Movement of Coastal Fishes in the Ulukhaktok Region

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Research Project Overview

Project Purpose and Goals

This project uses telemetry studies and Traditional Knowledge (TEK) to address fundamental questions on the behaviour and biology of coastal fishes (Arctic char and Greenland cod) that are important for subsistence and/or commercial harvest and key indicators of ecosystem change. Primary goals of this research include:

- Determining inshore-offshore movements and food web connectivity;
- Determining linkages and coastal ranging behaviour between major rivers and coastal focal points in the region;
- Identifying key habitats associated with fine-scale movement dynamics and centers of activity of coastal fishes.

Using this information, we aim to advance understanding of the scales of coastal fish movements, from days to years, within different coastal environments and across broad to narrow spatial scales. Through examining triangulated two-and three-dimensional fish positions in relation to habitat (substrate, bathymetry) and oceanographic variables (temperature, salinity) throughout the year, it will be possible to extrapolate fish behaviour for similar habitats throughout the region and model potential movements and associated physiological demand under different temperature scenarios.

This research approach stems from observations by Inuit fishers In Ulukhaktok and other communities in the region (e.g. Kuhluktuk) that identified concurrent shifts in Arctic char (*Salvelinus alpinus*) and Greenland cod (*Gadus macrocephalus ogac*) availability, seasonality and abundance (Char Working Group and OHTC, pers. Comm 2018). These observations add to apparent changes in the food web local to Ulukhaktok with, for example, unusual high abundance of beluga in 2014 that were found to feed on novel prey items (sandlance, Loseto et al. 2019). Inuit subsequently communicated to scientists the need for co-produced knowledge to improve baseline fisheries data and maintain sustainable management under increasing stressors through telemetry programs for key coastal fish species.

Approach

This project uses a synergy of TEK and conventional and advanced scientific techniques to characterise the local food web, track fish movements (Arctic char and Greenland cod) and characterize key coastal marine habitats near Ulukhaktok. Monitoring fish movements across multiple spatial and temporal scales and in relation to biotic and abiotic parameters, such as water temperatures and food web structure, will highlight dominant drivers of behavioural flexibility and develop understanding of species response to ecosystem change.

During the 2018 open water season, 50 bottom moorings were put in place to track the movement of fishes along the coast near Ulukhaktok in the Northwest Territories, spanning >300km of coastline and at a fine-scale within a 5km^2 grid in a semi-enclosed bay (Figure 1a). In addition to receivers that detect fish tags, fixed coastal moorings were also equipped with various combinations of oceanographic loggers for measuring water temperature, salinity, current strength and light levels. During the 2019 open water season, moorings were recovered and redeployed in a modified design (Figure 1b). These modifications will provide capacity to examine movements in different habitats and at different spatial scales. Throughout the 2018 and 2019 open water summer seasons, a total of 189 fish were tagged on the marine coast with internal telemetry transmitters (98 Arctic char, 91 Greenland cod). Fish were also measured and sampled to examine potential drivers of movements (blood and fin samples for genetics and bio-tracer habitat and diet analysis, digital photographs for detailed morphometrics and TEK co-production, body condition indices). Forage fish and invertebrates were also sampled for food web assessment, and bathymetry was mapped using sonar and underwater video camera deployments.

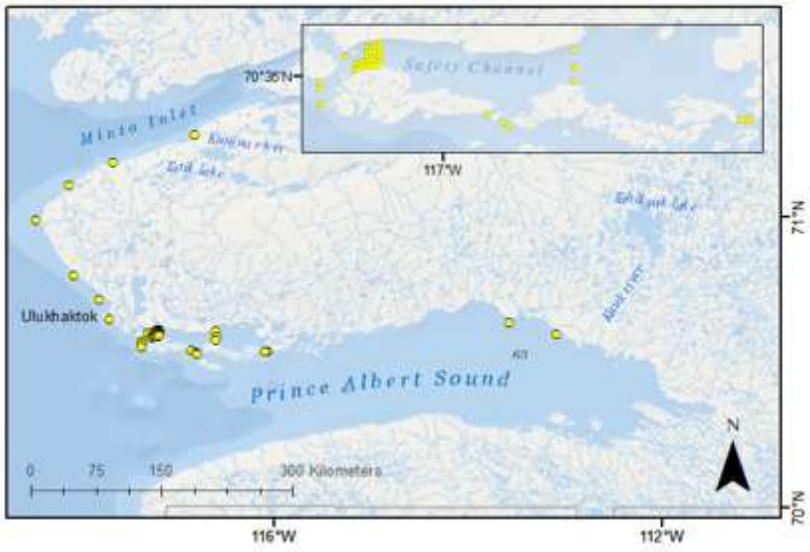

Figure 1a. Map of study site near Ulukhaktok and locations of coastal moorings for detecting fish movements and logging oceanographic data positions for 2018-19.

