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7
Adaptive Fisheries Co-Management in the Western Canadian Arctic

Burton G. Ayles, Robert Bell, and Andrea Hoyt

For a thousand years, the Inuvialuit and their ancestors' people have occupied the lands in the western part of the Canadian Arctic bordering the Beaufort Sea (McGhee 1976; Taylor 1976; Alunik et al. 2003). Although significant economic, social, and political change has occurred in the last fifty years and the majority of Inuvialuit are now part of the wage economy, hunting and fishing, particularly subsistence fishing, remain critical to the livelihoods of the Inuvialuit (Ayles and Snow 2002; Day 2002; Usher 2002; Alunik et al. 2003).

In 1984, the Inuvialuit and the government of Canada signed the first comprehensive land claim settlement for a region wholly within Arctic Canada, the Inuvialuit Final Agreement (IFA) (Canada 2005; McCann 2005). Established by the IFA, the Inuvialuit Settlement Region (ISR) has an area of approximately 1.09 million square kilometres of land, water, and ice (Bailey et al. 2005). The IFA also established a co-management system for all matters relating to the management of living resources and their habitats in the ISR (Bailey et al. 1995). Berkes and colleagues (2005) discuss various aspects of the evolution of renewable resource co-management in the ISR and elsewhere in the Canadian Arctic. Kristofferson and Berkes (2005) make the argument that adaptive co-management has been a step in the evolution of resource management of Arctic char in the Cambridge Bay area of Nunavut. The concept of adaptive management, as developed by Holling (1978) and Walters (1986), emphasizes the notion of treating resource management actions as experiments from which managers could learn. Adaptive co-management, as defined in Chapter 1, combines the learning dimension of adaptive management with the sharing of rights and responsibilities of co-management.

This chapter examines how co-management of fisheries, within the context of a comprehensive Arctic land settlement agreement, has led to adaptive management practices and how adaptive management feeds back to

strengthen the co-management process. The co-management context is described, as are adaptive management practices and their results. Three case studies of adaptive fisheries co-management initiatives are discussed. The initiatives vary in terms of complexity of the fisheries, relationships between agencies, and level of success or failure. Themes addressed in this chapter include: partnerships and power sharing; institutional designs for adaptive co-management; and conditions of adaptive co-management success and failure. Recommendations are made for the management of Western Arctic fisheries, and lessons learned for fisheries co-management in other parts of the world are presented.

Fisheries Co-Management in the Western Arctic

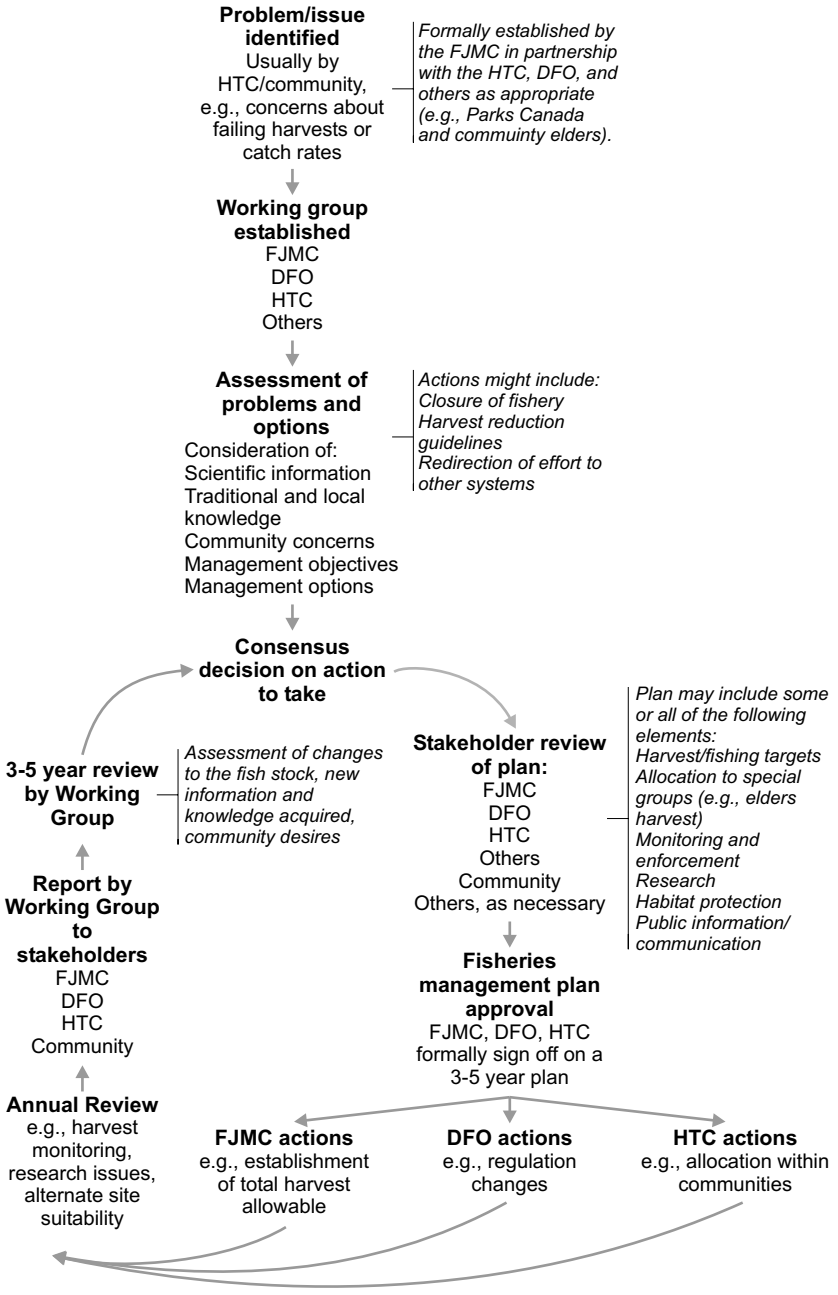
In the Western Arctic, co-management refers to the legislatively based sharing of management responsibilities between beneficiaries and the responsible government agency (Bailey et al. 1995; FJMC 2005). The Fisheries Joint Management Committee (FJMC) is the co-management board with responsibilities for fish and marine mammals in the ISR. Specific responsibilities of the FJMC are defined in the IFA, the Fisheries Act, and the Oceans Act. Some decisions are assigned to a single agency; for example, the FJMC is responsible for allocating subsistence quotas among communities, while local Hunters and Trappers Committees (HTCs)[1] are responsible for the suballocation of community shares and other quotas among individuals. Other decisions are shared; for example, the FJMC advises the Minister of Fisheries and Oceans on regulations and research, and funds research by the Department of Fisheries and Oceans (DFO), universities, and the communities.

