The Offshore Marine Fishes Project

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The Team

• Funding: BREA, ESRF, IGC, DFO (multiple internal sources) & ArcticNet.
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• University Linkages: Waterloo (M. Power, H. Swanson); Quebec at Rimouski (P. Archambault); Laval (L. Fortier); Manitoba – Biological Sciences (J. Treberg, M. Docker); Manitoba – Centre for Earth Observation (G. Stern); (NSERC leverage).
• Coastal Linkages: DFO (L. Loseto); UofM (G. Anderson, N. Halden, G. Davoren).

Government of Canada, co-management partners, many university partners, field crews, ships crew and owners of the F/V Frosti
Canadian Beaufort Sea Bathymetry, Leases & Previous Fish Studies


**Fish Research in Area**

- **2003-2009** – **Northern Coastal Marine Studies** (5-150m on shelf)
- **1984-1987** – **Northern Oil & Gas Action Program** Marine Studies (10-100m on shelf)
- **1970-present** – nearshore & coastal (0-5m) assessments of anadromous & marine fish communities
Tier 1 Gap Identified for BREA: Presence & Relevance of Fishes in Deepwater Areas?

Project approved (Sept 2011) by BREA - 4500k over 5 years (to March 2015)

- Multi-disciplinary ecosystem study with two major themes:
  - Offshore Fishes: diversity, habitat associations & ecosystem roles
  - Coastal Fishes: linkages among sub-ecosystems

- Linked directly with the following BREA projects:
  - Baselines and potential effects of mercury and hydrocarbons in Beaufort sediments and biota (Stern, U. Manitoba)
  - Active acoustic mapping of fish (Fortier, U. of Laval)
  - Regional coastal monitoring program (Loseto, DFO)

- Linked with other ArcticNet projects and US (BOEM) work in Beaufort

Complete new research - first-ever systematic sampling to 1500m depth
Why study marine fish diversity and their habitats?

1) Allows prediction of what fishes live in an area or habitat
2) Provides baselines from which to gauge changes, supporting:

• Project and mitigation planning
• Environmental assessment and regulatory review
• Conservation initiatives and monitoring
  • Ecologically and Biologically Significant Areas (EBSA)
  • Marine Protected Areas (MPA)
• Ecosystem studies
  • How do species interact with each other and their habitats?
  • Food-web and energy pathways i.e., who eats who, and where?
Are offshore marine fishes important?

- 60 of 68 marine fishes known to occur in the Canadian Beaufort Sea live on the bottom.
- Ecological roles of most offshore marine fishes are poorly understood.
- Is Arctic Cod (*Boreogadus saida*) the only marine fish of ecological relevance?

Knowledge of the types of fishes, and how they interact with each other and their habitats, will provide context for understanding ecosystem roles.
Establish **baselines** for diversity, relative abundances and distributions of offshore marine fishes of the Canadian Beaufort Sea

- What types of fishes are there?
- How many are there?
- Where do they live?

Determine the community structure and habitat associations of marine fishes

- Which fishes live together?
- Which habitat(s) do they live in?

Understand the ecosystem linkages of marine fishes and energy pathways within and amongst habitats

- Who eats who?
- Do the fishes move amongst the different habitats?
BREA Marine Fishes Sampling 2012 - 2014

2012: ~4 weeks in southern Canadian Beaufort Sea (+5 weeks transit to/from area) – 1000m
- Shelf & slope lease areas
- Transboundary collaboration

2013: ~6 weeks in eastern Beaufort Sea, Amundsen Gulf & Darnley Bay – 1500m
- Darnley Bay Area of Interest
- Interannual variability
- Deepwater focus
- Transboundary collaboration

2014: ~6 weeks in central Beaufort shelf and slope, Banks Is. and Amundsen Gulf – 2000 m
- Interannual variability
- Southwest Banks Island lease area
- Darnley Bay Area of Interest
- Bays and straits in Amundsen Gulf
Habitat and Foodweb Components

Sampling aboard the F/V Frosti

Zooplankton

Oceanography and Marine Productivity

Hydroacoustics

Infauna and Sediments

Fish and Epifauna
Marine fishes known to the Beaufort Sea before and after BREA

The BREA discovered new fish occurrences in all habitats.
New species likely represent both:

- Changes in fish distributions because of climate change and,
- Fish that were there but hadn’t been sampled yet.
Highest bottom fish diversity in habitats shallower than 500m

Arctic Cod were caught in all areas

Differences in fish community across areas and habitats

Baselines: Bottom Fish Diversity & Abundances
Four distinct fish groups occupy different habitats on the shelf and slope.

