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The Opportunity of DNA-Based Technologies for Biodiversity Assessment and Monitoring in the Arctic

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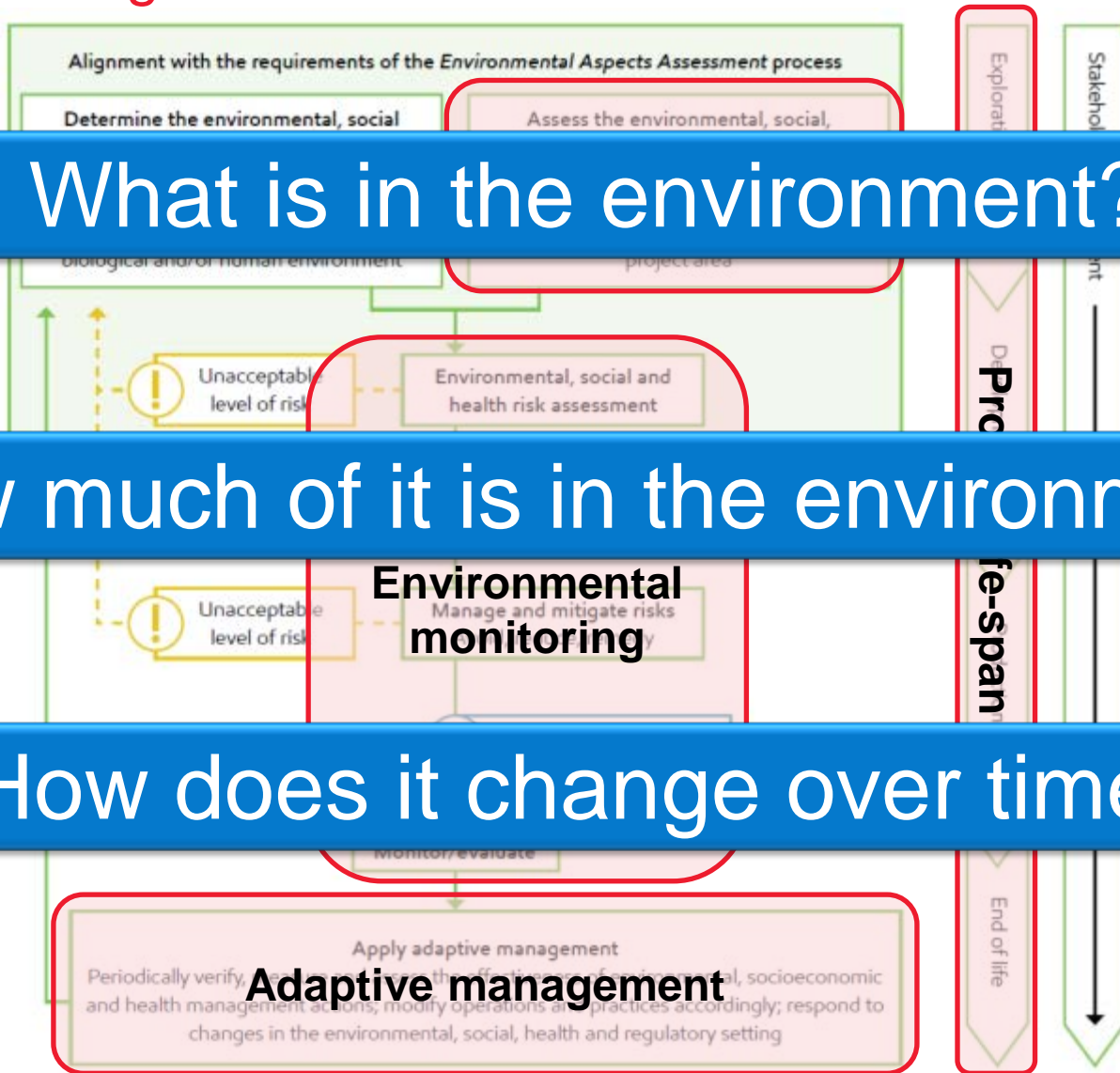
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Outline

- Introduction
- Overview of Studies at ExxonMobil
- Conclusions/Considerations

Introduction

ExxonMobil Upstream Environmental, Socioeconomic and Health Management Process



What is in the environment?

