Top predators and eDNA

Some ecological applications

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eDNA in environmental monitoring
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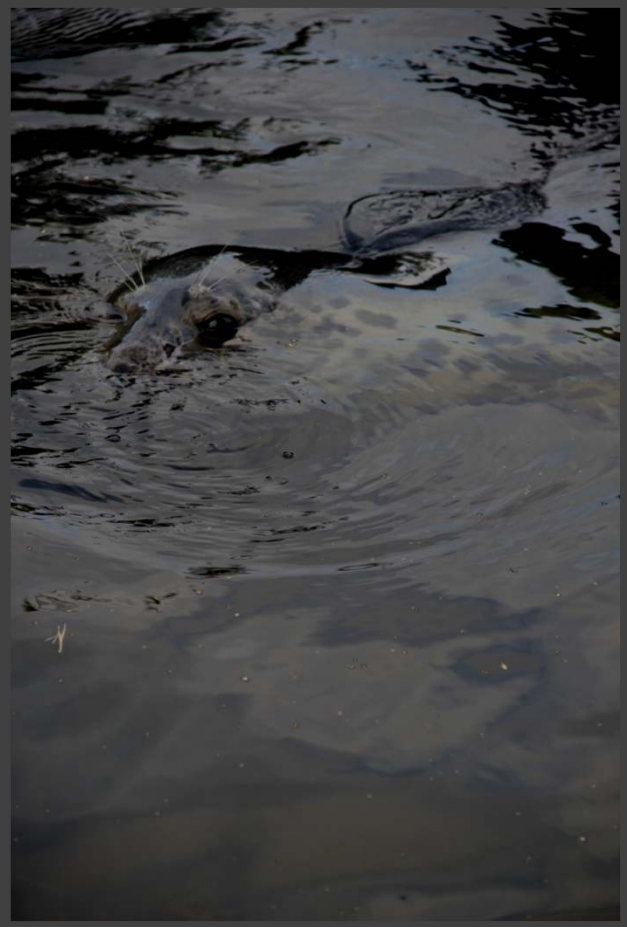
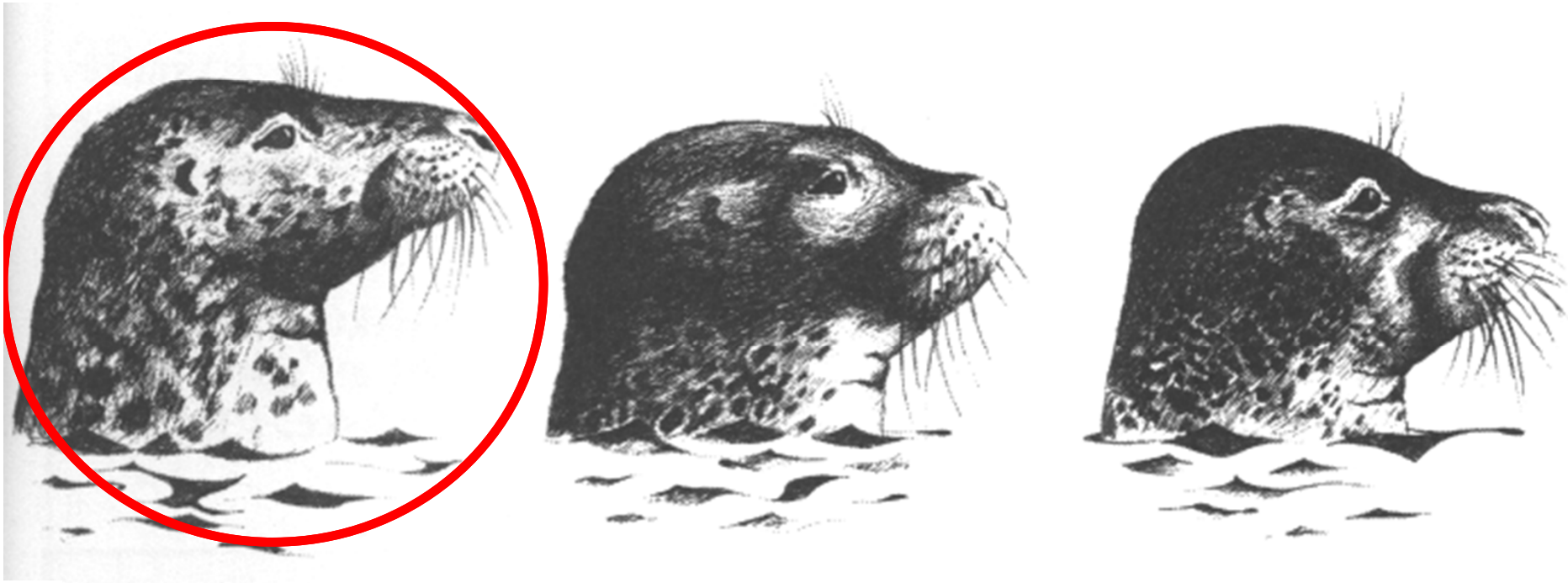
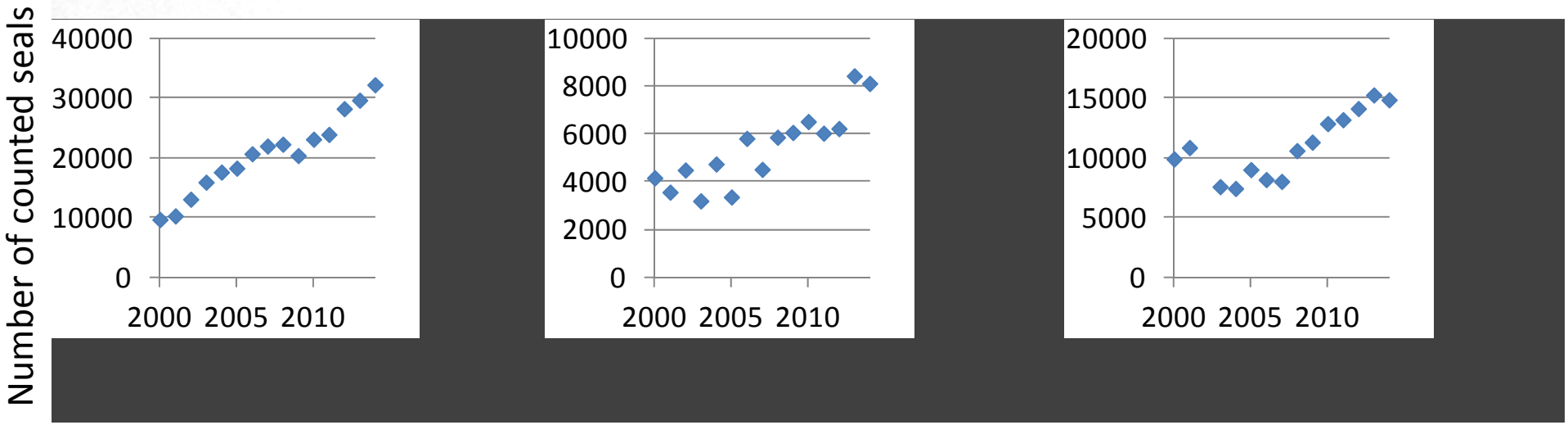
Some ecological applications

