COMMUNITY-BASED FISHERIES MANAGEMENT AND MONITORING DEVELOPMENT AND EVALUATION

By

ADRIENNE D. PAYLOR

A Practicum
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Abstract

This research involved the development and evaluation of a community-based fisheries management plan for the community of Holman on Victoria Island in the N.W.T. The management of this Arctic charr fishery is the shared responsibility of a co-management committee called the Fisheries Joint Management Committee (FJMC). The purpose of this research was to develop a framework for the implementation and application of community-based fisheries management and monitoring operating under co-management regimes. Catch data and biological data collected by community fishery monitors were analysed in combination with two community household surveys collected in 1993 and 1997, a weir project conducted in 1992, and a tagging program conducted in 1992 and 1993.

Results of this study showed that periodic household surveys demonstrate how community perspectives influence subsistence fishing practices. For example, theses surveys have been used to identified changes in fishing locations, measured subsistence charr needs, and to assess the degree of community support for alternative management options. Community-based fisheries monitoring provides a description of the fishery, builds a comprehensive database and encourages capacity-building at the community level. Complementary scientific assessment programs such as a tagging project, can make important contributions to the interpretation of community monitoring data.

Recommendations for improvement of the community-based approach to fisheries management include: unbiased sampling techniques in the monitoring program; a well designed tagging program; training programs for community members; and expanded community consultation programs.

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Chapter One - Introduction

1.1 Introduction to the Study

Aboriginal land claims settled in the Canadian north over the past 20 years have contributed to significant changes in resource management practices. Prior to the 1970's the management of renewable resources throughout Canada was the responsibility of federal, provincial and territorial governments. Many aboriginal land claims finalized since that time have included provisions for greater local control over natural resources, and have resulted in policies favouring increased user-group involvement in resource management, co-operative management, co-management and devolution in general (Berkes et al., 1991). User-group involvement in resource management matters can occur at various levels of integration between local and government management systems. Terms such as co-management can be difficult to define in relation to user-group involvement, since co-management arrangements reflect a continuum of increasing degrees of shared decision making power.

One definition of co-management with useful application for this study is "a joint management process that brings together local resource users and government agencies to share management responsibility for local or regional resources"(Roberts, 1994). This definition emphasizes that co-management is a process, and that most often there is room to improve the exsisting levels of integration between local and government management systems. The James Bay and Northern Quebec Agreement signed in 1975, was the first comprehensive land claim to be settled in northern Canada. In the Northwest Territories, the Inuvialuit, Inuit, Gwich'in, Sahtu Dene and

Nunavut have all settled land claims since that time. Each of these final agreements has resulted in the establishment of co-management arrangements. The co-management committees established under these agreements are today responsible for the management of a wide variety of natural resources, including wildlife and fisheries throughout the Canadian north.

In 1984 the Government of Canada and the Inuvialuit of the Western Arctic signed the Inuvialuit Final Agreement (IFA) (DIAND, 1988). This agreement grants the Inuvialuit special rights for a 1.092 million square kilometre area designated as the Inuvialuit Settlement Region (ISR) (Fig. 1). Responsibility for resource management within the IFA is divided among five co-management committees, through which the Inuvialuit interact with government agencies (Fig. 2). Six hunters and trappers committees (HTCs) representing the six local communities in the ISR advise the Inuvialuit Game Council (IGC) on resource issues. The IGC represents the collective Inuvialuit interest in all local renewable resource matters, and provides a vital link between the co-management committees and the local communities.

The Fisheries Joint Management Committee (FJMC) was also established under the IFA to assist Canada and the Inuvialuit in administering their rights and obligations related to fisheries in the ISR. The FJMC is comprised of four voting members and an independent chair appointed by the committee. The IGC and the government of Canada each select two of the four voting members. The FJMC is responsible for advising the Minister of the Department of Fisheries and Oceans on regulations,

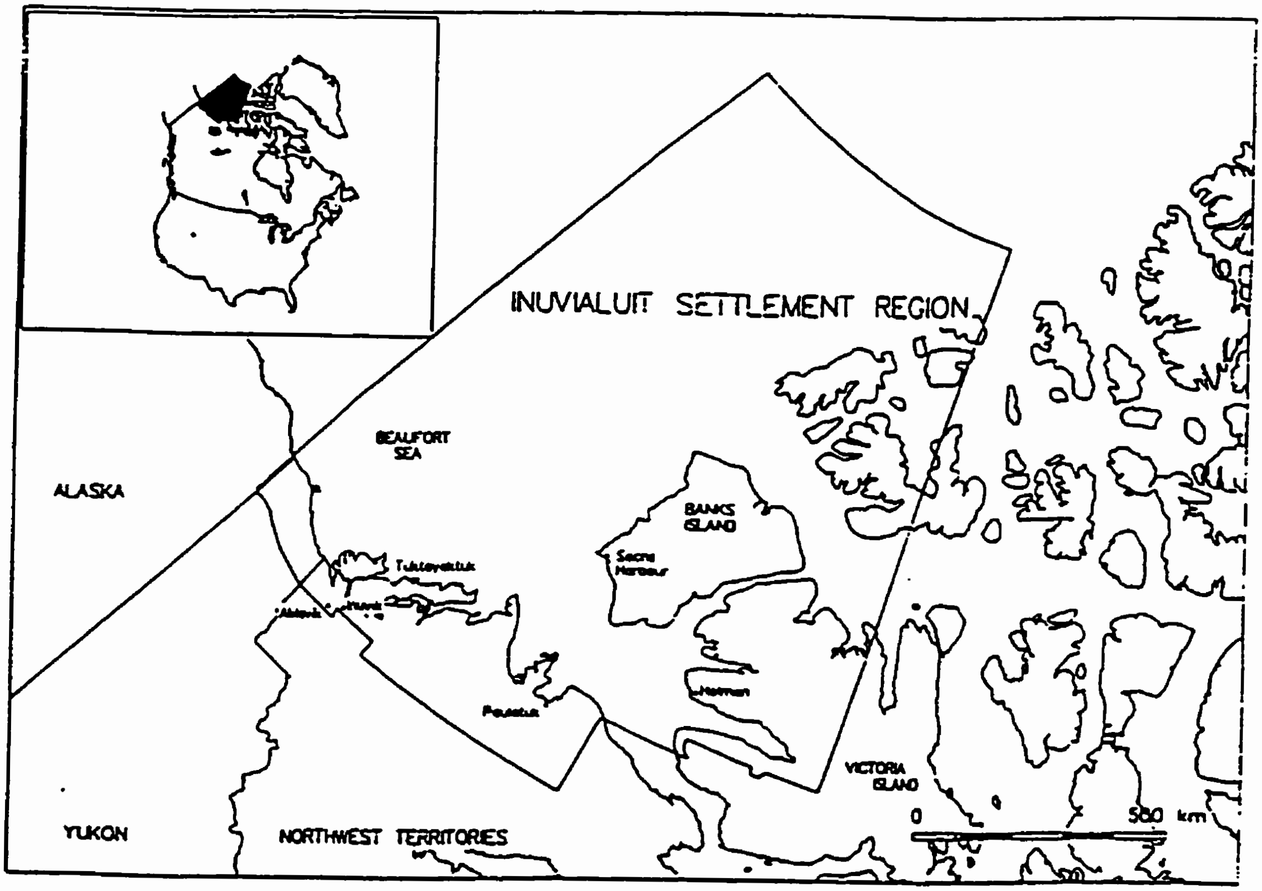


Figure 1. The Inuvialuit Settlement Region, Canada (Roberts, 1994).

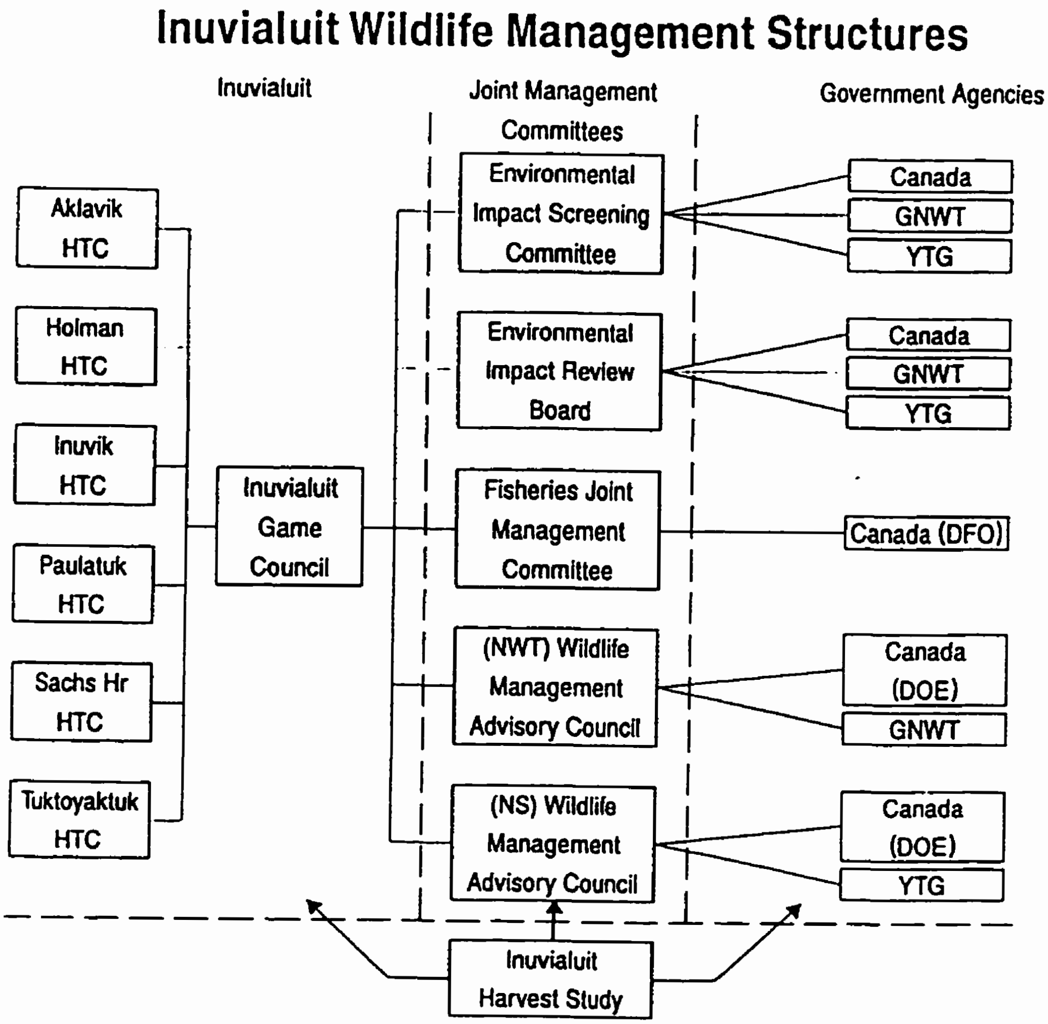


Figure 2. Inuvialuit Wildlife Managment Structures (Roberts, 1994).

research policies and management of fish and marine mammal resources within the ISR. In recent years the FJMC, in co-operation with DFO and the HTCs, has moved toward community-based fisheries monitoring. Historically, fisheries monitoring has been carried out by DFO biologists. The fisheries data collected by DFO was then used for decision-making in the co-management process.

Community involvement in fishery data collection represents an attempt to increase resource user participation in the co-management process. Involving the community in fisheries monitoring allows fishermen to be active contributors to improving the resource base, and to be in a better position to make themselves heard on policy matters (Pinkerton, 1989). In 1991 a pilot project to monitor harvest levels and collect fisheries data was developed for the Arctic charr subsistence fishery of Holman, on Victoria Island in the ISR (Fig. 3). The objective of this project was to study the use of community collected fisheries data in the development of a fisheries management plan.

Arctic charr fisheries have been described as a manager's nightmare (Armstrong, 1984; Johnson, 1989). A full-span conduit weir operating as counting fences can provide reliable abundance estimates for charr populations (Johnson, 1989). However, these weirs are expensive to operate and several years of operation may be required in order to obtain reliable estimates (Papst et al., 1996). Johnson (1989) concluded that the management of charr fisheries must be pragmatic in approach, and based on all available information. Where co-management committees are in place, community-based monitoring can be a potential source of fisheries information.

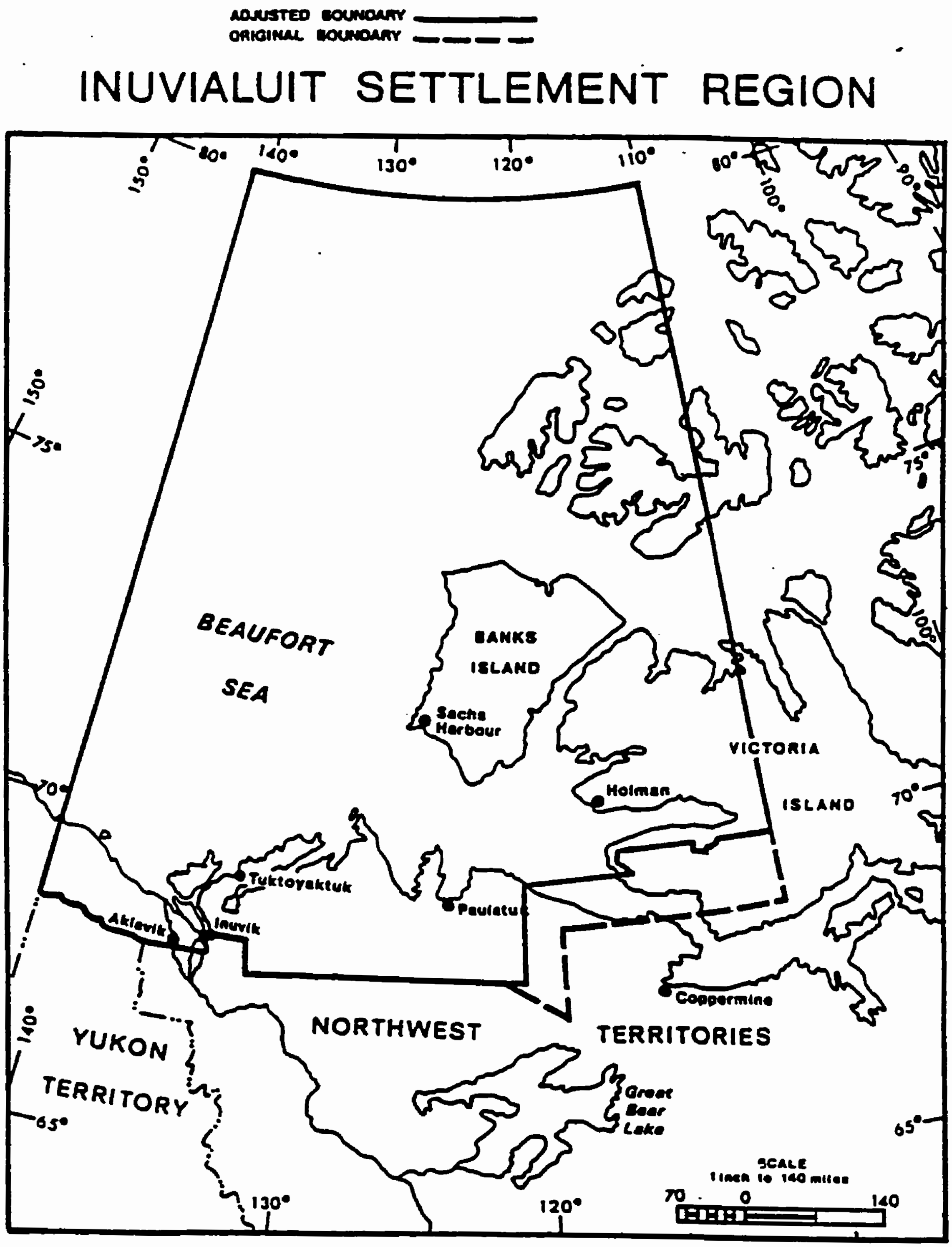


Figure 3. Location of Holman within the ISR (DIAND, 1988).

Successful co-management in this type of environment creates a willingness among both fishermen and government to share data about the resource, and therefore to collectively reach a more complete understanding of the resource (Wilson et al., 1994; Hilborn et al., 1993; Ostrom,1990, McCay and Acheson, 1987; Berkes et al., 1991; Pinkerton, 1989; Kuperan and Abdullah, 1994). Fishermen, who become partners in the management process can collect data which provides a description of the fishery. Using this data, fisheries scientists can work with the community to develop an effective fisheries management plan based on a more comprehensive understanding of the resource.

In order to achieve successful co-management of a fisheries resource, the partners must develop trust in the co-management process through both communication and participation. Historically, DFO scientists have collected the data used to make fishery resource management decisions, and DFO managers have made all the management decisions. Management decisions made by remote government officials, based on data collected solely by government biologists, tends to have low credibility with local fishermen who have alternative sources of data, such as extensive knowledge of local stocks based on years of observation and experience.

In the past, local knowledge has been disregarded during policy development, and consequently fishermen have been excluded from the management process. In some cases, fishermen's livelihoods have been severely disrupted by decisions based on data they know to be inadequate. When this occurs, fishermen tend to adopt confrontational postures which can ultimately be far more costly and inefficient than the alternative of bringing fishermen into the data-gathering/decision making process (Ostrom, 1987; Berkes et al., 1991; Pinkerton, 1989). The development of community-based fishing plans involves communities in the data gathering and decision making process, and provides an important opportunity for developing understanding and trust among the co-management partners. Furthermore, community-based management can be cost-effective, and can provide an opportunity to integrate community knowledge and scientific fisheries management techniques (Papst et al., 1996). Management plans which have involved the resource users in the data collection and analysis process are generally more accepted by fishermen and the community, than management plans which do not involve local resource users (Pinkerton, 1989).

The development of a community-based fisheries monitoring-management program is an attempt to bridge the gap between the theory and practice of co-management. Closing the gap between what should be done and what is actually done, produces a more functional co-management arrangement. When issues such as data collection/fisheries monitoring, recommendations, responsibility, and decision-making power are more equitably shared between local and government levels, a more comprehensive co-managment system can evolve. Local data collection which draws upon local knowledge and incorporates academic/scientific knowledge can produce superior data which may be used to generate more specific, flexible and timely responses to management opportunities (Pinkerton, 1989). Therefore, co-management, particularly in the area of data collection, can allow for a more efficient harvest of the subsistence fishery.

1.2 Issue Statement:

Section 14(4) of the Inuvialuit Final Agreement ensures the effective integration of the Inuvialuit into all bodies, functions and decisions pertaining to wildlife managment in the ISR. However, until 1991 DFO scientists took sole responsibility for monitoring the Arctic charr subsistence fishery of Holman. Since that time, a pilot project in community-based monitoring has been implemented in which local people have been hired to monitor the charr fishery. Through this pilot project, the community has demonstrated that it is capable of collecting fishery data on a practical level. At present, there is a need to evaluate the quality and reliability of the data generated by the community monitoring project. In addition, there is need for a mechanism within the joint management process through which community members can more fully participate in the evaluation and utilization of the data they collect.

Increased community participation creates a better understanding of the fishery, which in turn will enhance the communities' ability to make meaningful recommendations and sound management decisions. Extensive efforts can be made to manage the Kuujjua River charr stock, but until the processes involved in fishery management are incorporated into the lifestyles of the people who live off the charr, management may never be completely successful. The purpose of this research is to develop a framework for the implementation and application of community-based fisheries management and monitoring, operating under co-management regimes.

1.3 Objectives:

The objectives used to achieve this research purpose were:

1) To document and evaluate the existing Holman community monitoring program in order to obtain existing background information needed to construct a framework for community-based fisheries management and monitoring.
2) To analyze and evaluate the community collected data/information for its reliability and quality using scientific methodologies.
3) To identify strengths and weaknesses in the Holman Fishing Plan and to make recommendations to improve the community-based monitoring program.
4) To develop a framework for the implementation and operation of Arctic community-based fisheries management and monitoring programs.

1.4 General Methods

The following ten sources of data were used to conduct this research: community collected monitoring data; DFO whole fish sub-sample data; Inuvialuit Harvest Study data; mark and recapture data; DFO scientific data; Statistics Canada census data; household survey data; community meetings and workshop information; economic cost data; and 1997 summer field research data. Practicum chapters were organized into independent publishable journal articles resulting in some repetition between chapters.

1.4.1 Literature Review:

An in-depth literature review was carried out on subjects relevant to the research including: fisheries management; Arctic charr biology; the Inuvialuit Final Agreement; co-management; community monitoring; the Holman community; the Holman Arctic charr subsistence fishery; the Holman community-based monitoring program; and fisheries assessment techniques and bias. Relevant information found in the literature was used to guide this research.

1.4.2 Assessing the Usefulness and Accuracy of Community Collected Data:

Biological data collected by the community was sent to the researcher and filed into a Macintosh Stat View 4.1 database. In addition, the whole fish sub-samples were received by the researcher and analysed. These data were also entered into a Macintosh Stat View 4.1 database. Both data sets were analysed to determine their structure and content in order to organize the data for further analysis. All community collected monitoring data from 1991 to 1997 was analysed to determine both its usefulness and its accuracy.

The researcher employed the following standard fishery management techniques: catch curves; growth curves; survival rate and mortality; recruitment; population estimates; length/weight/age frequency distributions; catch per unit effort (CPUE); to determine the usefulness of community collected data as a fisheries management tool. The usefulness of community collected monitoring data relative to other sources of data was determined by comparing the information it generates to the information derived in the Inuvialuit Harvest Study and the information derived from

DFO sampling data.

The DFO whole fish sub-sample was used to collect additional biological information such as the male/female ratio and a maturity index. The usefulness of this additional information as a management tool was assessed to determine whether the existing measurements collected by the community monitors was sufficient for management purposes.

The random whole fish sub-sample sent to the DFO was used to perform a comparative analysis of the data collected by community monitors and the random whole fish sub sample analysed by the fishery scientist. The degree of correlation between the two data sources served to quantify the scientific integrity of community collected data. Age, fork length, and total weight frequency distributions resulting from analyses of the two data sources were tested for significant differences. Community monitoring data was also compared with the Inuvialuit Harvest Study data and DFO Technical Report data pertaining to the same fishery.

Accuracy of the community data was also verified by assessing the degree of bias introduced by the community's sampling technique. Biological samples collected by the community suffer from a net selection bias because all samples taken originate from the fishery which uses primarily 4 1/2" mesh nets. Therefore, the biological samples are representative samples, not random samples. Some fishery scientists believe that community-based fishery monitoring is invalid because of such sampling biases. An investigation was carried out to determine whether biases caused by sampling methods rendered population estimates invalid or whether the sampling biases were within an acceptable level.

1.4.3 Test Sentinel Fishery:

In the summer of 1997 a sentinel test fishery was carried out to collect random charr samples from the Holman area using a standard gang net. The 1997 summer field research also documented how community monitors collected the biological sample data, in order to compare the methods used to those described in scientific literature. How sample bias affected the statistical infancies was investigated, and recommendations made to improve sampling techniques.

1.4.4 Assessing Tagging Program Data:

An assessment of the 1992 Holman tagging project was carried out to determine its usefulness as part of the community monitoring program. This investigation involved analysing the data produced from the existing tagging program, as well as investigating the potential benefits of improving future tagging programs.

An investigation into mark and recapture methods, including a literature review and consultation with experts from University of Manitoba was conducted. Recommendations were then made as to how the tagging program in Holman could be improved. The information produced by tagging programs was compared to other available information, in order to determine if tagging programs, as part of community monitoring, were worthwhile.

1.4.5 Conducting a Community Household Survey:

A 1997 household survey was designed to collect recent information on the community demand for charr, and to further describe characteristics of the subsistence fishery. The 1997 survey documented the social dimension of the subsistence fishery, and demonstrated how community perspectives impact the fishery. Data gathered through the survey included: the percentage of people in the community who actively fished for charr; the percentage of people in the community who were dependent on charr for food; the range of age groups actively fishing for charr; preferred fishing locations; the number of charr required (needed) by households on an annual basis; the number of charr taken by households on an annual basis; opinions on the community-based fishing plan; the type of management tools preferred by the community (i.e. bylaws, quotas, area closures etc.); general observational information; and traditional-community knowledge.

A training manual was designed for the surveyors to explain how to prepare for the survey, how to carry out the interviews, how to fill in the survey form and to address other issues that might occur throughout the duration of the survey. The training manual also contained a detailed explanation of each question on the survey form (i.e. the intention of each question and what information was to be extracted from the interviewee was explained).

Once the survey had been conducted, all completed questionnaires and additional information was packaged and shipped to the researcher in Winnipeg. Data collected in the 1997 March survey was summarized, and presented to the community at the next FJMC community meeting. Information from the 1993 and 1997 community household surveys was compared to the annual Inuvialuit Harvest Study for further verification.

1.4.6 Evaluating the Data Analysis:

The results derived from the analysis described above were then evaluated from a co-management perspective. The evaluation served to address any information gaps found in the data, or in the operation of the community monitoring program. The results of this procedure allowed the program's strengths and weaknesses to be identified.

1.4.7 Developing Recommendations and Constructing a Framework for Community-Based Fisheries Management and Monitoring

The foregoing research was used to develop recommendations for the FJMC on how to improve the existing community-based monitoring program. This research was also used to develop a framework for the implementation and operation of community-based fisheries management and monitoring programs presented in chapter seven.

1.5 Scope:

This practicum was based on the investigation and evaluation of Arctic charr subsistence fisheries' data collected by the community of Holman. The information produced by this project will be used to develop a standardized protocol for community-based fishery management and monitoring.

Chapter Two - Background:

2.1 The Nature of Fisheries:

Fishery resources have often been characterized as a "common property" resource, prone to being plagued by the "tragedy of the commons". According to the theory popularized by Hardin (1968), the "tragedy of the commons" occurs when resources owned in common, such as fisheries, are over-exploited due to a lack of individual motivation to take responsibility for the shared resource. Common property resources are considered non-exclusive, since access is often difficult to control. Each user of the resource has the potential to subtract from the welfare of other users. This is a result of current benefits from resource harvest accruing directly to the individual, while losses due to over-harvesting are discounted, and dispersed among the group as a whole.

During the 1960's and early 1970's, problems associated with common property resources were addressed through centralized government intervention (McCay and Acheson, 1987; Berkes et al., 1991). During the 1980's problems of the commons were addressed by an alternative solution- "privatization". However, the indivisible nature of common property resources creates problems when trying to institute private property management and individual rights (Berkes et al., 1991).

Since the 1980's, many disciplines have explored the dilemma of the commons and searched for solutions. Such disciplines have included economics, psychology, biology, anthropology, cultural ecology, property rights, law and social evolution. Perhaps one of the most significant inquiries has been the investigation into the relationship between human groups and natural resources. How social institutions, human realities and patterns of behavior impact a fishery resource (a common property resource) are critical questions in devising management strategies. In many situations involving common property resources there are complex underlying social systems which govern the use of such resources. In reality then, many common property resources are not open-access resources, but in fact have defined users called the "community". Within this community of resource users, there can be a complex set of social duties, privileges and mutualities (McCay and Acheson, 1987).

Often within fisheries management there has been a tendency to restrict common property solutions to the intervention of external authority (McCay and Acheson, 1987; Ostrom, 1987; Berkes et al., 1991; Pinkerton, 1989). External intervention by government is frequently utilized in common property resource management since it is "thought to be necessary in the interests of economic efficiency and equity" (Berkes et al., 1991).

Another common problem associated with fisheries management is the conventional scientific approach which attempts to make quantitative estimates of stock abundance. The resulting management policies have involved numerical analysis and controls dictated by a centralized management regime. Wilson et al. (1994) points out that this type of management is based on two common theories. The first theory is that stock recruitment is a function of the spawning stock size. The second theory is that of common property resources which predicts inevitable over-exploitation and socially undesirable results. Policies developed as a result of these two theories attempt to mimic property rights and control stock abundance. Thus, regulations have been implemented by a centralized authority, and control is exercised directly through landing quotas, or indirectly through limits on fishing effort. There are numerous examples where this type of management approach has not been successful (Wilson et al., 1994; Hilborn et al., 1993; Ostrom,1990, McCay and Acheson, 1987; Berkes et al., 1991; Pinkerton, 1989; Kuperan and Abdullah, 1994). Hilborn and Walters (1993) argue that the complexity of fisheries systems precludes predictability of the sort required to exercise the numerical control envisioned by these two theories.

Wilson et al. (1994) suggests that the degree of accuracy and the completeness of knowledge required for prediction is far beyond any capabilities management might expect to achieve in a fisheries environment. The complex and likely chaotic nature of fisheries creates a very difficult and costly information problem, and a numerical approach to the long-term prediction and control of species abundance is practically infeasible. There has been a growing sense among fisheries managers that scientific effort should be directed toward an ecosystem approach, and rooted in community-based management (Wilson et al., 1994; Berkes et al., 1991; Pinkerton, 1989; Kuperan and Abdullah, 1994).

It has been argued that the conventional government approach to fisheries management ignores the existence of, and the potential for, user-group or local community management (Wilson et al., 1994; Berkes et al., 1991; Pinkerton, 1989; Kuperan and Abdullah, 1994). Interdependence, good communication and cooperation, when used towards managing such a resource, can avoid the "tragic" outcomes which are predicted by the "tragedy of the commons". Interdependence, communication and cooperation are essential characteristics found in most small isolated Arctic communities, where social acceptance is often required for survival in a harsh environment. In historical times, to be cut off from resources and community support often resulted in death.

Effective social mechanisms often ensure adherence to rules which exist by virtue of mutual consent within the community (Berkes,1989). Social disgrace is a significant punishment in a small interdependent community. Much of the Arctic Aboriginal culture has evolved from these conditions and the result has been a communal way of life. This communal way of life incorporates many characteristics which can generate positive results for common property resource management. Community-developed rules are most often tailored to fit local environmental and social conditions. As a result, there has been a renewed interest in the use of traditional systems as a framework for ecologically sound economic development, and socially acceptable resource management (McCay and Acheson, 1987).

It is important to distinguish a subsistence fishery, such as the Holman fishery which is the focus of this research, from that of other fisheries. In the classic tragedy of the commons which can occur in other fisheries, there is most often no "community". The geographical isolation of Holman helps to control access to the charr fishery and defines the user group as the Holman community. Access is further subdivided within the community by differences in individuals' knowledge of the land and traditional family fishing areas. Management of information regarding where people fish has become part of the community's history. People have preferred fishing areas, and for safety reasons often report to others the location and timing of their fishing activities. This makes the community well suited for collecting comprehensive fisheries monitoring information.

If management strategies are to be successful, fishermen must support management efforts. According to Wilson et al. (1994), decentralization is necessary since the information problem created by spatial and temporal diversity demands attention to detail which cannot be achieved by a centralized authority. Individuals who are required to engage in short-term sacrifice in order to obtain long-term benefits need to be assured that management measures have credibility. Therefore, there needs to be a cause-and-effect connection between a particular form of restraint and the future state of the fishery. Community fishing plans will only be politically acceptable if they are based on data credible to all parties involved. When that evidence is strong and there is a consensus, then the political dynamics of a community can lead to mutual agreement about mutual restraint. An important key to success is fostering a sense of stewardship among fishermen. Co-management or community-based management has the potential to meet this need, and small-scale communities are more likely to have the formal conditions required for successful and enduring collective management of the commons (Ostrom, 1987; Wilson et al., 1994).

Due to the complex nature of Arctic charr populations, traditional scientific fishery models are often inappropriate, and alternative monitoring measures are required. When the community is excluded from the monitoring and management aspects of their fishery, biological and harvest reporting to the government is often decreased in quality (Ostrom, 1987).

However, increased participation by the community can lead to an increase in the quality of the information reported by user groups, since they are now reporting to themselves and there is more incentive to be accurate and complete (McCay, 1989). Therefore, fisheries management can be improved by bringing local people with expertise into the monitoring and policy process. "Involvement creates changes within people who become critical analysts of social and political structures and who recognize their own potential for action" (McCay, 1989). The contribution of local fishermen's intimate knowledge of their resource, and how they use it, is critical in the application of practical resource management.

Recently there has been a revitalization of traditional approaches to fisheries management as a basis for contemporary management, given the failure of introduced "scientific-based" management systems to regulate exploitation. Privatization or state regulation may not always be essential to manage a common property resource. What appears to be a critical factor in the success of common property management schemes is the degree to which fishermen voluntarily cooperate to advance their collective interest at the expense of a short-term private interest. The community-based management approach to fishery resources is seen as an alternative, and possibly an improvement for managing common property resources (Kuperan and Abdullah, 1994). The increased legitimization of the regulatory rules through community participation in regulation and management plans can ensure improved cooperation, compliance and efficiency. In addition, community leaders are often more capable of mobilizing and organizing local user groups to initiate measures for fisheries management (Doulman, 1993).

Two of the most critical elements of fisheries management are deciding who will be involved in the decision-making process, and determining the kind and quantity of data required to support that process. Therefore, it is important to establish the extent of user involvement and define key monitoring requirements that will permit more precise stock assessments.

Complex fishery populations such as Arctic charr often show qualitatively predictable behaviour that varies within a range. Typical patterns are derived from the underlying stability in the dynamics of the overall system. Basic biological processes such as life stages, interrelationships among species, habitat, migration, spawning and growth can maintain a fishery within the normal bounds of variation. Developing management strategies focused towards maintaining biological parameters is what Wilson et al. (1994) calls a parameter based approach. A parameter based approach emphasizes "how", "when" and "where" to fish rather than how many fish should be taken.

However, exploitation does disturb the basic functioning of the system at many levels. Constraining the time, place, and mode of capture while not otherwise controlling the overall level of removals, can still drive populations to extinction. Therefore, effective management strategies or fishing plans should integrate qualitative as well as quantitative controls (Fogarty, 1995).

Regardless of what type of management approach is taken, specific objectives and means of validation are needed to monitor management performance over time. Quantitative management often requires much of the same information necessary under the qualitative approach, since changes in abundance reflects management success. There is an important distinction between assessment of biological potential and the decision about how to manage the stock. Once the stock assessment is complete, choice remains (Hilborn and Walters, 1992). Much of the challenge in stock assessment involves determining what data is essential, and the best way to summarize that information for interpretation. Thus, the role of stock assessment is to provide the best possible technical support for management decisions.

The management of an Arctic charr fishery is complex and requires a substantial amount of sophisticated information (Armstrong, 1984; Johnson, 1989). However, it is often not practical or feasible to collect unlimited data, forcing fishery managers to select what precise pieces of information are critical, and necessary to produce acceptable results for real-time management. In the case of the Holman subsistence fishery, the nature of the information, how it is obtained, organized and utilized must be based on co-managment principles. Under co-management one potential source of information is community-based monitoring. Fishers as partners in the management process collect data which provides a description of the fishery. Using this data, fishery scientists can work with the community to develop an effective management plan. To be effective, community-based monitoring must employ data collection methods which are easy to use by fishers, and which provide accurate and reliable data over a long period of time.

Planning and setting objectives for the management of small-scale coastal fisheries requires a good understanding of resource attributes, the traditional values of the fishing community, the institutional arrangements, and the overall environment in which fishers operate. Without this understanding, any attempt to manage the fishery is often met with resistance and noncompliance (Kuperan and Abdullah, 1994).

In comparison to conventional fishery stock assessment, community-based monitoring provides a social survey of statistical information about human fishing activities. Therefore, contemporary fishery management, which involves community members takes advantage of the incentives for local fishers to contribute and invest in the gathering of information to improve stock assessment (Walters and Pearse, 1996). Local fisher participation thus becomes an essential part of fishery management.

2.2 Problems and Biases Involved in Fisheries Data:

Any management choice will necessarily be based on some predictive model and therefore, any decisions concerning the fishery will be based on some assumptions about stock dynamics. Age composition, average fish size and catch per unit effort (CPUE) can be used to provide estimates of stock size, and to measure rates of "surplus" production as related to changing stock sizes (Hilborn and Walters, 1992). However, there can be a number of problems and biases involved in fisheries data.

The pursuit of fish can result in a highly non-random, and non-representative sampling pattern in time, space and characteristics of fish sampled (Hilborn and Walters, 1992). In addition, environmental factors such as ice conditions may effect the catchability of fish between years. If a fish stock is separated into different temporal and spatial segments, then the different parts of the stock can be subject to different rates of removal by the fishery. This complicates the estimation of vital statistics and introduces errors which may be difficult to detect. The net effect of ignoring such distortions in stock assessment will negatively impact subsequent management decisions. Therefore, it is important to identify whether biological, catch and effort statistics are likely to give a misleading picture of stock trends and health, and hence whether more systematic sampling procedures are required.

If a stock is not homogeneous and not all equally vulnerable to fishing, then an abundance estimate can only be reliable if (1) relative quantities of fishing effort attacking different subsections of the stock do not change from year to year or, (2) when the relative size of the stock in the different subsections does not change (Ricker, 1975). In addition, if fishing gear is dispersed unequally over the population, its action tends to produce local reductions in abundance greater than what the population as a whole is experiencing. The magnitude of reduction is cushioned if some fish from the rest of the stock move into the fishing area. Therefore, the CPUE reflects the size of only the immediately available, restricted portion of the stock, rather than the stock as a whole (Ricker, 1975).

Further complicating the CPUE index is the issue of migration. Summer coastal fisheries which take advantage of migrating fish are called "interception fisheries"(Treble, 1996). In an interception fishery, stock abundance indicators such as CPUE are more heavily influenced by factors other than changes in stock abundance. For example, migratory routes and timing could change from year to year, giving the impression that stock abundance is fluctuating, when in fact it is not. An additional consideration in summer coastal fisheries is that of stock mixing. Management of a mixed stock can be complicated by changes in the contributions of various stocks from year to year.

Even with accurate sampling and survey programs, it is often not possible to predict how a stock will respond to new management initiatives. Therefore, stock assessment does not merely consist of statistical predictions about optimum efforts and sustainable yield, but concerns the assessment of time trajectories of fish and fishermen in response to management and other changes (Hilborn and Walters, 1992). A key role of community-based management and monitoring is to provide regular updating and "feedback" of both community perspectives and fishery population parameters into the management decision making process.

2.3 The Nature of Arctic Charr:

Arctic charr (*Salvelinus alpinus*) have an extremely complex life-history. The "Charr Problem" as described by Nordeng (1983), is an intricate set of questions concerning the life-history and ecology of Arctic charr. Arctic charr are circumpolar in distribution and can take on distinct morphological "forms" either as resident, sea run, or dwarf. Resident charr are those that remain in fresh water lakes and rivers, and are classified as either large resident charr or small resident charr otherwise known as dwarf charr. Sea run charr are anadromous, over-wintering in freshwater lakes and rivers, then migrating to the sea in the summer to exploit its abundant resources. They therefore have the potential to grow much larger than the resident forms. These different forms often frequent the same river system and share a common gene pool (Johnson, 1989). It has also been found that an individual charr may manifest all three forms during its lifetime. The distinction and transformation between forms is dependent upon both genetic constitution and access to food (Nordeng, 1983). Johnson (1989) suggests the possibility that certain prolific resident charr systems may function as a "source" for a proportion of the anadromous charr systems, which may act as a "sinks" maintained by the source.

Due to the interaction between forms, a single cohort may mature anywhere from age 1 in a small resident charr, to age 6 in an anadromous charr. Therefore, an individual may reach sexual maturity at a body length extending anywhere from 100 to 560 mm. This demonstrates the well-known plasticity of Arctic charr (Nordeng, 1983). There is extraordinary variation in individual growth and fecundity due to the wide range of individual life-histories.

