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Towards Assessing the Effects of Lake Winnipeg Regulation and Churchill River Diversion on Resource Harvesting in Native Communities in Northern Manitoba

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ERRATA

Usher, P.J. and M.S. Weinstein. 1991. Towards assessing the effects of Lake Winnipeg regulation and Churchill River diversion on resource harvesting in native communities in northern Manitoba. Can. Tech. Rep. Fish. Aquat. Sci. 1794: vi + 69 p.

p. iii, LIST OF FIGURES - Should read:

p. 3, Fig. 1 - Light tone showing Nelson River discharge is missing. Refer to Newbury et al. (1984) for original.

p. 20, Table 2 - Column headings should read:

Author/date	Location/year	kg/capita/yr (edible wgt.)[1]	Method[2]

PREFACE

This report is one of a series done as part of the Federal Ecological Monitoring Program, a joint environmental research and monitoring program that resulted from the Northern Flood Agreement (NFA) of 1977. The NFA guaranteed that environmental effects resulting from hydroelectric development in northern Manitoba would be monitored. The present report seeks to lay a groundwork for understanding the effects of hydro development on natural resource harvesting activities of Native communities.

Five Native communities are signatory to the NFA: Nelson House, Split Lake, York Landing, Cross Lake, and Norway House. These communities, as well as South Indian Lake, were affected by hydro development. The report mainly concerns the five official signatory communities because, first, a base of socio-economic information did not exist for them, whereas South Indian Lake already had been studied; second, inclusion of South Indian Lake would have increased substantially the cost and time required for the study; and third, the conclusions reached by the authors would not have been altered in major fashion by the inclusion of South Indian Lake.

The report is seen as providing a framework for future natural resource harvesting research in northern Manitoba.

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Winnipeg, MB
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The Lake Winnipeg Regulation and Churchill River Diversion projects (LWR/CRD) have had major physical and biological effects on the regional environment, and major social and economic effects on local residents, particularly those of the Native communities that traditionally depended on the waterways for livelihood and travel. However, the full range and extent of these socio-economic effects, and the ways in which they are linked to physical and biological effects, are not well documented.

This report is intended to provide a basis for future social impact assessment (SIA) by: (1) outlining the process by which socio-economic effects (particularly those pertaining to resource harvesting) can be ascertained and monitored; (2) assessing the utility of existing data sources for that purpose and identifying additional data requirements; and (3) making some preliminary observations on resource harvesting impacts, to the extent that existing data permit.

SIA properly consists of impact projection, monitoring, and evaluation. It necessarily also involves the selection and justification of a basic paradigm of social change. SIA is a process of hypothesis testing that requires the identification of appropriate variables and indicators, and a workable system for monitoring these indicators on a continuing basis. As such, it serves not only to identify and minimize adverse effects, but also to modify the basic paradigm. In this way, it follows the scientific method and operates as a self-improving process.

No existing SIA of LWR/CRD meets these standards or provides the basis for a continuing monitoring program. Post-construction socio-economic assessments in the project-affected area have been oriented almost exclusively to the accounting and evaluation of damages for the purposes of compensation or mitigation. Such exercises have no predictive value. There has been little effort to understand the processes or the significance of social change itself, which might provide a basis for minimizing adverse effects in future by modifying projects at the design stage.

This report outlines a model of resource harvesting (with particular emphasis on the fishery) as a socio-economic system in northern Native communities. From this model are derived significant variables and measurable impact indicators. Existing data from institutional and literature sources are assessed for their suitability as impact indicators with respect to domestic harvesting of country food, commercial fishing, and trapping.

In some cases, existing information permits some preliminary conclusions on resource harvesting impacts of LWR/CRD. With respect to subsistence fisheries, survey methods have not been wholly compatible. Nonetheless it appears that there have been substantial declines in per capita harvests at Cross Lake and Split Lake (for which pre- and post-project data exist). Similarly sharp declines do not appear to have occurred in a similar non-project-affected community in northern Manitoba over the same time period. With respect to commercial fishing, there appear to have been adverse effects in all natural resource harvesting zones. These include a sharp production decline at Cross Lake, partial contamination by mercury at Nelson House, and increased unit costs of production at Norway House and, possibly, Split Lake. However, existing indicator data do not reveal the full suspected range of adverse effects. It appears that one response by resource harvesters to these adverse effects has been to intensify effort to maintain production levels, but there are insufficient data for any resource harvesting activity to measure this.

Existing fur harvest data are a potentially useful tool for assessing resource harvesting effects, but the task of organizing a data base of this magnitude and complexity was beyond the scope of this project. There are insufficient data to permit any assessment of LWR/CRD effects on subsistence harvesting of big game, water fowl, or small game.

The key additional indicator data required for a comprehensive, resource-harvesting SIA are identified, and some methods (chiefly surveys) by which these can be obtained or reconstructed are outlined. Such surveys can only be undertaken on the initiative of the communities, and are most likely to yield reliable results when residents themselves are fully involved in their design and implementation, and in the interpretation of the results.

Key words: Lake Winnipeg regulation; Churchill River diversion; social impact assessment; resource harvesting; fishery; trapping; native communities.

RÉSUMÉ

Usher, P.J., and M.S. Weinstein. 1991. Towards assessing the effects of Lake Winnipeg regulation and Churchill River diversion on resource harvesting in native communities in northern Manitoba. Can. Tech. Rep. Fish. Aquat. Sci. 1794: vi + 69 p.

Les projets de régularisation des eaux du lac Winnipeg et de dérivation des eaux de la rivière Churchill (RLW/DRC) ont eu des effets physiques et biologiques majeurs sur l'environnement régional, ainsi que de nombreux effets sociaux et économiques sur les résidents locaux, notamment ceux des autochtones qui dépendaient traditionnellement des voies d'eau pour survivre et se déplacer. Cependant, la gamme et l'étendue complètes de ces effets socio-économiques, et les manières dont ils sont liés aux effets physiques et biologiques, sont mal documentés.

Le présent rapport vise à constituer une base pour les futures évaluations d'incidences sociales (ÉIS): (1) en décrivant le processus par lequel les effets socio-économiques (particulièrement ceux qui se rapportent à la récolte des ressources) peuvent être confirmés et contrôlés; (2) en évaluant l'utilité des sources de données existantes à cette fin et en identifiant les besoins additionnels de données; et (3) en faisant des observations préliminaires des incidences sur la récolte des ressources, dans la mesure où les données existantes le permettent.

L'ÉIS consiste en soi à prévoir, contrôler et évaluer les incidences. Elle comporte aussi nécessairement le choix et la justification d'un paradigme de changement social de base. Il s'agit d'un exercice de test d'hypothèse qui requiert l'identification des variables et indicateurs appropriés, ainsi qu'un système fonctionnel de contrôle continu de ces indicateurs. Comme telle, elle sert non seulement à identifier et à minimiser les effets néfastes, mais aussi à modifier le paradigme de base. De cette façon, elle est conforme à la méthode scientifique et fonctionne comme un processus qui s'améliore de lui-même.

Aucune ÉIS des projets RLW/DRC ne satisfait à ces conditions ou ne constitue la base d'un programme de contrôle continu. Les évaluations socio-économiques après construction dans la région touchée par les projets ont été orientées presque exclusivement vers la comptabilisation et l'évaluation des dommages à des fins de compensation ou d'atténuation. De tels exercices n'ont aucune valeur prédictive. Peu d'efforts ont été faits pour comprendre les processus ou la signification des changements sociaux eux-mêmes, ce qui aurait pu constituer une base pour minimiser les effets néfastes dans de futur par la modifcation des projets au stade de la conception.

Le présent rapport décrit un modèle de récolte des ressources (où l'accent est mis sur les pêches) en tant que système socio-économique dans les collectivités autochtones du nord. De ce modèle découlent des variables importantes et des indicateurs d'incidences mesurables. Les données existantes tirées de sources institutionnelles et documentaires sont évaluées quant à leur pertinence comme indicateurs d'incidences sur la récolte intérieure de nourriture locale, la pêche commerciale et le trappage.

Dans certains cas, l'information existante permet de tirer des conclusions préliminaires concernant les effets des projets RLW/DRC sur la récolte des ressources. En ce qui a trait à la pêche de subsistance, les méthodes de dénombrement n'ont pas été tout à fait compatibles. Néanmoins, il semble qu'il y a eu des diminutions importantes des récoltes per capita à Cross Lake et à Split Lake (pour lesquels il existe des données antérieures et postérieures aux projets). Des baisses aussi fortes ne semblent pas avoir eu lieu dans une collectivité semblable du nord du Manitoba, non touchée par des projets, pendant la même période. En ce qui concerne la pêche commerciale, il semble que toutes les zones de récolte de ressources naturelles ont été touchées par des effets néfastes, qu'il s'agisse d'une forte baisse de la production à Cross Lake, d'une contamination partielle par le mercure à Nelson House et d'une augmentation du coût unitaire de production à Norway House, voire à Split Lake. Cependant, les données d'indicateur existantes ne révèlent pas toute la gamme attendue des effets néfastes. Il semble qu'une des réponses des récolteurs de ressources à ces effets néfastes a été d'intensifier les efforts pour maintenir les niveaux de production, mais les données, quelle que soit l'activité comportant la récolte de ressources, sont insuffisantes pour mesurer ce phénomène.

Les données existantes sur la récolte de fourrures pourraient être un outil intéressant pour évaluer les effets sur la récolte des ressources, mais la constitution d'une base de données de cette ampleur et de cette complexité débordait du cadre du présent travail. Les données sont insuffisantes pour permettre toute évaluation des effets des projets RLW/DRC sur la récolte de subsistance de gros gibier, de sauvagine ou de petit gibier.

Les autres données d'indicateur clés, nécessaires pour réaliser une ÉIS détaillée sur la récolte de ressources, sont identifiées, et certaines méthodes (sourtout des dénombrements) permettant de les obtenir ou de les reconstituer sont décrites. De tels dénombrements ne peuvent être entrepris qu'à l'initiative des collectivités et produiront selon toute vraisemblance des résultats fiables lorsque les résidents eux-mêmes seront pleinement engagés dans leur préparation et leur réalisation, et dans l'interprétation des résultats.

Mots-clés: régularisation des eaux du lac Winnipeg; dérivation des eaux de la rivière Churchill; évaluation des incidences sociales; récolte des ressources; pêches; trappage; collectivités autochtones.

INTRODUCTION

THE PROBLEM

The Lake Winnipeg Regulation and Churchill River Diversion scheme (LWR/CRD) constitutes one of the largest river diversion and regulation projects anywhere in the Subarctic (Fig. 1). LWR/CRD has had major physical and biological effects on the regional environment, and major social and economic effects on local residents, particularly those of the Native communities that traditionally depended on the waterways for livelihood and travel.

Such social and economic effects are ascertained by the process of social impact assessment (SIA) which, if it is to be effective, should consist of three stages: (1) impact prediction; (2) monitoring of key indicators; and (3) evaluation. Evaluation refers to both weighing the significance of change to those who experience it, and testing the efficacy of the procedure itself. SIA is, thus, a process of hypothesis testing that leads to both modification of the basic paradigm, and improvements in the design and implementation of major projects so as to minimize or prevent adverse effects.

This process has not been followed in the case of LWR/CRD. Very little baseline information was available for pre-project assessment in the early 1970s. Only one study from that time, Collinson et al. (1974a, b), could be said to constitute in any way a socio-economic impact prediction in contrast to mere issues identification. Since then, there has been no consistent monitoring of the social and economic effects of LWR/CRD (although this is required under section 17.5 of the Northern Flood Agreement [NFA]), and no comprehensive post-project assessment. As a result, pre-project impact forecasts were not only poorly grounded, they also remain unverified. Thus, by the standards described, there remains a need for a comprehensive socio-economic impact assessment of the effects of LWR/CRD, which would also serve as a basis for a continuing monitoring program.

Post-construction socio-economic assessments in the project-affected area have been oriented almost exclusively to the accounting and evaluation of damages for the purposes of compensation or mitigation, rather than to the understanding of the processes or the significance of social change as such. Damage accounting, however, has little analytic or predictive value, and it does not provide an adequate basis for systematic monitoring of project effects, without which predictions cannot be verified.

A review of the literature on social and economic effects in the project-affected area suggests that, to date, there has been neither a sound theoretical framework within which the problem and significance of adverse effects can be considered, nor an adequate baseline from which change can be measured and assessed. What exists is conceptually and methodologically inadequate by present standards of SIA. There is insufficient connection between impact hypotheses and the selection of indicators, and the actual measurement of some key variables is suspect. These problems of conception and method have arisen in part because of insufficient involvement in the SIA process by the communities themselves. The apparent continuing dissatisfaction with the results of impact assessment research to date, on the part of both the communities and the Northern Flood Committee (NFC), suggests that this deficiency remains uncorrected.

OBJECTIVES

This report does not remedy these deficiencies, but it provides an essential step towards that end, by suggesting a framework and indicators for assessing effects on resource harvesting, and by evaluating the potential contribution of existing data and information. The report is intended to enhance the ability to monitor and predict the effects of this and similar projects on a continuing basis. It does not, however, constitute a social impact assessment of LWR/CRD in whole or in part, nor is it a substitute for one.

We start the report by identifying some outstanding issues in assessing project effects on resource harvesting, and outline a model of resource harvesting (with particular emphasis on the fishery) as a human system in northern Native communities. From this model we identify probable significant impacts, and their indicators. We then assess the degree to which existing data from institutional and literature sources meet the requirements for impact indicators with respect to domestic harvesting of country food, commercial fishing, and trapping. Finally, we consider some means by which indicator data can be otherwise obtained.

STUDY AREA

The area covered by this report includes the Norway House, Cross Lake, Split Lake, and Nelson House Registered Trapline Sections (Fig. 2), in which the NFA bands have priority access to fish and wildlife according to article 15 of the NFA (which refers to these sections as "Zones"). These sections (as they are referred to in "TRAPPING") or zones (as they are referred to in "COMMERCIAL FISHING") are identified collectively in this report as the NFA area. Reference to the Norway House, Cross Lake, Split Lake, or Nelson House areas is to those respective trapline sections. (The Split Lake Zone includes the communities of Split Lake and York Landing).

Map 1 (in back pocket) indicates the water bodies whose flow and level regimes have been altered by the project; major effects began in 1976. (For a summary of physical and biological effects of this alteration, see Baker and Davies 1991). We use the term project-affected area to refer to both these waters and the tributary land areas used by fishermen, trappers, and hunters from the adjacent communities, because the nature of livelihood and of land and resource utilization is such that all residents are affected, directly or indirectly, by the flooding, dewatering, and altered flow regime that are the direct results of LWR/CRD.

The effects of CRD on the South Indian Lake (SIL) area have not been considered in this report (see "PREFACE"), even though that community has arguably been the most adversely affected. One reason for this exclusion is that the harvesting and social effects of the project on SIL have been more thoroughly documented than have those in the other communities (e.g. Collinson et al. 1974a; Waldram 1983, 1987, 1988; Wagner 1984), and indeed that body of research has provided significant guidance to our understanding of the NFA communities. Although our terms of reference did not include SIL, the principles of our analysis can be expected to apply to it. While it would have been useful to extend the analysis of commercial fisheries and trapping data to include SIL for the sake of uniformity and direct comparison, we have no reason to suppose that this would have altered either our own conclusions about the NFA communities, or those of other researchers about SIL.

STUDY IMPLEMENTATION

This study was designed in consultation with the member organizations of the Program Advisory Board established to implement aspects of the NFA. Phase One consisted of a preliminary review and evaluation of existing SIA information and resource harvesting data sources (Usher and Weinstein 1989). Phase Two involved file research and selected informal interviews in Thompson and the NFA communities (in November 1989), to obtain further harvesting data and some qualitative information on LWR/CRD impacts and issues. Because this project was not a comprehensive SIA, it did not involve formal consultation with or input from the communities, or a representative sampling approach to interviewing that would normally be expected of SIA.

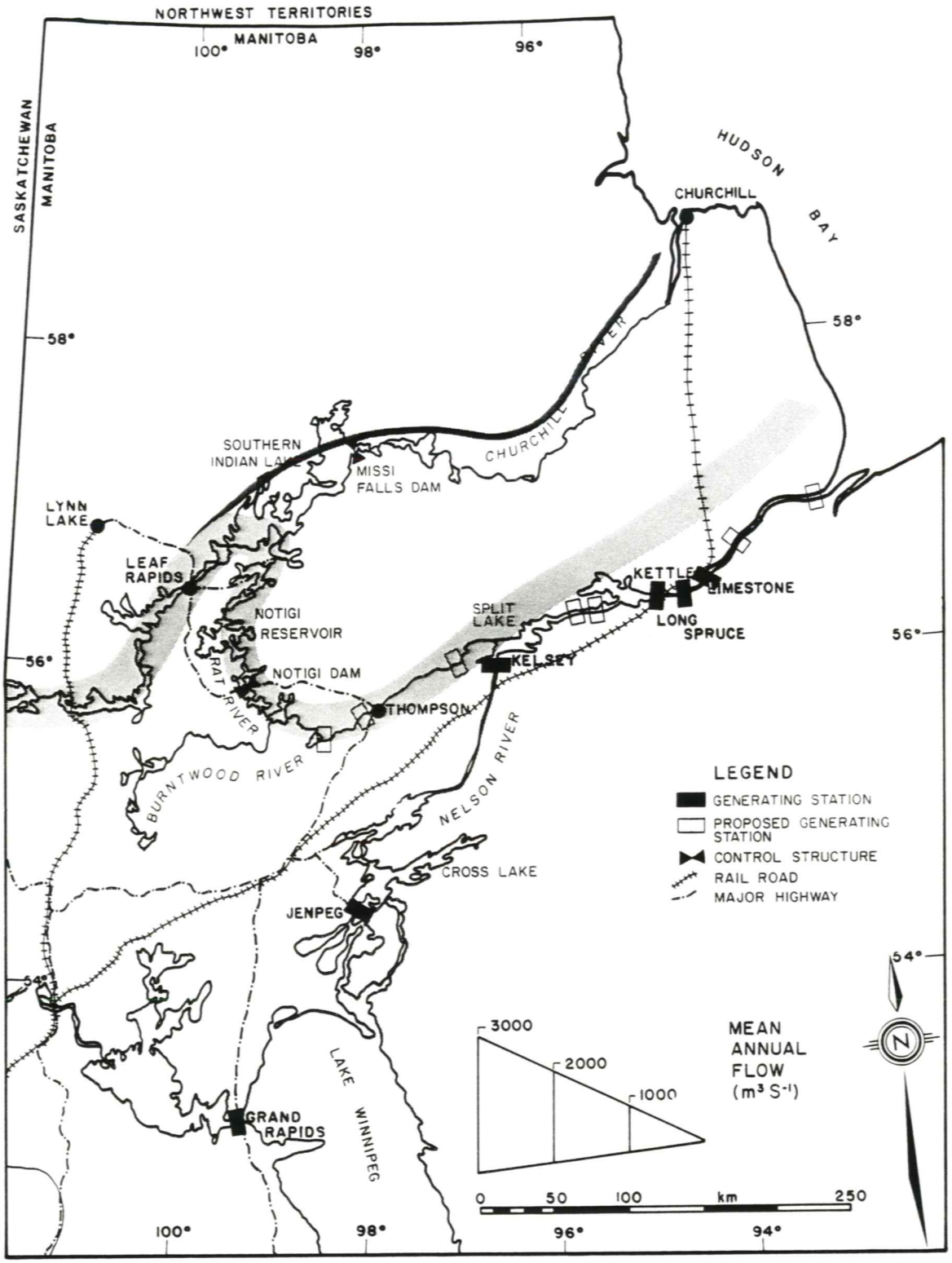

Fig. 1. Lake Winnipeg Regulation and Churchill River Diversion, indicating the altered flow regime of the rivers. Dark tone indicates relative magnitude of lower Churchill River discharge after diversion; mid-tone indicates Churchill River discharge diverted at Southern Indian Lake; light tone indicates Nelson River discharge. Source: Newbury et al. (1984).

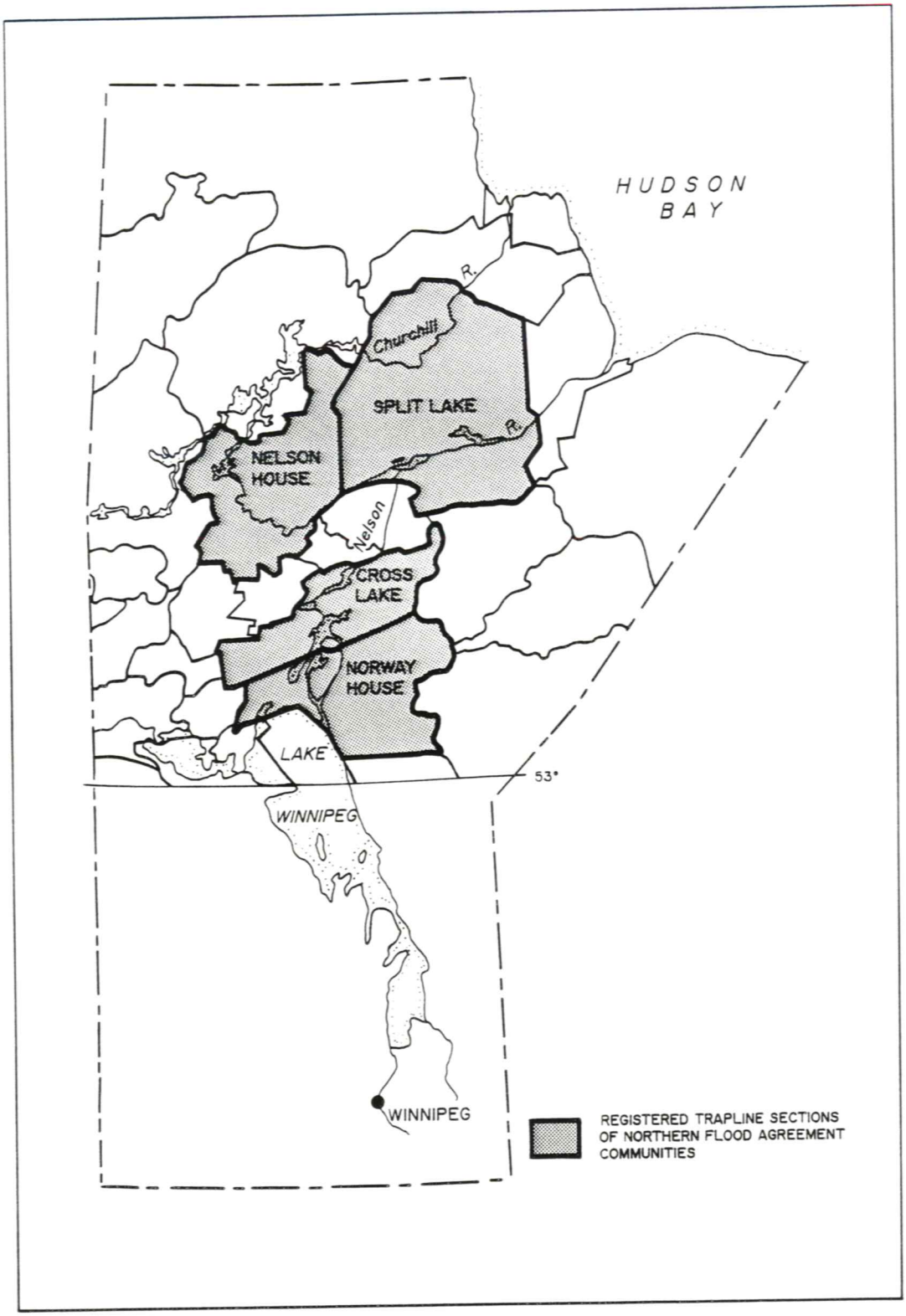

Fig. 2. Location map showing registered trapline sections north of latitude 53°N.