How much of it is in the environment?

How does it change over time?

Conventional approaches to biodiversity assessment and monitoring

Sampling



Observations



Marine mammals



Conventional approaches to biodiversity assessment and monitoring

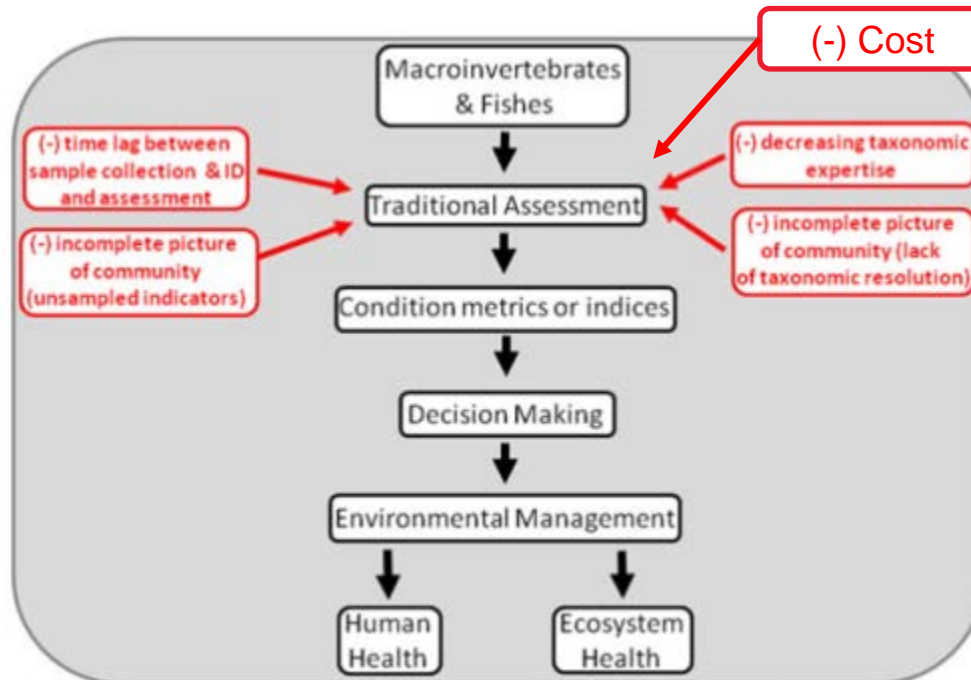
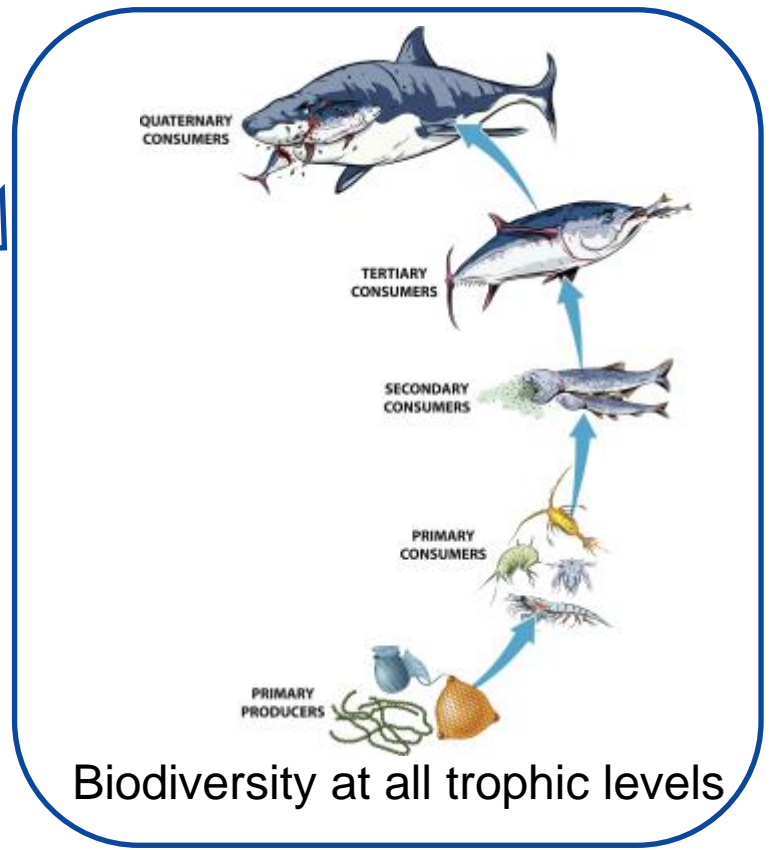


