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Review

State of knowledge on current exposure, fate and potential health effects of contaminants in polar bears from the circumpolar Arctic



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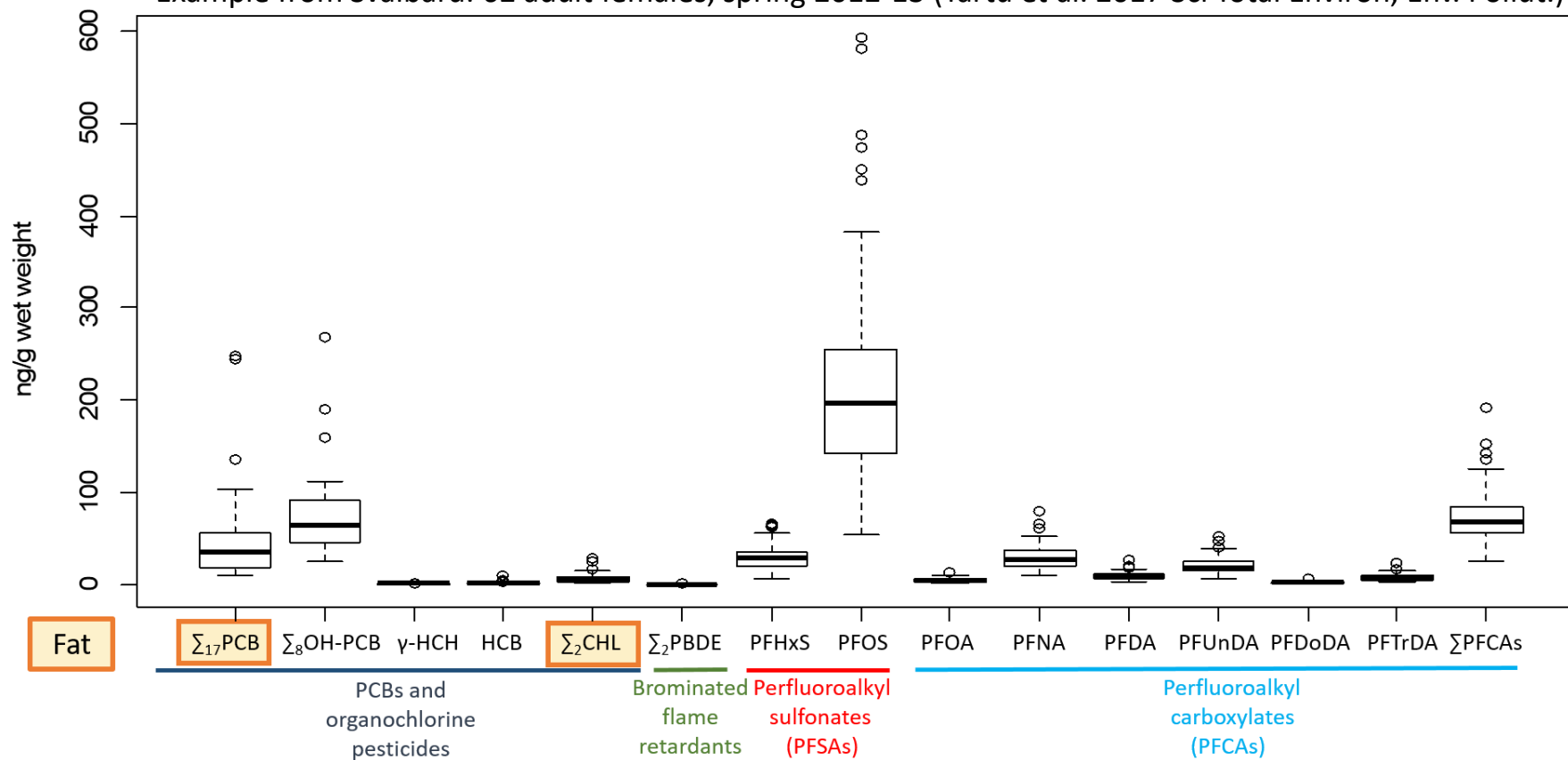
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Legacy persistent organic pollutants are still the main compounds in polar bears

- PFASs and OH-PCBs dominate in plasma
- PCBs and chlordanes dominate in fat tissue

Contaminants in polar bear plasma

Example from Svalbard: 62 adult females, spring 2012-13 (Tartu et al. 2017 Sci Total Environ, Env. Pollut.)