SOCIO-ECONOMIC IMPACT ASSESSMENT OF RESOURCE HARVESTING

OBJECTIVES, SCOPE, AND NATURE OF SOCIAL IMPACT ASSESSMENT (SIA)

The purpose of SIA is to ascertain how and to what extent specified social groups will become better or worse off as a result of certain externally generated actions. This is done first of all by means of projection or prediction. If claims of change are to be verified, however, there must also be a process of hypothesis testing and post-project evaluation. Hypothesis testing occurs through monitoring (Beanlands and Duinker 1983; LGL Ltd. et al. 1986).

Impact prediction consists, first, of specifying the status and properties of the social group. This requires not simply the determination or reconstruction of a baseline situation, but also an adequate understanding of the structure and functioning of the communities as socio-economic systems, the forces that have shaped these communities and continue to do so, and the processes of change that occur in them. It is then necessary to specify the changes that will result from the proposed actions. These predictions constitute, in effect, a set of hypotheses: logical statements of probable outcomes based on both a theoretical model and actual information about how the system works.

Testing these requires the identification and measurement of phenomena that are reliable indicators of the hypothesized change (see "IDENTIFICATION OF IMPACT INDICATORS", below). It also requires the ability to distinguish these changes from ones that might occur independently, and to evaluate their significance. Through verification and evaluation, and the determination of cause and effect, it may be possible to modify the agents of change in order to avoid problems in the first place, instead of having to mitigate or compensate for them after the fact.

This is the ideal, but it is not always met. Like environmental impact assessment (EIA), SIA is an applied science intended to have direct application to public policy. And like EIA, it is presently characterized by a lack of consensus about its content and methods, and considerable uncertainty with respect to prediction and to the determination of cause and effect. Overcoming this problem will depend, in large measure, on the ability of SIA to verify and assess its predictions, which requires adequate post-project monitoring. The opportunity for verification and assessment increases as proposed projects are implemented, especially if there is an adequate knowledge of pre-project conditions and processes.

The origins of SIA as a practical technique lie in cost-benefit analysis, economic assessment, and social indicators research. Invariably, SIA is also informed by general theories or paradigms of social change, whether these are explicitly acknowledged or implicit in the terms of reference and the choice of variables assessed. These paradigms may be reduced, in essence, to two, which in the present context may be labelled acculturation/modernization and subsistence/adaptation (although they are rarely identified explicitly as such and there is no standardized terminology for them). These are described in more detail below. Within each paradigm, there is substantial consensus about scope and methods; controversy among practitioners arises chiefly with respect to paradigm selection.

SIA has emerged in Canada primarily as a response to concerns about the effects of major industrial projects in rural and northern areas. Typically, the agent of impact is conceived of as a single industrial project undertaken by (or catastrophic event caused by) an identifiable party, while the target of impact is one or more communities.

SIA thus has a collective or community focus which distinguishes it from the determination of private or individual losses, which have traditionally been the focus of claims for trespass, damage, or violation of rights, and from the calculation of the value of those losses according to neo-classical economics and accounting principles that use the individual as the basic unit of analysis. SIA includes an accounting of such losses, but this is only a part of a more comprehensive evaluation of changes in social and personal well-being. These states, which are only partially measurable in quantitative, let alone market terms, are the outcomes of responses based not so much on individual preference or choice as on interdependent preference rooted in cultural values and social relations.

The question of how or by what standards to evaluate change inevitably arises. Are there objective, "value-neutral" standards, or are there only the standards of those who experience change? The answer is often implicit in the paradigm selected, but there is a growing consensus in the social sciences around the latter, with debate focusing on how preference is actually revealed.

Although development projects may lead to certain predictable physical, biological, and institutional changes, how these are perceived and experienced locally cannot be predicted without reference to the historical experience, culture, and social organization of the community itself. Hence, it is now generally recognized that the affected communities must have a central role in setting the objectives of an impact assessment by indicating what, of value to them, is likely to be (or has been) changed, and how.

The hypotheses to be tested must be regarded as valid and significant by community residents. They, after all, are the ones who are affected by specific changes, and who assign significance to them, and they are the source of much of the necessary data. Thus, not only must the design, implementation, and utilization of SIA be credible and acceptable to the communities involved, but SIA can really only proceed with the desire and cooperation of the people themselves.

The existing framework of public policy review focuses on single industrial projects, but there is no theoretical reason why SIA cannot just as appropriately focus on institutional or policy innovations, such as the effects of Native claims settlements or of changes to fish and game laws. Indeed, now that we are in a position to evaluate the effects of existing initiatives, not simply predict the effects of proposed ones, retrospective impact assessment must necessarily take into account the effects of project-induced institutional changes. For example, a retrospective SIA of LWR/CRD cannot now ignore the effects of the NFA, the most significant institutional change that resulted directly from the project.

SIA AND RESOURCE HARVESTING

The assessment of project or other effects on northern communities requires a generic model of their economy that specifies its characteristics and properties. This model is still being elaborated by practitioners; there is no textbook version.

Earlier SIAs of northern development projects (and even some more recent ones) have thus often used an industrial, wage-based model, with only minor modifications based more on speculation than fact, for northern communities. Typical indicators selected were job training, employment, income, and investment in infrastructure. If these rose more than enough to compensate for cash income declines in existing activities such as trapping or commercial fishing, then there was said to be a net beneficial effect.

Data for these indicators, if they do not already exist in government and industry files, can be obtained through simple survey methods and even by anecdote. Income from trapping and fishing, in this model, is obtained solely from government records, which are typically accepted and interpreted uncritically. Although the inadequacy of this approach is now widely acknowledged, there is less clarity about how to rectify it. It is to that problem that we now direct our attention.

The impact of industrial development on small, largely Native communities (of which there are at least 200 in the Arctic and Subarctic) differs significantly from its impact on southern Canadian communities, rural or urban. The content and pattern of social change itself, and the significance and distributional effects of this change, are distinctive in these communities because their socio-economic characteristics, and the cultural and historical forces that created them, are distinctive. The need for SIA to take account of these differences has been generally acknowledged (e.g. Berger 1977; CEARC 1985; LGL Ltd. et al. 1986), and there is now a considerable body of empirical knowledge of northern communities on which to base impact hypotheses.

However, this recognition in principle needs to be matched by more precise formulations of these differences in practice as the basis for selecting appropriate indicators. It is still the case that impacts on harvesting are often allocated to a middle world between physical-biological and socio-economic effects. Positive impacts are suggested on the basis of a few quantifiable economic and social indicators, whereas negative ones tend to be indicated by vague and general references to acculturation and the quality of life, which are intrinsically difficult to measure (Staples 1985).

One distinctive characteristic of northern Native communities is the place of resource harvesting - e.g. fishing, hunting, trapping - as a central and integrative activity, and of subsistence as a socio-economic system. Resource harvesting patterns, and subsistence systems, are not simply cultural responses to environmental conditions but also the outcomes of economic and institutional forces. For example, one important but often inadequately considered element is the indigenous system of land tenure and resource management, which preceded the development of Crown systems and which continues to function in modified form.

SIA methodology must be able to take account of such historical determinants of resource harvesting, in view of their importance and of the ways they condition local responses to project effects. This cannot be done effectively by relying entirely on synchronic or "systems analysis" approaches which are inherently ahistorical.

MODELLING RESOURCE HARVESTING SYSTEMS

Although neither wage employment nor the market system are foreign or even, in many cases, new to northern Native communities, there is typically a substantial level of economic activity that takes place outside of the market sphere. This we refer to as <u>subsistence activity</u>. Subsistence activity does not constitute a separate and distinct economy in northern

communities, but is combined, at the individual, the household, and the village levels, with wage labour and transfer payments. These communities have the appearance of "modern" economic activity, but it is underpinned by distinctive social and property relations which are neither aboriginal (in any "traditional" sense) nor like those prevailing in southern, non-Native communities.

Northern Native communities are now widely recognized as having mixed, subsistence-based economies. Specific characterizations and terminology vary in the literature (viz. Berger 1977; DeLancey and Usher 1986; LGL Ltd. et al. 1986; Lonner 1986; Quigley and McBride 1987; Wolfe and Walker 1987; Berkes 1988a), but there is sufficient consensus to provide a brief account of the major characteristics and properties of such economies.

Subsistence-based economies have two spheres of activity, institutions, and customs - market and subsistence - but these are inextricably linked. The household is commonly the basic unit of both production and consumption (cf. industrial economies in which these functions are divided respectively between firms and individuals). Figure 3 indicates how the household works as a micro-enterprise in organizing production and allocating productive factors (land, labour, capital) so as to optimize income flows. These decisions are made according to principles of kinship and alliance rather than the market, particularly with respect to the allocation of land and labour.

There is an economizing rationale in subsistence, in the sense that on average, outputs must at least match inputs over each production cycle. The ends of economic activity tend, however, to be inseparable from the social system, and are more likely to be the maintenance of the system of social relations rather than accumulation at the level of enterprise. Not only is there a distinctive system of social organization of production, but also of property relations, not least with respect to land tenure and resource management.

Although the specifics of the Cree system of land tenure in northern Manitoba are unreported, certain features may be presumed to operate on the basis of information from other areas, particularly the James Bay area of Quebec.

The Cree are wide-ranging harvesters, but seemingly nomadic land-use patterns may actually be short-term variants of semi-flexible territorial systems of tenure that are designed to accommodate resource variability. Such territorial systems are sustainable and long-lasting where animal species are sedentary, of limited range, and ubiquitous. At times when these species are not abundant, hunting groups move to other areas, join other groups, or leave the home territory completely in pursuit of more abundant game, all under established social codes.

The present tenure system in Manitoba operates under the umbrella of provincial resource administration, but, as elsewhere (e.g. Usher 1987; Bearskin et al. 1989; Weinstein and Penn, in press), the basic rules for harvesting probably follow modified versions of the traditional codes for access and behaviour toward animals, the environment, and other harvesters.

This is as likely true of resource management as it is for tenure. Under the Native system, the role of manager and harvester are not separated, and the management of resources and labour are integrated. There is dependence on more or less unrestricted access to large areas of land and water, but the access is not random. In the case of the Quebec Crees, each family group has a harvesting territory, which is the same area as a provincial trapline. The codes require non-kin-group members to request permission of the chief hunter for use. A powerful ethic of sharing and a pride in the "home" territory virtually guarantees permission as long as the codes are adhered to. Kin-group members also keep the chief hunter informed about harvesting and the status of animal populations as a matter of course through regular conversations. This process continually provides the chief hunter with information about the state of animal and environmental conditions of his group's lands.

Management, however, is non-hierarchical. A cardinal social value is the avoidance of conflict within the group. Decisions are essentially made by consensus, although the person recognized as having the most knowledge of and experience on the land has a formally recognized role and moral authority as leader.

The social objectives and supply of basic needs underlie the system of management. Subsistence harvesting and management strategies are based on the premise that food needs are fixed rather than open-ended as in the case of commodity production. Management techniques are concerned about the efficient use of labour in harvesting. Particular animals are harvested seasonally, when they are abundant. Differential harvest strategies focus efforts on habitats in which one or some resources are abundant, harvesting less abundant animals only if they are encountered in the same habitat and generally ignoring rare animals or plants, unless there is a special medicinal or social need for them.

Rotational harvesting and management systems are commonly used within the "home" territory. In some cases, rotational techniques similar to pulse fishing may be used on small, concentrated animal populations whose harvest would not justify travel and reestablishing a camp unless caught

in large numbers. The population is harvested intensively, then allowed to recover for a number of years while other areas are worked. This system is based on sustainable harvesting over a greater than annual period, rather than managing for stable populations by cropping a fixed annual surplus.

The contemporary mixed economy in northern communities tends to focus the hunting effort of many people on areas within a range of single day or overnight travel from the village. Consequently, many communities have dual geographic harvesting patterns: a relatively intense harvesting zone along roads and waterways within limited travel time, and use areas centred on more distant kin-group camps scattered throughout each community's traditional lands. The Cree, as other aboriginal groups, rely on universal and unrestricted access to large areas of land and water, but for individuals, access is not random but is governed by social convention and negotiation.

Both subsistence activities and subsistence outputs are essential for the maintenance of the social system. Through both production and distribution, norms and virtues of patience, sharing, and celebration are reinforced and reproduced. Subsistence must, therefore, be understood as a system of human relations involving the organization of production, distribution, and consumption, in which the reproduction of social relations is as much a concern as the production of material goods.

These characteristics of subsistence-based economies are sensitive to industrial development and other externally generated changes - not only direct physical and biological changes to aquatic and terrestrial environments but also competition for and restrictions on access to the resource base. Imposed changes in resource use and harvesting patterns will have a direct effect on the systems of land tenure and resource management, and the organization of production and distribution. Measuring the sensitivity of subsistence-based economies to these changes is problematic, however, precisely because subsistence is a flexible and resilient system. Its participants can and do adapt to change, whether adverse or beneficial. Yet, clearly, there are limits beyond which they cannot adapt, and there are cumulative adverse effects which impair the capacity to adapt and respond. The better subsistence is understood and modelled, the more precisely these limits can be specified.

The mixed, subsistence-based economy is not a static phenomenon, nor is it one easily captured in "before and after" states by synchronic observation. It evolves continually in response to various external forces as well as its own internal dynamics. At any particular time, it is the outcome of several key forces: the nature of the environment itself, local cultural traditions (especially as they are expressed in Native institutions), fur trade history, the nature of the state management regime, and the activities of other resource users. Some of these forces are interdependent.

Accordingly, an historical outline of the way in which these forces were played out in each community must be developed, not simply as a chronology of events (although that is important in its own right for a more accurate determination of associated changes among variables), but also for an understanding of the processes of change into which project effects fit. What is required is not merely a descriptive account, however, but an analytical and predictive account that links historical conditions to institutional arrangements (Craig and Tester 1982).

One of the problems with the "modernization/acculturation" model of socio-economic change that dominated the social sciences up to about the mid-1970s is its ahistorical bias. Although this model has since been either substantially modified or even discarded by social scientists, it continues to permeate much of the contemporary SIA literature, especially that within the "technical" framework identified by Lang and Armour (1981). That model tends to see the community as an autonomous phenomenon, rather than the outcome of historical experience. SIAs in that model typically contain a perfunctory pre-project history in which significant or relevant change begins only recently. An apparently timeless prehistory is followed by history, often cast as a gradual transition which culminates in the 1950s, when the communities become "modernized" through sedentarization, education, public investment in infrastructure, and the introduction of the welfare state and wage work. This brief historical account is seldom empirical; it is deduced from a popular outline of northern history now largely rejected in the contemporary social-scientific literature.

Yet, the people of the Nelson River area have been in longer and more complex contact with European society than any aboriginal groups in Canada except for those of the Atlantic and St. Lawrence River areas. Commercial exchange dates from the 17th century, and the area has been a major transportation route since then. Wage labour and a stratified occupational hierarchy have been facts of economic life in the region for at least two centuries. Since at least the 1880s, many other economic developments, including commercial sturgeon fishing, railway construction, mining, and white settlement, have added to the complexity of the social and economic life of the region (Tough 1987).

It is perhaps precisely for these reasons that there has been such a paucity of ethnographic research in northern Manitoba that might

otherwise provide essential baseline information for SIA. In the era when anthropology sought its data from relatively "untouched" aboriginal groups, the Nelson River area seems to have been correctly identified as an unpromising field location for that purpose.

PROBABLE ADVERSE EFFECTS OF LWR/CRD

From this systematic description can be derived a series of hypotheses about LWR/CRD impacts on resource harvesting and their consequent effects on the social system. Figure 4 is a schematic arrangement of the probable sequence of major adverse effects on harvesting activities in the NFA communities resulting from LWR/CRD (with particular emphasis on the fishery), based on the general principles already identified. Precise hypothesis formulation would be premature here; however one approach to that process, which involves resource harvesters directly, is described in Delancey and Usher (1986) and LGL Ltd. et al. (1986).

The most obvious and immediate physical and biological effects of regulation and diversion are changes in the nearshore, shoreline, and littoral zones (including subsequent erosion, transport, and deposition) resulting from flooding or dewatering; altered seasonal flow regime; changes in water quality (temperature, turbidity, and chemistry); changes in substrate quality; and altered ice regime (summarized in Baker and Davies 1991).

With respect to the fishery, these changes are most immediately reflected in: (1) the size, composition, and productivity of fish stocks; (2) the relative accessibility of fish to fishermen (including such factors as changed location of fish stocks or changed patterns of their movement, changes in harvesters' established travel patterns due to shoreline alteration, debris, ice conditions, etc.); and (3) the quality of fish stocks (e.g. firmness of flesh, parasitic infestations, mercury contamination).

These factors, in turn, can be expected to affect fishing success (e.g. catch per unit effort); the value in cash and in kind of the commercial and domestic catches respectively; and the palatability of the catch, ranging from subtle qualities of taste to the measurable presence of toxins known to produce clinical symptoms. Because fishing is part of a complex, mixed economy in northern communities, changes in the success and viability of fishing may affect other harvesting activities.

These same initial physical and biological changes also affect directly the abundance, productivity, and accessibility of waterfowl, moose, and aquatic fur-bearers, and hence harvesting success. Flooding reduces the total area of land available for harvesting activities, causing changes and displacement of land use and resource harvesting patterns. Flooding, and altered flow regime and ice conditions, affect established travel routes on both land and water. These effects on travel may, in turn, alter the accessibility and viability of harvesting on lands and waters otherwise unaffected by the project.

In sum, these changes should affect harvesting costs and income, the place of harvesting in the mixed economy, and hence possibly the overall viability of the mixed economy.

IDENTIFICATION OF IMPACT INDICATORS

It follows from both the general characteristics of SIA, and the specific characteristics of the subsistence system, that a purely neo-classical, sectoral analysis of the fishery or of any other component of resource harvesting in the context of a subsistence-based economy is not sufficient for the objectives at hand. The fishery cannot be assessed in isolation from other economic activities or from the social organization of the community. Nor, because of its substantial domestic component, is it sufficient to examine the fishery solely as a commodity-producing activity. It is therefore necessary to reconsider what are appropriate impact indicators.

A recent review (Staples 1985) of impact assessment and monitoring with respect to resource harvesting concluded that:

- indicators are often chosen indiscriminately, with little attempt to identify the social, economic, and environmental factors that have the greatest significance for resource harvesting;
- impact predictions often depend on the use of indicators for which baseline data are not available;
- impact predictions generally bear little relationship to the indicators employed;
- monitoring programs intended to verify predicted impacts were not related to indicators known to be appropriate for determining real impacts on harvesting.

Beanlands and Duinker (1983, p. 19) define an indicator of change as "(i) a biophysical component or variable which is monitored to detect change in that component or variable or (ii) a calculated index of the condition of all or part of an ecosystem". Indicators are thus symptoms on which one can base a diagnosis. They are variables, or characteristics of variables, which can be monitored, and which if not measurable on a cardinal scale can at least be ranked. Resource harvesting indicators must: (1) accurately reflect harvesting as a social system; (2) be amenable to repetitive measurement or

observation; (3) be generated from and related to an impact hypothesis; and (4) be agreed on by investigators and harvesters (Staples 1985; DeLancey and Usher 1986; LGL Ltd. et al. 1986).

To these criteria we would add, with respect especially to quantitative post-project assessment, the requirement for a standardized data set of sufficient historical depth and geographical coverage. In order to take account of natural variability, resource harvesting data, for example, should ideally cover at least a decade prior to the development project, and several years if not a full decade after project completion (or as long as project effects continue). Three to five years on either side of the event should be regarded as the bare minimum. Resource harvesting data should also cover all lands and waterbodies within each community's traditional use area. These data should be in a form that permits discrimination between areas physically affected by the project (by categories of effect) and those unaffected; among categories of resource users based on use and tenure; and among socio-economic characteristics of harvesters such as community of residence, Indian status, household composition, and age.

Ideally it should be possible to link these data by individual and household, and to aggregate or disaggregate data by more than one level of social unit, as necessary. For example, annualized data on catch, income, and effort by fishermen may seem to be the most obvious measures of change. Yet, because the individual harvester is part of a household production unit, in order to assess changes in the viability of resource harvesting as an activity and a continuing process, and its place in the mixed economy as a functioning whole, it is necessary to analyze changes in harvesting at the level of the household, as well as of larger social aggregates within communities. Because of differing social, economic, and demographic characteristics among households, as well as the distribution of their harvesting effort as a result of the tenure system, project impacts will be experienced differently among households.

A significant problem of project-oriented SIA is accounting for the effects of other agents of change, whether they be specific to the community at the time or more general socio-economic processes. Thus, a further requirement, although one not always readily met, is the use of a control community; this is preferably a nearby community of similar background and circumstances, but one that has not experienced the effects under study (see, for example, Usher et al. 1979, on the effect of mercury pollution at Whitedog and Grassy Narrows, Ontario, in which Shoal Lake, a similar community with a then-unimpaired fishery, was used as a control). In the present case, with five communities each experiencing LWR/CRD differently, some internal checks may be possible.

The primary sources for quantitative information on resource harvesting are institutional data sets maintained for administrative and monitoring purposes. Catch or kill statistics maintained by natural resource management agencies are an outstanding example. These sources cover only a narrow range of indicators, however, and they must be carefully evaluated for their suitability for impact assessment, because they are seldom designed for that purpose (Usher and Wenzel 1987).

Quantitative information may also be found in published literature or unpublished reports, although it is less likely to be repetitive, and must also be evaluated for suitability. As already noted, such information is comparatively rare for northern Manitoba.

In the absence of either of these types of data, it is difficult (although not impossible, using ethnographic reconstruction and ethnohistorical techniques) to create a reliable baseline against which to measure change.

Table 1 is a list of impact indicators that have been proposed for SIA in other parts of the North (e.g. DeLancey and Usher 1985; LGL Ltd. et al. 1986), although not all have been tested in any recent comprehensive impact assessment. (Somewhat more general indicators, based on similar principles, have been proposed for subsistence SIA in Alaska: e.g. Stephen R. Braund and Associates 1985; Impact Assessment Inc. 1988).

These indicators are consistent with the model of resource harvesting as a social system, they can be generated from impact hypotheses, and they are for the most part amenable to repetitive measurement or observation. We believe they meet these criteria with respect to the NFA region, although they would also have to be agreed on by harvesters and field-tested before they could be adopted for use there. It is not a comprehensive list, and it may be appropriate to add to it. In the following chapters, we consider how these indicators could be used to assess or monitor project effects in the NFA area, based on existing information.