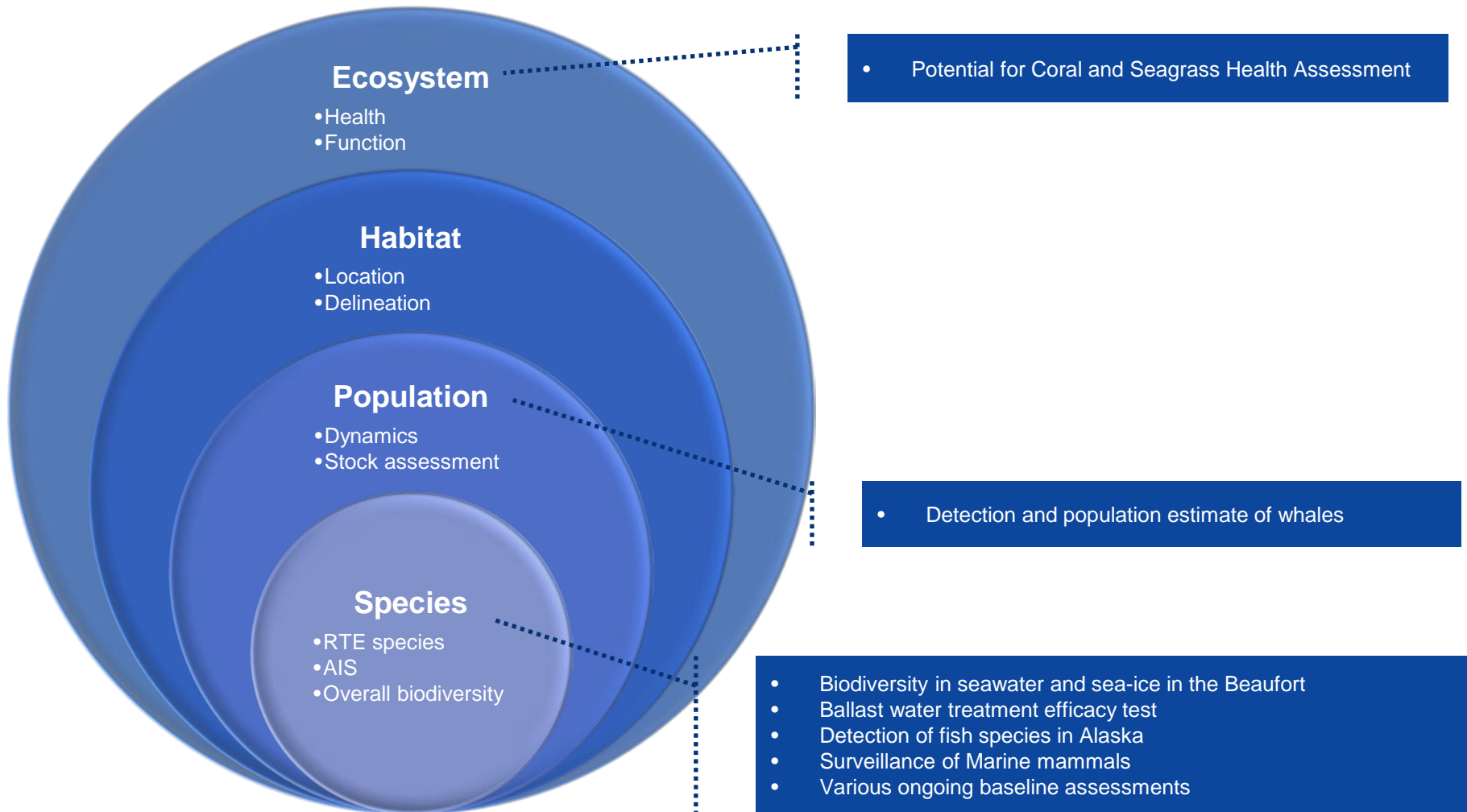
Figure 1. Conceptual model of traditional bioassessment programs. Problems related to traditional morphological taxonomic identification are marked in red.