Anadromous Arctic charr populations are fragmented into distinct stock components consisting of row -> juveniles -> smolts -> immature sea run -> mature non-reproductive sea run -> pre-spawners -> post-spawners -> and resting mature charr. Each life-history phase has its own unique bioenergetics and ecology. Movement between the different phases is independent of age or the duration spent in each phase. Some factors which seem to influence population systematics are annual resource availability and individual growth rate (i.e. size and condition of the individual). This results in age classes and length classes that are poorly correlated and consequently fish of the same age can be dramatically different in length.

Anadromous Arctic charr are known to spawn on an intermittent basis. Thus, a given individual may spawn more than once during its life span. The number of spawns and the time interval between spawning is however, dependent on multi-factoral events. As a result, there is a large variation in the reproductive capacity between individuals of the same population.

Growth rate is thought to have a direct influence on the number of times an individual spawns. Early smoltification can lead to early maturation thereby extending the period during which the individual is capable of repeated spawning. Johnson (1989) looked at the condition factor of spawning charr. The condition factor or "condition" of a fish is an index coefficient which reflects the fatness or general well-being of the fish. It is calculated by dividing its weight by its length cubed ($K=w/l^3$). Johnson found that a certain threshold value of "condition" may trigger spawning, since pre-spawners had a better condition factor than non-reproductives in the same population.

Given the severe nature of the Arctic environment, individual charr require varying amounts of time to achieve a high condition factor. This adds another source of variation in stock recruitment. It was also found that some post-spawners never recovered from the dramatic reduction in condition, resulting from the high energy/resource demand of spawning. Instead, these fish became "slinks" (mature fish with very low condition factors) which were incapable of repeated spawning. In addition, Johnson (1989) observed that the largest fish (over 850 mm) in his study area were part of the sea migrants, but were never found on the spawning grounds. This indicates that some fish become "senile", losing their reproductive capacity later in life.

Young charr remain in their river system of birth until they migrate to the sea for the first time, at an average length of 220 mm and an average age ranging from 3 to 8 years. The spawning segment of the population is surprisingly small comprising only 4-10% of the total population in a given year (McCart, 1980; Johnson, 1989; Nordeng, 1983). It has been reported that during the year in which charr spawn they remain in their home freshwater river and do not migrate to the ocean (Johnson, 1989).

It has also been reported that mature anadromous Arctic charr never spawn two years in succession (Dutil, 1984). This is a result of the resources lost from not going to sea that summer, and the high drainage of energy from gonad production. Given the constraints of the harsh Arctic environment and the low incidence of spawning, Johnson (1989) suggests it is quite possible that some fish may never spawn at all, or at maximum, spawn only once. The combination of the above situations combine to produce extreme variation in annual recruitment, making the population recruitment as a whole very difficult to estimate.

Anadromous Arctic charr stocks are characteristically composed of a bi-modal length structure. A bi-modal length structure is a population frequency distribution which has two peak groups or average ages. The first modal is usually at 220 mm, representing the smolts. The second modal, at 590 mm, is somewhat larger in frequency representing non-reproductive adults (Fig. 4).

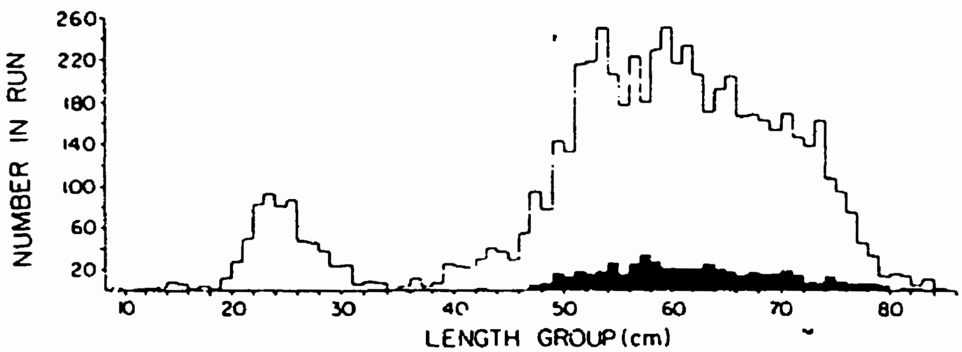


Figure 4. Characteristic bi-modal length frequency distribution of anadromous Arctic charr (Johnson, 1980)

This bi-modal structure has been found to be extraordinarily stable with respect to size and abundance. Stocks under intense exploitation and declining abundance will not usually show any directional change in structure. This is another reason recruitment and abundance are extremely difficult to predict in Arctic charr populations. As a result, the management of Arctic charr fisheries is somewhat precarious. Johnson (1989) found that stocks in the Canadian Arctic retain a population structure of bi-modal size and low recruitment until an extremely low abundance threshold is reached. Once at this low abundance level, the stock will change rapidly. There will either be a surge of recruitment or demise of the population.

Complex migration patterns are an additional factor to consider in the study and management of Arctic charr. Spawning charr show a considerable degree of homing to their natal system. However, other individuals may travel past the boundaries of their migration range, exploring new opportunities. This may result in the establishment of a new population, or immigration into an existing population. Size, rather than age, appears to determine movement. When charr reach a length of 400-600 mm they return to their home waters each year with a high degree of fidelity. Once they are over 600 mm in length the rate of out-migration to rivers up to 500 km away increases (Johnson,1989).

The combination of complex charr characteristics imposes constraints on determining management strategies for Arctic charr fisheries. Johnson (1989) concludes management of such fisheries must be pragmatic in approach and based on all available information in order to cope with the complexity of charr. Kristofferson et al. (1989) stress that controlling the timing and location of the fishery is essential to the overall management strategy. It is also necessary to determine the existence and relative contribution of other charr stocks which may exsist on the fishing grounds. Due to the many complex interactions described above, exceptionally close monitoring is critical to sound management practices in Arctic charr stocks. Johnson (1989) concludes that the only way to get a true measure of stock abundance and recruitment is through a full-span conduit weir in operation over several consecutive years. However, this approach is often not economically feasible for even a short term study, and it is obviously unrealistic for long term management. One of the most practical ways to conduct intensive monitoring in the remote Arctic is to involve the local fishermen who are actually utilizing (and therefore defining) the fishery.

Community involvement can greatly enhance the implementation of efficient and effective management strategies.

2.4 The Inuvialuit Final Agreement:

The Inuvialuit brought forward a comprehensive land claim in 1976, on the basis that they were never part of the treaties which had been signed in the Mackenzie Valley, NWT. Negotiations with the government were initiated and continued for the next 8 years. The Inuvialuit Final Agreement (IFA) was passed by the House of Commons on June 26, 1984, becoming the first "comprehensive" settlement of the Canadian territories. Under this agreement the Inuvialuit agreed to surrender to Canada all aboriginal claims, rights, titles and interests in the Northwest and Yukon Territories, in exchange for the protection of their hunting, fishing and trapping rights, title to "Settlement" lands, and financial compensation. Title to approximately 35,000 square miles of land was granted to the Inuvialuit. This title included surface and subsurface rights (less certain natural resource rights) to 30,000 square miles of the settled land. The Inuvialuit were advanced $9.6 million between 1977 and 1981, in anticipation of signing the Final Agreement. This Final Agreement ultimately directed that the balance of capital transfer payments totalling $152 million be advanced to the Inuvialuit between December 31, 1984 and December 31, 1997, in annual instalments ranging from $1 million to $32 million.

For an individual to be a beneficiary under the land claims settlement the following criteria have to be met: 1) he/she must be on the official voters' list used to approve the IFA; or 2) he/she must be of Inuvialuit ancestry (by custom or tradition), and be accepted as a member of a community corporation; and 3) he/she must provide proof that he/she has at least one-fourth Inuvialuit blood and was born in the Inuvialuit Settlement Region, or has been a resident of the region for a total of at least ten years. Once enrolled as a beneficiary and having attained the age of 18, each person receives a life interest share in the Inuvialuit Trust.

Under the IFA, each of the six participating Inuvialuit communities formed non-profit community corporations to receive and manage all the compensation and benefits provided for in the Agreement. The Inuvialuit Regional Corporation, incorporated in 1985, initially received both title to the Settlement lands and the financial compensation awarded under the IFA. This body administers Inuvialuit lands through a division called the Inuvialuit Land Administration and is responsible for all matters related to land supervision and management. Ownership of the Settlement lands is held by the Inuvialuit Land Corporation.

Resource management responsibility has been divided among five co-managment committees under the IFA. It is through these five committees that the Inuvialuit interact with government agencies to make resource management decisions. These committees include: the Environmental Impact Screening Committee; the Environmental Impact Review Board; the Fisheries Joint Management Committee; the NWT Wildlife Management Advisory Council; and the North Slope Wildlife Management Advisory Council. Joint management on these boards and committees is accomplished through a 50% Inuvialuit representation. The other 50% representation is Canadians chosen by the government. These committees provide mechanisms to facilitate planning for the conservation and regulated harvesting of wildlife as well as the preservation of habitat and traditional Native use of resources.

The Inuvialuit Game Council consists of 12 Inuvialuit members and provides a vital link between the co-management committees and the local communities. The Inuvialuit Renewable Resources Conservation and Management Plan provides direction for resource users and managers in the Inuvialuit Settlement Region. This plan was developed in 1988 by the Wildlife Management Advisory Council for the Northwest Territories, in conjunction with the Fisheries Joint Management Committee, the Inuvialuit Game Council, the local Hunters and Trappers Committees, and federal and territorial government agencies. This regional plan led to the development of community conservation plans for each of the six Inuvialuit communities: Paulatuk, Sachs Harbour, Tuktoyaktuk, Inuvik, Aklavik and Holman. These community conservation plans have produced innovative community initiatives and precedents in community-based planning (Robinson et al., 1989). They serve as a guide to community residents and others with interests in the resources of the community area. Development of the regional and community plans enabled community members to play a role in affecting local planning and resource management efforts.

At the outset of comprehensive claims negotiations beneficiaries typically have several layers of expectations. Elders desire the means to keep the culture alive and dynamic. From this perspective, land is a foremost priority, followed by compensation and rights to self-government. Middle-aged beneficiaries who are already part of the wage economy may place a higher value on cash and rights than they do on land. Youth may favour enhanced access to education and new job choices, many of which are based in urban localities. However, the fundamental objective of all beneficiaries is conservation, and this forms the foundation of the land claim.

The land claim beneficiaries have faced a problem with staffing the many corporations, boards and committees associated with the claim settlement. While the demands for trained personnel have been immediate, the beneficiaries have typically been ten to fifteen years away from having the necessary trained Aboriginal labor force (Robinson et al., 1989). With the need for readily available Native professionals and managers, beneficiaries often have no option other than to rely on outside consultants. Thus training programs which recruit community members are a priority for the people involved in land claim settlements.

2.5 Co-managment:

Co-management has been defined as "a joint management process that brings together local resource users and government agencies to share management responsibility for local or regional resources"(Roberts, 1994). The pivotal idea in this definition is that joint management is a "process" which can exist as local resource users having a simple advisory role at one end of the spectrum, to legitimate management authority with equal representation on the other end of the spectrum. The later end of this spectrum has been referred to as "complete co-management" (Pinkerton, 1989).

The "process" of moving through this spectrum requires a reconstruction of conventional relationships between resource users and management authorities.

> "Institutions and legal arrangements can only permit, support, and create incentives for new relationships; it is the new relationship which generates the communication, trust, and willingness to risk innovation which makes the benefits of co-management actually materialize" (Pinkerton, 1989).

These new relationships have the potential for long-term positive impacts resulting in high quality management, less conflict, and community-based development. One of the common sources of conflict in the management of resources such as fisheries, results from the critical disagreement on baseline data/information on stock size or stock trends. Fishermen often don't have access to data held by government biologists and officials. However, fishermen have their own alternative sources of data, such as extensive knowledge of local stocks based on years of observation and experience. Therefore, fishermen are able to recognize when government data is incomplete and when their own information contradicts government analysis. As a result, even when fishermen are involved in the co-management process they may question the validity and /or reliability of decisions based solely on government data. When fishermens' livelihoods are disrupted by decisions based on data they know to be inadequate, they tend to adopt confrontational postures which are far more costly and inefficient then the alternative of bringing fishermen into the data-gathering and analysis process. "The most successful and smoothly managed negotiations occur when neither government nor fishermen's groups have exclusive control over data and data analysis" (Pinkerton, 1989).

Co-management has the potential to stimulate better data collection and analysis by allowing this process to occur at the local level in addition to incorporating scientific expertise from external sources. Since both fishermen and government have input into the process, the data becomes more reliable and more accepted by both sides. In this way biological considerations can be separated from political ones.

Successful co-management creates a willingness among both fishermen and government to share data about the resource, and therefore to reach collectively a more complete understanding of the resource. The first obstacle in a fisheries joint management process is to determine facts on the fishery and on limiting biological factors. The second step is to develop a politically acceptable consensus on the "facts". This allows decision makers to deal with points of difference rather than argue about the reliability of data and scientific conclusions.

Once agreement is reached on baseline data/information such as the state of the resource, the committee can move forward into management development. Local resource users, now having a more intimate understanding of data and data analysis, can use this information to contribute more fully to the management development phase. "Local people can often figure out the simplest, most appropriate, and most efficient harvest plan which ensures conservation, using cultural mechanisms available to them which are not available to government" (Pinkerton, 1989). As a result, local harvesting regimes can become tailored to local opportunities and constraints. In addition, decisions made with local involvement have high credibility and produce less user conflict (Berkes et al., 1991). Local control in harvesting activities and resolving fisherman conflicts becomes essential in small isolated communities of vast territory where government presence and intervention is limited.

Local participation in information gathering can ensure fishermen have collective strength and enter into management arrangements on a more equal footing with government officials. Often the stakeholders' perspectives arise from radically different cultural and educational backgrounds. Government representatives trained as fisheries managers and scientists often have faith in the "rightness" and workability of concepts like "maximum sustainable yield" and "stock-recruitment" models (Dale, 1989). However, there can be serious imperfections in the body of information necessarily used in the scientists' efforts to support their management decisions (Freeman, 1989).

Distinctions between local "community knowledge" and "scientific knowledge" are essential to understanding the barriers in communication between community representatives and scientists. Community knowledge is defined as the wholistic knowledge held by community members which incorporates traditional knowledge as well as cumulative experience and adaptations to new technological and socioeconomic changes. Individuals who make co-management work "are those able to cast scientific knowledge into the local language and into practical concerns....they are people who whether scientist, bureaucrat or fisherman, are able to bridge the gaps between ["community"] and "scientific" knowledge" (McCay, 1989). Historically, scientists often disregarded "community knowledge" because they did not consider it to be scientific. Fishermen in turn resented the objectivity of scientists when their livelihoods were at stake. Many Aboriginal people regard "scientific research to be the forerunner of major change in their lives and consequently want greater say over the process and practice of science in the north" (Berkes,1989). The implementation and operation of a community-based fisheries monitoring program is an important step for the Inuvialuit in regaining control over the management of their resources.

2.5 Community-Based Monitoring:

Monitoring involves the systematic collection and organization of information, which is to be used to improve the management decision-making process. It can be used indirectly to inform the public, or directly as a feedback tool designed for purposes of project management, program evaluation or policy development. On-going monitoring assists an organization in keeping its policies and decisions responsive to new opportunities and unforeseen changes in the decision environment. In order for a monitoring program to be practical, it must be easy to implement, cost-effective, and geared towards real-time decision-making (Carley, 1984).

The role of various individuals and committees in any monitoring program should be well defined, and designed specifically to fulfil the stated objectives. Conflicts between value systems and divergent perspectives which can occur in co-management committees require that a wide range of information be collected and shared with the community. When dealing with community-based monitoring it is important to distinguish the relationship between quantifiable information and non-quantifiable information. There is often the tendency to treat quantified data (such as monetary values) as somehow more real than other values. However, northern communities and Aboriginal social systems have an important range of values, many of which are non-monetary, beginning with their relationship to the land and their sense of community.

> While individuals participate in hunting as individuals, it is in fact a community affair which binds people together, not only in traditional ways, but in terms of shared interests, concern for others, and with a sense of community. Values in this case then, do not refer to the nutritional value or "economic" value of game, but to its essence in terms of the beholder being human [and in this case being Inuvialuit] (Carley, 1984).

It is important to have a cumulative perspective on resource harvest, fishery populations and community conditions, in order to fully understand the resource and its relationship with the community. In addition to biological and harvest monitoring of a fishery, perspectives in the community must also be monitored. This would include monitoring changes in the Aboriginal relationship to the land, changes in the role of elders, and changes in the community way of life, since these factors have significant impacts on the fishery.

The methodology of monitoring is very important when trying to draw inferences from the collected data. Therefore, careful selection of indicators which provide valuable information in real-time decision making have to be determined. Additional factors to consider are: who will do the monitoring; what will be monitored; who reviews and interprets the information; how is the data used; and who pays for the program. Individuals and committees involved in the monitoring program must have sufficient financial and human resources to carry out the objectives of the program. In addition, the public or community must have confidence in the program. The public should be able to readily ascertain who is responsible and how to access the program. These are all issues which need to be addressed when considering community-based fisheries monitoring. A successful community-based monitoring program will require a high degree of cooperation and local participation (Carley, 1984).

2.7 Description of the Holman Community:

A large number of Holman residents depend on the local domestic economy. The domestic economy includes harvesting (hunting, trapping, fishing, gathering), and processing activities by which people provide food, fuel, and other material household needs. Though these activities generate some cash (eg. the sale of furs), the greater part of production is consumed directly by households without entering a monetary market. The domestic economy is not a separate economy, but rather is part of a mixed economy. People do a little bit of everything to get by. Income comes from jobs, transfer payments, sale of commodities (such as furs or handicrafts) and domestic production (country food, firewood). Many Native groups in the Canadian north, who have had long-term stable relationships with the fish and game view their dependence on these natural resources as the secure portion of the economy, able to carry them through the vagaries of commodity and labor markets (Feit, 1988).

Unlike the wage economy which is organized around the firm, the domestic economy is organized around the household and kin. Its resources are animals, fish and other materials from the land. Its capital is the household's harvesting equipment (skidoos, rifles, gill nets, etc.). The domestic economy has a labour pool. Some family members harvest while others process (such as filleting fish, butchering meat and preparing meals). Still others are servicers (fixing machinery, make clothing, etc.) and others are supporters, taking jobs to earn the money required to purchase equipment, gasoline, etc. Most families rely on both the domestic and wage economy, sometimes from one month to the next, sometimes at different times of their lives. At a policy level, support for the domestic economy must be seen as a legitimate and permanent part of the mixed economy which is the basis of community life and survival (Usher et al., 1989). Sustainable use of the resources being harvested is critical, since country food will be an important part of community economies far into the future.

It is important to recognize and support the domestic economy since so many people rely on it for their well-being. Income support programs such as welfare and UIC provide some support. However these programs send people the wrong message and often do not provide enough money to support their family and harvesting equipment. Welfare in particular tends to erode cultural values. Better alternatives are capital grants, operating subsidies, price support systems, tax benefits, etc. since they better motivate the people. In addition, the domestic economy can be protected through government efforts to maintain and improve programs for conservation, management, enhancement, and environmental protection. Appropriate information and evaluation systems should be established to assess the viability of resources in which the domestic economy is dependent (Usher et al., 1989). Programs such as the development of community-based fisheries monitoring are essential to maintaining and managing the resources which nourish the domestic economy and support the people of Holman.

2.7 The Holman Subsistence Fishery & Kuujjua Arctic Charr Stock:

The Holman subsistence fishery consists of both a summer fishery and a winter fishery. Charr fishing occurs in the summer months along the coastal areas near the community of Holman on Victoria Island in the western Canadian Arctic and in the winter, as part of an under the ice fishery in Fish Lake (Tatik Lake) (Fig. 5). Fish Lake is part of the Kuujjua River and is thought to be the primary over-wintering grounds for the charr stock. The summer fishery is assumed to be a mixed stock fishery. The origin and contribution of various stocks to this fishery is not known. However, tagging studies suggest that a significant portion of the stock originates in the Kuujjua River, about 60 km north east of Holman (Lewis et al., 1989 and Cosens et al., 1993).

Some biological aspects of the Holman subsistence Arctic charr fishery have been previously described (Lewis et al., 1989; Cosens et al., 1993). Lewis et al. (1989), presents biological data by age group for Arctic charr sampled from domestic gill nets in Fish Lake (Kuujjua River) October 8-9, 1978. This 1978 data suggests that 100 percent maturity does not occur until age 15 years. The length interval data from the sampling indicates that females do not reach 100 percent maturity until they have a mean length of 677 mm. Males were found to be much larger at maturation with a mean length of 800 mm. However, based on subsequent data from a 1992 sampling presented in a stock

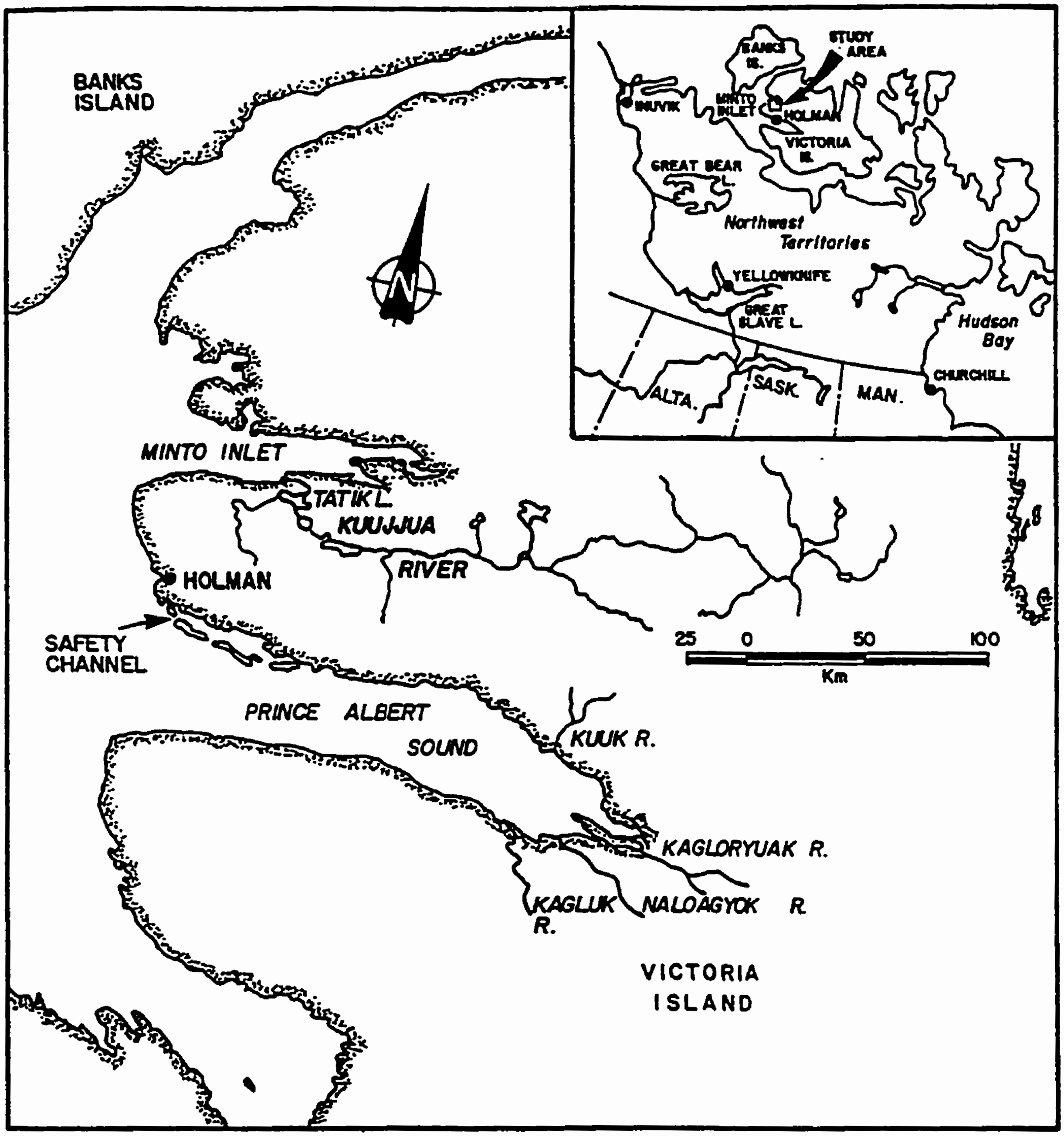


Figure 5. Map of western Victoria Island showing the Kuujjua River, Fish Lake (Tatik Lake) and the community of Holman (Lewis et al., 1989).

status report of Arctic charr in the Kuujjua River, L. A. Harwood (1993), concluded that age at first maturity was 7 years for both males and females. By age 10 both males and females were found to be 100 percent mature. The average length for 100 percent maturity was 566 mm for females and 450 mm for males.

There are obvious discrepancies between these two reports on the Kuujjua stock. According to Johnson (1989) and Lewis et al. (1989), there is a high probability that charr from the Holman fishery have not spawned before they are fully recruited into the harvest at age 10 (Papst et al., 1996). However, according to Harwood (1993), the charr may have spawned at least once prior to full harvest recruitment. Among the recommendations made by Harwood (1993) was the need to gain more information on maturity and fecundity. The criteria used for sex and maturity determination in the 1992 sample was a hand-written guide by field technician, Paul Sparling. This guide provides a description for distinguishing a resting fish from an immature fish. However, Dutil (1984), concludes that immature fish are not distinguishable from resting fish. The exact origins of the information written in this guide are unclear. Thus the interpretation of charr maturity is often subjective .

Clearly, determining the age or size of first maturity of Arctic charr, as well as their spawning frequency, is a priority for fisheries managers. Perhaps a detailed analysis of the aging structures will provide information about the age of first spawning and spawning frequency. For example, Paylor (1996) conducted a study involving biological data obtained by community monitors concerning the Holman subsistence Arctic charr fishery. This study suggested that a detailed analysis of aging structures, such as otoliths collected by community monitors, may provide a growth record of the charr. Growth records can provide information about the timing of critical life history stages such as smolting and first spawning (Paylor, 1996; Gobkov, 1990; Jones, 1992; Halden et al., 1995 and Nordeng, 1961; MacCallum, 1984). Such information would be useful to the community of Holman for the management of Arctic charr fisheries. Further study is required to confirm the analysis of aging structures. However, the community-collected data proved to be both reliable and valuable to the research. If aging structures could be used in this way, community monitors could collect the structures to improve the co-managment of the Holman fishery.

2.9 The Holman Community-Based Fisheries Monitoring Program

In 1991 the FJMC in co-operation with DFO and the HTCs established a pilot project on community-based charr monitoring in Holman. The project has been on-going, employing community members to collect data on the Arctic charr subsistence fishery of Holman. As part of the community monitoring plan a tagging program was initiated on the Kuujjua River. Nine hundred and ninety one (991) charr were tagged and released at the weir site. These 991 charr were not tagged in a random fashion; instead a selective sample was chosen consisting of a portion of small, medium and large size fish. An additional four hundred and eighty seven (487) charr were tagged and released at the mouth of the Kuujjua River in the spring of 1993 (Paylor et al. in prep.). Recovery of tagged fish during the monitoring program has been reported by community fishermen. The tagging program allows annual increases in length to be calculated for a limited sample of tagged charr which were measured both at the time of tagging and at the time of capture. This type of information is useful in assessing growth rates of the population and can be beneficial in the management process.

The initial Holman community monitoring project which started in 1991 was set up to monitor the Kuujjua Arctic charr stock which is believed to overwinter in Fish Lake further up the Kuujjua River. Monitoring samples were to be collected on an annual basis from the winter fishery on Fish Lake in October. However, in 1993 a high proportion of Kuujjua River tagged fish were recovered in the summer coastal fishery. This appeared to indicate that Kuujjua River charr make up the majority of charr entering the summer coastal fishery as well. As a result community monitoring samples were collected from the summer coastal fishery starting in 1993.

Fisheries monitors are appointed from the community by the Holman Hunters and Trappers Committee (HTC) and sponsored by the Fisheries Joint Management Committee (FJMC). Community monitors use field record books and fishermen's log books to record information on fishing efforts, including length of net, size of mesh, duration of net set, location of set, and number of charr caught. Monitors collected a representative sample of approximately 100-200 charr from the winter fishery from 1991 to 1997 with the exception of 1993. A representative sample was also collected from the coastal summer fishery in each of the years from 1993 to 1997. Monitors collect measurements on the fork length and total weight of each charr in the representative sample. In addition, sagittal otoliths are collected from each charr and sent to DFO for age determination. Age was determined as described by Kristofferson and Carder (1980) and Paylor (1996).

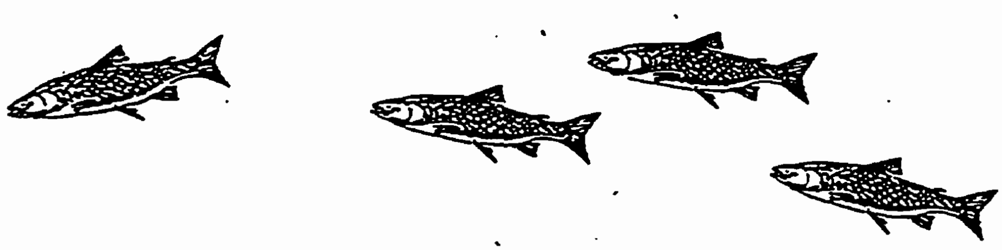
An additional random sub-sample of approximately 35 charr was collected by community monitors using the same methods as employed in the subsistence fishery. Monitors remove every third charr from the net irrespective of its size or condition. This sub sample of charr was packaged and frozen whole for shipment to the Freshwater Institute, Winnipeg, Manitoba, where the charr were thawed and fork length, total weight, and gonad weights were measured by fishery scientists. Sagittal otoliths are extracted and aged for this sub-sample as well by the same methods as sited above.

In addition to the tagging project and biological data collection, a household survey was conducted as part of the community monitoring program. The door-to-door household survey was administered in order to determine the community requirements for charr. The methods used in the 1993 household survey consisted of personal interviews based on a pre-planned questionnaire. The 1993 household survey had approximately 90-95% coverage of community households, and showed that the Holman community is heavily reliant upon the Arctic charr in the area.

An evaluation of this monitoring program was conducted for the period beginning from 1991 to 1994. The results of this evaluation were summarized and presented at the 1995 "Circumpolar Aboriginal People and Co-Management Practice Conference" in Inuvik, N.W.T.. These results also indicated that the subsistence fishery of Holman is dependent on the Kuujjua Arctic charr stock. In 1992 a total of 10,493 charr were counted moving through a full-span conduit weir between August 11 and September 8. This is thought to represent an accurate estimate of abundance for the Kuujjua river charr run (Cosens et al., 1993). Data collected by the monitoring program indicated a record low harvest in 1991 and as a result, following the 1992 fishing season, the Fish Lake (Tatik Lake) winter fishery was closed by community consensus, except for the monitoring program. Harvest monitoring has provided a clear definition of the size and age of charr that make up the subsistence fishery. Data collected between 1991 and 1994 indicated that charr had a mean length which ranged from 529 to 554 mm, and a mean age range of 9.5 to 10.2 years (Papst et al., 1996). Charr were found to enter the fishery around the age of 6 years and were fully recruited into the fishery at the age of 10 years. Few charr older than 15 years were caught in the fishery. No current-year female or male spawners were present in the samples. The study found that both the age and size range of charr caught in the fishery has remained stable over several years. However, Arctic charr population age and size structures often do not change in response to fishing effort, and for this reason age and size structures are often poor indicators of the impact of fishing on charr populations (Johnson, 1989).

Results of the monitoring program indicate that the fishery rarely contains current-year spawners. This could be because current-year spawners remain in freshwater the year prior to spawning (Johnson, 1989 and Dutil, 1984). McCart (1980) reports that most anadromous charr mature by age 8 or 9. A long term study was conducted on an Arctic charr population by Lionel Johnson (1989). This study was initiated in 1973 at Nauyuk Lake on the south east side of Victoria Island, N.W. T.. Since the study was conducted in close proximity to the Kuujjua stock, it may serve as a useful reference system. Johnson (1989) reports a slightly older maturation age of anadromous Arctic charr than McCart (1980). The youngest spawners at Nauyuk Lake were found to be 10 years old, with a mean age of 13.2 years at first spawn. Most Northern charr populations have similar characteristics to the Nauyuk Lake system (Johnson, 1989).

Charr enter the Holman fishery at age 6 and are fully recruited by age 10. If the charr have not spawned by age 10, this will result in devastating effects on stock recruitment. Thus, the age at first spawning is a critical question that must be addressed by co-managers of the Holman subsistence fishery. According to Dutil (1984) charr 600 mm in length have a maximum quantity of energy stored per gram relative to charr at other lengths. Therefore, anadromous Arctic charr must reach an approximate length of 600 mm before they are large enough to undergo the rigorous energetics of spawning. Since Holman monitoring data has revealed a mean length below this size threshold, there is reason to question whether the fishery selects for immature fish that have not spawned. The community based monitoring program has played a key role in bringing this issue to the attention of fishery managers, and may continue to fill the critical role of watching over the resource.



Chapter Three- Community Household Survey on Holman Charr Fishing Priorities, Needs and Traditions

3.1 Introduction

Successful fisheries co-management requires the development of effective communications between community fishers and co-management partners. Community level surveys can provide insight into the needs, traditions and concerns of community fishers. Results of a recent study of young Inuit males which included the community of Holman, suggest that many young fishers are making a conscious effort to remain active in subsistence fishing to provide for themselves and related households (Condon et al. 1995).

The Holman charr fishery consists of two seasonal fisheries: a winter fishery which harvests charr from Fish Lake and a summer fishery which harvests charr from the coastal areas around Holman and Prince Albert Sound. On average the community harvest is approximately 9,000 charr per year (Fabijan, 1988, 1996, pers. comm.). Following the 1992 fishery, the community closed Fish Lake to fishing for three years in response to community concerns that the number and size of charr in the fishery was declining. A community fishing committee was established to examine ways of ensuring the long term health of the fishery. In 1997 the committee commissioned a survey of households to collect information about the needs and concerns of community fishers. The present study reports the results of the 1997 household survey and examines these results within the context of developing a Holman Community Fishing Plan.

3.2 Methods

The Community:

The 1997 household survey examined the community of Holman on Victoria Island in the North West Territories. Holman has a population of 423 in 124 households (Stats Canada, 1997). The population has increased by 17.2% since 1991, at which time there was a population of 361 and 105 households. The majority of the population (67%) is under the age of 30, 26% between 30 and 50 years of age and 7% are over 50 years of age (Statistics Canada, 1997). According to the 1991 Canada census, 59% of individuals in Holman over the age of 15 have some form of employment (Statistics Canada, 1991). However, the large majority of Holman residents are still heavily dependent on a subsistence lifestyle.

Survey Design:

The household survey consisted of 38 short questions (Appendix A). Surveys were completed using in-person interviews. Two interviewers were used, both of whom were people from the community and both were able to speak the local Inuktitut language. The survey was conducted from July 1 to July 20, 1997.

Survey questions were developed following the basic outline of a similar survey conducted in Holman in 1993 by the Fisheries Joint Management Committee (FJMC) and through consultations with the Olokhaktokmiut Hunters and Trappers Committee (HTC). Prior to beginning the interviews a draft survey was approved by the HTC and the Department of Fisheries and Oceans Area Office in Inuvik.

3.3 Results

Survey Coverage:

A total of 97 responses were received, representing 80% of the total households. The survey included households both with and without active fishers. Sixty of the 97 households surveyed (62%) contained active fishers, while 37 households (38%) reported no active fishers present for two years previous to the survey. However, 96 out of the 97 households surveyed reported consuming Arctic charr.

The average number of people per household was found to be 3.9, with a range of 1 to 7 persons. There were on average, 2.0 active fishers per household, with a range of 0 to 5 fishers per household. Most households reported having 1 or 2 active fishers and in total there were 117 active fishers. The majority of active fishers in Holman were between 21 and 40 years of age (fig. 6).

Harvest Level:

A majority of households (51.8%) reported a charr harvest level from 1 to 50 fish for the 1996 summer fishery, and 8.9% of active fishers reported that they had not harvested any Arctic charr in the summer of 1996. Household summer harvest levels ranged from 0 to 200 charr and no household reported a harvest greater than 200 charr (fig. 7). A total of 56 households responded to the harvest question, 14 of which reported an exact number of charr harvested during the 1996 summer fishery. Harvest levels for these 14 households ranged from 3 to 200 charr, with an average of 73.6 charr per household. According to the household survey, there were approximately 3,099 charr harvested in total by the community for the 1996 summer fishery.

More households reported fishing during the summer fishery in 1996 than in the winter fishery. There were 47 fishing households in 1996 which did not fish during the winter. Nine households (15%) reported fishing during the winter with each household harvesting between 1 to 50 charr in 1996. Five of the households which reported fishing during the winter provided exact harvest numbers with harvest levels ranging from 15 to 26 charr. The total community harvest reported by the survey for the winter fishery in 1996 was approximately 311 charr.

July was the best fishing month, according to 79.2% of active fishers (fig. 8). When fishers were asked why they caught more charr during the best fishing month, there was an equal number who replied, it was because there were more fish (31.4%) or because more time was spent fishing (35.3%). An additional 29.4% reported that it was due to a combination of more fish and more effort.

According to the survey, 57% of active fishers do not own their own gill net. The majority of fishers who did not own nets report using their father or father in law's nets. There were 26 households (26.8%) who reported owning their own nets. A total of 44 nets were recorded by the community, 96% of which are 4.5" mesh or larger (Table 1).

The immediate coastal area surrounding the community of Holman is the most heavily fished location. There were 76 reported fishing locations, 46 of which were located in the area directly surrounding Holman. The second most heavily fished area is the coastal shore west of the Holman community including the First, Second and Third Rivers. Only 7 fishers reported fishing at Fish Lake over the last five years and only 5 fishers reported fishing in Prince Albert Sound past the Safety Channel.

Consumption and Need:

The majority of fishing households reported consuming charr at least twice a week (fig. 9). However, many of the respondents reported that the frequency of their charr consumption is dependent on availability. Some of the common responses were "whenever we can" or "every day in the summer, once a week in the winter". Only one household did not report the consumption of charr.

Out of the 60 households which contain active fishers, there were 44 that reported at least 50% of their household foods were country foods and some reported up to 100% use of country foods. Therefore, 73% of the fishing households in the community use country foods for at least half of their household food supply. Households which did not contain active fishers reported a lower usage of country foods with the majority (79%) reporting only 25% use of country foods. Charr is an important source of household country foods, therefore, fishers were asked what type of charr they preferred to catch. The question produced a wide range of responses, however, the majority of fishers reported a preference for "silver charr" (Table 2).

Of the 97 households surveyed, 89 (or 92%) reported consuming charr which they did not catch themselves. Only 8 households reported they did not receive charr from other sources. Many households reported that they share charr with family and friends within the community. Another important source of charr was the fishing activities sponsored by the HTC (Table 3). A total of 17 out of the 60 households which contained active fishers (28.3%) reported giving charr to family or friends.

A significant proportion of households reported their current harvest levels were inadequate to meet family needs. The most common concerns were in regard to increasing family sizes. When asked if current yearly harvest levels were more than enough, ok, or not enough; only 2 households reported they had more than enough (fig. 10). There were 23 households (38.3%) who reported their harvest level was not enough. By comparing answers on the same survey, fishers' perception that their current harvest levels is insufficient, was not correlated to larger family sizes or lower catch levels. In addition, over half of the households who reported their harvest level was not enough, also reported that they had provided charr to family or friends outside the household.