The FJMC is a mature organization that has operated for over twenty years and has fully institutionalized procedures (FJMC 2005; Iwasaki-Goodman 2005). While post-IFA agreements are structured differently and have transferred some additional responsibilities to the co-management bodies (Ayles and Snow 2002), fisheries co-management in the ISR essentially meets Pinkerton's key aspects (2003) of "complete co-management."[2]

In the years since it was established, the FJMC, in cooperation with the DFO and the HTCs, has moved towards the development of integrated fisheries management plans for individual fish stocks or stock complexes as the process for establishing conservation, socio-economic, and ecosystem objectives; strategies to support those management objectives; and plans to implement those strategies. The evolving process (Figure 7.1) follows a general DFO model[3] and remains flexible enough to reflect the specifics of the resource and the needs of the communities. The development of each fisheries management plan is an ongoing, cyclical process driven by a multi-agency working group. The group is responsible for assessing the problem, considering a range of management alternatives, monitoring the implementation of the consensus decisions, reviewing the results, and modifying the

Figure 7.1

A generalized cycle of adaptive fisheries co-management in the Inuvialuit Settlement Region



actions at the end of the planning cycle. The HTCs, the DFO, and the FJMC are responsible for the final decisions and implementation.

The development of the process has been driven by several institutional factors (see Chapter 4), primarily the goals of the IFA, the terms of reference for the FJMC, the terms of reference for the HTCs, and DFO policies related to integrated fisheries management planning. Table 7.1 summarizes these key institutional factors in relation to Walters' three cyclical phases (1986) in the adaptive management process (identifying a range of management alternatives, developing key management indicators, and designing and implementing an effective monitoring system) and Hilborn's three essential steps (1992) in institutional learning from trial and error (documenting decisions, evaluating results, and responding to evaluation).

The institutional factors identified in Table 7.1 are further developed through the FJMC's strategic plan (FJMC 2002). The vision of the FJMC is that fish and marine mammal resources will be managed and conserved for the wise use and benefit of present and future generations through use of sound scientific and traditional knowledge, effective co-management, and support of Inuvialuit culture, beliefs, and practices with respect to fish and marine mammals. Fundamental principles particularly related to adaptive co-management are the following:

- Incorporate the "precautionary principle" in the FJMC's approach to the management of the renewable freshwater and marine resources of the ISR.
- Support the spirit and principles of co-management in the FJMC's approach to the management of the fish and marine mammals of the ISR.

Besides the institutional factors summarized above, the FJMC has established practices that, while not specifically directed towards adaptive management, have fostered cross-scale interactions and social learning within the HTCs, the FJMC, and the DFO. These practices include:

- frequent FJMC meetings (at least five annually) and teleconferences to discuss fisheries issues in the ISR
- meetings with the Minister of Fisheries and Oceans to discuss critical issues and provide advice and recommendations
- facilitation of numerous resource management workshops that involve both scientific and community members
- meetings in each community every eighteen months to discuss community issues
- active participation (non-voting) of the regional DFO representative in virtually all meetings

Table 7.1

Relationship between some of the key institutional factors in the development of the fisheries management planning process in the Inuvialuit Settlement Region (ISR) and their significance for adaptive fisheries management*

Key institutional factors	Significance for an adaptive management process
The goals of the Inuvialuit Final Agreement are (Section 1.[1]): (a) to preserve Inuvialuit cultural identity and values within a changing northern society; (b) to enable Inuvialuit to be equal and meaningful participants in the northern and national economy and society; and (c) to protect and preserve the Arctic wildlife, environment and biological productivity.	Inuvialuit need to be involved in management decision making, thereby ensuring input of local and traditional ecological knowledge, and the aspirations and needs of local people, as well as consideration of a range of alternatives for managing the fisheries resource(s).
The terms of reference for the Fisheries Joint Management Committee (FJMC) gave the Inuvialuit certain rights and priorities for fish harvests (Sections 14.[24]-[35]) and require the FJMC (Section 14.[61]-[72]) to review fisheries information, determine harvest levels, restrict and regulate aspects of fishing, allocate quotas among communities, recommend to the Minister of Fisheries and Oceans on a range of topics, and advise the minister on any issues related to fisheries in the ISR (14.[61]-[72]).	The FJMC as well as the Department of Fisheries and Oceans (DFO) has to be involved in the management of the fisheries of the ISR. The involvement of the different agencies ensures consideration of a range of alternatives for managing the stock(s). The requirement to review information and determine harvest levels necessitates the establishment of monitoring programs in order to provide the necessary information and make the decisions. Because they involve different agencies, these requirements necessitate a formal decision-making process and documentation and evaluation of results on a regular (cyclical) basis. This also means that the FJMC should have funding to address the necessary tasks.

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◄ *Table 7.1*

Key institutional factors	Significance for an adaptive management process
The terms of reference for the Hunters and Trappers Committees (HTCs) (Section 14.[75]-[79]) give them responsibilities for sub-allocation of quotas within their jurisdiction, making bylaws with respect to their own harvest, and assisting in providing harvest data.	Individual HTCs as well as the FJMC and DFO have to be involved in the management of local fisheries. It also requires the establishment of a system to monitor the results of decisions on harvests.
DFO policies for the development of integrated fisheries management plans provide a process for standardized development of plans nationally but allow regional flexibility to address specific needs.	In the ISR, the framework has been modified to ensure that Inuvialuit traditional ecological and local knowledge are publicly documented and considered in scientific stock evaluations and that Inuvialuit are fully involved in all aspects of the development of the plans. The process also requires formal performance reviews.