- **Diet**
  - **Ecosystem dynamics, predator-prey interactions**
  - **Quantification of food demand**
  - **Exceptional species**
    - Invasive
    - Threatened
- **Presence**
  - **Detection of top predators**
- **Additional thoughts**
  - **Prey sub-populations**
  - **Host-parasite interactions**
  - **Genetic identification of individuals**



Seals in Swedish waters

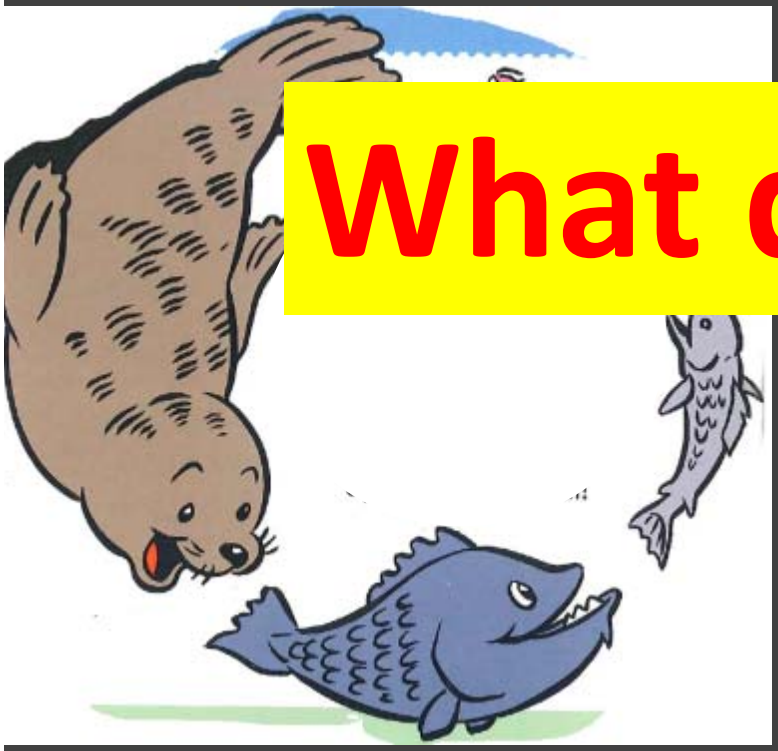




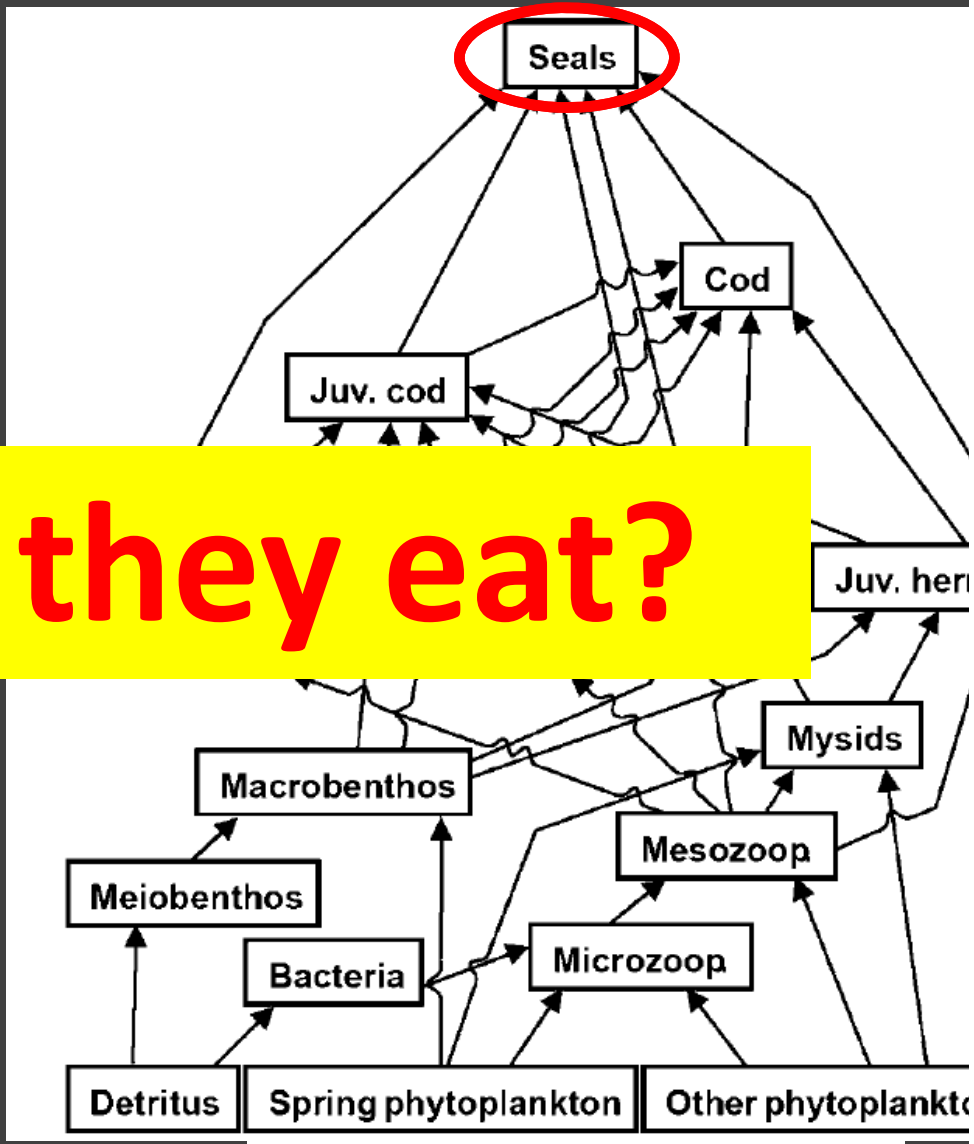
Seals cause damage to fishing gear and catches