Of the 35 households, who reported their current harvest level was "Ok", 20 expected their needs would increase in the future. Only 23% of fishing households reported being confident that future needs would be met without an increase in harvest (fig. 11). When households were asked about their perspective of the community' harvest level, the majority of respondents reported the community does not over-harvest (fig. 12). A majority of households (80%) reported that there was no fish wastage in the community, while 20% reported some wastage (fig. 13).

Community Fishing Plan:

A decline in the size of charr in 1991, was one of the initial reasons for the development of a fishing plan for Holman. In 1997, a majority of fishing households (69.1%) reported that charr size had increased or remained the same (fig. 14). A majority of fishers reported that their catch had increased or remained the same during the time Fish Lake was closed from 1993 to 1995 (fig. 15). Fishers were asked if they had increased their fishing effort since the closure of Fish Lake. A total of 58.8% of fishers responded they had not increased their fishing effort, while 17.6% reported they had increased their effort.

Over half of the households reported they were aware of the community fishing plan. A clear majority of households agreed that Holman needed a fishing plan (fig. 16). Further, 79.3% of households agreed that, community representatives, the HTC, FJMC and DFO should participate in the preparation of a fishing plan. Household responses strongly support the use of community monitors for the collection of fisheries data (fig. 17). Most households (90.4%) report there should be a community fisheries monitor for Holman, Fish Lake and Prince Albert Sound. Twenty percent of the active fishers in Holman said that they are interested in taking a more active role in the community fishing plan.

There were a significant number of respondents (67%) who indicated they would be willing to accept catch limits on the summer fishery. However, the support for a summer limit was largely dependent on the limit being set by the HTC, not DFO. A significant percent of respondents (32.3%) would not accept a limit on the summer charr fishery. When asked what type of management approach would be most appropriate for the charr fishery, the most preferred choice was to place quotas on both (summer and winter) fisheries. The second choice was to implement larger mesh size regulations (Table 4).

To the question "should a community fishing plan include bylaws?", 59 respondents were against bylaws and 69 respondents (53.9%) thought the fishing plan should include bylaws. When asked which bylaws should be included, the most common response was the number of charr taken and net/mesh size regulations.

Most people in the community (94.8%) agree with Fish Lake being reopened in 1996 for fishing. However, most people also agree there should be a limit on the number of charr taken from the Fish Lake fishery. When people were asked what the limit should be per household for the Fish Lake fishery the majority (62.9%) responded 25 charr.

The final question on the 1997 survey asked respondents how they would rate the quality of Arctic charr fishing in 1996. A significant proportion (30.5%) of respondents rated the fishing in 1996 as "very good", 66.3% rated the fishing as "good" and 3.2% rated it as "ok". There were no respondents who stated the 1996 fishing was "poor" or "very poor".

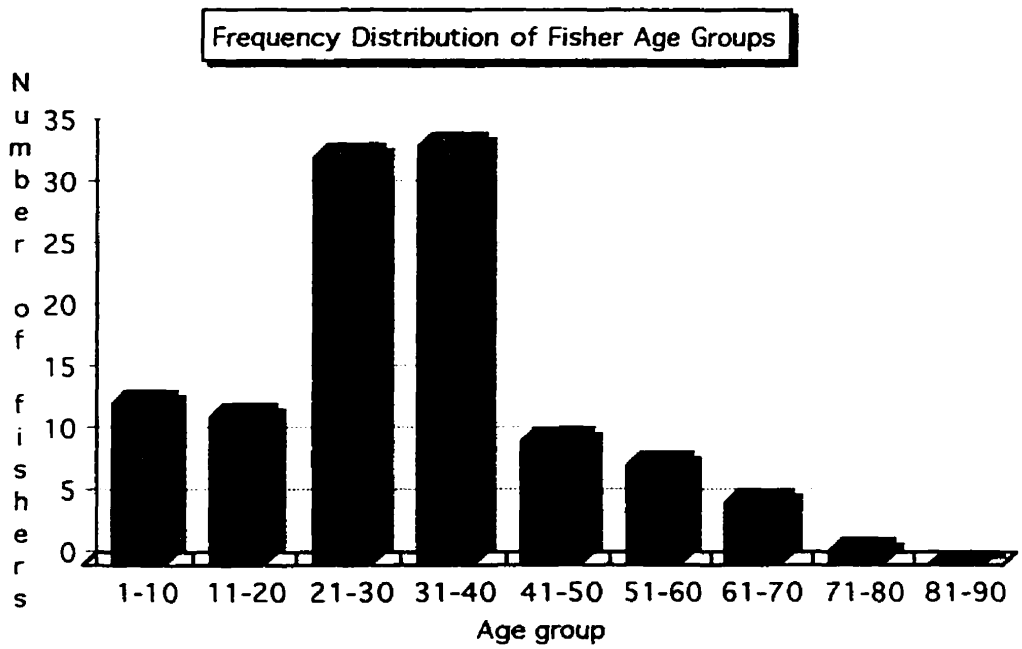


Figure 6. Age frequency distribution of active fishers in Holman.

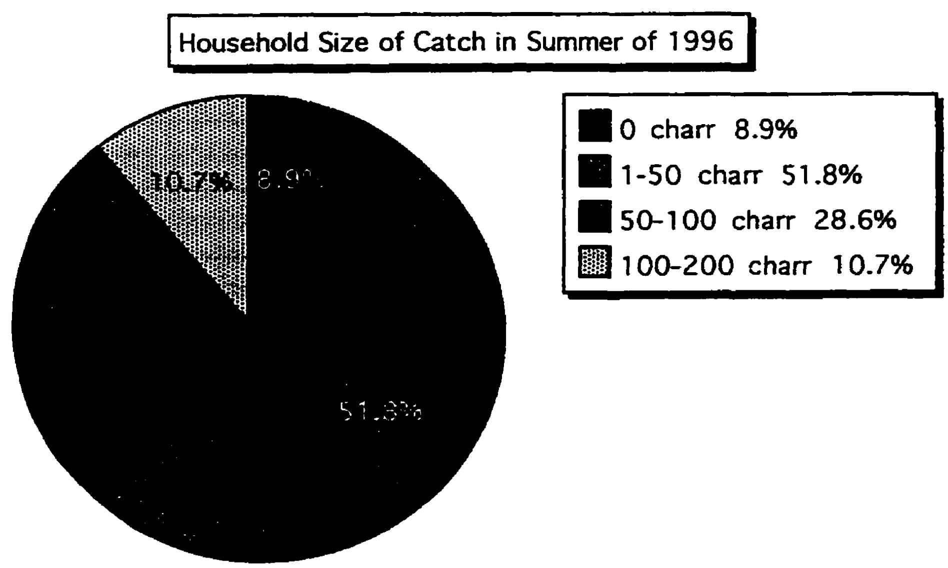


Figure 7. The percentage of households within each harvest level range.

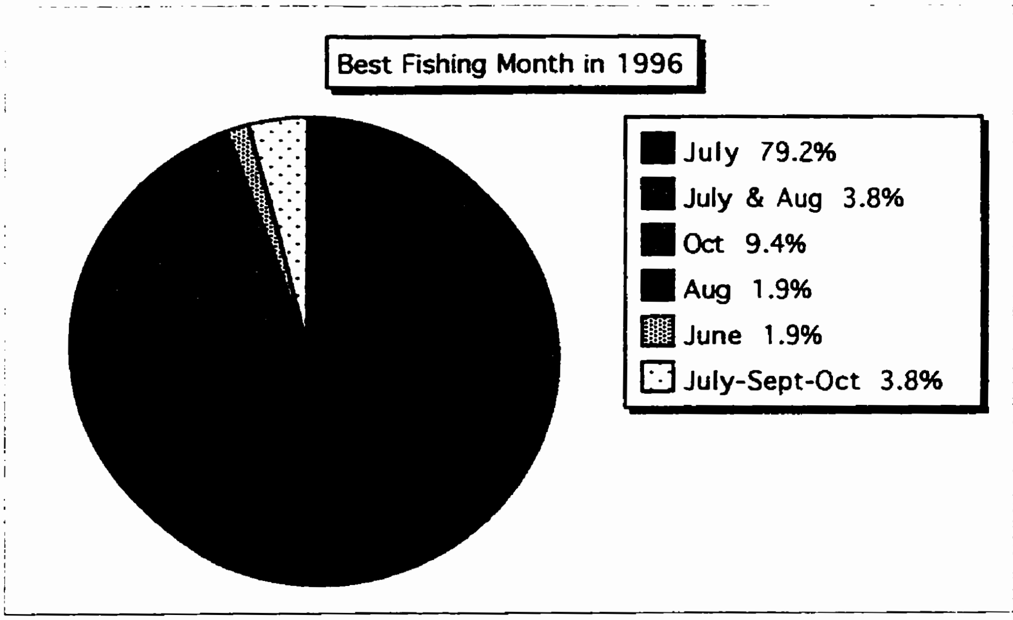


Figure 8. Percentage of fishers who caught the most fish in July as compared to other months of the year.

Table 1. The size and number of nets owned by community fishers in 1997.

Net Size	Number of Nets in 1997	Percent of Total Nets
3 1/2"	1	2.30%
4"	1	2.30%
4 1/2"	20	45.40%
5"	18	41.00%
5 1/2"	4	9.00%

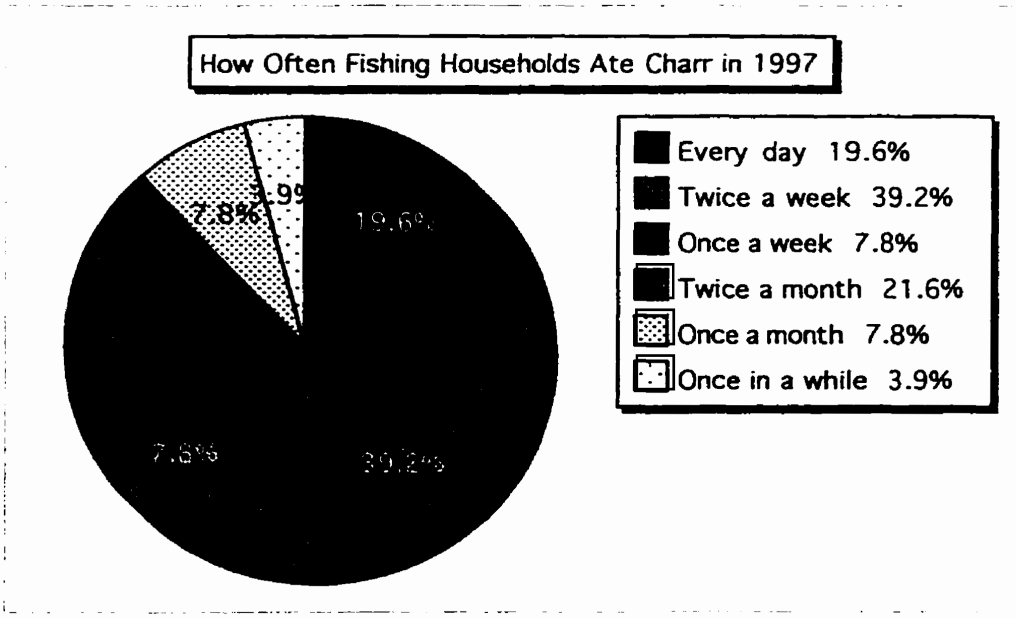


Figure 9. Percentage of households that consume charr at different rates.

Table 2. Type of charr preferred by Holman fishers.

Preferred Type of Charr	Number of Households
Silver	26
Any size, colour or location	5
Any size or colour, Holman	4
Medium, silver	1
Small, silver, Holman	1
Medium, Holman	1
Medium, silver, Holman	1
Large, silver, Holman	3
Red, large Holman	1
Silver, large, second point	1
Any size, silver, Holman	1
Both	7

Table 3. Additional sources of charr for a household.

Source of Additional Charr to Household	Number of Households who Received Charr from	Average Amount of Charr Received in a Year
From Friends	18	12
From Family	65	14
From HTC	67	6
From other Communities	2	10

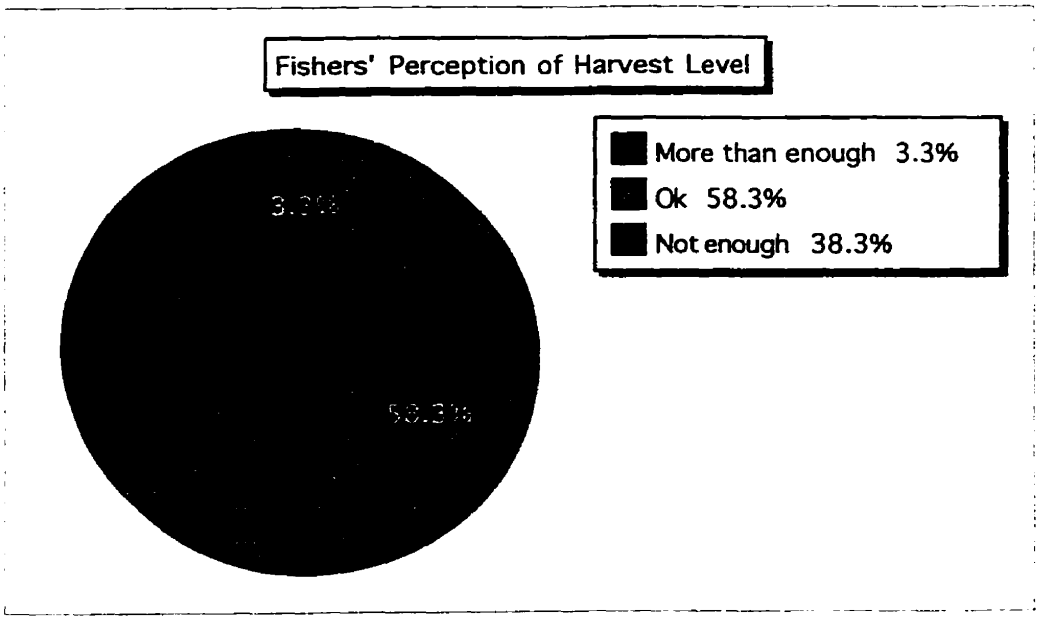


Figure 10. Community opinion on current harvest level of charr in relation to need.

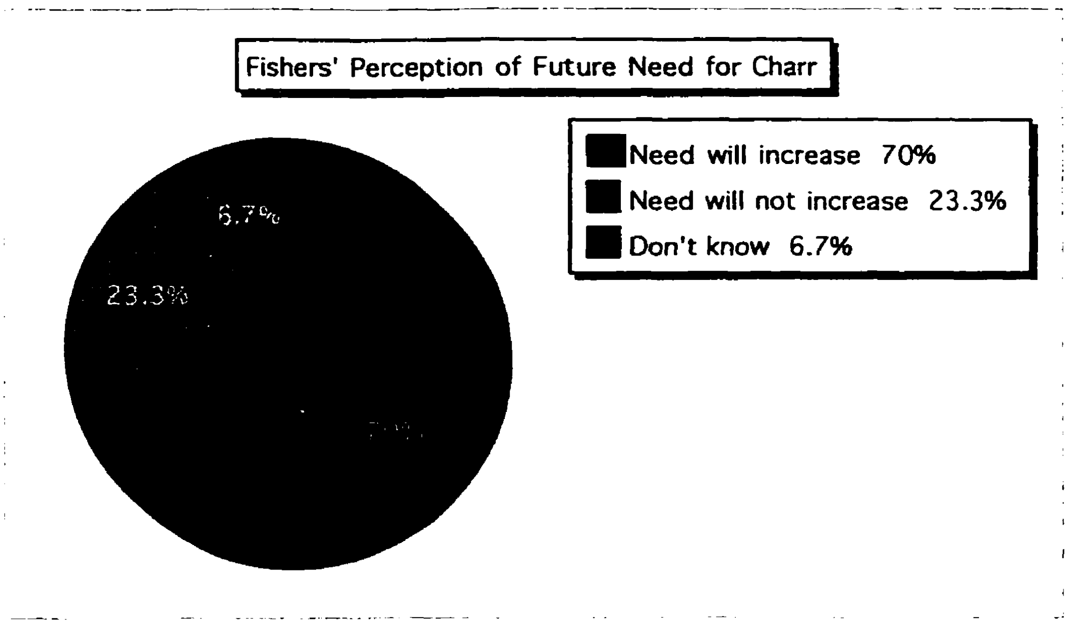


Figure 11. Community opinion on future need for charr.

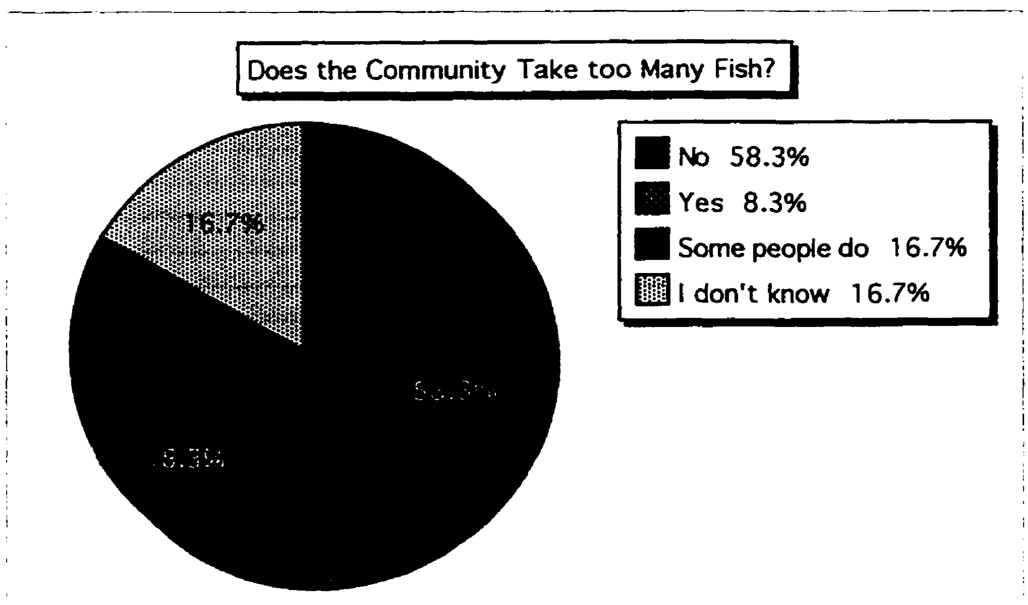


Figure 12. Community opinion on over harvesting of charr.

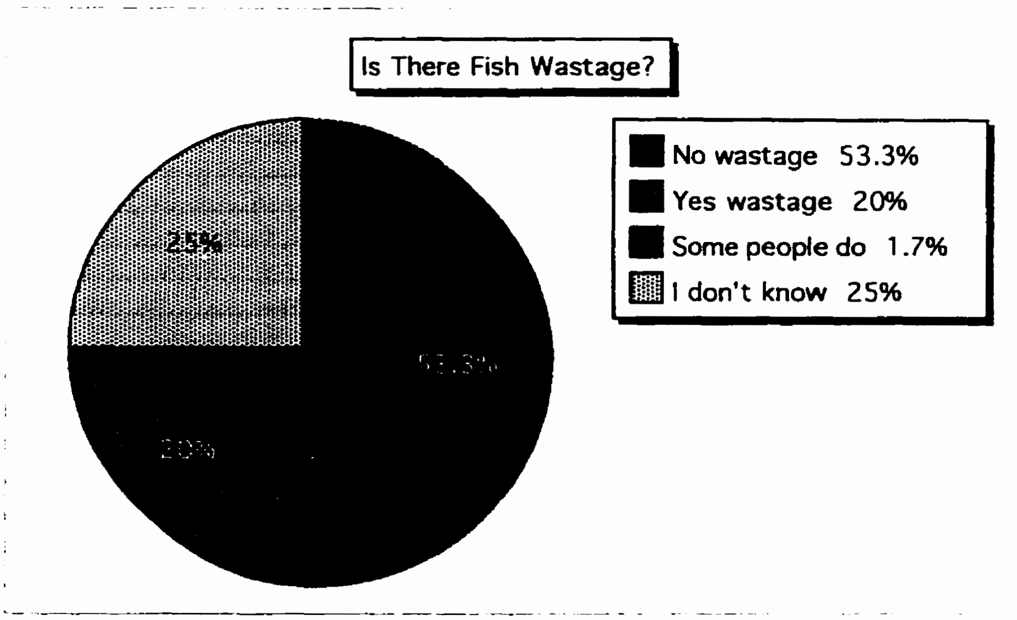


Figure 13. Community opinion on wastage of fish.

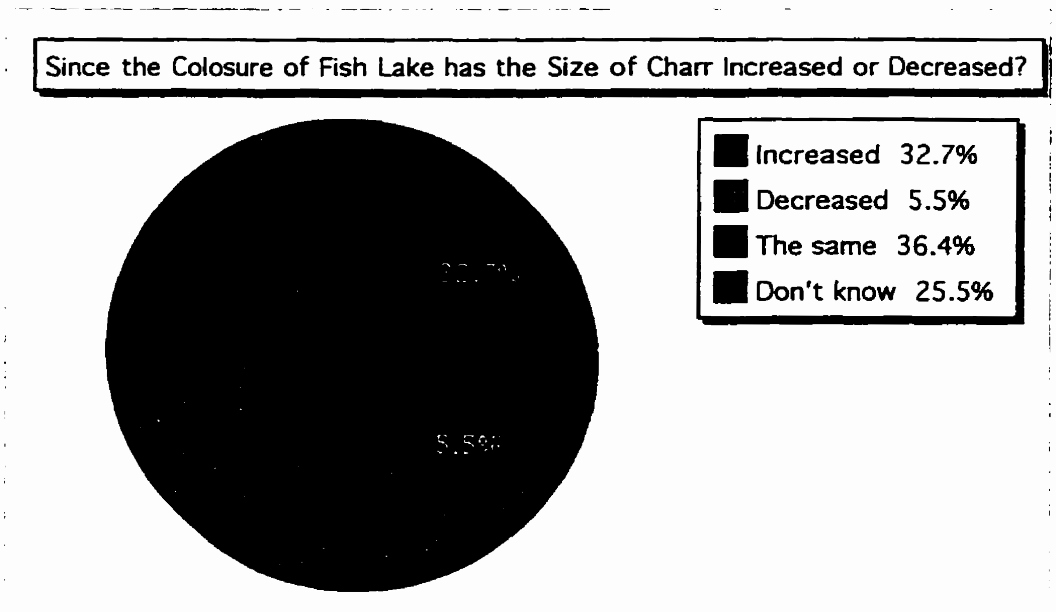


Figure 14. Community opinion on increase/decline in size of charr since the closure of Fish Lake

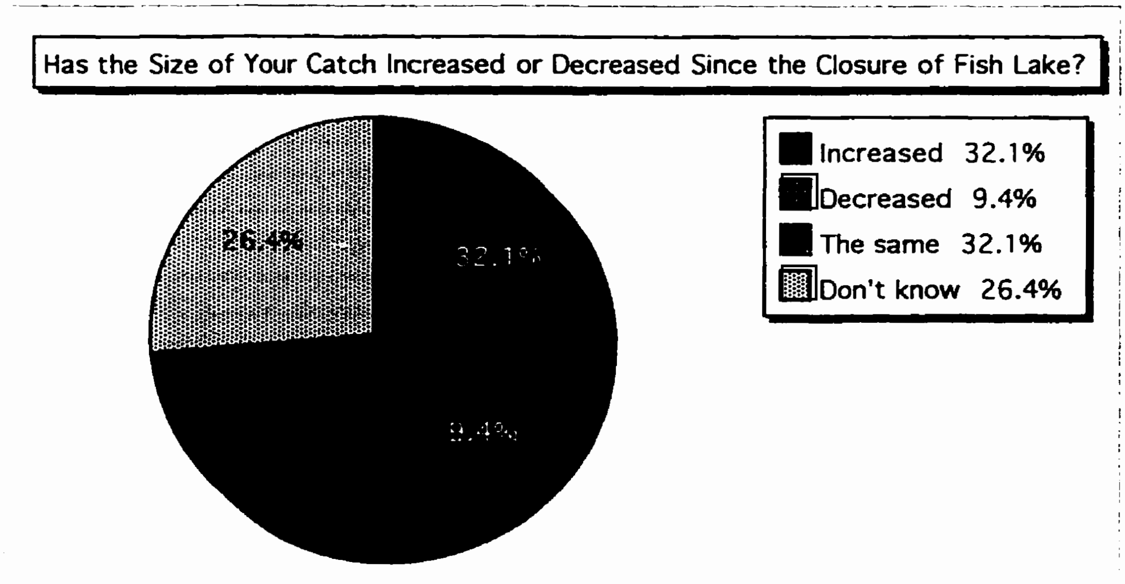


Figure 15. Community opinion on increase/decrease in size of catch.

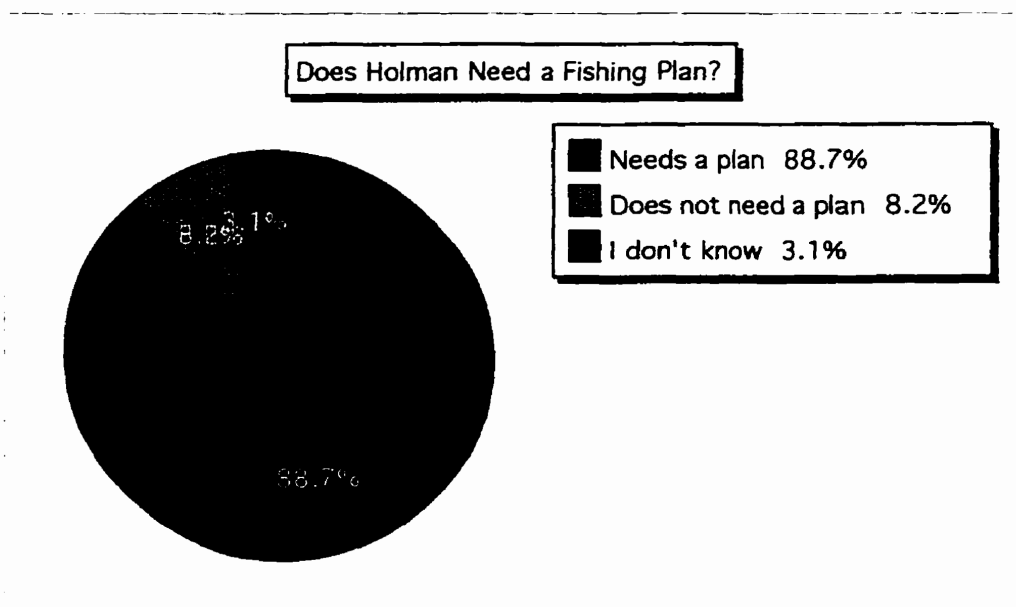


Figure 16. Community opinion on the need for a fishing plan.

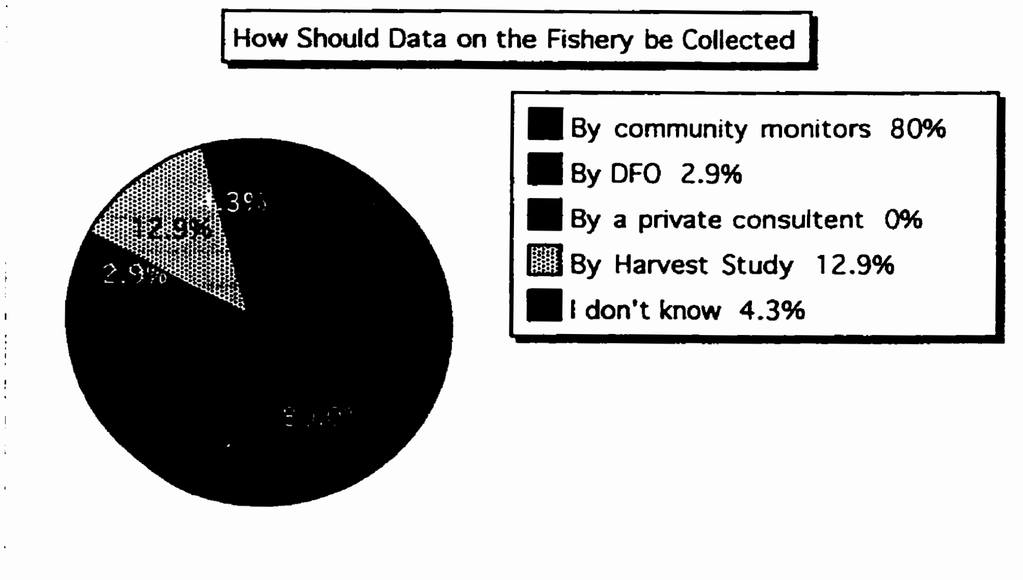


Figure 17. Community opinion on the collection of fisheries data.

Table 4. Most appropriate management approach according to community preference.

Management Approach	First Choice	Second Choice	Third Choice
Limits on the summer fishery	9	0	2
Limits on the winter fishery	5	4	0
Quotas on both fisheries	50	5	1
Larger mesh size regulations	3	37	4
Closure of certain areas	1	2	2
None	20	0	0

3.4 Discussion

Arctic charr are an important part of the diet of the people of Holman, and 99% of the households surveyed in 1997 reported they consumed charr. A majority of households reported consuming charr at least twice a week. Some common responses to the survey question regarding how often charr was consumed included: "whenever we can"; "every day in the summer, once a week in the winter". The community continues to have a high preference for silver charr. All fishers responded that they harvest and consumed their preferred type of charr. Therefore, the community does not show any preference toward red spawning charr nor does the fishery select for this segment of the population. The prevalence of younger fishers active in the fishery provides evidence that the tradition of subsistence charr harvesting is being carried on within the community. The continuation of the Arctic charr harvest demonstrates the cultural importance of subsistence charr fishing, a strong community dietary preference for charr, as well as the economic importance of charr as a staple food within the household.

In Holman charr are often shared among households; with 89 out of 97 households surveyed reporting using charr they did not catch themselves. The sharing of charr does not seem to be correlated with higher harvest levels, and the giving of charr was still carried out by households who felt that their current harvest levels were inadequate. These results suggest that there is a domestic economy at work and a communal way of life in Holman. The trading and sharing of country foods within the community makes it difficult to quantify harvest and consumptive levels on a household basis. Many households recorded that they share charr with friends and family, however they where unsure of the exact numbers given or received. Adding to the complexity is the occurrence of secondary and tertiary food distribution within the community (Condon et al., 1995).

Part of the Holman fishing plan developed by the community fishing committee was for the HTC to provide charr from Prince Albert Sound. The additional charr were distributed to households in order to "off-set" the reduction in harvest resulting from the Fish Lake winter fishery closure. The program was sponsored by FJMC and a large proportion of households (70%) receive charr from the HTC fishing activities. Based on the response by the community that harvest levels were just enough, it would appear the fishing activities of the HTC could be considered vital to meeting the community needs for charr. Therefore, the HTC program was an important component in implementing the community fishing plan.

A significant number of households reported that current harvest levels were inadequate to sustain their family needs. Results suggest that a large majority of families (small and large) are in a growth phase and that subsistence fishers feel a responsibility to meet the needs of their growing community. In addition, a majority of Holman fishers believe their need for charr will increase in the future. The most common reason given for this prediction was growing family size. These community concerns are supported by Canada Census data which show an increase in the average household size in Holman. The average number of fishers per household in 1997 was 1.95, while in 1993 there were on average 2 fishers per household (unpublished report by FJMC). As a result, there are still only 1-2 fishers per household who are now trying to support larger families and extended networks of kinsman. Given the high consumption rates of charr, the significant number of households that state their current harvest is inadequate, and the belief that needs will increase, it seems unlikely that the Holman charr harvest will decline in the future.

The majority (89.3%) of households harvested less than 100 charr in 1996. No households reported taking more than 200 charr. These harvest levels appear to be reasonable for a community heavily dependent on the charr fishery. However, when the harvest levels reported in the household survey are compared to the Inuvialuit Harvest Study levels recorded for 1996, there is a significant under- representation of total charr harvested reported by the household survey. The 1996 Inuvialuit Harvest Study reports a total subsistence charr harvest of 5875 charr, whereas the community household survey recorded a total subsistence charr harvest of 3410 in 1996. The discrepancy between these two harvest levels may question the ability of household surveys to generate accurate harvest data from a single personal interview at one point in the year, compared to the Inuvialuit Harvest Study which conducts personal interviews once a month. These results demonstrate the difficulty in recalling large numbers of animals harvested over an extended period of time. It is a lot easier for subsistence hunters to recall the number of polar bears they shot in a year than to remember the precise number of charr they caught last July. The number of charr harvested could be in the hundreds and distributed throughout many different community networks. Therefore, a regular and timely monitoring program is required to estimate accurate harvest data for charr.

The 1997 survey results indicate a large majority of the community harvest occurs in July when the charr are running out of the rivers. The community perception that there are more fish at this time of the year conveys a heavy concentration of charr around the community fishing grounds off the coast of Holman. This concentration of fish could be the result of a number of charr stocks running together or one particular stock, such as the Kuujjua, which has not yet dispersed into the ocean for the summer.

The 1997 survey shows the summer fishery takes a much higher harvest than the winter fishery and involves many more active fishers. Based on a comparison between the 1993 and 1997 surveys, there has been an obvious displacement of fishing pressure from the winter fishery at Fish Lake to the summer coastal fishery. Results from the 1993 survey show 36% of fishers participated in the winter Fish Lake fishery and 64% of fishers participated in the mixed summer coastal fishery. These proportions have changed drastically since Fish Lake was closed in 1993 and reopened in 1996. In 1996 there were only 10% of fishers fishing at Fish Lake and 93% of fishers participating in the summer coastal fishery. The 1997 survey indicated the large majority of summer coastal fishing occurs directly off the shore surrounding the community of Holman and to an area directly west of Holman. This timing and method of fishing drastically reduces the time, money, equipment, expensive gas and level of knowledge (travelling on the land in the winter) which is needed to participate in the winter fishery at Fish Lake 60km northeast of Holman. Another factor which may instigate or reinforce this switch to the summer fishery is the high involvement of the younger generation (22-35) which Condon et al. (1995) found likes to spend more time in the community. In addition, the most popular subsistence activities are warm weather pursuits during 24 hour or extended daylight. Therefore, it is not surprising then that Condon et al. (1995) found the spring and summer charr fishery had the highest level of subsistence community involvement. The high involvement of community members makes the charr fishery both an important and practical resource to manage at the community level.

The displacement of fishing pressure from the winter fishery to the coastal summer fishery makes the composition of the charr concentration off the Holman coast in the summer a vital question. The contributions, if any, from other charr stocks to the Kuujjua stock in the summer fishery are unknown. Therefore, it is unclear whether pressure on the Kuujjua stock has been diminished by this shift in effort, or if fishing pressure on the Kuujjua stock has remained the same or increased by closing Fish Lake and shifting effort to the summer coastal fishery.

Most fishers report that the size of their catch and the size of their charr has increase or stayed the same since the closure of Fish Lake in 1993. Fishers also feel that they have not had to increase individual effort to catch the same amount of fish they caught in the past. These reports would indicate that the closure of Fish Lake had a positive impact on rejuvenating the Kuujjua stock and that local fishers are not currently concerned about stock health.

Very few fishers in 1997 use net mesh sizes below 4.5" mesh. A shift from 4" mesh nets to 5" mesh nets can be seen in fishers' preferences from 1993 to 1997. There were no fishers in 1997 who said they prefer anything smaller than 3.5" mesh, compared to 6.8% who preferred this size in 1993.

The effectiveness of larger mesh sizes as a conservation measure for the fishery should be investigated in order to determine if this trend has had a positive impact on the charr stock.

Only 43% of active fishers in the community own their own net. Net sharing may be one of the factors controlling the level of effort of this subsistence fishery. Agencies involved in the management of this fishery should avoid implementing policies which would alter this "balance", such as net purchasing programs to replace smaller mesh nets with larger mesh sizes. It is important to note however, a significant proportion of fishers (38%) report the use of rod and reel.

A large majority of fishers in Holman have routine or traditional fishing locations close to the community. There were however a large number of fishers (52.5%) who said that they would be prepared to move their fishing locations further from Holman if it were required for the health of the fishery. The distance fishers were willing to move ranged from 15 miles to 150 miles. However, a number of fishers who said that they would be willing to move also indicated that they would want to move up the west coast towards the Kuujjua River. Therefore, the use of relocation of fishing sites as a management tool may be limited in its' capacity to reduce the harvest of Kuujjua Charr.

A majority of respondents said that they would be willing to accept limits on the summer charr fishery if they were set by the HTC or a combination of community representatives, HTC and the FJMC. The 1997 survey asked fishers what management approach they felt was most appropriate for the charr fishery. First choice was to place quota's on both fisheries (summer and winter), the second choice was to implement larger mesh size regulations. This second management approach may not be necessary since the majority of fishers active in the fishery are already using fairly large mesh sizes of 5" or 5.5". The 1993 household survey also found a large majority of fishers (93.5%) who felt larger mesh sizes would be a good conservation measure. It is interesting to note that five years ago the community was in favor of larger mesh sizes and they seem to have taken the initiative to switch to these large mesh sizes without regulations to enforce this change. This change may be in part due to a FJMC/DFO sponsored workshop on the effects of mesh size (Norton, 1997). Caution should be taken to ensure that this change does not result in a significant increase in the number of nets available in the community.

The community agrees with the reopening of Fish Lake and the majority feel that there should be a limit of 25 charr per household on this winter fishery. This is a very positive result which demonstrates that the community is quite willing to be responsible with their individual harvest levels and are putting the health of the fishery before their own harvest "needs". This is especially true since the majority of people responded that their present harvest levels were not enough and that their needs would increase in the future, yet they are still willing to accept a limit on their fishery. Again it is interesting to note the limit of 25 charr from Fish Lake that the majority of the community feels is appropriate, closely reflects the limits recommended by the community fishing committee, and the actual limits being taken from the Fish Lake fishery.

It would appear that the opinion of the larger fishing community, in regard to both mesh size and quota limits, seems to have a significant influence the activity of individual fishers. This would suggest the implementation of community workshops and educational programs regarding fishing practices and their implications could be a successful tool in controlling or changing harvest practices in response to management initiatives.

The large majority of households in the community (89%) are familiar with, and in support of, the Holman community fishing plan. Fishers are in favor of an integrated management plan which includes community representatives, HTC, FJMC, and DFO participating in the decision-making process and operating at the community level. The 1993 Holman survey showed that 72.7% of households surveyed felt that there should be a fish monitor in Holman. This support of a community monitor has been continued in 1997 with 80% of the community still supporting the idea of a community monitor. In fact the 1997 survey shows that this support has expanded to include the desire for a community monitor not only in Holman but also in surrounding areas such as Prince Albert Sound and Fish Lake. There were 20.3% of active fishers who said they would like to take a more active role in the community fishing plan. If this proportion is combined with those who said they were unsure, there becomes a significant number of fishers (43.8%) who potentially would get involved in one way or another. These results demonstrate a large support for community monitors and a willingness on behalf of fishers to get more involved in the community monitoring program.

3.5 Conclusion

Over all, the 1997 household survey demonstrated that there is a growing awareness and support for community-based fisheries management in Holman and that people are willing to make some sacrifices for the heath of their fishery. The results of the 1997 household survey indicate that the subsistence Arctic charr fishery is an integral part of traditional community culture and serves as an essential source of household foods. The demand for and dependence on charr will increase in the future.