***** As identified by Walters (1986) and Hilborn (1992).

- meetings with industry to discuss development issues of relevance to the committee
- direct involvement of individual members in working groups responsible for developing fish management plans
- leadership, training, and assessment of community-based projects by the FJMC resource biologists and DFO staff.

In her analysis of the personal interactions during FJMC meetings, Iwasaki-Goodman (2005) noted consensus decision making, respect for differences of opinion of other members, the personal friendships that had developed among members, and recognition by members of the important role that the FJMC plays in resolving conflicts.

It is our assessment that the overarching institutional factors, including legislation, federal policies for integrated fisheries management, the FJMC strategic plan and vision, and FJMC operating procedures, have been critical for the development of an adaptive co-management process for fisheries in the ISR. These institutional factors have been supported by the strategic factors of social organization that have facilitated the necessary cooperation. In the following section, we discuss three fisheries co-management initiatives that vary in terms of complexity of the fisheries, relationships between

agencies, and level of success or failure but have all evolved towards a system of adaptive management (Figure 7.1). This system has strengthened co-management in the local community and the ISR. As we will see, however, not all fisheries management initiatives in the ISR have met with success.

Case Studies

Fish were probably the single most important element in the traditional diet of the Inuvialuit (Alunik et al. 2003), and two very similar species, Dolly Varden char (*Salvelinus malma*) in streams west of the Mackenzie River and Arctic char (*Salvelinus alpinus*) in streams east of the Mackenzie River, are the most highly valued culturally and for sustenance.

Char are anadromous. In the simplest description of the life history, they spawn, the eggs incubate and hatch, and the young spend their first few years in fresh water. At four to five years of age, the char migrate to the sea in the summer to feed in the richer marine environment and then return, generally to the same river where they were spawned, to overwinter. The concentrations of char summering (feeding) in nearshore coastal waters and later returning to the rivers in the late summer are the focus for local harvests. In reality, both char species exhibit complex life histories and complex stock interrelationships that are not well understood, and fisheries management can be problematic. Kristofferson and Berkes (2005) have discussed some of the problems of conventional management of Arctic char and described how Inuit traditional management practice and conventional scientific management practice can potentially complement each other in an effective adaptive management regime.

This section describes the management of char fisheries in three highly traditional communities – Paulatuk, Holman, and Aklavik (Table 7.2) – where one-half to three-quarters of the population are involved with hunting and fishing (compared with 36.7 percent for the Northwest Territories as a whole), and one-third to one-half of the households indicate that traditional foods comprise at least half of their daily intake (compared with 17.5 percent for the Northwest Territories as a whole). This reliance on country foods may be further encouraged by the fact that the food price index for the communities is almost twice that of Yellowknife (Yellowknife food price index = 100). These figures demonstrate the importance of the subsistence economy and the potential impact from the loss of one of its main constituents, in this case, Arctic char or Dolly Varden char.

All three systems were periodically harvested for subsistence use prehistorically and more heavily beginning in the last century as people moved off the land and communities became established (Table 7.2). In the 1960s and 1970s, governments encouraged the establishment of commercial fisheries in these systems, but all eventually closed (Corkum and McCart 1981). Present-day fisheries are primarily for subsistence use.

Table 7.2

Basic community information for the three Inuvialuit communities involved in the case studies

	Paulatuk	Holman	Aklavik
Community information			
Total population	312	421	631
% hunters and fishers	49.5	76.1	49.3
% of households that rely on traditional foods*	51.9	45.8	35.5
Food price index**	193	182	183
Number of HTC members	119	Not available	238
Working group membership	Chair (HTC), HTC (5), DFO (1), FJMC (1), PC (1)	Chair (HTC), HTC (varied), FJMC (2), DFO (2)	Chair (HTC), HTC (2), FJMC (4), DFO (1), PC (1), Elders Committee (2)
Key developments in the adaptive co-management of char fisheries			
Pre-1960s	Subsistence fishery.	Subsistence fishery.	Subsistence fishery.
1960s and 1970s	Commercial fishery established with support from INAC. Very small sport harvest established then ended.	Small sport fishing outpost established on Kuujjua River, then closed.	At least two attempts made to initiate commercial fisheries. Large subsistence harvests in the late 1970s.
Early 1980s	Total harvests rose gradually, then declined.	Assessments of the potential of establishing commercial fisheries.	Harvesters reported concerns about decreasing harvests and observed numbers of fish.

1984-86	IFA was signed and new roles were determined for FJMC and HTCs.	IFA was signed and new roles were determined for FJMC and HTCs.	IFA was signed and new roles were determined for FJMC and HTCs.
Late 1980s	*1986:* Age and length of fish had decreased and CPUE was very low. *1986:* Commercial fishing ends. Subsistence harvests continued at a low level.	*1987:* Community members expressed concern over decline in size and abundance of char. Scientific assessment studies were carried out.	HTC asked for an investigation into decreasing harvests. Scientific assessment (weir counts and tagging) indicated that overfishing was the problem. *1987:* HTC asked that the fishery be closed.
1990s	Subsistence harvests rose. *1995-97:* Fishers expressed concerns as harvest, average size, age, and CPUE decreased. *1996:* Working group established. *1997:* Draft fishing plan in place. *1998-2002:* Formal plan approved by HTC, DFO, and FJMC, and implemented.	*1991:* Review of scientific and local knowledge and community issues. *1993-95:* First fishing plan developed by HTC, FJMC, and DFO. *1996:* Working group established.	Some fishers reported changes in water levels and water quality in river. *1992-97:* Fishery reopened to limited subsistence harvest but catches remained poor. Conflict between community members and DFO. *1998:* Preliminary habitat survey indicated low water flows and possible changes in water chemistry.