But…

- **What is the significance of seals in the food web?**
- **What is the impact of seals on fish stocks?**
- **How are seals affected by environmental changes?**



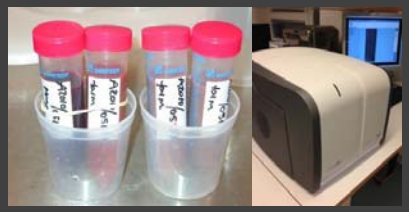
What do they eat?



Hansson et al. 2007. Ambio: 36: 265-271

Diet analysis of aquatic top predators

- **Prey remains from digestive tracts**
  - **Visible prey remains**
  - **DNA**



- **Further dietary information**
  - **Fatty acids**
  - **Stable isotopes**

Long-term dietary patterns

DNA analysis of aquatic top predator diet

Advantages

- Accurate identification
- Fast
- Morphological identification (taxonomic expertise) not needed
- Continual development

Limitations

- No information about prey size
- Unclear quantification of weight proportions ("roughly proportional")
- Contamination risk
- No detection of cannibalistic feeding (?)

Traditional analysis

Advantages

- Prey size
- Simple

Limitations

- Time consuming
- Subjective
- Erosion and retention of hard parts
- Dependent on morphological identification

DNA analysis of seal diet

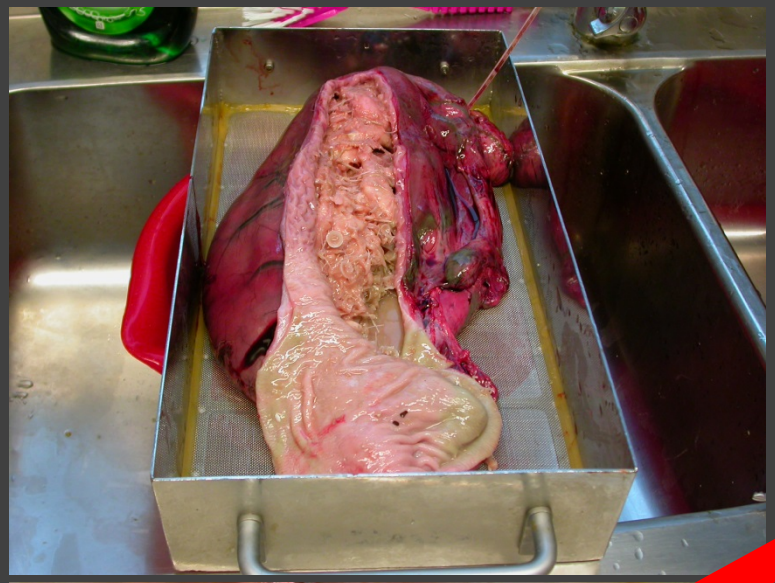
- **Digestive tract contents**
  - **Stomachs**
  - **Intestines**
  - **Faecal scats**

