General Fish-out Protocol for Lakes and Impoundments in the Northwest Territories and Nunavut

J.D. Tyson, W.M. Tonn, S. Boss, and B.W. Hanna

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by

J.D. Tyson[1], W.M. Tonn[2], S. Boss[2,3], and B.W. Hanna[4]

[1]Tetra Tech, 400 – 161 Portage Avenue East, Winnipeg, MB R3B 0Y4

[2]Department of Biological Sciences CW 405, Biological Sciences Bldg.
University of Alberta, Edmonton, AB T6G 2E9

[3]Environment Canada Prairie and Northern Region
Rm 200 4999 98 Avenue, Edmonton, AB T6B 2X3

[4]Fisheries and Oceans Canada, Suite 301 5204 - 50th Avenue,
Yellowknife, NT X1A 1E2

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ABSTRACT

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Some development activities in northern Canada will result in unavoidable whole or partial lake destruction. If such a development is approved by Fisheries and Oceans Canada (DFO), the requirement for a fish-out program is included as a component of the *Fisheries Act* s.35(2) authorization. The guiding principle of the fish-out program is to ensure that both the ecological data and fish specimens that are collected can be used to their fullest extent. This can be achieved by recovering and distributing fish to local communities and by properly collecting, recording, and archiving the data from the fish-out program. Whole lake studies, including fish-out programs, can provide exceptional data on fish populations and fish – environmental relationships in the North. This information is useful for assessing patterns and relationships between fish community composition and the habitat characteristics of barrenland lakes. A database has been created that includes information collected on fish species composition and biological, limnological, and habitat characteristics from the lakes that have been fished out in the Northwest Territories. The purpose of this document is to provide a consistent and standardized protocol for proponents to follow when developing a fish-out program.

RÉSUMÉ

Tyson, J.D., W.M. Tonn, S. Boss, and B.W. Hanna. 2011. General fish-out protocol for lakes and impoundments in the Northwest Territories and Nunavut. Can. Tech. Rep. Fish. Aquat. Sci. 2935: v + 34 p.

Certaines activités de développement menées dans le nord du Canada conduiront à la destruction inévitable, complète ou partielle, de lacs. Si des activités de développement de ce type sont approuvées par le ministère des Pêches et des Océans, (MPO), l'exigence d'un programme de pêche-sur-place est reprise en tant qu'élément de l'autorisation en vertu de l'article 35 (2) de la *Loi sur les pêches.* Le principe Pour ce faire, il faut récupérer le poisson et le distribuer aux collectivités locales et collecter, consigner et archiver, comme il se doit, les données tirées du programme de pêche-sur-place. Les études portant sur l'ensemble des lacs, y compris les programmes de pêche-sur-place, peuvent fournir des renseignements de nature exceptionnelle sur les populations de poissons et sur les liens qui prévalent entre l'environnement et les poissons, dans le Nord. Ces données sont utiles pour faire l'évaluation des modèles et des relations entre la composition des communautés de poissons et les caractéristiques sur l'habitat des lacs situés en terres stériles. Une base de données a été mise sur pied; elle comporte les renseignements collectés sur la composition des espèces de poissons et sur les caractéristiques biologiques, limnologiques et sur l'habitat des lacs qui ont fait l'objet de la pêche dans les Territoires du Nord-Ouest. Ce document vise à fournir aux promoteurs de projets un protocole uniforme et normalisé à suivre lors de l'élaboration d'un programme de pêche-sur-place.

INTRODUCTION

BACKGROUND

The need for a fish-out protocol for the Northwest Territories and Nunavut originated in the permitting and construction of diamond mines in the mid-1990s. Kimberlite pipes, one form of the ore-bearing geological structures containing diamonds, are often found to occur under lakes. In order to access these pipes for mining, the overlying lakes need to be dewatered in whole or in part. BHP Billiton's (BHPB) EKATI Diamond Mine, located on the barrens, 300 km northeast of Yellowknife, NT, was the first diamond mine to be permitted in Canada. As a condition of the *Fisheries Act* s.35(2) authorization issued by Fisheries and Oceans Canada (DFO), BHPB was required to recover the fishes from the authorized lakes.

DFO recognized during the development of the authorization that the dewatering of entire lakes at EKATI provided a unique opportunity to acquire a detailed data set on the fish communities and environmental characteristics of several small tundra lakes. A research plan was initiated by DFO Science to conduct the field studies, however, the field tasks were eventually turned over to BHPB. As a result, the following conditions were included in the authorization:

1. Water chemistry and chlorophyll levels would be monitored during the open water season;
2. Benthic invertebrate population densities would be determined;
3. Standardized sampling of fish populations would provide catch-per-unit-effort data;
4. Fish population size estimates would be determined using mark-recapture methods;
5. Fish population size estimates would be determined using hydroacoustic methods;
6. Fish would be batch-marked, by size-class and species, to determine proportional recovery by species and size-class after drainage;
7. A complete census of fish populations, including lengths and weights, would be taken and ageing structures from a subsample of each species would be collected and analyzed; and
8. Data summary reports would be provided to DFO within one year of the field work.

BHPB engaged local communities to staff the fishing crews and prepare the harvested fishes for traditional community uses.

As additional mines completed permitting, fish-out conditions were included in the *Fisheries Act* s.35(2) authorizations. However, the diversity of development activities resulted in an increasing variety of waterbodies to be fished-out. Because there was no established protocol, there were inconsistencies in the way the fish-out programs were conducted which, in turn, affected the confidence in the resulting data and comparability among lakes (Dillon 2002; Thistle and Tonn 2007).

PROTOCOL DEVELOPMENT

The initial fish-out programs provided a number of lessons learned about the practicality of a complete census of fish populations. As well, a need was identified for a common framework and set of objectives to ensure that data acquired through fish-out programs would be collected in a consistent manner. Subsequently, projects were conducted to examine data collected during fish community baseline studies at the various development sites (Dillon 2002) and to establish a database for fish-out data (Tonn 2006). Collected data was also examined to determine whether patterns could be observed among fish communities in barrenland lakes using the baseline and fish-out datasets (Thistle and Tonn 2007).

Lessons Learned

Once the fish-out programs were put into practice, it became evident that a complete census of the fish communities was rarely practical. Even with multiple gear types and an almost complete saturation of the lakes with fishing gear, low rates of fish captures continued for an extended period. Simultaneous lake dewatering concentrated the remaining fishes into ever decreasing basins however, there were no safe methods to recover all the remaining fishes (Tyson 1998a, 1998b; Tyson 1998c; Tyson 1998d; Tyson and McCarthy 1997). The exposed lake bed did not provide a suitable wading substrate for seining or backpack electrofishing. Adding to this, as water levels declined in dewatered lakes (e.g. Panda, Koala, and Airstrip lakes at EKATI), wave action re-suspended sediments resulting in high turbidity. The complete census objective was therefore modified to an intensive cumulative catch per unit effort population estimate. Other lessons are included in the Field Methodology section.

Data Consistency

Given the need for research to further the understanding of fish-habitat relationships in barrenland lakes and that there is a potential for fish-out programs to provide reference data that could be used in such research, it was recognized that a necessary step would be to compile and organize these data into a reference database. These data could contribute to research that would help provide more precise tools for habitat biologists to use in future habitat management decisions. Despite the recognized value of a reference database developed from the fish-out and related projects, major problems were encountered initially. A preliminary assessment (Dillon 2002) concluded that the data were not in a form that was readily useable.

DFO, with financial assistance of BHP-Billiton Diamonds, Inc. and Diavik Diamond Mines Inc., contracted W. Tonn at the University of Alberta to see if the data problems could be overcome. The project had the following objectives:

1. develop a reference database;

2. assess the suitability of the fish population sampling methods and from this assessment, provide methodological recommendations for future baseline fisheries studies; and
3. if possible, quantify fish production, and productivity of lower trophic levels in barrenlands lakes.

