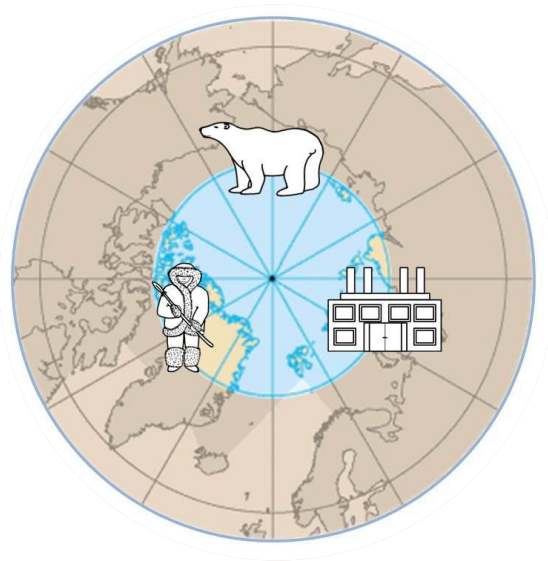
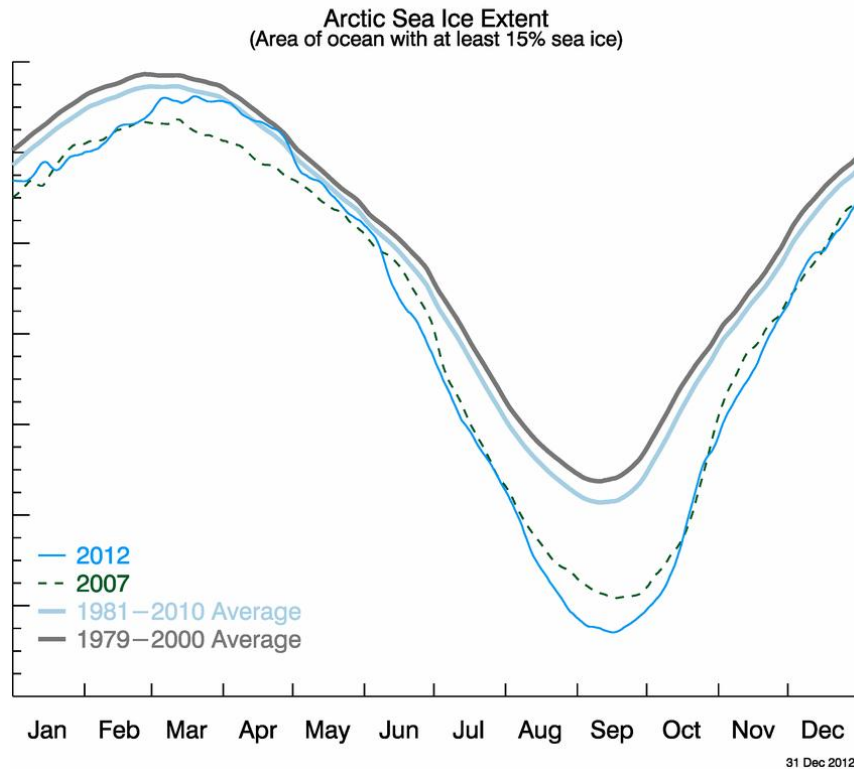


Marine indicators for environmental impact assessment in the Arctic

M.J. van den Heuvel-Greve, M.J.J. Kotterman, C.J.A.F. Kwadijk, N.W. van den Brink & B.C. Bolman