Fishing was productive in 1996, following the 1993 to 1995 closure of Fish Lake. A large majority of the community rated the quality of fishing as good or very good in 1996. The 1993 survey had numerous comments which expressed alarm/concern regarding fewer and smaller charr being caught. The 1997 survey did not have any comments which expressed such alarm or concern over fewer or smaller charr. There does seem to be a certain level of community concern over inadequate harvest levels to sustain their families. However, the community contributes this inadequate harvest level to growing family sizes not to dwindling stock sizes.

Results of the survey suggest the overall community fishing effort may be limited by net availability. This is an important consideration for managers attempting to implement alternative management options. In particular, the community fisheries committee had looked at encouraging fishers to switch to larger mesh sizes. This conservation effort would introduce additional nets into the fishery and could have the negative effect of increasing fishing effort.

A second management option which was considered by the fishing committee was the relocation of fishing effort to alleviate pressure on the Kuujjua stock. However, there was a mixed response by fishers who reported a willingness to move their traditional fishing sites. While many fishers said they would relocate, it was ambiguous as to what direction they would move and whether they expected transportation to be subsidised by the HTC. Therefore, opportunities to relocate fishing effort may be restricted and further consultation with the community is needed.

Survey results also indicate the fishing activities of the HTC had an important effect on the availability of charr in the community. The alternative fishing in Prince Albert Sound sponsored by the FJMC was used to supplement the charr supply in over 70% of community households. Although there is no direct method of measuring the effect of this program, it would seem reasonable to assume it had a significant impact on community demand for charr.

The community fishing committee hosted a number of workshops and open houses meetings. Two of the major issues which have been addressed in the community are the effects of mesh size (Norton, 1997) and household limits on the winter Fish Lake fishery. The survey has demonstrated how community consultation and educational programs can influence community opinion and the activities of fishers.

In conclusion, community household surveys can provide a valuable source of information regarding community perspectives and how they influence both the local subsistence fishery and related management decisions. Periodic household surveys and community-based fisheries monitoring programs can serve as useful management tools which ensure both community involvement and comprehensive decision making. Household surveys provide fisheries managers with insight into factors impacting the fishery such as: the number of nets being used, changes in fishing locations, subsistence needs and the degree of community support regarding management options.

Chapter Four - Community Monitoring Data

4.1 Introduction:

Involvement of fishers in fisheries monitoring programs is an important aspect in the implementation of a co-managment system. In a survey of households in the community of Holman, Northwest Territories a majority of households identified community-based catch monitoring as an important part of a community fishing plan (chapter 3).

The use of such monitoring information in the development of a fisheries management plan presents the fisheries manager with several challenges. Catch data is often biased by such factors as gear selection and, in the case of subsistence fisheries, the unstructured nature of the fishery makes the collection of catch per unit effort data (CPUE) difficult. In the case of Arctic charr fisheries, difficulties can arise from a lack of change in modal length or age in the population in response to fishing pressure (Johnson, 1989). Information regarding trends in the length and age distribution of the catch, is often the principle type of information collected by monitoring programs. In some situations counting fences can provide reliable abundance estimates, however such fences can be expensive to operate and several years of operation may be required.

Johnson (1989), concluded that the management of Arctic charr fisheries must be "pragmatic in approach and based on all available information". This study describes the results of a community-based monitoring program for a subsistence Arctic charr fishery and evaluates the usefulness of the results in developing a fisheries management plan.

4.2 Background:

The community of Holman (70°43'; 117°43' W) Northwest Territories, is located in the Inuvialuit Settlement Region (ISR) established under the terms of the Inuvialuit Final Agreement (IFA S.C 1988, c.16). Within the ISR the fishery resource is managed cooperatively by the Department of Fisheries and Oceans (DFO) and the Fisheries Joint Management Committee (FJMC). Residents of Holman harvest Arctic charr from late June to late August along the coast of Prince Albert Sound and at Fish Lake (71°16'; 116°49' W), also known as Tatik Lake from late September through October. Results of a survey of Holman households suggest that the subsistence requirement for Arctic charr by the community is 9,000 annually (Chapter 3).

Gill nets are the principle type of fishing gear used, 114 and 127 mm mesh nets are the most commonly used. Net lengths range form 23 to 46 meters. During the summer coastal fishery nets are most often set from shore and during the winter fishery at Fish Lake nets are set under the ice. The Kuujjua River flows through Fish Lake into Minto Inlet. Fishing takes place generally in two locations in Fish Lake, one in a bay at the north end of the lake known locally as "Aimoakatahok" and the other at the south end of Fish lake.

In 1991 the community of Holman became concerned about the status of the Kuujjua River charr stock due to a record low harvest, coupled with smaller fish sizes. In response to this concern, in 1992 the FJMC and DFO installed a full span conduit weir on the Kuujjua River below Fish Lake where charr are believed to over winter. The full span conduit weir was in operation from August 11 to September 8, 1992 and is believed to have intercepted the complete run. The weir project was used to enumerate the Kuujjua Rover charr stock and to initiate a tagging program for the population. The weir project provided a count of 10,493 upstream migrants. The absence of old charr, a low mean age, a low mean size, a high occurrence of net marks and reports from community harvesters all indicated that the Kuujjua River stock was subject to a high level of exploitation and was in a depleted state (Harwood, 1993). It was concluded that the exploitation rate of the population was at least 20-35% and that this represented an over harvesting of the population (Harwood, 1993).

During the time the weir was in operation a random sample of 2,334 charr were measured to obtain a record of fish fork length. Of these 2,334 charr, 991 tags were placed on the dorsal flesh of the charr and they were released. In addition to the 1992 weir tagging, in the spring of 1993 an additional sample of 570 charr were captured at the mouth of the Kuujjua River using fishing rods and seining nets. There were 18 tags recaptured from the 1992 fall weir project, and an additional 487 new tags placed on the untagged charr. A large number of tagged charr were recaptured in the 1993 summer coastal fishery, increasing the community's concerns about over harvesting. Upon community consensus, the winter Fish Lake fishery was closed for a three year period starting in 1993. People in the community and fishery managers were so concerned about the health of the Kuujjua stock that a decision was made not to take the 200 charr monitoring sample from Fish Lake in the winter of 1993. The winter monitoring sample was taken for all other years in which the program was in place (1991 to 1997).

Historic harvest levels for the Fish Lake fishery for the period from

1966 to 1978 ranged from a high of 4,000 to a low of 1,704 charr, with a mean harvest of 3,197 charr per year (Lewis et al., 1989). The number of fisherman involved in this fishery from 1966 to 1978 varied from a low of 8 in 1967 to a high of 30 in 1978. Estimates of the number of charr caught per net day were made during the period from 1971 to 1978 and estimates ranged from 2.5 to 5.7 charr per net day (Lewis et al., 1989). Although an experimental fishery was conducted along the Holman coast in 1978, 1982 and 1983, harvest data was not regularly collected until the Inuvialuit Harvest Study began in 1988 (Lewis et al., 1989). No harvest data for Fish Lake was collected for the period form 1978 to 1988 (Lewis et al., 1989).

4.3 Methods:

This study included information collected by the Fish Lake and summer coastal fisheries monitoring programs as well as harvest data from the Inuvialuit Harvest Study. Community monitors were appointed by the Holman Hunters and Trappers Committee (HTC). Monitoring at Fish Lake began in 1991 and continued till 1997 with the exception of 1993 when no fishing was done at Fish Lake at all. Sampling of the summer fishery began in 1993 with the collection of a sample from the community's catch and the distribution of log books to fishers. The distribution of log books was discontinued in 1996 due to a low number of returns and at this time the monitor began collecting data on catch and effort by interviewing fishers.

Catch sampling for both the Fish Lake and summer programs involved measuring the fork length and weight of approximately 200 charr. The Fish Lake sample came from nets set by the monitors, where as the summer sample was collected from various fishers. The sagittal otoliths were collected from these charr, placed in labled envelopes and stored dry for age determination. Otoliths were read under a binocular microscope using the method described by Kristofferson and Carder (1980). Annual survival rate estimates were done for each year's catch using the age frequency distributions (Robson and Chapman, 1961).

At Fish Lake in addition to the catch sample a random sample of approximately 35 whole charr was taken frozen and shipped to the Freshwater Institute in Winnipeg, Manitoba. A similar sample of whole fish was taken from the summer catch in 1995 and 1996. However the summer sample was not random as an effort was made to collect whole charr that had been tagged at the Kuujjua River in 1992 and 1993. The sample of whole charr was examined to determine the sex and to calculate a Maturity Index (MI = gonad weight/body weight X 100).

Catch per unit effort (CPUE) estimates as the number of charr caught per net day, for the Fish Lake program were calculated from the net set records of the monitors and the mean CPUE was calculated from the individual net sets. During the summer program in 1996 and 1997, CPUE was calculated using net set times and catch information obtained by the interviewing of fishers by the fisheries monitor. Information about the number of active fisherman and total harvest values for both the Fish Lake and summer fishery were obtained from the Inuvialuit Harvest Study.

The Holman charr fishery was divided into three zones for this study. Zone 1 referred to the Fish Lake fishery, zone 2 referred to the coastal fishery from the mouth of the Kuujjua River on Minto Inlet to an area approximately 100 km east of Holman and zone 3 referred to the coastal fishery along Prince Albert Sound east of zone 2 (fig. 18).

In early August of 1996 some angling was done in Fish Lake during a water quality study. Two Arctic charr which appeared to be current year spawners were caught. Maturity index data from these two charr were used for comparison purposes in this study.

4.4 Results:

Holman Charr Harvest

According to the Inuvialuit Harvest Study, the average annual subsistence Arctic charr harvest at Holman from 1988 to 1996 was 8,098 charr, from 1988 to the closure of Fish Lake in 1993 the average harvest was 6,892 charr. During the same period the average harvest for zone 1 (Fish Lake) was 2,942 and the average harvest for zone 2 was 3,631 charr. After the closure of the Fish Lake fishery the average community harvest was 9,606 charr and the average zone 2 harvest was 5,608 charr. Both the total community harvest and the zone 2 harvests increased after the closure of Fish Lake (fig. 18). The charr harvest in zone 3 (Prince Albert Sound) increased markedly after the closure of Fish Lake (fig. 18).

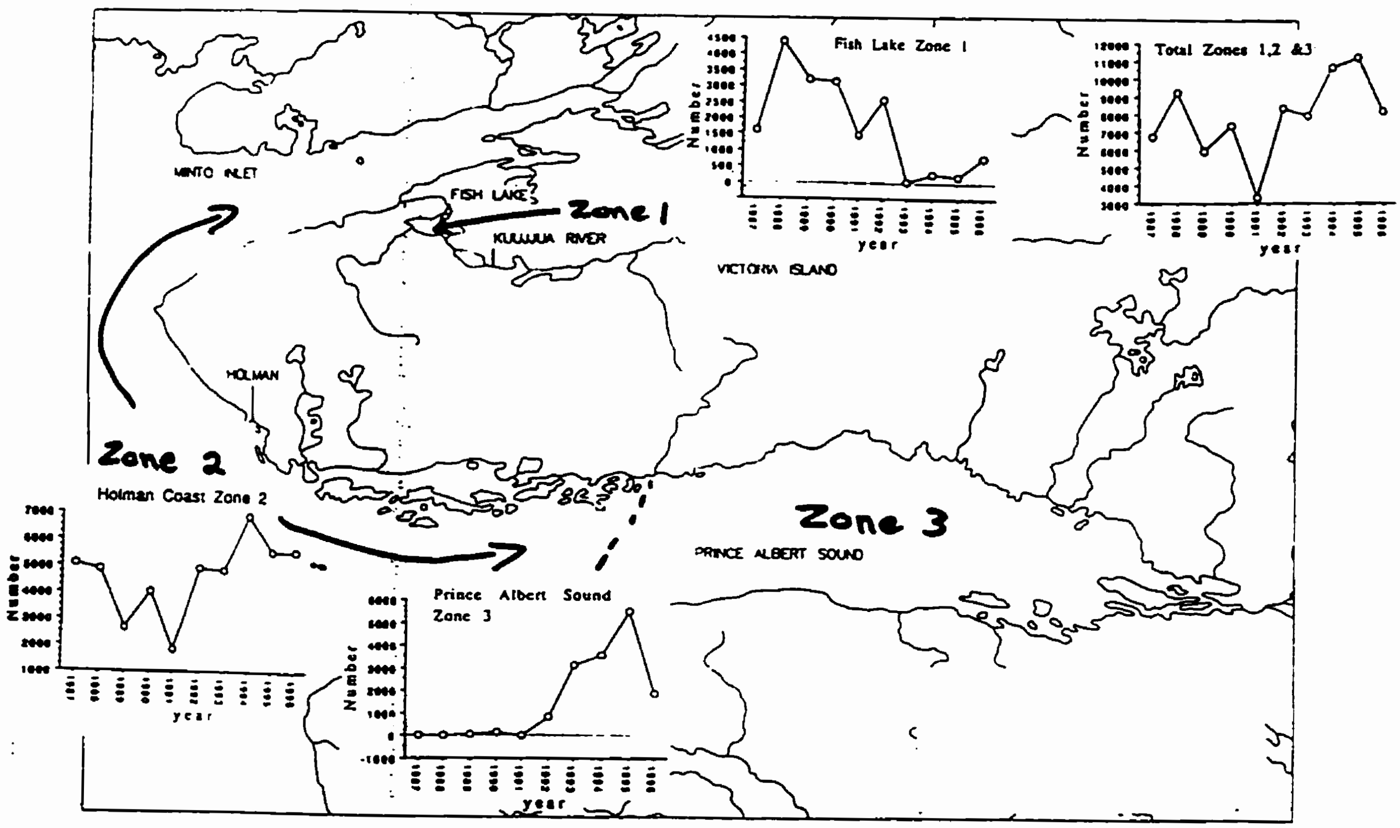


Figure 18. Subdivisions of fishing regions surrounding the Holman area, including zone 1, zone 2 and zone 3 with annual harvest levels from 1987 to 1996.

Zone 1 - Fish Lake

Catch and Effort

Numbers of fishers active in the zone 1 Fish Lake fishery has remained relatively constant since the early 1970's (fig. 19). The number of charr caught by fishers has varied between approximately 250 to 75 charr per fisher, from the 1970's to the closure of Fish Lake (fig. 19). Changes in the number of fishers appeared not to be correlated with changes in the number of charr caught per fisher (fig. 19).

Harvest levels for the time period from 1988 to the closure of the fishery after the 1992 season ranged from 4,386 to 1,465 charr with an average harvest of 2,943 charr per year (fig. 18). Following the community closure of the zone 1 fishery in 1993, no charr were harvested that year. In 1994, 274 charr were taken as part of the fisheries monitoring program and in 1995, 262 charr were taken as part of the same study. In 1996 a limited opening of the fishery took place with a harvest of 769 charr.

Catches for the monitoring program (1991 to 1997) ranged from 140 to 274 charr. The mean number of charr caught per net day as part of the monitoring program ranged form a low of 1.6 in 1991 to a high of 20.9 in 1994 (table 5). The number of net sets varied among the years of the monitoring program from a low of 23 in 1992 to a high of 49 in 1995 (table 5). In 1996 only 4.5 inch mesh nets were used. The number of charr caught per net day varied markedly among sets for each of the years (table 5). The relative ranking of the years by catch per unit effort did not change markedly with mesh size (table 5).

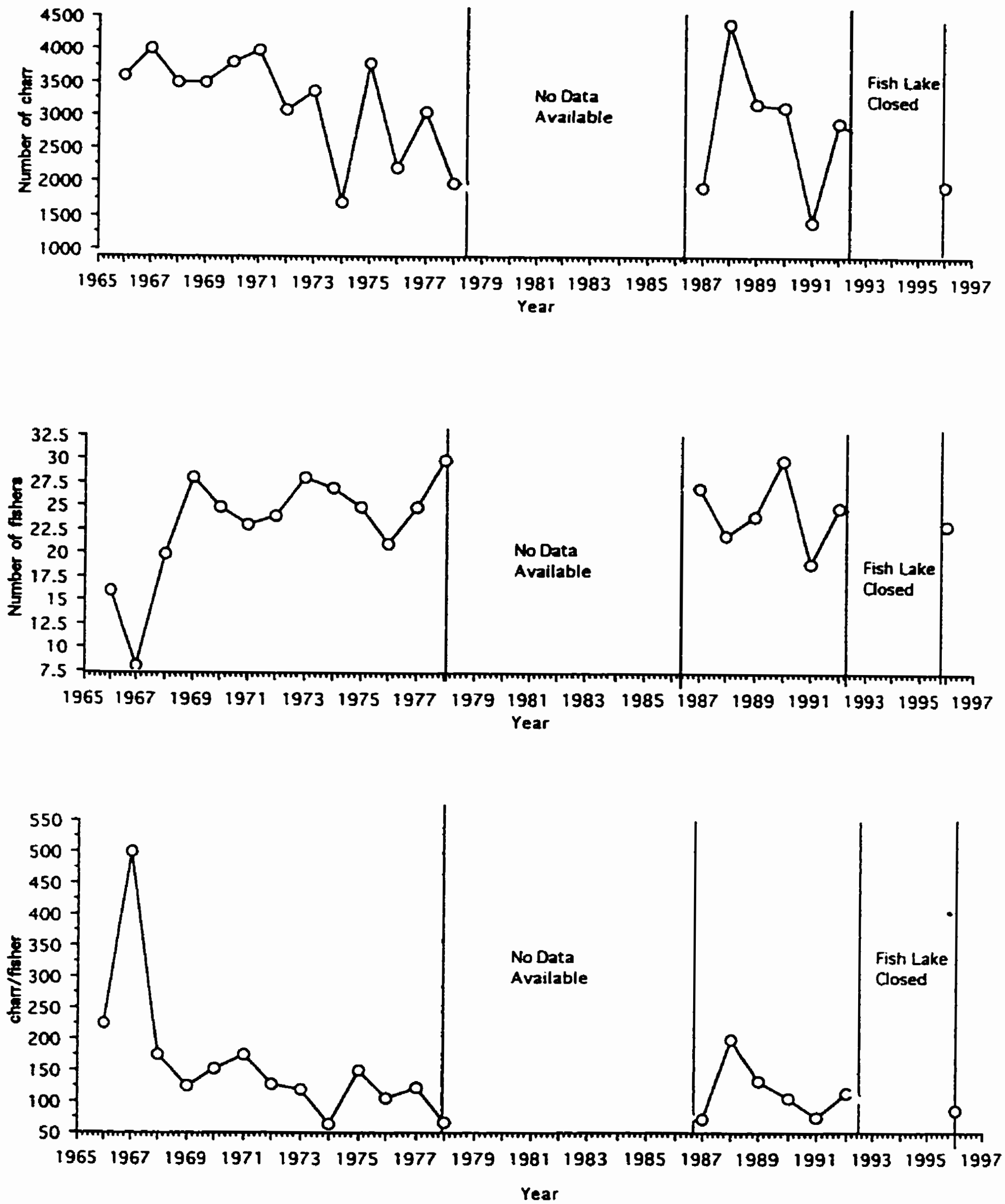


Figure 19. Data from the zone 1 Fish Lake fishery showing the number of charr, fishers and charr per fisher for 1966 to 1978 (Lewis et al., 1989) and from 1987 to 1997 (Fabijan, 1996).

Table 5. Number of net sets and mean catch per unit effort (CPUE) as charr per net day (minimum-maximum), for the Fish Lake monitoring program 1991 to 1997, by net mest size.

	4.5 Inch Mesh Net		5.0 Inch Mesh Net		Combined	
Year	Sets	CPUE	Sets	CPUE	Sets	CPUE
1991	30	2.0 (0.0-5.9)	13	0.8 (0.0-2.0)	43	1.6 (0.0-5.9)
1992	16	2.8 (0.5-12.0)	7	1.8 (0.3-6.2)	23	2.5 (0.3-12.0)
1993	-	-	-	-	-	-
1994	6	9.3 (4.0-16.0)	20	12.4 (3.1-27.3)	26	11.6 (3.1-27.3)
1995	40	5.0 (3.0-27.3)	9	2.4 (0.0-23.4)	49	4.5 (0.0-23.4)
1996	25	20.9 (2.7-60.8)	-	-	25	20.9 (2.7-60.8)
1997	18	7.4 (1.3-17.4)	7	13.0 (0.0-27.0)	25	9.0 (0.0-27.0)

Biological Characteristics

The mean age of the Fish Lake monitoring program catch varied little over the six years of the program (table 6). Age of full recruitment into the fishery ranged from 8 to 10 years of age (table 6). In most years the youngest charr entering the zone 1 fishery were 6 years of age, charr were fully recruited by age 10 and few charr over 15 years of age were caught (table 6). Annual survival rate estimates from age 10 to 15 years were similar in each year (table 6). The lowest annual survival rate estimate was 0.46 in 1995 and the highest estimated annual survival rate of 0.55 occurred in 1992.

Examination of the catch data by cohort suggest that the surviviorship of cohorts after entering the fishery were similar (table 7). The age of full recruitment of the cohorts differed amongst the years. Few cohorts are represented in the catch after reaching 15 years of age.

The mean individual charr weight generally increased over the sampling period, although the increase was not marked (table 6). Mean fork length also increased over most of the sampling period with the lowest mean fork length of 515 mm in 1991 and the highest mean fork length of 589 mm occurring in 1996 (table 6). The modal fork length has gradually increased since the zone 1 fishery was closed in 1993, fewer fish 400 mm or less were caught after 1992 (table 8). The 1992 monitoring catch contained the smallest charr (200 to 250 mm) caught in the monitoring program (table 8). Few charr larger than 700 mm were caught in Fish Lake. The majority of the charr caught were between 450 and 600 mm in length (table 8).

A trend toward a larger mean fork length and a reduced number of smaller charr in the catches was observed from 1992 to 1997 (fig. 20). In comparison the 1992 weir sample of 2,358 charr had a mean fork length of 453 mm with a modal length of 400 mm (fig. 20).

Generally there were equal numbers of male and female charr in the whole fish sub-samples form the Fish Lake fishery (table 9). In 1997 there were fewer females than males, in 1994 there were more females then males

Table 6. Fishing effort (net days), catch (number of charr), Catch per unit effort (charr/net day), catch at age, mean age, mean weight, mean fork length and estimated annual survival rates (ages 9 to 18), with 95% confidence limits for zone 1 Fish Lake fishery monitoring program 1993 to 1997. For comparison 1978 data from Lewis et al., 1989.

Year	1978	1991	1992	1994	1995	1996	1997
Effort		98.8	70.2	22.7	63.3	34.9	22.9
Catch	164	140	223	274	262	234	200
CPUE		1.42	3.18	12.07	4.14	6.71	8.73
Age							
4	0	0	3	0	0	0	0
5	0	0	6	2	0	0	0
6	2	3	6	1	13	1	2
7	7	15	13	6	35	6	15
8	45	28	29	42	44	23	51
9	38	30	50	67	78	66	43
10	40	31	56	71	46	70	47
11	15	19	22	43	26	36	19
12	7	5	18	28	12	10	9
13	6	2	6	7	7	12	4
14	1	2	5	4	0	4	5
15	3	1	4	1	1	5	0
16	0	2	4	2	0	0	1
17	0	0	0	0	0	1	0
18	0	1	0	0	0	0	0
19	0	0	1	0	0	0	0

Mean age of individuals in catch

1978	1991	1992	1994	1995	1996	1997
9.4	9.5	9.7	9.9	9.1	10.0	9.4

Mean weight (kg) of individuals in catch

1978	1991	1992	1994	1995	1996	1997
2.00	1.96	1.87	2.27	2.11	2.73	2.22

Mean fork length (mm) of individuals in catch

1978	1991	1992	1994	1995	1996	1997
539	554	515	553	542	589	580

Estimated annual survival rate (95% confidence limits)

1978	1991	1992	1994	1995	1996	1997
0.48	0.50	0.55	0.50	0.46	0.49	0.47
(0.57)	(0.59)	(0.61)	(0.55)	(0.53)	(0.56)	(0.55)
(0.40)	(0.41)	(0.49)	(0.44)	(0.38)	(0.42)	(0.39)

Table 7. Catch (number of charr) and age (years) for different cohorts (year hatched) from the zone 1 Fish Lake winter monitoring program 1991 to 1997.

	Catch (age)						
Cohort	1981	1982	1983	1984	1985	1986	1987
Year							
1991	31(10)	30(9)	28(8)	15(7)	3(6)	0(5)	0(4)
1992	22(11)	56(10)	50(9)	29(8)	13(7)	6(6)	0(5)
1993	-	-	-	-	-	-	-
1994	7(13)	28(12)	43(11)	71(10)	67(9)	42(8)	15(7)
1995	0(14)	7(13)	12(12)	26(11)	46(10)	78(9)	51(8)
1996	5(15)	4(14)	12(13)	10(12)	36(11)	70(10)	49(9)
1997	1(16)	0(15)	5(14)	4(13)	9(12)	19(11)	47(10)

Key

____ Referance to year class moving through fishery

31(10)

Number of charr (Age of charr in years)

Table 8. Fork length interval, mean fork length of catch (plus or minus standard deviation), modal length and coefficient of variation (CV = standard deviation/mean X100) for the fork length distributions from the monitoring program catches from zone 1 Fish Lake.

Fork Length Interval mm	1978	1991	1992	1994	1995	1996	1997
200	0	0	4	0	0	0	0
250	0	0	6	0	0	0	0
300	0	0	7	0	0	0	0
350	1	0	8	1	0	0	0
400	24	2	14	9	18	2	0
450	102	29	60	41	54	7	5
500	160	28	64	90	80	59	68
550	101	31	29	98	70	73	73
600	55	18	21	40	35	65	59
650	30	10	16	17	10	27	418
700	21	2	6	3	2	7	6
750	11	2	3	0	0	1	1
800	4	0	0	0	1	1	0
850	2	0	0	0	0	0	0
Catch	511	142	258	299	270	242	230
Mean	555	554	515	553	542	589	580
(S.d)		(64.7)	(103.2)	(59.3)	(64.0)	(59.1)	(54.1)
Mode	525	510	500	510	584	620	540
C.V.		11.7	20.1	10.7	11.8	10.0	9.3

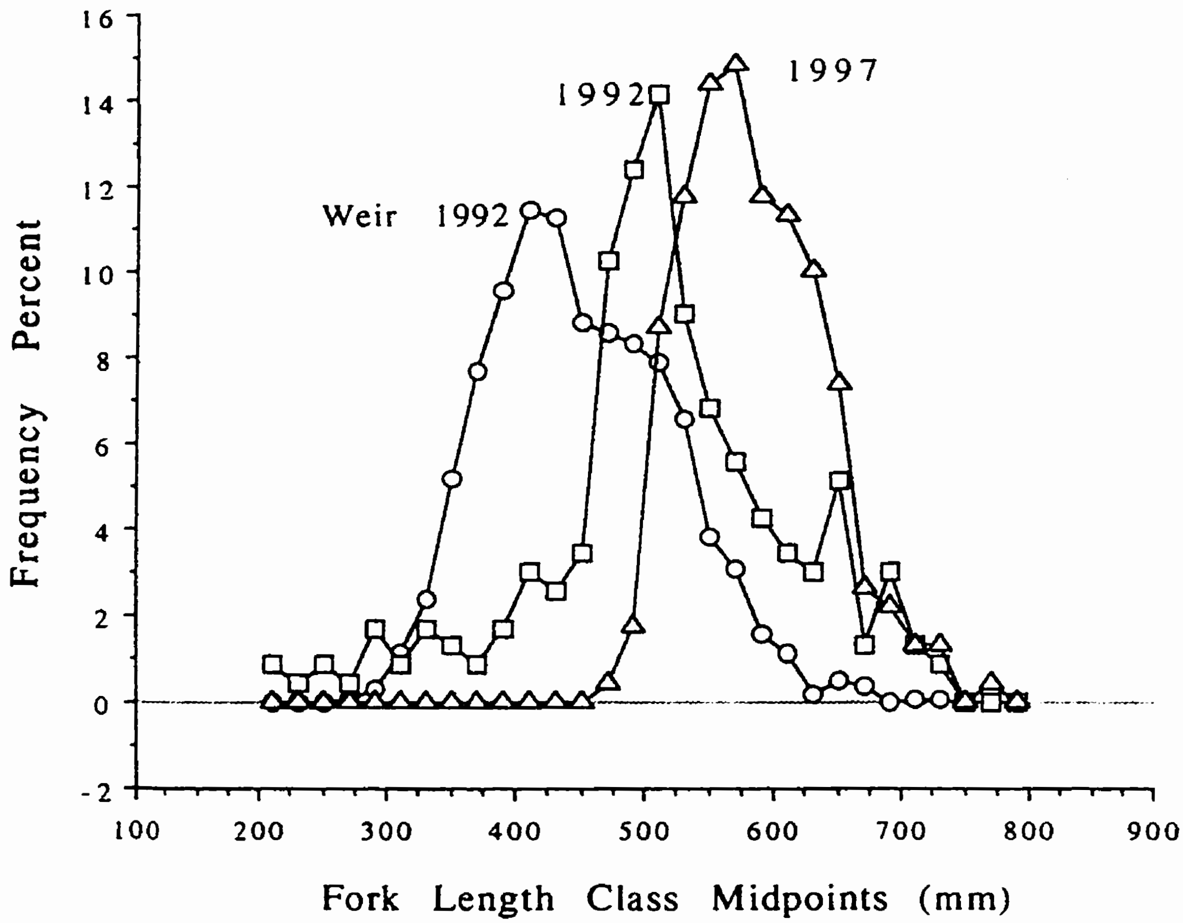


Figure 20. Length-frequency distributions of the Fish Lake monitoring program catch 1992 (n=223), 1997 (n=230), and the random sample from the 1992 weir (n=2287).

Table 9. Results of random sampling of monitoring catch, mean length (mm), mean weight (gm), mean age (years), mean Maturity Index (MI=gonad weght/body weight X 100) and percent females in the sample.

Year	Males		Females		%Females
	Number	Mean (Min.-Max.)	Number	Mean (Min.-Max.)	
1991	15	0.08 (0.04-0.32)	20	0.68 (0.18-5.05)	57.1
1992	15	0.06 (0.02-0.23)	19	0.51 (0.16-1.21)	55.9
1993	-	-	-	-	-
1994	11	0.12 (0.06-0.31)	23	0.58 (0.16-2.01)	67.7
1995	17	0.06 (0.04-0.09)	18	0.32 (0.14-0.89)	51.2
1996	18	0.07 (0.04-0.14)	24	0.48 (0.19-0.96)	57.1
1997	19	0.04 (0.04-0.21)	11	0.43 (0.20-0.69)	36.7

(table 9). Only a few charr had Maturity Index values higher then 1.0% (fig. 21). Females tended to have higher maturity Index values then males. The two charr caught during the August water sampling in 1996 were both female and had Maturity Index values of 4.4 and 8.5 %. By comparing these Maturity Index values to those obtained in the fishery sub-sample, it would appear that the zone 1 fishery mostly catches immature or resting charr.

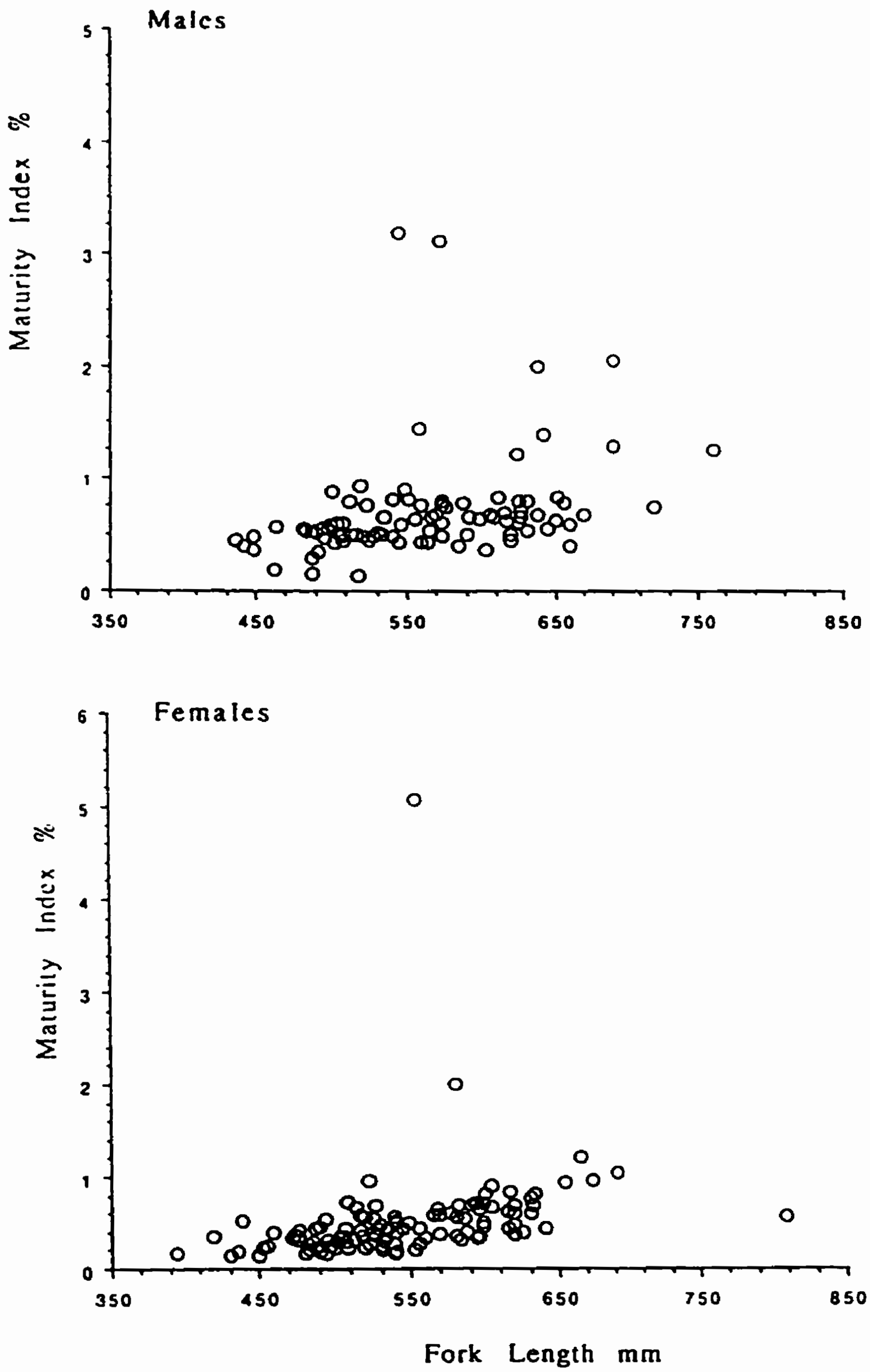


Figure 21. Maturity Index (gonad weight/body weight X 100) versus fork length (mm), for male and female Arctic charr from the Fish Lake monitoring program random samples 1991 to 1997.

Holman Summer Coastal Fishery - Zone 2

Catch and Effort

Based on the Inuvialuit Harvest study, the total number of fishers reporting for the summer months of June, July and August has generally increased each year since 1989, with slight decreases occurring in 1991 and 1995 (fig. 22). The total number of charr reported caught by these fishers followed a similar pattern with the exception that the number of charr caught in 1996 was only slightly higher then in 1995 (fig. 22). The lowest number of charr per fisher occurred in 1991 (fig. 22). The highest number of charr per fisher occurred in 1992 (fig. 22). Charr per fisher increased slightly in 1994 but has been decreasing since 1994 (fig. 22).

The community-based monitoring program began collecting CPUE data for zone 2 in 1996 and 1997. These preliminary results indicate the same trend of decreasing CPUE as the Inuvialuit Harvest Study. From 1996 to 1997 effort increased from 184.9 net days to 265.3 net days and CPUE decreased from 18.45 charr/net day to 10.57 charr/net day (table 10).

Biological Characteristics

The mean age of the catch sample from the summer zone 2 fishery was almost constant during the coastal monitoring program from 1993 to 1997 (table 10). The mean individual charr weight and fork length in the catch increased from 1993 to 1997 (table 10).

Charr generally enter the fishery after age 7 years, although some charr at age 6 years or younger were caught in the fishery (table 10). Charr were

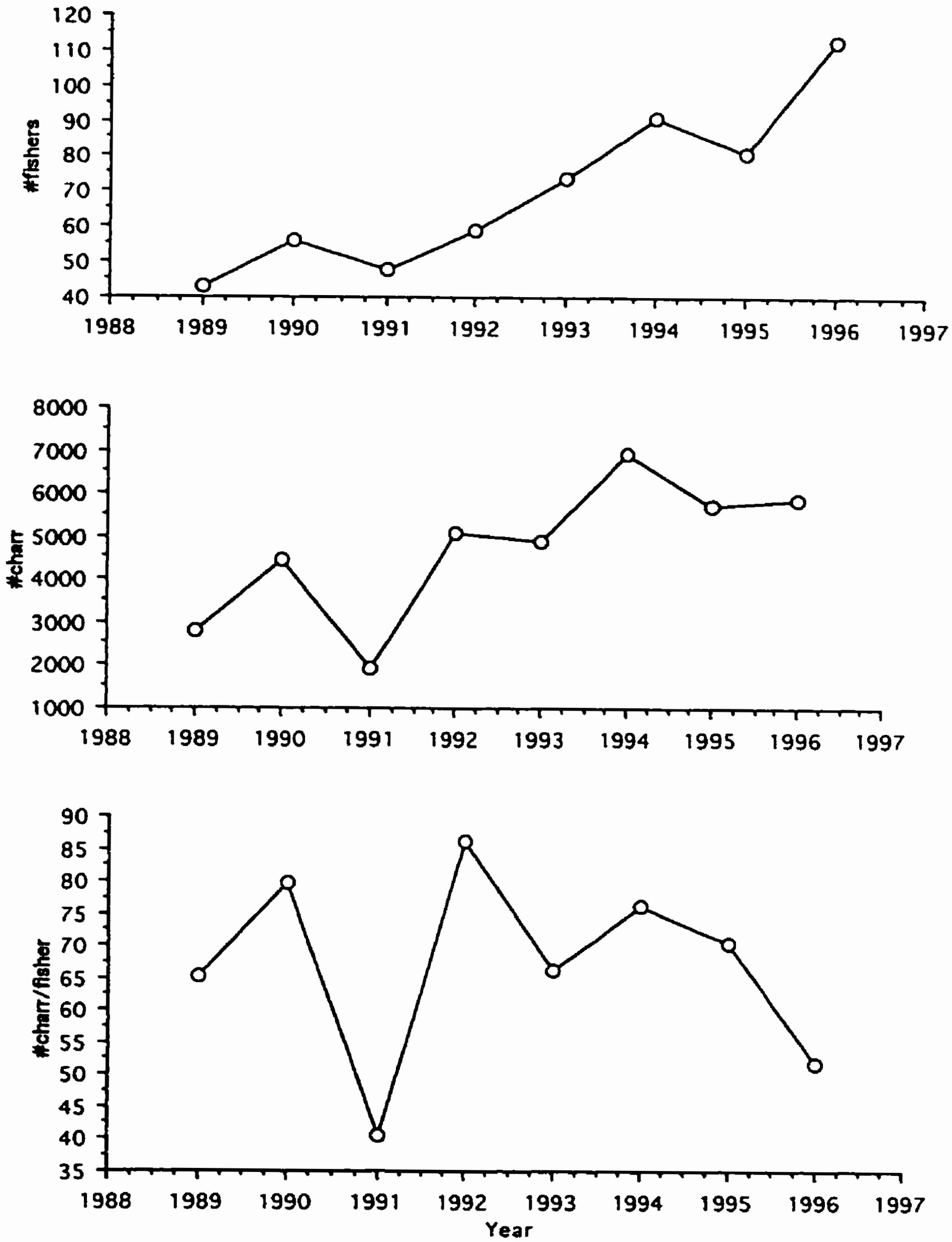


Figure 22. Data from the zone 2 summer fishery showing the number of charr, fishers and charr per fisher from 1989 to 1996 (Fabijan, 1996).