The project results were presented in Tonn (2006) and Thistle and Tonn (2007). Problems encountered included inconsistencies in data integrity, data errors and the absence (or loss) of much data in useable digital format. Recommendations for standardizing data recording based on the database design were provided.

Given the variety of lake sizes, fish communities, and logistical considerations in the Northwest Territories and Nunavut, one detailed protocol is not practical for every potential application. A general protocol has therefore been developed with the expectation that more detailed, site-specific work plans would be drafted that incorporated objectives for each application yet still provided consistency with the general fish-out framework. This protocol incorporates the lessons learned from past fish-out programs as well as the recommendations from the data reviews and is presented in the following sections:

- Program Objectives – overall and guiding objectives of the program
- Project Management – roles and responsibilities of organizations and personnel
- Components – core components plus optional studies and applications
- Field Methodology – field components and equipment specifications and deployment
- Deliverables – sample and data analysis, data management, and reporting.

PROGRAM OBJECTIVES

The guiding principle of the fish-out program is to ensure that fish stocks in the waterbodies are fully utilized. Following this principle, value can be obtained from the fish stocks for both local traditional resource users as well as those agencies responsible for managing the stocks. Harvested fishes can be delivered to the communities for traditional uses while data of the kind not normally available can be collected during the fish-out for resource managers. In a few cases, fish stocks may be transferred from one waterbody to another or from an isolated area of a waterbody to the main waterbody (e.g. from Diavik's A154 pit into Lac de Gras). The program objectives are therefore:

1. To engage local communities and ensure that fish harvested during the fish-out are fully utilized by traditional resource users; and
2. To collect ecological information (biological, limnological, and habitat) on Arctic lakes in the Northwest Territories and Nunavut.

Full utilization of harvested fish can be achieved by engaging local communities. Most northern communities maintain a domestic fishery to supply fish for human consumption and dog food. Community members can be engaged to harvest, sort, dress, and deliver fishes to the communities. Material not prepared for human consumption, such as rough fishes, small-body fishes, and offal, can be frozen and delivered to the communities as dog food. The fish-out programs can have an added benefit within the communities in that fishing pressure on the usual domestic stocks can be offset by the amount of fish recovered from the fish-out.

Scientific data collection can be integrated with the fish harvesting by community members. The fishing crews can be trained and directed by biologists to record fishing effort and biological data. Biologists can also provide training and supervision for the harvest of ageing structures, fish stomachs, and any other biological samples, as well as the collection of water quality data. Data collected through the fish-outs will provide important information on the ecology of waterbodies in the Northwest Territories and Nunavut. As noted in the Introduction, fish-out programs can provide invaluable data for both fisheries and habitat managers. All data collected will be maintained in a database and be available for researchers and managers upon request.

A fish transfer is usually the least preferred method of fish disposal and should only be considered when fishes are transferred from a smaller, isolated portion of a lake to a larger main waterbody. Generally, barrenland lakes are oligotrophic with productivity limited by low levels of phosphorus and nitrogen and with a commensurately low standing stock of fish (Wetzel 2001). Though the small stocks might suggest that receiving lakes could easily assimilate the transferred fishes, the receiving lakes are likely already near their carrying capacity. Therefore, transferring fishes from one lake to another lake of similar size is not likely to enhance stocks but more likely to disrupt the fish community in the receiving lake by pushing the standing stock over the carrying capacity. As a result, fish condition in the receiving lake is likely to decline through competition for limited resources (Matthews 1998). The fish biomass of the lake receiving stocking will likely decline to the pre-transfer carrying capacity and result in no net increase in standing stock. The condition under which a transfer may succeed (and not cause damage) is when a small area of a large lake is isolated for dewatering. Less ideal would be if the fish community from a small lake is transferred to an adjacent and much larger lake to which there is good connectivity and significant fish movement. However, an estimate of productivity in the receiving lake should be undertaken to determine if the receiving waterbody has the capacity to absorb the additional stock with minimal impacts.

Other difficulties with stock transfers include fish handling mortalities, disruption of natural community composition, and locally adapted gene pools, and a reduction in the quality of scientific data. Though species such as Lake Trout (*Salvelinus namaycush*) are more robust and may have low mortality rates during transfer, coregonids such as ciscoes and whitefishes (*Coregonus* spp. and *Prosopium* spp.), as well as juveniles of other species, are sensitive to most capture and handling techniques and have high mortality rates. Data collected during fish transfers may not be directly relatable to data collected during a fish-out program. Because the priority during fish transfers is to minimize fish mortality, the unit of effort will likely differ from that of a fish-out. For example, in a fish transfer, short-term gill net sets may be used to capture fishes. As these nets are run several times a day and not set overnight, the unit of effort, even if expressed on a per-hour basis, will not be comparable to the overnight (18-24 hr) sets recommended for a fish-out program. Fish transfer therefore has limited applications and should be carefully considered prior to any decision to use this method.

PROJECT MANAGEMENT

The three stakeholders that manage or contribute to the project are: DFO, the proponent, and the local communities. It is the responsibility of the proponent to engage the local communities. There is nothing that precludes DFO participating as a research partner in the ecological and biological data collection. However, if DFO is to participate, the roles and responsibilities of DFO and the proponent should be clearly identified in the work plan. The protocols contained herein assume that DFO is not participating as a research partner and that the proponent will be conducting the fish-out program. An example of a fish-out program organizational chart is presented in Figure 1.

ROLES AND RESPONSIBILITIES

The DFO habitat biologist responsible for the project referral will be the principal contact with the project proponent. During the development of the work plan the habitat biologist will be responsible for seeking input from DFO Science, when required and providing timely communications and advice (technical and regulatory) to the proponent. Timely communications between the proponent and the DFO habitat biologist (or designate) should continue once the fish-out is underway. Following the fish-out program, it will be the responsibility of the habitat biologist to receive the deliverables from the project proponent, review the fish-out report, and coordinate with DFO Science to ensure the data are entered into the Arctic aquatic database. Compliance with the terms of the *Fisheries Act* s.35(2) authorization should also be noted in the referral file.

The project manager is the proponent's representative and has the responsibility of managing the fish-out program including developing the work plan, schedule and budget, staffing, communicating with DFO, and providing the deliverables (e.g. work plan, data, reports, etc.). The project manager may designate the project biologist to communicate directly with DFO during the fish-out.

The project biologist is the key technical position during the fish-out. The project biologist is responsible for meeting the technical requirements of the fish-out program; therefore, this position should be staffed by a qualified and experienced biologist. The project biologist should participate in the development of the work plan. The project biologist will be responsible for training field staff, supervising field activities and data collection, quality assurance/quality control, conducting data analysis, and preparing deliverables.

The field technicians will conduct the fish-out and data collection under the supervision and guidance of the project biologist. If possible, these positions should be staffed by members of the local communities with experience in operating boats, using gill nets, and handling fishes. Community members provide a valuable source of traditional knowledge and field skills. Field technicians will also record biological data, collect tissue samples, and sort and prepare fishes for community use.

WORK PLAN

The work plan is the document that clearly lays out how the particular fish-out project will be conducted, incorporating both the guiding principle and objectives of the fish-out program and any specific understandings agreed to by DFO and the proponent of the particular fish-out program. The work plan should include the following:

Objectives

The overall objectives of the fish-out should be clearly stated. This should also include specific study objectives of each component included in the project.

Project Management

The management plan for the project should be clearly detailed with roles and personnel identified. Lines of communication and decision makers should also be identified.