Table 1. Resource harvesting impact indicators. The list is restricted to economic and social aspects of the spheres of production, distribution, and consumption (see also Fig. 4). Most of these items can be measured on cardinal or ordinal scales.

Production

Resource base
- productivity
- abundance
- accessibility
- quality

Social organization (at basic unit and village levels)
- demographic characteristics
- social characteristics
- employment and transfers
- participation and income
- organization of labour
- property rights
- mutual aid
- inter-generational transmission of skills and values

Resource control
- tenure
- management
- access

Factors of production (effort)
- geographic distribution of effort
- time (time x gear = unit of effort)
- gear
- operating costs
- skills
- knowledge

Harvests
- volume
- value

Distribution and Consumption

Sharing and reciprocity
Nutrition and health
Social and psychological implications of food
- contamination

Taste preference
Use in feasts, celebrations; spiritual significance

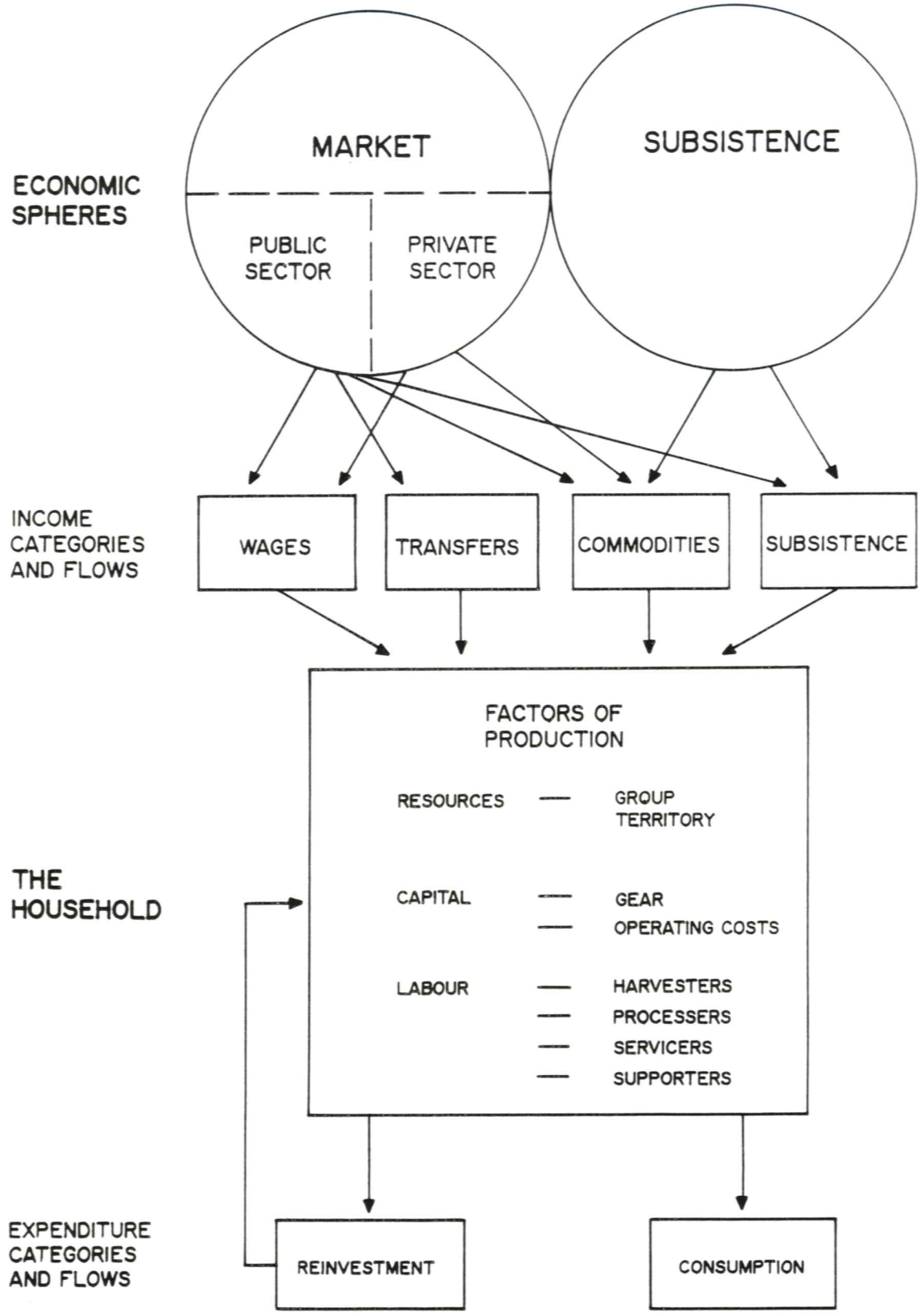

Fig. 3. The household in the mixed economy. The direction of flow indicates the path of income (cash and in-kind) from the major sectors of the economy via income categories to the household. The household factors of production are indicated in the "household" box.

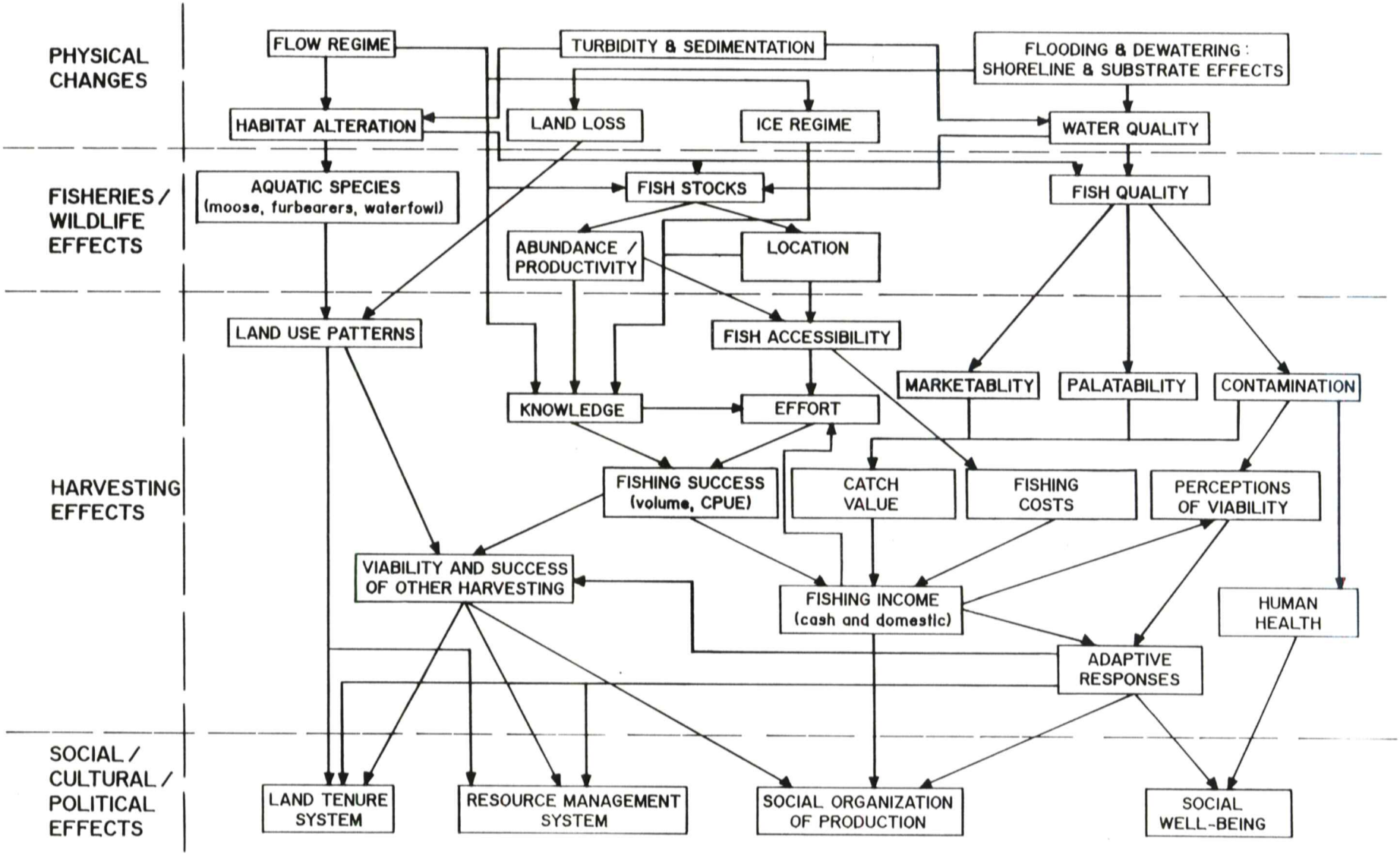

Fig. 4. Effects of Lake Winnipeg Regulation and Churchill River Diversion on resource harvesting/subsistence in Northern Flood Agreement communities, with emphasis on the fishery. Boxes indicate major categories of effects (indicators in the case of harvesting); arrows indicate pathways of probable cause and effect.

SUBSISTENCE HARVESTING

Country food accounts for a significant portion of the household diet and of effective household income in most northern Native communities. The chief indicator of this income is edible yield by species by weight, from which can be derived an additional indicator, value of income in kind based on replacement cost (Usher 1976). Other significant indicators of subsistence harvesting include areal extent/location, participation, and effort, although these are less often quantified.

In Manitoba, as in other jurisdictions, there has been no official system for obtaining these data on a continuing basis. Status Indians have not been required to obtain permits to fish or hunt for their own use, or to report their subsistence harvests. During the 1950s, conservation officers sometimes estimated domestic harvests in their annual reports by unstated and presumably inconsistent methods (see below). Records of ungulate harvests have been kept irregularly since, and estimates of food harvests from fur bearers can be derived from provincial fur records.

Systematic and comprehensive subsistence harvest surveys using standardized techniques have been undertaken in some other parts of northern Canada (especially Quebec and N.W.T.) since the early 1970s in connection with impact assessment and Native claims (see especially Weinstein 1976; McEachern 1978; JBNQ 1982a, b; Gamble 1988). Only one such survey has been undertaken in northern Manitoba (Wagner 1985, 1986), covering only three communities on a one-time basis, for purposes unrelated to LWR/CRD.

The availability of useful baseline or monitoring data on subsistence activity with respect to LWR/CRD is, thus, quite limited. This section (1) reviews these data (with particular attention to sources and reliability), and (2) draws some preliminary conclusions based on them. Fisheries data are considered first, then hunting, although some sources provide both, and the principles of data gathering and evaluation are the same. The term subsistence is used here to describe all harvesting for home or community (non-market) consumption (sensu Berkes 1988a, and in preference to such terms as "domestic harvesting" or "Indian food fishing").

DATA REQUIREMENTS

Volume estimates for subsistence harvesting (country food) are necessarily based on recall surveys rather than direct observation. Survey methods and estimation procedures are discussed and evaluated by Filion (1980), JBNQ (1982a, b), Berkes (1983), Usher et al. (1985), and Usher and Wenzel (1987). Whether these estimates are based directly on catch data or inferred from diet data, their validity depends on the extent to which the survey conforms to basic methodological criteria such as sampling, questionnaire design and administration, and attention to response bias in reporting and non-response bias in projecting. Unless these procedures are performed correctly and reported clearly, the resulting harvest estimates are of uncertain value. By these standards, almost none of the existing estimates for northern Manitoba is acceptable.

Two additional (although less exacting) tests may be applied. One is internal consistency of results, although this indicates precision rather than accuracy. The other is an external test: how closely do the estimates compare with reliable survey results from similar types of communities? Such comparisons are problematic, because of the wide variety of natural, economic, and social conditions that affect effort and production from place to place and from year to year. This is nonetheless a useful test when internal checks are absent.

SUBSISTENCE FISHERIES

Background

Subsistence fishing in NFA communities is largely, but not entirely, separate from commercial fishing. Historically, households have set gill nets near the community, easily accessible to family members, from time-to-time in both open-water and winter seasons. (Commercial fishing may take place further away from the community and may use different lengths and meshes of gill nets). As well, trappers often fish near their winter camps. The tendency has been to fish as needed, although some fish are stored by freezing, drying, or smoking. The premium is on proximity and flexibility; nets are moved often as circumstances require, and many species are taken at different times of the year. Culls from commercial fishing may supplement the subsistence harvest, and rod and reel may be used in addition to gill nets in summer.

Fish has been a staple in all NFA communities (often accounting for the bulk of country food), being easily accessible for much of the year. The aboriginal population of the Nelson system is relatively dense compared with many other parts of the North, and it seems likely that the abundant fisheries were an important sustaining factor.

Existing harvest data

Table 2 summarizes the available estimates of subsistence fisheries catches for NFA and neighbouring communities. Of the 21 estimates

cited, 11 are derived from surveys, and 10 are speculative. Only six of the 21 post-date LWR/CRD.

Six pre-project estimates are based on consumption surveys undertaken between 1972 and 1975, covering four communities that were eventually affected by LWR/CRD and one (Pukatawagan) downstream from a dam that was proposed but not subsequently built on the Churchill River west of the Manitoba boundary (Weagle 1973; Collinson et al. 1974a, 1975). Collinson et al. (1975) also provide estimates for Brochet and Granville Lake, but these do not appear to be survey-based, and are not cited here. Gislason's (1975) estimate is acknowledged to be based on an unrepresensentative sample and is therefore omitted from further consideration.

Weagle's unpublished report, cited in Koshinsky (1973), appears to be no longer extant, and the basis for his estimates cannot be verified. His figures for Norway House and Cross Lake, although said to be survey-based, appear not to be independent estimates but rather to have been derived from a single estimated family consumption rate.

The estimates by Collinson et al. (1974a, 1975), although widely cited, do not appear to meet acceptable standards. The reports do not indicate the size or the basis of selection of the sample of households, or the selection of and instructions to individual respondents. Hence the apparent treatment of the sample as random may not be justified, and the results may be unduly influenced by non-response bias. Respondents were asked to specify the average number of meals per week by season and by type of food. Problems of recall, definition, and in-season variability were not described. The use of "meals" as the sole measure of food consumption presupposes that nourishment is confined to three discrete consumption events per day. This is not necessarily a valid assumption for Native communities, and Collinson et al. give no indication that it was tested. Assumed portion size of 0.18 kg (0.4 lb)/meal (equivalent to urban adult portions as part of balanced meals) probably also contributes to a downward bias.

There are two post-project estimates (Wagner 1985), based on consumption surveys. Cross Lake and Split Lake were included in this first attempt at a province-wide subsistence harvest survey. The sampling procedure was sound, although non-response bias due to absence from the community was acknowledged to be a problem at Split Lake. The fisheries component of the survey was consumption- rather than harvest-based. The questionnaire tested frequency of consumption rather than number of meals but, requiring full year recall, it was vulnerable to the same recall difficulties as the Collinson et al. (1974a, 1975) survey. Assumed portion size was more realistic at 0.34 kg (0.75 lb)/meal. This difference alone requires that Collinson et al.'s estimates be doubled (or Wagner's halved) to enable direct comparison between pre- and post-project survey results.

One post-project estimate (Gaboury and Patalas 1982) is based on a harvest survey of the type mentioned above. It appears to satisfy most of the basic criteria. At least 80% of "active" fishermen appear to have been surveyed. Non-response was treated as random, apparently without verification. Questions were concrete and unambiguous. The use of recording aids, if any, was not specified, but because data were recovered at two to four week intervals, recall failure was minimized. No assumed values were used for any variable. The estimate does not include occasional fishermen, the sturgeon fishery, winter fishing on traplines, or the contribution of angling or of commercial culls to domestic consumption, and therefore does not encompass the entire subsistence fishery.

In addition to these survey-based estimates, there exist numerous speculative estimates, often generated for internal administrative and monitoring purposes (Usher and Wenzel 1987). These are estimates made by apparently knowledgeable observers based on unstated methods that probably include limited observation, hearsay, and unstated assumptions about such diverse matters as fish size, meal size, frequency of consumption, frequency and duration of fishing, and the representativeness of whatever actual data were obtained. These estimates are not necessarily inaccurate on that account; indeed some may be much more accurate than the survey-based consumption estimates. The problem is that this cannot be directly verified.

None of the other estimates of subsistence fisheries for NFA and other northern Manitoba communities (e.g. Lombard North Group Ltd. 1975; Adams et al. 1976; Teillet et al. 1977a; Green and Derksen 1984; NRG 1986) are independently generated. They are, instead, extrapolated from Collinson et al.'s (1974a, 1975) per capita estimates to fit local populations at different places and times. The effect of the continued reiteration of and extrapolation from these data has been to provide the appearance of a substantial body of empirical documentation of domestic fish consumption in northern Manitoba (e.g. 15 community figures cited by Berkes (1990), of which nine were projected from Collinson et al.'s suspect data), when in fact there is very little.

Analysis

Pre-1970 estimates (i.e. generated independently of LWR/CRD assessment) are few and of uncertain validity, because the methods by which they were generated are unclear (see "Other estimates", Table 2). Excluding the two highest

estimates solely on the grounds of internal inconsistency (if not improbability), the range is 31.2-150.6 kg. Two later speculative estimates for Norway House fall within that range.

These pre-project estimates are consistent with contemporary and recent reported per capita rates in communities unaffected by diversion and regulation. The average of 96 reported estimates of subsistence fishery catches from across Canada (Berkes 1990) is 42 kg edible weight, although not all of these estimates meet acceptable standards. More comprehensive and reliable estimates by the Alaska Department of Fish and Game (Division of Subsistence) indicate an average of 86.7 kg edible weight in interior Subarctic villages (Wolfe and Walker 1987).

Although none of the pre-project estimates cited can be accepted as methodologically valid, they are reasonable on grounds of internal consistency and external comparability.

The range of Weagle's (1973) and Collinson et al.'s (1974a, 1975) pre-project, consumption-based estimates for three NFA communities is 11.6-25.8 kg. This is substantially lower than both the other pre-project estimates cited in Table 2, and the normal range for Subarctic communities. By the tests of consistency and comparability they are improbably low, and may be artifacts of the suspect sampling procedures, questionnaire design, and unverified assumptions identified above.

There are six post-project estimates, four of which (Gaboury and Patalas 1982; Wagner 1985) are survey-based and methodologically acceptable. The other two (LNOST 1981) are of unstated origin. The range of consumption-based estimates is 10.4-27.1 kg, or up to 39.1 kg including the Gaboury and Patalas (1982) harvest-based estimate. There is a substantial disparity between the two estimates for Cross Lake, which is unlikely to be fully explained by the possibility that the larger one may include fish fed to dogs. As in the pre-project case, survey-based consumption estimates produced the lowest values.

The question thus arises whether there might be systematic difficulties with consumption surveys that result in under-enumeration, perhaps because of conceptual ambiguities in questionnaire design, and the practice of assigning values, which have not been empirically determined, to some variables. The key problems appear to be the concept of "meals", and the assumed portion size per meal. Consumption-based estimates in Manitoba have assumed 0.18-0.34 kg (0.4-0.75 lb)/meal, a range sufficient to produce a nearly two-fold disparity in projected results. The implication is that consumption estimates which a) use meals as the key variable (thus assuming that all fish is consumed at "meals"), and b) assume a portion size more typical of urban dwellers rather than determining it empirically in northern communities, introduce a significant downward bias to final estimates that is absent from harvest surveys.

Figure 5 indicates a substantial decline in per capita catch rates at Cross Lake and Split Lake, the two LWR/CRD-affected communities for which there are pre-project and post-project data, if the Weagle (1973) and Collinson et al. (1974a, 1975) estimates are excluded. For Cross Lake, the most comparable estimates have been paired: 1955 and 1980, which include all fish, and 1972 and 1984, which are human consumption estimates. Comparing only the Collinson et al. (pre-project) and Wagner (1985) (post-project) estimates, the decline is somewhat greater at Cross Lake than at Pukatawagan, a community not affected by LWR/CRD.

Given the problems with the data, the conclusions cannot be regarded as robust. However, neither the Pukatawagan data, nor Berkes' (1990) analysis of Canadian trends generally, lend support to the hypothesis that domestic fish consumption declines are a general phenomenon in Subarctic communities, or that they are a consequence of "modernization" independent of direct industrial impact on fisheries themselves.

Other indicators

Other indicators of subsistence fishing have seldom been quantified. Only Gaboury and Patalas (1982) measured participation and effort (numbers of fishermen, duration of fishing, net length), and there are no other data with which to compare them. The actual location of subsistence fisheries is almost never documented. It is generally known that the bulk of subsistence fishing takes place near the communities, on the main waterways (e.g. the Nelson and Burntwood Rivers or the lakes that are part of them). Existing data are not more specific than this, and provide no basis for ascertaining project effects on the spatial distribution of effort and catch.

Information (i.e. knowledge of fish and their habitats) and skills are powerful determinants of success in subsistence fisheries, and project effects on them cannot be ignored. There are, however, no good descriptive accounts of pre- project domestic fisheries in northern Manitoba that would provide a pre-project baseline.

If quantified, these indicators would likely exhibit post-project decline. Adverse physical-biological effects of LWR/CRD such as dewatering, flooding, winter drawdown, debris, and changing shorelines (Baker and Davies 1991) have made subsistence fishing, like commercial fishing, more difficult, more expensive, and less enjoyable. Reports suggest that one or more of

the following have resulted: damage to nets and boats has increased, more gear is required, and greater distances must be travelled (including travel to off-system lakes where possible).

Less tangible is the matter of rendering familiar waters unfamiliar. Fishermen report that after regulation and diversion, their knowledge of the river system was rendered almost useless, and that fish habitat and behaviour were no longer as predictable. Their existing body of knowledge, built up by experience and tradition, no longer served them well in terms of fishing success, fishing enjoyment, or as something useful to transmit to coming generations. It is possible to document these effects by means of interviews and participant observation, but at present only anecdotal information exists.

Finally, there is the issue of changes in fish quality: palatability, toxicity, and acceptability. Although crucial to the maintenance and viability of any domestic fishery, these are beyond the scope of this study.

HUNTING AND TRAPPING FOR FOOD

Background

Birds and mammals hunted or trapped for food in northern Manitoba can be divided into four groups: big game (moose, caribou, and bear), edible fur bearers (muskrat, beaver, lynx, and possibly other species), waterfowl (ducks and geese), and small game (ptarmigan, grouse, porcupine, and snowshoe hare). The harvest of these animals occurs through a combination of specialized seasonal and opportunistic hunts. (By hunts we refer not only to the moment of kill, but the entire activity beginning with travel to the preferred area, followed by search, location, stalking, the kill, butchering, transport home, and preservation.)

Migratory species, such as geese and ducks, are hunted seasonally, when they are available in efficiently harvested concentrations for brief periods. Seasonal hunts also occur for ungulates during their mating period, when harvest efficiency is high. However, big game animals are also hunted opportunistically, as is small game.