Table 10. Fishing effort (net days), catch (number of charr), Catch per unit effort (charr/net day), catch at age, mean age, mean weight, mean fork length and estimated annual survival rates (ages 9 to 18), with 95% confidence limits for the summer coastal Holman fishery monitoring program 1993 to 1997 (1978 &82 from Lewis et al., 1989).

Year	1978	1982	1993	1994	1995	1996	1997
Effort	-	-	-	-	-	184.9	265.3
Catch	-	-	-	-	-	3412	2805
CPUE	-	-	-	-	-	18.45	10.57
Age							
4	0	0	1	0	0	0	0
5	0	0	0	2	0	0	0
6	0	0	0	4	1	2	0
7	0	0	4	17	5	5	7
8	1	1	12	25	27	18	5
9	3	0	32	50	28	59	10
10	10	9	19	47	28	32	13
11	7	35	9	31	18	24	6
12	5	37	5	14	9	7	5
13	13	27	2	15	3	5	1
14	8	6	3	8	0	1	2
15	15	2	0	2	0	1	3
16	9	0	0	4	0	1	0
17	6	2	0	1	0	0	0
18	2	0	0	1	0	0	0
19	1	0	0	0	0	0	0
20	2	0	0	0	0	0	0
	Mean age of individuals in catch						
	1978	1982	1993	1994	1995	1996	1997
	14.6	12.0	9.6	10.0	9.5	9.7	10.0
	Mean weight (kg) of individuals in catch						
	1978	1982	1993	1994	1995	1996	1997
	4.08	3.37	1.88	2.29	2.20	2.79	2.85
	Mean fork length (mm) of individuals in catch						
	1978	1982	1993	1994	1995	1996	1997
	694	632	512	548	559	602	612
	Estimated annual survival rate (95% confidence limits)						
	1978	1982	1993	1994	1995	1996	1997
	0.36	0.66	0.50	0.56	0.44	0.47	0.59
	(0.30)	(0.61)	(0.30)	(0.50)	(0.34)	(0.39)	(0.47)
	(0.42)	(0.71)	(0.62)	(0.62)	(0.54)	(0.56)	(0.71)

generally fully recruited into the fishery by age 9 years of age. Few charr older than 13 years of age were caught in the zone 2 summer fishery (table 10). Estimates of annual survival rates for charr aged 10 to 15 years of age, ranged from 0.44 to 0.56 (table 10).

4.5 Discussion

Arctic charr are fully recruited to the Holman fishery by age 9 or 10 and few charr older than 15 years are caught. The community monitoring program helped define the biological characteristics of the Holman fishery. The fishery primarily recruits fish which have a fork length of 450 mm or larger. A comparison of the weir catch and the results of the monitoring program in Fish Lake in 1992 suggests that the fishery is biased toward these larger sized fish. Although there was not a marked change in the mean age of the catch from 1991 to 1997, there was a noticeable increase in the mean fork length and weight of charr caught. Based on the comparison of the monitoring and weir data, this increasing size may have resulted from the progressive recruitment of the 375 to 425 modal group of charr observed in the weir sample. As these charr grew they were recruited into the fishery and the modal size of the fishery increased as these fish grew. If this interpretation of the catch data is correct, the increased size of charr in the catch and the increased CPUE observed in the monitoring program may have resulted from this recruitment, and if so, individual size and CPUE may decline as this modal group matures. It is important to note that this interpretation of the monitoring data was made possible because of the availability of the weir data, pointing to the importance of having studies like the Holman weir project to complement community monitoring data.

Increased CPUE and the increased individual size of charr in the catch at Fish Lake may also have resulted from the closure of Fish Lake to fishing from 1993 to 1995, however estimates of annual survival rates for fully recruited charr from the monitoring catch data did not change markedly during the monitoring program. Since the annual survival rate results from the sum of the natural mortality and fishing mortality, survival estimates from the catch data would appear to suggest that mortality rates for fully recruited charr were not significantly effected by the closure of Fish Lake. Estimates of survival rates calculated from the results of the tagging study were similar to the estimates from the catch data (chapter 5). Increased harvesting of charr along the coast in the years following the closure of Fish Lake may be the reason for the lack of change in survival estimates, since the Fish Lake charr stock is thought to make up at least 50% of the Holman coastal charr complex (Harwood, 1993). Alternatively the lack of change observed in survival rates may have resulted from the relatively short period of time the monitoring program has been collecting data since the closure.

Analysis of the catch data by age cohort might have provided insight into the impact of the closure of Fish Lake but the lack of data prior to the closure and the lack of data for 1993, the first season the lake was closed, makes such an analysis difficult. As monitoring data is collected, post closure analysis of age cohorts from the catch might provide more insights into the effects the closure had. Recruitment in 1994 of the 1984 year class cohort and the recruitment in 1995 of the 1986 year class appeared to be markedly higher then recruitment's prior to the closure. There appeared to be a shift in the age of full recruitment following the closure from age 10 to age 9 to 8. This shift in age of full recruitment was consistent with the general shift of the catch after 1992 from containing significant numbers of smaller young fish to containing limited numbers of large young fish. As with the other trends noted in the catch data, this shift may have resulted from the recruitment of the 375 to 425 mm fish observed at the weir or may have resulted from the closure of Fish Lake or perhaps as a result of both.

When monitoring data from 1991 to 1997 is compared to earlier DFO records there is indication that for some characteristics, the Holman stock complex has responded to heavy exploitation. The zone 1 winter fishery shows a decline in catch levels over the 5 years prior to the closure of the fishery (1988 to 1992). The number of charr caught per fisher has also declined during this time period. Age and length class representation shows less variation in range and a shift to smaller, younger fish since 1987. Although catch levels have increased in zone 2 from 1992 to 1996, there has also been a significant increase in fishing effort resulting in declining charr caught per fisher over the last 5 years. Age and length frequency distributions have also declined in zone 2 since 1978. These results indicate that there has been a long term removal of larger, older charr from the Holman fishery.

The community-based monitoring data does show an increase in charr size over the last 5 years in zones 1 and 2. However, age distributions and range have remained lower than earlier DFO records. The shift to lower age classes may indicate that recruitment over fishing has occurred. In addition, the more recent shift upward in fish size while age remains low, is consistent with growth over fishing of a stock (Gulland, 1983; Sutherland, 1990).

The overall lack of spawners caught in the fishery suggests that the spawning charr and non-spawning charr may have different migrations and that the spawning charr are not subjected to fishing pressure in their spawning year. Johnson (1989) concluded that in some charr populations the current year spawners remain in freshwater the year before spawning. This might explain the absence of spawners in the fishery. Regardless of the reason, it is important to the management process that the monitoring program has found that the fishery rarely contains current year spawners. The important question of how many of the non-spawners have spawned prior to being caught remains to be answered.

Harvest levels from zone 3 have been significant in sustaining the charr requirements of the community. This is particularly true during the zone 1 closure. Since future needs and demands are not expected to decrease, the zone 3 fishery will continue to be an important contributor to the Holman annual harvest. For this reason it would be beneficial to expand the community-based monitoring program to include information on the zone 3 fishery.

Results of the Holman Community Fisheries project demonstrates that community-based programs can collect useful fisheries data on which management decisions may be based. The results also demonstrated the usefulness of having complementary fisheries programs such as the weir and tagging programs operating in conjunction with the monitoring program. These complementary programs provided data essential to the interpretation of the monitoring information. It is clear from the Holman experience that an accurate and long term harvest study, was an essential part of the monitoring program. Studies like the Inuvialuit Harvest Study provide valuable information on the numbers of charr harvested and fishing locations. Analysis of the Holman monitoring data also demonstrated the need for consistency in the collection of data. This was perhaps most critically demonstrated with efforts to collect CPUE data and by the decision not to monitor Fish Lake in 1993. In planning monitoring programs, determining gear size, fishing location and target catch sizes are critical to the programs success. It is clear from the analysis of the existing Holman monitoring data that the real "strength" of the program will only be realized after many years of consistent data collection. For example the final interpretation of the effects of the closure of the Fish Lake fishery and the effects of the apparent recruitment after 1992 of the 375 to 425 mm group will not be possible till after several more years of data has been collected.

4.6 Conclusion:

Community-based fisheries monitoring data proved to be useful in defining what is caught by the fishery. This information is important to fishery managers since is allows an assessment of how fishing activities impact the population. Age structure information generated by the monitoring program is a useful indicator to assess the effectiveness of management measures. For example, survival rates calculated from the age structure of the catch indicates that the closure of Fish Lake had a minimal impact on the stock due to the uncontrolled fishing effort along the Holman coast. This information is useful for directing future management efforts such as imposing harvest limits on both the Fish Lake winter fishery and the summer coastal fishery to improve the the effectiveness of conservation efforts.

The evaluation of the community-based monitoring program also demonstrated the advantages associated with periodic extensive scientific assessment programs. Intensive assessment measures such as the weir and tagging projects, when linked to consistent ongoing community-based monitoring, worked to improve the collective understanding of the charr stock. The importance of the Inuvialuit Harvest Study was also demonstrated by the critical contributions it made to data interpretation. Future recommendations to improve the community-based monitoring program would be to standardize sample sizes to improve cohort analysis, standardize the measure of CPUE in both zones 1 and 2, and to complement monitoring data with intensive scientific evaluations and harvest studies.

Chapter Five - Tagging Program

5.1 Introduction

Tagging programs or mark and recapture experiments, have been widely used in the study of many fish populations (Ricker, 1975; Seber, 1982; Gulland, 1983; Hilborn and Walters, 1992). A sample or proportion of fish from a given population can be tagged and released back into the larger population to derive estimates on abundance, rate of exploitation, rate of survival and mortality rates. Such estimates can be useful in the formulation of future stock management strategies. A variety of marking and recovery procedures can be used for any given tagging program, and consequently the subsequent statistical estimates must be suited to or adjusted to accommodate these different conditions. Therefore, the design of a tagging program should be carefully planned prior to initiation of the project. The designs of many tagging programs rely on catch data from a fishery to obtain recaptures of tagged fish over time. Often these types of tagging designs require statistical adjustments for both size selection bias in fishing gear as well as for temporal correction factors (Ricker, 1975). The cumulative effects of statistical adjustments in tagging data are increased error and a higher degree of uncertainty surrounding any conclusion based on the analysis. The purpose of this chapter is to examine whether data produced by the Holman tagging project provided useful information about the Kuujjua charr population and community-based monitoring.

A number of important assumptions are made when using the Peterson method of analysis (Ricker,1975). In order to produce a reliable estimation the following conditions should be satisfied:

1. The marked fish suffer the same natural mortality rate as the unmarked;
2. The marked fish are as vulnerable to the fishing as unmarked fish;
3. The marked fish do not lose their mark;
4. The marked fish become randomly mixed with the unmarked fish;
5. All marks are recognized and reported on recovery; and
6. There is only a negligible amount of recruitment to the catchable population during the time the recoveries are being made.

To make a tagging experiment representative either the tagged fish or the total fishing effort should be randomly distributed over the population being studied. Unequal vulnerability of different sized fish to fishing gear (i.e., selective or non random fishing effort) is a source of systematic error in population estimates (Ricker, 1975). Variation in vulnerability with size and its effects on subsequent estimates can be minimized by excluding from consideration fish near the limits of vulnerability to any given type of fishing gear. In addition, error due to recruitment may also effect subsequent population estimates. This type of error may be avoided by making allowances for fish growth and confining the marking or calculations to a restricted segment of the population which is vulnerable to recapture. Fish which are incompletely recruited have a fishing mortality rate less than the maximum or definitive rate, since some of their members are too small to be consistently taken by the kind of fishing gear in use. This being true, their total mortality should be less than the definitive rate, other things being equal. When recruitment occurs abruptly, tagging experiments should make adjustments to avoid smaller fish so that they will not be confounded with fully vulnerable fish in the analysis.

In situations where the average length of the catch is somewhat greater than that of the group tagged, in order to obtain an estimate of stock abundance the number of tags released should be reduced by an approximate factor obtained by superimposing the two size frequency distributions of tagged fish and the fishery. This will allow for the calculation of percent units of tagged fish which were not vulnerable for recapture in the fishery. Therefore, the total number of available tags can be reduced by this percentage (Ricker, 1975).

5.2 Background

In 1991 the community of Holman became concerned about the status of the Kuujjua River charr stock due to a record low harvest, coupled with smaller fish sizes. In response to this concern, in 1992 the FJMC and DFO installed a full span conduit weir on the Kuujjua River below Fish Lake where charr are believed to over-winter. The full span conduit weir was in operation from August 11 to September 8, 1992 and is believed to have intercepted the complete run. The weir project was used to enumerate the Kuujjua River charr stock and to initiate a tagging program for the population. The weir project provided a count of 10,493 upstream migrants.

During the time the weir was in operation a random sample of 2,334 charr were measured to obtain a record of fish fork length. Of these 2,334 charr, 991 tags were placed on the dorsal flesh of the charr and they were released. However, the tagged sub-sample of charr was not chosen in a random fashion as the larger weir sample had been, but rather it was a stratified sample based on size.

In October of 1992 the traditional community subsistence winter fishery took place, harvesting 2,466 charr at Fish Lake using 4.5 to 5.0" mesh nets. The community-based monitoring program provides a fork length frequency distribution of charr caught using the same fishing gear employed by the subsistence fishery. Based on the 1992 winter monitoring the mean fork length of charr in the 1992 winter fishery was found to be 531 mm.

In the spring of 1993 an additional sample of 570 charr were captured at the mouth of the Kuujjua River by angling and sein nets. An additional 487 charr were tagged.

5.3 Methods

Results used for this study were obtained from community tag returns, community-based monitoring data and total harvest levels from the Inuvialuit Harvest Study. Utilizing this data, population estimates were derived using Peterson Point estimates provided by Ricker (1975) and shown here as equation 1:

Equation 1. $$N = MC/R$$

Where N is the estimated size of the population at time of marking, M is the number of fish marked, C is the size of the catch or sample taken for census and R is the number of recaptured marked fish in the sample.

An estimate of rate of exploitation "u", is given by equation 2:

Equation 2. $$u = R/M$$

Correction factors also described by Ricker (1975) were used to adjust population estimates influenced by biased resampling procedures. In addition, exploitation rates, survival rates, and mortality rates were estimated for the Kuujjua River stock using temporal correction factors outlined by Ricker (1975).

Growth data was obtained from a sample of tagged charr for which length information at the time of tagging and at the time of recapture was available. A Ford-Walford Plot was constructed to obtain a growth function (Gulland, 1983). This growth function estimate was used to adjust the size distribution of 1993 spring tagged charr for the years following the initial tagging. This procedure allowed the total number of 1993 spring tags available for recapture in the 1994 and 1995 fisheries to be estimated.

5.4 Results

The initial 1992 fall tagging at the weir and subsequent resampling during the 1992 winter fishery was not random. The mean fork length of the weir sample was 453 mm while the mean fork length of the tagged fish was 514 mm. Fish under 420 mm were not tagged at the weir. An overlay of the size frequency distributions for the 1992 upstream migrants, the 1992 fall weir tags and the 1992 winter fishery show that there was a strong bias towards larger sized fish in both the placement of tags as well as in the winter fishery (fig. 23). Therefore, the estimates derived using the 1992 fall tags and catch data from the 1992 winter fishery do not accurately reflect the population as a whole. However, since both tagging and resampling targeted the same portion of the population, error is reduced by considering only the larger size class segment rather than the whole population. The abundance estimate for this portion of the population, using equation 1 was 12,085 charr, with a 95% confidence interval of 10,534 to 13,885. Similarly the exploitation rate on this segment of the population using equation 2 was 20.4% with a 95% confidence interval of 17.8% to 23.4%. These results indicate the 1992 weir count underestimated the abundance of Kuujjua sea migrants.

Tagging procedures employed in the spring of 1993 achieved a more random sampling of the Kuujjua run (fig. 24). There were 18 tags recaptured from the 1992 fall weir project, of which 17 were released back into the run. The recovery of 18 fall tags in a random sample of 570 charr during the spring of 1993 gives an abundance estimate of 25,016 charr, with a 95% confidence interval of 15,822 to 39,604. However, since a significant amount of time had passed since the original tagging (9 months) the assumption that zero mortality had occurred is likely violated. Therefore, a correction was made for natural mortality among fall tagged fish. In order to make this correction, survival and total mortality rates for fall tags were derived using a regression plot of log recaptures vs time. Survival., natural mortality and mean exploitation rates using the 1992 fall tag returns were found to 56.50%, 18.00% and 25.50% respectively (fig. 25). Table 11 was constructed based on this survival rate and shows the expected number of 1992 fall tags available for resampling in subsequent years after accounting for natural mortality and recoveries from the fishery. When the spring sampling abundance estimate using 1992 fall tags was adjusted for natural mortality it was found to be 20,963 charr, with a 95% confidence interval of 13,258 to 33,187.

As a result of the random methods employed in the 1993 spring tagging, tagged fish had a wider range of size classes representing the size composition of the original weir run (fig. 24). However, as a result of tagging smaller sized fish, a significant portion of tagged fish were too small to be vulnerable to recapture by the 1993 gill net fishery. To correct for the size selectivity of the fishing gear, the % frequency size distribution of 1993 spring tagged fish and the 1993 summer fishery were compared. The percent of smaller size classes not vulnerable for recapture in the summer of 1993 was found to be 33.74% (fig. 26). The abundance estimate for 1993 spring tags caught in the 1993 summer fishery adjusted for size selection was 22,033 charr, with a 95% confidence interval of 17,381 to 27,931. The exploitation rate after adjustment was 21.12% with a 95% confidence interval of 16.65% to 26.77%. This abundance estimate is similar to the one derived from the 1992 tags in the random 1993 spring sampling after adjusting for natural mortality.

The 1992 fall tag returns during the 1993 summer fishery were also used to calculate a third abundance estimate which was found to be 13,835 charr, with a 95% confidence interval of 12,052 to 16,055. The exploitation rate using the 1992 fall tags was found to be 33.6% with a 95% confidence interval of 28.9% to 38.5%. Once again these estimates only pertain to the larger size class segment of the migrant population.

A separate calculation of survival rate, mortality rate and mean exploitation was carried out using the 1993 spring tag recoveries (fig. 27 and table 12). The survival, natural mortality and mean exploitation rates were found to be 71.45%, 13.87% and 14.68% respectively. When compared to the 1992 fall tag estimates, the survival rate is significantly higher and the mortality and exploitation rates are significantly lower. The difference between these estimates could be attributed to the significant number of 1993 spring tagged fish which were too small to be vulnerable to the 1993 and 1994 fisheries. To account for the systematic error in unequal vulnerability, adjustments were made to correct for both size selectivity of fishing gear and recruitment of smaller 1993 spring tagged fish into the catchable size segment of the population. To adjust for the growth of smaller tagged fish, the increases in length per year for a sample of tagged charr was plotted against initial lengths at tagging (fig. 28). Using regression analysis, a growth function of "Growth = 184.935 - 0.273 * Initial Length"was determined ($p<.0001$, $R^2 = 0.619$).

Using the growth function, the predicted % frequency of 1993 spring tagged size classes by the years 1994 and 1995 was estimated (fig. 29). As a result, 42.44% of the remaining total spring tags were still not vulnerable for recapture in the 1994 fishery (fig. 30). Therefore, the total number of spring tags available for recapture in the year 1994 was reduced by 42.44%. By 1995, all tagged fish should have grown large enough to be vulnerable to the fishery.

During the summer of 1995 a sample of tagged charr was collected by community monitors and measured for length. This length information allows the predicted size frequency distribution of 1993 spring tagged fish in 1995 to be compared to the actual size distribution of recaptured 1993 spring tagged fish. Figure 31 shows that the two size distributions are reasonably close and that both would have been completely vulnerable to the fishing effort in 1995. Therefore, no adjustments were required for the tag returns in 1995 and 1996. Based on this information, the survival rate and the corresponding survival table was reconstructed correcting for the 33.74% of spring tags not available for resampling in 1993 and the 42.44% not available in 1994 (fig. 32 and table 13). The number of recaptures in 1993 and 1994 were adjusted accordingly. The results of this analysis estimated survival, natural mortality and mean exploitation rates to be 58.75%, 15.58% and 25.67% respectively.

No fishing or monitoring was carried out in the winter of 1993, therefore, the next possible abundance estimate was calculated for the 1994 summer fishery. The 1994 summer fishery harvest level of 6831 charr was higher than the 1993 summer harvest level of 4653. The 1994 tagging abundance estimates were also much higher at 24,811 with a 95% confidence interval of 20,117 to 30,605 based on the 1992 fall tags. An abundance estimate of 36,924 with a 95% confidence interval of 26,788 to 47,060 was calculated using the 1993 tags. By 1995 all 1993 spring tags would have grown large enough to be vulnerable to fishing effort. Therefore, both the 1992 fall tags and the 1993 spring tags should represent the larger size classes of the run and give similar abundance and exploitation estimates. The abundance based on the 1992 tags recaptured in 1995 was 29,579 charr, with a 95% confidence interval of 21,168 to 41,352 and with an exploitation rate of 19.10% and a 95% confidence interval of 13.66% to 26.69%. An abundance estimate of 28,024 charr, with a 95% confidence interval of 21,256 to 36,951 and an exploitation rate of 20.16% with a 95% confidence interval of 15.29% to 26.58% was calculated from the 1993 tag returns in 1995.

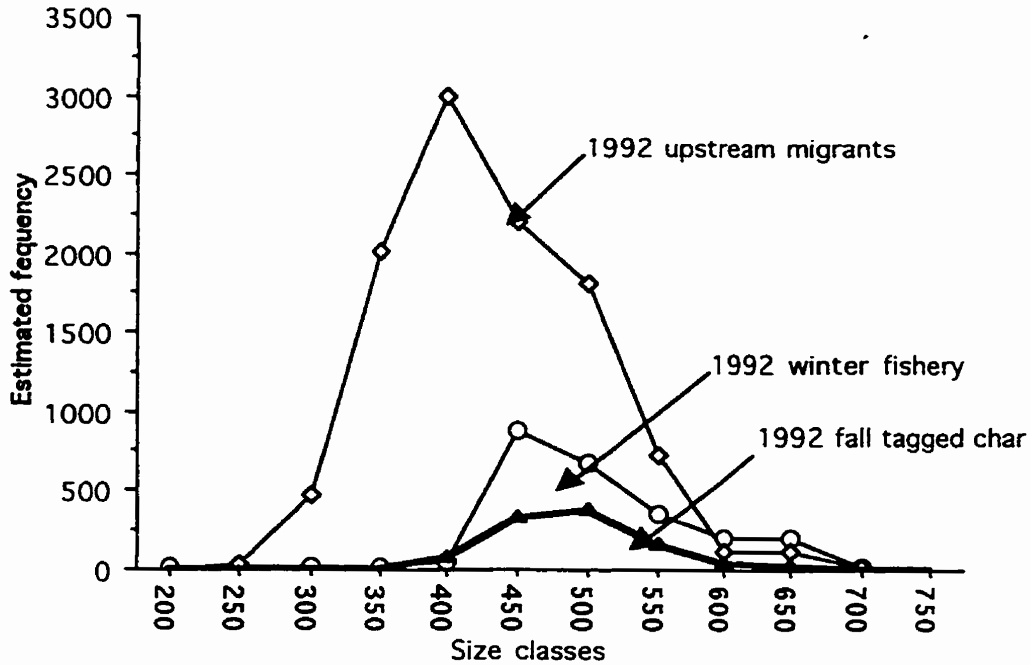


Figure 23. An overlay of the length frequency distribution of (a) the 1992 weir sample of upstream migrants from a sample of 2358 charr; (b) the 1992 winter fishery according to community-based monitoring and (c) the char tagged in the fall of 1992 at the weir. Length frequency distributions show a bias towards larger size classes in both the fall tagging and the subsequent sampling during the 1992 winter fishery.

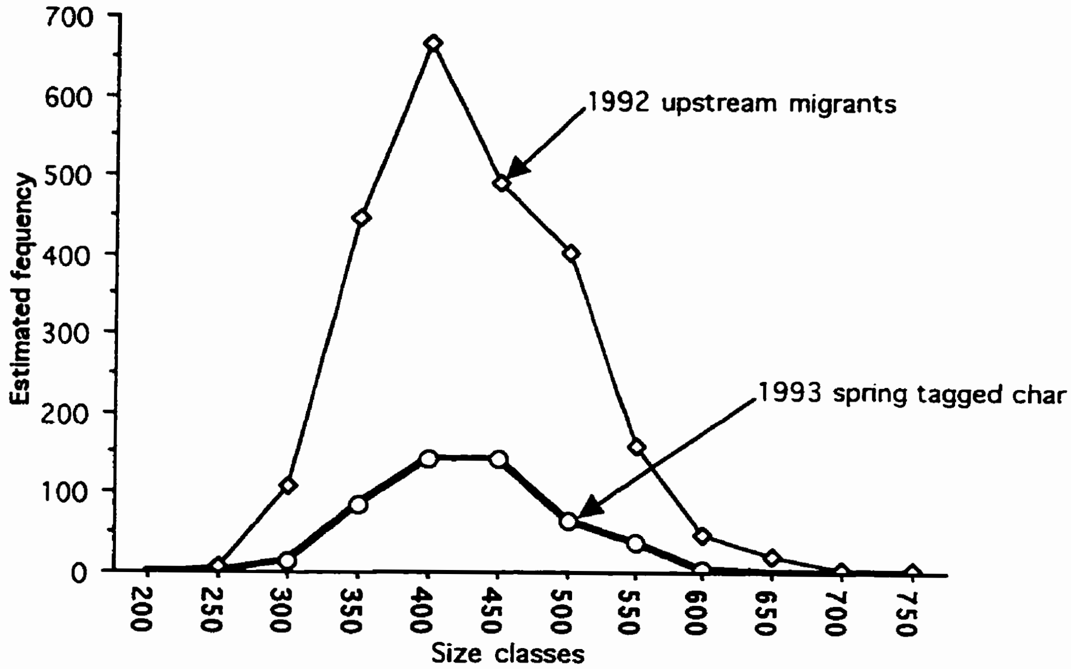


Figure 24. An overlay of length frequency distributions for the migrant portion of the Kuujjua population with the 587 charr tagged during the spring sampling at the mouth of the Kuujjua River. This overlay indicates that the 1993 tagging was done randomly.

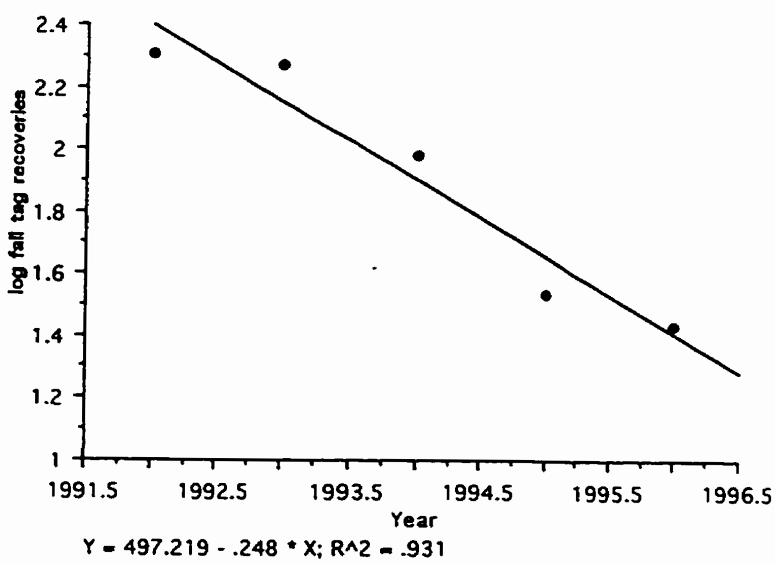


Figure 25. Regression plot of logarithms of the number of fall tag recoveries in successive years of the Holman tagging program. The line has a slope of -.248 log-units per year, corresponding to a survival rate of the antilog which equals 56.5%.

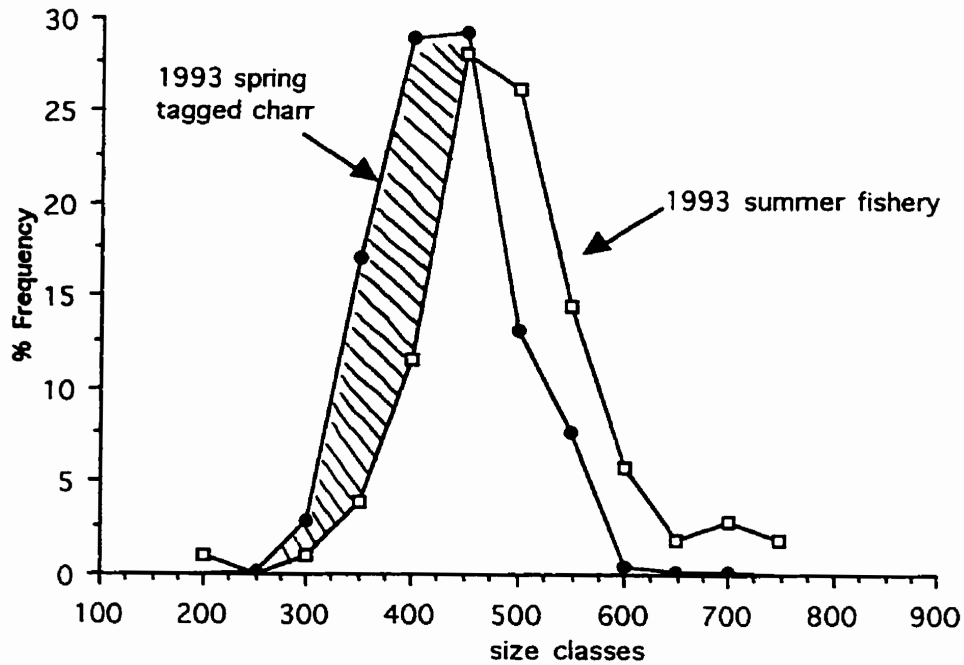


Figure 26. Length frequency distribution of charr taken in the 1993 summer fishery and those tagged and released in the spring of 1993 as a percentage. The lined region comprises 33.74% and represents the percentage by which the number of tags must be reduced to obtain the number "effectively" tagged for this fishery.

Table 11. Expected survival rate of the Kuujjua stock based on 1992 fall tag returns.

Time Period	1992	1993	1994	1995	1996	Total
Initial Stock of Tagged Fish	991	559	316	178	100	2144
Recoveries	202	188	96	34	27	548
				Mean Exploitation Rate		25.5%

Table 12. Expected survival rate of the Kuujjua stock based on 1993 spring tag returns with data not adjusted for the difference in size vulnerability of tagged fish.

Time Period	1992	1993	1994	1995	1996	Total
Initial Stock of Tagged Fish	-	487	348	248	177	1260
Recoveries	-	68	44	52	21	185
				Mean Exploitation Rate		14.68%

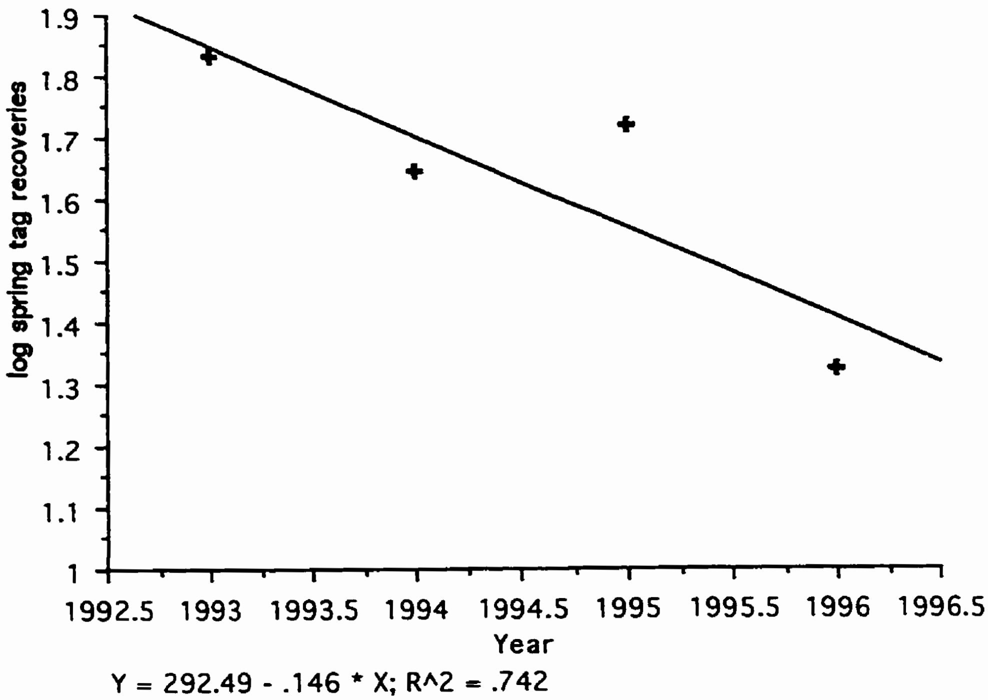


Figure 27. Regression plot of logarithms of the number of 1993 spring tag recoveries in successive years of the Holman tagging program. The line has a slope of -.146 log-units per year, corresponding to a survival rate of the antilog which equals 71.45%.

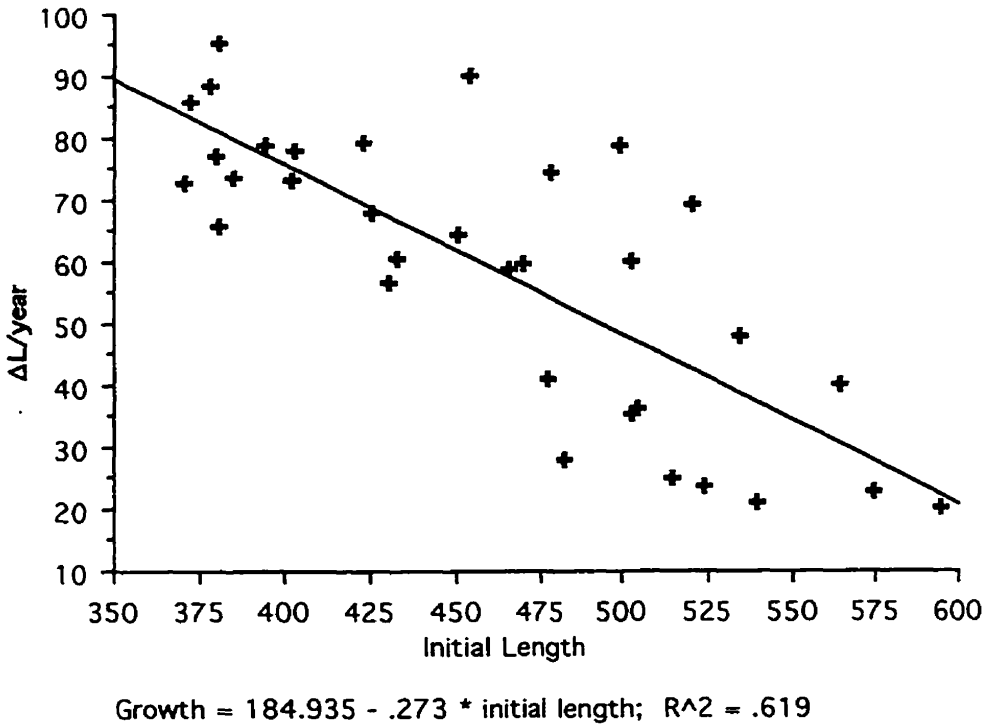


Figure 28. Regression analysis of the change in length per year vs initial length for a sample of 33 tagged char. The resulting growth function is Growth = 184.935 - .273 * initial length $p<.0001$ and R squared = .619.

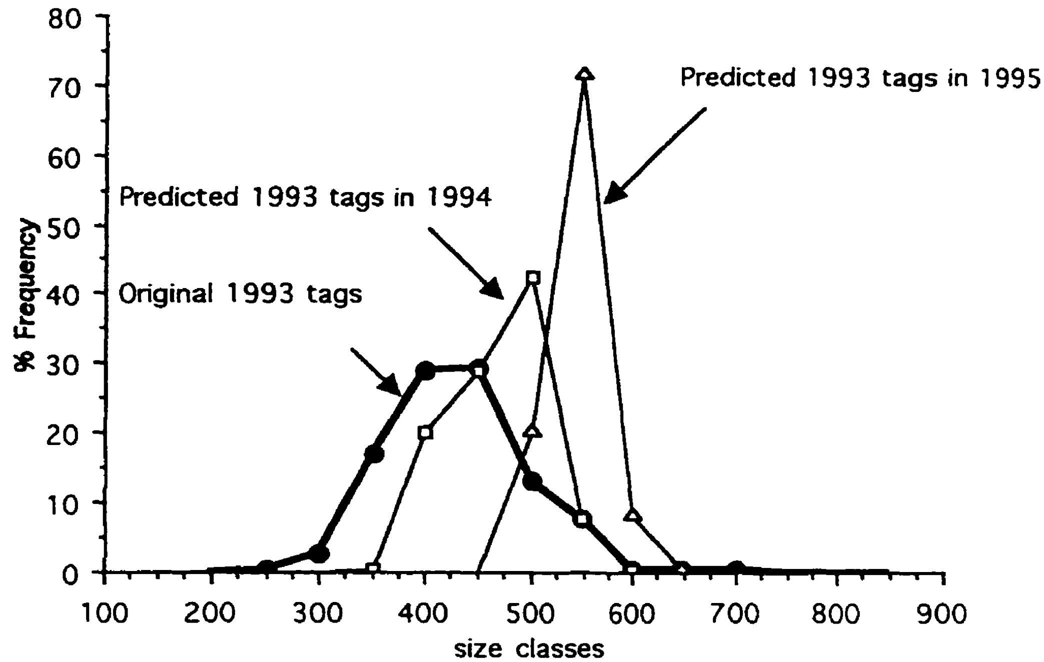


Figure 29. Predicted length frequency distributions for 1993 spring tags in 1994 after one year of growth and in 1995 after two years of growth.