Components

The components to be included in the fish-out program should be identified as well as the goals of each. Decision criteria for proceeding from one phase to the next should be clearly identified. Existing data for the lake, particularly data used to estimate crew and equipment requirements, should also be identified and, if unpublished, included in the plan.

Field Methodology

The field methodology should include methods for fishing during each phase, biological data collection, aquatic biology/physical limnology, habitat assessment (if applicable), and any laboratory analyses. This section should also include estimates of crew and equipment required for each component and phase of the program.

Deliverables

The deliverables should be clearly stated. This should include the format and extent of analyses in the report as well as any samples and electronic data.

COMPONENTS

The core components of the fish-out program, as derived from the program objectives, are:

a) the recovery of fishes;

b) the distribution of fishes to communities; and

c) the collection of basic fish and fish habitat data.

A lake fish-out provides a rare opportunity to conduct intensive multidisciplinary research that can provide resource managers in the Northwest Territories and Nunavut with information that would otherwise be unavailable. In particular, a lake fish-out provides the opportunity to investigate linkages between fish community structure, composition, and productivity and fish habitat via whole-lake sampling. Given this opportunity, other components, such as a mark-recapture study, can be added to the fish-out program.

The basic program is divided into three general components:

1. Fish Community
2. Aquatic Biology/Limnology
3. Physical Habitat Inventory.

Baseline information for each of the above components should already exist prior to the development of the fish-out work plan. To reach the stage where a *Fisheries Act* s.35(2) authorization has been issued with the requirement for a fish-out, productivity in the candidate lake must have been previously evaluated. An example of a project schedule where all components, including a mark-recapture study, are conducted within the same open water season is presented in Figure 2.

FISH COMMUNITY

The fish community component is composed of (a) the CPUE phase, and (b) the final removal phase. The lake or waterbody should be isolated prior to the initiation of the CPUE phase and should remain so until the end of final removal phase to prevent immigration and emigration of fishes. As well, the CPUE and final removal phases should be conducted within the same open-water season to avoid the changes in growth, mortality, and recruitment resulting from reduced competition and predation (Tyson 2008; Tyson 1999a). An optional mark-recapture study, however, may require the marking phase in the year prior to the fish-out program to ensure dispersal of marked fishes and adequate time for the fish-out.

CPUE Phase

The objective of the CPUE phase is to collect fish community catch-per-unit-effort data for each population in the lake. These data will then be used to estimate the fish populations. Variously, this method of population estimation has been referred to as fishing success (Ricker 1975), removal (Kelso and Shuter 1989), and catch-effort (Gould and Pollack 1997) methods for estimating populations. Ordinary least squares (OLS) methods regressing CPUE with cumulative catch (Leslie method) and cumulative effort (DeLury method) are commonly used to estimate fish populations (Hayes et al. 2007). More recently, increasing computer capabilities have led to the development of computer programs allowing for maximum-likelihood estimators for catchability and population size.

The removal method has a number of assumptions most notably that of a constant catchability coefficient relating effort to catch and the probability of capture being equal among fish (Knight and Cooper 2008). Departure from these assumptions can result in an underestimation of the original population (Kelso and Shuter 1989). A number of studies have sought to address the bias (e.g. Akamine et al. 1992; Gould and Pollack 1997; Mantyiemi et al. 2005) during data analysis. Schwarz and Seber (1999) provide a review of recent analytical applications to the removal method. Gould and Pollack (1997) simulated population estimates under different population sizes and catchability coefficients for the Leslie, DeLury and maximum-likelihood methods. They found that the maximum-likelihood method consistently provided less biased and more precise estimates than the OLS methods.

It is critical that the standard unit of effort remain unchanged for the duration of the CPUE phase. Equipment type, fishing methods, and fishing periods must remain unchanged throughout the CPUE phase. For example, if trap nets are used at the start of the CPUE phase then the use of trap nets must be continued through the duration of the CPUE phase and not removed in later stages to make room for additional gill nets. Likewise, if trap nets are not deployed at the start of the CPUE phase, traps should not be added later in the phase. The only variable that will change will be the number units of effort. As CPUE declines, it is permissible to increase the unit of effort. For example, if five gangs of gill nets are being fished in a lake and the daily CPUE begins to decline, additional gangs may be added provided all other variables (e.g. fishing periods) remain the same.

The lake should remain physically and chemically unchanged during the CPUE phase. That is, no development activities, such as water transfers in or out of the lake should occur and seasonal changes to the environment and/or fish populations should be minimized. Dewatering has been observed to alter fish distribution through changes to available habitat while the re-suspension of sediments affects fish catchability (Tyson 1998a; Tyson 1998c; Tyson 1998d; Tyson and MacCarthy 1997). The CPUE phase should continue until the CPUE objective is met.

The ideal CPUE objective is achieved when no fish are captured for 24-48 hr of continuous netting, nets are removed for 48 hr, nets are then re-deployed for 24-48 hr of netting and fish are still not captured. In practice, this ideal should be weighed against the time required to achieve this, given the seasonal changes (e.g. water temperature and fish activities) that should be minimized, together with changes in catchability following intensive harvesting. At this point, the CPUE phase should be suspended. If the lake will be dewatered, this would be a time to begin, proceeding to a point where the remaining fish are sufficiently concentrated. The program may then continue with the final removal Phase.

Final Removal Phase

The transition from CPUE phase to final removal phase will be triggered when the lake has reached gear saturation and there have been no (or virtually no) fish captured for 48 hr. The objective of the final removal phase is to capture all remaining fishes in the lake to provide as complete a fish community census as conditions will allow. This can include using all available fish capture techniques, including methods not used in the CPUE phase, altering the distribution of mesh sizes that are fished, or even the development of new capture techniques. Lake dewatering can be initiated during the final removal phase and may assist by concentrating fishes into an ever decreasing lake volume. However, precautions should be taken to properly screen the intakes to avoid losses to pump entrainment (Tyson 1998a; Tyson 1998c; Tyson 1998d; Tyson and McCarthy 1997; DFO 1995).

The final removal phase can also be used as an extension of the CPUE phase. This would be done by adjusting the unit of effort to focus the numerically strongest size classes of the fish populations and then stratifying the effort accordingly during data analysis. Typically, larger fishes are removed most rapidly from the lake as they are susceptible to both the large meshes and, to a lesser degree, the smaller mesh sizes (e.g. Tyson 1999). As a result, even at gear saturation, the majority of the lake can be occupied by gear that will no longer catch fishes. By swapping out panels of mesh sizes that have the lowest CPUE for panels of mesh sizes that have the highest CPUE, fishing effort is concentrated on the remaining fish size classes. For example, if no fishes have been captured in the 4" panels for a week whereas the 1.5" panels were found to have captured the most fishes during the CPUE phase, most of the 4" panels can be swapped out for 1.5" panels. In order to allow for stratification of unit effort, it is important to continue fishing a few panels of each mesh size throughout the duration of the final removal phase.

Mark-Recapture Study (Optional)

A mark-recapture study can be included in the fish-out program. The study would include a marking period prior to the fish-out. The CPUE phase would then be used as the recapture period. Because Arctic summer fishing periods are short, the marking phase might need to be conducted during the previous year to allow for marking of an adequate number of individuals. This would avoid a potential encroachment on the time available for a fish-out and reduce the risk of an incomplete fish-out. Caution should be used in developing a mark-recapture study as handling mortality, especially amongst coregonids, may affect recovery during the CPUE phase, resulting in an underestimation of the original fish community populations (Tyson 1998c).