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◀ *Table 7.2*

	Paulatuk	Holman	Aklavik
2000-4	*2003-5:* New plan of expanded scope implemented.	*1996-2003:* Series of fishing plans, usually with three-year life spans, and progressively more comprehensive.	*2000:* FJMC proposed new management regime. Minister of Fisheries and Oceans agreed, contingent upon completion of a satisfactory management plan. *2001:* Working group formed. *2003:* Scientists and fishers explicitly recognized that habitat change was likely limiting the size of the stock.
2005	Fishery has recovered from its low point and stock is healthy. Plan is being reviewed and modified for 2006 implementation. Working group is functioning very well.	Fishery remains stable and the stock remains healthy. 2004-6 plan is in place. Working groups are functioning very well.	No evidence of stock recovery. No formal plan yet in place. Decreasing interest by fishers. Working group now trying to shift focus to environmental monitoring by community youth and elders.

Note: CPUE = catch per unit effort; DFO = Department of Fisheries and Oceans; FJMC = Fisheries Joint Management Committee; HTC = Hunters and Trappers Committee; IFA = Inuvialuit Final Agreement; INAC = Indian and Northern Affairs Canada; PC = Parks Canada.

* NWT (2005).

** Yellowknife food price index = 100.

Paulatuk Arctic Char Management Plan

The Arctic char harvested by the community of Paulatuk come from what is believed to be a discrete stock, geographically isolated and confined to the Hornaday river system (DFO 1999). Although the char were undoubtedly harvested in past centuries, modern subsistence use dates back to the 1940s (PHTC 1999). Characteristics of the fisheries prior to 1986 are summarized in Table 7.2.

A decline in harvests and catch per unit effort (CPUE) in the early 1980s suggested to the community and to the DFO that the stock was being overexploited. As a consequence, no further commercial fishing licences were issued for this stock (DFO 1999). The subsistence fishery, monitored by the community through the Inuvialuit Harvest Study (Harwood 1999; Anonymous 2003) continued at a low level (1,800 to 3,200 char) from 1988 to 1994, then rose to 3,851 char in 1995. Harvests, average size and age, and CPUE decreased each year from 1995 to 1997 (Harwood 1999). Fishers became concerned about potential overharvesting, and a need for action to help the fishery recover was first identified formally at the Paulatuk HTC annual general meeting in the spring of 1996.

In the fall of 1996, with the support of the FJMC and the DFO, the Paulatuk HTC established a working group (Table 7.2) and charged it with assessing the problem and with developing options for a management plan for the fishery. The group met four times from 1996 to 1998; each meeting lasted two to three days so that there was ample time to discuss and review the details and the data and to discuss options. Eventually the group developed a plan that was much broader than a more common western scientific approach. It was based on the blending of scientific and traditional knowledge and community aspirations for the fishery. It included not only harvest guideline recommendations but also seasonal and area closures, alternate fishing area strategies, community monitoring programs, community bylaws for fishing gear, identification of key habitat areas, and advice for research and monitoring programs (PHTC 1999). Reflecting the important role that elders play in Inuvialuit culture, the plan also contained special provisions for elders fishing. The goals of this co-management plan were:

- to ensure a healthy stock(s) of char in the Hornaday River and other char fishing locations in the Paulatuk area
- to preserve and protect char habitats in the Hornaday River and other char fishing locations in the Paulatuk area, to ensure that the char stocks continue to thrive
- to manage and conserve Hornaday River and other char in the Paulatuk area to ensure that subsistence needs of the residents of Paulatuk are met today and in the future.

Key elements to protect the stock and still maintain the fishery that was so critical to their culture and livelihoods were:

- limitation of the total annual harvest to 1,700 char per year and ensuring that a portion of this was set aside for elders
- continued endorsement of an ongoing fisher-based monitoring program to provide biological samples and catch and harvest data at the end of the fishing season
- limitation of maximum lengths for gillnets to 45.5 metres (50 yards) and minimum mesh size to 11.4 centimetres (4.5 inches)
- closure of fishing of areas of the Hornaday system critical for spawning and overwintering of char
- establishment of a financial support program for fishers to fish at alternate locations and for alternate species. The fishers who accepted support then agreed not to fish at all on the Hornaday.

Especially important was gaining support of the community fishers. The contents of the plan were presented to the public by the community working group members in three well-attended public workshops. The FJMC and DFO members on the working group provided technical support and background information and gave short presentations on the status of the stock, but most of the communication was from the community working group members to the fishing public. It took time and effort for the provisions of the plan to be accepted, digested, discussed in the community, and finally ratified.

The draft fishing plan was put into place for the 1997 fishing season, and a formal plan for the years 1998 to 2002 was approved by the HTC, the DFO, and FJMC in July 1998. The fishery operated for the next five years. Although there were no formal actions by the working group, it was critical to maintain the group momentum, so annual meetings were held. The DFO biologist on the committee provided the data analysis and reported annually to the HTC and FJMC on the state of the fishery and the plan. During the five-year period, fewer char were caught at the mouth of the Hornaday during the August upstream migration, closed areas were not fished, fish were provided to community elders, and the annual average harvest was 1,670 fish. The char stock responded in the way that the working group had anticipated. The DFO/community biological data showed an increase in CPUE and an increase in the average size of harvested char. The average age remained fairly stable through the first four years of the plan and then increased in 2002.

In 2002, the working group reconvened as usual but with a larger task at hand: to prepare the next version of the plan. The group's assessment was that the fish stock was recovering but that a recovery plan needed to remain

in place for at least another three years. Major changes proposed for the new plan included the following (PHTC 2003):

- an increase in total harvest from 1,700 to 2,000 fish
- opening of the closed area for fishing for 300 char explicitly for elders
- recognition that fish harvested in coastal fisheries of Darnley Bay should be considered part of the total harvest
- formalization of the community monitoring
- assessment of char stocks in the nearby Brock River system, and a tagging program to assess the relationship between Brock River and Hornaday River char.