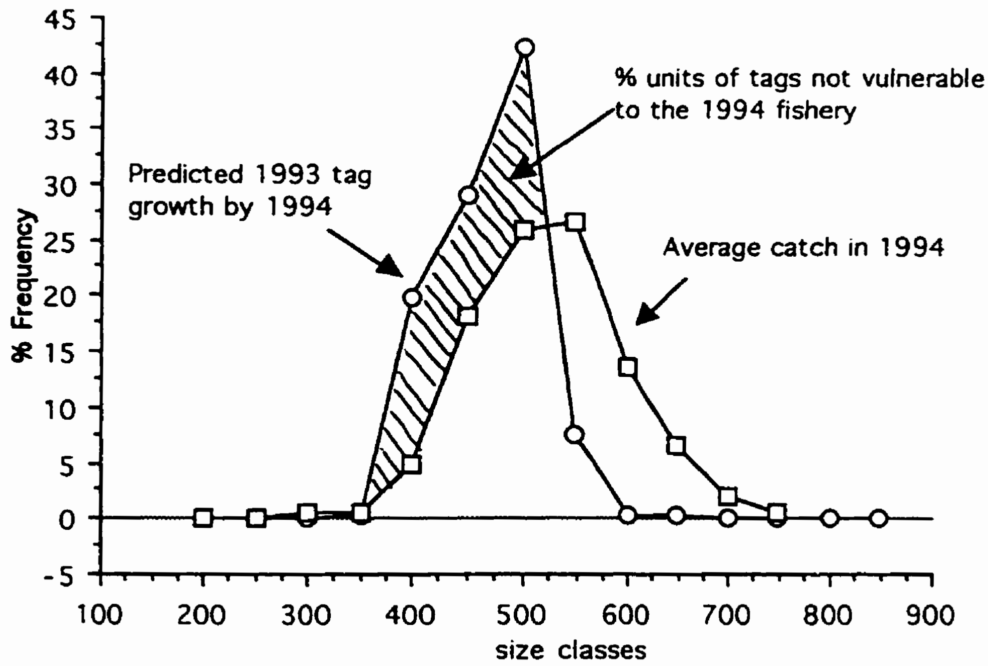


Figure 30. Length frequency distribution of charr taken in the 1994 fishery and the predicted length frequency distribution of 1993 spring tags in 1994 after one year of growth, as a percentage. The lined region comprises 42.44% and represents the percentage by which the number of tags must be reduced to obtain the number "effectively" tagged for this fishery.

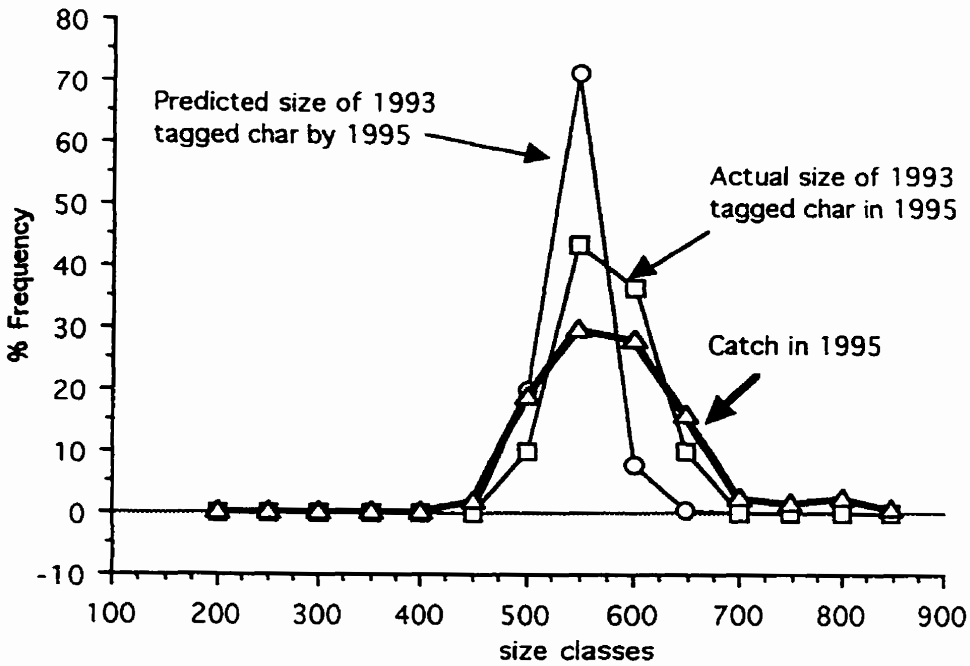


Figure 31. Length frequency distribution of charr taken in the 1995 fishery, the actual length frequency distribution of tagged char recaptured in the 1995 summer fishery and the predicted length frequency distribution of 1993 spring tags in 1994 after one year of growth, as a percentage. The overlay shows that all remaining 1993 spring tagged char would have been completely recruited into the Holman fishery by 1995.

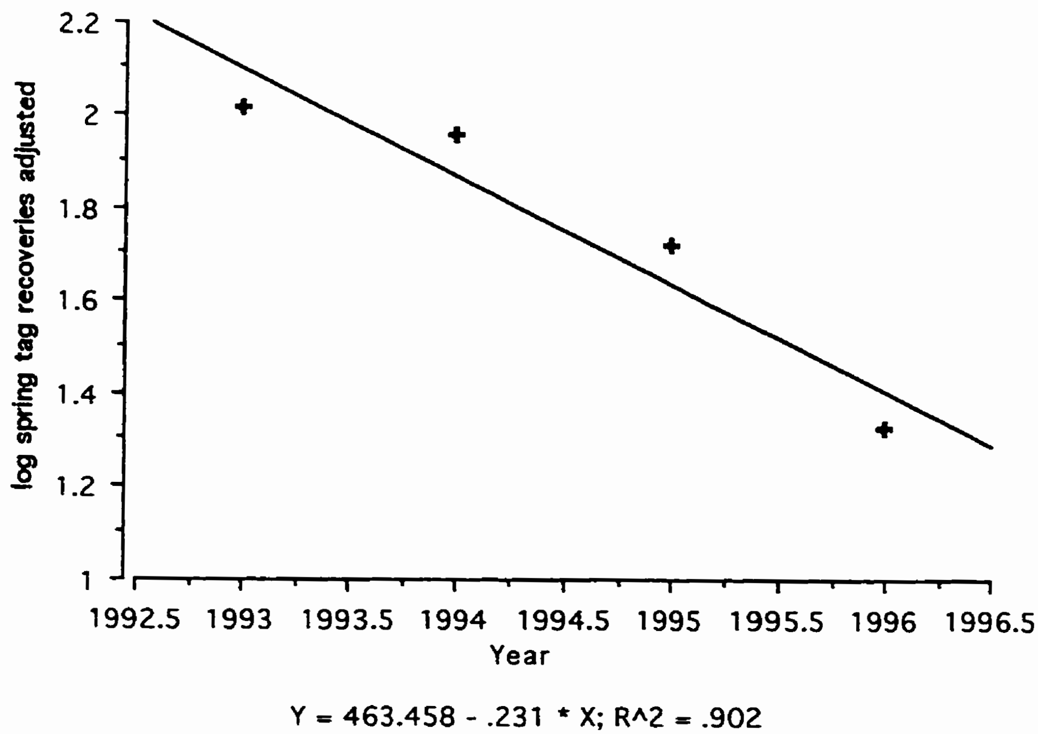


Figure 32. Regression plot of logarithms of the adjusted number of 1993 spring tag recoveries in successive years of the Holman tagging program, corrected for different vulnerability. The line has a slope of -.231 log-units per year, corresponding to a survival rate of the antilog which equals 58.75%.

Table 13. Expected survival rate of the Kuujjua stock based on adjusted 1993 spring tag returns corrected for differences in vulnerability.

Time Period	1993	1994	1995	1996	Total
Initial Stock of Tagged Fish	487	286	168	99	1040
Recoveries	103	91	52	21	267
			Mean Exploitation Rate		25.67%

5.5 Discussion

The tagging data from Holman is not sophisticated enough to perform a complex mark and recapture analysis of the Kuujjua River stock. However, the data generated by a combination of both the tagging project and subsequent community monitoring efforts allow the data to be adjusted for a general interpretation of stock conditions.

There are a number of factors to consider when attempting to interpret the results of the Holman tagging analysis. Firstly, abundance estimates apply to the time at which the tagged fish were released. Therefore, abundance estimates do not refer to the complete population of Kuujjua charr in Fish Lake or the complete population of Kuujjua charr surrounding the coast of Holman, since both sets of tags were applied during the charr migration along the river. As a result, a certain degree of error is introduced due to the fact that the majority of tag resampling was done at locations other than that at which the tags were actually placed.

Secondly, the analytical methods employed in the tagging analysis were developed for a closed population. The 1992 Fish Lake resampling was relatively close to the weir site and both locations ensure tagging and resampling was done on a closed population. The sampling and tagging carried out at the mouth of the Kuujjua River in the spring of 1993, would also have targeted a closed population. However, the tag recoveries obtained during the mixed or "open" summer coastal fishery violates the closed population condition and may add bias to the estimates. Since summer catch statistics cannot distinguish between different charr by place of origin, contributions from other charr stocks tends to dilute the number of tags available and thereby inflate abundance estimates. It is interesting to note however, this does not seem to be the case in the 1993 summer fishery since once the abundance estimate is adjusted for unequal vulnerability of 1993 spring tags, it gives the same abundance as the sampling done on the closed population at the mouth of the Kuujjua River using 1992 fall tags corrected for mortality. This result may suggest the coastal summer fishery surrounding Holman has minimal contributions from charr stocks other than the Kuujjua.

Tagging analysis for the following 1994 and 1995 summer fisheries resulted in significantly larger abundance estimates from both sets of tags. These findings may be the result of a number of things:

1) The closure of Fish Lake may of had a pronounced influence on stock abundance. The closure of the winter fishery at Fish Lake from 1993 to 1995 would have eliminated the 20.4% exploitation rate estimated to occur in the winter fishery. As a result, the effect of escapement plus recruitment may

have significantly increased the abundance of the Kuujjua charr population.

2) There may have been a higher degree of stock mixing during the summer of 1994. However, the occurrence of tag recoveries from other charr systems were low in both 1993 and 1994 (Harwood, 1996, pers. comm.).

3) Distribution of Kuujjua charr in the ocean during the summer may become so dispersed and mixed that the concentrated fishing effort off the coast of Holman may not effectively sample the population.

For unbiased results of a tagging analysis both tagging and subsequent sampling should be random, however Ricker (1975) reports either one singly would suffice to give unbiased estimates. This being true, the most reliable population estimate for the Kuujjua run would be 20,963 charr obtained using random sampling at the mouth of the Kuujjua River and recaptures of 1992 fall tags which were biased for larger size classes. The estimate is reliable since random resampling was used, corrections for natural mortality were made, and because it incorporates tags both placed and subsequently recaptured during a time when the population was isolated from surrounding stocks (closed). In addition, the abundance estimate derived using randomly placed 1993 spring tags and biased recaptures from the 1993 summer fishery give a similar result of 22,033 charr. This second estimate is reliable since tags were placed in a random fashion, resampling occurred shortly after tagging (limiting the amount of mixing and dispersion along the coast) and adjustments were made for unequal vulnerability to fishing gear.

The bias in fall tag placement and subsequent bias in resampling by the fishery in 1992 gave an abundance estimate of 12,085 charr for the larger sized segment of the run. This estimate underrepresents the less biased estimate of

20,963 charr, which used the biased fall tags and random sampling at the mouth of the river. If 12,085 estimates the abundance which is vulnerable to the fishery and 20,963 represents the complete run, then approximately 57.64% of the run is vulnerable to fishing mortality. This can be compared to the 33.74% of randomly placed 1993 spring tags which were found to be not vulnerable to recapture by the fishery. Therefore, these two separate estimates support one another resulting in approximately 60% of the run being vulnerable to fishing, 30% is not vulnerable and about 10% of the run falls some where in between (i.e. is partly vulnerable).

If 33.74% of the run is not vulnerable to the fishery then a significant portion of the run is not exposed to fishing mortality. Table 14 shows the variation in survival rate, and mean exploitation between the vulnerable segment of the run using the 1992 tags and the 1993 tags corrected for gear selectivity, compared to the 1993 tags uncorrected for fishing vulnerability and therefore representing the complete run.

Table 14. Summary of survival rates, total mortality, mean exploitation and natural mortality of the 1992 tags, the 1993 tags corrected for gear selectivity and 1993 tags not corrected for vulnerability therefore representing the complete run.

	Survival Rate	Total Mortality	Mean Exploitation	Natural Mortality
1992 tags vulnerable segment	56.5%	43.5%	25.5%	18.0%
1993 tags vulnerable segment	58.75%	41.25%	25.67%	15.58%
1993 tags completerun	71.45%	28.55%	14.68%	13.87%

The survival rates of 56.6 - 58.75% calculated using tagging data for the vulnerable segment of the run closely correspond to the mean survival rate of 55.75% calculated using the age frequency distribution from the catch data (chapter 4). The resulting estimated natural mortality rate of approximately 16% is consistent with other published estimates for Arctic charr populations (Dempson, 1978; Moore, 1975; and Johnson, 1989).

The lower total mortality rate of 28.5% and lower mean exploitation rate of 14.7% found using recaptures from randomly tagged 1993 fish which were not adjusted for vulnerability may better reflect the complete run. These lower results take into account the fact the 33.74% of the complete run is not exposed to the added effects of fishing mortality. Therefore, the Holman fishery exploits 14.68% of the 20,963 Kuujjua charr run, which is essentially the same as reporting an exploitation rate of 25.5% for the estimated 12,085 Kuujjua charr vulnerable to the winter fishery.

The above analysis has treated the fall tagging and spring tagging as two separate experiments, both of which give equivalent estimates for the Kuujjua charr stock. For example, by 1995 both sets of tags represent the same segment of the run and give corresponding abundance estimates for this year. Since both tagging experiments give similar results, there can be a greater degree of confidence in the information produced. As a result of the random sampling of fall tags and the random placement of spring tags we are able to gain a more comprehensive understanding of the complete run. However, these estimates still only apply to the sea migrant portion of the Kuujjua population.

If a random sampling had been conducted during the winter of 1993 at

Fish Lake it would have made important contributions to the interpretation of the above results since the Kuujjua stock is isolated at this time and location. The higher estimate for the downward run opposed the upward run into Fish Lake may suggest that only a portion of the Kuujjua stock over-winters in Fish Lake. It has been suggested by community members that a large proportion (which may include the spawning segment of the population) of Kuujjua charr over-winter downstream from Fish Lake in large deep pools if the river. If this is true it would mean a large portion of Kuujjua charr would not have been counted in the 1992 weir project nor would have they been tagged and resampled for the 1992 winter abundance estimate. Another explanation for the large downward migration could be that a portion of the stock over-winters upstream of Fish Lake. However, this second hypotheses is unlikely since migration barriers such as rapids and falls have been observed. In addition, during the winter of 1995, field monitors sampled upstream waters and found them to be frozen to the bottom.

The most reliable estimate of annual exploitation is found from the mean rate of exploitation corrected for natural mortality. Once again the mean rates derived from both sets of tags indicate a mean exploitation rate of 25.5%. However, it is important to note that the tagging experiments were carried out over the time in which the winter fishery was closed, therefore this may under-represent historical annual exploitation rates. The 1992 winter fishery had an exploitation rate of 20.4% and the 1993 summer fishery an exploitation rate of 21.12%. If these rates are typical of past winter and summer fisheries, then annual exploitation would have been close to 41.52% (for the vulnerable segment of the population). The closure of the Fish Lake winter fishery would have effectively cut annual exploitation by half for 1993, 1994 and 1995. This being true, one would expect the higher abundance estimates found in 1994 and 1995. However, Johnson (1989) recommends an annual exploitation rate of no more than 10% for the vulnerable segment of an Arctic charr fishery. Therefore, even with the closure of Fish Lake, the exploitation on the Kuujjua stock represents a high harvest rate for this population.

According to monitoring data, the summer fishery does not appear to be as selective for size as the winter fishery. The broader range of sizes recorded for the summer fishery may be a result of a significant number of fishers who employ rod and reel angling methods in the summer opposed to the exclusive net fishery in the winter. The degree to which this increases the randomness of tag resampling is poorly understood since the length of tagged fish is not reported upon recapture. Therefore, the type of fishing gear used for recapture, in addition to length at recapture, become important factors for future tagging analysis.

5.6 Conclusion

Since the Holman tagging program relies predominately on catch data from the fishery for tag recoveries, the information obtained on abundance, exploitation rate, survival rate and mortality rate is biased towards the larger size classes of the population. However, the random spring sampling which occurred at the mouth river in 1993 was a significant event which allows a broader picture of the the complete run to be obtained.

Results of this study suggest that the weir count in 1992 under represented the abundance of the Kuujjua run by as much as 50 percent.

Since the operation of a full span conductor weir imposes significant costs to stock assessment, a less expensive alternative would be to conduct tagging experiments utilizing trap nets. Through careful design of tagging programs, stock assessment can become both more accurate and more comprehensive. Tagging procedures such as the Seber-Jolly method described by Ricker (1975) generate information on stock recruitment as well as abundance, survival and mortality. A minimum of three separate random tagging and resampling events using trap nets at the mouth of the Kuujjua River and at Fish Lake would greatly increase the accuracy and understanding gained through tagging analysis.

Due to the size selectivity of the Holman subsistence fishery, only a portion of the Kuujjua charr population is exposed to fishing mortality. Therefore, exploitation estimates derived from tags recaptured in the harvest only reflect the larger size segment of the stock. As a result, statistical adjustments are required, increasing both error and uncertainty in the analysis. If a length measurement were given upon tag return, the actual size at capture could be determined and subsequent tagging analysis would not have to rely on predictions to adjust for vulnerability.

The fact that the survival estimates derived from the tagging analysis and those derived using the age frequency distribution of the catch are similar, suggests that these estimates approximate the actual survival rate. In addition, natural mortality estimates, calculated using the survival rate, are consistent with published estimates for Arctic charr populations.

It would seem improbable that a population of 10,000 to 20,000 charr could withstand exploitation rates of 25.5% during the Fish Lake closure, and as high as 40% in other years. However, over-exploitation is inconsistent with other biological indicators, and continued levels of harvest which suggest the stock is not being seriously over-fished. Possible explanations for this contradictory evidence could be: the population is larger than estimated; the harvest levels may be lower than estimated; fish from elsewhere might be contributing to the Kuujjua system; or the Kuujjua charr are recruited at a higher rate than other populations in the Arctic. In order to gain a clear understanding of Kuujjua charr population dynamics it is important to achieve random sampling of charr present both on and off the fishing grounds. In this way biological measurements obtained, as well as tag returns, will give a more accurate picture of the stock.

The present tagging analysis has demonstrated the importance of obtaining accurate harvest levels and biological data for the fishery. Information generated by community-based monitoring has been essential to the interpretation of Holman tagging data. While the above analysis provides only approximate estimates, such tagging programs have the potential for vast improvement with refined experiment design and formal training of community field workers.

5.7 Recommendations

Recommendations for future stock assessment of Holman Kuujjua River charr include:

1) that a survey be carried out on the Kuujjua River below Fish Lake to investigate the hypotheses of additional over-wintering pools of charr;

2) that subsequent tagging programs employ random tagging and recapture procedures, utilizing trap nets;

3) that future tagging experiments be carefully designed to employ a minimum of 3 separate marking and resampling occurrences;

4) that community monitoring be expanded to incorporate tag return information on length at recapture and type of fishing gear used; and

5) that workshops be carried out for field workers to gain a clear understanding of random sampling and its importance in stock assessment.

Chapter Six - Management Evaluation

6.1 Introduction

The fundamental purpose of fisheries management is to ensure sustainable production over time from fish stocks inorder to promote economic and social-wellbeing. The conventional scientific approach to fisheries management attempts to make quantitative estimates of stock abundance. The resulting management policies have involved numerical analysis and controls dictated by a centralized management regime (Wilson et al., 1994; McCay and Acheson, 1987; Ostrom, 1987; Berkes et al., 1991; Berkes,1989; Pinkerton, 1989). This type of management is based on two common theories. One is that stock recruitment is a function of the spawning stock size. The second is that of common property resources which predicts inevitable over-exploitation and socially undesirable results. Policies developed as a result of these two theories attempt to mimic property rights and control stock abundance.

Indigenous communities around the world traditionally used effective systems of resource management (Doulman, 1993; Berkes et al., 1991; Pinkerton, 1989; Kuperan and Abdullah, 1994). Isolated communities with a long history of subsistence livelihoods provide a strong foundation for a community-based approach to management. The local peoples' intimate knowledge about their surroundings has allowed communities to make choices concerning resource use within sustainable limits.

In many traditional societies, fisheries resources were jointly owned and communally managed. As a result there was often a high degree of popular participation to arrive at measures designed to mange the fish stocks (Doulman, 1993; Berkes et al., 1991; Kuperan and Abdullah, 1994). Information which was passed orally from one generation to the next taught an understanding of the environment, fishing practices and the dynamics of the fishery resource. Traditional management measures were therefore designed to meet specific community needs. Dependance on the fisheries resource as a primary food source meant that communities were acutely aware of the need to ensure proper use of these resources. Communal sharing of fish is knowen to enhance food supply, and avoided waste in isolated communities (Doulman, 1993). This practice mitigated against overfishing, contributing to the stabilization of production by acting as a disincentive to increase individual harvest levels.

Traditional societies and modes of operation toward fisheries management have been strained by social change and the process of modernization (Doulman, 1993; Berkes et al., 1991). In many communities it has been difficult to maintain a balance between technological change and resource use. The introduction of monofilament nets and motorized fishing craft along with growing community populations have had a significant impact on subsistence fisheries. When change-induced stresses cannot easily be accommodated within evolving social institutions, an erosion or breakdown of traditional practices can result.

In a co-managment system there is an effort made to "blend" the traditional and scientific methods of fisheries management. The resulting management system often relies on fisheries and harvest data collected by the community, combined with traditional knowledge about fishing patterns and harvest levels. Although such programs promise to bridge the gap between traditional community and scientific fisheries management, few comprehensive studies of such management systems have been completed.

A reliance on catch data in community-based fisheries management presents scientific mangers with several challenges resulting from biases such as gear selectivity. It is often difficult to develop catch per unit effort models for small scale subsistence fisheries, where fishing effort, timing and location can be effected by social and cultural influences, as well as biological influences. Communities can perceive programs to collect scientific data as an infringement on tradition. Management recommendations based on scientific data can be viewed with skepticism within the community.

The purpose of this study was to examine the components of the Holman community fisheries program and use the results to develop an operational model for arctic community-based fisheries management.

6.2 Background

The community of Holman, N.W.T. is located in the western Arctic, within the Inuvialuit Settlement Region (SIR). Within the ISR the fishery resource is managed cooperatively by DFO and the FJMC, as described by the Inuvialuit Final Agreement (IFA S.C.1988,c.16). The Holman subsistence fishery harvests approximately 9,000 Arctic charr per year, with charr being harvested along the coast of Prince Albert Sound in the summer and at various lake locations in the winter (Fabijan, 1996). Although several stocks of charr are thought to contribute to the Holman charr complex, the charr associated with the Kuujjua River and Fish Lake are thought to be the most important (Lewis et al., 1989).

In 1991 during a combined FJMC/DFO community tour, residents of Holman raised a concern about declining size and numbers of charr. Cooperatively FJMC and DFO concluded that the communities concerns might be best addressed by the development of a community-based fishing plan. The principle elements of the plan included: a community charr fishery management committee with the majority of representation coming from the community; a community-based fisheries monitoring program run by the local Hunter and Trappers Committee, with DFO technical assistance; and a community charr fishery news letter. This approach did not involve the more typical (at the time) DFO fisheries science "expedition" which would have involved bringing a research crew into the area and collecting fisheries data. FJMC sponsored the community program and DFO provided technical assistance to the community but had limited direct involvement in conducting the community-based program.

6.3 Chronology of the Holman Community-Based Fishing Program

1991 Holman Community Fishing Meeting

Following the 1991 community tour, FJMC, DFO and the Holman HTC agreed that a comprehensive scientific evaluation of the Kuujjua charr was needed and that the community should have a lead decision-making role in the process. As a result, a number of related projects were initiated to provide information for the development of the Holman fishing plan.

1991 Community-Based Monitoring of the Fish Lake Winter Fishery

The Fish Lake community-based monitoring program began in 1991 to collect information on harvest levels, fishing effort and biological data.

1992 Weir Project

In 1992 the FJMC and DFO installed a full span conduit weir on the Kuujjua River below Fish Lake. The weir project provided a count of 10,493 upstream migrants and the fork length of 2,334 charr were measured.

1992 Tagging Program

In addition to the weir operation, a tagging program was initiated in the fall of 1992 to provide information on migration patterns and abundance. During the weir operation, 991 tags were placed on the dorsal flesh of the charr and the charr were released.

1992 Community Fishing Meeting - Closure of Fish Lake Winter Fishery

The preliminary research from the above projects indicated the Kuujjua stock was in a depleted state. In 1992, the community fishing committee called a meeting to discuss the situation and present study results to the rest of the community. Maps, poster, and data summaries were used to convey information on stock status as well as alternative management options. In order to rejuvenate the Kuujjua stock, the community fishing committee recommended a three year closure of the Fish Lake winter fishery. The community as a whole passed a resolution supporting the closure of the Fish Lake fishery from 1993 to 1995 by community consensus.

1993 Holman Community Fishing Meeting

On May 11 & 12, 1993, a community fishing meeting was held to discuss the scoping/planning/logistics for the 1993 programs. During the meeting there was a discussion about increasing net mesh size as a management tool to conserve the Kuujjua stock. This issue was later addressed by a mesh size workshop held in 1995 (Norton, 1997).

1993 Tagging Program

In the spring of 1993, a sample of 570 charr were captured at the mouth of the Kuujjua River by angling and sein nets. An additional 487 charr were tagged and released. Tag recaptures were collected by the community fishery and reported to the Holman HTC.

1993 Alternative Fishing Site Reconnaissance

A reconnaissance study was carried out to identify alternative fishing site relocations. A number of alternative sites were located in the Prince Albert Sound area. No alternative sites were identified for the Minto Sound/Fish Lake area.

1993 Community-Based Monitoring of the Summer Coastal Fishery

In 1993, a high proportion of Kuujjua tag returns prompted the initiation of a summer coastal community-based fisheries monitoring program for the area surrounding Holman. Information was collected on harvest levels, fishing effort and biological data.

1993 Community Household Survey

A community household study was carried out to gain information on community need for charr.

1993 One Year Suspension of the Fish Lake Winter Monitoring Program

As a result of the high Kuujjua tag returns during the summer fishery, the Community Fishing Committee decided to postpone the Fish Lake monitoring sampling in the winter of 1993 due to the threat of severe over harvesting.

1994 Fishermen Log Books

The community fishing committee experimented with the use of individual fishermen log books to collect data on fishing effort. However, only 6 of 15 effort booklets were filled out and returned. As a result, it was decided that a community monitor would be hired to collect effort data from the active fishermen in the area.

1994 Community Fishing Plan Brochure

In April of 1994, the Holman HTC published a brochure explaining the Holman Area Charr Fishing Plan. The brochure out lined the "Plan for Recovery of the Kuujjua River Charr Stock" explaining the Fish Lake closure and providing guidelines for the recommended charr harvest in 1994 and 1995. In addition, information was given on the HTC program for alternative fishing sites.

1994 Fish Lake Winter Monitoring Sampling resumed

In October of 1994, the Fish Lake monitoring program resumed sampling and continued to do so for each winter season in the years to follow.

1995 Workshop on Fishing Practices and Mesh Size

On February 15-17, 1995 representatives from the Holman community, FJMC and DFO attended a workshop to examine the status, conservation and fishing practices, including mesh size, relative to the primary Arctic charr fishery resource. During the workshop, traditional and scientific knowledge on the life history, population characteristics and behaviour of Arctic charr were pooled to provide the best information base available for developing conservation goals and attaining a sustainable fishery.

There was consensus that the Holman charr fishery has experienced problems resulting from a intensive fishery at the main spawning and over wintering grounds in Fish Lake (Tatik Lake) on the Kuujjua River. It was also concluded that the same stock was being fished along the Holman Coast and in Safety Channel. During a meeting in Holman in May 1993, the community suggested using net mesh size as a management tool to conserve the stock. Participants of the workshop decided to continue the use of 4.5" mesh rather than switching to a larger 5.5" mesh in order to target the most abundant medium size class allowing the escapement of small charr and larger spawners. However, there is presently no scientific evidence to support this conclusion. It was also decided that pressure on the Kuujjua River stock could be reduced by encouraging people to fish at other locations, such as the Prince Albert Sound area.

1996 Formal Organization of the Charr Working Group

In 1996, a Holman "Charr Working Group" was organized made up of 8 community members representing the Holman HTC, 5 members of the FJMC and one member representing DFO. The Holman Charr Working Group held their first meeting in Holman on July 17-18, 1996.

The group discussed the results of the recent charr studies (weir, tag returns, monitoring) in Holman, Kuujjua and Prince Albert Sound areas, and made recommendations for the management of the charr fisheries in the Holman area.

1996 Charr Open House Community Meeting

A "Charr Open House" was held on July 18, 1996, and was attended by 66 people from the community. The Working Group put forward it's recommendations from the previous two day's workshop, and videos and posters about the charr projects were presented. Conclusions and recommendations from the Working Group and community included:

(1) Tag returns have shown that the summer fishery along the coast consists of at least 50%Kuujjua River charr. Heavy fishing in the summer from 1993 to 1996 has not taken much pressure off the Kuujjua River charr, even with the Fish Lake closure. Therefore, the Working Group recommended fishing along the Holman coast should be kept to a minimum.

(2) Fishing at Fish Lake should be started up again with caution, and that a limit should be set at 25 charr per household. By Motion (#96-111) on August 13, 1996, the HTC decided to reduce the 1996 take of Fish Lake charr to 25 charr per household.

(3) To compensate for the reduced Kuujjua charr harvest, the HTC launched a project to provide charr form Prince Albert Sound. The prince Albert Sound charr was distributed to community households to make up for the reduced Kuujjua River charr supply.

(4) The Working Group also decided to repeat a "Charr Needs Survey"

to update information on community demand for charr.

1996 Community Newsletter

On August 15, 1996, a "Holman Charr Newsletter" was sent out to inform the community of the Working Groups conclusions and recommendations.

1996 Survey of Fish Lake and Upper Kuujjua River for Spawners

In the summer of 1996, Dr. M.H. Papst captured and sampled two current year spawners in the Kuujjua River directly below Fish Lake.

1997 Charr Working Group Meeting

On June 2-3, 1997, the Holman Working Group met to review and discuss the number of charr harvested in 1996 and harvest locations, compare the 1996 harvest to the 1996 fishing plan, review and plan projects and activities for the 1997 season and prepare the Holman Charr Fishing Plan for 1997-1999.

1997 Charr Open House Community Meeting

A Public Meeting was held on June 3, 1997 and was attended by 75 adults from the community. Conclusions and recommendations from the Working Group and community included:

(1) The total harvest of charr from the coast in the summer of 1996 had not been reduced from the average of 5500 which is similar to the 1992, 1993, 1994 and 1995 annual harvest form this area. The Holman Working Group recommended that total harvest should not increase over the 1996 level (5500 charr).

(2) The harvest from Fish Lake in 1996 was about 1000, compared to 2500 per year before the closure. This is a result of people following the

Holman Fishing Plan recommendation of 25 charr per household in 1996. The Holman Working Group recommended that the community should continue with the limit of 25 charr per household for at least the next three year. Fish Lake would be open from October 1 - November 1 only and all catches would be carefully monitored.

(3) The harvest of charr from Prince Albert Sound in 1996 was 1880, considerably lower than total s taken in each of 1994 (3500 charr) and 1995 (5500 charr). The Working Group members felt this was due to the HTC fishermen starting late in 1996. The Holman Working Group recommended that the HTC apply to FJMC for funding to conduct two charr studies in Prince Albert Sound to locate additional sources of charr and to monitor charr catches at the Kagloryuak River.

1997 Community Newsletter

On June 16, 1997, a second "Holman Charr Newsletter" was sent out to inform the community of the Working Groups conclusions and recommendations.

1997 Community Household Survey

In June, 1997, the second community household survey was conducted to collect data on the communities fishing priorities, needs and traditions.

1997 Test Sentinel Fishery

In an effort to overcome bias in the catch data, in July of 1997, a test sentinel fishery was carried out using a standard gang net located in Jack's Bay by the community of Holman. A second attempt was made to employ a standard gang setting during the winter Fish Lake fishery in October of 1997.

1998 Kuujjua River Charr Workshop

On March 16, 1998, The FJMC, DFO and Holman HTC held a Kuujjua River Charr Workshop. Participants in the workshop included managers, FJMC members, Holman HTC members, scientists, biologists, Holman fishers and community representatives. The main objective of the workshop was to develop an appropriate management plan, and to plan future research and monitoring. Discussions at the workshop focused on current scientific models and data on harvest levels and population size which indicated that the Kuujjua charr stock was being seriously over-harvested. In contrast, other biological indicators and the continued level of harvests indicate that the population is not being over-harvested. The workshop was organized to examine current assumptions about the Kuujjua River charr fishery and to look for possible solutions to resolving the apparent contradictions. Up to 1998 the basic components of the Holman community fishing plan involved restrictions on harvest from Fish Lake and redirection of harvest to other rivers in Prince Albert Sound. Therefore, the workshop also addressed the current understanding of systems in the Prince Albert Sound ares such as the Kuuk, Naloagyuk, Kaghluk and Kagloryuak rivers.

The workshop was structered around informal, collegial brainstorming sessions emphasizing new ideas and making maximum use of community knowledge, scientific knowledge, personal experiences and intuitions. Prior to the meeting a series of assumptions were developed and circulated to the participants. The assumptions were grouped under the following four categories: demand for charr; population size and discreteness; harvest levels; and the charr model. For each of the assumptions about the Kuujjua River and Prince Albert Sound charr populations, the workshop addressed the following questions: What was the basis for the assumption? Was the assumption valid? Could it be qualified? What would be the consequences if the assumption was incorrect? What would it mean for other assumptions? What would it mean for the overall understanding of the fisheries? What would it mean for the management of the fisheries? How important was it to the overall interpretations if the assumption was untrue? Did the assumption need to be reexamined?

6.4 Results

Community Fishing Committee/Charr Working Group Meetings:

The annual Community Fishing Committee meetings provided a positive atmosphere to facilitate the sharing of concerns, ideas and solutions among community representatives, biologists and management. These annual meetings allowed a consensus to be reached on the objectives, logistics, planning and implementation of projects related to the community fishing plan. The annual meetings also facilitated community involvement, and functioned to keep management initiatives up dated and adaptive.

Closure of Fish Lake Winter Fishery:

The Fish Lake fishery was closed from 1993 to 1995 by mutual consent among both mangers and the community. No enforcement measures by DFO were required, and an assessment of the community program suggested that there was no fishing during this period. An evaluation of biological indicators and CPUE indicated that this was a significant event that made positive contributions to the rejuvenation of the Kuujjua stock.

Fishery Workshops:

The two fishery workshops carried out in 1995 and 1998 were a valuable aid in blending scientific and traditional knowledge, and providing the best information base available for developing a community fishing plan. These workshops served to strengthen mutual confidence between fishermen, the community, researchers and management. The workshops encouraged brainstorming sessions which worked to generate new ideas and understandings.

The 1995 workshop participants agreed that effective management involved regulating and monitoring all aspects of the fishery, including: mesh size and length of nets; number of fishermen; frequency and location of fishing; and total catch. It was also concluded that the detailed information necessary for satisfactory management could only be obtained through the application of a management plan designed to uniformly distribute the intensity of fishing, and to ensure the fishery was adequately monitored.

Based on the assessment and the discussions of the 1998 workshop, a series of statements were developed identifying priority knowledge and information needs and studies were outlined to address those needs. The major conclusions of the 1998 workshop were that the charr in Minto Inlet Area and the charr in the Prince Albert Sound area were most likely two separate complexes which overlap in the area between Holman and Safety channel during the summer, but which generally maintain discrete over-wintering populations. It was also concluded that while the Kuujjua River/Minto Sound system was very productive, the annual estimated harvest rate of about 40% of the Kuujjua charr was most likely not correct. The specific information needs and studies proposed as a result of this workshop are outlined in Appendix B.

The 1992 Weir Project:

The 1992 weir project provided an abundance estimate for the portion of the Kuujjua run that over-wintered in Fish Lake in 1992. The random sampling done on length at the weir also gave a one time "snapshot" of the size composition of this run, and an idea of upcoming year-class strength. An additional benefit of the weir was the application of a large number of tags placed on Kuujjua charr. There were three significant problems associated with the weir project. Firstly, the tagged sub-sample of charr was not chosen in a random fashion, as the larger weir sample had been, but rather it was a stratified sample based on size. This resulted in estimates which reflected only the larger size segment of the run. Secondly, the dead sample of charr was not taken in a random fashion, and therefore the resulting age distribution did not accurately reflect the run. Thirdly, the weir was in operation during a marked low-water year. The low water in combination with the weir may have obstructed fish movement up stream to Fish Lake, resulting in an abundance estimate which may have been an under-representation of a more typical run.

Tagging Program:

Tag return information provided insights into the distribution of Kuujjua River charr. The large number of tags returned from the 1992 winter fishery confirmed that the winter fishery was largely dependent on the August run of Kuujjua River charr, and the mark-recapture population estimate of 12,085 charr (10,534 to 13,885) was close to the weir count of 10,493 charr (chapter 5). The capture of tagged charr from the summer fishery emphasized the importance of the Kuujjua River charr stock to the Holman charr fishery (chapter 5). Examination of the size distribution of tagged charr caught in successive years provided insights into the selectivity of the fishery. Relatively few tagged fish were caught outside the summer coastal and Fish Lake fisheries, suggesting that Kuujjua charr do not make up a significant portion of Prince Albert Sound Fisheries (chapter 5). This observation makes the use of alternative fishing sites in Prince Albert Sound a management option.

An unexpected benefit of the tagging program was that a significant number of tagged charr were collected by the monitoring programs and as a result length at age data was collected (chapter 5). This information was used to estimate basic growth perimeters for the Kuujjua stock. Because of the high variation of length at age found in charr populations, it is difficult to estimate growth data directly from length at age data.

The growth information derived from the tagging program provided the basis for adjusting the distributions of the tagged fish for growth, which in turn allowed the estimate of survival rates over time (chapter 5). These results provided an independent estimate of survival rates which could be compared with the survival rate estimates based on the catch data (chapter 4). Problems associated with the tagging program were a result of gear selectivity (non random sampling), and failure to sample a closed population (mixed summer fishery).

Community-Based Monitoring Data:

Catch data collected by the monitoring program helped define the fishery in terms of the age and sizes of charr caught (chapter 4). The monitoring program also provided a method of recovering information from the tagging program. The catch data provided a means of estimating annual survival rates for the fully recruited portion of the population, and the average age for recruitment was determined (chapter 4). Comparison of size distributions from the monitoring program and the weir provided insight into the size selectivity of the fishery. This information was particularly interesting in regards to the shift in the size distribution observed in the fishery over time, raising the possibility that large recruitments of charr occur periodically, followed by periods of low recruitment (chapter 4).

The biological sub-sample collected from the winter monitoring program confirmed that few current-year spawners were caught in the Holman winter fishery (chapter 4). The results from the biological sub-sample also provided data supporting the conclusion that the sex ratio of the stock was equal. Both the biological sample and the monitoring sample provided otoliths and other tissues which were preserved for future studies.

Results from the monitoring program for CPUE were both interesting and limited. The winter monitoring program CPUE data were for the most part collected using standardized methods, and a general trend in the data over the years was present (chapter 4). However, the CPUE data were highly variable, and changes in the fishing locations and mesh sizes over the years compromised the usefulness of this data (chapter 4). The results of the winter monitoring program suggest that community monitoring programs can collect CPUE data, and that with some refinements this type of data could be used to detect trends in the fishery.

The summer monitoring program was less successful at collecting CPUE data as this fishery was far less concentrated than the winter fishery, and the monitor relied on fishers' recollections of the set times and catch levels. Efforts to collect CPUE directly from fisher log books was not successful.

The harvest study collects a form of CPUE data, since information is collected on the catch and number of reporting fishers. Although this data lacks the detail of the CPUE data collected by monitors, it can provide useful insights into the general trends in CPUE for the fishery over time (chapter 4). During this study for example, this harvest data was used to interpret the observed significant decline in the harvest in 1991 (chapter 4).