The Stockholm Convention on Persistent Organic Pollutants

Global treaty to protect human health and the environment from chemicals that

- persistent
- long-range transport
- bioaccumulate, biomagnify
- have harmful impacts on human health or on the environment

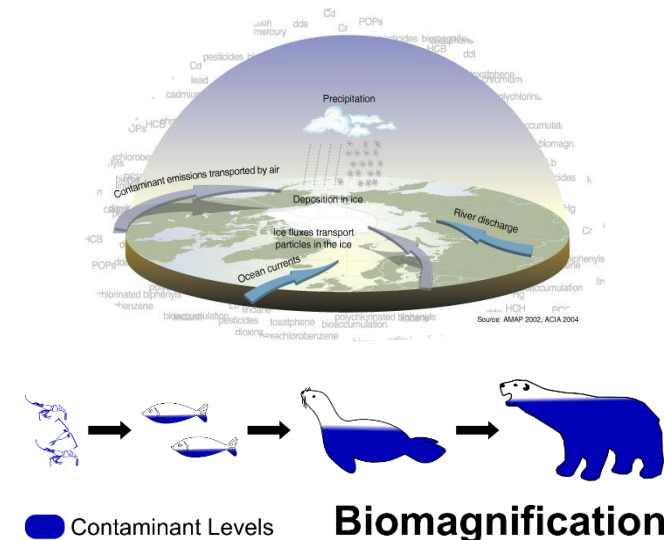


Entered into force 2004

- PCBs, several chlorinated pesticides, dioxins

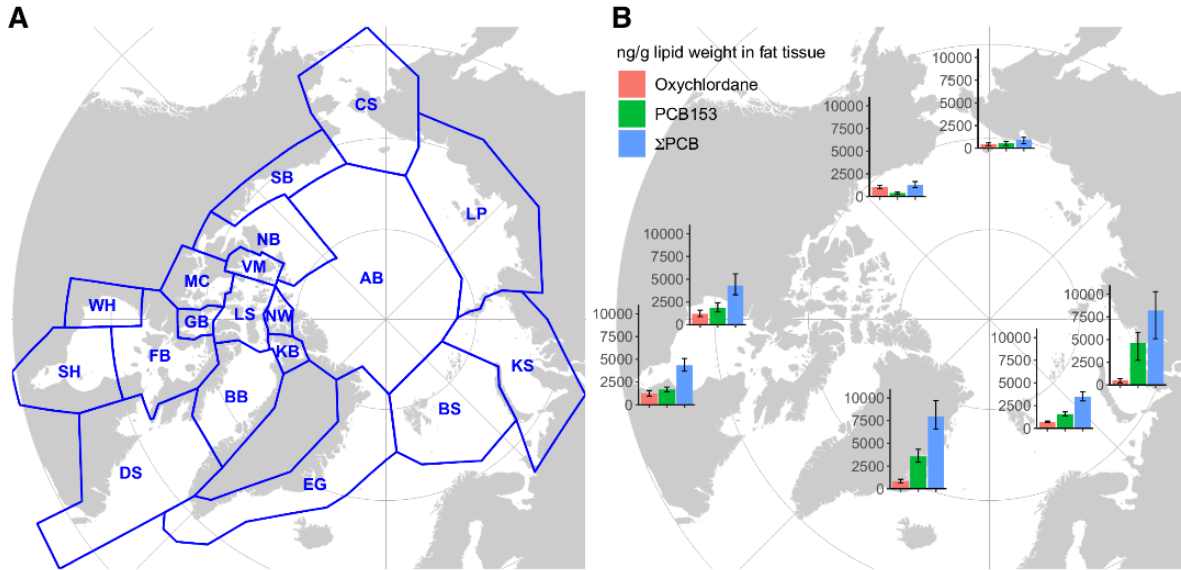
Compounds added later:

- Several brominated flame retardants (PBDEs, HBCDD)
- More chlorinated pesticides
- PFOS



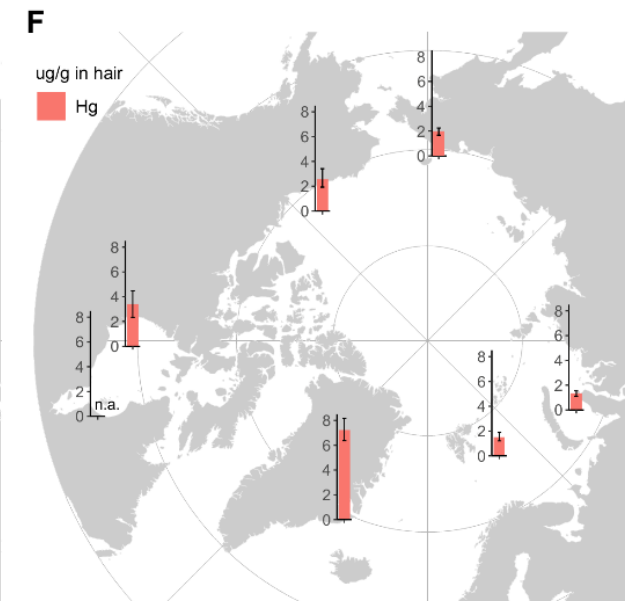
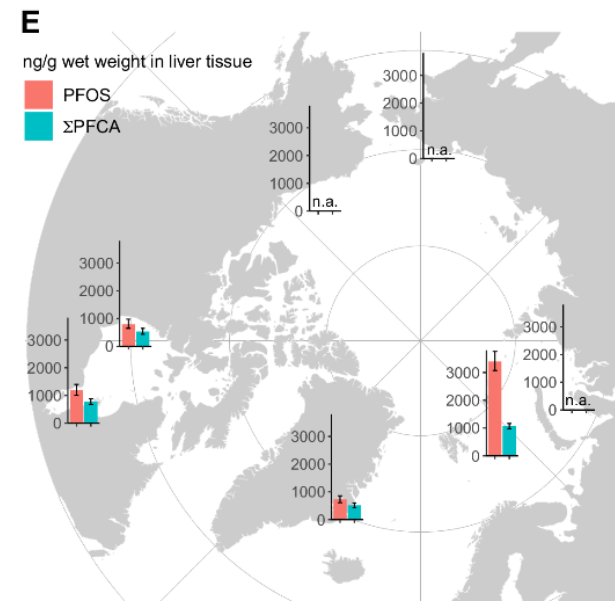
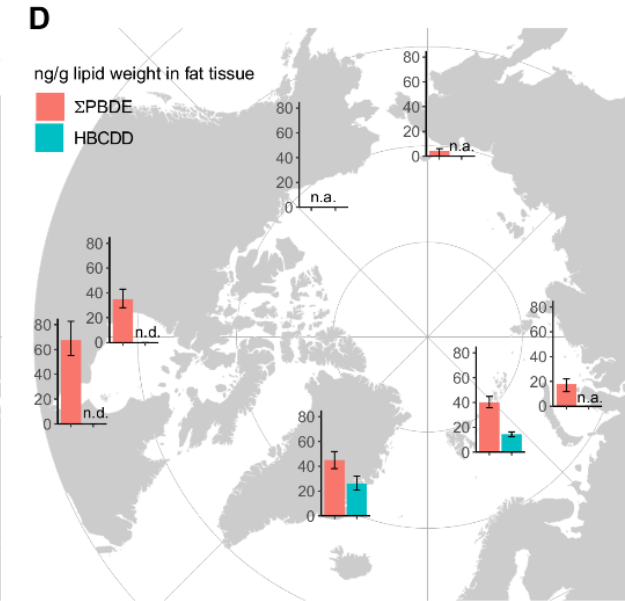
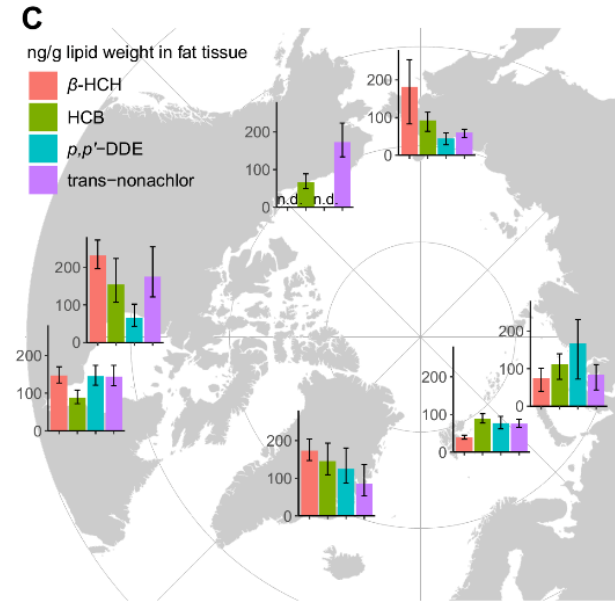
Circumpolar trends of contaminants in polar bears

