

Environmental DNA (eDNA) Assessment of Arctic Fish in the Beaufort Sea (Elson Lagoon), Barrow, Alaska

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Background

Objectives

Objectives of this study were to

- Develop eDNA methods to evaluate seasonal presence and absence of fish in Elson Lagoon (Barrow, Alaska)
- Validate eDNA data with supporting evidence from scientific surveys (fyke net) and catch data from local subsistence fishermen

Setting



Fyke net deployed in Elson Lagoon



Elson Lagoon in relation to Beaufort Sea

Results

Fish species and abundance (fyke net data only) compared to species detected by eDNA.

Species	Number Caught	Detected by eDNA
Arctic cisco	74	+
Arctic cod	37	+
Arctic flounder	470	- (1)
Broad whitefish	18	+
Capelin	3	+
Dolly varden	3	-
Fourhorn sculpin	1581	+
Pacific herring	3	+
Humpback whitefish	3	+
Least cisco	2361	+
Pink salmon	2	+
Rainbow smelt	186	+
Saffron cod	146	+
Threespine stickleback	123	+

Pink Salmon were detected by qPCR on all days when they were collected in gill nets

Detection of Pink Salmon by qPCR			
Number of Samples	Collection Date	Location	Detection Rate
3	12-Jun	Elson Lagoon	0 of 3
2	26-Jun	North Salt Lagoon	0 of 2
1	12-Jul	North Salt Lagoon	0 of 1
1	17-Jul	North Salt Lagoon	0 of 1
1	18-Jul	Elson Lagoon	1 of 1
2	25-Jul	Elson Lagoon	1 of 2
2	26-Jul	Elson Lagoon	2 of 2
2	1-Aug	North Salt Lagoon	2 of 2
2	3-Aug	Elson Lagoon	2 of 2
4	16-Aug	North Salt Lagoon	1 of 4

Dates Reported in Fyke Net or Gill Net

Methods

Fish Survey

- Gill nets of various mesh sizes and lengths are set in Elson Lagoon as part of regular subsistence fishing tradition that has existed for centuries
- Fyke net is a net system secured to shore that progressively funnels into smaller nets (see photo below) for quantitative survey
- Nets checked every 24h and within ~200m of shore

qPCR

- A previously published COI qPCR assay (TaqMan[®]) was used to detect Pink salmon (Hellberg et al. 2010 J. Food Sci. 75: C595-C606)

eDNA

- One-liter samples of water processed through 0.2 µm nylon filter and DNA extracted and purified for analysis
- PCR amplification targeting mitochondrial gene encoding COI, the barcoding gene
- Sequence analysis of COI products using Illumina MiSeq 300 bp reads

Bioinformatics

- Sequences obtained compared against a database of 420,000 known-species reference sequences using BLAST

Discussions and Challenges

- eDNA analysis identified nearly all fish species collected in the fyke nets
 - Arctic flounder was not identified by eDNA analysis but 470 were caught in the Fyke net. It is possible that COI does not differentiate between this species and other flounder species which were detected.
 - Relationship in abundances (number caught versus COI sequence frequency level) is not consistent.
- qPCR results correlated well with pink salmon catch data. Pink salmon were detected on all days in which they were caught in gill nets, but not in all water samples from those days. This brings into question the amount of water that needs to be sampled in eDNA analyses.
- eDNA ID of non-fish species
 - Clams, multiple worm species, algae, waterfowl, and marine mammals including bowhead and beluga whales and seals
- Ambiguous information.
 - Some closely-related species cannot be distinguished by a 300-bp sequence of DNA
 - *Coregonus lavaretus* (European whitefish) was sometimes the top match, but the sequences were likely from a related Arctic species.