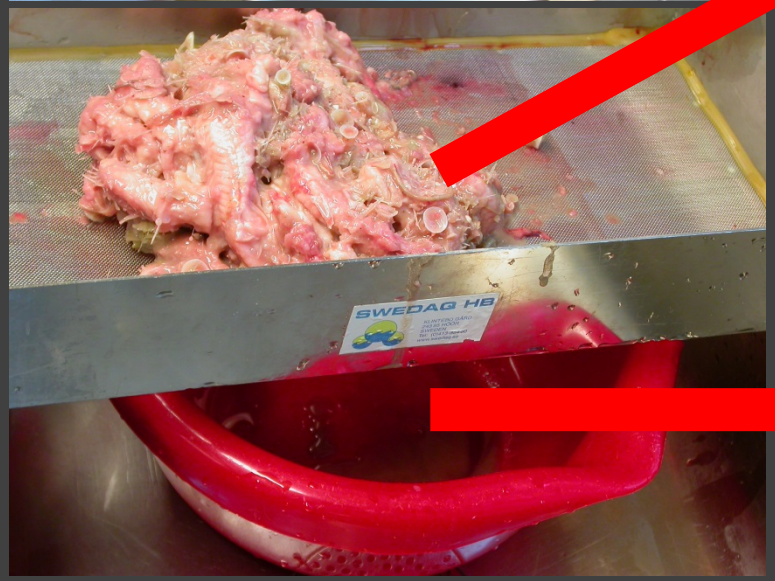
Photo: E. Isakson

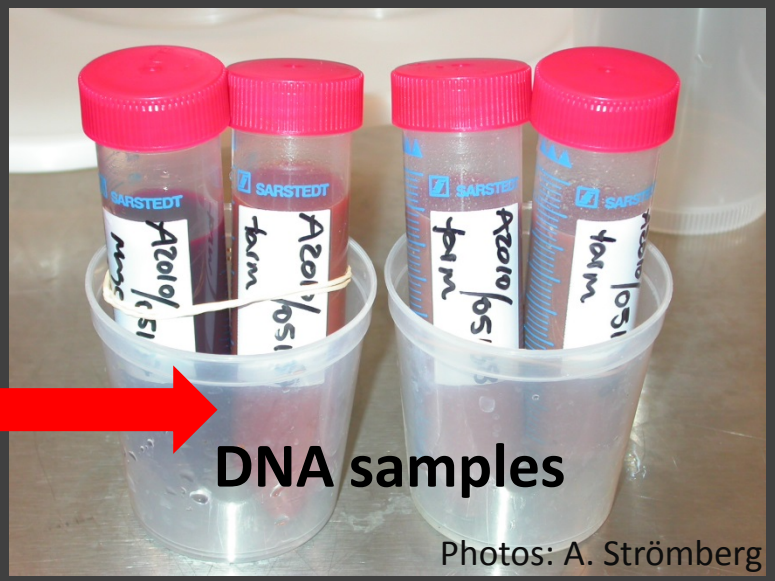
- **Studies in the Baltic Sea**
  - University of Oulu, Swedish Museum of Natural History
  - Faecal scats (n=93, Florin et al. 2013)
  - Digestive tracts (n=31, Strömberg et al. 2013)
  - Digestive tracts (n=160, ongoing evaluation)

ECOSEAL

DNA analysis of seal diet - Methodology







Photos: A. Strömberg

DNA analysis of seal diet - Methodology

1. DNA extraction from digestive tract contents
2. PCR amplification
   - 16S rDNA genetic marker
3. Sequencing
4. Prey identification
   - Matching with DNA sequence databases
5. Quantitative assessment of species sequences

DNA analysis of seal diet - Results

DNA *vs.* hard parts from grey seal digestive tracts

n=155

	DNA	Hard parts
No of seals with identifiable prey	155	132

	DNA	Hard parts
No of species found	34	33+unknown

DNA analysis of seal diet - Results

DNA *vs.* hard parts from grey seal digestive tracts

Occurrence (%)

Prey	Hard parts	DNA
Herring	46%	62%
Perch	23%	28%
Cyprinids	21%	32%
Eelpout	17%	25%
Smelt	12%	14%
Sprat	8%	24%
Pike perch	5%	17%
Cod	4%	8%
Ammodytidae	3%	3%

Prey	Hard parts	DNA
Flounder	3%	5%
Eel	2%	4%
Whitefish+vendace	9%	17%
Salmon+trout	2%	5%
Stickleback	1%	8%
Pike	1%	1%
Gobiidae	10%	7%