Samples collected in 2011-2016



Temporal trends 1980s ->

- Most legacy compounds are declining over time
- Some are increasing
- Large variation among subpopulations



Studied endpoints for effects

East Greenland

- Samples from harvest: tissue samples available
 - Liver and kidney lesions
 - Bone mineral density, skull morphology
 - Size of sexual organs
 - Tissue concentrations of vitamin A and E
 - Cortisol levels in hair
 - Hormone concentrations and gene transcript levels in tissues
 - In vitro studies

Barents Sea

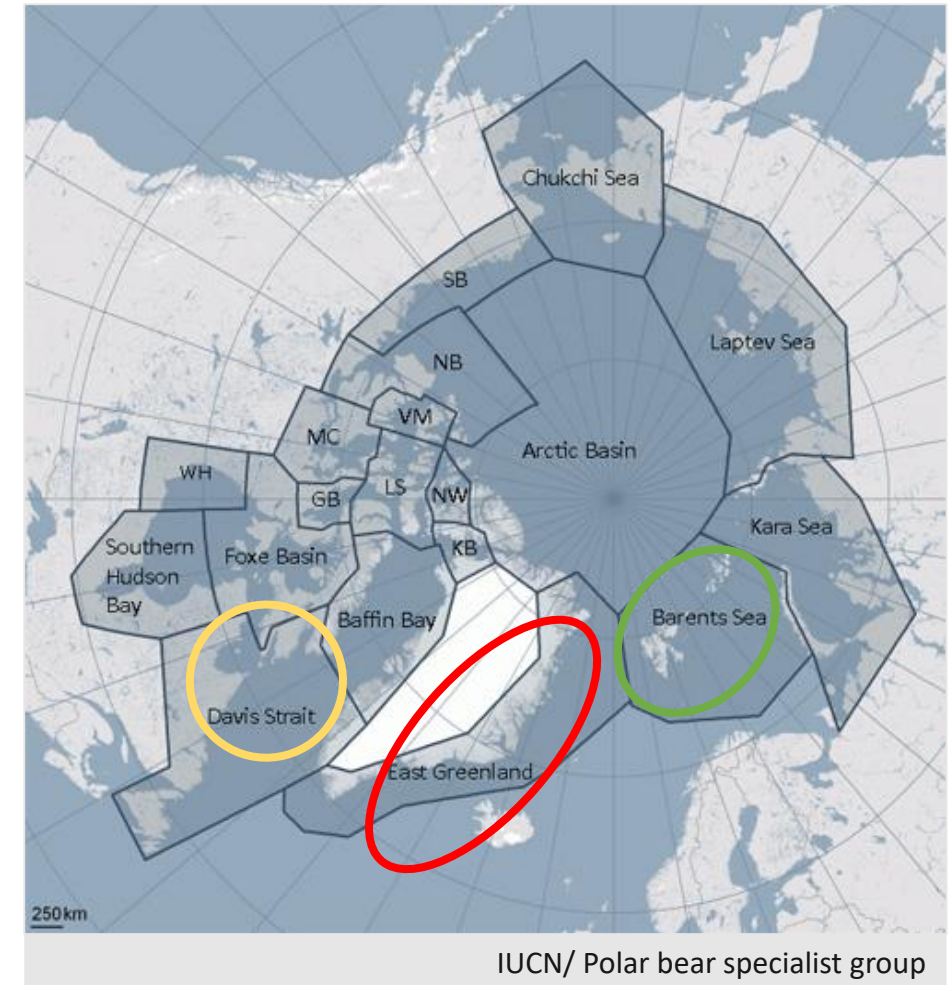
- Not hunted: hair, blood and fat biopsies available
 - Plasma concentrations of hormones and vitamins
 - Immunological effects (response to vaccination)
 - Lipid metabolism: mRNA, metabolomics, blood parameters
 - Blood chemistry
 - In vitro studies