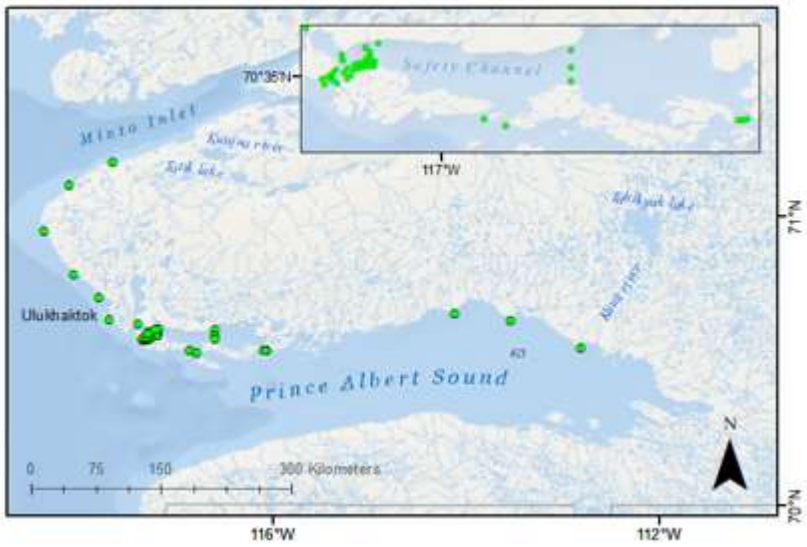

Figure 1b. Map of study site near Ulukhaktok and locations of coastal moorings for detecting fish movements and logging oceanographic data positions for 2019-20.

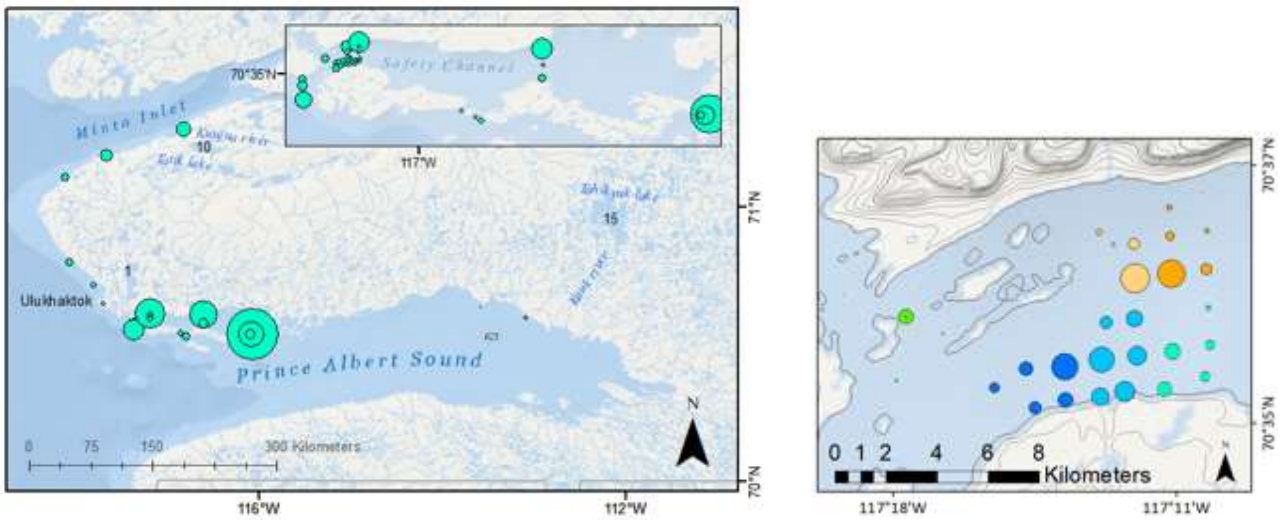

Figure 2. Map of study site near Ulukhaktok with residency index bubble plots for fish detected on each receiver from July 2018 to August 2019. a. Arctic char along the marine coast and b. Greenland cod in Safety Channel. The size of each bubble represents the mean total days each fish was detected with larger size indicating longer residency. Bubble size is not comparable between 2a and 2b as bubble size was inflated in 2a for clarity due to low residency overall. Different colours in 2b indicate different data analysis bins. Numbers in lakes represent total fish that were tagged on the marine coast and detected in lakes using a portable receiver during winter/spring 2019. Fish were tagged in July-Aug 2018 in Ulukhaktok (Arctic char) and in the northwest corner of Safety Channel (Arctic char and Greenland cod).

Use of Traditional Knowledge

In February 2019, a pilot study workshop was conducted in Ulukhaktok to obtain TEK on the indicators of potential origin and health of fishes captured on the coast by linking interview questions with photographs of tagged fish and a 1:250,000 scale map of Victoria Island that includes fishing areas and

hydrology. Following the success and community engagement in the pilot study, this research component has developed into a master's project undertaken by Jessica Smart (UNBC) for which full data collection using semi-structured group interviews with open-ended questions are planned for Spring/Summer 2020. TEK on Arctic char fish movements and visual indicators of health and populations from different lakes will be layered with measured condition indices, morphometric traits and summarised movement patterns to provide a more complete understanding of the behaviour among different populations.

Summary of Results/Outcomes

Data recovered from the moorings includes detections from fish that were tagged on the coast in both 2018 and 2019; over 11 million detections from a total of 53 Greenland cod individuals and over 50 thousand detections from a total of 89 Arctic char.