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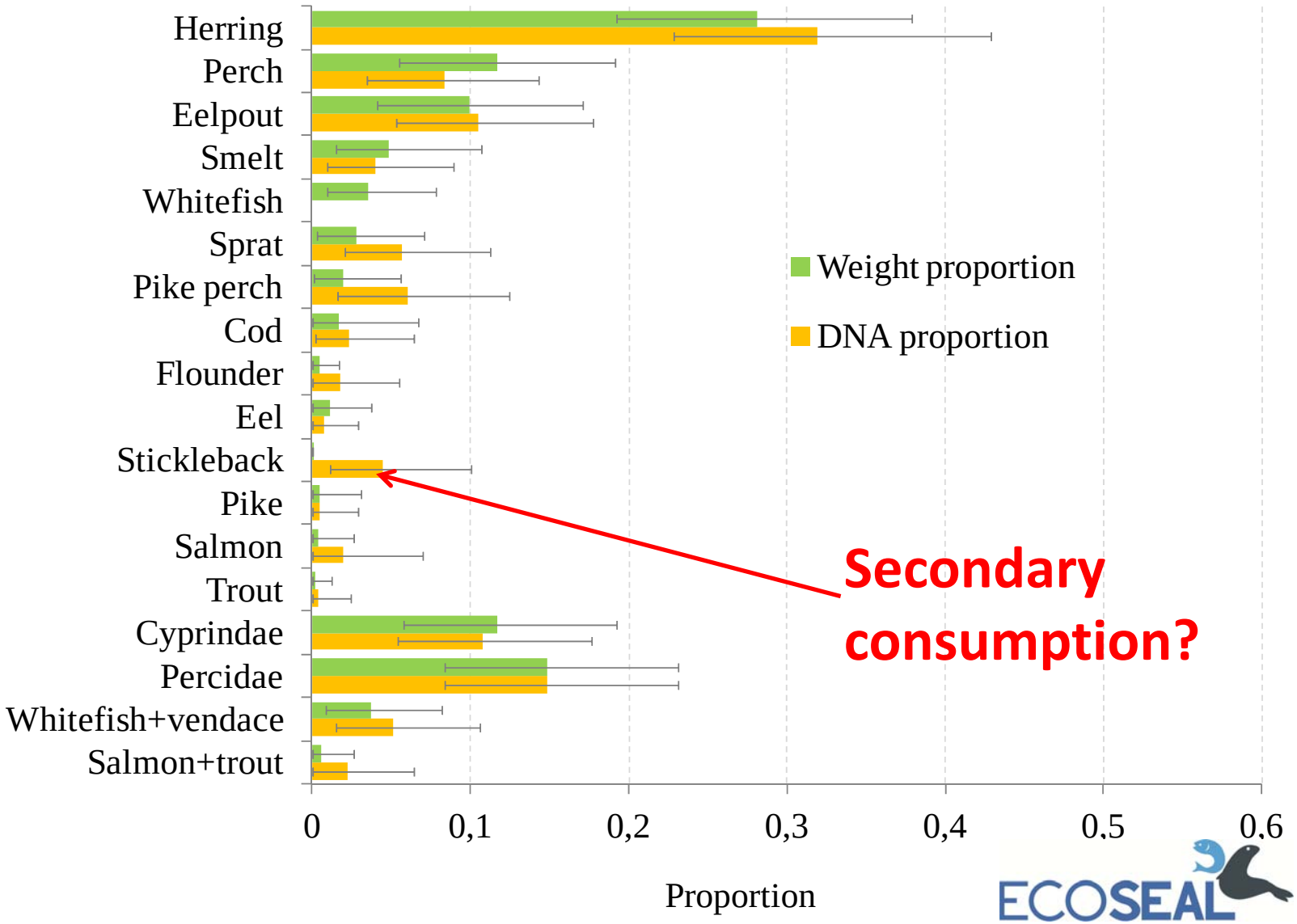
DNA analysis of seal diet - Results

DNA *vs.* hard parts from grey seal digestive tracts



ECOSEAL

- Marine protected areas
  - No-take zones
- Occasional seal visits are suspected
- Grey seal eDNA
- Water samples
  - 10x50 ml
- Positive control samples
  - Skansen Zoo

Photo: Å. Thudén

- **Whom to blame?**

Photo: Å. Thudén

Grey seals kill porpoises and could attack humans, scientists warn

Swimmers have been warned to keep clear of grey seals after scientists discover that they attack and kill porpoises

The Telegraph Nov. 25 2014

van Bleijswijk et al. 2014 (MEPS), Leopold et al. 2014 (Proc. Roy. Soc. B)

Ongoing DNA projects 2014-2015

- **Analysis of seal diet**
  - **Grey seals in the Baltic Sea**
  - **Harbour seals in the Skagerrak**
  - **Prey DNA in digestive tract contents**
    - Faecal scats
    - Hunted (and bycaught) animals

Large material available!