The provision of wild meat is a constant concern in northern Native communities. Hunting for small game animals is a regular activity, dependent on the phase of abundance in their population cycles. During the population highs, these animals are important food resources; during lows they are usually ignored as food. Big game and small game hunting typically occur at the same time as trapping, and sometimes during commercial and subsistence fishing, for the provision of fresh meat needs in camp and to bring meat back to the village.

Existing harvest data

The only hunting and trapping harvest data other than Manitoba Department of Natural Resources estimates are provided by three surveys (Collinson et al. 1974a; Gislason 1975; Wagner 1985). Survey methods, to the extent that the authors reveal them, are described in the previous section on subsistence fisheries. Gislason's (1975) estimates were acknowledged to be based on an unrepresentative sample. Collinson et al. (1974a, b) included nutritional surveys conducted at Cross Lake and Nelson House, which were limited to estimates of the number of meals per week from species and species groups (including waterfowl, moose, muskrat, beaver, lynx, hare, and upland game birds). Wagner (1985) used a harvest recall survey for large and small game. That survey also tested for time spent hunting, consumption of wild meat, and changes to animal populations, although the results are neither provided nor discussed in the text.

The largest body of information about wildlife harvests by the NFA communities comes from provincial records. This includes: (1) estimates of country food harvests during the 1950s; (2) estimates of edible fur mammal harvests before and after LWR/CRD (see "TRAPPING"); and (3) several ungulate harvest surveys. Except for the fur data and the efforts toward recording moose and caribou harvests during the late 1980s, records of game animal harvests are irregular and the methods used for collecting the data are seldom specified. The earliest estimates of big game, small game, waterfowl, fur mammal, and fish harvests are tabulated in country food tables in the annual reports of conservation officers (Manitoba 1953-61). The estimates for moose and caribou were based in part on a questionnaire (incorporated into the trapping licence and filled out upon renewal application) on the status and harvest of moose and caribou on each trapline (Bryant 1955). The basis for estimates other than ungulates is not explained in the reports, although it was probably a combination of hearsay and projection from observations.

There are significant uncertainties about the identity of the harvesters to which these tables pertain. The records are categorized by entire Registered Trapline Section. It is likely, but not certain, that the records refer to harvests by Native (Treaty and Metis) hunters. However, harvests by non-native community residents may also have been included. Harvests listed under the Split Lake Registered Trapline Section likely include those of members of other bands or communities who held traplines there (see "TRAPLINE TENURE" under "TRAPPING").

The records also change over time. Full estimates of all game harvests were attempted for 1953 and 1954, but records for the subsequent years became progressively limited to ungulate

harvests. The fall-off in records appears to be due to a decline in trapper compliance with record keeping and return of the licences.

Pre-project moose and caribou harvest data are limited to the conservation officer annual reports (Table 3). These are considered to be reasonably accurate, although the estimates for Split Lake are recognized as only a partial record (Bryant 1955). There are, however, no independent survey records from this period that could be used as a cross-check.

The size of the caribou harvest prior to the late 1950s indicates the importance of caribou to the subsistence economy during this period. The winter range of the Kaminuriak barren-ground caribou herd extended as far south as the Norway House traditional use area, up to the 1950s. More recent harvests have been from woodland caribou populations.

Later wildlife records have been limited to ungulate harvests. These have been irregular reports of local conservation officers, based on observation and community reports. Levson and Kabzems (1981) considered the data on Split Lake and York Landing moose and caribou harvests during the 1970s, which were based on conservation officer reports, to be generally underreported. They took the figures for 1977, a year when greater effort was taken to document moose kills, as a minimum harvest level.

Since the early 1980s, more systematic efforts have been made to obtain accurate data on moose and, to a lesser extent, caribou harvests in the communities as part of the general ungulate management program in northern Manitoba. The accuracy of the records depends on the quality of relations between the communities and conservation officers. Moose harvest figures for 1986-88 for Cross Lake are considered to be the most accurate; those from Nelson House, Norway House, and York Landing somewhat less so (C. Elliot, Manitoba Department of Natural Resources, Thompson; pers. comm.). Split Lake harvests are generally acknowledged to be significantly underreported.

Only Wagner's (1985) survey data can be used to cross-check the provincial records. However, the sampling and projection technique employed poses significant accuracy problems for harvests of animals caught in relatively small numbers by a limited number of households (Usher et al. 1985). Results require some verification for reasonableness from knowledgeable community residents, and it is not clear if this was actually done. At Cross Lake, sampling was nonrandom, being based on a selection from a list of hunters, trappers, and fishermen. Projection from the results likely resulted in an elevated estimate (102 moose), considerably higher than provincial records considered accurate by wildlife officials and community members.

Data in Table 3 can easily be converted to edible yield for moose and caribou. In the absence of local conversion data, we have used Quebec figures: 200 kg edible yield for moose and 60 kg for caribou (JBNQ 1982a).

Harvest information is entirely lacking for the small game species, except for a scatter of pre-development records from the Registered Trapline annual reports (see country food tables in Usher and Weinstein 1989). Records kept by government agencies usually concentrate on wildlife hunted by both sports hunters and Natives, particularly the ungulates. Harvests of smaller game, which are usually caught in large numbers and consequently are more difficult to estimate, are rarely included in administrative reports. This omission makes it difficult even to assess the relative importance of these species in the bush food economy.

This is equally true of the Collinson et al. (1974a, b) survey, which concluded that small game was not a significant food resource. A comparison with the provincial fur record indicates that that survey was conducted during a low in the lynx cycle, and hence presumably also a low in the hare cycle.

Research in other parts of the North indicate that these species play a vital role in Subarctic Indian subsistence. Many species that undergo dramatic population cycles are food staples during the years in which they are abundant, and then are almost entirely absent from the diet for an equally long period when other, more plentiful, species are relied on. The cyclic availability of these species, combined with the ways that their abundance influences harvesting strategies for other food resource species, means that harvest surveys should be repeated through an entire population cycle in order to provide a comprehensive basis for interpretation.

No information exists for waterfowl harvests (P. Boothroyd, Canadian Wildlife Service, Winnipeg; pers. comm.) or for harvests of plant materials (firewood, berries, and medicinal plants).

The largest body of information about wildlife food harvests is provided by the provincial trapping record. Beaver and muskrat can supply significant yields of meat to harvesters. The provincial trapping records (see "TRAPPING") provide an estimate of potential (e.g. Fig. 6). Actual edible yield is less, due to wastage. A significant amount of beaver and muskrat trapping happens during the spring when temperatures require that the meat be preserved quickly by smoking or drying. Intensive trapping during

this time of year would result in an unknown proportion of the harvest being unfit for human consumption.

The magnitude and complexity of this data set, and the requirement to differentiate between project-affected and unaffected traplines, however, has made even a preliminary analysis beyond the scope of this project.

Wagner's (1985) survey results provide independent estimates for harvests of edible fur animals in Cross Lake and Split Lake in 1983 (Table 4). This is the only available cross-check of the fur record. Larger Cross Lake harvests shown by the survey results for beaver and muskrat may be due to actual under-reporting of the provincial record due to domestic retention or unreported sales, or it may be an artifact of Wagner's sampling and projection procedure. Generally, however, except for lynx (which shows the kind of discrepancies that are to be expected from projecting rare events from samples), the numbers are in reasonable agreement. This general agreement, however, raises questions about the Split Lake survey data. Because of significant numbers of non-Split Lake trappers in this Section, we would have expected the survey results from one community's trappers (albeit the community with the largest share of traplines in the Section) to be less than the provincial record for the entire Section.

Utility for SIA

The existing data on wildlife harvests enable pre- and post-project comparisons for the fur bearer component of the food supply, on the same basis as trapping. Conversion factors can be used to convert whole animals into edible food weights and a dollar income-in-kind equivalent. Recording of fur bearer harvests by trapline also provides geographic information that can be used to test hypotheses about the effects of the developments on fur bearer food harvests as well as fur (see "TRAPPING", below).

Existing data do not permit such comparisons for big game because of the limited record, and because big game animals are typically wide ranging enough to move away from disturbance. Consequently other factors, including changes in habitat productivity and harvester effort, are also required to test impact hypotheses. (Tables of the available big game harvest record have been included in this report simply because there is no easily accessible source for the existing big game Native harvest record.)

Finally, the record also does not permit pre- and post-project comparisons for small game and waterfowl harvests because there are no data.

Other indicators

A key indicator for comparing project-related effects on resource harvesting is the geographic distribution of harvests. Geographic information is critical for comparing effects between project-affected and unaffected areas. Information on location of beaver, lynx, and muskrat harvests is available for the 1960s to 1980s on a trapline by trapline basis, although with considerable limitations on reliability, as discussed in "TRAPPING", below. Big game harvest location data are limited to kill sites during the late 1980s. In addition, as noted above, effects on effort, especially travel, must also be considered. Unfortunately, these and other indicators for wildlife harvesting are also lacking. Neither hunting effort nor participation have ever been quantified, or located, in northern Manitoba.

Table 2. Subsistence fisheries estimates for northern Manitoba communities. All source data converted to kg/capita/year (edible weight, where edible weight = 0.75 x round weight). Consumption survey data are assumed to be reported in edible weight, harvest survey data in round weight (unless otherwise stated). Human food only unless otherwise specified. Per capita rates calculated on the basis of approximate estimated population (from a variety of sources) for the closest year.

Author/date	Location/year (edible wgt.)[1]	Method[2]	kg/capita/yr
Estimates based on surveys			
Weagle (1973)	Norway House 1972	16.9	CS[3]
	Cross Lake 1972	16.9	CS[3]
Collinson et al. (1974a, b)	Cross Lake 1972	25.8	CS[4]
	Nelson House 1972	11.6	CS[4]
	South Indian Lake 1972	24.2	CS[4]
(1975)	Pukatawagan 1972	36.5	CS[4]
Gislason (1975)	Cross Lake 1974-75	107.9	CS[5]
Gaboury and Patalas (1982)	Cross Lake 1980-81	39.1**	HS[6]
Wagner (1985)	Cross Lake 1984	11.3	CS[7]
	Split Lake 1984	10.4	CS[7]
	Pukatawagan 1984	27.1	CS[7]
Other estimates			
Manitoba (1953-61)	Norway House		SE[8]
	1953-55	1318.9	
	1955-56	150.6	
	Cross Lake		SE[8]
	1953-54	392.5	
	1955-56	112.9*	
	Nelson House		SE[8]
	1953-54	31.2	
Schlick (in Koshinsky 1973)	Norway House 1972	37.7**	SE[9]
Scribe (in Koshinsky 1973)	Norway House 1972	58.6	SE[10]
LNOST (1981)	Split Lake 1966	55.5*	?[11]
	Split Lake 1980	22.0	?[12]
	York Landing 1980	16.0	?[12]

Table 2. Cont'd.

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1 *Includes dog food; ** may include dog food.

2 CS = consumption survey; HS = harvest survey; SE = speculative estimate; ? = unstated.

3 Method: interviews, no details given. Data presented as lb/family/year.

4 Method: questionnaires (no. meals/week by season). Sample size and response rate not specified but treated as random. Assumption: 1 meal = 0.4 lb.

5 Method: interviews (no. meals/week), methods unstated. Sample: N = 15 (over-represents older trappers).

6 Method: questionnaires? (bi-weekly harvest recall over one-year period, use of recall aids not stated). Sample: N = 22 (ca. 80% of fishermen). May refer only to fishing in Cross Lake itself.

7 Method: questionnaire (no. meals/year, by species). Sample: Split Lake - random, from band list (possibly unrepresentative because many absent during survey); N = 38 (covers 23% of resident band population). Cross Lake - random, from list of fishermen, trappers, and hunters; N = 71 (covers 24% of resident band population). Pukatawagan (Mathias Colomb) - haphazard list of fishermen, trappers, and hunters; N = 41 (covers 24% of resident band population). Assumption: 1 meal = 0.75 lb.

8 Calculated as numbers of families fishing x estimated average household consumption; based on casual observation and anecdote. We have not included estimates from this source for which the component variables are unspecified.

9 Cited as pers. comm., based on unspecified studies at Island Lake.

10 Cited as pers. comm., personal estimate by former Chief of Norway House.

11 Source and basis of estimate not stated; may be derived from unpublished 1967 nutrition study referred to but not cited in Woolcott (1974).

12 Source given as Wall, pers. comm. (identity not stated); basis of estimate not stated.

Table 3. Estimates of ungulate harvests by Northern Flood Agreement communities.

	MOOSE[1]				
	Cross Lake	Nelson House	Norway House	Split Lake	York Landing
1952[2]	29	74	30	17	
1953	8	53	49	40	
1954	70	69	44	38	26[3]
1955		21	39	17	
1956	100	32	30	33	
1957	30	44		40	
1958	18		33	39	
1959	31	43	43	25	(11)[4]
1960	7	20	20	18	(16)
1961		74	24		
1962		31	15		
1976[5]					3
1977				49	4
1978				9	2
1982[6]	5	18	2		
1983	10	22	6	2	
1984	10	9	13	7	2
1985	38		24		
1986	44	15	33	18	8
1987	49	39	22	17	1
1988	48	10	7		
1983[7]	102			53	

	CARIBOU[1]				
	Cross Lake	Nelson House	Norway House	Split Lake	York Landing
1952[2]	907	341	242		
1953	12	159	8	705	
1954	8	15	8	400	130[3]
1955	0	31	27	1230	
1956	125	24	20	800	
1957	40	0	0	5	
1958	18	2	21	27	
1959	46	20	56	2	
1960	0	75	3	22	
1961		69	16		
1962		1	15		
1977[5]				17	0
1978				12	0
1983[6]		3			
1984					
1985	1				
1986			1		
1987					
1988	10		1		
1983[7]	13		9		

Table 3. Cont'd.

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1 The 1952-61 figures are for the Registered Trapline Sections as a whole. Data for Split Lake may include harvests of other communities with traplines in that Section.

2 From Manitoba (1953-61). Method: Trappers reporting on returned licences, probably also supplemented by conservation officer hearsay and observation.

3 York Landing figures for 1954 are York Factory Band kills from the York-Shamattawa Registered Trapline Section before the band moved to York Landing. Although outside of the NFA area, they are included because they were considered accurate by the conservation officer and, if that is correct, they are an indication of the level of the Band's harvests before relocation.

4 11 of the 25 known Split Lake Registered Trapline Section moose kills in 1959 were killed by York Landing residents; same for 16 of the 18 known kills in 1960.

5 Levson and Kabzems (1981), using local conservation officer reports based on a combination of hearsay and observation.

6 Manitoba Department of Natural Resources (Thompson) files. Method: Conservation officer observation and hearsay.

7 Wagner (1985). Method: Recall survey questionnaire.

Table 4. Survey results for Cross Lake and Split Lake edible fur bearer harvests compared to the provincial Registered Trapline Section data, 1983-84 trapping season. Source: Wagner (1985) and Manitoba Department of Natural Resources fur harvest records.

	Sample[1]	Projection[2]	Provincial record
Cross Lake			
Muskrat	3155	13400	12120
Beaver	277	1180	884
Lynx	3	13	6
Split Lake			
Muskrat	518	2301	2161
Beave	179	795	649
Lynx	1	4	13

[1] Reported total from questionnaires.

[2] Projected estimate for total resident band population.

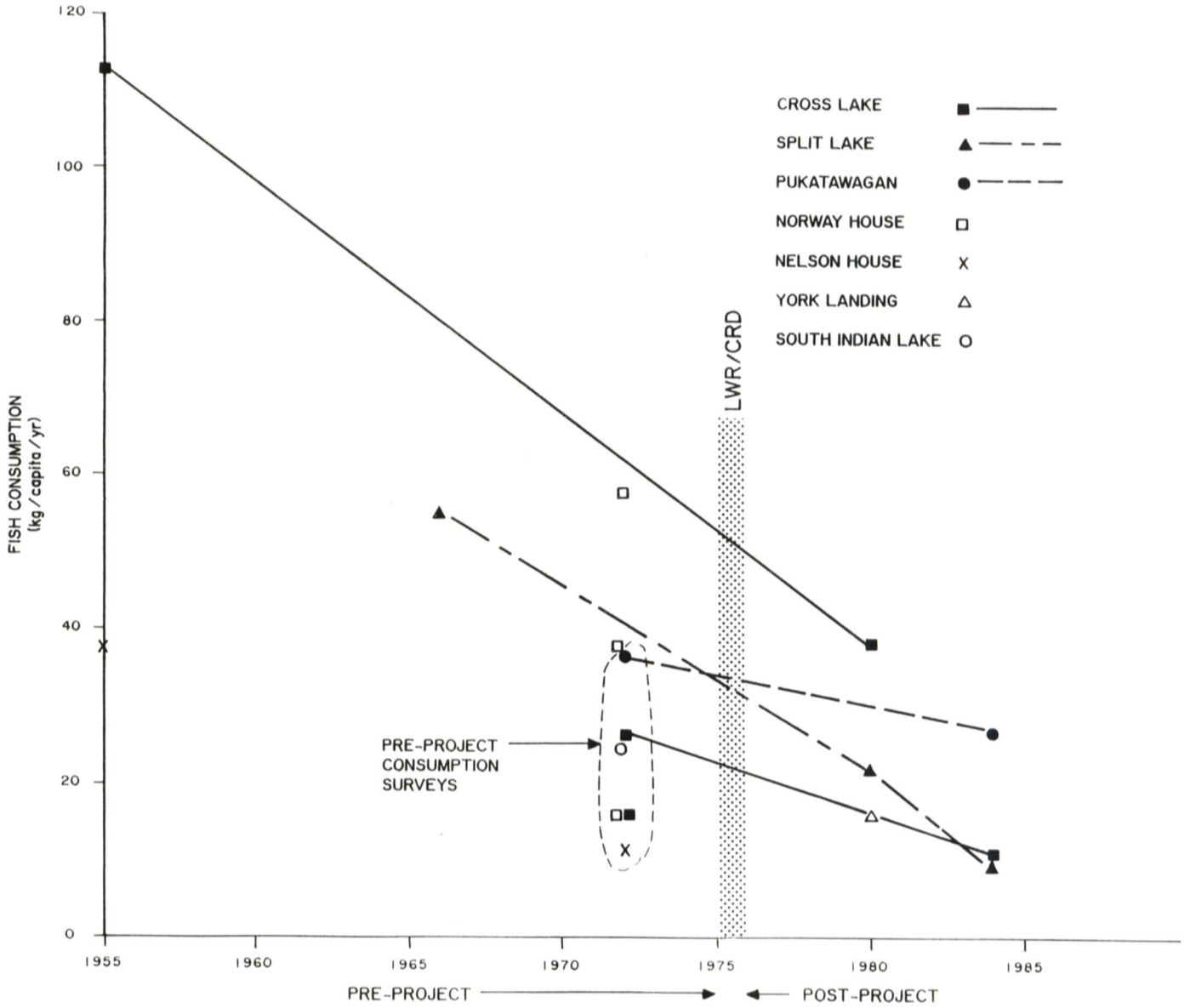

Fig. 5. Annual subsistence fish consumption (kg/capita) for selected northern Manitoba communities, 1955-84. Trend lines show where comparable data exist for more than one year. The upper trend line for Cross Lake joins results including dog feed; the lower one joins results which do not. The 1972 consumption survey results (which are substantially lower than other pre-project estimates) are encircled. From Table 2.

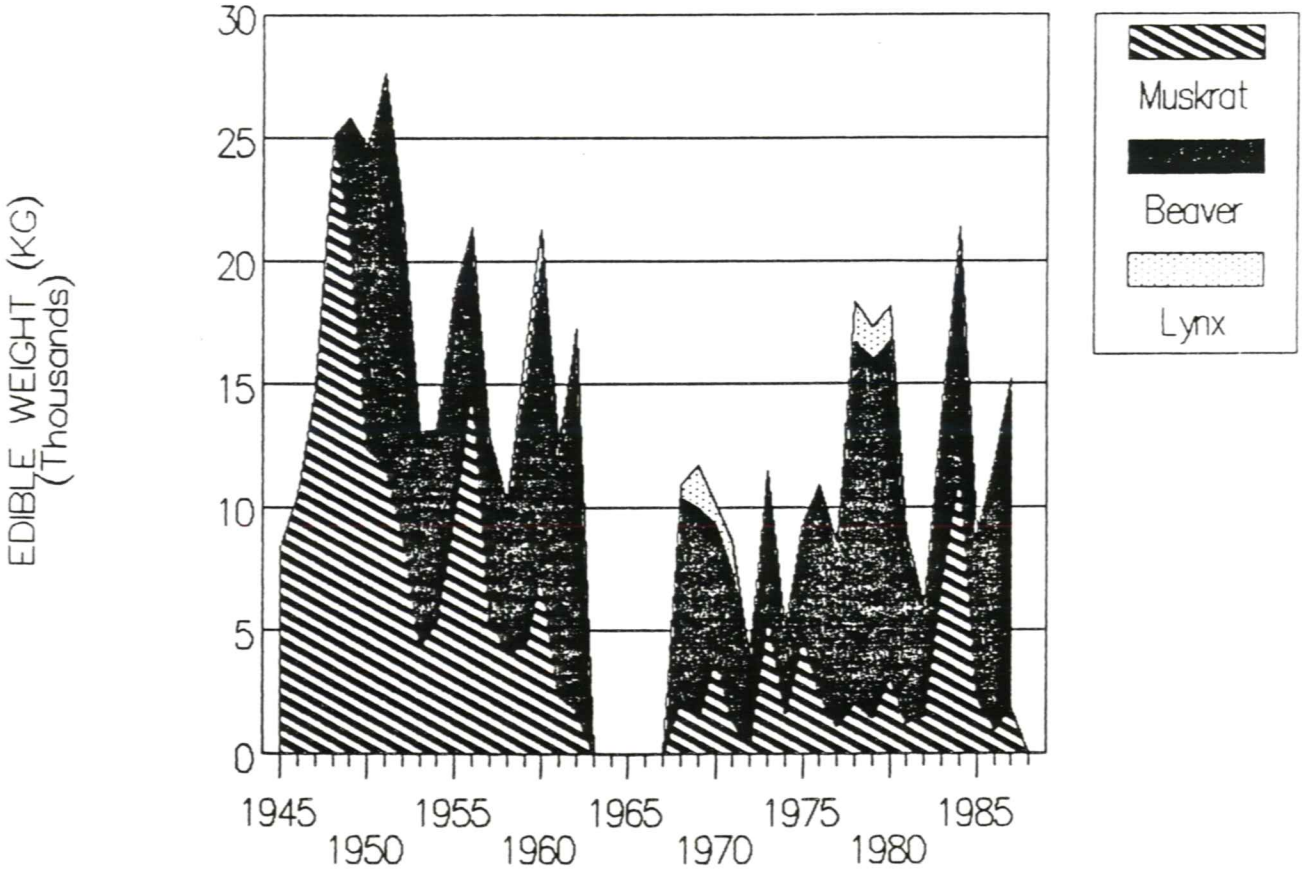

Fig. 6. Estimated potential food harvests from fur mammals trapped on the Cross Lake Registered Trapline Section, 1945-87. Estimated edible portion of harvests from JBNQ (1982a): muskrat = 0.6 kg; beaver = 7.8 kg; lynx = 3.8 kg. From Manitoba (1953-61) and Manitoba Department of Natural Resources records.