Decrease in sea ice coverage



Graph: National Snow and Ice Data Center

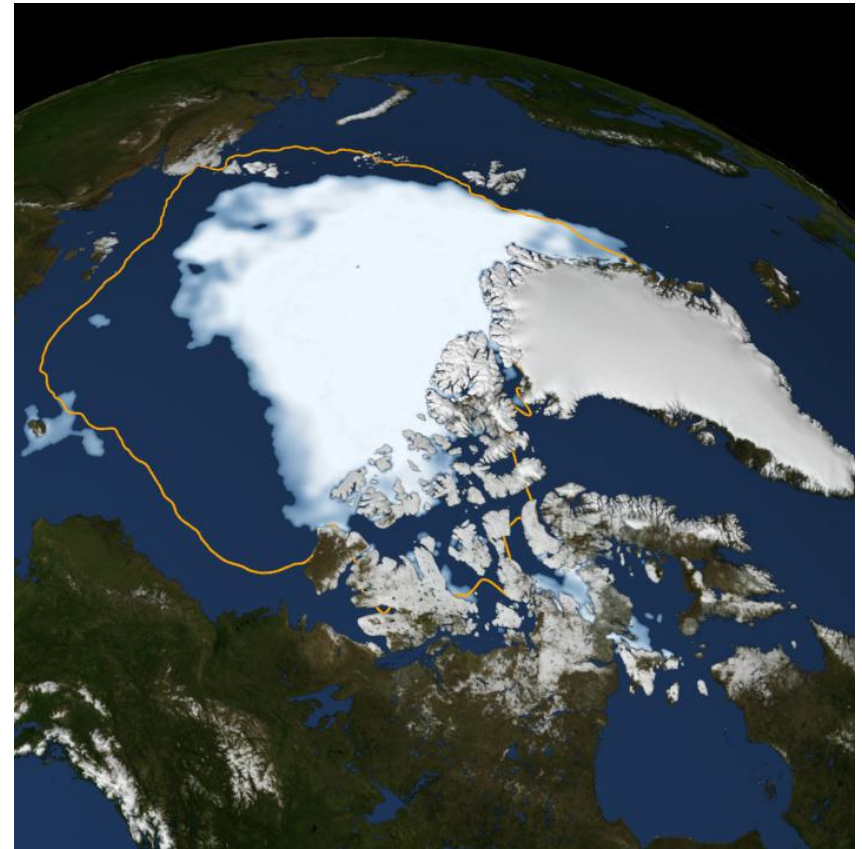


Photo: Scientific Visualization Studio, NASA Goddard Space Flight Center

Increase in Arctic developments

Harbour development and shipping



Offshore oil & gas exploration



Tourism



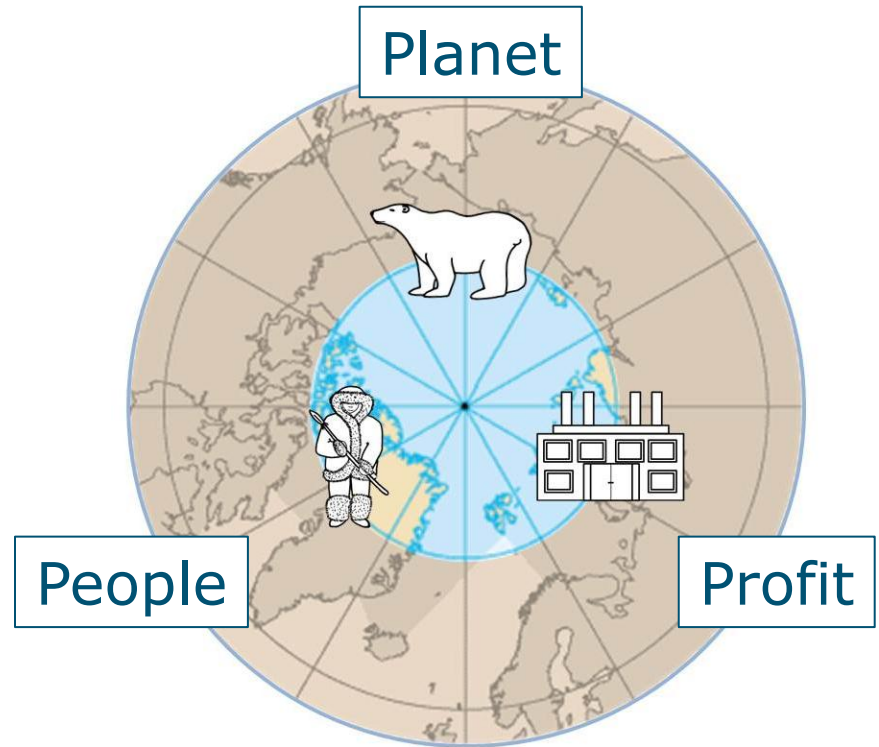
Fishery



Challenge

- Potential pressures of new activities on ecosystems
Example: oil spills, emission of chemicals, air pollution

- How to develop new activities in the Arctic ...
...in reconciliation with people and planet?



