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EXPLORATORY FISHERY PROTOCOL - NUNAVUT AND NORTHWEST TERRITORIES ANADROMOUS ARCTIC CHARR

Illustration by DFO

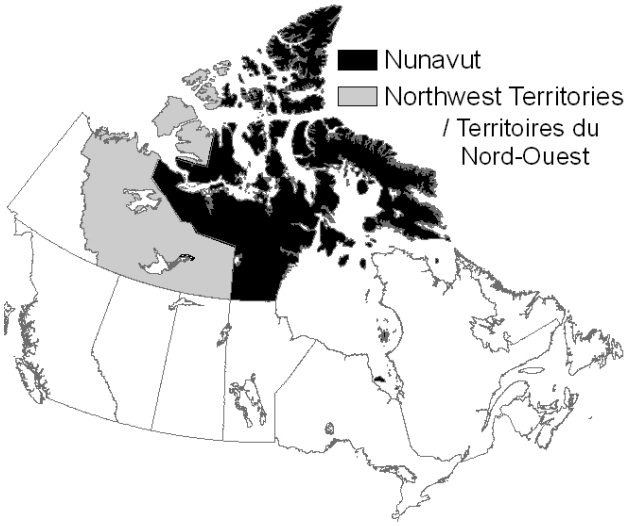

Figure 1. Map of Canada highlighting Nunavut and the Northwest Territories.

Context :

Fisheries and Oceans Canada (DFO) has been actively developing new commercial fisheries in the North since the early 1970s. To explore the potential for commercial fisheries on Arctic Charr, Salvelinus alpinus, in the Northwest Territories (NT; now NT and Nunavut, NU) provisional quotas were test fished starting in 1973 (Kristofferson and McGowan 1981, McGowan 1985). Kristofferson and McGowan (1981) described data collection requirements and sampling sheets for test fisheries. McGowan et al. (1993) further described the rationale for the exploratory fishery protocol and the five years of sampling needed to evaluate a stock's potential for a commercial fishery.

Fisheries and Aquaculture Management, Central and Arctic Region, has requested science advice on whether revisions are needed to the five year sampling protocol for exploratory fisheries in light of DFO's New Emerging Fisheries Policy. The existing protocol was developed for freshwater/anadromous finfish species. Given the new policy and the potential for new fisheries to target a variety of species the exploratory sampling protocol also needs to be re-assessed to ensure it is appropriate for other species.

A peer review meeting was held to review and revise DFO's exploratory fishery protocol for anadromous Arctic Charr in Nunavut and the Northwest Territories to provide a sampling protocol for licence holders that will allow assessment of the biological sustainability of a commercial fishery.

SUMMARY

A data collection protocol for assessing anadromous Arctic Charr, *Salvelinus alpinus* (Linnaeus), fisheries in Nunavut (NU) and the Northwest Territories (NT) was reviewed and recommendations were made on the type and amount of data needed. Information was also provided on the level of uncertainty in the conclusions that might result from an assessment of these data.

- All provisional quotas should be fished fully for a minimum of five years.
- Biological, catch-per-unit-effort (CPUE), and total harvest data should be collected every year for five years before stocks are assessed and recommendations are made about the biological viability as a commercial fishery.
- Biological sampling should include individual fork length, round weight, sex, and sagittal otoliths for a minimum of 200 anadromous Arctic Charr.
- Fish selected for biological processing should be done so in a stratified manner (i.e., every third fish) throughout the duration of the fishery.
- Bycatch species should be identified, counted, and released. Fish that are unlikely to survive release should be sampled for biological data (fork length, round weight, sex, and ageing structure as appropriate).

INTRODUCTION

Commercial fishing for Arctic Charr has been documented since the late 1940s in what was the Northwest Territories *(NT; now NT and Nunavut, NU;* Grainger 1953). In 1973, a test fishery program was established by the Fishery Management Division, Department of the Environment (now Fisheries and Oceans Canada (DFO)), in cooperation with the Wildlife Service, Government of the Northwest Territories (GNWT), to facilitate the development of new commercial fisheries (Kristofferson and McGowan 1981, McGowan 1985). The test fishery program was designed to determine commercial feasibility, establish initial quotas, identify any potential problems a commercial fishery may encounter, and collect biological data. A provisional quota was set and fishers were asked to fish the full quota. The biological sampling protocol in the test fishery program required a minimum of 100 fish be sampled annually for fork length, weight, sex, sexual maturity (if time permitted), stomach contents (if time permitted) and age structures (scales or otoliths). All other fish were to be identified, counted, and also sampled if possible. Catch, effort and biological data were recorded by GNWT staff and data analyses were performed by the Department of the Environment staff. Test fisheries ran for two to three years, under permits applied for annually, until sufficient data were collected for assessment. If it was determined upon completion of the analyses that the stock could sustain a commercial fishery, it was submitted for inclusion under Schedule V of the Northwest Territories Fishery Regulations as a commercial waterbody.

