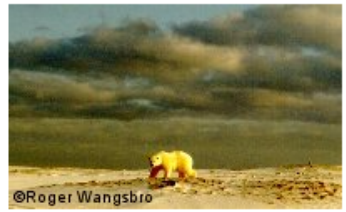
Coordination:
- Documents
- Schools
- Project personell
- GLOBE coordinators

Links:
Norwegian Institute for Air Research
The GLOBE program

Arctic POPs

This project seeks to create a network of GLOBE schools and scientists above the Arctic circle that will study the Arctic environment and contribute data to support Arctic research. Students will take GLOBE measurements and investigate the distribution and level of selected POPs in the Arctic region, increase the knowledge of POPs and general environmental science in the involved schools, and contribute to the documentation of new emerging POPs in the Arctic.

15 schools from countries in the Arctic are taking part in an international scientific investigation of toxic pollutants in the Arctic. These pollutants are a threat to the environment in the Arctic. The importance of the problem was clearly shown during the Stockholm Convention in May 2001 where the press release said: "Governments Give Green Light to Phase Out of World's Most Hazardous Chemicals".



Related links:

- **AMAP: A State of the Arctic Environment Report**
  The Arctic, Physical pathways, POPs etc.
- **Globe Stars - Studying the Arctic**
- **The Arctic Council**
- **The GLOBE program**
  Global learning and observations to benefit the environment
- **UNEP- What are POPs?**
  Good educational pages about POPs

Project news:
Fish sampling fall 2002

You decide when to do the sampling. You can get the fishes before you have received the equipment. Keep the fishes in the freezer until you have equipment and can do the sampling. If time consuming and difficult to do the sampling yourself, get the fish from others. Send the samples before December 15.

Datasheets should be sent per e-mail (esh@nilu.no), and may also be send together with the samples. Analysis will be performed in January 2003. Results should be available end of February.

Important:
Please **verify correct sampling** when writing the report. Verify with both text and photos that the sampling is correctly performed. If possible show by pictures, that the cutting and handling of the samples are done scientific correctly, for instance that the sample handling is performed using clean forceps. Try to avoid touching the samples with hands or gloves.

Please read the file 'PROTOCOL_add-ons' located in the right margin within 'Documents'

All the best,
Eldbjørg Sofie

GLOBE project: Arctic POPs

First page

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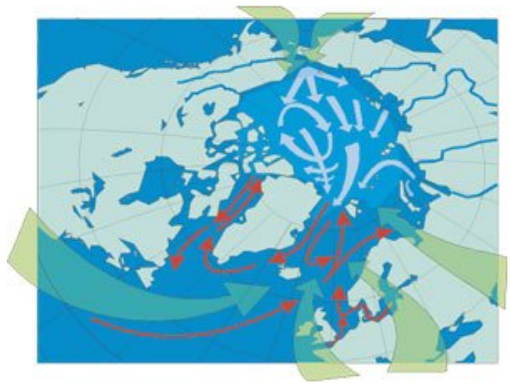
- GLOBE coordinators

Links:
Norwegian Institute for Air Research
The GLOBE program

Background

Several of the pollutants that impose a threat on animals in the polar regions are transported with winds, ocean currents and sea ice from industrial areas at more southerly latitudes.

Irresponsible or excessive use of pesticides and industrial chemicals contributes to the high levels of pollutants that are found in polar bears and other species. Most countries no longer use PCBs, but as a result of their slow degradation and the fact that emissions have continued for many years, the compounds are still finding their way into Arctic ecosystems. New chemical compounds are also being transported to the Arctic ecosystems and end up in polar bears.



©NILU
Green arrows: wind currents
Red arrows: ocean currents
Light blue arrows: ice drift
Blue lines: rivers

Because they are very soluble in fat, persistent organic pollutants (POPs) readily enter food chains, especially in the marine environment. These compounds accumulate in fat deposits, a process known as bioaccumulation, and thus become more concentrated in higher organisms that prey upon lower organisms. Storing energy as fat is crucial for survival in cold environments, and fat is therefore important in the diets of both people and animals, which also increase the intake of these pollutants. The combined characteristics of being fat-soluble and persistent make biomagnification a major concern.

Biomagnification is the increase in contaminant load as predators take on the chemicals eaten by their prey, thus further concentrating the toxic material at each successive level of the food web. Indeed, the highest levels of persistent contaminants are usually

Files for download

Right click on the wanted file to save it on your harrdisk. To view, **left** click, but be aware that this can be slow with bad lines and big files.