AQUATIC BIOLOGY/LIMNOLOGY

Basic aquatic biology and limnology information for the lake should already exist prior to the fish-out, but more detailed and/or updated sampling may be desirable to provide supporting data for the fish-out. Because the lower trophic levels of the lake community may be affected by the removal of fishes (Kitchell and Carpenter 1993), sampling should be conducted during the mark-recapture or early CPUE phase or during the prior open-water season.

HABITAT INVENTORY

A habitat inventory of the lake should also already exist prior to the fish-out, as habitat is often used as a surrogate for estimating productive capacity in the development a *Fisheries Act* s.35(2) authorization. A habitat inventory map will be used to ensure all habitats are fished adequately during the CPUE phase (e.g. using a stratified-random sampling design). A habitat inventory can also be conducted shortly before the CPUE phase. A habitat confirmation survey could also be conducted once the lake has been partially drained and the littoral areas have been exposed. Its goal would be to confirm the physical habitat features delineated during the initial habitat survey.

FISH TRANSFER

A fish transfer is a special situation where fish can be captured and transferred from one waterbody to another. This should only be conducted if there is no reasonable expectation for there to be significant effects on the fish community in the receiving waterbody. The species of fish being transferred must occur in both the donor and receiving waterbodies. Following are cases in which fish transfers might be considered worth the additional effort: (1) the fish community in a small portion of a large lake that has been isolated for dewatering can be captured and transferred to the main lake; (2) the small-body fish community from a small lake could be captured and transferred to a much larger lake (>1,000 ha) with few effects on the receiving lake, where both lakes support all species considered for transfer. In the case of the latter smaller lake transfer, all components of the fish-out program should be conducted. In the case of the transfer of fishes from an isolated portion of a lake, the emphasis should be on minimizing capture and handling mortality. Because it is likely that the habitat has already been disturbed and the fish community may have been altered during the process of isolation, the aquatic biology/limnology and habitat inventory components would not be required. The biological and CPUE information on the fish, however, may still be collected.

FIELD METHODOLOGY

Ideally, the fish-out methodology should be consistent with the methodology used during the lake assessment. The Northwest Territories and Nunavut, however, do not have standard fish community survey or biological sampling protocols; rather, a variety of lake assessment methodologies are currently used, depending upon the choice of the lead investigator. A recent project to construct a database from a number of lake assessment and fish-out projects encountered significant challenges due to the variable quality of data and inconsistencies in methodologies (Tonn 2006). Various jurisdictions in Canada and abroad have sought to address similar challenges by developing standard sampling methods for fish community characterization and assessment (e.g. Cavanagh et al. 1997; Appelberg 2000; Environment Canada 2002; Morgan and Snucins 2005; Sandstrom et al. 2008; Beauchamp et al. 2009; Lester et al. 2009). The development of standard sampling methods is beyond the scope of this document, therefore, the methods developed during the initial fish-out programs will be continued herein. Ideally, if a proponent (or DFO) wants to adopt one of the 'standard' protocols from other jurisdictions, both the 'original' and 'new' protocols should be used side-by-side, at least initially, to allow for the conversion of one protocol to the other and thus insure continuity and consistency in the accumulating data base.

PROJECT TIMING

Unless specified otherwise, all components should be conducted during the same open-water season. The one exception could be that the marking phase of a mark-recapture component might be conducted during the previous open-water season. Because the open-water season in the Northwest Territories can be very short, preparations should be made to have sufficient crews and gear to provide a high level of effort to the fish-out program. Consideration must also be given to selecting fishing gear that provides high rates of capture (Tyson 1998a; Tyson 1998c). For example, trap nets tend to have lower rates of capture per unit area fished than gill nets; therefore trap nets may not provide sufficient captures to complete a fish-out during one open-water season. Winter fishing should not be conducted. Winter fishing is logistically difficult, labour intensive and, because of the thick surface ice, does not allow fishing of the shallower littoral areas. In addition, CPUE during winter fishing is lower than and not comparable to open-water fishing (Tyson and McCarthy 1997).

FISH COMMUNITY

The goal of the fish community component is to provide an accurate description of the fish community, including population estimates, size distributions, and age structures of its component populations. Fishing methods will depend on the size of the lake.

Fishing Gear

Gill nets are the primary gear type to be used to capture fishes during the fish-out. Gill nets can be readily standardized, provide good rates of success in a variety of habitats, catch a wide variety of fishes and fish sizes, and are easy to transport and use. Trap nets can also be used but because of lower CPUEs when compared with gill nets (except during lake dewatering after littoral habitat has been exposed; Tyson 1998a, Tyson 1998c), trap nets generally require longer periods of deployment which are not always available during the short Arctic summers. As a rule of thumb, gill nets should be used exclusively to fish-out lakes with large-body fishes while trap nets and Gee minnow traps can be used with small-mesh gill nets for lakes with only small-body fish species.

Standardized gill nets should be used to capture fishes during the CPUE phase while additional gear types may be used during the final removal phase. Gear should be checked daily for damage. Small tears in gill nets can be repaired using monofilament line, however, panels with large or numerous holes should be replaced. A sufficient stock of equipment should be available prior to the start of fishing to provide replacement panels as required due to wear and tear, as well as to ensure gear saturation during the late CPUE and final removal phases.

Gill Nets – All nets should be bottom setting and constructed of monofilament. Stretched mesh-sizes to be used are 102 mm (4"), 76 mm (3"), 51 mm (2"), 38 mm (1½"), 25 mm (1"), and 13 mm (0.5"). Standard single-mesh panels are 45 m (150') long by 2.4 m (8') deep. Panel lengths may be increased or decreased depending upon the size of the lake, however, panels used in any lake should all be the same dimensions and dimensions of all nets must be clearly recorded on data sheets.

Trap Nets – Where appropriate (e.g. small lakes dominated by small-body fish species), small-mesh trap nets can be used for all phases of a fish-out program. The traps should be constructed of 6 mm square mesh with a house of 1.23 x 1.23 x 1.23 m. The leads should measure 61 m in length and 1.83 m in depth.

Gee Minnow Traps – Minnow traps can be used for fish-outs of small lakes or ponds that are dominated by small-bodied fish. Standard traps are constructed of 1/4" (6.4 mm) square galvanized wire mesh and measure 16" (42 cm) long and 9" (23 cm) wide with a 7/8" (22 mm) entrance hole. Bait can be used in the minnow traps but the use of bait and bait type should remain consistent through out the CPUE phase.

Other gear – During the final removal phase, additional gear types may be used in order to conduct a complete census of the fish community. Active fishing methods, such as electrofishing and seining, can be effective at capturing benthic and/or less-active species but only if the substrate conditions allow. Baited set lines or baited traps may be effective for catching burbot.

Gear Deployment

Gill net, trap net, and minnow trap sites and identifications should be drawn on a map of the lake and GPS coordinates (easting/northing) recorded on the field data sheet. Date, time of setting (24 hour clock), and time of retrieval should also be recorded for each net and trap. Water depths at the start and finish of the gill nets and trap net leads are to be recorded, based on field measurements (e.g. fish finder) or from a bathymetric map. Mesh sizes (gill nets) and lengths and heights (trap net leads, gill nets) are also to be recorded. Gill net panels should each have a unique identity code attached to allow quick identification and data recording in the field. A master list with codes, mesh sizes, and dimensions should be maintained onshore.

The trap leads should be anchored to shore and set perpendicular to the shoreline. Trap nets must be moved regularly (every 2-3 days) around the shoreline to ensure full coverage of the available habitat in the lake.

Net checks could initially be conducted once per day. Nets should be moved daily such that all available habitats are fished and avoidance behaviour minimized. However, since fish abundance and biomass are generally highest in the littoral zone, fishing effort should be more intense in (but not exclusive to) shallower depths. Daily gear redeployment will also serve to rotate of panels and mesh sizes through any given patch of habitat. As catch decreases, effort (amount of gear) should be increased. Eventually, the lake will become saturated with gear.