One of the major short-comings of the community monitoring data was that it suffered from gear selectively bias and the unstructured nature of fishing effort. As a result, there was limited information on the pre-recruit segment of the population and the rate at which they are recruited into the fishery. This restricts management's ability to forecast upcoming year-class strength, and to make the appropriate management decisions accordingly.

It is also important to note that the monitoring program did not provide an estimate of total annual harvest. As a result, fishery mangers had to rely on the Inuvialuit Harvest Study for this information. While this situation did reduce user response burden and the repetitiveness of related programs, it also meant that the monitoring program could not function independently to inform mangers, and that there was no means to confirm estimates of total annual harvest.

Community Household Survey:

Information collected by the community household surveys helped define the social dynamics which influence fishing practices and the demand for charr. According to the 1997 household survey, the annual community requirement for charr was on average 75 charr per household. The 1997 community household survey also indicated that the demand for charr would most likely increase in the future (chapter 3). Another important aspect of the fishery identified by the survey was the fact that the overall community fishing effort was controlled by net availability. A surprising result of the 1997 household survey was the poor response to locational questions involving maps. The household surveys did however, provide valuable information regarding community perspectives and how they affected related management decisions.

The 1993 and 1997 household surveys provided fisheries managers with insight into factors impacting the fishery such as: the number of nets being used; changes in fishing locations; subsistence needs; and the degree of community support regarding management options. Therefore, household surveys can help ensure both community involvement and comprehensive decision making.

Alternative Fishing Sites:

The alternative fishing program sponsored by the Holman HTC has proven to be an important factor in meeting the community demand for charr. Tagging studies have indicated that the Prince Albert Sound (PAS) charr stocks are not subjected to the intense fishing pressure surrounding the community of Holman. Therefore, the alternative fishing program which relocated fishing effort to the PAS area was important for alleviating pressure on the Kuujjua charr stock. It was unclear exactly how many fishermen were willing to relocate to PAS, and whether financial subsidies would be required to encourage relocation.

The 1997 Test Sentinel Fishery:

The 1997 test sentinel fishery proved to be unsuccessful in obtaining a sufficient sample size from the population. The standard gain net employed in both the summer and winter test sentinel fishery did not catch charr with any measurable amount of efficiency, compared to the shorter nets used by fishermen. As a result, no information was obtained on the pre-recriut segment of the Kuujjua charr stock.

6.5 Discussion

The Holman Fishing Plan is an attempt to govern how the catch taken from the Kuujjua stock can be adjusted from year to year, depending upon the size of the stock, the social conditions of the fishery, conditions of other stocks, and the state of uncertainty regarding biological knowledge. In order to make predictions about how a stock will respond to management initiatives, it is often necessary to develop a fisheries model upon which to base decisions. The above chronology of the Holman Fishing Plan has outlined the main components and activities which have taken place under this community-based approach to fisheries management. The results section has summarized the structure and content of the information/data produced through the activities of the community fishing plan. There is presently a need to organize this information/data into a formal fisheries management model. Deciding on the appropriate model involves the selection of model structure and parameters which can be fitted to the available data, and which produce an acceptable level of accuracy.

Stock Assessment Model:

According to Pitcher and Hart (1982), the dynamics of a fishery can be modelled by incorporating four basic processes which influence the stock of exploitable biomass. The four main sub-systems operating as components of the model include; recruitment of new individuals (R) and tissue growth (G), which add to stock biomass and natural mortality (M) and mortality due to fishing (F) which reduce stock biomass. The following fishery equation summarizes even the most sophisticated of contemporary dynamic pool models : $S_2 = S_1 + (R+G) - (M+F)$ where S_1 and S_2 stand for the biomass of the stock at the start of two successive time periods.

Each of the four processes (R, G, M, F) can be broken down into a hierarchy of complex sub-systems. The challenge is in deciding how much detail is needed to achieve the specific management objectives. Often there needs to be a compromize between realism and precision. When comprehensive information on sub-system dynamics is not readily available, it is best to keep a simplistic model to avoid accumulative error.

Pitcher and Hart (1982) suggest sufficiently accurate answers can generally be obtained by considering processes just one to two levels down in the hierarchy from the level at which the answers are required (e.g. answers of yield and fishing effort). Therefore, the operation of the fishery model need not go much further than obtaining functions or empirical data for the four sub-systems themselves. When the age structure of the fish population is included in the fishery model, the four processes identified can operate realistically and independently on each cohort or age group.

Modern dynamic pool models are built around summation of yields from each age class in the stock. In order to calculate the current number in an age group, managers have to trace that group's history back in time to the year in which it was recruited. Therefore, the fishery model may be employed to simulate the actual exploitation history of a fishery, and can be used to extrapolate the age classes into the future, giving some capacity to forecast sustainable harvest levels. The vital feature of this type of model is its ability to simulate changes over a number of years.

The aim of management using a dynamic pool approach is to find the optimum combination of age of entry and fishing rate. The major research task is in obtaining sufficiently accurate information from the fish stock to enable this level of detail to be fitted to the model. The dynamic pool model can be used for the optimal control of fisheries, and a range of options can be selected by managers for the particular kind of information required.

The Holman Community-Based Fishing Program has generated much of the required information needed to fit the dynamic pool model described by Pitcher and Hart (1982). The Community-Based Monitoring Program has described what is being taken from the stock by the fishery. The Community household surveys have explained many of the factors which control the subsistence harvest, as well as socially acceptable methods to manipulate harvest levels. The 1992 and 1993 tagging program has given reasonable estimates of growth rate, natural mortality and fishing mortality (fig. 33).

The main component of the model for which there is very little information is the rate of recruitment into the fishery. The failure of the test sentinel fishery to capture a random sample of pre-recriuts has left a substantial gap in stock information. Since monitoring data is collected by methods employed in the fishery, managers have gained little understanding of the population dynamics which feed into the fishery. Variations in year class strength can greatly affect catches in the years immediately following the recruitment. It would clearly be useful to management to have predictions of up-coming year class strengths upon which to based recommended harvest levels.

Tagging programs and monitoring sampling methods can be improved to provide more reliable estimations of model components including an

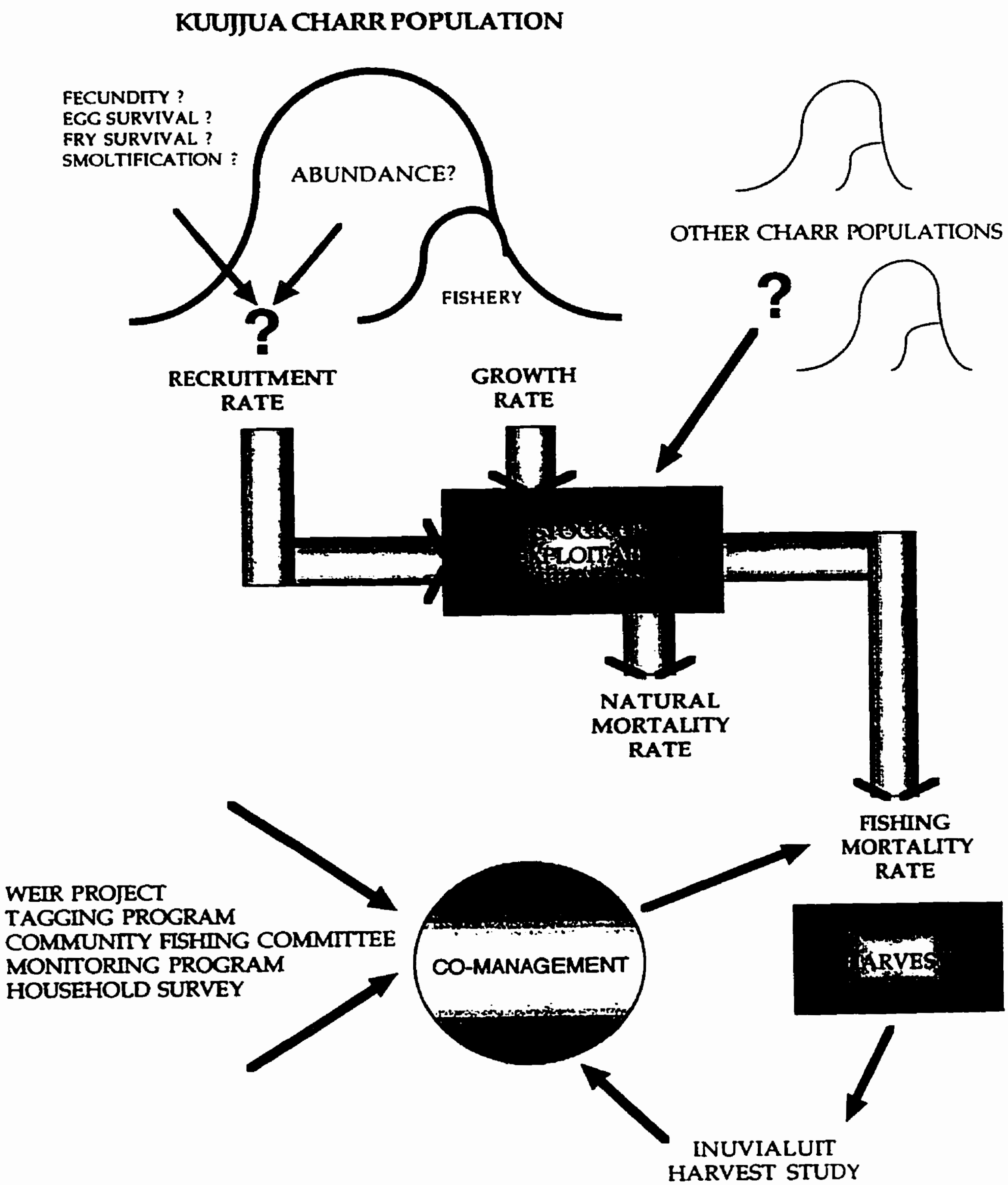


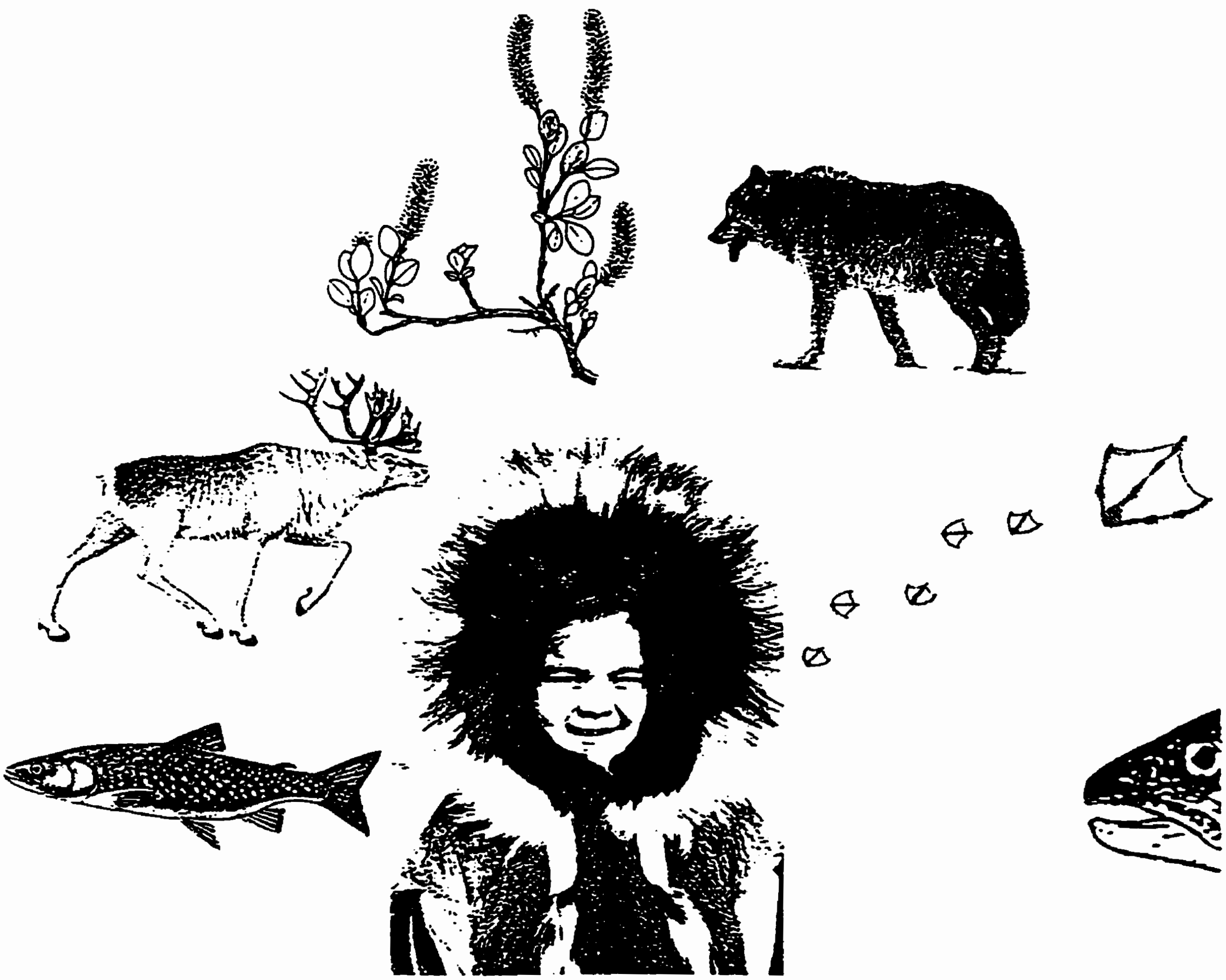
Figure 33. Holman Stock Assessment Charr Model.

estimation for the rate of recruitment. However, even with acceptable parameter estimations, the unanswered question of stock composition will continue to inhibit the effectiveness of management. It is of great importance to choose an appropriate group of fish, the unit stock, that can be treated as a homogeneous and independent unit in a fisheries model. Interactions and contributions of other stocks can add considerably to the complexities of charr stock assessment and management. The 1998 Kuujjua Charr Workshop brought this issue to light, and has recommended future studies to address stock composition.

Management Approach:

The community-based approach to fisheries management in Holman has demonstrated that community members are fully capable of identifying issues, defining solutions and taking the necessary actions to manage and preserve the fishery without conflict. Through this co-management process, DFO was able to meet its conservation mandate and collect the scientific data required to support its recommendations. Management did not have to implement an enforcement program, and DFO did not have to initiate a large scale fisheries scientific stock assessment. In addition, the FJMC was able to fulfil its mandate to deepen community engagement and ownership of the fishery resource.

Constant feedback was an essential element in this community driven process. In order to achieve the agreed upon objectives, the management process had to establish ongoing information feedback loops. This allowed all parties involved to continually build upon their understanding of the issues, to establish community consent and coordinate efforts. A fundamental aspect of successful community consultation is clarification of issues, problems and accepted solutions at each stage of the process. Another essential element of the community-based fishing plan was that the community was directly involved early on in the process. This allowed a partnership to be established at the outset, and gave participants a shared sense of purpose and ownership of the issue.



Chapter Seven - Concluding Chapter

Proposed Operational Framework for the Implementation and Application of Community-Based Fisheries Monitoring Operating Under a Co-management Regime

7.1 Introduction:

Developing a model for fisheries management requires a systems view approach. The systems view deals with theories about the behavior of entities which exhibit organized complexity. Such an approach combines knowledge of the available analytical tools, an understanding of when each is appropriate, and skill in applying these tools to practical problems. The various components of a fishery can be organized into a loop of cause-and-effect relationships known as a feedback process. The understanding of such dynamic interactions can increase management's capacity to develop more appropriate solutions.

The systems approach to fisheries management can establish the proper order of inquiry, and help select the best course of action to accomplish a prescribed goal. This approach can broaden the information base available to decision-makers, provide a better understanding of the fishery system and its component subsystems, and facilitate the prediction of consequences resulting from various courses of action. As such, the systems approach provides an operational framework for analysis and decision making within a particular set of conditions involving; nature, social life, resources, economics, politics, law and morality.

7.2 Proposed Framework, Conclusions and Recommendations:

The following operational framework developed for community-based fisheries monitoring consists of three main components (fig. 34). The first component is "adaptive management decision-making" directed by a community fishing committee and functioning through a co-management regime. The second component of this framework is that of "stock assessment" which involves community-based monitoring of biological and harvest information in combination with a well designed tagging program. The third component is "alternative management options" which incorporates the social dynamics of the fishery through community household surveys, community consultation and communication programs. All three components of this framework interact to form an information feedback loop functioning to accumulate data and adjust future management decisions.

Adaptive Management Decision-Making:

The first step in the development of a community-based approach to fisheries management is the establishment of a community fishing committee (CFC). The CFC should be organized early on in the process, and should take a lead role in the scoping, setting of program objectives and planning phases. This allows trust to be established between co-manager partners and provides a true sense of shared responsibility/authority. The CFC is a vital link between the co-management process and the rest of the community. The existence of the CFC involves community leaders who are better able to mobilize and organize local user groups and facilitate essential

Operational Framework
for a
Community-Based Approach to Fisheries Management

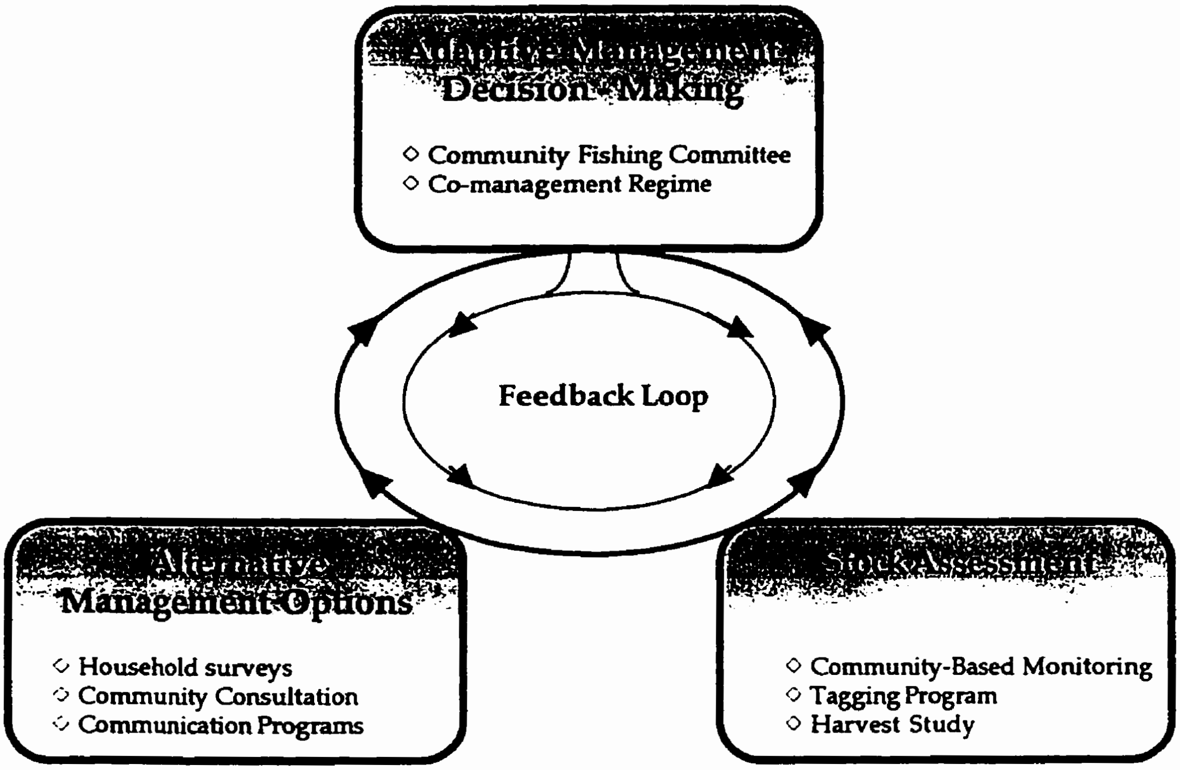


Figure 15. Operational Framework for Community-Based Fisheries Management and Monitoring.

two-way communication.

Stock Assessment:

The collection of fisheries data by community members is an important factor in the progression towards a more complete co-management process. The community is able to build a stronger sense of ownership over fisheries information through active participation. This in turn can empower the community to become more involved in the resulting management decisions and initiatives.

Problems associated with monitoring data collected through the fishery relates to biased sampling methods. While gathering information on the fishery is essential and should continue, there is also a need to expand sampling methods to obtain more complete information on stock dynamics. Altering the traditional fishing practises employed in the fishery imposes the risk of disturbing both social and stock conditions. Therefore, the monitoring program should continue to collect data from active fishers, in addition to caring out separate random sampling on various components of the stock.

One option to achieve random sampling could be the use of trap nets. Local community monitors could be trained to utilize such equipment, and hired to carry out sampling at various times of the year. If trap nets prove to be efficient at capturing a random sample from the stock, they may also serve to conduct a sophisticated tagging program. Under this program, biological data would not suffer from bias due to mesh size. The trap net method would allow fish to be measured, weighed, tagged and released, thereby reducing mortality due to sampling. When tagged fish are later caught in the fishery, their age at tagging could be back-calculated, providing a more representative age distribution. The trap net monitoring and tagging system would provide information on the rate of recruitment, growth rate, natural mortality and fishing mortality. Estimation of these stock processes would provide the necessary components to the dynamic pool model for fisheries management.

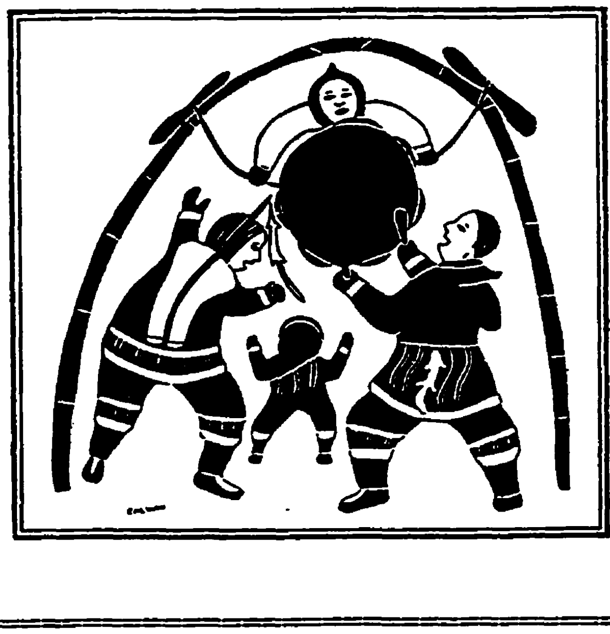
Workshops on the use of trap nets and tagging could be offered to community members. Interested residents and student groups could be invited to participate in the community sampling and tagging. Assisting monitors at the trap net locations could work to deepen community engagement and improve the collective understanding of the fishery.

Alternative Management Options:

With the stock information feedback loop well established, the choice of alternative management initiatives still remains. A third level of community involvement thus needs to be established in the co-management process. The feedback of community perceptions plays a fundamental role in the implementation of practical management initiatives. In order to develop appropriate management strategies, local opinion and social conditions must also be monitored. This can be achieved through periodic household surveys and community consultation/communication programs.

The annual gathering of the CFC and co-managment committee should not be limited to formal meetings. Workshop activities have proven to be a valuable asset in communication and education of all parties involved. A variety of communication techniques should be utilized in order to expand the out reach capacity of the program. Open house meetings, news letters and workshops help build awareness in the active fishers and the elders of the community. However, expanding these programs to incorporate school educational programs would engage the next generation of co-management partners. Issues addressed at school are often brought home and shared with parents which in turn furthers the flow of information.

Community participation is embedded in each component of the fisheries co-management operational framework. Community engagement combined with an expanded monitoring and tagging program serves to establish a continuous feedback loop of information. This in turn allows the co-management process to become more comprehensive and adaptive. In order to continue and enhance community engagement, stock assessment training programs aimed specifically at local beneficiaries should be developed and provided to the community to better prepare the next generation of co-management partners.



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APPENDIX "A"

1997 HOLMAN COMMUNITY HOUSEHOLD SURVEY
AND
SURVEYOR TRAINING MANUAL

HOLMAN COMMUNITY HOUSEHOLD SURVEY
INSTRUCTION SHEET FOR THE SURVEYOR

The surveyor should attempt to visit each household in the community. If a household indicates that no one in the family has actively fished in the last two years then fill out the survey cover sheet and only ask the household question #12 on page 5 of the survey form. When there are no active fishermen in the household give the household a identification number and write on the cover sheet "no active fishermen in household". If a household is visited a number of times and the fishermen are never home, fill out a survey cover sheet with a household identification number and write on the cover "fishermen could not be reached". The household survey should be conducted by an informal interview(eg sitting around the table while the surveyor asks questions from the survey form and record the fishermen's answers directly on to the form). The surveyor may want to call ahead to a household to ensure that as many active fishermen are at home as possible. Once a meeting time is organized (if this is necessary) the surveyor will go to the household for the interview. The surveyor will first fill in the cover sheet of the survey as described below and then proceed to ask each question in the survey.

The survey questions may be read aloud to the fishermen and the answers then recorded by the surveyor in the space provided or by circling the letter corresponding to the chosen answer. The surveyor may also wish to show each question to the fishermen and allow them to point to the answer they wish to provide (which ever way the surveyor prefers or finds works best). Which ever method is used the surveyor should be the only person filling in the answers to the questions. Also, the surveyor should ensure that all questions are answered correctly before they leave the household. If the fishermen answering the questions provide additional information in relation to a question, the surveyor should try and make notes some where on the form beside the question (perhaps on the back of the page). If a fisherman does not know an answer to one of the questions or if he/she chooses not to answer a question, then the surveyor should mark "no response" beside the question. The surveyor may return to a household later in time to clear up any misunderstandings or to complete any unanswered questions.

Questions 1 to 25 in the survey are to be answered by all fishermen in the household as a group, questions 26 to 38 are to be answered by each individual fisherman within that household. If there is only one fisherman in the household than he/she should answer all the questions. If there are three fishermen in the household say a father and two sons, then there should be three separate answers for questions #26 to#38 for each of the fishermen in the household. If the father is individual #1 than mark his answer in the blank numbered 1) and keep him as individual 1) for the reset of the survey form. Likewise if the oldest son in the household is individual 2) than place all of his answers in the 2) blank for the remainder of the survey form. The other son would be individual 3) and all of his answers would go in the 3) space.

For any questions related to a map the surveyor should present the map to the fishermen and allow them to point to the locations for which their answers relate. The surveyor should then make an X on the map and fill in the additional information such as net size etc.

Once all the households possible have been surveyed the completed forms should be packaged up and sent to this address:

Dr. Mike Papst
Fisheries Research Manager
Fisheries and Oceans
Freshwater Institute
501 University Crescent
Winnipeg, Manitoba. R3T 2N6

EXPLANATION OF THE SURVEY FORM

COVER SHEET: Each household should be given a separate identification number on the cover sheet in the space provided (eg HOUSEHOLD # __8__) Households may be numbered ahead of time or as you go along, as long as there are not two households with the same number.

Mark yes or no to whether the head of the household is present during the interview.

Record the number of fishermen (men or women) that are present during the interview. Only record people who have been actively fishing in the past two years (eg in 1994, 1995 or 1996). For example if there are five people sitting around the table during the interview and three of them do all the fishing for the household record three fishermen in household. (eg NUMBER OF FISHERMEN PRESENT __3__).

Question #1: How many people live in your household means the total number of individuals in the household including all children, grandparents, aunts/uncles or non-relatives etc. This does not mean the number of fishermen only.

Question #2: How many fishermen are there in the household which have been actively fishing for the last two years.

Question #2b: This question pertains to the active fishermen only. If there are five fishermen in the household eg/ an elder age 62, a father age 45, and three sons ages 16, 22 and 28 the answer sheet would look as follows:

ages 1 - 10	0
ages 11 - 20	1
ages 21 - 30	2
ages 31 - 40	0
ages 41 - 50	1
ages 51 - 60	0
ages 61 - 70	1
ages 71 - 80	0
over 80	0

Question #3:	If the fishermen in the household know the exact number of charr they caught in the summer of 1996 (last summer) write the number of charr in the space provided on the right hand side. If the fishermen are not sure exactly how many charr they caught but have an approximate idea of say 150 charr then circle the correct letter which in this case would be d) 100 - 200
Question #4:	This question is basically the same as #3 but note we are now asking about the winter fishery of 1996 (last winter) as opposed to the summer fishery of 1996.
Question #5:	Mark an X on the map any where the fishermen show you they have fished over the past five years. Beside the X write the year and month that they fished in that location. eg/ X July, 1993
Question #6:	On this map mark an X at the same locations in which the fishermen of that household fish. Beside the X's write the kind of gear the fishermen use there (eg 4" monofiliment gill nets or rods) and mark the number of charr caught at that location with that gear in 1996. eg/ X 4"gill net, 34 charr
Question #7:	On this map mark an X only at the locations in which the fishermen say they have caught charr with eggs in them. Beside the X write down if the charr was red or silver and if the size of the eggs were category 1 or 2. eg/ X red, 2
Question #8:	During the year of 1996, if the fishermen caught the most charr in July then mark July in the space. If the fishermen caught the most charr in October the mark Oct in the space provided.
Question #9:	Circle the letter of the most appropriate answer. If people are not to sure they may guess.
Question #10:	This question is intended to find out which kind of charr people try and catch the most or which kind of charr they would catch if they had a choice. A typical answer may be "I like large, silver charr caught in the summer from Jacks Bay" or " I prefer small silver charr caught in October in Fish Lake"etc.
Question #11:	This question is asking if the fishermen caught the kind of charr they wanted to for their household. It the fishermen did not catch the kind of charr they wanted then get them to explain why. eg/ No my household prefers large silver charr from Fish Lake but we could only catch (find) smaller charr kings bay because we're not allowed to fish in Fish Lake any more.

Question #12: This question is asking if the household eats charr or uses it in any way, even if they don't catch it themselves. If the answer is yes, circle the letter which indicates where they get the charr from and write in the blank how much they would normally get in a year from that source. The household may have more than one answer so you may circle as many as you need as long as an approximate number is given beside the source. For example if the household normally receives 50 charr a year from their father-in-law and 20 charr a year from friends, then the answer would look as follows:

12. Does your household use charr that you do not catch yourself?
(yes or no) __YES____

If yes, where do you get the charr and how much do you usually receive in a year?

a) from friends _20_____
b) from family __50____
c) HTC _______
d) other communities _______
e) other _______

Question #13: This question is simply asking the fishermen if the fishermen gave any charr away or traded any charr to other people out side the household in 1996. If people offer more information such as which community they trade charr with then write the answer down somewhere on the page beside the question.

Question #14: This question is asking if they catch enough charr in a year to feed their family and satisfy their needs.

Question #15: This question is asking if they think they will need to catch more charr in the future or if they will probably catch less charr in the future because they don't need as much. Whether they answer more or less try and get a reason why they might need more (or less) charr in the future.

Question #16: Write down the size of nets and how many of each size the household owns (this means all fishermen together in that house). I the fishermen do not own there own nets write down who owns then. If the household owns some of their nets and not others than write down the in formation for both owned and unowned nets in the space provided in the form. SIZE means the size of the net such as 4" mesh or 4.5" etc. NUMBER means the number of each size net the fishermen owns.

Question #17 & #18: These questions are relatively straight forward so simple read them out to the fishermen and write down their response in the space provided. If you need more space write on the back of the page.

Question #19: This question is trying to find out if fishermen are moving away form traditional fishing areas to new areas because the fishing is not as good in the old spots or if they are moving for other reasons. It may be fishermen are not moving at all because the fishing is still good in the same spots they have always fished in. For example an answer may be " yes I have changed my fishing location because I can catch more fish by the Kagloryuak River".

Question #20: This question is asking if the fishermen would be willing to move their fishing locations further from Holman. For example if too many charr are being taken from the Kuujjua stock, would they be willing to fish further down Prince Albert Sound by the Kagluk River. If the fishermen are willing to move in order to preserve the Kuujjua stock how far would they move. The answer may be in miles or they may give a location. You may want to use one of the maps so the fishermen can show you where they would move to.

Question #21 & #22: Question #21 is asking if the size of individual charr that they catch seem to be larger, smaller or the same since Fish Lake closed. If the say the charr are the same size, then ask them if they feel the charr are large or small compared to what they use to catch. Question #22 is asking if they have more charr in there nets compared to before Fish Lake was closed.

Question #23: This question is to get an idea of how much food comes directly from the land. 50% would be half of their food is from the land and half is bought from the store. Simply circle the letter which gives the most accurate percent.

Question #24: This question is asking if fishing effort has increased in order to maintain a given harvest level or amount of charr that the household needs.

Question #25: Mark an X on the map where fishermen fish for fish other than charr. For example mark an X in the locations where fishermen

set nets for trout and beside the X write the net size and the number of trout they would normally catch.
eg X 3" gill net, 20 trout

Question #26: This question should be recorded for each separate fishermen in the household. If there are four fishermen than there should be four answers. Give each of the fishermen a number before starting this section so you can write individual 1) into the same space for each question #26 to #38. If individual 1 answers yes to the question then write yes in the 1) space. If individual 2 answers no to the same question than simply write no in the 2) space and so on.

Question #27: For this question write yes or no in the individual spaces. If an individual answers yes to Holman needing a fishing plan then write the letter of the answer to who that individual feels should participate. eg/ 1) yes, a 2) no 3) yes, b A community fishing plan is a management plan for the fishery which is decided upon using community involvement.

Question #28: This question is asking the individual who they think should be collecting information (data) on the fishery such as fish lengths, weights and population size. Individuals may wish to give more than one answer, so simply write the letters to the chosen answers in the space for that individual. If an individual chooses e) other than write down who they think should collect the data.

Question #29: If the individual answers yes to this question then write down what he/she would like to do.
eg/ 1) no 2) yes, data collection 3) yes, office work

Question #30: Simply write in the date or the month which ever is provided by the individual. eg/ 1) June 2) Dec 5 3) Nov 2

Question #31: This question is asking who the individual would like to be responsible for the setting of limits on the fishery. If the individual does not want limits to be placed on the fishery then write an "e" in the space for that individual.

Question #32: This question is asking which one of the choices provided for protecting and managing the fishery would be an individuals first choice, second choice etc. Simply place the letters in the order of preference the individual has chosen.

Question #33: A bylaw is an enforceable rule adopted by the community to manage the fishery. If an individual thinks there should be a bylaw write yes in the space for that individual and write the letter for the kind of bylaw they agree to. eg/ 1) yes a,c,f

Question #34: Simple write yes or no in the space for each individual. The question means if the individual thinks people should be allowed to Fish in Fish Lake or not.

Question #35a & #35b: If an individual thinks there should be a limit on the number of charr taken from Fish Lake write yes in the space for that individual and write the letter for the size of limit they agree to. eg/ 1) yes, 50 charr If an individual thinks there should be a limit but does not know what size then simply write yes in the space provided for that individual.

Question #36: Write the letter corresponding to the preferred mesh size the individual would like to fish with. You may write more than one choice for each individual. If an individual chooses f) other then write the size of mesh they prefer beside the letter f. eg/ 1) a 2) a,b,d 3) f 3.0"

Question #37: This question is asking if the individual thinks the community should have someone monitoring the fishery and if they do where do they think the monitors should be. Write the letter corresponding to the individuals choice in the space provided for that individual. There may be more than one answer for each individual. eg/ 1) a,b 2) d 3) e

Question #38: This question is asking the individual fishermen if the Arctic charr fishing is good or bad for them in 1996. There should only be one answer for each individual. Additional comments should be encouraged and written down somewhere beside the question. For example, if fisherman 2 answers e) very poor try and get him to tell you why he thinks its poor (eg the fishing was poor in 1996 because to many people took to many fish in 1994 and 1995).

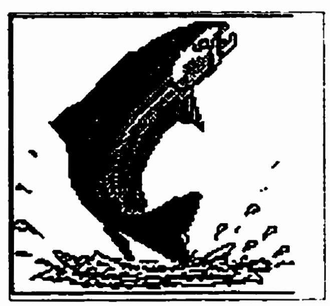
IF YOU HAVE ANY ADDITIONAL QUESTIONS ABOUT THE SURVEY PLEASE CALL ADRIENNE PAYLOR AT 204-261-1061. THANK YOU FOR YOUR PARTICIPATION IN CARRYING OUT THE SUERVEY.