- **Arctic links** (doc-format, 25 Kb)
- **Effect links** (doc-format, 39 Kb)

NOEL, Tolerable Daily Intake etc.

- **Fish links** (doc-format, 30 Kb)
- **POPs links** (doc-format, 26 Kb)
- **Sampling manuals-links** (doc-format, 26 Kb)
- **Transport links** (doc-format, 32 Kb)

Transport routes of POPs

To read the pdf.files you need Adobe Acrobat Reader. This program can be downloaded for free from Adobe

Arctic links

UNEP- Arctic portal
http://arctic.unep.net/

Arctic Environmental Atlas
http://maps.grida.no/arctic/

UNEP- GRIDA- Arctic themes- graphics
http://www.grida.no/db/maps/prod/level1/70401.htm

Arctic maps
http://www.athropolis.com/links/maps.htm

Online Map Creation (check this out!)
http://www.aquarius.geomar.de/omc/omc_intro.html

Arctic theme page
http://www.arctic.noaa.gov/maps.html

Geography network
Write in Arctic in the 'Find' (ctrl f) window
http://www.geographynetwork.com/free.cfm

Arctic Council -links
http://www.arctic-council.org/links.asp

Arctic bulletin - downloadable PDF files
http://www.ngo.grida.no/wwfap/core/publications/arctic_bulletin.html#ab

Arctic Pollution Issues:
A State of the Arctic Environment Report:
http://www.amap.no/assess/soaer-cn.htm

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Transport routes of POPs

Background information on persistent organic pollutants (POPs)
http://www.cep.unep.org/gpa/pops.htm#background

Inputs of POPs in The Marine Environment *(good educational page)*
http://pops.gpa.unep.org/031marin.htm

Look also in general at:
http://pops.gpa.unep.org/

Physical pathways of contaminant transport
http://www.amap.no/assess/soaer3.htm#physical%20pathways%20of

Look also in general at:
http://www.amap.no/assess/soaer-cn.htm

Dominating wind currents
http://www.grida.no/db/maps/prod/level3/id_1246.htm

Transport routes of POP and concerned areas
http://www.grida.no/db/maps/prod/level3/id_1188.htm

Ocean current and sea ice extend
http://www.grida.no/db/maps/prod/level3/id_1178.htm

The Link between Persistence and Long-Range Transport
http://www.cefic.be/icca/pops/en/pops1002.htm

The significance of long range transport of persistent organic pollutants by migratory animals

GLOBE project: Arctic POPs

First page

About the project:
- General
- Scientific background
- Results
- Reports

Coordination:
- Documents
- Schools
- Project personell
- GLOBE coordinators

Links:
- Norwegian Institute for Air Research
- The GLOBE program

Results

Fall 2001:
The results from the analysis of PBDE47, PBDE99 and PCB153 are now ready.

We have made an Internet portal for registration of your data from your school.

You need to have the 'Field Datasheet' for sample1 and sample2 and the 'Arctic-POPs-Results' file in order to fill in the necessary data fields. If you do not have a copy of the 'Field Datasheet' ask us to send them to you immediately. You should describe how the sampling procedure was performed. It is nice if you can inform if clean equipment was used for each sample and that handling of the samples was done in an scientific appropriate way etc. If something funny happened, add of course that too! ;-)

When you have finished writing the report **do not forget to click on 'Send to approval'!**

Go to Report-generator for POPs in Arctic project >>

Files for download

Right click on the wanted file to save it on your harrdisk. To view, **left** click, but be aware that this can be slow with bad lines and big files.

- **How to report results** (doc-format, 27 Kb)
- **Reported levels of PBDEs** (doc-format, 25 Kb)
- **Specific tasks** (doc-format, 21 Kb)

To read the pdf.files you need Adobe Acrobat Reader. This program can be downloaded for free from Adobe

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Report from Verkmenntaskólinn 2001 on PBDE's and PCB's in Fish from Krossanes-pier.
- Part of GLOBE project 2001-2003 POP's in Artic.
Written by: Students-4N