High detections within the fine-scale grid in Safety Channel were partly inflated by study design whereby fish are purposely recorded simultaneously on multiple receivers. Throughout the study to date, 25% of fish tag transmissions were detected on three or more receivers, with triangulated position estimates for 62 different fish. Greenland cod detections and position estimates reflect their residency and narrow home range on the coast for most of the year, with short distance seasonal movements in association with depth, temperature and substrate that are thought to coincide with spawning and feeding activity. Arctic char detections coincide with their seasonal migration, from freshwater lakes to the marine coast, to feed in June and return to lakes in late July/August. Detections of Arctic char near spawning rivers and satellite tracking data add to TEK on the timing of seasonal migrations in relation to specific lakes where they overwinter. Using a portable receiver during Spring/Winter, Community Researchers confirmed the presence of tagged char in two major lakes near Ulukhaktok (10 fish in Tatik Lake, Kuujjua River, 15 fish in Tahikyak Lake, Kuuk river, Figure 2a). This identified the overwintering location for 45% of all tagged fish in 2018 (i.e. out of 55 tagged). Lake detections for 2019-20 are currently being investigated by community members.

Initial findings indicate an annual switch in overwintering habitat for the majority of fishes (e.g. only one individual detected in Tatik lake in both 2018 and 2019). Together with TEK from co-production community meetings and workshops, several additional important overwintering lakes were identified both closer to the community and further along the coast. Data collection and analysis is ongoing to examine potential drivers of changing overwintering location, including annual variation in weather and water temperature, length of the summer season, water levels and river drainage. These observations of flexible behaviours indicate the potential for species to respond to ecosystem change, but have likely implications for energy budgets, feeding ecologies and food web structure on the marine coast. For example, to investigate the importance of seasonal movements for food web connectivity, we analysed the carbon and nitrogen stable isotope composition in tissues sampled from tagged fishes. Early findings indicate that larger fish that primarily overwinter in a distant lake at the end of a long river (Tahokyak lake) feed on prey from a greater diversity of habitats compared to smaller fish that primarily overwintered in a closer lake with a shorter river (Tatik lake). Analysis of forage fish, zooplankton and benthic crustaceans is ongoing to provide further context for the overall food web and potential implications of flexible diets and movement behaviour for responding to ecosystem change.

Links to BRSEA

The information gathered from this research program will be used to improve models of species distribution and vulnerability to ecosystem change through, for example, identifying centres of activity and examining the capacity of fish populations to maintain activity rates under different temperature and food web scenarios (e.g. Suprenand et al. 2018). Hotspots of coastal activity at daily, seasonal and annual scales in relation to, for example, bathymetry and substrate, current profiles and thermal regimes will be invaluable for examining the potential implications of oil and gas exploration in coastal ecosystems (Figure 2). Inshore-offshore movements and patterns of seasonal habitat in relation to specific behaviours, such as spawning or feeding, will be crucial for establishing regional policy on shipping routes and activity centres. Our findings to date coincide with others in the region (Moore et al. 2016, 2017) demonstrating the importance of maintaining an uninterrupted coastline for Arctic char to move freely at long distances along the coast during the summer migration, and between different river and lake systems (Figure 2a). Freedom of movement provides capacity for these fishes to use flexible behaviours to respond to ecosystem change by, for example, switching to a less energetically demanding overwinter habitat or moving greater distances to a foraging hotspot. Specifically, the area surrounding Safety Channel in Prince Albert Sound was identified as a critical area for both summer (char, cod) and winter activity (cod, Figure 2). Moreover, the compilation of food web sampling, habitat assessments and TEK obtained throughout the study indicates this is critical habitat for both predators and prey (e.g. seals and crabs, respectively) of the focal coastal fishes.

Year-round residency of the majority of tagged Greenland cod within Safety Channel suggests the full range of habitats this species requires at different life stages are available within Safety Channel (Figure 2b). Seasonal activity hotspots indicate the importance of shallow, nearshore habitats with soft bottom during the spring which are likely important for spawning (Morin et al. 1991). Our findings and previous coastal surveys (e.g. Morin et al. 1991) highlight the importance of deeper coastal waters (~40-200m) for residency during the rest of the year (mature individuals) and/or year-round (non-reproductive individuals). Greenland cod were found to move deeper with sudden drops in water temperature and, once within rocky channels, repeatedly follow the same pathways during mid-winter polar darkness. These findings highlight the value that deep-water channels provide, not only as a potential refuge from extreme conditions, but could also support navigation under 24/hour darkness. These findings and the very high homing ability (repeatedly returning to the same location) of both species indicates the potential damaging impact of changes to coastal habitat. The marine coast would be particular vulnerable to extractive activities during the crucial ice-break up period and open water summer season for Arctic char, whereas Greenland cod are dependent on nearshore coastal ecosystems year-round. In the event of oil spills, material is likely to collect in estuaries, inlets and bays that Greenland cod are dependent on for spawning in spring and Arctic char for feeding in summer (Morin et al. 1991).

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