1996 HOLMAN
COMMUNITY HOUSEHOLD SURVEY

HOUSEHOLD # _______

HEAD OF HOUSEHOLD PRESENT _______ (YES OR NO)

NUMBER OF FISHERMAN PRESENT _______



1a. How many people live in your household? _______

2. How many people in your household fish for charr (in the last two years)? _______

2b. Please indicate the number of household fishermen within each of the following age groups. e.g.) ages 21 - 30 __3 fishermen__

ages 1 - 10 _______
ages 11 - 20 _______
ages 21 - 30 _______
ages 31 - 40 _______
ages 41 - 50 _______
ages 51 - 60 _______
ages 61 - 70 _______
ages 71 - 80 _______
over 80 _______

3. How many charr did your household catch in the **SUMMER** of 1996? (please write exact number if you know)

a) 0
b) 1 - 50
c) 50 - 100
d) 100 - 200
e) 200 - 300
f) 300 - 400
g) other _______

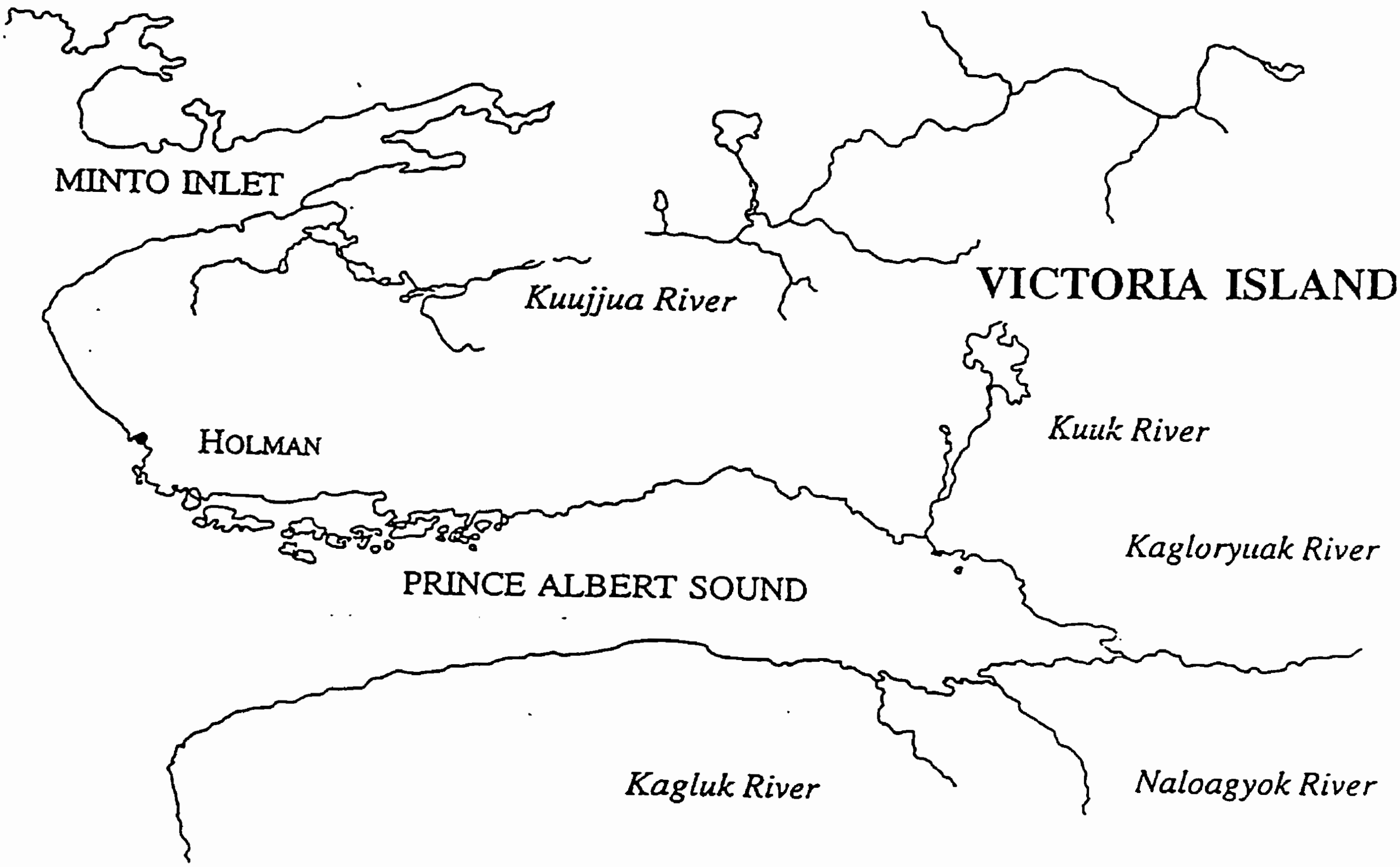
Exact Number: _______

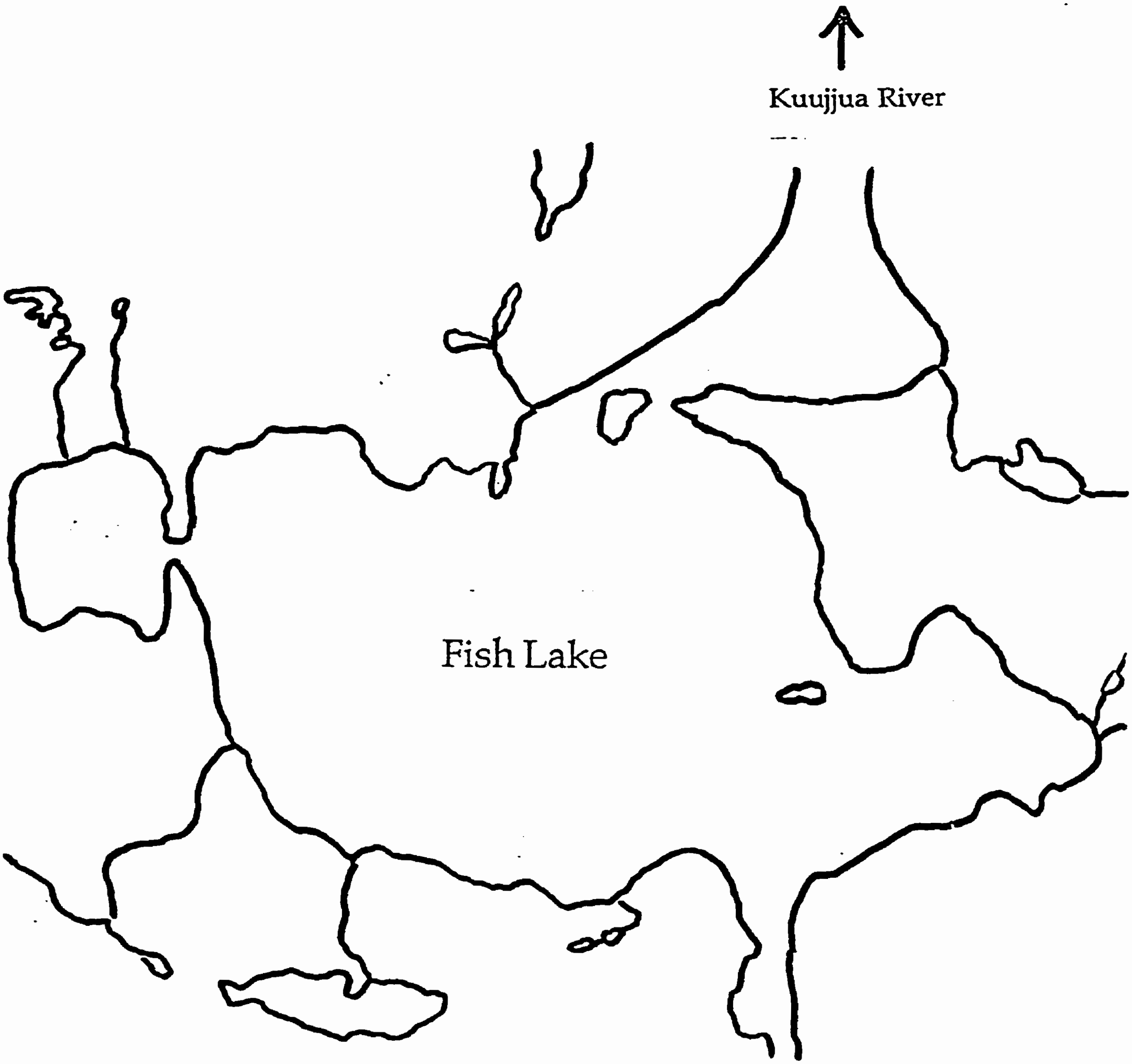
4. How many charr did your household catch in the **WINTER** of 1996? (please write exact number if you know)

a) 0
b) 1 - 50
c) 50 - 100
d) 100 - 200
e) 200 - 300
f) 300 - 400
g) other _______

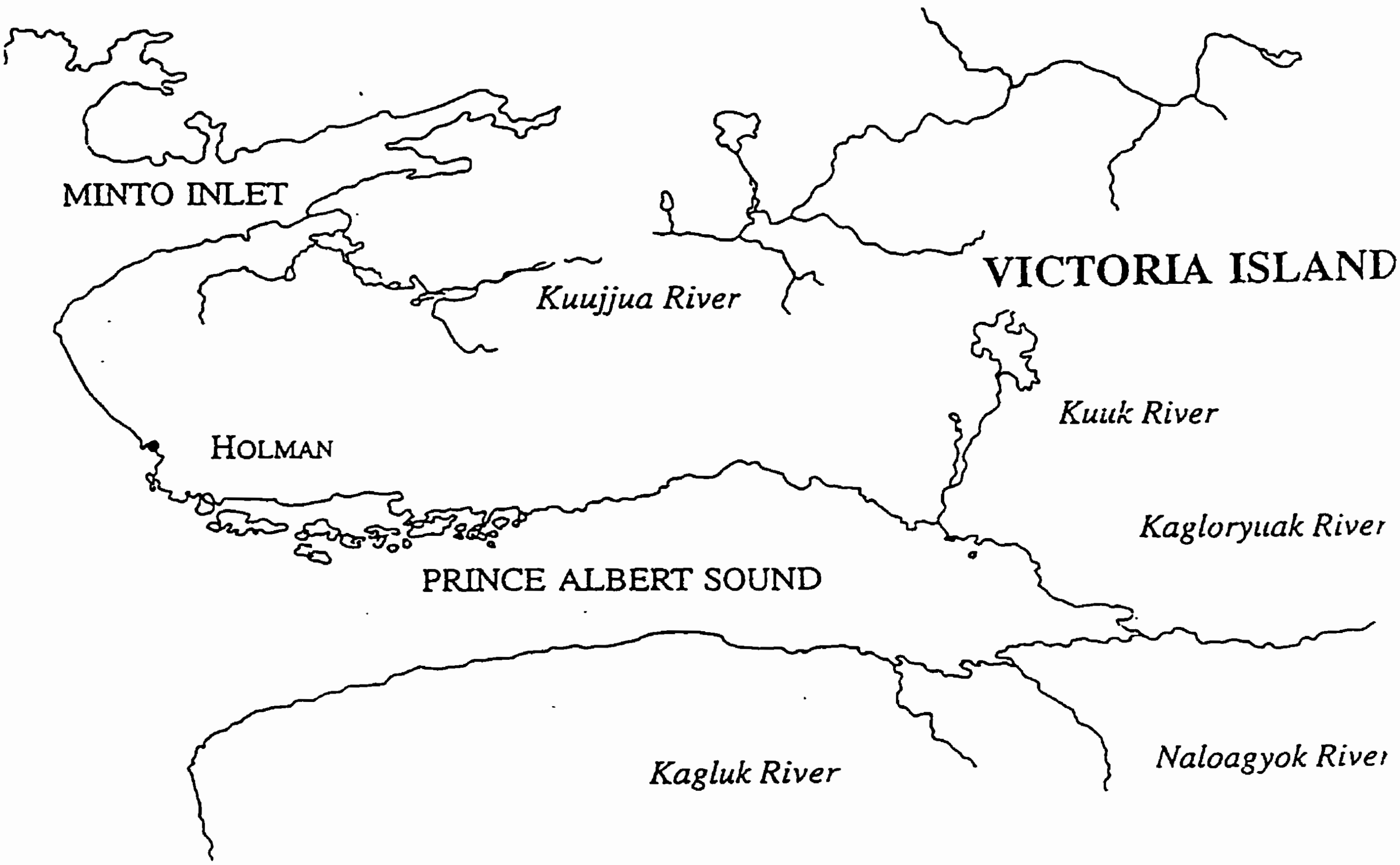
Exact Number: _______

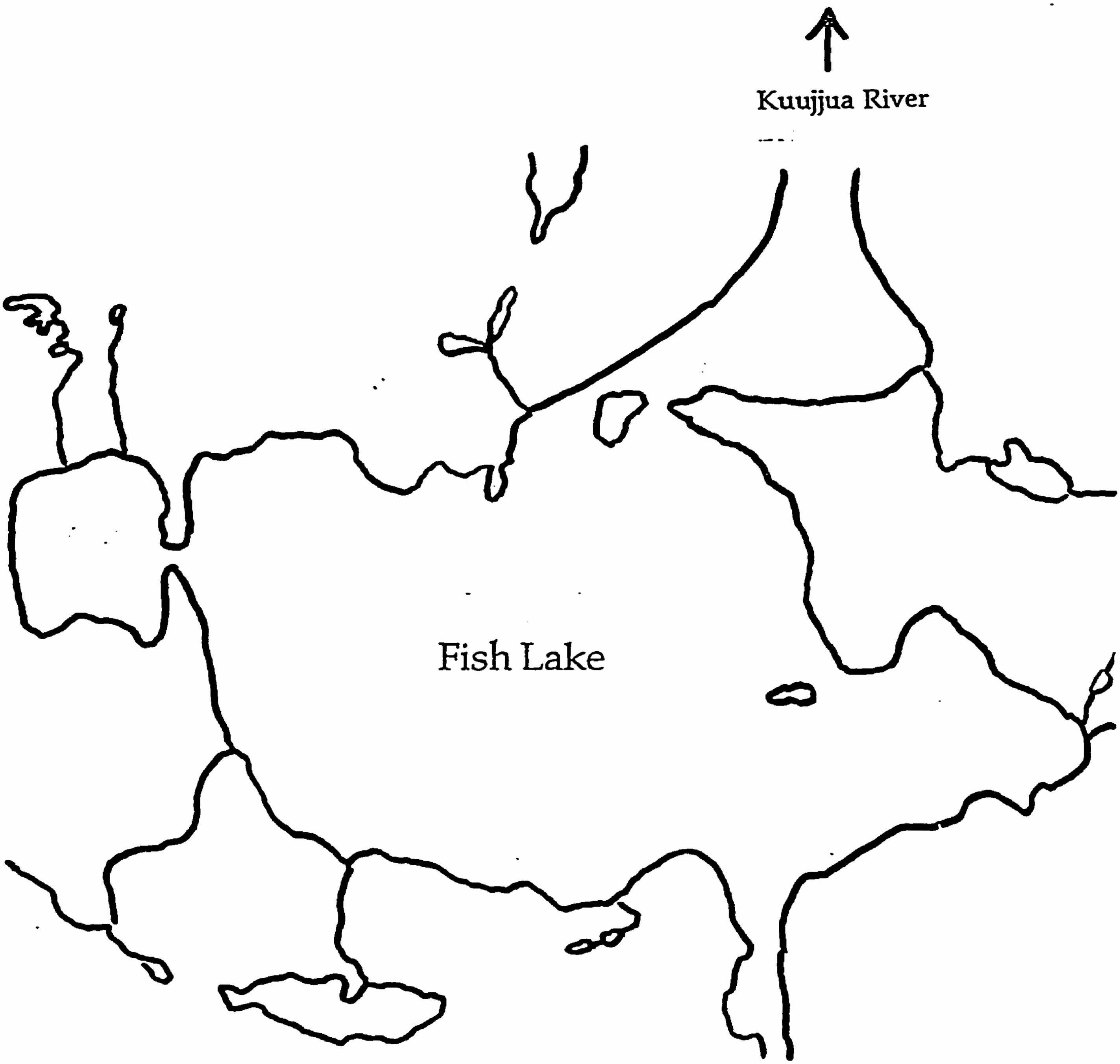
5. Mark on the map where you (or any other member from your household) fish for charr (non-commercial) over the last five years. Mark what year and month you would fish that location. (ie/ mark where you fished in 1996, 1995, 1994.....)

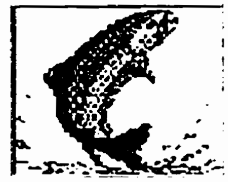



Kuujjua River
Fish Lake

6. At the locations where you (or any other member from your household) fish for charr, mark what gear you would normally use and how many charr you caught at that location in 1996.




Kuujjua River
Fish Lake

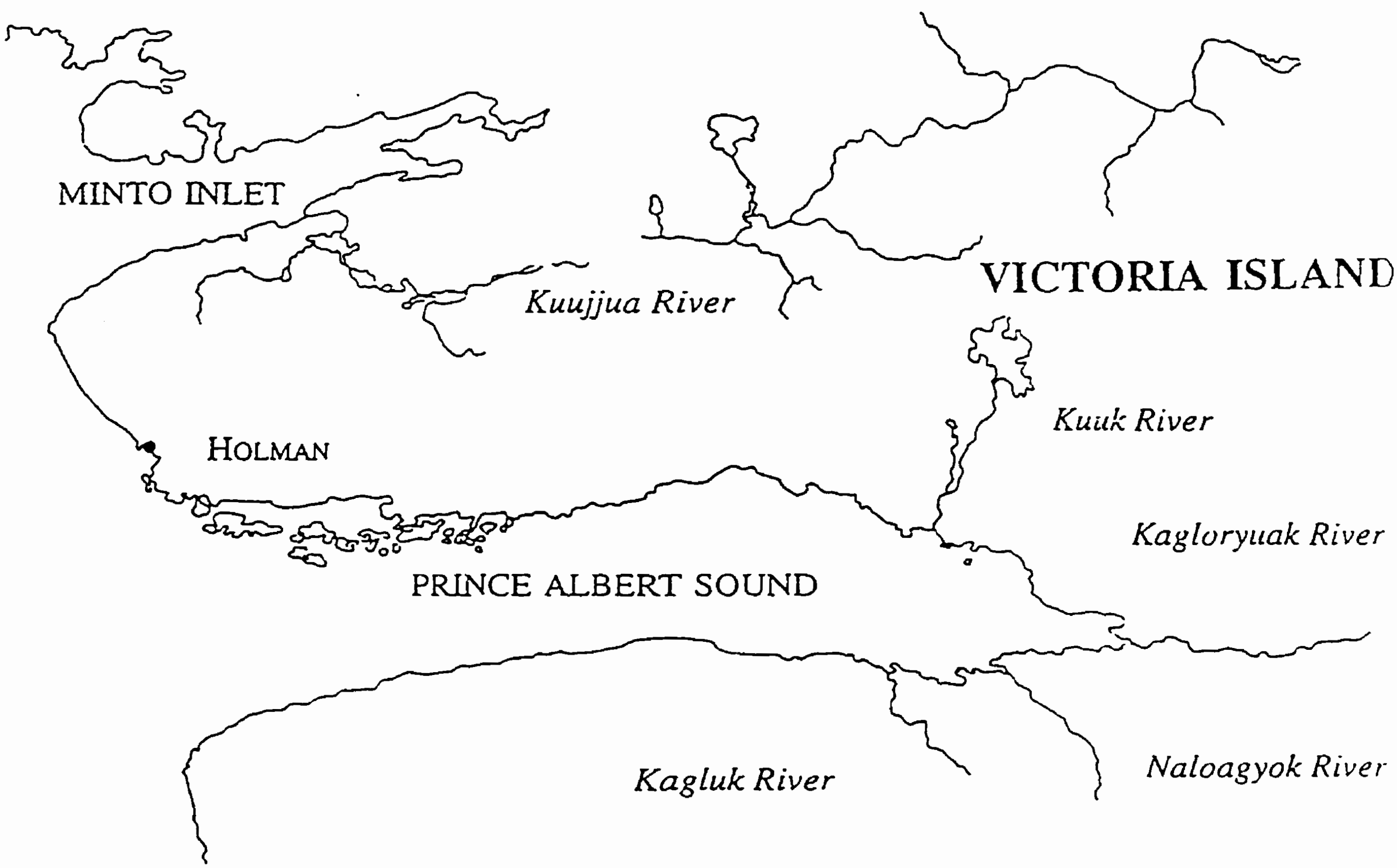


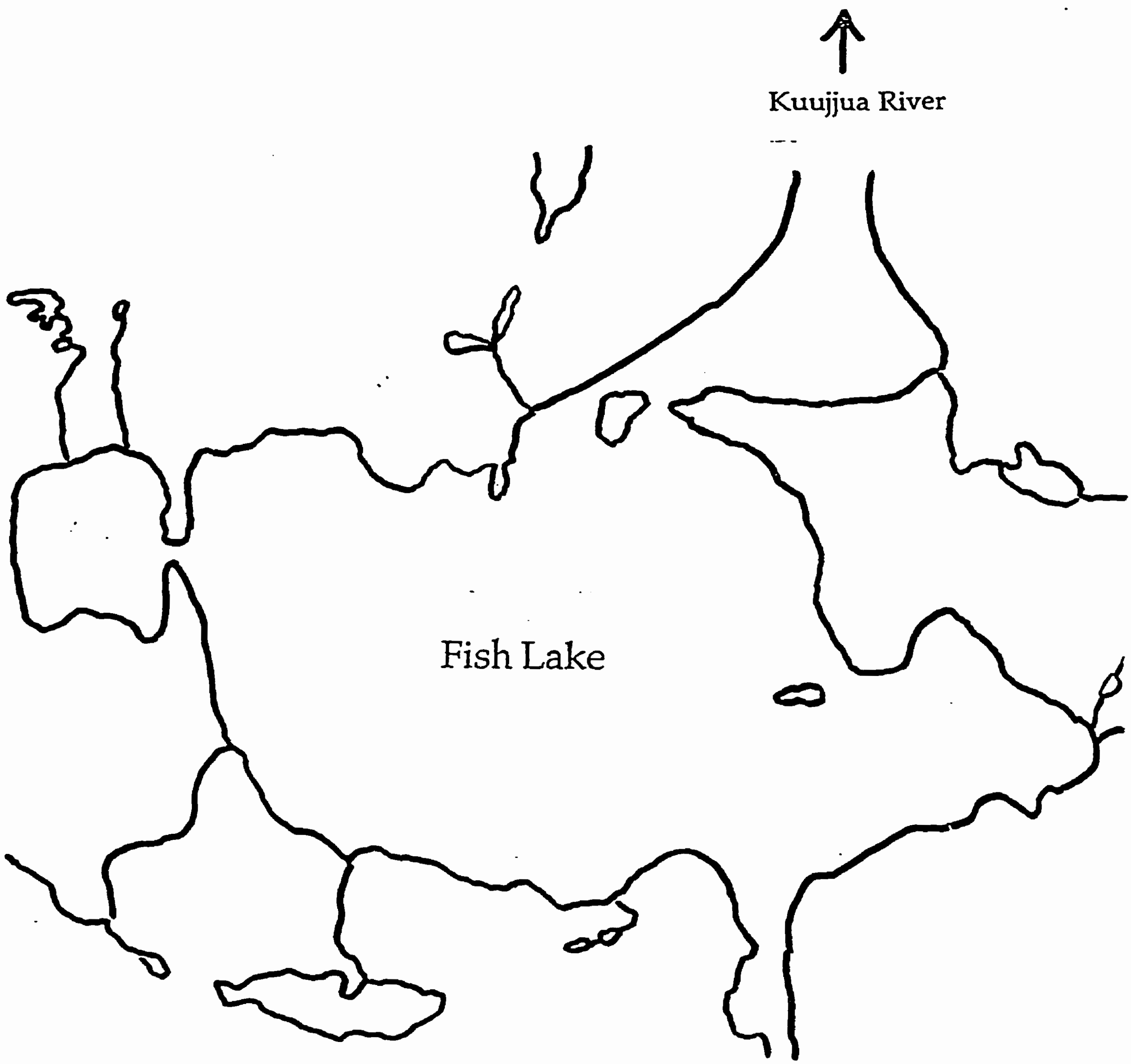
7. Mark on the map any location in which you (or any other member from your household) have caught charr which contain eggs. Please indicate if the charr that had eggs was red or silver at the time and the size of the eggs.

EGG SIZE

1) o

2) ◯





Kuujjua River
Fish Lake

8a. In which month did you catch the most charr during 1996? ________

8b. Was this because there were more fish or because you spend more time fishing? ________

9. How often do you or your family eat arctic charr?

a) every day
b) twice a week
c) once a week
d) twice a month
e) once a month
d) other ________

10. What type of arctic charr do you prefer? (size, colour, location etc.)

11. In 1996, did your household consume the preferred type of charr? If not, why not?

12. Does your household use charr that you do not catch yourself? (yes or no) ______

If yes, where do you get the charr and how much do you usually receive in a year?

a) from friends ______
b) from family ______
c) HTC ______
d) other communities ______
e) other ______

13. During 1996, did any members of your household trade or share charr between households or between communities? (yes or no) _______

If yes how much charr did you **give** in 1996? _______
how much charr did you **receive** in 1996? _______

14. Is your current yearly harvest of charr.....

a) more than enough
b) ok
c) not enough

15. Do you think your household "need" for charr will increase in the future? (yes or no) _______
Why ______________________
eg/ no, because my family is grown & moved out
eg/ yes, because I have more people to feed

16. Do you own your own nets? (yes or no) _______

If **yes**, what size and how many? eg/

SIZE	NUMBER
4.5"	4 nets

If **no**, who owns your nets, what size are they and how many do you have?

eg/

SIZE	NUMBER	WHO OWNS
4.5"	4 nets	HTC

17. Do you feel that the community as a whole takes too many fish? (why?)

18. Is there fish wastage?

19. Have you changed your fishing locations in the last five years (eg/ have you been fishing farther from Holman?) If yes, Where? Why?

20. Would you be prepared to move your fishing location further from Holman? If yes, how far would you be willing to go?

21. In the last three years (since the closure of Fish Lake) has the size of your charr increased or decreased ? _______

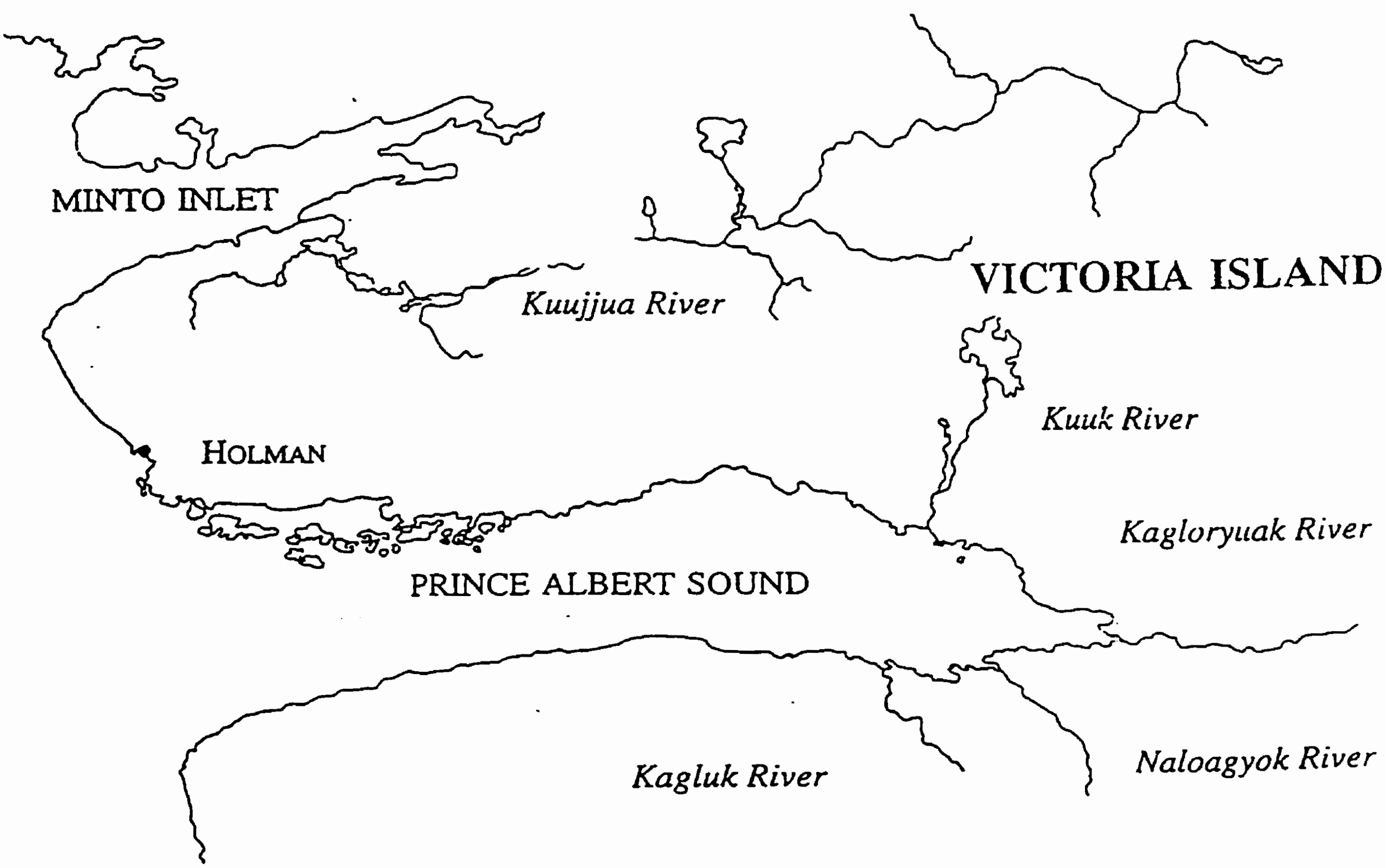
22. In the last three years (since the closure of Fish Lake) has the size of your catch increased or decreased ? _______

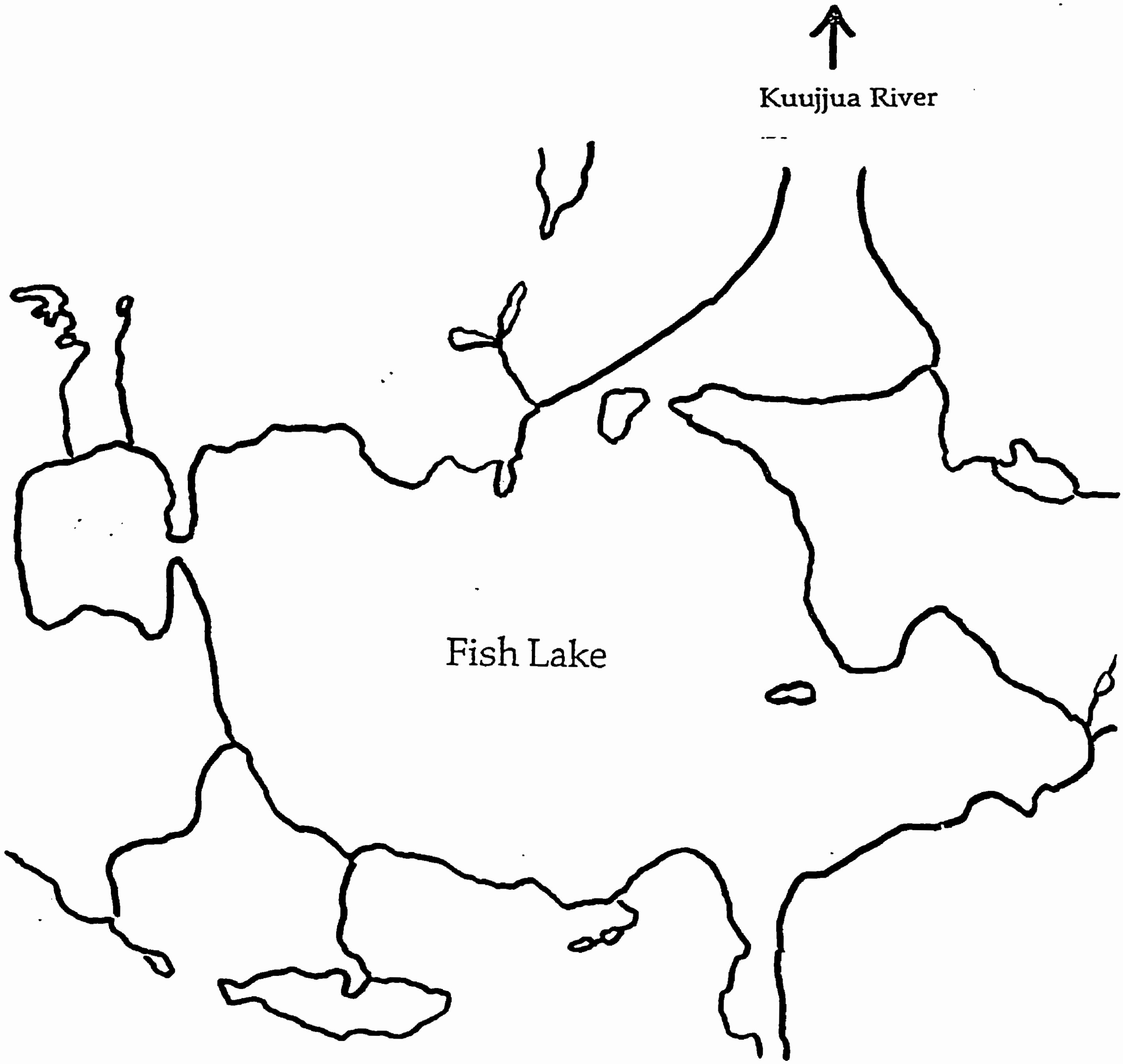
23. What portion (%) of your household foods were country foods in 1996?

a) 25%
b) 50%
c) 75%
d) 100%

24. In the last five years (1991 to 1996), have you had to fish more often or harder (e.g. use more nets or set nets for longer periods of time) than before to catch the same amount of charr?

25. What other types of fish did you catch in 1996? Mark on the map where you catch other fish, what you use to catch them, and how many you catch.




Kuujjua River
Fish Lake

ALL FISHERMEN IN THE HOUSEHOLD ANSWER INDIVIDUALLY PLEASE

26. Are you aware of the community fishing plan? (yes or no)

INDIVIDUAL #: 1) ______ 2) ______ 3) ______

4) ______ 5) ______ 6) ______

27. Do you feel that Holman needs a community fishing plan? (yes or no)
If yes, who do you feel should participate?

a) community representatives
b) HTC
c) FJMC
d) DFO
e) all of the above
f) other

INDIVIDUAL #:

1) ____________ 2) ____________ 3) ____________

4) ____________ 5) ____________ 6) ____________

28. How do you think data on the fishery should be collected?

a) by community monitors
b) by DFO
c) by a privet consultent
d) by the Inuvialuit Harvest Study
e) other

INDIVIDUAL #:

1) ____________ 2) ____________ 3) ____________

4) ____________ 5) ____________ 6) ____________

29. Would you like to take a more active role in the community fishing plan? If yes, what sort of role?

INDIVIDUAL #:

1) ____________ 2) ____________ 3) ____________

4) ____________ 5) ____________ 6) ____________

30. What would be the best time for a community fishing plan meeting?

INDIVIDUAL #:

1) ____________ 2) ____________ 3) ____________

4) ____________ 5) ____________ 6) ____________

31. Would you accept limits being placed on the summer charr fishery if they were set by.......

a) community representatives
b) HTC
c) FJMC
d) DFO
e) I would not accept a limit on the summer fishery

INDIVIDUAL #:

1) ____________ 2) ____________ 3) ____________

4) ____________ 5) ____________ 6) ____________

32. What type of management approach do you feel is most appropriate for the charr fishery? (please rank in order of preference eg/ 1) d, a, c)

a) limits on the summer fishery
b) limits on the winter fishery
c) quota's on both fisheries
d) larger mesh size regulations
e) closure of certain areas
f) none
g) other

INDIVIDUAL #:

1) ______________ 2) ______________ 3) ______________

4) ______________ 5) ______________ 6) ______________

33. Should a community fishing plan include bylaws? (yes or no)
If yes, which of the following bylaws should be included:

a) net sizes
b) fishing time
c) # charr taken
d) # nets per household
e) closed areas
f) mesh size

INDIVIDUAL #:

1) ______________ 2) ______________ 3) ______________

4) ______________ 5) ______________ 6) ______________

34. Do you agree with "Fish Lake" being open for fishing? (yes or no)_______

INDIVIDUAL #:

1) _____________ 2) _____________ 3) _____________

4) _____________ 5) _____________ 6) _____________

35a. Do you think there should be limits on the number of fish taken from the "Fish Lake" fishery ? (yes or no)

35b. If yes, what limit (per household) would you recommend?

INDIVIDUAL #:

1) _____________ 2) _____________ 3) _____________

4) _____________ 5) _____________ 6) _____________

36. What mesh size would you like to be using? (you may mark more than one size)

a) 3.5"
b) 4.0"
c) 4.5"
d) 5.0"
e) 5.5"
f) other

INDIVIDUAL #:

1) _____________ 2) _____________ 3) _____________

4) _____________ 5) _____________ 6) _____________

APPENDIX "B"

INFORMATION NEEDS AND STUDIES
PROPOSED AT
1998 HOLMAN CHARR WORKSHOP

Information Needs and Outline of Study Proposal

The major conclusions from the assessment of the assumptions were firstly that the charr in Minto Inlet Area and the charr in the Prince Albert Sound area are most likely two separate complexes which overlap in the area between Holman and Safety Channel during the summer but generally maintain discrete over-wintering populations. Secondly it was concluded that while the Kuujjua River/Minto Sound system is very productive the annual estimated harvest rate of about 40% of the Kuujjua charr is not correct. This is probably in part because the population size has been underestimated and probably in part because other rivers are contributing to the Holman fishery and to the Kuujjua over-wintering population. Specific knowledge needs were categorized as follows:

abundance of charr in the Kuujjua River system;
life history of Kuujjua River charr;
status of the Minto Inlet arctic charr complex
the fishery

<u>I. Abundance of charr in the Kuujiua River system.</u>

We need to have a better handle on the total charr population utilizing the Kuujjua River including the following: populations below the weir in ponds and possibly overwintering in the ocean; earlier movements of possibly larger and older fish; spawning populations including size and locations throughout the system; and juvenile abundance and rearing locations.

Projects/studies to address the information and knowledge needs in order of time and priority include:

Reconnaissance studies - location and time studies focusing on non juveniles, including spawners and non-spawners, movements and holding areas throughout the system, other than in the lake. This should take place in the first year.

Movement studies - movement of charr within the system possibly using radio tags. This should take place after the reconnaissance studies.

Population estimation studies - using mark-recapture techniques (non-weir) after the reconnaissance studies and possible tagging studies. The location would be logically be at the Kuujjua but consideration could be given to tagging at the fishing site near Holman, this could answer the questions but in a different way. Another weir is not considered practical since assessments are it would only work under low water conditions.

II. Life history of Kuujjua River charr.

We need better estimates of vital rates including the following: egg survival; juvenile survival; age and size variability at smolting; age and size variability at recruitment into the fishery; growth and survival after recruitment; age and size at maturity and spawning frequency and fecundity.

Projects/studies to address the information and knowledge needs in order of time and priority include:

Fisheries monitoring studies - ongoing studies will contribute to age and size at recruitment and growth and survival after recruitment. (Note: any assessment of a pulse of recruits would have to be reactive. Other studies would not be practical.).

Otolith studies - using samples from the ongoing monitoring studies and from the reconnaissance studies (I1) should contribute to the age and size variability at smolting and possibly to determining the age and size at maturity and even spawning frequency.

Reconnaissance studies (I1.) - independent of the otolith analysis these studies may also contribute to understanding age and size at maturity.

Other studies - studies of egg survival and juvenile survival are not considered of high priority at this time.

III. Status of the Minto Inlet arctic charr complex.

We need to know more about charr that over-winter in the Kuujjua and that may be harvested in the area adjacent to Holman but that originated from spawners coming from rivers other than the Kuujjua. Specifically we need to know: what other rivers have charr populations; how big those char populations might be or might once have been; how important those other charr rivers are to the Kuujjua over-wintering population; how important they are to the Holman fisheries; and how discrete they are genetically or in point of origin.

Projects/studies to address the information and knowledge needs in order of time and priority include:

Community TEK Assessments - Community members should be interviewed for their knowledge about other rivers that may have been fished in the past. Information requested would include past evidence of habitation both permanent and temporary as well as specific information about fish harvesting. It would also include information on timing, type of fish (silver or colored) and year to year variability. Areas would include the north coast of Minto Inlet, north west of Minto Inlet along the Amundsen Gulf, north west of Holman, south east of Holman to Safety channel and half way to Kuuk River and the north west part of Wollaston Peninsula to Cape Bering.

Other background studies - Desk analysis should be carried out on land use planning documents, documents from earlier pipe line studies and other studies as available. This should be carried out concurrent with the community TEK study.

Field surveys - Opportunities for collections of fish and water, for potential micro-pixie analysis should be integrated with the reconnaissance, monitoring and other surveys. Field surveys of a broader scope, e.g. with PCSP support or CCG support or other, should be advanced on an opportunistic basis after the community TEK assessments have been completed so that the broader studies can be more focused and effective.

Genetic work - Genetic work or other stock identification work (e.g. micro-pixie analysis) should be planned for and samples taken in conjunction with the other field sampling programs but analysis should not commence until there is a specific hypothesis to be tested. Other systems than the Kuujjua offer better opportunities for developing genetic identifiers for Arctic charr.

IV. The fishery

We need to have continuing information on the following: size of harvest; sex, maturity, age and size structure of the harvest; timing of the harvest; and catch per unit effort. Projects/studies to address the information and knowledge needs in order of time and priority include:

Inuvialuit harvest study - The Inuvialuit harvest study needs to be continued.

Fish lake monitoring study- The fish lake monitoring study needs to be continued.

Summer monitoring - The Holman summer monitoring needs to be continued.

Other Prince Albert Sound fishery issues - The HTC will also want to address other Prince Albert Sound issues.

Conclusions and Next Steps

The workshop identified information needs and priorities for studies to address those needs in four areas. These priorities should form the basis for a two-four year research and monitoring plan. Specific studies for the 1998 need to be developed immediately for discussion with the Holman HTC and for integration into the Holman fishing Plan at the June 1998 meeting.

IMAGE EVALUATION TEST TARGET (QA-3)

150mm

6″

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989