DNA-based Approach to Environmental Assessment and Monitoring

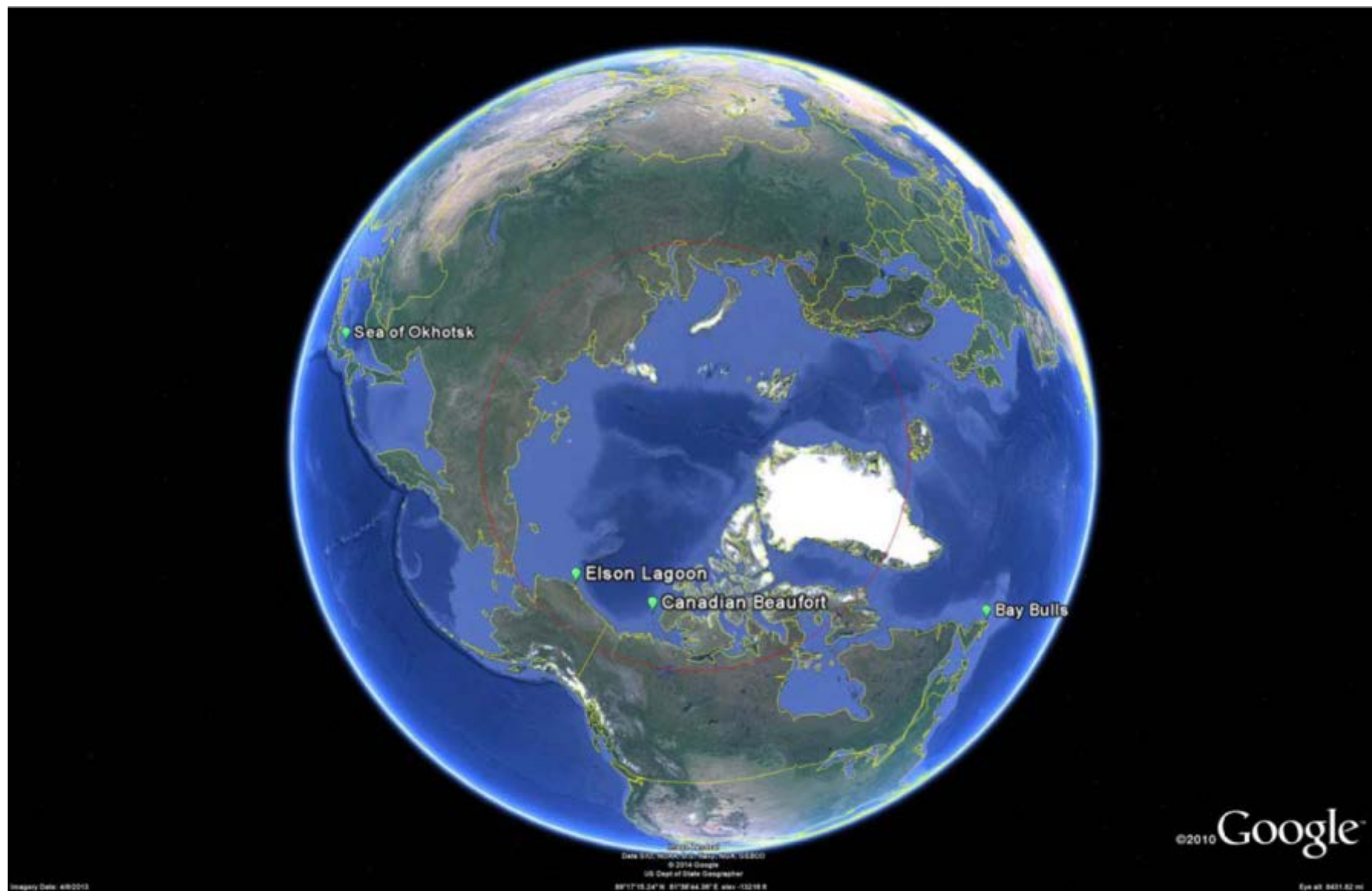


Overview of studies at ExxonMobil

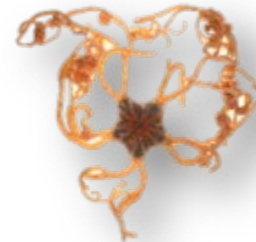
DNA-based Technologies studies at ExxonMobil



Examples of Arctic/Subarctic Studies at ExxonMobil



Biodiversity Assessment in the Canadian Beaufort



Northern Basket Star
Gorgonocephalus arcticus



Amphipod
Tmetonyx cicada



Genus: *Trophon*



Order: *Cumacea*



Previously undocumented isopod