- **Nearshore-shelf** (20-75m): 10 species total
  - E.g., Arctic Cod, Arctic Staghorn Sculpin, Stout Eelblenny, Ribbed Sculpin, Canadian Eelpout

- **Offshore-shelf** (75-200m): 13 species total
  - E.g., Arctic Cod, Twohorn Sculpin, Arctic Alligatorfish

- **Upper-slope** (200-500m): 19 species total
  - E.g., Arctic Cod, Greenland Halibut, Kelp Snailfish

- **Lower-slope** (500-1000m): 7 species total
  - E.g., Adolf’s Eelpout, Greenland Halibut, Arctic Cod, Gelatinous Seasnail, Arctic Skate

The diagram illustrates the distribution of these fish groups across different depth layers. The Pacific water mass is colder and less salty, while the Atlantic water mass is warmer and saltier. The mixed layer separates the two water masses.
Habitat Associations: Bottom Fishes

- Arctic Cod was found in all groups and habitats
- Other fishes characterized only one or two groups, and occupied narrower ranges of habitats

Arctic Cod
Greenland Halibut
Twohorn Sculpin
Stout Eelblenny

Depth
0 – 60m
60 – 200m
200 – 300m
300 – 900m
900m +
Fish diversity lower in water-column catches compared to bottom catches.

Arctic cod dominated catches in all areas.

Fish diversity highest in habitats shallower than 500m.
Habitat Associations: Water-column Fishes

2012 & 2013

- Less fish at the surface than in previous years
- Bottom layer not present in 2014
  - Mainly large Arctic Cod in bottom catches; 1yo in water-column catches
  - Less age 2 and 3 Arctic Cod compared to past years

Beaufort Shelf & Slope, 2014
High fish numbers at surface in bays in Amundsen Gulf

Net catches suggest high numbers of YOY Arctic Cod

Scattered layer of fishes on bottom

Habitat Associations: Water-column Fishes

2012 & 2013

Franklin Bay 2014

Arctic Cod

YOY

Age 1+

225.32m
Water-column and bottom coupling

Water-column feeding → Bottom feeding

-200m
-1000m

Pelagic

Benthic

- Greenland Halibut
- Adolf's Eelpout
- Arctic Staghorn Sculpin
- Arctic Alligatorfish
- Arctic Cod
- Kelp Snailfish
- Capelin
- Stout Eelblenny
OFFSHORE: Co-occurring Arctic Cod and Juvenile Capelin
- Capelin and Arctic Cod collected together in benthic trawl (2013)
- Stomach analysis indicate they are feeding on zooplankton (~80% dietary overlap)
- Important habitat for juvenile fishes
- Prey source for pelagic predators (halibut, seals, possibly Beluga)

NEARSHORE: Capelin
- Capelin spawned in July, 2014
- Nearshore habitat critical for maintaining Capelin population
- Aggregations of Capelin onshore serve as a prey source for coastal predators (Arctic Char, sea birds and possibly Beluga)

When Capelin become mature they move onshore

Arctic Cod
Immature Capelin
Darnley Bay
Amundsen Gulf
Male Capelin
Female Capelin
Paulatuk

Arctic Char Stomach Contents
Geographic Coverage

Sampling coverage 2012-2014
Geographic Coverage

Fish capture location from scientific collections
Conclusions – New Knowledge

Knowledge pre-2012

- ~70 fish species – 20 sea-run spp, 52 marine, mostly on shelf
- Relatively few water-column marine species (assumed)
- Relatively more bottom marine species (assumed)
- Offshore fish habitat use unknown
- Arctic Cod important but uncertain numbers & habitats

New Knowledge

- 16 new marine fishes recorded
- Confirmed low water-column diversity & high bottom diversity
- Linked fishes to habitats
- Fish community differs by habitat/area
- Arctic Cod found everywhere, in particular in slope habitats; high numbers
- Couplings between bottom and water-column habitats, and nearshore and offshore habitats confirmed

Key Knowledge gaps:
- Year-to-year differences of fish community and habitats
- Importance of unexplored areas such as embayments
Next Steps 2014/2015 and beyond...


- BREA results forum
- Publication of project reports, communication materials and metadata
  - DFO reports, Polar Data Catalog

Medium term (2014-2016):

- Analysis and publication of diversity of fishes, other animals and their habitats
- Completion of graduate student projects
  e.g., Arctic Cod energetics, Capelin studies, foodweb structure

Longer term (2016-):

- Publication of foodweb & energy pathways within and among offshore habitats
- Publication of the energetic links within/among offshore and coastal habitats