Since that time, the test fishery program has been revised several times. Fishers are now issued an Exploratory Fishery licence (New Emerging Fisheries Policy Stage II; McGowan 1989, McGowan *et al.* 1993, VanGerwen-Toyne and Tallman in prep.). The major revisions up to 2009 include:

- The licensee collects data for five years before assessment is performed.
- The exploratory status includes fisheries in fresh and marine waters.
- Fishing occurs under an exploratory licence, issued annually.

- Prior to 1990, the GNWT staff performed or directly supervised the test fisheries, but after 1990, exploratory licences were issued to local associations and individuals within the communities.
- Biological samples are collected by the licencee or person approved by the licencee.
- The five-year sampling protocol was formalized and includes specific instructions on the data to be collected in each of the five years.
- The sampling of 200 fish (100 otoliths) occurs in year one and five of the exploratory fishery, and is strongly recommended in interim years.
- Catch, effort and total harvest data are collected in all five years.

Interest in developing commercial fisheries for anadromous Arctic Charr continues, although primarily in Nunavut. Arctic Charr stocks also occur in the Northwest Territories so any protocol developed for Arctic Charr would apply to both territories.

DFO is developing a Sustainable Fisheries Framework to form the basis for decision-making in Canadian fisheries. The framework incorporates existing and new policies for fisheries management, conservation and sustainable use, governance, and economics. The New Emerging Fisheries Policy was developed in 1996 to lay out the requirements that have to be met and the procedures that have to be followed before a new fishery can be initiated. The Policy requires that a scientific basis be established with which responses to new fishing pressures can be assessed. The objective is to achieve sustainable use of fisheries resources while conserving the fish stocks. It is meant to apply to all new fisheries undertaken in marine or fresh water areas where DFO manages the fishery.

As a general rule, new fisheries involve three stages (from http://www.dfo-mpo.gc.ca/fm-gp/policies-politiques/efp-pnp-eng.htm#2):

i. STAGE I (Feasibility): The objective of this stage is to determine if harvestable quantities of the species/stock known to be present in a particular fishing area exist, if the species/stock can be captured by a particular gear type, identify multi-species and habitat impacts, if markets exist and, the best approach for proceeding further, e.g., to Stage II.

ii. STAGE II (Exploratory): The commercial and stock assessment stage is reached if and as soon as feasibility has been demonstrated. The objective of this stage is to determine whether a species/stock can sustain a commercially viable operation and to collect biological data in order to build a preliminary database on stock abundance and distribution.

iii. STAGE III (Commercial): The commercial fishery stage is reached once it has been determined that a species/stock can sustain (commercially and biologically) commercial fishing operation. A formal Integrated Fisheries Management Plan is introduced.

The three stages are often not distinct and in some cases stages I and II may be combined. This is likely appropriate for anadromous Arctic Charr where there is aready sufficient information available to procede directly to stage II.

Fisheries and Aquaculture Management asked, “what revisions are required to the five year sampling protocol to ensure it reflects the current needs resulting from:

- Implementation of the New Emerging Fisheries Policy (3 stage approach), and

- Increased diversity of species under emerging fisheries."

Response to this request for advice needs to be addressed in several steps. Given the potential variety of species that could be fished, several protocols will need to be developed.

This review focuses on the current Stage II Exploratory Fishery licence conditions to determine if the information requested will be sufficient to provide an assessment of the impact of the harvest level on the fish stock and thereby determine if the level of harvest is sustainable over the long-term.

ASSESSMENT

Determining effects of exploitation on a stock

One avenue for the assessment of a stock is to experimentally determine the sustainable removal level. However, this would require knowledge of the stock size and the total removal of fish from all sources, which is not always known for anadromous Arctic Charr in NU and NT.

If an estimate of stock size is not feasible then an exploratory fishery approach (i.e., setting a provisional quota and fishing to that level over a certain number of years) becomes a test to see whether the level of harvest has any measurable impact on the population and whether it is acceptable and doesn't negatively affect the long-term sustainability of the fishery.