- **Analysis of cormorant diet**
  - **Baltic Sea**
  - **Prey DNA in digestive tract contents**
    - Hunted birds

Photo: M. Boström

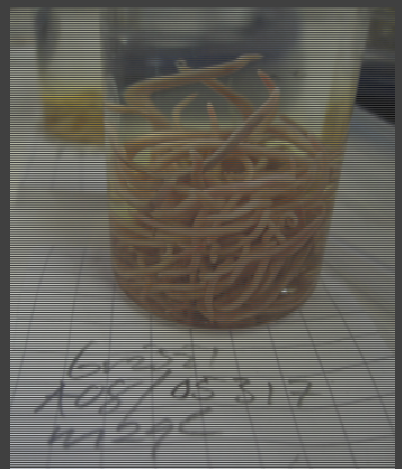
Some additional thoughts

Prey sub-populations

- Predation on local fish populations?
  - Dietary resolution
  - e.g. can seal predation on local cod stocks be detected?

Host-parasite interactions

- Occurrence of seal worm/cod worm
  - Monitoring of parasite DNA in prey species and seal digestive tracts
- Relationship between parasites and diet
  - e.g. trematode liver infections in Baltic grey seals



Genetic identification of individuals

- **Faecal scats**
  - **From which species do we collect?**
    - e.g. harbour seals vs. grey seals
  - **From how many individuals do we collect?**

- **Population dynamics?**
- **Population size?**


Photo: G. Britse

Conclusion

- DNA barcoding is well suited for dietary monitoring
  - Used in combination with other dietary methods

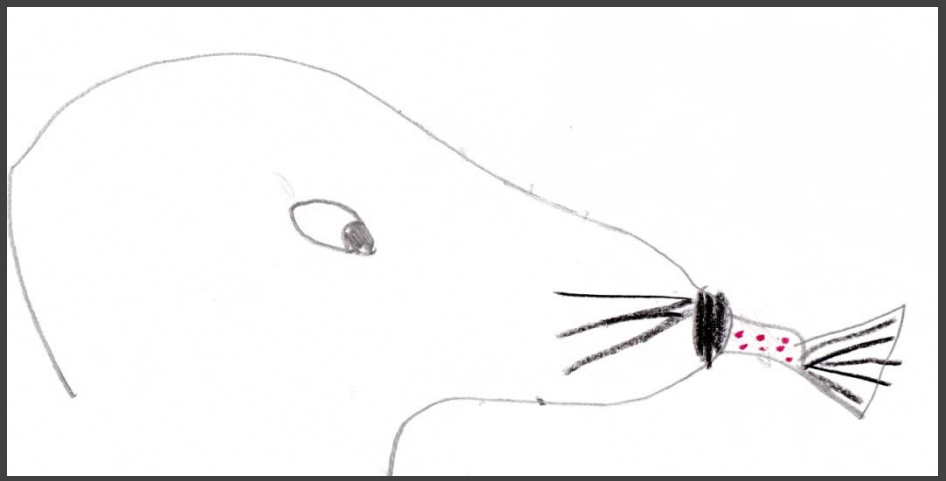
- Best practice?
  - Sampling (in the field)
  - Preservation of samples
  - Sub-sampling (to the lab)

Standard protocols

- Combination of disciplines
  - Ecology
  - Technique (the lab)
  - Bioinformatics
  - Statistics

All involved at an early stage of the project

Acknowledgements



- SLU DNA barcoding FOMA network
- Swedish Museum of Natural History
  - Centre for genetic identification
  - Department of Environmental Research and Monitoring
- Finnish Game and Fisheries Research Institute
- County Administrative Boards
  - Gotland
  - Stockholm
  - Gävleborg

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