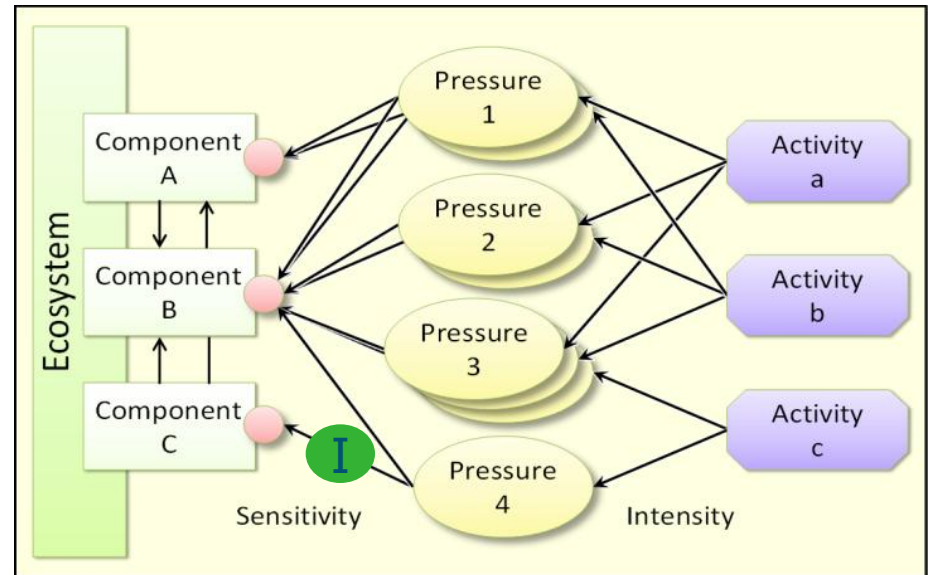
Environmental Impact Assessment

Impact Assessment:

→ Assess pressures of one or more activities on ecosystems components

Indicators:

→ Tools to measures one or more pressures of one or more activities on ecosystems components



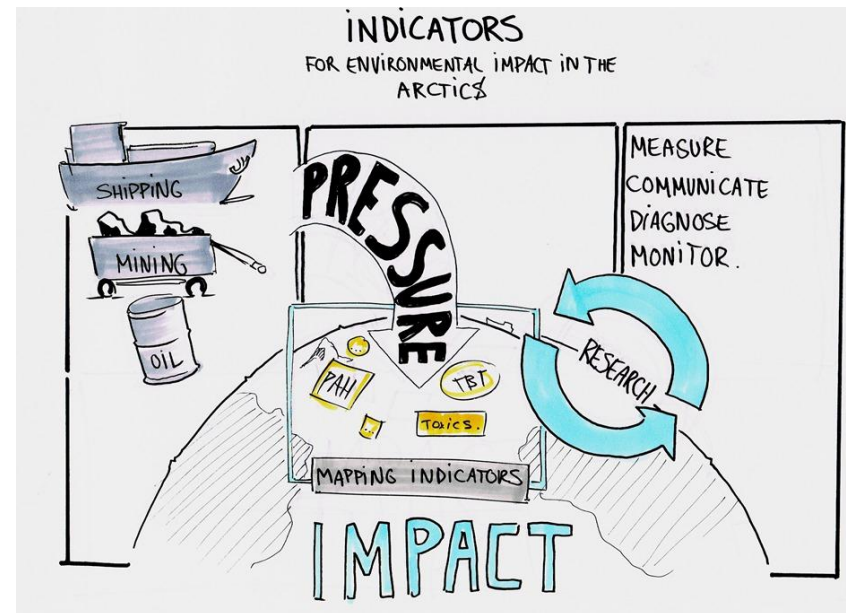
Karman & Jongbloed, 2008

See poster:

Lagerveld et al - Integral framework for assessing impacts on Arctic marine productivity

What are indicators...