Initially in an exploratory fishery, a conservative provisional quota is recommended and fishers are asked to fish to the full quota for each of five years. It is important to make every effort to fish the full quota as the amount of effort required to reach the quota could be used to infer the relative abundance of the stock and evaluate the feasibility of a commercial fishery. For example, if the full quota is reached for a particular location, but requires a large amount of effort, it could indicate that the population abundance is low at that particular place and time, suggesting that a commercial fishery may not be viable. Conversely, if the full quota is reached with little effort over successive years, this would suggest that fish are abundant at that place and time, and that a commercial fishery may be viable. However, if consistent effort to fish the full quota is not applied, the relative abundance of the stock, and its response to the exploratory fishery, may be misinterpreted; stock abundance may be high but interpreted as low or variable if effort is minimal or unevenly applied among years.

Maintaining effort to consistently fish the full quota throughout the exploratory stage is also important to properly assess any changes that may have occurred in the biological characteristics of the stock. Fishers are asked to provide length, weight and otoliths for a subsample of the catch each year along with catch-effort data. Based on the samples and data provided, the population characteristics are monitored for changes which may result from the harvest. Dramatic changes in the age structure of the population, for example, a drastic reduction in the number of age classes, may signal harvest at an unsustainable level and quotas may have to be adjusted accordingly.

Therefore, failing to invest effort towards achieving the entire provisional quota for the duration of exploratory status prevents proper assessment of the stock (relative abundance and biological characteristics) and reduces the ability to evaluate the potential for a commercially viable fishery.

CPUE

The collection and assessment of catch-per-unit-effort (CPUE) data can also be monitored to determine the status of a stock. However, there are many assumptions that must be considered when using CPUE in a stock assessment analysis, such as (Ricker 1975):

- The stock is homogeneous.
- All fish in the population are equally susceptible to the gear.
- Fishing effort and gear are consistent.
- The fish are randomly distributed.

While the collection of CPUE is relatively easy and inexpensive, the potential issues associated with relying solely upon it to estimate relative stock size and infer overall stock health and sustainability is not recommended. Rather, combining CPUE with other analysis tools, such as monitor biological data, provides an improved basis of information for studying stock dynamics and impacts of exploitation.

Biological data

The health of an Arctic Charr stock may be assessed in numerous ways using biological data, such as through the monitoring of age or length frequency distributions, population growth, or mortality. The basic information required for these assessments includes fork length, round weight, sex, and age (sagittal otoliths for age determination). The biological data requested for Arctic Charr from fishers in NU and NT with a Stage II Exploratory licence includes all of the above and is therefore sufficient for assessment purposes.

Number of samples of biological data to collect

Fisheries organizations frequently employ random sampling programs for estimating growth. However, this approach often results in over-sampling of common age classes and under representation of older ones (Brouwer and Griffiths 2005).

The protocol on the most recent licences for 2009 states that 200 fish be sampled for fork length, round weight, and sex, but only 100 otoliths are required. Sampling of 100 otoliths and thus age determination for 100 fish is not sufficient to characterize population age structure. VanGerwen-Toyne and Tallman (in prep.) illustrate this using age-frequency data collected from Arctic Charr in 2007 at Kingnait Fiord, NU. They compared data collected for 200 aged Charr to simulated data that were created by randomly sampling 100 ages from the original data set, with replacement. When 100 age estimates were used the resulting age-frequency distributions were misrepresented compared to the actual data of 200 Charr.

Proper representation of the age classes, especially the older age groups, is critical because they have an influence on the statistics for calculating two parameters that are used in assessing a stock: mortality and growth.

Total instantaneous mortality rate: Total instantaneous mortality rate (Z) is essentially the total mortality on a stock and can be described mathematically as the number of fish at time t+1 minus the number of fish at time t (Ricker 1975).

$$Z = - (\ln N_{t+1} - \ln N_t)$$

When the size of a sample is increased from 100 to 200, there is a reduction in uncertainty of Z estimated from the data (VanGerwen-Toyne and Tallman in prep.).

Total instantaneous mortality is comprised of both fishing mortality and natural mortality (Ricker 1975); therefore, if we assume that natural mortality is constant, shifts in Z can be attributed to fishing mortality. In this way, a stock can be monitored for effects of exploitation. Conversely, if fishing mortality from all sources is accurately tracked and remains constant, yet Z increases, it could be an indication that an environmental factor is influencing the stock and that avenue can be explored more thoroughly. However, total harvest for Arctic Charr in NU and NT is not always known.