Previously undocumented amphipod

- **Goal**

- To assess the utility of DNA-barcoding
- To evaluate the potential of DNA-based technologies for the assessment of biodiversity of primary producers in seawater and sea-ice

- **Sample acquisition**

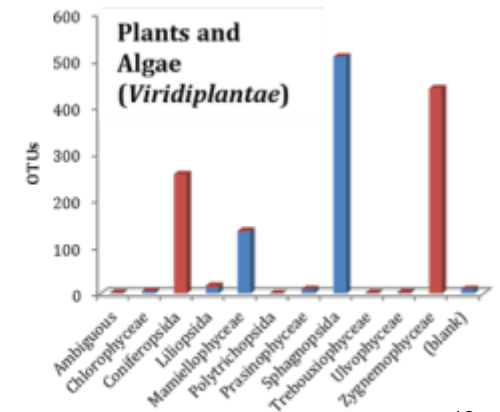
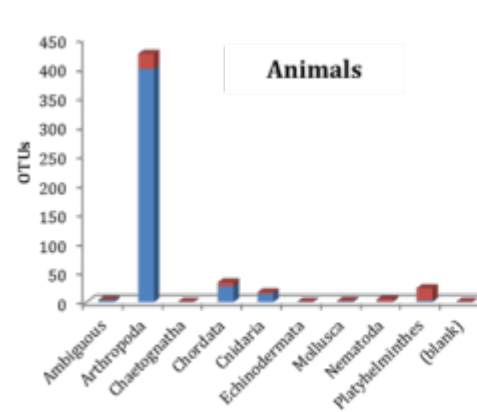
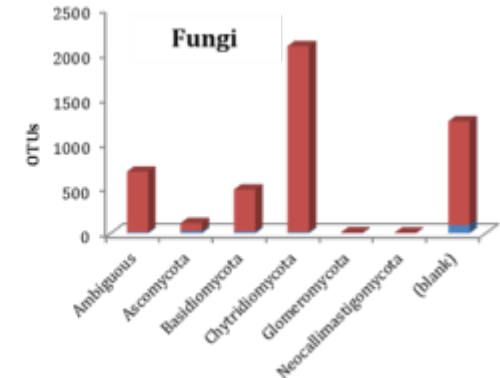
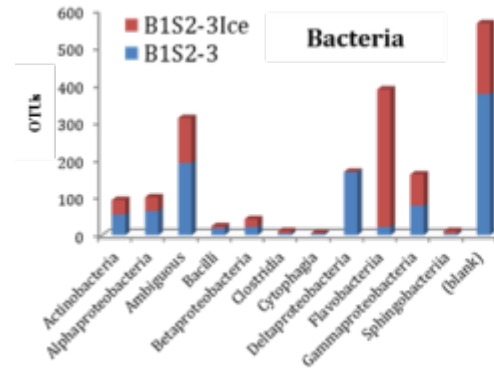
- 2010 and 2011 ArcticNet expeditions
- Canadian Arctic – Beaufort Sea
- Seawater, Sea ice and Specimens