Field Crews

Generally, crews setting and picking gear also conduct the biological data collection from the catch. Care should be taken to balance the amount of gear being fished and the capacity of the crews to pick and move nets and to record biological data. Catches at the start of the CPUE will be highest and setting too much gear at that time can overwhelm the crews. The majority of the larger fishes tend to be removed early, therefore it is preferable that sufficient personnel should be available at the start of the CPUE phase to ensure all large-body and adult fishes can be processed without the risk of sub-sampling. As the fish-out continues, the majority of the later catches will be juveniles, which can then be sub-sampled.

At the start of the CPUE phase, one crew of three (boat operator, net picker, and data recorder/helper) can manage at least one and perhaps two complete standard gangs. This includes picking and moving nets as well as processing the catch for biological information. As CPUE declines, more gangs can be deployed. If sub-sampling of the juvenile and small-body fishes is being conducted then the proportion of time crews spend picking and moving nets increases while the proportion of time spent processing the catch decreases. Preparations should therefore be made to adjust the crew complement to meet the fishing and data collection needs as required. Preparations should also be made to rotate crews offsite and fresh crews onsite without interruption to the program.

CPUE Phase

During the CPUE phase, gear types, including mesh-sizes and lengths of individual nets, should remain constant such that a standard "unit of effort" can be defined. However, additional units may be required as stocks, and hence catch rate, decrease. The full range of gill net mesh-sizes must be fished at all times; there should also be a consistent proportion of the different panels used for each set during the CPUE phase. The total number of sets should be increased as CPUE decreases.

It is critical that all fishing methods that make up the standard unit of effort be held constant during the CPUE phase. For example, if trap nets are used at the start of the

CPUE phase, then trap nets should be continued to be fished through the duration of the CPUE phase and not removed in later stages to make room for additional gill nets. Likewise, if minnow traps are used in a pond fish-out, they should be continued throughout the CPUE phase and seining and electrofishing held off until the final removal phase.

Final Removal Phase

To assess the accuracy of the population estimates, as well as to achieve the program objective of removing all fish from the lake, a total census of the lake's fish community must be completed. Every effort should be made to capture every fish in the lake. During the CPUE phase, the goal is to capture and remove as many fish as possible while keeping the gear types constant and effort standardized. During the Final Removal Phase, *every* effort will be made to capture *all* remaining fish in the lakes, thus, additional capture methods may be added (see "Other gear", above) and the number of gill-net panels of each mesh size may be increased disproportionately, e.g. to favour mesh sizes that continue to catch fish. Proposed methods will be presented to, and reviewed by, DFO.

After the lake volume has been sufficiently reduced for lakes being 'de-watered' (possibly during the winter) the fish-out will resume. The final removal phase will continue until the removal objective is met. This objective should be presented to, and reviewed by, DFO prior to the start of the field work. Possible benchmarks could include the capture and removal of marked fish (fin clips and/or numbered tags) that exceed a certain percentage (e.g. >99%) of all fish marked by that method. Another objective could be based on CPUE, e.g. no fishes are captured for 48 hr of continuous sampling (with sufficient effort), sampling is halted for 48 hr, sampling then resumes for 48 hr and fish are still not captured.

Captured and removed fish should be treated as in the CPUE phase: counted and classified, biological data (and tissues) extracted, fish sacrificed, and/or distributed, in accordance with agreements.

Mark-recapture (Optional)

The fish-out program can be used to conduct a mark-recapture population estimate to complement the CPUE estimates. The mark-recapture phase of the program requires a period of catch and marking (marking phase) followed by a period of dispersal prior to the CPUE (recapture phase) and final removal (Figure 2).

For the mark-recapture phase, the goal is to release fish back to the lake alive, therefore either trap nets or short-set small-mesh gill nets (e.g. 38 mm stretched mesh, set for 30 to 60 min) should be used to minimize mortalities. If the marking phase is during the same open-water season as the fish-out phases, marking should commence soon after ice out and before surface water temperatures above 10°C increase the risk of capture mortality. Detailed set data should be recorded for each net and trap and full biological data (see below) should be collected from fish mortalities. Due to low survival rates of whitefishes during netting and marking procedures, the use of a mark-recapture component should be carefully considered with respect to program goals before being included. Small-mesh trap nets and minnow traps could also be used if there are substantial numbers of small fish present and the schedule allows.

Partial fin clips, removing ⅓ to ½ of a fin, can be used to mark fish. It is important to minimize stress on fish and to return the marked fish to the water as soon as possible. However, live wells/holding tanks should be available during the marking phase, as needed, to allow stressed fish some recovery time before being returned to the lake. If anaesthetic is being used, fish must be held until they have recovered from the anaesthesia.

Record the counts of all fish captured during this phase by species and fate category (see Fish count record form). Based on prior information about the fish populations, separate mark-recapture estimates could be made on different size/age-classes (e.g. juveniles vs. adults) or sexes within (some) species. If so, clip different fins to avoid confusion and record the distinction. As the phase progresses, more and more of the fish being captured will already have been marked (i.e. will be recaptures). Although marking and recapturing a greater proportion of fish in a population will produce more precise estimates of abundance (see Ricker 1975 or Krebs 1999), it is often not practical to maximize precision for all species in a lake. The work plan for the fish-out program should indicate *a priori* the recapture rate (e.g. 10%) that will be used as the target objective for the mark-recapture phase and whether the phase will be terminated when all, half, or some other proportion of species reach that target objective.

<u>Note</u>: If a substantial time gap is anticipated between any of the three phases of the fish-out program, then a sizeable number of fish should be given more permanent marks such as tags or adipose fin clips during the marking phase. These can subsequently be used to assess the effectiveness of the complete censuses during the CPUE and final removal phases.

Fish Transfer

If fish are to be transferred to another waterbody (but see earlier discussion and caveats), the goal is to release fishes alive, similar to the marking phase of the optional mark-recapture component. Care must therefore be taken to minimize capture, handling, and transportation mortality. Capture and handling methods should follow the methods above described for catching and marking fishes. The receiving waterbody should be adjacent to the source lake and there should be easy access between the two. If fishes cannot be reliably captured and transferred with minimum fish mortality then a fish-out should be considered.

Biological Data Collection

All fishes must be removed from the lake, sacrificed, and distributed in accordance with any agreements between the proponent and the communities. A count of all captured fish, by species (and size-class, if appropriate), must be made and recorded, along with their "fate" or category, e.g. whether the fish had previously been marked or not, and whether it was removed or escaped. The proportion of marked fish (from the optional marking phase) that was captured and removed during the CPUE phase can be used as an index of the proportion of all fish in a population captured and removed. Biological data (see "Fish sample record" form) should be taken on every fish or on a substantial sub-sample as noted below.

Data codes and sample data sheets are provided in Appendix A. Biological data collection procedures should be developed prior to the field program and should include QA/QC procedures. Data collection procedures should follow established procedures (e.g. Cavanagh et al. 1997; EC 2002; and Sandstrom et al. 2008).

During the optional marking phase of the program, fish stress and mortality must be minimized. For fishes marked with unique identifiers (e.g. Floy tags), the following data should be recorded:

- Species
- Length
- Weight
- Tag number
- Mark type

Batch-marked fishes should only be marked and/or examined for marks before being released. Full biological data should be taken from any mortalities. For each fish species or category (which may be a size-, age-, or sex-class of a species), record only the number and category ("fate") of all fish captured in each trap or net (see "fish count record" data form, Appendix A).