The proposed 2003-05 Paulatuk Char Management Plan was presented to the public in Paulatuk at two public meetings and came into effect in June 2003. In December 2005, the current plan expired and the working group is assessing the latest data from DFO scientists, community-based monitoring results, harvest studies, and local knowledge on the Paulatuk fishery.

Although institutional factors (Table 7.1) helped guide the process, it is the assessment of some of the working group members that personal relationships and a common understanding of co-management were essential to the success of the plan. Group membership changed very little during the period, and this continuity was important for the development of personal relationships, social learning, and group dynamics. Members trusted each other and understood the role that each played within the overall process. Three members of the group – the original chair, the DFO biologist, and the FJMC member – had all worked together on the FJMC and had a similar understanding of how co-management should function in the ISR. The DFO and FJMC members provided technical, scientific, and management advice, but the leadership for the plan development rested with the HTC members. In particular, their interests can be seen in the parts of the plan that relate to fairness, equity, and fish for elders. This made it a stronger plan and ensured community support. In the past, the DFO would establish the plan internally based on biology, and then inform the community. The DFO plans were not even public documents.

The success of the plan, as exhibited not just by the recovery of the char stock but also by the community support it garnered, is a matter of pride for the working group and the Paulatuk HTC. It is viewed as a success for co-management in the wider ISR community, and in 2003, the working group members received the FJMC Co-Management Award for their contribution to co-management in the Arctic. A further result is that community members are ready to take greater personal responsibility for the management of their resources. A telling example occurred during the 2004 FJMC community meeting in Paulatuk, during which the working group reported on the

continued recovery of the char stocks and their intentions to renew the plan when it expired in December 2005. The current working group chair stated, "Some of the fellows in the HTC feel that, since the stock has recovered we don't need a Fishing Plan any more. But, don't worry. That is our problem. We will bring them around."

Holman Arctic Char Management Plan

The Arctic char harvested by the community of Holman on Victoria Island are from a mixed-stock complex. The primary fishery is based on char that spawn in the Kuujjua River, but char from the Kuuk, Kagloryuak, Naloagyok, and Kagluk rivers on Prince Albert Sound may also be harvested.

In 1987, at one of the first FJMC-sponsored community meetings, residents of Holman expressed concern over a decline in the size and abundance of char captured in the Kuujjua River system, the most intensely fished of the lake and river systems in the area. At that time, little biological information was available for any of the systems, so over the period from 1986 to 1992, a series of weir counts was carried out to estimate char populations in each of the four accessible river systems (Kuuk: Baker 1986; Stewart and Sparling 1987; Kagluk: Sparling and Stewart 1988; Naloagyok: Lemieux and Sparling 1989; Kagloryuak: Lemieux 1990). Each weir count was a collaborative operation involving individuals identified by the HTC, technicians and scientists from the DFO, and funding from the FJMC. Involvement of community members ensured that informal information from the projects was almost immediately available to the residents of the community.

In 1991, the FJMC, the DFO, and the HTC reviewed the scientific and local knowledge of the stock and addressed community issues. Results from weir counts and tagging and subsequent recapture of fish by Holman residents revealed not only that was there significant harvest during the fall at Tatik Lake and elsewhere on the Kuujjua but also that 50 percent of the coastal char harvest that occurred every summer in the vicinity of the community was of Kuujjua River origin (Kristofferson et al. 1984). Thus, reducing harvests in one area (e.g., Tatik Lake) was not going to accomplish the objective of stock rebuilding if fish were merely harvested at another location. There was therefore agreement that a larger plan was needed to ensure that all stocks within the area were effectively managed and that no single stock was overharvested. The resulting series of fishing plans, described below, usually had three-year life spans and they were progressively comprehensive.

The Holman Area Charr Fishing Plan (Holman HTC et al. 1993), which covered the years 1993 to 1995, was approved by the officers and directors of the HTC, endorsed by the FJMC and the DFO, and had three main elements:

- reduction of the harvest at Tatik Lake to near zero from the previous year's 2,700

- targeted reduction of the summer coastal fishery in the vicinity of Holman, largely fish from the Kuujjua River system, from the previous year's 4,000 fish to 1,000
- increase in the number of char taken from the four major rivers of Prince Albert Sound from 2,000 to 6,200.

The plan gave the HTC the role of allocating the 200 Kuujjua fish within the community, as well as devising mechanisms for reducing the coastal fishery. The plan was given a life span of three years.

In 1996, a formal working group was established (Table 7.2). At its first multi-day meeting in July 1996, and as a result of its deliberations plus discussions at a well-attended public evening meeting, the group agreed to a limited reopening of Tatik Lake, recommending a harvest of 25 char per household (Holman Charr Working Group 1996). The plan also recommended safe harvest levels for the Kuuk, Kagluk, Kagloryuak, and Naloagyok rivers.

By 1998, there was growing concern that, given current scientific models, data on harvest levels from the Inuvialuit Harvest Study, and the estimated population size, the Kuujjua River char population was again being overharvested. To assess the situation, the FJMC convened a workshop that involved its members, scientists and managers from the DFO, and representatives of the HTC, including members of the working group (Ayles 1998). In the discussion, it was agreed that both community experience and the technical monitoring programs suggested that there was no significant decrease in the size of fish caught or in the CPUE. Thus it was concluded that the population size was probably being underestimated, that other populations were contributing to both the coastal fishery in Holman and to the Kuujjua overwintering population, and that fishing should continue as described in the fisheries management plans. Given that the harvests were high relative to the population estimate, however, the community-based monitoring program at Tatik Lake would be carried out each winter, and annual harvest levels would be determined. In addition, an assessment project for Tatik Lake and the Kuujjua River was recommended and was undertaken in 1998 and 1999 to examine the use of these areas by char during the summer months (Holman Charr Working Group 1998). Further, as a result of positive monitoring program results combined with pressure of community needs, the take of char from Tatik Lake was increased from 25 to 30 per household (Holman Charr Working Group 1999).