Growth: The monitoring of growth parameters is also a useful tool in the assessment of fish stocks and the accuracy of it, too, relies heavily upon accurate representation of all age classes in a stock.

Brouwer and Griffiths (2005) tested various sample sizes to determine the impacts on the confidence intervals produced for the parameters in the von Bertalanffy growth equation. There was wide variation in the confidence intervals until a sample size of 200 fish was reached, after which the confidence intervals stabilized. This provides support for the rationale to collect otoliths from 200 Arctic Charr in NU and NT.

Duration of biological data collection

Arctic Charr are known to migrate in specific groups, such as sex or size classes (DFO 2001). Collecting a predetermined number of fish in a short time period may result in only a portion of the population being represented. Sampling throughout the duration of a fish run would ensure the representation of the entire harvestable population. Spatial and temporal sampling consistency should be maintained throughout the exploratory period. Where deviations occur an explanation should be provided.

To ensure an unbiased sample is collected, a designated system of fish selection should be adopted; for example, sampling every third fish that is landed was recommended in the Stage II Exploratory Fishery licence issued in NU and NT in 2009.

Frequency of biological data collection

Assessment of an exploratory Arctic charr fishery becomes difficult if the full quota is not harvested annually for at least five years. If the quota is not reached, an explanation should be provided. The most recent Stage II Exploratory licence requires biological data to be collected in the first and fifth year of the fishery. While a comparison between two years may provide some insight into population dynamics, it is likely to be optimal only if all factors influencing the population remain constant. This is rarely the case. Data collected annually over a five-year period would encompass variation from many sources and provide a more accurate representation of the population.

Bycatch Species

When fishing with gillnets, there is the potential to catch non-target (bycatch) species. If bycatch species suffer mortality it may negatively impact a population that is not being monitored. Therefore, any bycatch caught should be identified, counted, recorded in the CPUE record sheets, and released. Fish that are unlikely to survive release should be sampled for biological data (fork length, round weight, sex, and ageing structure as appropriate).

CONCLUSIONS AND ADVICE

Commercial fishing for Arctic Charr has been documented since the late 1940s in what was the Northwest Territories *(NT; now NT and Nunavut, NU;* Grainger 1953). Since then, DFO has initiated and revised programs and licenses to ensure proper information is requested to assess potential impacts of harvest. In 2009, commercial fishers were issued an Exploratory Fishery License which includes a five-year sampling protocol for biological data collection. Fisheries and Aquaculture Management sector of DFO Central and Arctic region, requested Science review and revise the five-year sampling protocol to ensure it reflects current needs, including those related to the New Emerging Fisheries Policy.

The bulk of the current five-year sampling protocol remains sufficient for assessment needs; all provisional quotas should be fished fully for a minimum of five years; catch-per-unit-effort (CPUE), and total harvest data should be collected every year for five years before stocks are assessed and recommendations are made about the biological viability as a commercial fishery; fish selected for biological processing should be done so in a stratified manner throughout the duration of the fishery; bycatch species should be identified, counted, and released; and bycatch species that are unlikely to survive release should be sampled for biological characteristics.

However, revisions are required to the quantity and frequency of biological samples collected. The protocol on the 2009 Exploratory Fishery license states that 200 fish be sampled for fork length, round weight, and sex, but only 100 otoliths are required. Sampling of 100 otoliths and thus age determination for 100 fish is not sufficient to characterize population age structure. Ages for a sample of 200 Arctic Charr provides an improved representation of the population age structure (VanGerwen-Toyne and Tallman in prep.). Also, frequency of biological sample collections requires revision. The collection of biological samples is currently requested in years one and five of exploratory status, but not in the interim years. Given the potential annual variance in Arctic Charr populations, this is insufficient. Biological samples should be collected every year for five years before stocks are assessed and recommendations are made about the biological viability as a commercial fishery.

OTHER CONSIDERATIONS

- At the end of the five-year exploratory stage an assessment will be made, however the data may be insufficient to determine the biological sustainability of the fishery.
- Data collection may vary among resource users.
- Other sources of mortality during the course of sampling should be noted.
- Where harvesters are willing to collect supplemental information (e.g., environmental and biological information), this should be encouraged.

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