During the CPUE and final removal phases, biological data and/or samples should be collected for each fish captured. The following data should be recorded from a sub-sample of the smaller, younger fishes and all of the larger, older fishes (see "fish sample record" data form, Appendix A):

- Species
- Unique fish number
- Weight (to the nearest 0.1 g)
- Length (fork or total length; to the nearest mm)
- Sex
- Maturity
- Reproductive status
- Ageing structure (s) taken
- Biological tissues collected (e.g. muscle tissue, stomachs, whole carcass)

- Marks
- Tag number

Fish dissections should be conducted in the field at the time of collection.

Ageing Structures

Ageing structures should be removed from a sub-sample of the smaller, younger fishes and all of the larger, older fishes. A list of the appropriate structures by group is provided in Table 1. Methods for the collection, storage, and reading of ageing structures can be found in Mackay et al. (1990) and Mann (2004). Procedures should be part of the Project Biologist's QA/AC procedures.

AQUATIC BIOLOGY/PHYSICAL LIMNOLOGY

One of the principal goals of the fish-out program is to identify fish and fish habitat relationships. Therefore, information about lake ecosystem components other than the fish community must be collected. Generally, this information is collected during the fish and fish habitat assessment of the lake prior to the development of a fish habitat compensation plan. In the event that this information has not been collected, an aquatic biology/physical limnology program should be conducted prior to the fish-out field work. The Northwest Territories and Nunavut do not have standard biological sampling procedures, however, a number of other jurisdictions do provide manuals that may be used as references when designing a sampling program (e.g. Cavanagh et al. 1997; EC 2002; USEPA 2007).

The aquatic biology/physical limnology program should include the following:

- Physical Limnology
- Water Quality/Nutrients
- Chlorophyll *a*
- Zooplankton
- Benthos
- Habitat Mapping

Ecosystem sampling should be conducted during the open water-season. Permanent survey sites should be established at the deepest portions of each basin within each lake (e.g. a lake with three basins will have three survey sites for physical limnology, water quality/nutrients, chlorophyll *a*, and zooplankton). Samples from these sites will be considered representative of the basin. Except for benthos, sampling surveys should be carried out at each site during three, equally spaced sampling visits. The benthos survey should be conducted once, during the late summer or fall.

Physical Limnology

Record wind (direction and speed), cloud cover, air temperature, and surface water temperature in the field notebook and data form comments box during *every* visit to the lake.

The following components will be carried out at each site during each of the three limnological sampling visits:

- Dissolved oxygen and temperature profiles (1-2 m intervals)
- Secchi depth.

Water Quality/Nutrients

A minimum of two water samples should be taken: (a) at a depth of one metre (or from the epilimnion with an integrated tube sampler), and (b) at a depth below the thermocline (in stratified lakes) or at a depth three-quarters of the maximum depth in fully mixed lakes. Samples should be analyzed for:

- Total phosphorus
- Total nitrogen
- Total dissolved solids
- Dissolved nutrients – ammonia, nitrate, nitrite, ortho-phosphate, silica
- Total dissolved nitrogen
- Total dissolved organic carbon

***Chlorophyll* a –** Samples for chlorophyll *a*, as an index of primary productivity, should be taken from each of the water quality/nutrient sampling locations. Samples will be handled and analyzed following standard protocols.

***Zooplankton* –** Zooplankton is the dominant group of primary consumers in the pelagic zone and an important component of the diets of fish inhabiting that zone. Zooplankton sampling should be conducted during the water quality/nutrient sampling periods. Sampling should consist of four hauls per station, from about one metre off the bottom to the surface (recording the total length of the haul), using a 25-30 cm diameter net with 70 to 100 micron mesh. Samples should be preserved and analyzed for total biomass and taxonomic composition using standard procedures.

Benthos – Macroinvertebrates are dominant consumers in the littoral and profundal zones of a lake and important components of fish diets. Benthos samples should be taken once during late summer. A total of 21 dredge hauls should be taken below 5 m in each basin, in areas of softer sediments, distributed amongst the following depth intervals: six between 5-10 m; four between 10-15 m; three between 15-20 m; one between 20-25 m; and two deeper than 25 m. Dredge samples should initially be washed through a 250 or 500 µm mesh and preserved. One dredge haul from each depth interval should be analyzed for taxonomic composition, whereas the remaining 15 hauls should be used for biomass determinations.

Habitat Mapping

The Northwest Territories and Nunavut do not have standard fish habitat inventory protocols but rather a variety of inventory methodologies are currently used, depending upon the choice of the proponent project manager. Some jurisdictions in Canada have developed locally applicable standard inventory methods (see Resource Inventory Standards Committee for British Columbia and Bradbury et al. 2001 for Newfoundland and Labrador) which may be adapted for use in the Territories. Armantrout (1998) provides a glossary of habitat inventory terminology.

DELIVERABLES

SAMPLE ANALYSIS AND DATA MANAGEMENT

The analyses of all samples, from water quality to aging structures, are the responsibility of the proponent. All sample analyses will be conducted by qualified laboratories/ personnel. QA/QC results and analysis should be included.

DFO will provide the MS Access data entry template to the proponent. Field data forms, designed to be consistent with the fish-out database, are provided in the Appendix for gear-set data, fish counts, and fish biological data, along with a page of codes for these forms. Data should be entered from these field sheets directly into the MS Access database forms.

REPORTING

A daily CPUE report should be submitted electronically to DFO during the CPUE and final fish-out phases. Data should be in the form of a total daily fish count and the amount of fishing effort (e.g. number of gill nets). This information will be used by DFO to determine when to transition from CPUE to final fish-out phases as well as the end point to the final fish-out phase.

At the conclusion of the fish-out program, the proponent will provide the data in a summary data report that should present and discuss the data in relation to the objectives of the fish-out program. In addition to the biological and survey data, sample analyses of results will be provided that demonstrate the suitability, precision, and accuracy of the data. The report will also include mark-recapture and CPUE population estimates and comparisons to baseline data, assessments, and predictions. QA/QC results, analysis, and discussion should be included in the report.

In addition to the report, the proponent will supply DFO with:

- Photocopies of all field data/notes
- Copies of photographs
- An electronic database in Microsoft Access of all data collected, including the results of all sample analyses.

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Table 1: Ageing structures to be collected by species group and listed in order of reliability (after EC 2002 and Mann 2004).

Species	Structure
Lake Trout and other salmonids	a) ototliths b) 1st four leading pectoral rays c) scales
Whitefish and other coregonids	a) ototliths b) 1st four leading pectoral rays c) scales
Smelt	a) ototliths b) 1st four leading pectoral rays c) scales
Northern Pike	a) cleithrum b) scales
Burbot	otoliths
Suckers	a) ototliths b) 1st four leading pectoral rays c) scales
Cyprinids	a) otoliths b) scales
Sticklebacks	otoliths
Sculpins	otoliths
Walleye and other percids	a) ototliths b) 1st three dorsal spines c) opercules d) scales