Biodiversity Assessment in the Canadian Beaufort: Seawater vs. Sea Ice Biodiversity (2010-2011)

- Demonstrated the practicality of doing biodiversity assessments from environmental DNA and using a multi-probe approach
 - Allows for broad overall biodiversity assessment
 - Results showed different trends between seawater and sea-ice
 - Presence/absence
 - Relative abundance



Sea ice sampling by ArcticNet scientists

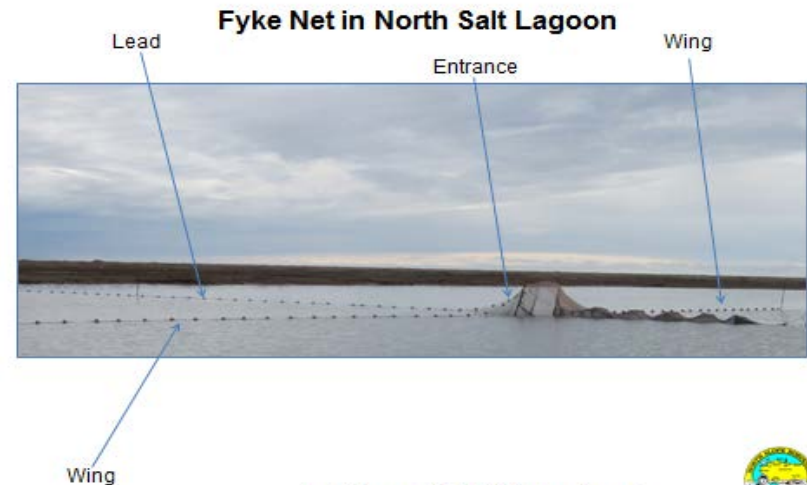


Fish Detection in Barrow, Alaska

- Goal
 - To develop and verify the use of DNA-based technologies to evaluate the seasonal presence/absence of fish species in North Salt and Elson Lagoons in conjunction with local subsistence fishermen
- Most of the fish caught by local subsistence fisherman were also detected in the water using environmental DNA



Sampling at Elson Lagoon
(photo courtesy of Todd Sformo)