COMMERCIAL FISHING

Commercial fishing has been an important component of the mixed, subsistence-based economy of northern Manitoba communities. As a seasonal activity, it is complementary to trapping, and has been a major source of cash. Although the number of households participating in the commercial fishery has declined, fishing remains for some an important alternative to wage employment. Significant indicators for commercial fishing include volume and value of production, effort (participation, input costs), and location and access.

In this section, we assess the utility of existing data sources as indicators of commercial fishing, and derive from these a standardized set of indicators. We then examine patterns and trends in use, production, and participation on project-affected (on-system) water bodies and unaffected (off-system) ones. Finally, we consider some impact hypotheses, so far as existing data permit.

BACKGROUND

The modern era of commercial fishing in northern Manitoba, based on the export of small species (chiefly whitefish, pickerel, pike, and lake trout) in fresh or frozen form, dates from the construction of the Hudson Bay railway in the 1920s, which provided economic access to external markets. The fishery was organized by large, southern-based companies that provided credit. At first, the labour force was primarily non-Indian, consisting of either experienced commercial fishermen from southern lakes, or non-natives and Metis living in recently settled villages along the railway.

Most NFA area lakes were far enough from the railway that winter fishing was required to ensure a quality product. With improvements in transport and processing facilities, and greater local availability of alternative forms of winter wage employment, winter fishing declined. By the mid-1960s, most production occurred in summer.

The fishery was reorganized in 1969, with the formation of the Freshwater Fish Marketing Corporation (FFMC) as the sole purchasing agent. There was a decline in lakeside management of fishing operations as the private companies withdrew, and individual fishermen operated more as independent firms than as an employed labour force. In 1970, there were widespread closures in commercial fishing throughout Manitoba, including the Nelson system, due to mercury contamination. Since then, there have been occasional lake closures and rejected shipments because of the mercury problem. (See Green and Derksen 1984 for a brief history of the organization, technology, and problems of the commercial fishery on the northern lakes).

Until the 1960s, Indian involvement in the fishery was determined by a mixture of internal considerations of household economic and seasonal strategy and external considerations of the capital structure of the fishery. Indians appear to have been concentrated in the least capital-intensive fisheries: the summer fisheries on the major river systems. The more mobile winter fisheries utilized mostly non-Indian labour, whether company-employed or self-employed. Beginning in the late 1950s, the Department of Indian Affairs began playing a more active role in promoting Indian involvement in commercial fishing throughout the Canadian mid-North, as an economic development measure.

The actual extent and pattern of Indian involvement in the fishery is not clear from the official record, and may be under-reported. Disparaging observations about Indian commercial fishing operations are frequent in Fisheries Officers' reports during the 1950s and 1960s. Indian economic behaviour did not fit the resource managers' perspective of how commercial fishing should be undertaken, and there was a clear preference at the field level for licencing and encouraging non-Indian fisheries.

There were indeed significant differences between Indian and non-Indian patterns of commercial fishing. Non-Indians generally fished as a sole occupation during the season. Their strategy for maximizing income and return on effort was to fish intensively in order to take their quota as quickly as possible. Although a few Indians are said also to have operated this way, the majority appear to have regarded commercial fishing as an adjunct to a complex seasonal round of harvesting and employment activities centred on community or trapline, and involving domestic as well as commercial production. This would account for their reported tendency to fish less intensively over a longer period of time.

The non-Native strategy was more economically efficient, if commercial fishing was the sole activity. However, the Indian strategy was more efficient from the overall perspective of the mixed, subsistence-based economy. Capital requirements were reduced, and fishing could more easily be combined with other economic activities on an opportunistic basis. Not the least of these activities was the river-based subsistence fishery, mostly located in close proximity to the communities. The commercial and subsistence fisheries were thus best combined on larger water bodies from which a steady supply of fish could be taken, rather than on smaller lakes that were best fished by a pulse or rotational strategy. The latter strategy, on its own more capital intensive, appears to have been used by Indians only in connection with trapping.

USE AND TENURE

When the modern commercial fishery was established in northern Manitoba, it was superimposed on long-established Indian domestic fisheries, and largely disregarded them. These domestic fisheries consisted of major summer operations on main waterways near reserves and settlements, and smaller, scattered winter fisheries near family hunting and trapping camps. Although there is no specific documentation in the literature, it may be assumed that there was a local customary system of access involving recognized traditional rights to specific waters. The Indian treaty right to fish for food was not regarded by governments, however, as constituting a right of tenure or even an exclusive right to harvest in any specific body of water. Nor did the establishment of the RTL sections (see "TRAPPING") imply a recognition of exclusive or preferential harvesting rights to anything other than fur. In contrast, Indians regard these RTL sections as confirmation of traditional territories and rights.

By at least the 1940s, the province had established a system of opening lakes to commercial fishing based on prior biological inspection to establish quota and grade. Individuals could obtain or renew commercial fishing licences that were valid for one season: summer or winter. Preference was given to persons or companies considered capable of obtaining the assigned quota and at the same time meeting conservation and inspection requirements, i.e. skilled commercial fishermen with sufficient capital and entrepreneurial ability.

By the 1970s, when LWR/CRD commenced, the spatial pattern of commercial fishing use indicated in Map 2 was already well established. Article 15.1 of the NFA provided reserve residents first priority to all the wildlife resources within their trapline zones. In view of the adverse effects of LWR/CRD on existing harvesting areas, article 15.2 obligated Manitoba to "use its best efforts to make available new alternate Resource Areas to the extent that it is practical to do so." Article 15.4, however, recognized the existing harvesting interests of non-reserve residents within these zones. As Map 2 indicates, the geographic extent of these rights within the communities' trapline zones were, and continue to be, extensive.

COMMERCIAL FISHERIES DATA

Data sources

Commercial fishing is a licenced activity. Manitoba and Canada have maintained regular systems of data collection for administrative and monitoring purposes since the inception of the commercial fishery in the NFA area over 50 years ago. These data provide useful information on volume, value, participation, and location for the entire period. Input cost data can be reconstructed partially for recent years.

The licencing and monitoring of commercial fishing operations in northern Manitoba is lake- and season-specific. (In a few cases, small adjacent lakes are grouped under a single licence, or specific reaches of rivers are licenced separately, although the latter does not apply to the NFA area). Thus, the basic geographic units of data collection are lakes, and the basic time units are seasons (summer = open water; winter = under ice), with yearly lake totals also provided.

The data sources examined were as follows:

1. Manitoba Department of Natural Resources
   a) Annual production files 1930-1971 and master index of lakes (Winnipeg office).
   b) Lake production and correspondence files 1961-1989 (Thompson office).

2. FFMC
   a) Lake production records 1970-1988.

Here we assess the nature and reliability of the data, and describe how we have interpreted and standardized the data as a set of indicators.

Manitoba (Department of Natural Resources, and predecessors)

In the late 1930s, the province developed its own reporting system, based on the existing federal one. This practice coincided with the opening of the northern lakes. (The first record of commercial fishing within the NFA area is from Sipiwesk Lake for the summer of 1937).

The provincial returns consist typically of a one-page table for each water body, indicating production, value, and effort, as measured by several indicators, as well as the assigned catch limit and designated whitefish grade.

From about 1945 onwards, the lake reports frequently include brief two or three sentence reports by the fishery or conservation officer (CO) on the season's operation (hereafter referred to as "CO reports"). These are idiosyncratic in content and style, but often include information on the identity of fish companies or individual licencees, residence and competence of crews, condition of buildings and equipment, method of transport, success of fishery, as well as management and licencing recommendations.

Up to 1970, the prevailing system for compiling the seasonal lake summaries was that licencees were responsible for supplying fisheries or conservation officers with monthly records of weights shipped and prices paid.

Larger operations had designated station operators who were supposed to keep these records.

The annual reports indicate that there were continuing problems with the record-keeping system in the field. There are frequent comments in the 1960s about the difficulty of obtaining adequate records from fishermen and station operators (both Native and white) who were said to be illiterate or uncooperative.

Thus, it should be assumed that the lake records consistently under-report actual economic production, although this does not appear to render the record suspect for analysing trends. There may also be a problem with strategic bias, i.e. deliberate misreporting. This most likely occurred where lake quotas were exceeded; however, where an enterprise fished several lakes, the most likely result was reallocation to underfished lakes, which would not affect the total regional catch reported.

Following the establishment of the FFMC, the provincial reporting system was modified, and now relies on FFMC records.

FFMC

The FFMC began operations in 1969. Data on the commercial fishery began in 1970; the record has been computerized from the outset. In the first two or three years, there were problems with non-reporting, miscoding of lakes, clerical and data entry, and the misidentification of fishermen. Records for these years were subsequently corrected as much as possible. Data from 1973 to the present are considered consistent and reliable, although instances of lake misidentification, miscoding, and mis-allocation of production continue.

There are currently two primary records. The initial one is the Daily Catch Record (DCR), based on fishermen's sales slips. This identifies the fisherman, the lake, the point of delivery, and records the number and weight (round or dressed) of fish by species and price paid, including product description (grade and size). The DCRs are now the basis of the provincial record-keeping system.

There is a second record based on the weighbill or Fish Purchase Ticket (FPT). These are weekly summaries of DCRs. The FPT records are the basis of both payment to fishermen and the FFMC computer record. The effect of the new system was to replace the company-submitted catch records (in effect, their shipping records) with sales records of individual fishermen.

The computer record thus includes: (1) name and residence of seller; (2) location of catch (by lake); (3) month of sale; (4) delivery point; (5) product by weight and sale value; and (6) deliveries per week. At the request of the Department of Indian Affairs and Northern Development, the computer record also specifies whether the fisherman is a status Indian.

Possible sources of strategic bias in the reporting system include lake reallocation to benefit from higher grade or where quota is reached; and selling fish through others for a variety of accounting reasons. Provincial authorities cannot specify the extent to which these practices bias the record, but overall distorting effects are probably minimal.

Provincial records are more accurate for the period since 1970, but since about 1980 they do not include payments to fishermen. For the purposes of this project, custom tabulations were supplied by the Department of Fisheries and Oceans (which co-manages the FFMC data base) by lake and season from 1970 to 1988. These were checked against provincial data (at the Thompson office), and corrected for lake and season miscoding. As a result, payment data are missing from our record in a few cases for recent years.

IMPACT INDICATORS

The key indicators that may be derived from these records are volume and value of production, and participation in the fishery. Data for these indicators are lake- and season-specific. For reasons listed below, the data are insufficient to reconstruct production costs, especially for the pre-project period. Comparisons of pre- and post-project production costs have been made by other investigators for the purposes of cash or program compensation under article 19.4 of the NFA. These are useful but largely unsystematic observations from the perspective of SIA.

We created a standardized data set (Appendix II) for three indicators: catch weights, catch value, and participation, as described below.

Catch weights

Both the original federal recording system and the subsequent provincial system defined quantity as fish caught and landed. This is an economic definition: catch for which money was paid - a quantity somewhat smaller than that removed from fish stocks.

All recording systems indicate, at minimum, the weight of fish by species. Weights prior to 1971 are actual product weights sold (i.e. dressed or headless dressed) in pounds (lb) or hundredweight (cwt). Weights since then are round equivalent weights in kg.

Although we converted all of the pre-1971 weights to metric equivalents, none is converted to round equivalent weight as there is no

consistent basis for doing so. (FFMC weight conversion factors are: round weight equivalent = 1.2 x dressed weight, and 1.4 x headless dressed weight). Over the years, packing house processing instructions to fishermen have changed with technological innovation and consumer preference. Pre-1971 weights in our data set should be multiplied by at least 1.2 in order to provide direct comparison with subsequent weights.

Only total catch weights were tabulated for the purposes of this analysis. Both the provincial and FFMC records provide a breakdown by species. The provincial records distinguish between fresh and frozen shipments, and the FFMC records distinguish product type, and in the case of whitefish, grade.

Catch values

Both the original federal recording system, and the provincial one derived from it, indicate two sets of values for the catch: value to fishermen, and value as marketed. The distinction according to Schedule 1B instructions to fisheries inspectors was:

> Value to fishermen - value of the catch when first brought to land.
>
> Value as marketed - value to buyers or shippers, if any, at the shipping point. Where fishermen ship their own fish, or market them locally, the two values will be the same.

Various provincial narrative reports indicate how these figures were actually calculated. For example, the summer 1949 report indicates that prices to fishermen were figured at the lake of operation, not including boxes, paper, ice, or transport; this accounts for the difference with market price. According to the summer 1962 report, figures on value to fishermen "... were obtained from the fishermen or dealers and vary greatly depending on several factors, namely:

a) Distance from market and type of transportation used i.e. boat, truck, train or aircraft.
b) The schedule or category of the whitefish concerned."

Specific practices also varied by fish company. For example, the summer 1965 report indicated that value to fishermen varied among lakes depending on market fluctations, quality, freight rates, and method of payment to fishermen (i.e. monthly wages, per pound basis, or per pound plus bonus). It is evident from the individual lake sheets that total values were calculated by COs from per pound prices supplied by dealers, and the forms often indicate these prices directly.

Given the complexity and uncertainties of the system for calculating values, the results should be regarded only as reasonable and informed estimates. For the purposes of community SIA, value to fishermen is the indicator selected for this data set.

The FFMC system is in principle a more accurate record of fishermen's receipts. Since the establishment of the FFMC, fishermen receive an immediate payment as well as a final adjustment later on. The custom tabulation requested final payments to fishermen. In principle, this is the equivalent of "value to fishermen" under the previous system.

All values are recorded as unadjusted dollars in the data set, hence the appearance, in Figs. 6-18, that values tend to rise in relation to production over time. Also, average values of production by lake, as indicated in the summary tables, are not directly comparable because lakes fished only in recent years show a much higher average than comparable lakes fished over a long period of time, or those fished mainly in early years. The use of these tables for certain types of economic analysis would require conversion of the value data to constant dollars.

Participation

Several indices of effort are contained in the Manitoba and FFMC data, but they are less accurate and reliable than the catch data, and less amenable to standardization.

The pre-1971 (provincial) records include data on effort and capitalization as measured by:

1. Number of licences issued - Each person fishing required a licence; this is the indicator used in our data set as "number of men", although not all licences were necessarily used.
2. Number and value of nets used - Number of nets used was generally estimated at ten per licenced fishermen, except where the amount was known to be different.
3. Number and value of boats used (summer fishery only).
4. Number and value of buildings (i.e. ice houses, packing sheds).

Values were estimated by COs, apparently on the basis of field inspection.

The FFMC records provide the following data only:

1. Number of operators (e.g. licencees).
2. Number of hired men (not applicable to northern inland fisheries).
3. Number of deliveries per week.

We selected number of men (i.e. number of licences issued in the provincial records and number of operators in the FFMC records, the two being virtually equivalent) as the indicator of participation. This must serve as a proxy for effort (in the provincial records, the number of nets is almost always given as ten times the number of men).

The number of fishermen per lake per season cannot be reliably summed per year or by region. The same individuals may be licenced for both seasons for the same lake, and the same individuals may also obtain licences for more than one lake per season, especially in the case of the smaller, off-system lakes. Consequently, although the seasonal counts of fishermen in the tables in Appendix II are correct, the annual totals may in some cases be over-estimates. Likewise, the on-system and off-system totals in Tables 6-9 are probably over-estimates.

Good longitudinal data thus exist only for participation, i.e. number of men, and then only on a lake-by-lake basis. There is no record of duration of fishing in the provincial data. Some direct input costs (boats, nets) were recorded. However, because their value seems to have been arbitrarily assigned, because motors, gasoline, shelter and other gear are not recorded, and because ownership is not indicated (i.e. whether the gear was supplied by the company or belonged to the individual fishermen), no useful set of cost indicators can be reconstructed from the provincial data

FFMC records, especially where the purchasing agent provided credit, can be used to reconstruct input costs, although most of these data post-date the start of LWR/CRD. The procedure is, however, reported to be laborious and of somewhat limited value due to the aggregation of dissimilar types of data (P. Thompson, Freshwater Institute, Winnipeg; pers. comm.).

ORGANIZATION OF INDICATOR DATA

Data were obtained for each year of record of commercial fishing. The earliest record is for Sipiwesk Lake in 1937, and the series ends in 1988, the last year for which complete data were available. The series has been standardized to the extent possible, as described above. The indicator series contains the following information by lake for each season (i.e. summer and winter): (1) weight (kg) of fish purchased; (2) dollar value to fishermen; and (3) number of licences issued.

Selection and classification of lakes

Seventy-eight lakes were identified as having been fished commercially in the NFA area. These are classified in Table 5 as "on-system" or "off-system" (see also Map 2). On-system lakes are integral parts of the Churchill and Nelson rivers and the CRD, or are adjacent waterbodies with direct access by vessel. Off-system lakes are "inland" lakes connected to the main system by rivers or streams, but whose water levels were not affected by the project. Bruneau, Macheewin, West and Central Mynarski, Mystery, and Osik lakes have become on-system lakes due to flooding; Walker Lake has been cut off from the system due to dewatering. The term "on-system" as used here is equivalent to "waterway" as defined in article 1.22 of the NFA: any river, stream or lake on which the water regime is controlled or is modified in any way by the project. (LWR/CRD flow and level effects by category are indicated and described in Map 1 and Appendix I).

Our lake classification is based on the assumption that commercial fishing on on-system lakes is more likely than that on off-system lakes to have been directly affected by physical and biological changes associated with flooding or diversion. If this assumption is correct, then impact hypotheses may be tested by comparing secular trends between on-system and off-system fisheries, other things being equal. Depending on the impact hypothesis to be tested, however, it may be appropriate to reclassify the lakes. For example, if and where there is migration or interchange of fish stocks between on-system and off-system waters, changes in the productivity and quality (e.g. mercury contamination) of these stocks in on-system waters may affect off-system fisheries. However, there is no indication that this is the case, either from data on mercury loadings in fish, or from reported migration patterns (A. Derksen, Manitoba Department of Natural Resources, Winnipeg; pers. comm.).

RESULTS AND DISCUSSION

Tables 6-9 summarize the raw lake data on commercial fisheries presented in Appendix II. For each lake, by resource harvesting zone, the tables show historic use (resident or non-resident); number of years fished (total, summer, winter); average weight and value of the catch, and average number of fishermen, for each year reported; and the 1975 quota.

Lake quotas for 1975 indicate the relative contribution of each lake to the total potential commercial fishery in each resource harvesting zone, prior to LWR/CRD impact (1976 was the first year of LWR operation). (Quota information is approximate, having been obtained from both file and literature sources and normalized to eliminate anomalous one-year variations. Lakes for which no quota is indicated had not then been opened to commercial fishing).

Map 2 shows historic use patterns, distinguishing between (1) on- and off-system lakes,

and (2) their use by residents of NFA communities compared to residents of other communities. The delimitation of NFA community fishing areas has been generalized because use of some lakes has changed over time.

Figures 7-19 illustrate some patterns in the commercial fishery in the NFA area. Figures 7-14 show trends in catch, value, and numbers of fishermen by resource harvesting zone, on-system and off-system. Figures 15-19 show the same trends for certain key lakes in the NFA area. Figures 20-26 compare summer and winter catches by resource harvesting zone. (Intervals on the y axis have been standardized to facilitate comparison among zones.) Norway House on-system lakes are not included in this comparison because they have been almost exclusively summer fisheries. Data for isolated single years have been excluded from the figures.

Certain preliminary observations can be made with respect to LWR/CRD effects on commercial fisheries harvests and participation, on the basis of existing impact indicator data.

Norway House

Norway House residents have a long history of involvement in the commercial fishery. Playgreen Lake, the most productive fishery in the entire NFA area, has been fished steadily by large numbers of fishermen since the mid-1950s, when they were excluded from Lake Winnipeg (Table 6, Fig. 7). Norway House fishermen have also fished all of the major off-system lakes in their zone.

The off-system fishery (mostly a winter fishery except for Molson and Gunisao Lakes, cf. Fig. 20) has declined since the late 1960s (Fig. 8). Distance from surface transport has rendered most of these lakes uneconomic as commercial fisheries, although Molson Lake remains an important domestic fishing location. Some of the off-system lakes have been converted to sport fishing use. Norway House residents have owned some lodge enterprises.

In contrast, Playgreen Lake has continued to be the largest single commercial fishery north of Lake Winnipeg, other than Southern Indian Lake. The number of licenced fishermen has remained constant since 1968 (Fig. 7), by policy of the Norway House Fishermen's Co-op. The quota has been doubled since then, and catch rose steadily until the mid-1980s (Fig. 15).

According to fishermen, LWR has changed conditions in Playgreen Lake so that they must travel further to fish, and must contend with a greater incidence of debris and net fouling (Symbion Consultants, undated; see also Hilderman et al. 1983; McLaren Plansearch Inc. 1985). The economic effect has been to increase the costs of production, for which Manitoba Hydro compensates at the rate of $0.82/kg ($0.37/lb).

Cross Lake

The commercial fishery in the Cross Lake zone has been concentrated in the on-system lakes (Table 7). Production from these lakes has been substantially greater than in any other part of the NFA area except for Playgreen Lake itself, and has been more or less continuous for decades, beginning with Sipiwesk Lake in 1937 and most other lakes in the 1950s. In the 1940s and 1950s, the on-system lakes were fished mostly in winter; however, since the early 1960s, they have been almost exclusively summer fisheries (Fig. 21).

Sixteen off-system lakes have also been fished commercially, but almost entirely by Wabowden fishermen. Several of these lakes show modest production records, especially those fished five years or less (Table 7). The off-system fisheries began entirely as winter operations, many dating from the late 1940s and early 1950s, although most have been converted to summer operations since 1970 (Fig. 22).

Fishing by residents of Cross Lake is concentrated in the on-system summer fisheries, which were the most adversely affected by LWR. On-system catches since the early 1970s, and especially since 1976 (the first year of LWR operation), have been erratic and participation has declined (Fig. 9). The fishery on Cross Lake itself has virtually ceased since 1979 (Fig. 16) due to the effects of dewatering, and the Walker Lake fishery has declined substantially since 1981 (Fig. 17). Cross Lake fishermen formerly operated chiefly on Cross, Pipestone, and Walker Lakes but only the last remains a productive fishery; due to the loss of direct water access to it, costs of harvesting have increased. This has been the subject of a compensation agreement with Manitoba Hydro. There is no apparent effect of LWR on catch at Sipiwesk Lake (Fig. 18), which is fished primarily by fishermen from outside the resource harvesting zone.

Split Lake

Commercial fishing in the Split Lake zone dates mostly from late 1950s (Figs. 11, 12). Split Lake residents fish mostly in Split Lake itself, a summer operation which has on average produced the largest catches of any lake in the zone (Table 8). Split and Waskaiowaka Lakes have also been fished by York Landing residents since the 1960s.