Davis Strait

- Samples from harvest
 - Neurochemistry

Studies from Canadian Arctic

- Neurochemistry
- Cortisol in hair



East Greenland: e.g. Sonne et al.; Becshoft et al.; Gabrielsen et al.; Pedersen et al.; Daugaard-Petersen et al.; Desforges et al.

Barents Sea: e.g. Lie et al.; Braathen et al.; Oskam et al.; Ciesielski et al.; Gustavson et al.; Tartu et al.; Bytingsvik et al.; Simon et al.; Routti et al.

Davis Strait: Krey et al.

Do contaminants have any effects?

Correlative field studies + in vitro:

Circulating thyroid hormone levels

Lipid metabolism

Neurochemistry

Correlative field studies + in vitro + risk assessment approaches:

Immune systems

Understanding of population level risks and effects of contaminants in polar bears is still very limited!!

Further recommendations to implement CAP actions concerning contaminants and pollution

Heli Routti, Jon Aars, Todd C. Atwood, Bjørn Munro Jensen,
Melissa A. McKinney, Robert J. Letcher, Christian Sonne

Contaminants in polar bears from the circumpolar Arctic

State of knowledge and further recommendations
for monitoring and research – Action #42 of the
Circumpolar Action Plan for polar bear conservation



- Action 43. Examine the impact of contaminants and pollution on polar bear life history characteristics
- Action 44. Where appropriate, monitor contaminants and pollution to determine temporal and spatial trends, modes of transmission etc.
- Action 45. Investigate how contaminants interact in order to establish cause – effect relationships and assess the hazards from exposure to multiple contaminants
- Action 46. Periodically monitor for the presence of new contaminants/pollutants (i.e., those not previously detected in polar bear samples)

Climate change



Contaminant emissions and pathways

- *Long-range transport*
- *Partitioning in physical environment*
- *Uptake and biomagnification in food webs*

Polar bear individual characteristics

- *Body condition*
- *Feeding*
- *Movement*
- *Activity*

Exposure and fate

- *Legacy contaminants*
- *Oil spills*
- *Emerging compounds (CAP #46)*
- *Marine litter (CAP #46)*
- *Individual variation*
- *Temporal trends*
- *Spatial trends*



Effects

Vital rates (CAP #43)

- *Integral projection models*
- *Multiple stressors*

Cause – effect relationships, mixtures (CAP #45)

- *In vitro methods*
- *Application of mixtures*
- *Effect-directed analyses*
- *Systems toxicology*

Subpopulations currently monitored for temporal trends in contaminants