- simple measures that tell us what is happening in the environment
- used to communicate the state of the environment to the general public and decision makers
- diagnostic tool through detecting trends in the environment (related to a certain pressure)
- applied in monitoring and assess results of mitigation measures

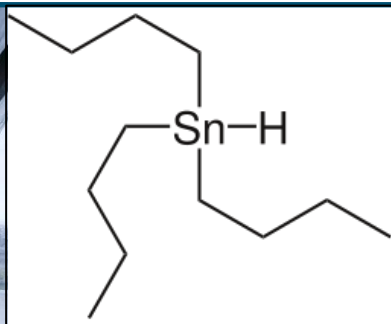


Types of biological indicators

- Contaminant concentrations in water, sediment, species (e.g. bivalves, bird eggs, marine mammal tissue)
- Effects in species (e.g. biomarkers)
- Community indices (e.g. BEQI)
- ...



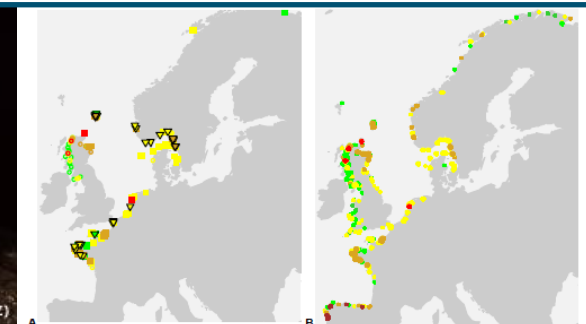
Activity:
Shipping



Pressure:
Emission of TBT
through antifouling
paints



Effect:
Tissue concentration
or effects of TBT in
molluscs



Monitoring:
Imposex rates in molluscs
(OSPAR QSR2010)

Examples of biological indicators

Activity	Pressure	Ecosystem component	Indicator
Shipping	TBT emissions	Invertebrates, especially bivalves and gastropods	-Imposex in gastropods (OSPAR) -[TBT] in bivalves and gastropods
Shipping	Introduction of non indigenous species	Species interactions	DNA profiling
Oil & gas extraction	PAH emissions	Invertebrates	Chemical and toxicological profiling
Fishery	Extraction	Fishes	Large fish indicator (OSPAR)

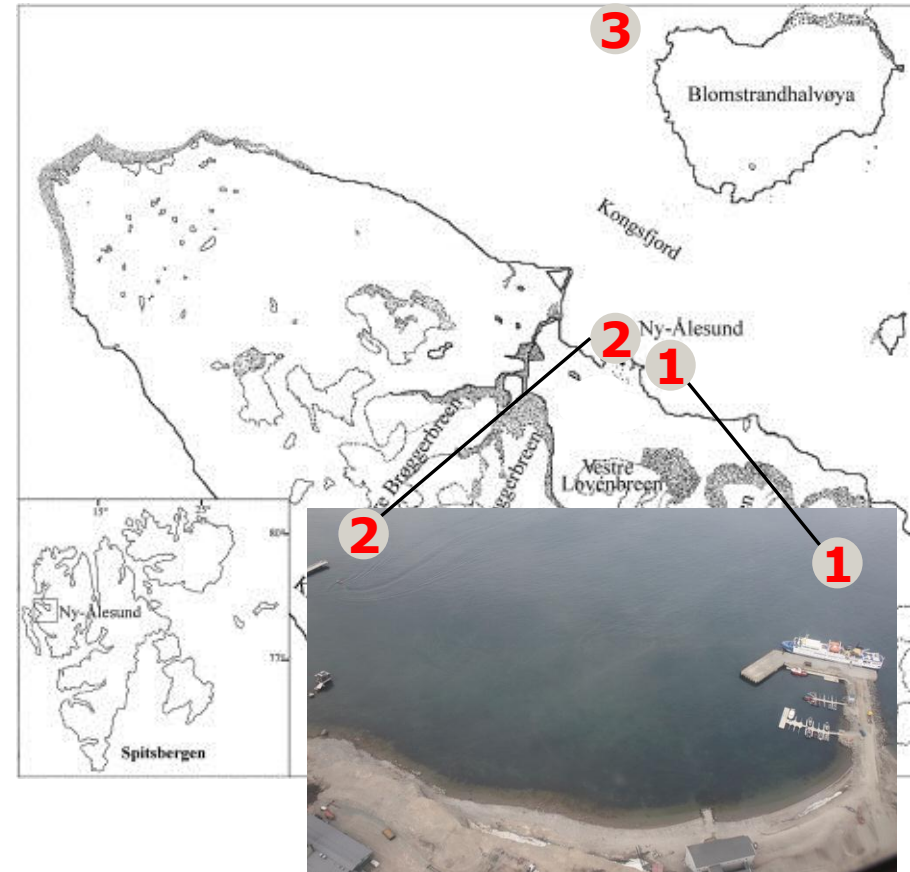
Pilot indicator development Svalbard 2012