The off-system lakes in total normally account for most of the total production in the Split Lake zone, although the proportion has declined since 1970 (Table 8, Figs. 11, 12). Off-system fisheries began as winter operations

but converted almost completely to summer operations between 1965 and 1971 (Fig. 24). Almost all have been fished chiefly by residents of Ilford. Assean, Atkinson, Holmes, and Waskaiowaka have been the most important off-system lakes; of the rest, six have been fished for five or fewer years. The relatively low production and poor accessibility of most off-system lakes, as well as the fact that most are cutter grade for whitefish, have rendered them increasingly uneconomic for commercial fishing. However, several have been recently converted to sport use.

Nelson House

Lakes on the Burntwood River system were fished regularly in summer by Nelson House residents prior to the diversion (Fig. 25). Production on these lakes has declined since flooding by CRD (1976) (Fig. 13). A further on-system effect has been mercury contamination of the fishery, which has resulted in closures and restrictions. The off-system lakes have accounted for nearly three-quarters of the average production in the Nelson House zone, and their share of production has increased over the last decade (Figs. 13, 14). Gauer Lake, the largest, continues to be an important producer (Table 9).

Except for Suwannee Lake, and in the earlier years, Wuskwatim Lake, Nelson House zone on-system and off-system lakes have been summer operations (Figs. 25, 26). All of the on-system (except for Mystery Lake near Thompson) and many of the off-system lakes have been fished by Nelson House residents, a pattern that seems to have been initiated in the late 1950s with the assistance of the Department of Indian Affairs.

Many of the off-system lakes have also been fished by residents of South Indian Lake and Granville Lake (some of them members of the Nelson House Band). South Indian Lake fishermen have been granted temporary access to some off-system lakes in the northwestern part of the zone in consideration of the decline of the fishery on Southern Indian Lake.

Regional overview

LWR/CRD appears to have had adverse effects on commercial fishing in each of the NFA zones. The effects vary: the Cross Lake fishery has experienced a sharp decline in production, the Nelson House fishery has been partially contaminated by mercury, and the cost of fishing has increased at Norway House and possibly also at Split Lake. The respective domestic fisheries have probably been affected in the same ways.

These effects are only partially revealed by the indicators used here - volume, value, and participation - for which administrative and monitoring data are available (for mercury effects, see Canada-Manitoba 1987). The response by fishermen to adverse physical and biological effects has, in some cases, been the intensification of individual effort to maintain production levels. This adaptive strategy in response to declining catch per unit of effort was documented at South Indian Lake by Waldram (1983), using the following indicators: capital equipment, net utilization, frequency of net relocation, travel distance, length of working day, and gasoline consumption. No such indicator data are available and no monitoring system has been devised to measure this response in NFA communities.

Article 15.2 of the NFA makes provision for another possible response: the geographic reallocation of effort. This is not easily achieved, however. As Map 2 and Tables 6-9 indicate, the bands' commercial fisheries were almost always concentrated on the on-system waterbodies near the reserves. In the Norway House and Cross Lake zones, on-system lakes accounted for half of the commercial fisheries quota at the time of the agreement. In every zone, most of the off-system quota was either already allocated to non-resident fishermen, or it was uneconomic to harvest in the context of subsistence system strategies (or in some cases, by any standard).

Uses and limits of institutional data

The indicators that can be derived from existing institutional data have sufficent time depth and geographic coverage to undertake a more broadly based assessment of fisheries impact than has occurred in NFA fisheries studies to date. The incorporation of pre-1970 data, thus far virtually ignored, provides a long pre-project statistical series that can be used to assess the relative importance of non-LWR/CRD effects. The three indicators employed here, however, are not alone sufficient for a comprehensive impact assessment. Existing data enable the development of more detailed indicators of volume and value (e.g. by species and grade), and to a much lesser extent, input costs. These would be useful for testing certain economic hypotheses. Other indicators would have to be developed on the basis of field interviews and surveys (viz. Waldram 1983), and ethnographic reconstruction; these are technically feasible but costly.

The use of on-system and off-system comparisons for hypothesis testing is a sound approach but requires empirical refinement. The complex effects of the project on the waterways used by NFA-area fishermen have not been fully described. Further hypothesis testing requires the direct involvement of the communities and of individual harvesters.

Problems of interpretation

Project impacts cannot be viewed in isolation from the many other environmental, social, and economic changes that have affected the fishery. Mercury closures predate the project, although project-related mercury effects have also occurred. Effort and return have responded to market forces in the fishery itself, alternative employment opportunities (including working on the project itself during the construction phase), and perhaps also to changes in the community and reserve economies, in addition to project effects. This does not mean that assessing the effects of LWR/CRD is impossible, but it does mean that the fishery cannot be assessed in isolation and out of context.

For several reasons, focusing exclusively on economic losses as measured by conventional methods is likely to underestimate the significance of the fishery to the affected communities. Losses in this sector alone often appear minimal: fishing is highly seasonal, earnings per fishermen on an annualized basis, or as measured by return on effort, are almost invariably low. A further complication is that many other factors may be affecting the commercial fishery in particular, and the mixed economy as a whole. Both traditional SIA approaches and the normal jurisdictional boundaries of resource management agencies tend to ignore or override the interrelatedness of the various activities that make up a mixed, subsistence-based economy.

Although standard economic assumptions and accounting methods are useful for assessment and compensation purposes, they are not sufficient to identify and explain the full effects of the disruption of the fishery and related activities. Expected relations between resource abundance, price, and effort may not hold within the context of a mixed, subsistence-based economy. The significance of the fishery to the whole economy and to the social life of the community must also be understood.

The issues of context and significance underline both the importance of paradigm selection, and the need for controls in hypothesis testing. Consider, for example, the problem of assessing the significance of commercial fishing. In its contemporary form it is, unlike trapping, not a "traditional" activity but a relatively recent economic innovation in the NFA region. How people have incorporated it into their overall economic life is an essential point of inquiry, if project impacts on the fishery are really to be understood. One hypothesis is that despite its relatively recent expansion - within the 20-year period prior to LWR/CRD - it became a central focus of economic activity and social organization as other activities such as hunting, trapping, and possibly even unskilled (or perhaps more accurately, under-capitalized) wage work declined.

If that were the case, fishing would have had a far more central importance to the communities than economic data alone would indicate, and its decline or collapse would have been of more profound significance, as has been reported in other parts of the Subarctic (Usher et al. 1979). The growing centrality of the fishery in such a case is associated with the development of reserve economies as enclaves increasingly isolated from the surrounding industrial economy, a process which intensified between the 1950s and the 1970s. Project impacts must, therefore, also be interpreted in the context of this very important socio-economic development.

These types of changes are important not simply because they represent "acculturation" or "modernization", but rather because they are likely to involve disruption, stress, and a perception of loss of autonomy and control, with distinctive effects on personality, community, and society. Although the process and the chain of causation are imperfectly understood, the typical manifestations are sharp increases in such social indicators as violent deaths, suicides, crime associated with substance abuse, family violence, child neglect, and so on.

The investigation of this connection requires the development of an appropriate set of indicators based on health and law enforcement records, comparative analysis using control groups, and an accurate chronology of events. This has not yet been done in the context of SIA in northern Manitoba.

Table 5. Number of lakes commercially fished in each zone of the Northern Flood Agreement area.

Zone	Lakes	1975 quota (kg)
Norway House		
on-system	3	173,000
off-system	9	174,000
Total	12	347,000
Cross Lake		
on-system	7	166,000
off-system	16	160,000
Total	23	326,000
Split Lake		
on-system	4	83,000
off-system	15	144,000
Total	19	227,000
Nelson House		
on-system	9	70,000
off-system	15	142,000
Total	24	212,000
Total	78	1,112,000

Table 6. Commercial fishing use, quota, and production, Norway House zone, by lake.

Lake	Use[1] R	Use[1] NR	Total years fished	Years fished[2] S	Years fished[2] W	Duration	1975 quota	Avg. weight	Avg. $	Avg. men
ON-SYSTEM										
Playgreen	X		40	37	5	1940-88	136,000	180,480	132,003	71
Kiskitto		X	30	25	9	1957-87	14,000	11,344	9,112	2
Kiskittogisu		X	24	23	1	1958-88	23,000	29,519	32,416	3
TOTAL			40	37	13	1940-88	173,000	206,700	158,286	74
OFF-SYSTEM										
Bolton	X	X	24		24	1949-79	23,000	19,416	6,961	4
Butterfly		X	14	7	7	1959-87	7,000	5,048	7,118	1
Gunisao	X		14	12	3	1948-69	27,000	16,360	2,836	4
Lawford	X	X	25	18	12	1959-86	25,000	23,918	15,104	4
Little Bolton	X		4	4		1976-82	7,000	6,439	8,084	1
Logan		X	3	1	3	1965-83	5,000	3,890	4,561	1
Max		X	6	1	5	1976-86	5,000	5,416	6,281	1
Molson	X		30	10	23	1946-73	70,000	61,978	9,533	15
Robinson		X	5	1	4	1961-87	5,000	5,507	7,336	4
TOTAL			41	25	35	1946-87	174,000	81,055	26,608	19

[1] R = resident; NR = non-resident

[2] S = summer; W = winter

Table 7. Commercial fishing use, quota, and production, Cross Lake zone, by lake.

Lake	Use[1] R	Use[1] NR	Total years fished	Years fished[2] S	Years fished[2] W	Duration	1975 quota	Avg. weight	Avg. $	Avg. men
ON-SYSTEM										
Cross	X		26	22	7	1957-88	45,000	37,768	23,848	13
Drunken	X	X	25	11	16	1960-88	5,000	7,373	6,042	2
Duck		X	15	15		1955-88	14,000	12,518	8,244	3
Pipestone	X		17	9	11	1951-82	14,000	14,705	10,394	5
Sipiwesk	X	X	50	50	26	1937-88	45,000	39,554	28,019	16
Walker	X	X	44	24	25	1942-88	38,000	38,831	16,647	14
Bruneau		X	18	13	5	1952-87	5,000	4,067	2,195	2
TOTAL			51	51	44	1937-88	166,000	105,167	63,614	41
OFF-SYSTEM										
Bear		X	23	19	7	1948-82	38,000	21,150	7,147	9
Black Rabbit		X	5	2	3	1966-87	5,000	2,383	2,104	1
Bully	X		1		1	1977-78	2,000	1,699	792	1
Cotton		X	25	5	21	1956-88	14,000	8,570	5,999	3
Cuddle		X	26	11	16	1943-88	11,000	8,309	3,745	4
Dugas	X	X	24	10	15	1952-86	5,000	4,485	2,527	3
Hermon		X	9	4	5	1970-87	2,000	2,781	2,666	4
Hill	X	X	2	1	1	1948-62	2,000	1,271	371	4
Mutcheson		X	3	1	2	1972-79	2,000	2,845	2,075	2
Peekwachikwaskay	X	X	11		11	1967-88	2,000	5,899	8,840	1
Scatch		X	4		4	1984-88	2,000	1,945	2,508	2
Silsby		X	21	11	11	1952-88	18,000	10,466	4,186	4
Trout		X	11		11	1955-74	5,000	1,683	489	2
Utik		X	32	12	23	1952-86	45,000	34,304	17,230	7
White Rabbit		X	28	10	19	1947-88	5,000	5,385	4,092	2
Wilkins		X	5	1	4	1969-83	2,000	2,249	1,466	2
TOTAL			42	29	42	1943-88	160,000	62,972	32,594	21

[1] R = resident; NR = non-resident

[2] S = summer; W = winter

Table 8. Commercial fishing use, quota, and production, Split Lake zone, by lake.

Lake	Use[1] R	Use[1] NR	Total years fished	Years fished[2] S	Years fished[2] W	Duration	1975 quota	Avg. weight	Avg. $	Avg. men
ON-SYSTEM										
Split	X		28	28	1	1954-88	45,000	21,834	16,239	14
Stephens	X		5	4	2	1979-84	20,000	2,325	4,843	2
Billard		X	7		7	1966-76	7,000	7,976	3,501	3
Fidler		X	17	7	10	1959-87	11,000	7,733	3,266	4
TOTAL			31	29	12	1954-88	83,000	26,138	17,449	16
OFF-SYSTEM										
Assean	X	X	9	9		1965-88	5,000	13,611	6,025	5
Atkinson		X	22	13	12	1958-87	23,000	13,839	7,903	4
Buckland		X	8	8	1	1967-88	9,000	9,485	4,539	2
Butnau	X		3		3	1968-83	2,000	1,545	180	1
Caldwell		X	3	2	1	1971-83	11,000	3,235	1,789	2
Campbell		X	3	2	1	1965-71	11,000	8,535	1,260	3
Christie		X	4	3	1	1965-72	7,000	2,598	786	4
Dafoe		X	19	8	11	1958-88	14,000	7,659	4,385	3
Holmes		X	10	8	2	1961-73	20,000	17,636	4,553	4
Kiask		X	4	2	2	1963-72	5,000	3,206	594	3
Moosenose		X	10	10		1968-87	5,000	5,862	3,235	1
Myre		X	2		2	1961-63	2,000	1,907	529	3
Settee		X	8	3	5	1957-69	5,000	4,234	1,297	3
War		X	24	11	14	1950-86	2,000	2,621	1,524	2
Waskaiowaka	X	X	11	10	6	1954-73	23,000	17,454	4,158	8
TOTAL			34	23	25	1950-88	144,000	36,444	15,154	13

[1] R = resident; NR = non-resident

[2] S = summer; W = winter

Table 9. Commercial fishing use, quota, and production, Nelson House zone, by lake.

Lake	Use[1] R	Use[1] NR	Total years fished	Years fished[2] S	Years fished[2] W	Duration	1975 quota	Avg. weight	Avg. $	Avg. men
ON-SYSTEM										
Notigi	X		13	11	2	1945-83	5,000	5,130	1,539	5
Rat	X	X	15	12	4	1951-79	20,000	15,054	3,544	9
Wapisu	X	X	9	9		1963-78	14,000	4,239	1,515	7
Wuskwatim	X		29	20	11	1943-88	18,000	11,454	7,850	8
Mynarski West	X	X	10	9	2	1963-83	9,000	13,115	7,033	8
Macheewin	X		4	3	1	1981-88	2,000	1,032	939	1
Osik	X		8	6	2	1965-88	2,000	4,309	3,672	2
Threepoint	X		1	1		1987-88		1,765		1
Mystery		X	1	1		1982-83		4,337	2,026	1
TOTAL			37	29	15	1943-88	70,000	21,917	10,607	15
OFF-SYSTEM										
Apeganau	X	X	6	6		1965-87	7,000	2,644	3,917	1
Baldock	X		20	15	6	1950-88	36,000	13,523	5,060	7
Barnes	X		2	1	1	1964-88	5,000	1,563	261	2
Costello		X	13	7	7	1957-87	5,000	4,471	1,370	3
Gauer	X	X	26	26	4	1952-88	27,000	21,022	15,196	7
Harding	X	X	7	7		1960-88	9,000	2,380	1,246	2
Leftrook	X	X	21	20	2	1961-88	14,000	12,253	5,939	6
Livingston	X	X	2	1	1	1983-88		2,663	3,966	1
Moak		X	4	3	1	1981-85		3,211	2,295	1
Moose Beard Creek	X		2	1	1	1982-85		1,574	1,034	1
Mynarski East	X	X	9	6	3	1964-88	9,000	13,402	12,020	5
Roe	X		1	1		1964-65	2,000	182	36	1
Rusty		X	12	11	1	1969-88	5,000	4,624	4,265	1
Suwannee		X	27	7	20	1949-87	14,000	19,735	5,542	6
Uhlman	X	X	11	9	2	1965-88	9,000	10,463	9,738	2
TOTAL			38	34	28	1949-88	142,000	53,094	28,871	22

[1] R = resident; NR = non-resident

[2] S = summer; W = winter

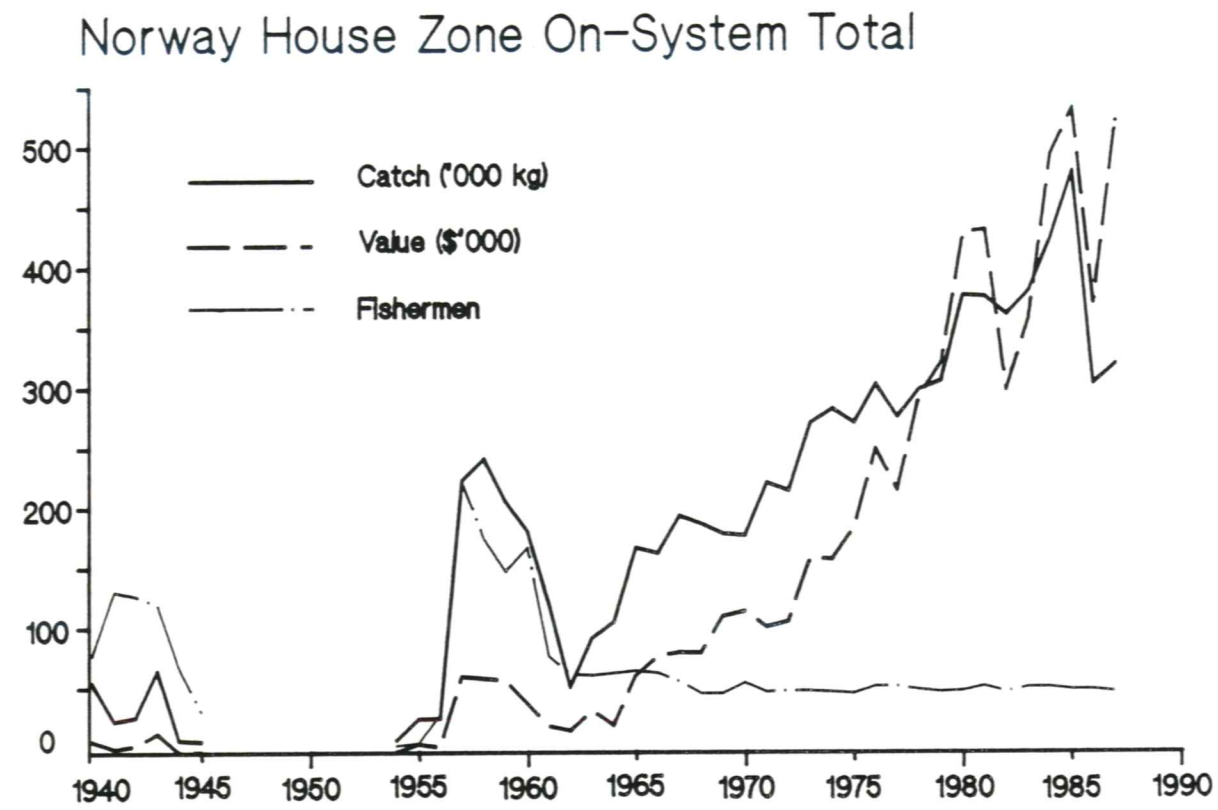

Fig. 7. Catch, value, and participation, commercial fishery, Norway House zone, on-system total.

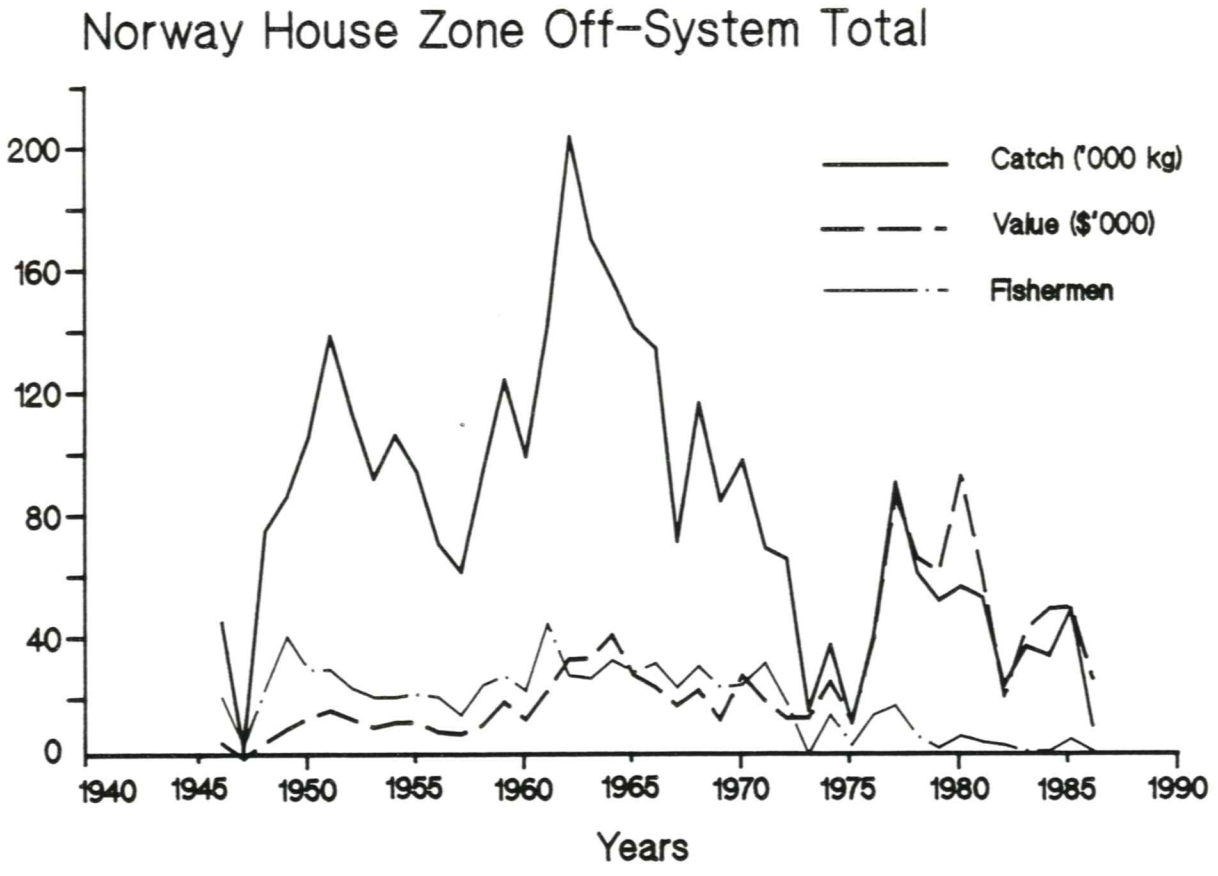

Fig. 8. Catch, value, and participation, commercial fishery, Norway House zone, off-system total.