Report basic facts

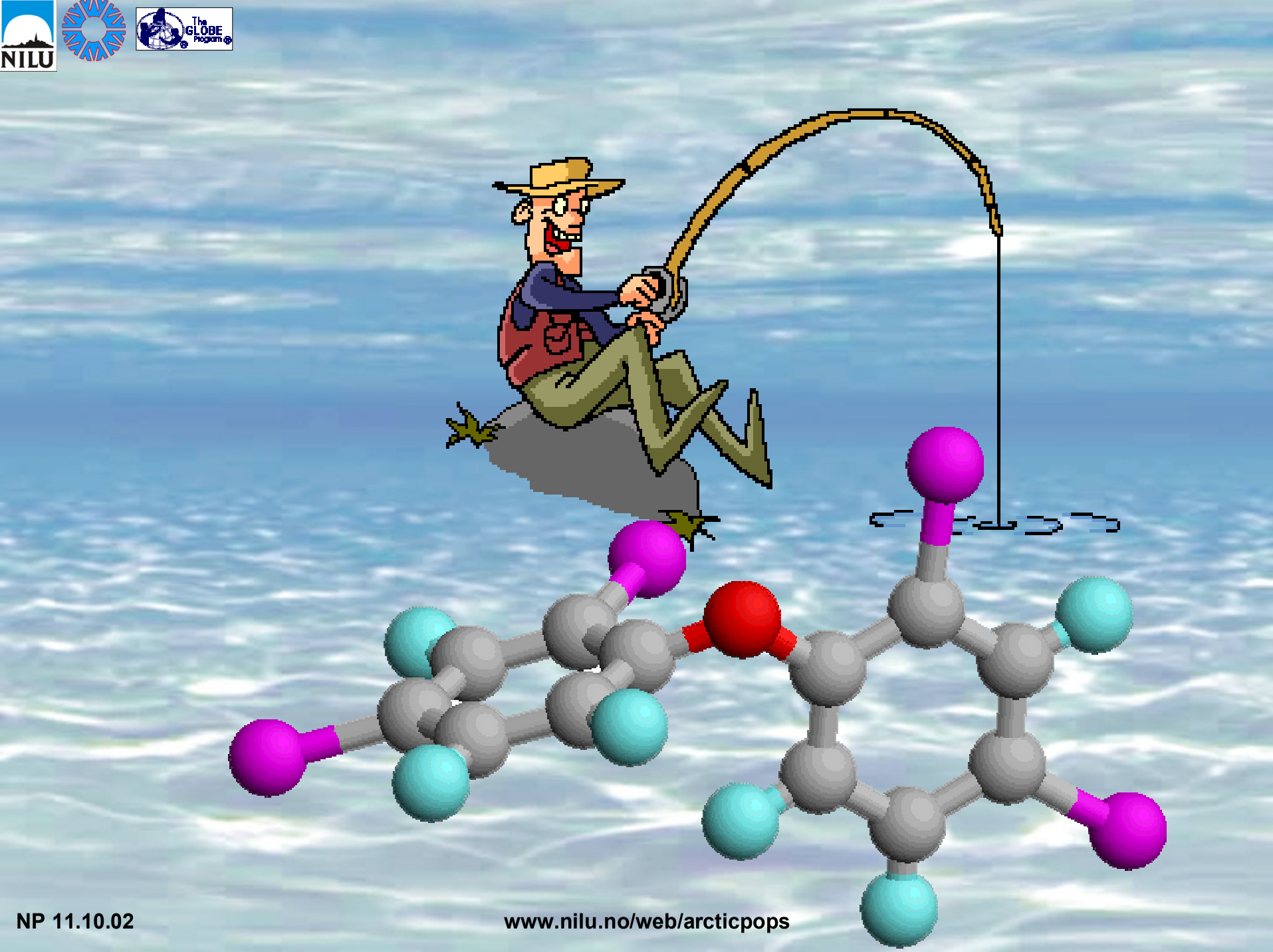
Date of sampling:	10/10/2001
Sample taken:	Fish
Latin name of species:	gadus morhua
Sampling method in field	angling
Type (and name) of sampling area:	Krossanes-pier
Latitude and longitude (* GLOBE GPS Investigation):	65,70367N 18,11279W
Nearest city/town/village:	Akureyri
Near industry (if, which industry):	fishing

Report on sampling

Description of the sampling process
Tried to catch arctic char in a river but due to bad weather, it was decided to catch some cod by angling. After 90 minutes 3 small cods were caught by angling and the cods were transported to the classroom in a metal box.
There the liver examples were taken as descriped by Nilu, packed and the teacher took it home were it was kept frozen until sent by DHL to Norway.

Evaluation of the sampling process
The protocols were easy to follow once translated. Decided to catch a cod again in spring.

Students of VMA



NP 11.10.02

www.nilu.no/web/arcticpops