Working group meetings and the associated community open houses were held annually during this period. Following review of the data to 1999, a new three-year plan was adopted. The increase in the allowable harvest per household was reaffirmed (a total of approximately 1,000 fish), and a small commercial fishery of 500 char per year from the rivers of Prince Albert

Sound was initiated to enable the sale of char to the local restaurant and visiting cruise ships and to enable other small entrepreneurial opportunities (Holman Charr Working Group 2004).

The current plan, for 2004-06, signed 9 June 2004 (Holman Charr Working Group 2004), has evolved from a one-page document that served for 1997-99 to a thirteen-page commercially printed booklet containing sections dealing with historical, current, and safe harvest levels; the allocation of harvests in the community; storage and processing of char; research and monitoring needs; and commercial fishing. Although most of the provisions are similar to those of its predecessor, the commercial fishing section was adjusted to close the Kagloryuak River and to support the issuance of exploratory fishery licences[4] (500 char) to the HTC for the Kagluk and Kuuk River systems and for the Holman coast.

The record suggests that the Holman char fishery can be divided into two phases. The first phase occurred prior to 1998 and relied upon a weir-generated population estimate for a river system combined with a comprehensive harvest study to determine whether current harvests were sustainable. The second phase, from 1999 to the present, relies heavily on community-based fishing plans, annual monitoring of CPUE, and a sample's size and physical characteristics, along with harvest monitoring. Annual working group and community meetings are held, where information is reviewed; decisions are made based on a combination of western science and community wisdom. To date, no element of the community-based plan has been challenged by either community or government organization.

There is little question that the HTC, the FJMC and the DFO all consider the Holman process a success. One small measure is that DFO staff are greeted with hugs and handshakes when they arrive in the community, a rather different welcome from that which frequently occurs on Canada's other two coasts. Reasons for success may be related to the following:

- Importance of the resource. Char are central to the domestic economy of Holman. The thought of losing the fishery captures everyone's attention and makes bearable the need for short-term inconvenience.
- Trust and respect. As the HTC, the FJMC, and the DFO gained experience and trust in themselves and their partners, it gave them the confidence to test non-conventional management approaches.
- Continuity. The DFO scientist in charge of developing the community-based monitoring program had been a Canada member of the FJMC, knew its goals, and took a special interest in the project. The DFO biologist was involved in all meetings up to 2004. The FJMC member of the working group was a retired DFO conservation officer who began working in the area in the 1960s and was well known and liked by the community.

- Community involvement. Community members and the HTC are responsible for most of the provisions of the plan, including harvest monitoring, allocation of the commercial catch, the field portions of research projects, and the setting of "safe" harvest levels. The role of the DFO and the FJMC at these meetings is to provide technical support and background information to assist the fishers, not to seek support for decisions already made.
- Community ownership. The plan is viewed as a community document and it is now only witnessed by the FJMC and the DFO. In all, seventeen HTC members participated in working group meetings and many more were involved in the evening community meetings. In the past, the DFO would establish the plan internally, based on biology, and then inform the community. The DFO plans were not even public documents.

Aklavik Dolly Varden Char Management Plan

The Inuvialuit have harvested anadromous Dolly Varden from the rivers and along the coast of the Yukon North Slope for many generations (Papik et al. 2003). Dolly Varden were harvested along the coast in late summer as part of a mixed-stock fishery, and at the mouth of the Big Fish River in early fall, before the fish went upstream to spawn. In the 1940s, as people moved off the land and into settlements, the Big Fish River became a preferred fishing area because of its proximity to Aklavik (Table 7.2).

In the 1980s, Aklavik fishers became concerned about decreasing harvests and numbers of fish at the Fish Hole, and the Aklavik HTC asked the DFO and the FJMC to investigate the decline. The two agencies commissioned a number of projects, including weir and mark-and-recapture studies, to estimate population size and harvest rate. The scientific consensus was that the decline in fish size and abundance was due to overfishing, and that the fishery should be closed to allow the stock to recover (DFO 2002). In 1987, at the request of Aklavik harvesters, the FJMC asked the DFO to close the Big Fish River char fishery for five years while the coastal mixed-stock fishery remained open. In 1992, the Big Fish River was reopened to limited subsistence harvests, but catches were poor and harvests in the next five years never exceeded 300 fish in total (DFO 2002).

In the years following the 1992 limited reopening, tensions between the DFO and Aklavik fishers rose as it became clear that the stock had not recovered as had been anticipated. Harvesters were frustrated by what they felt was a "wait a while and see" attitude from the DFO. Some community members reported that changed environmental conditions in the Fish Hole were the problem; others disputed the DFO's estimates of the numbers of fish. DFO biologists became concerned when individual fishers proposed to "harvest the remaining char before they are gone completely," complained

that they were not receiving timely reports of fish from the community, and felt that the fishers were ignoring the primary cause of the problem: excess harvests. As early as 1990, Aklavik fishers reported that water levels and water quality were changing, but no habitat research was done until several years later (Stabler 1998; Sandstrom and Harwood 2002), suggesting that the decisions were being made based on incorrect scientific understanding.

In 2000, the FJMC moved to resolve the conflict by proposing to the Minister of Fisheries and Oceans that the community should become responsible for the management of the Big Fish River Dolly Varden and that all regulations governing the fishery be removed. The minister accepted that there must be a shift beyond the current management regime to community-based management, but was prepared to adopt such a regime only when a management plan had been completed and approved by the FJMC and the DFO.

In response to the minister, in February 2001, the FJMC, with the DFO and the HTC, formed a working group (Table 7.2) to coordinate the development of fisheries management plan(s) for the rivers and streams in the ISR west of the Mackenzie Delta to the Canada/Alaska border. The terms of reference for the group were broader than just Big Fish River char, in the hope that tensions would be defused by having community representatives, federal government staff, and FJMC members working together towards a less contentious common goal.