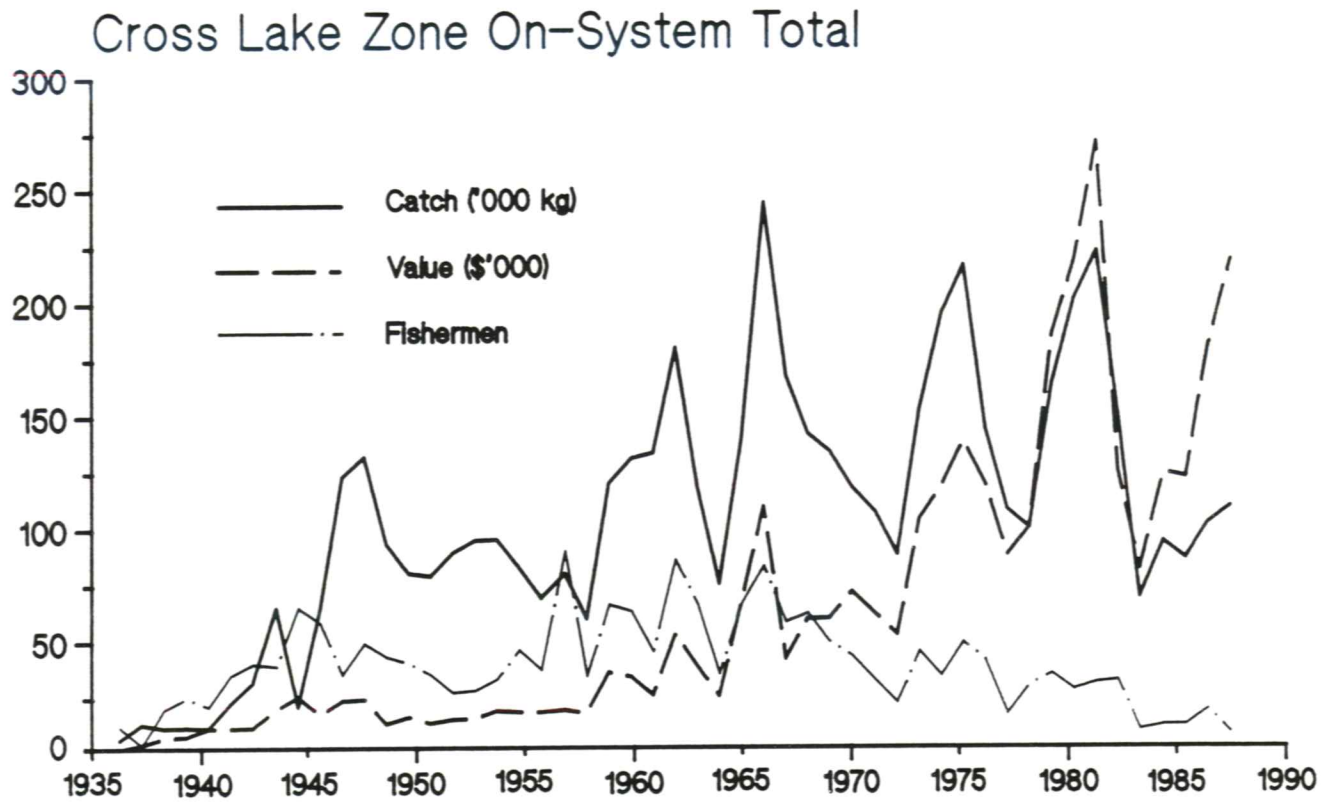

Fig. 9. Catch, value, and participation, commercial fishery, Cross Lake zone, on-system total.

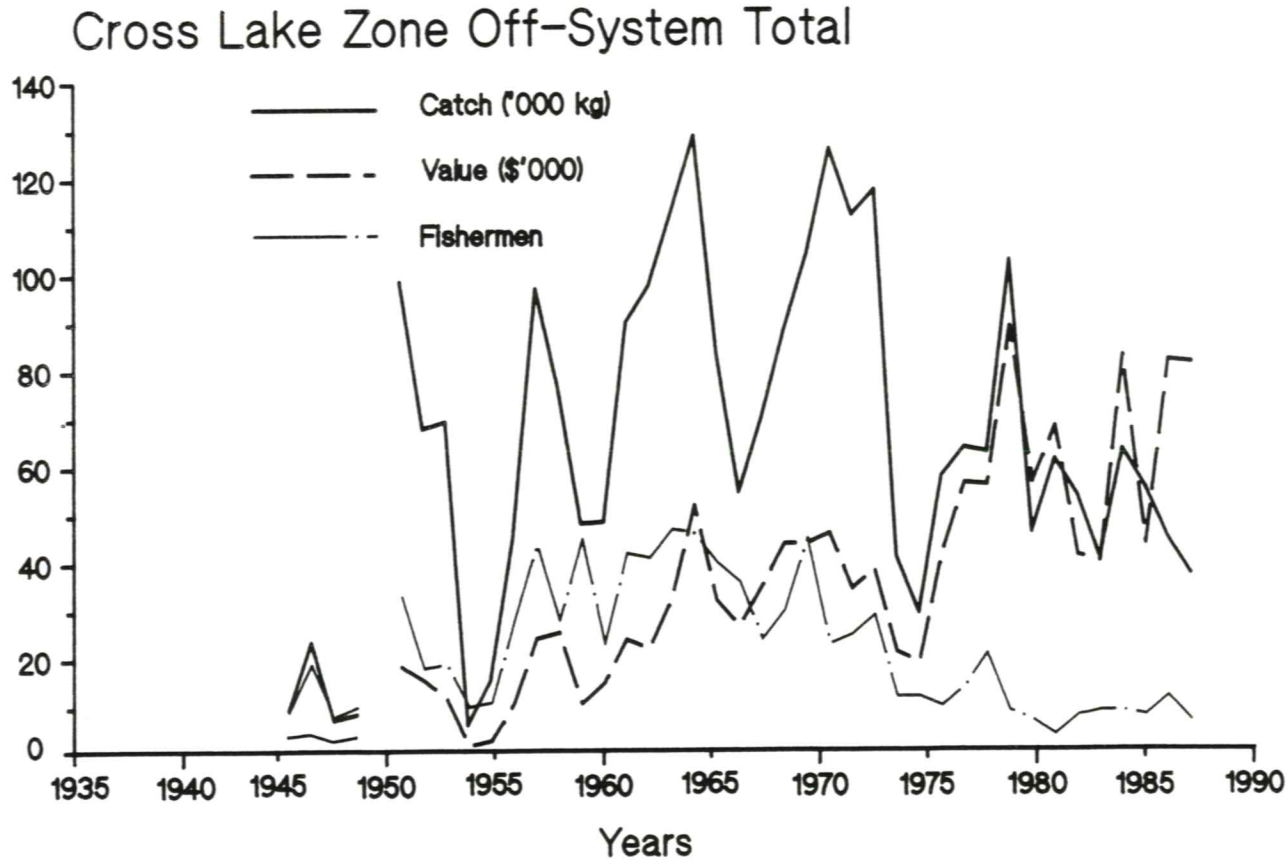

Fig. 10. Catch, value, and participation, commercial fishery, Cross Lake zone, off-system total.

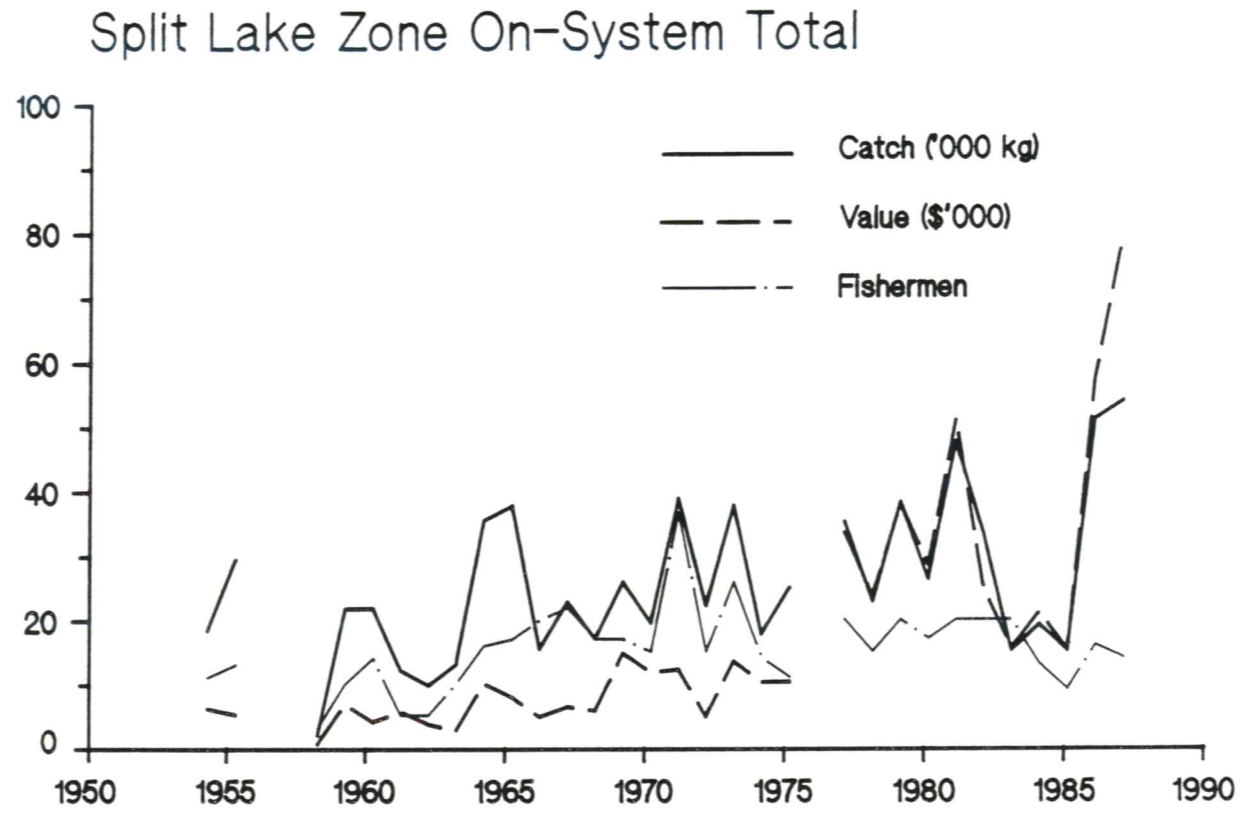

Fig. 11. Catch, value, and participation, commercial fishery, Split Lake zone, on-system total.

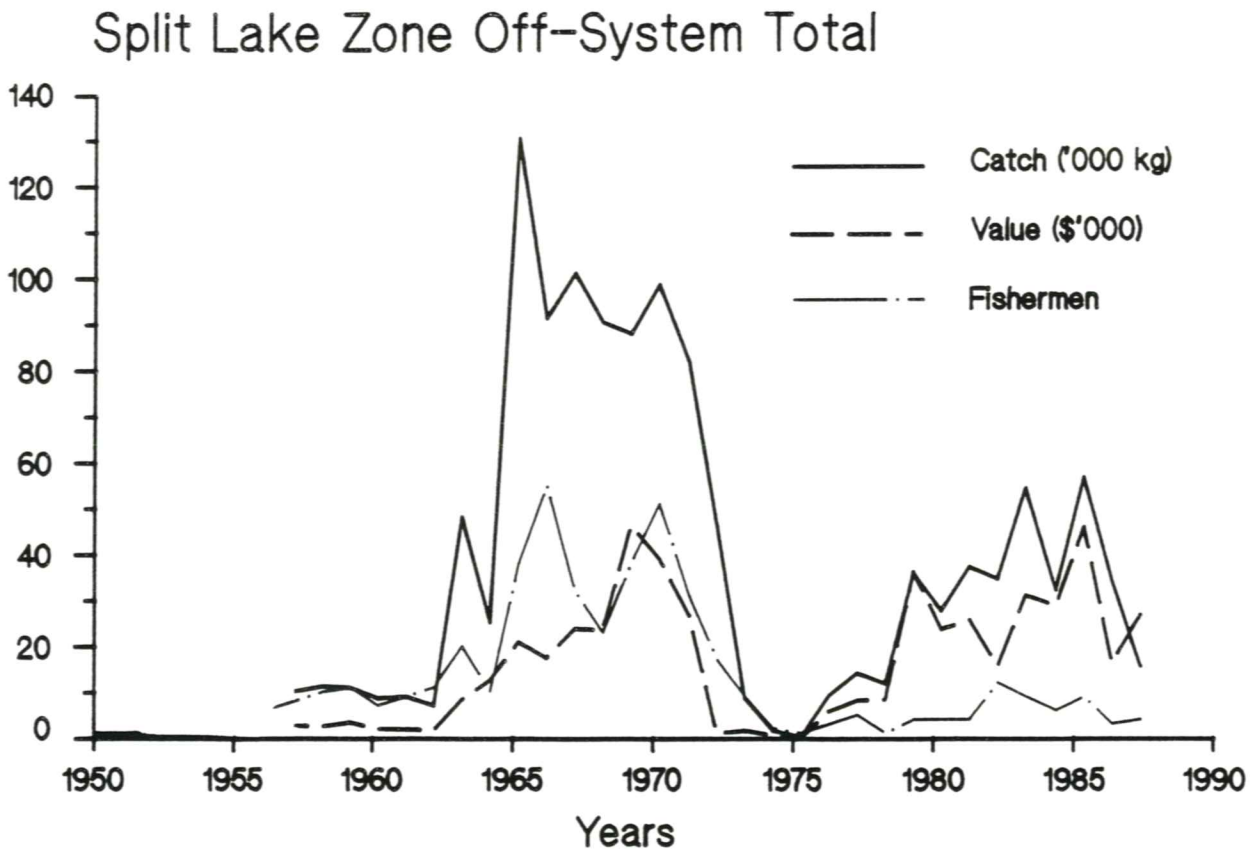

Fig. 12. Catch, value, and participation, commercial fishery, Split Lake zone, off-system total.

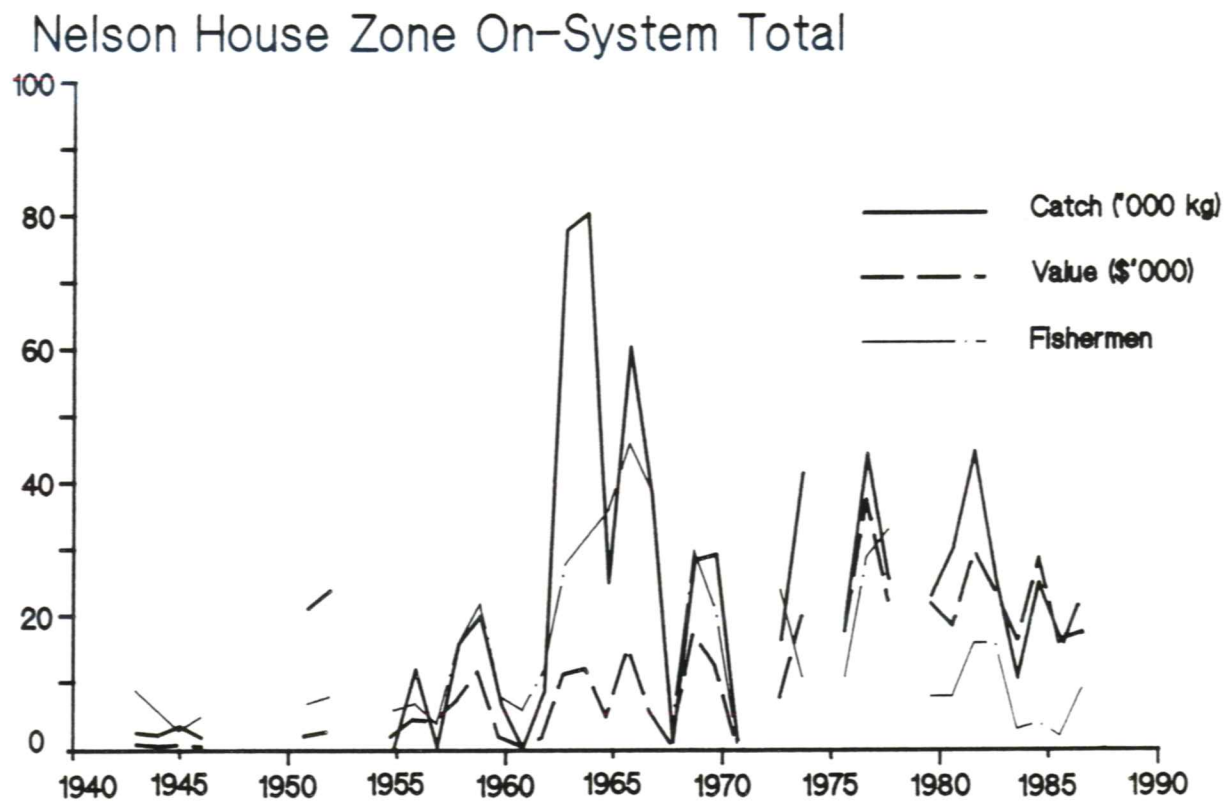

Fig. 13. Catch, value, and participation, commercial fishery, Nelson House zone, on-system total.

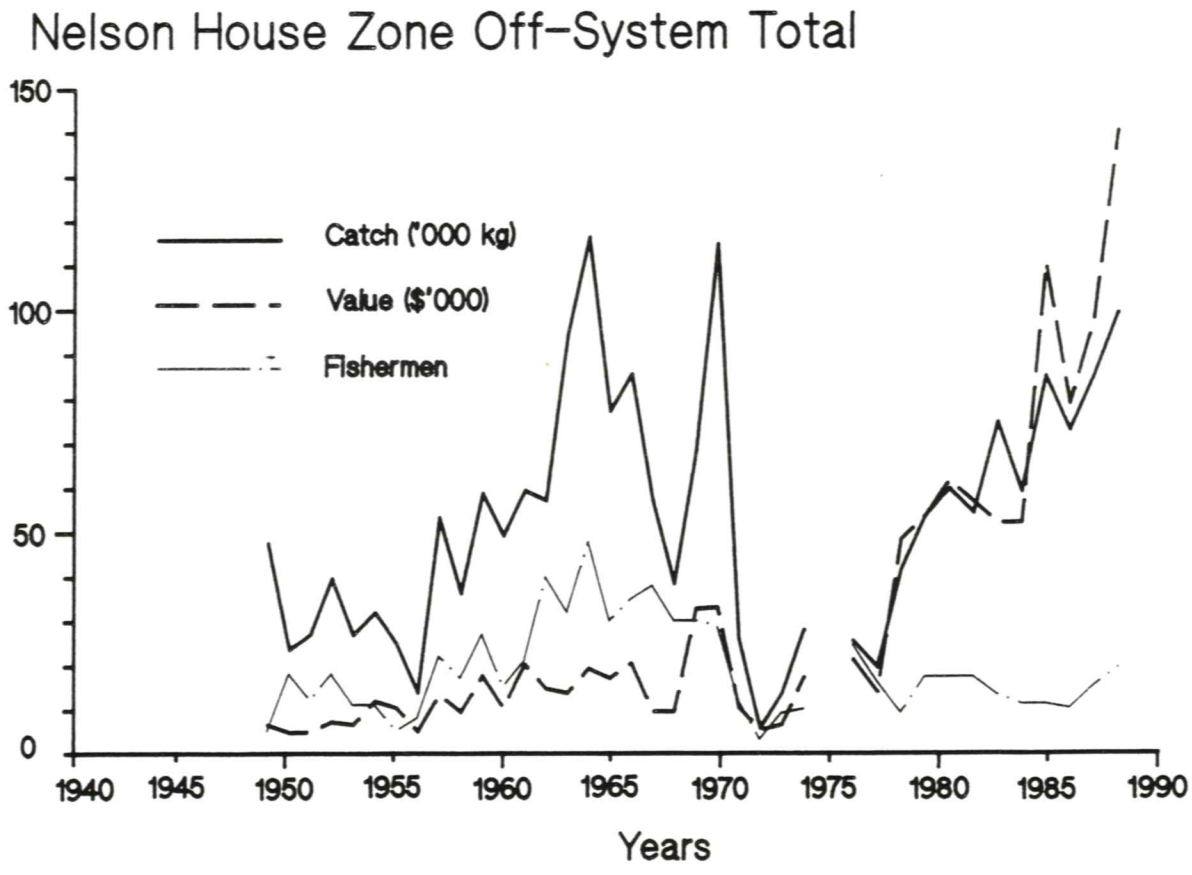

Fig. 14. Catch, value, and participation, commercial fishery, Nelson House zone, off-system total.

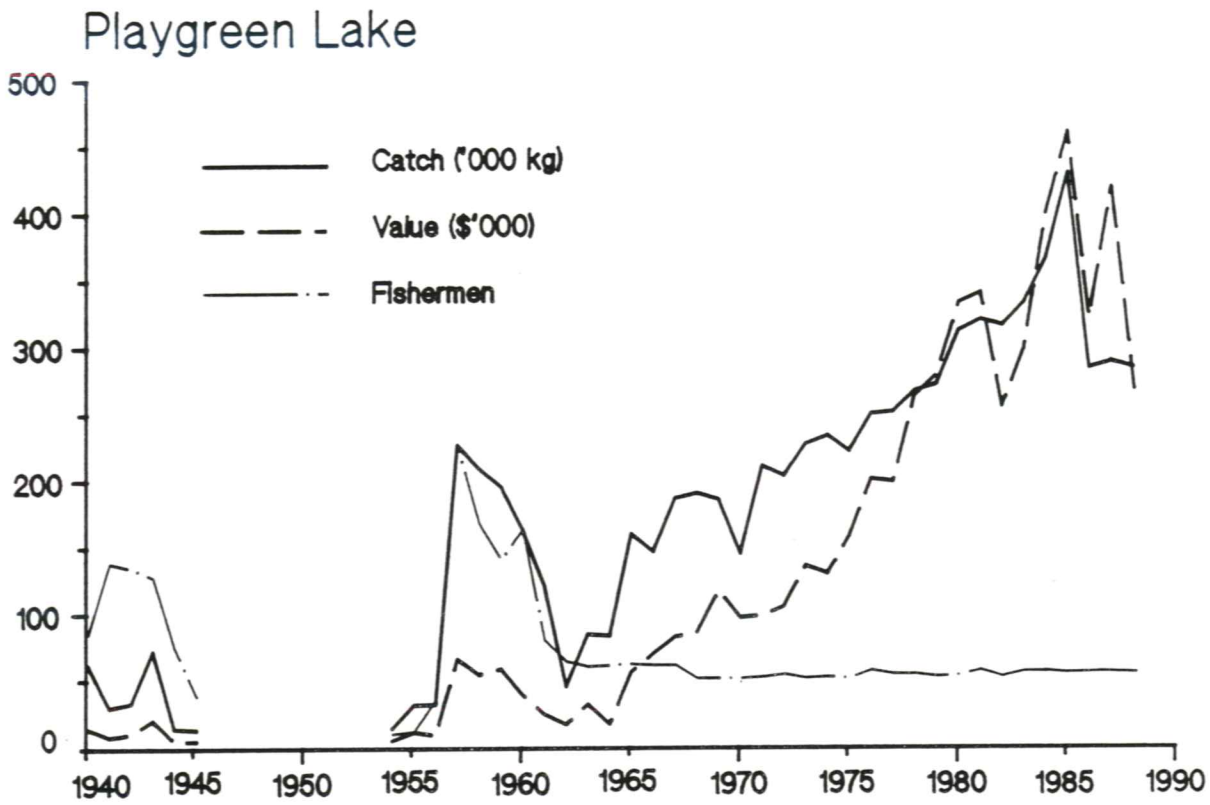

Fig. 15. Catch, value, and participation, commercial fishery, Playgreen Lake.