- Goals:
 - Benthic biota - sampling methodology
 - Sediment – chemical analysis
 - Benthic biota – chemical analysis
- Van Veen grab and small dredge



Pilot indicator development Svalbard 2012

- June 2012
- 2 days Teisen work boat
- Kongsfjorden, Ny-Ålesund
- Impacted and reference sites:
 1. Ny-Ålesund harbour
 2. Coal harbour Ny-Ålesund
 3. Reference site



Pilot - Benthic biota - sampling

Shell fish:

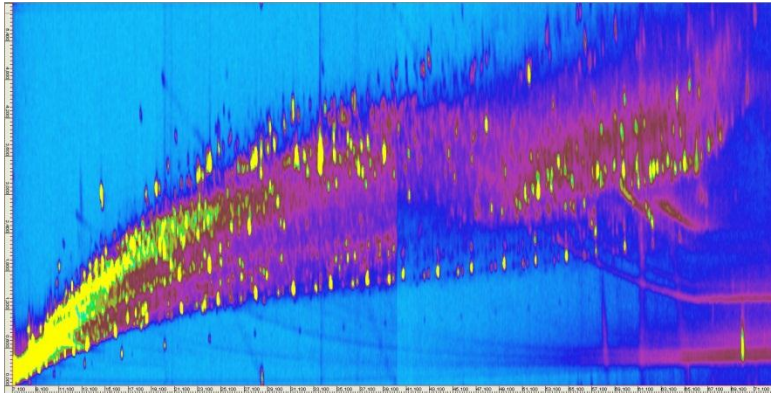
- *Astarte borealis*
- *Macoma* spp.
- *Serripes groenlandicus*
- *Hiatella arctica*



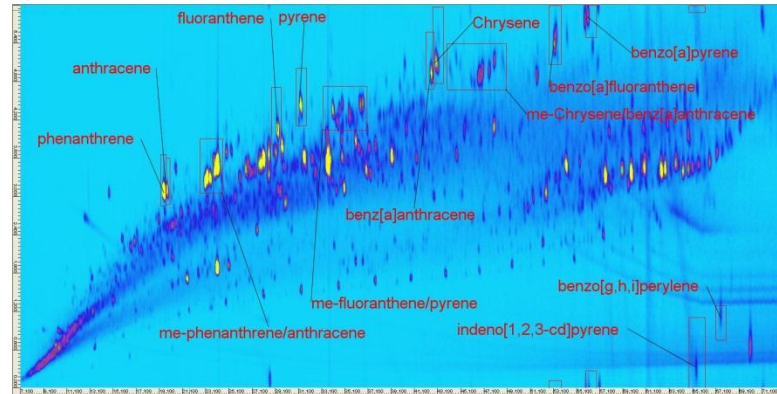
Marine worms:

- *Nephtys* spp.
- *Pectinaria* spp.