The first tasks of the working group focused on assembling traditional and local knowledge, while the DFO consolidated the scientific information (Figure 7.1). It was becoming increasingly clear by this time that there had been changes in the river, possibly as a result of earthquake activity (Clark et al. 2001; Sandstrom and Harwood 2002). Decreased water flows and significantly lower salinity potentially reduced spawning and overwintering habitat (Stabler 1998; Sandstrom and Harwood 2002; Papik et al. 2003). These observations supported some fishers' long-held contention that overfishing was not the only, or even the primary, cause of the reduction in the stock size. During the DFO Regional Advisory Process for North Slope Dolly Varden (DFO 2002), scientists and fishers explicitly recognized that habitat change was likely limiting the size of the stock.

In June 2003, the FJMC and the DFO organized a public meeting in Aklavik to discuss the status of the stock and future actions. The working group had addressed the conflicts, established an ongoing dialogue between agencies, and increased the understanding of the stock and the social and cultural needs of the community. There was no apparent solution to the reduced numbers of char and the underlying environmental problem of habitat loss, however. HTC members still considered the Big Fish River and the char to be important historically and culturally for the community, and it was decided that the working group would continue the dialogue. The group

discussed the next step in the planning process (Figure 7.1) and drafted the following management goals:

- to ensure the maintenance of char, and other important fish stocks, in rivers and streams west of the Mackenzie Delta primarily for the purpose of subsistence food and as a mechanism for the support of traditional Inuvialuit culture
- to manage, to the extent possible, the char fisheries in a manner consistent with Inuvialuit cultural practices
- to manage the char and other important fisheries using adaptive management processes with full community participation.

The second goal was particularly important to the Inuvialuit even though the group could not specifically define what those "cultural practices" might mean in practice for Dolly Varden fisheries in the Babbage or Firth Rivers to the west. The uncertainty was discomforting for some DFO staff, who could not see how such a goal might be implemented under the present federal regulatory regime. Similarly, neither the DFO nor the working group had developed any specific hypotheses that might be evaluated using "adaptive management" practices. Nevertheless, the objectives were eventually accepted by DFO regional management, a clear indication of that agency's support for the co-management process.

By 2006, the fishery had still not recovered and the outlook remains uncertain, but it is possible that lessons have been learned that will ensure the long-term protection of other stocks on the North Slope. The working group is now shifting its focus to community involvement in the study and management of the Big Fish River. A program has been developed that involves students from the high school, HTC members, and elders in monitoring the river. A project to monitor the char harvest at Shingle Point was also initiated in 2005, and in future years, tagging projects and biochemical genetics projects will add to understanding of the movement of Big Fish River Dolly Varden and other char in rivers along the Yukon North Slope.

The successes and failures related to the management of the Big Fish River char were due to various factors. In the early years of concern over the declining char population, the emphasis of management efforts was on scientific research and western science–based solutions. When fishers brought their concerns to the DFO and later the FJMC, the response was to do population estimates and, based on those data, close the fishery, on the assumption that overfishing was the cause of the population declines. The preference for science was supported by a group of younger harvesters from Aklavik who were educated and had faith in western scientific approaches. In later years, this division between the younger "radicals" and older "traditionalists" created some friction within the community of harvesters. Further,

within the working group, personality conflicts between members slowed down the progress of the group as a whole, and a lack of consistent leadership meant that the group changed and adjusted as the goals and procedures were being developed. Finally, and most importantly, the ecosystem was not well understood, so when the system didn't respond in expected ways (i.e., stop fishing and the populations will increase), all the organizations involved were disillusioned and unhappy.

There have been successes, however. Despite the two decades of uncertainty, the almost complete loss of the fishery, and the probability that neither scientific knowledge nor traditional knowledge will be able to restore the environment, a dialogue continues among the agencies. Community monitoring of the river will result in greater understanding of the Big Fish River ecosystem, and the use of science and traditional knowledge will help increase capacity in the community, promote social and cultural values, and develop scientific research skills in the youth of Aklavik.

Discussion

These three char fisheries have several common elements and thus provide a special opportunity to examine the development of fisheries management processes in a co-management setting. The co-management body (the FJMC) and key partners (the DFO and the Inuvialuit), as well as the overarching institutional factors – including legislation, federal policies for integrated fisheries management, the FJMC strategic plan and vision, and FJMC operating procedures – are the same for all three fisheries. The fisheries are also generally very similar. They are single-species, subsistence fisheries that have had negative experiences with commercial operations. Although the fisheries are based on closely related fish species with similar life histories and biological productivity, there are significant scientific unknowns with respect to growth rates, reproductive rates, stock mixing, and safe harvest levels. Each fishery involves a single community with a small renewable resource base, and the community differences are small. All three communities are isolated and heavily dependent on governments for incomes. Paulatuk and Holman are exclusively Inuvialuit and, although Aklavik has First Nations (Gwich'in) and non-indigenous people as well as Inuvialuit, the fishery was prosecuted almost exclusively by Inuvialuit. The primary differences between the three fisheries are (1) differences in the nature of the crisis or problem with the stock at the beginning of the process (two of the stocks were probably being overfished and responded to the management action, while the third stock was declining, at least in part, because of changes in water flows and reduced spawning and rearing habitat), and (2) differences in leadership and personalities among fishers, HTCs, and the task groups.

As illustrated by these three fisheries, the evolving fisheries management planning systems in the ISR have led to incorporation of the key features of adaptive co-management:

- The processes developed meet the need for common policies, regulations, and procedures but are flexible enough to also meet specific biological and community needs.
- The processes are public, leading to greater involvement and collective accountability for decisions.
- Local community involvement in planning and decision making means that outcomes are based on cultural and social factors and not just economic or resource-protection factors;
- community involvement means that local or traditional ecological knowledge, not just western science, is explicitly considered in the processes.
- The processes established are ongoing, with built-in review times for learning and feedback and making changes in response to the outcomes of decisions.

We have argued that the institutional factors – legislation and federal and FJMC policies and procedures – have supported the development of adaptive co-management, but we do not mean to imply that this was inevitable. Although the institutional factors may have been a prerequisite, our case studies illustrate the importance of the strategic factors of social organization discussed in Chapter 4 – the trust that developed with long associations, the common goals, the personal friendships and expressions of respect, the willing acceptance by DFO staff to assume new supportive roles, and the willing acceptance of HTC members of their responsibilities – which, though not measurable, are at least as important as the institutional factors. Both the institutional and strategic factors were necessary for success.