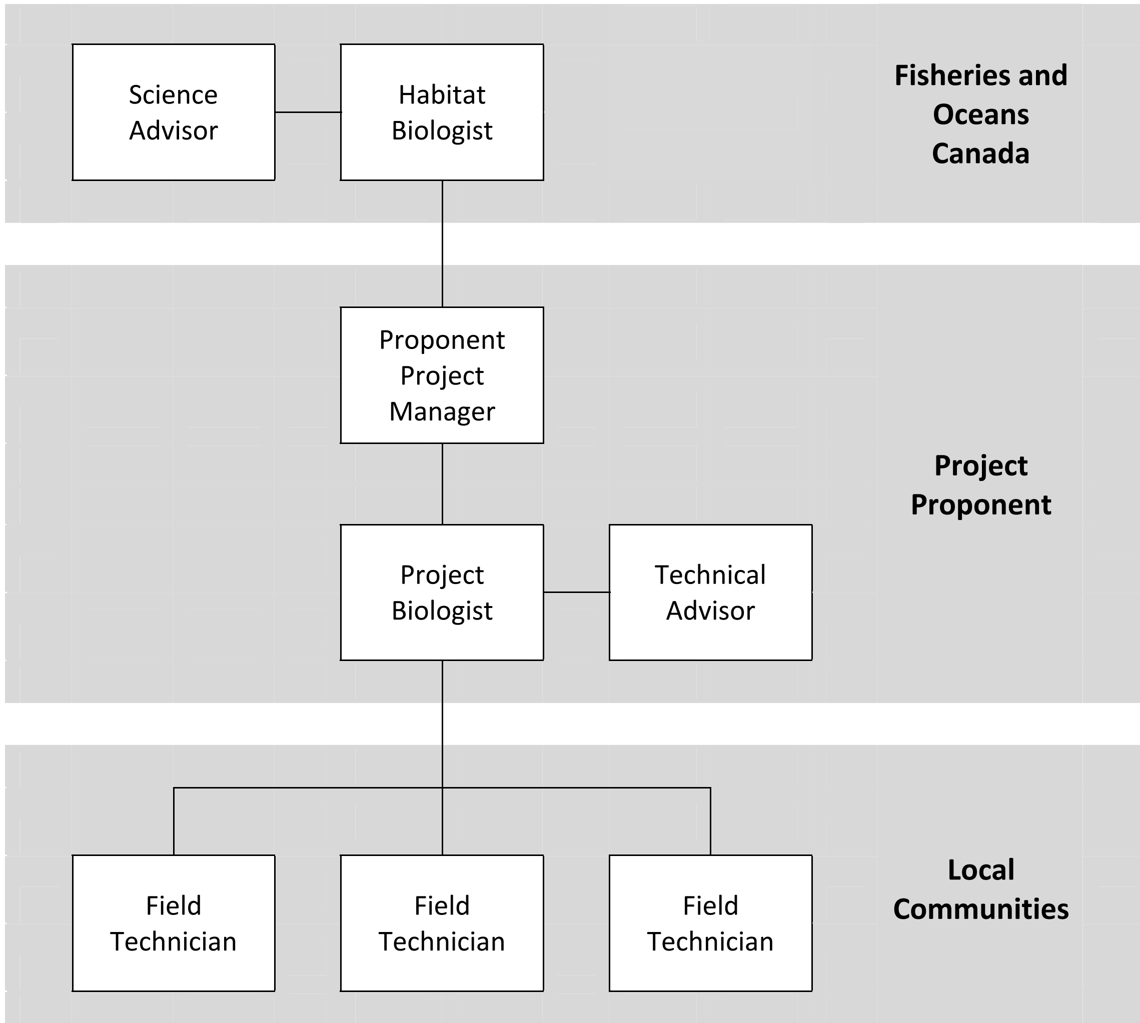

Figure 1: Example of a fish-out program organizational chart.

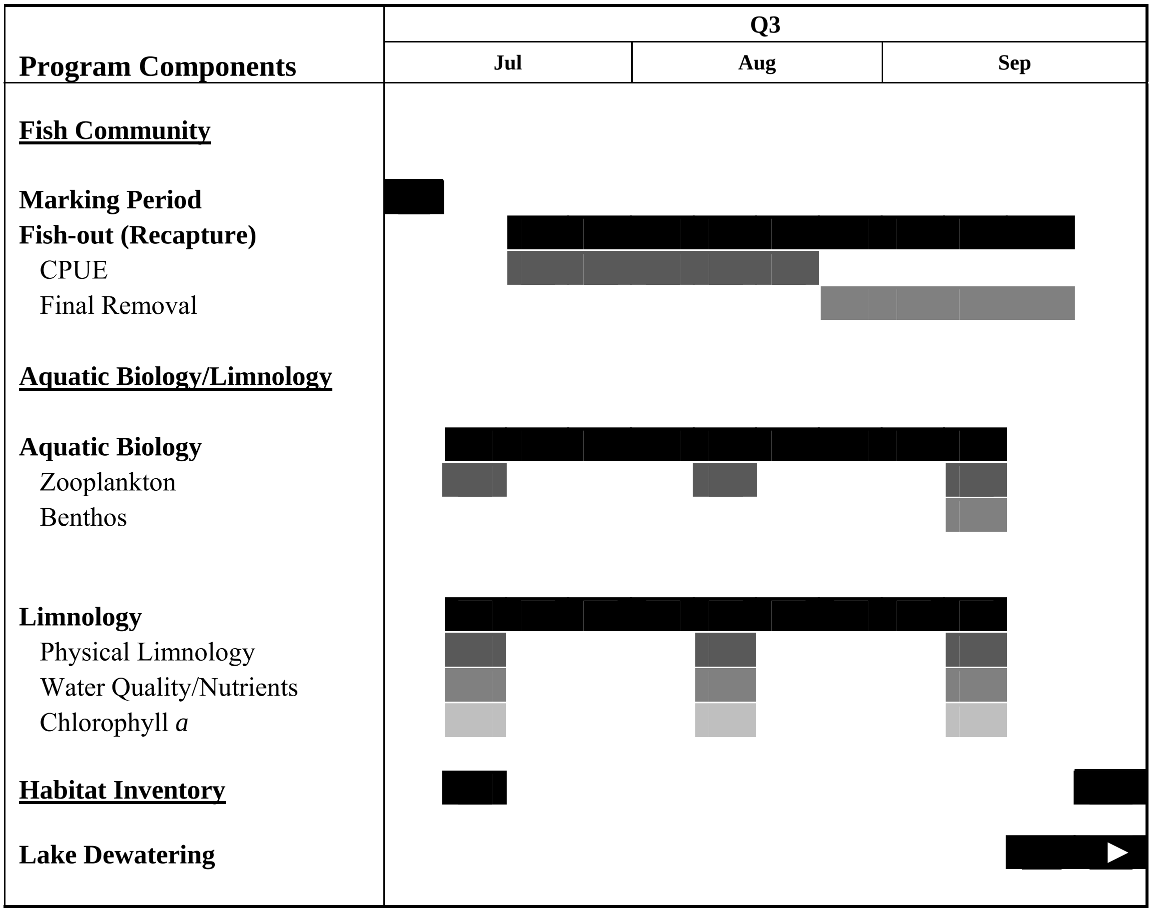

Figure 2: Example of a fish-out program field schedule where the fish-out, aquatic biology, physical limnology, and habitat assessment occur during the same year and dewatering begins following the conclusion of the fish-out program.

APPENDIX A

DATA CODES

Appendix A.1: Species codes for freshwater and anadromous fishes in the Northwest Territories and Nunavut, Canada (after Sawatzky et al. 2007).