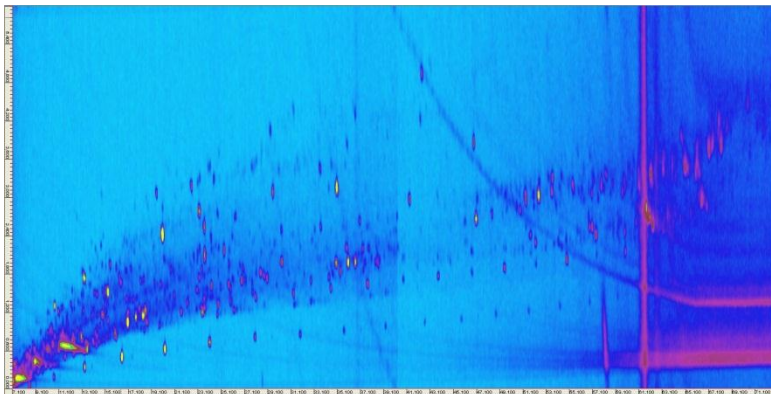
Pilot - Sediment screening by GCxGC-MS



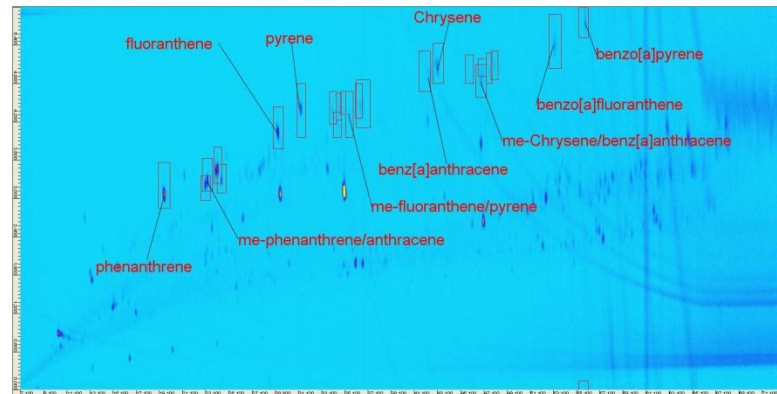
Ny-Ålesund harbour: full scan



Ny-Ålesund harbour: PAHs/Alkylated-PAHs



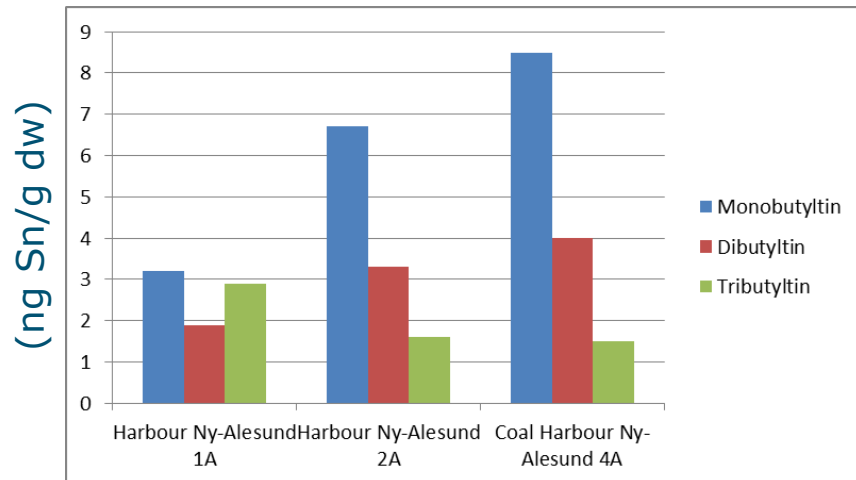
Reference site : full scan



Reference site: PAHs/Alkylated-PAHs

Pilot - TBT in sediment

Sample location	Sum Butyltin	Sum Phenyltin
Harbour Ny-Ålesund	2 of 3 samples Range <4.2-12 ng Sn/g dw	< dl
Coal Harbour	1 of 3 samples Range <3.6-14 ng Sn/g dw	< dl
Reference	< dl	< dl



Butyltin Degradation Index (BDI)
(Diez et al., 2002):

$$BDI = [MBT] + [DBT] / [TBT]$$

BDI harbour N-A (Butyltin > dl):

> 1 (1.2 – 5.6)

→ Degradation processes

Pilot - TBT in biota

Sample location	Sample	Sum Butyltin	Sum Phenyltin
Harbour Ny-Ålesund	1 pooled sample	< dl	< dl
Coal Harbour	1 pooled sample	< dl	< dl
Reference	1 pooled sample	< dl	< dl

Future analysis:

- Profiles of PAHs en alkylated PAHs in sediment and biota



Astarte borealis

Indicator development – future work

- PhD project ARCIND

(Development of ARCTic biological INDicators for the impact assessment of (new) human activities (2013-2016)(oil & gas)



Ariadna Szczybelski

- Project IPOP Arctic

(mining, shipping, harbour development)(2012-2015)



Acknowledgements pilot Svalbard 2012



Questions?