An additional element that cannot be ignored was the response of the fish stocks to the management actions, especially at the beginning of the process. In Paulatuk and Holman, the char stock responded positively to reduced fishing. This helped to build the confidence of fishers, scientists, and managers in the co-management process. On the other hand, the Big Fish River char stock did not respond to reduced harvests and continued to decline, most likely as a result of the changes in water quantity and quality of the river. One could certainly argue that this was the primary cause of any conflicts between individuals and agencies and that, if the fishery had responded as anticipated by most, then those conflicts would now be forgotten. One could also argue that if managers had paid more attention to the local knowledge of some of the fishers in the early years, the possibility that environmental changes were a major cause of the reductions would

have been recognized sooner. Although the recognition of traditional knowledge was required under the IFA, imbalances with scientific knowledge remain (see Ellis 2005 for a general discussion for the Northwest Territories), and it was not until the stock status review in 2002 (DFO 2002) that this local knowledge was explicitly recognized. It is perhaps a mark of the overall strength of the co-management process that the community members remain willing to be engaged with programs on the Big Fish River even though the probability of the stock recovering in the near term is minimal.

Recent syntheses have identified numerous conditions that facilitate the successful implementation of co-management (e.g., McConney et al. 2003; Pinkerton 2003; Berkes et al. 2005; Chapter 9). Our three case studies demonstrate that when the adaptive management techniques of acknowledging uncertainty, learning from experience, feedback, and new actions taken have been applied to the fisheries of the ISR, the outcome is an enhanced co-management system. Acknowledging scientific uncertainty of Arctic ecosystems and incorporating traditional and local knowledge improved decision making and increased the sense of empowerment and satisfaction of fishers in all three communities. Community involvement in monitoring and research on problems identified in common has helped to build links between fishers and scientists and enhance the acquisition of knowledge and understanding. Local fishers are more trusting and supportive of scientific interpretations of data and scientists have more respect for the local knowledge and experience of fishers. Management actions in Paulatuk and Holman that led to expected changes/improvements in the resource helped to build the confidence of fishers, scientists, and managers in the co-management process. Even actions that led to failure or that did not improve circumstances, such as on the Big Fish River, can be viewed positively because they were based on a consensus decision with unknown, but real, risks of failure rather than decisions based on government fiat. The process has helped to build trust and willingness to take chances, and has built confidence among regulators and users that decisions have the support of all involved. A particular example of this trust was the willingness of the DFO to accept the proposed management objectives for fisheries west of the Mackenzie River even though the working group could not explain what traditional Inuvialuit cultural practices might mean for fisheries management.

Our review of these three systems has also helped us identify some shortfalls in this developing adaptive management process as viewed from the perspective of Walters (1986) and Hilborn (1992). We need to document actions and rationale more carefully. Our assessment has relied heavily on the memory of specific individuals within the DFO and the FJMC, and this corporate memory needs to be supplanted with proper documentation. As well, if we are going to make full use of the techniques of "adaptive management," we need to make explicit hypotheses and develop management

actions to test those hypotheses. Further, we may need to consider how to use different systems as "experiments" to be able to probe some of the many unknowns related to managing char in the Arctic. The necessary actions are all well within the mandates and capabilities of the FJMC, the DFO, and the HTCs.

Our review has also helped us identify some specific factors that we believe would help promote adaptive co-management of small artisanal fisheries in general:

- a strong co-management process (legislation, money, and a mandate accepted by communities as well as government)
- joint planning for research to develop innovative questions and proposed programs
- a willingness to accept the ideas, beliefs, and practices of others to reach a consensus for change
- plans with renewal times built in to allow feedback, learning, and modification
- regular biological monitoring and communication of results among all parties
- both new scientific and new community knowledge accepted as valid
- a willingness by all parties to trust and to share authority.

The DFO has never had the resources necessary for adequate research, management, or enforcement in the Arctic, and regional and area managers have long tried to work with the communities and fishers on a consensus basis (Kristofferson and Berkes 2005). Nevertheless, prior to 1984 and the signing of the IFA, fisheries management was formally the responsibility of the DFO. Now, clearly, power has been shifted to the FJMC and the Inuvialuit. They have been prepared to accept their responsibilities for these fisheries and work cooperatively with the DFO, and, arguably, the resource and the fishers have benefited under the new management. The adaptive co-management model described here will not necessarily work under all circumstances (Nadasdy 2003; Chapter 11), but it is working for fisheries in the western Canadian Arctic.

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Notes

1 The IFA established local Hunters and Trappers Committees in each community in the ISR. HTCs are co-management partners – with the DFO and the FJMC – responsible for fish and marine mammals in their local areas.

2 Pinkerton (2003) has proposed that comparisons between co-management situations be made by distinguishing core aspects of co-management arrangements through a framework that considers the specific rights and powers of fishing communities.

3 Beginning in the 1990s, the DFO developed an "Integrated Fisheries Management Plan" process in order to standardize the fisheries management plan process, identify performance outputs, ensure greater integration within the DFO, and improve program delivery. In the early 2000s, the DFO introduced an objectives-based management approach to help with the application of a more precautionary approach and the use of ecosystem and fishery performance measures. (Many specific plans are available on the departmental website, http://www.dfo-mpo.gc.ca/communic/fsh_man/ifmp/index_e.htm.) A specific initiative emphasized that stakeholders should have a more direct role in developing the plan rather than commenting on a DFO proposal. The following steps are based on current and evolving practices within the Central and Arctic Region of the DFO: (1) Establish working group; (2) assemble background information on the stock(s); (3) set conservation limits for the stock; (4) set fisheries management objectives and fisheries management strategies for the stock; (5) develop the fisheries management operational plan; (6) plan implementation; and (7) review.

4 Exploratory fishing licences may be issued under Section 52 of the federal Fishery (General) Regulations when there is insufficient information to issue a formal commercial fishing licence and more scientific information is required.

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