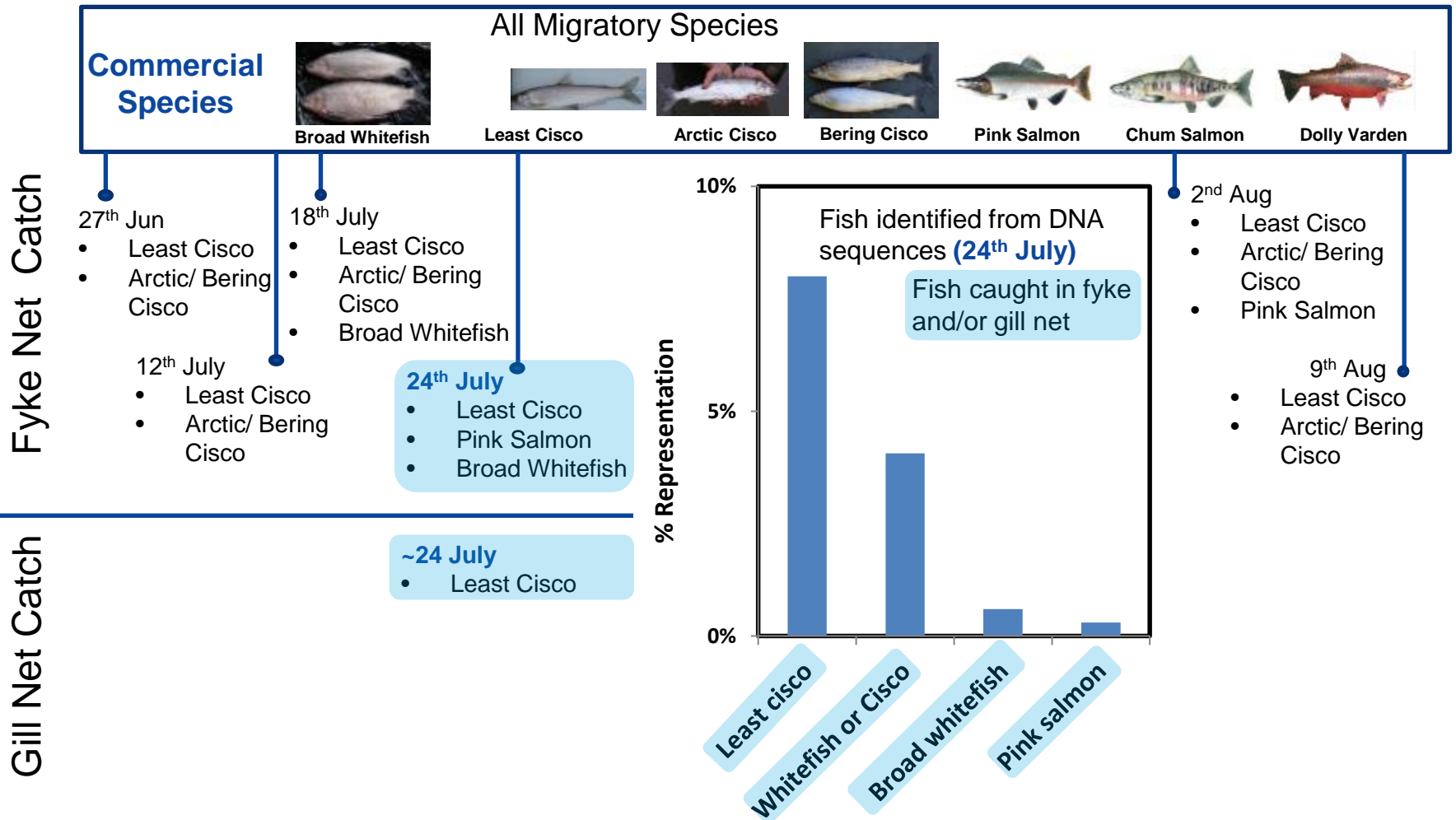
Todd Sformo, NSB Wildlife Department



Fish Detection in Barrow, Alaska

North Salt Lagoon Fishing Season

- Starting approximately in mid to last week of Jun
- Lasts ~14 weeks (Last subsistence net during first week of September)



Detection of Marine Mammals – Ongoing work

- **Goal**
 - To develop and verify the use of DNA-based technologies to detect and monitor marine mammals and their habitats effectively
- **Approach**
 - Primer design
 - Positive control tests
 - Controlled setting (e.g., seal tank)
 - Real environment (e.g., open water marine environment)
 - Analysis of seasonal environmental samples from various geographical locations



Conclusions/Considerations

Opportunities and challenges for the mainstream application of DNA-based technologies for biodiversity assessment and monitoring (marine/aquatic focus)

Considerations	Conventional	DNA-based
Cost – Ship time, types of sampling devices required, etc	Higher	Lower to mid
Cost – Specimen identification	Higher	Lower
Time – Sampling activities	Longer	Shorter
Time – Specimen identification	Longer (>6 months)	Shorter (~1 month)
Completeness of information	Limited/specific	Comprehensive
Data processing effort	Lower	Higher
Quality of information	More false negatives; No false positives	Less false negatives: Some false positives
Quantification	Direct counts or estimates	Estimates or relative abundance
Integration with other environmental parameters	More challenging	Less challenging
Safety	More safety considerations	Less safety considerations
Early identification of environmental sensitivities	Less potential	More potential
Regulator buy-in	Accepted protocols exist	New protocols being developed

Thank you for your time

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