Species Code	Scientific Name	Common Name
ARLM	*Lampetra camtschatica*	Arctic Lamprey
GOLD	*Hiodon alosoides*	Goldeye
PNSL	*Oncorhynchus gorbuscha*	Pink Salmon
CHSL	*Oncorhynchus keta*	Chum Salmon
COSL	*Oncorhynchus kisutch*	Coho Salmon
RNTR	*Oncorhynchus mykiss*	Rainbow Trout
SCSL	*Oncorhynchus nerka*	Sockeye Salmon
CNSL	*Oncorhynchus tshawytscha*	Chinook Salmon
ARCH	*Salvelinus alpinus*	Arctic Char
BLTR	*Salvelinus confluentus*	Bull Trout
DLVR	*Salvelinus malma*	Dolly Varden
LKTR	*Salvelinus namaycush*	Lake Trout
CISC	*Coregonus artedi*	Cisco
ARCS	*Coregonus autumnalis*	Arctic Cisco
LSCS	*Coregonus sardinella*	Least Cisco
SHCS	*Coregonus zenithicus*	Shortjaw Cisco
LKWH	*Coregonus clupeaformis*	Lake Whitefish
BRWH	*Coregonus nasus*	Broad Whitefish
PGWH	*Prosopium coulterii*	Pygmy Whitefish
RNWH	*Prosopium cylindraceum*	Round Whitefish
MNWH	*Prosopium williamsoni*	Mountain Whitefish
INCO	*Stenodus leucichthys*	Inconnu
ARGR	*Thymallus arcticus*	Arctic Grayling
PDSM	*Hypomesus olidus*	Pond Smelt
RNSM	*Osmerus mordax*	Rainbow Smelt
NRPK	*Esox lucius*	Northern Pike
LNSC	*Catostomus catostomus*	Longnose Sucker
WHSC	*Catostomus commersoni*	White Sucker
LKCH	*Couesius plumbeus*	Lake Chub
PRDC	*Margariscus margarita*	Pearl Dace
PEAM	*Mylocheilius caurinus*	Peamouth
EMSH	*Notropis atherinoides*	Emerald Shiner
SPSH	*Notropis hudsonius*	Spottail Shiner
NRDC	*Phoxinus eos*	Northern Redbelly Dace
FNDC	*Phoxinus neogaeus*	Finescale Dace
FTMN	*Pimephales promelas*	Fathead Minnow
FLCH	*Platygobio gracilis*	Flathead Chub
LNDC	*Rhinichthys cataractae*	Longnose Dace
TRPR	*Percopsis omyscomacus*	Trout-Perch
BURB	*Lota lota*	Burbot
BRST	*Culaea inconstans*	Brook Stickleback
THST	*Gasterosteus aculeatus*	Threespine Stickleback
NNST	*Pungitus pungitus*	Ninespine Stickleback
SLSC	*Cottus cognatus*	Slimy Sculpin
SPSC	*Cottus ricei*	Spoonhead Sculpin
DPSC	*Myoxocephalus thompsonii*	Deepwater Sculpin
IWDR	*Ethiostoma exile*	Iowa Darter
YLPR	*Perca flavescens*	Yeloow Perch
WALL	*Sander vitreus*	Walleye

Appendix A.2: Biological data codes to be used with the field data sheets.

Assess Code	Assessment Type
FO-MR	Fish-out: Mark-Recapture phase
FO-CPUE	Fish-out: CPUE/Removal phase
FO-FREM	Fish-out: Final Removal phase
B-line	Base line sampling
AEMP	Aquatic Effects Monitoring Program

Gear Code	Gear Type
AN	Angling
BS	Beach seine
DN	Dipnet
EF	Electrofisher
GN	Gill net
MN	Minnow trap
TN	Trap net
OT	Other

Length Code	Length
F	Fork
T	Total

Sex Code	Sex
F	Female
M	Male
U	Unknown

Maturity Code	Maturity
IM	Immature
MA	Mature
SD	Seasonal development
UN	Unknown

Reprod Code	Reprod Status
GR	Green
RI	Ripe
RU	Running
SP	Spent
UD	Undeveloped
UN	Unknown

AgeStruct Code	Aging Structure
FR	Finray
OT	Otilith
SC	Scale
NO	None
CL	Cleithrum
OP	Operculum bone

Fate Code	Fate
NR	New, released marked
NM	New, mortality
RR	Recapture, released
RM	Recapture, mortality
E	Escaped unmarked

Tissue Code	Tissue Sample
ST	Stomach
MU	Muscle
LV	Liver
EG	Eggs
GO	Gonad
NO	None

Fin Code	Fin Clip
AD	Adipose
LPc	Left Pectoral
RPc	Right Pectoral
LPv	Left Pelvic
RPv	Right Pelvic
DO	Dorsal
AN	Anal
UC	Upper Caudal
LC	Lower Caudal

APPENDIX B

FIELD DATA SHEETS

Gear set data and fish sample record

Page___of___

Lake:	Set date:	Net Length (m):	Recorder:
Assessment type:	Set time:	Net Height (m):	Comments:
Gear type:	Lift date:	Net depth (m): /	
Site ID:	Lift time:	Surface temp:	
Easting:		Mesh size(s):	
Northing:	NAD: 83 27		

Species Code	Sample No.	Mesh Size (cm)	Length (mm)* F or T	Weight (g)	Sex	Maturity Code	Reprod Status Code	Aging Struct Code	Fin Clip	Fate Code	Tissue Sample Code	Liver Weight (g)	Gonad Weight (g)	Comments

*Total length (T) for burbot, sculpin, Stickleback sp.; Fork length (F) for all others.

Gear set data and fish sample record Page___of___

Lake:	Set date:	Net Length (m):	Recorder:
Assessment type:	Set time:	Net Height (m):	Comments:
Gear type:	Lift date:	Net depth (m): /	
Site ID:	Lift time:	Surface temp:	
Easting:		Mesh size(s):	
Northing:	NAD: 83 27		

Species Code	Sample No.	Mesh Size (cm)	Length (mm)* F or T	Weight (g)	Sex	Maturity Code	Reprod Status Code	Aging Struct Code	Fin Clip	Fate Code	Tissue Sample Code	Liver Weight (g)	Gonad Weight (g)	Comments

	Set date:	Net Length (m):	Recorder:
Assessment type:	Set time:	Net Height (m):	Comments:
Gear type:	Lift date:	Net depth (m): /	
Site ID:	Lift time:	Mesh size(s):	
Easting:	Northing:	NAD: 83 27	

	Set date:	Net Length (m):	Recorder:
Assessment type:	Set time:	Net Height (m):	Comments:
Gear type:	Lift date:	Net depth (m): /	
Site ID:	Lift time:	Mesh size(s):	
Easting:	Northing:	NAD: 83 27	

*Total length (T) for burbot, sculpin, Stickleback sp.; Fork length (F) for all others.

Gear set data and fish count record

Page___of___

Lake:	Set date:	Net Length (m):	Recorder:
Assessment type:	Set time:	Net Height (m):	Comments:
Gear type:	Lift date:	Net depth (m): /	
Site ID:	Lift time:	Surface temp:	
Easting:		Mesh size(s):	
Northing:	NAD: 83 27		

Species	Number Captured							Comments
Code	Fin clip	New, released marked	New, mortality	Recapture, released	Recapture, mortality	Escaped, unmarked	Total	

Biological data for some/all fish have been recorded on Fish Sample Record. Yes___ No___

Gear set data and fish count record

Lake:	Set date:	Net Length (m):	Recorder:
Assessment type:	Set time:	Net Height (m):	Comments:
Gear type:	Lift date:	Net depth (m): /	
Site ID:	Lift time:	Surface temp:	
Easting:		Mesh size(s):	
Northing:	NAD: 83 27		

Species Code	Number Captured							Comments
	Fin clip	New, released marked	New, mortality	Recapture, released	Recapture, mortality	Escaped, unmarked	Total	

Biological data for some/all fish have been recorded on Fish Sample Record. Yes___ No___

	Set date:	Net Length (m):	Recorder:
Assessment type:	Set time:	Net Height (m):	Comments:
Gear type:	Lift date:	Net depth (m): /	
Site ID:	Lift time:	Mesh size(s):	
Easting:	Northing:	NAD: 83 27	

Species Code	Number Captured							Comments
	Fin clip	New, released marked	New, mortality	Recapture, released	Recapture, mortality	Escaped, unmarked	Total	

Biological data for some/all fish have been recorded on Fish Sample Record. Yes___ No___