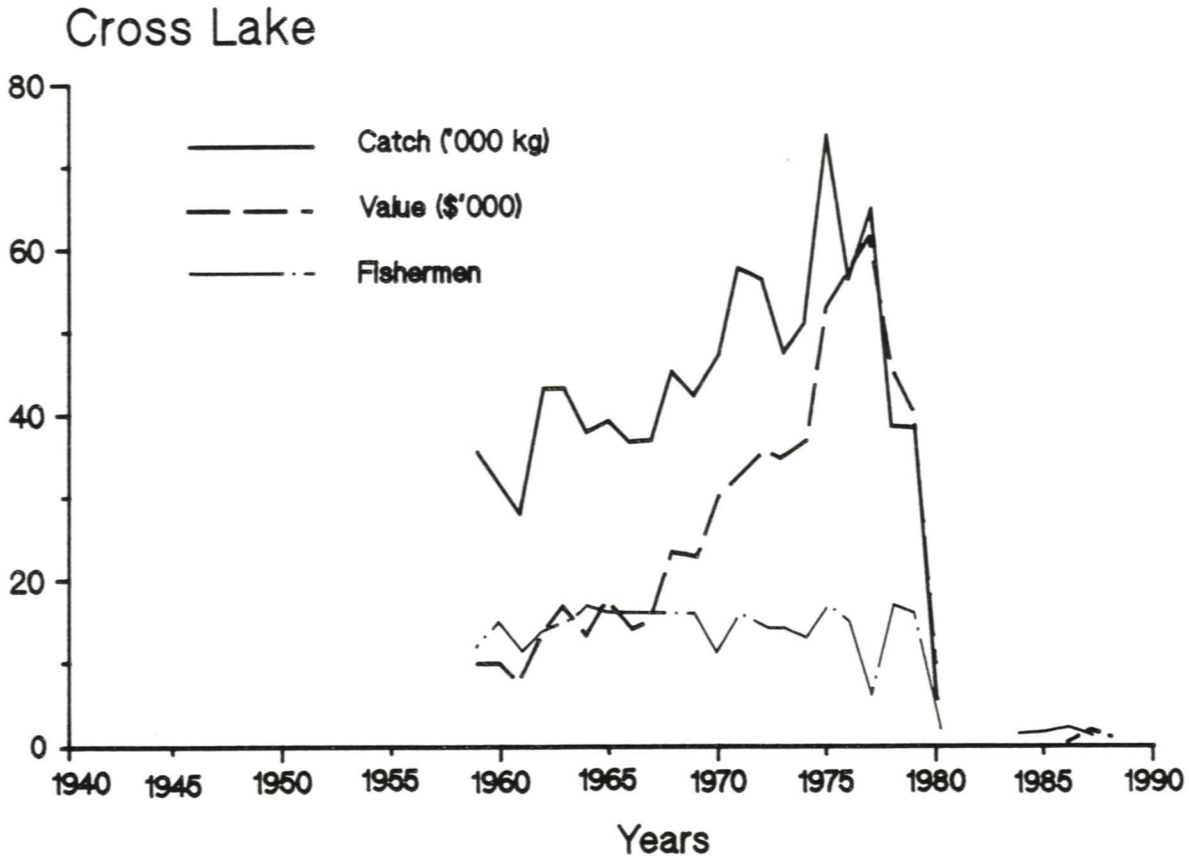

Fig. 16. Catch, value, and participation, commercial fishery, Cross Lake.

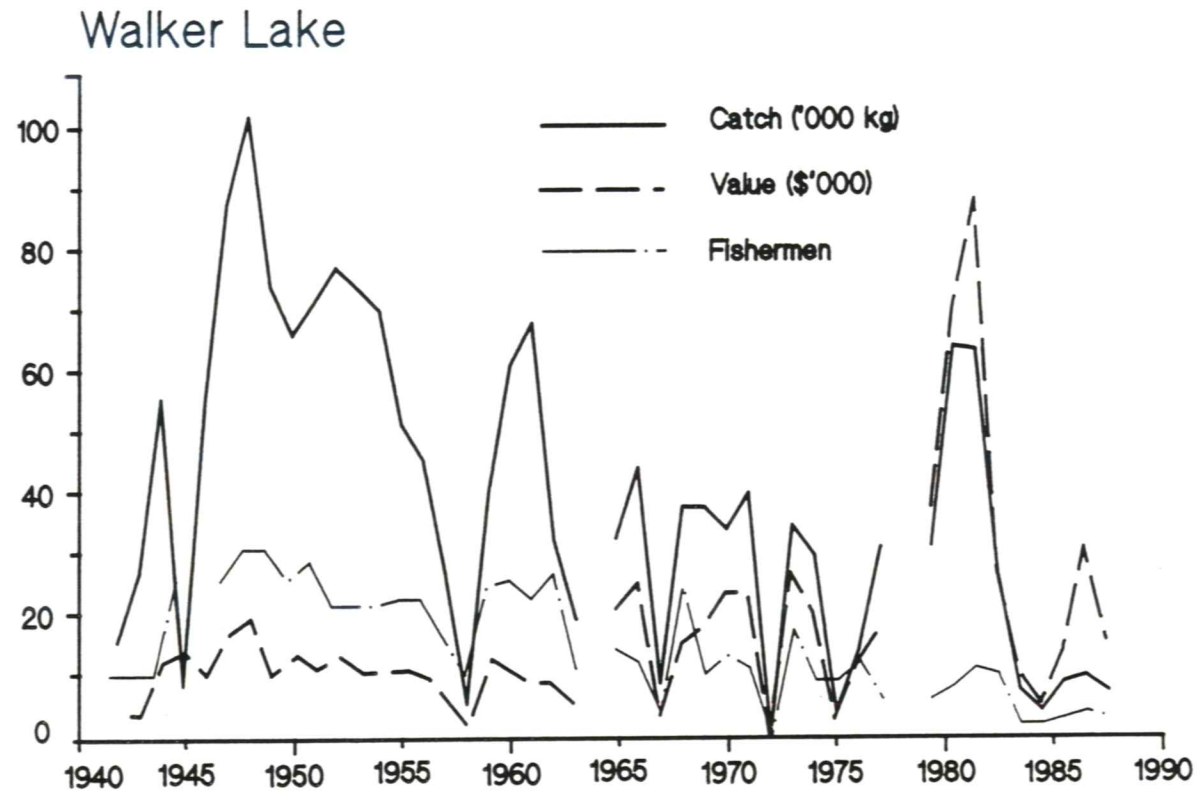

Fig. 17. Catch, value, and participation, commercial fishery, Walker Lake.

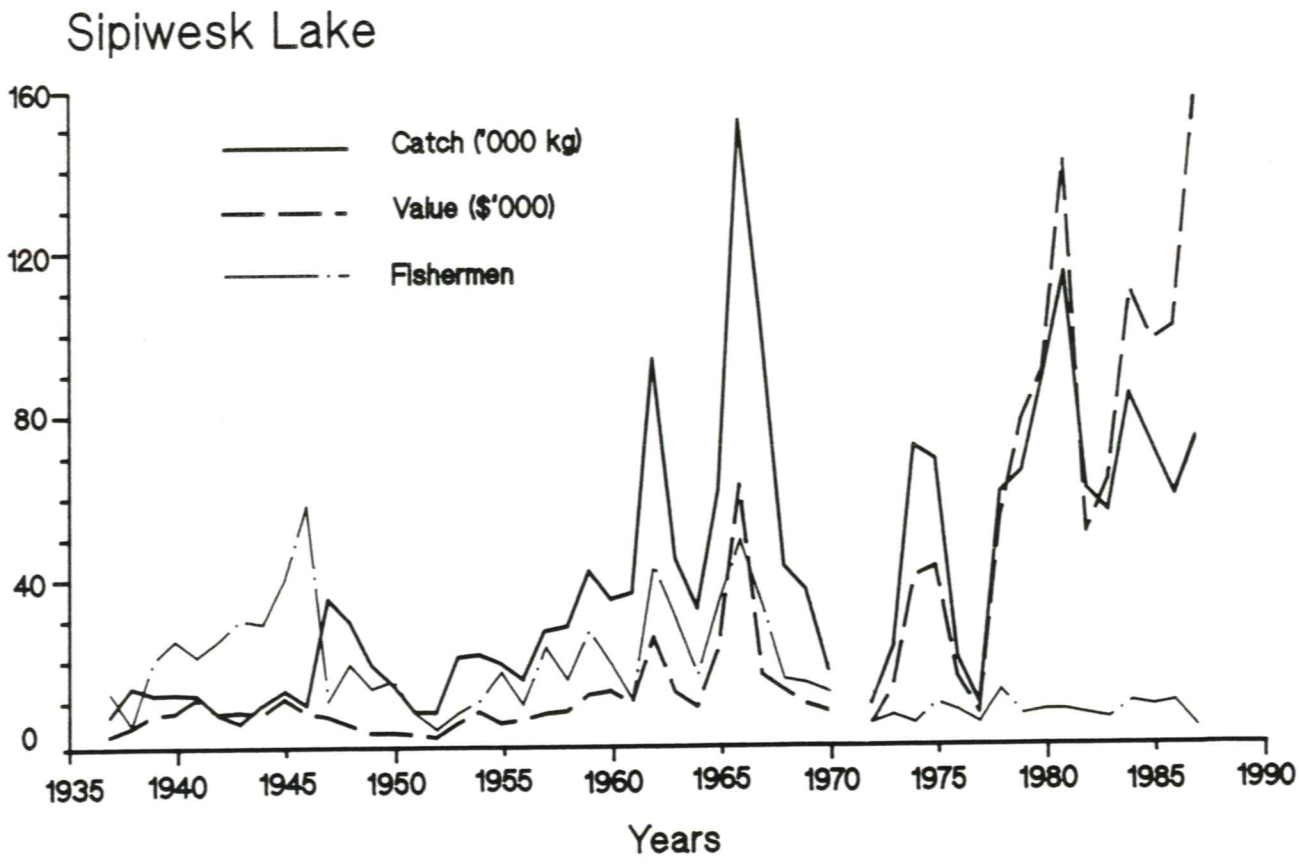

Fig. 18. Catch, value, and participation, commercial fishery, Sipiwesk Lake.

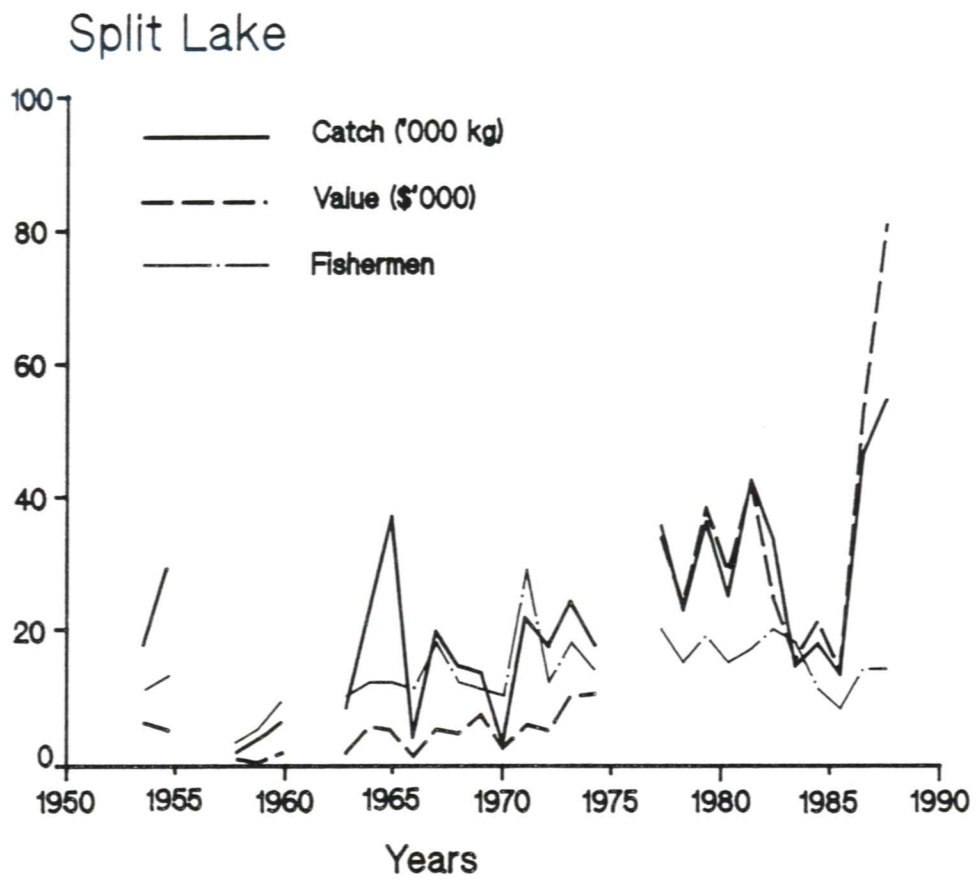

Fig. 19. Catch, value, and participation, commercial fishery, Split Lake.

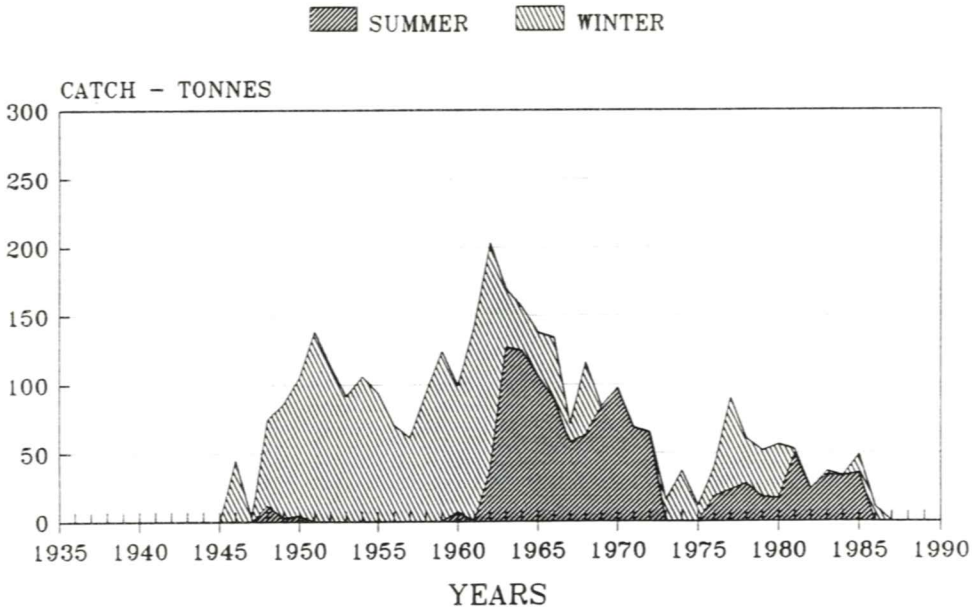

Fig. 20. Summer and winter commercial fishery, Norway House zone, off-system.

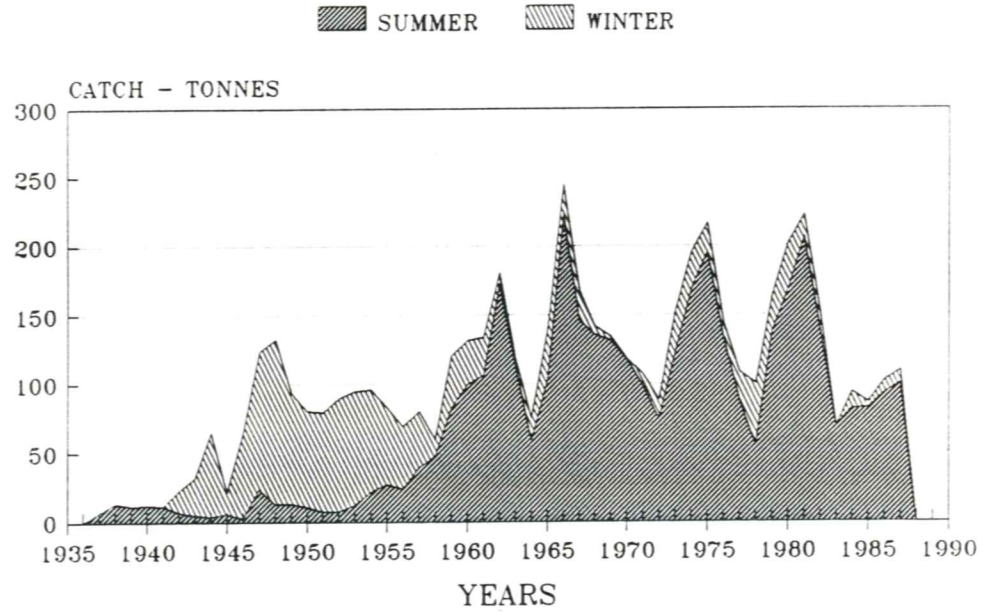

Fig. 21. Summer and winter commercial fishery, Cross Lake zone, on-system.

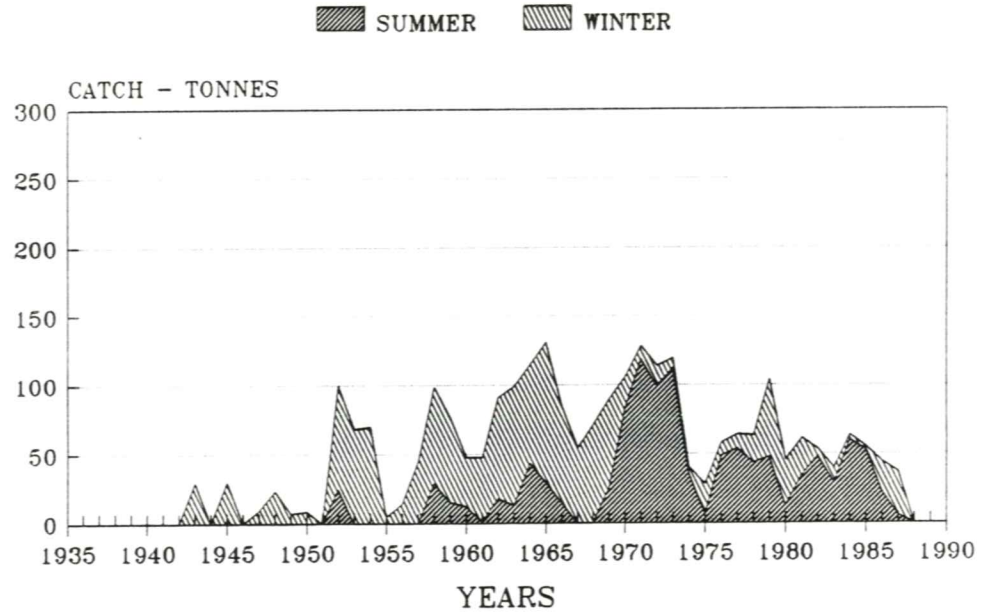

Fig. 22. Summer and winter commercial fishery, Cross Lake zone, off-system.

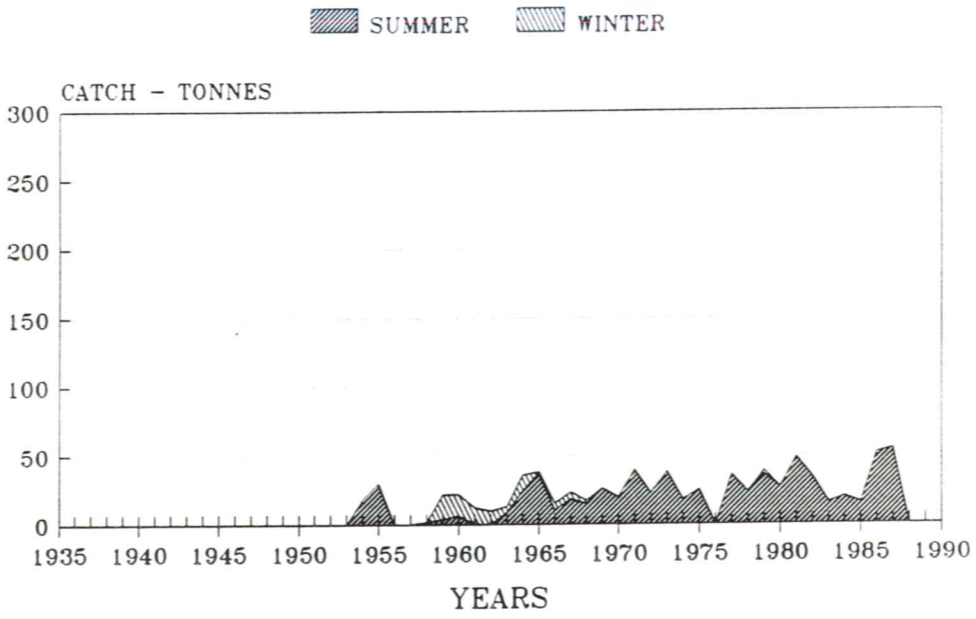

Fig. 23. Summer and winter commercial fishery, Split Lake zone, on-system.

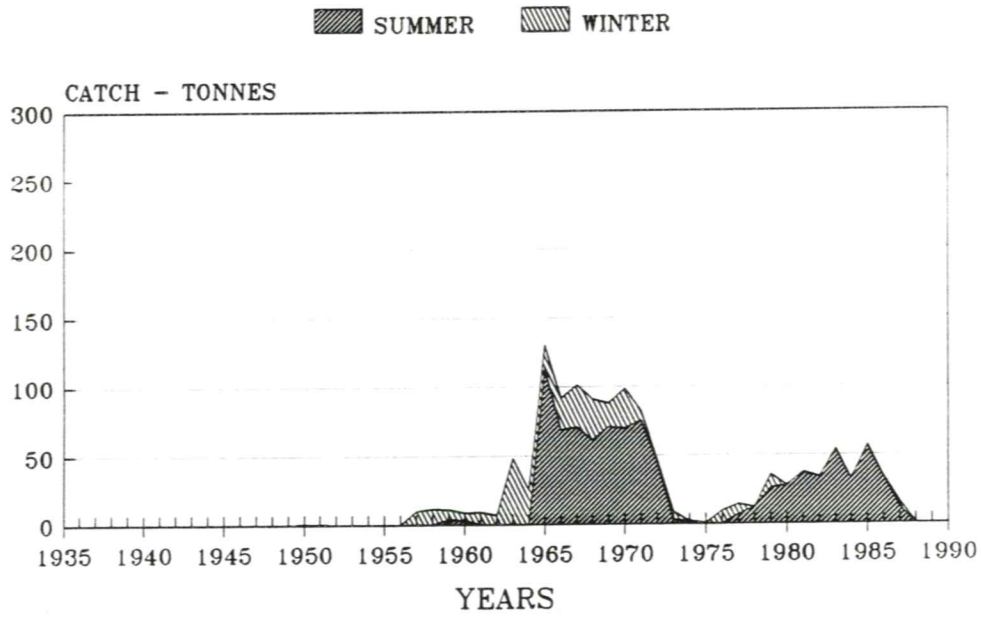

Fig. 24. Summer and winter commercial fishery, Split Lake zone, off-system.

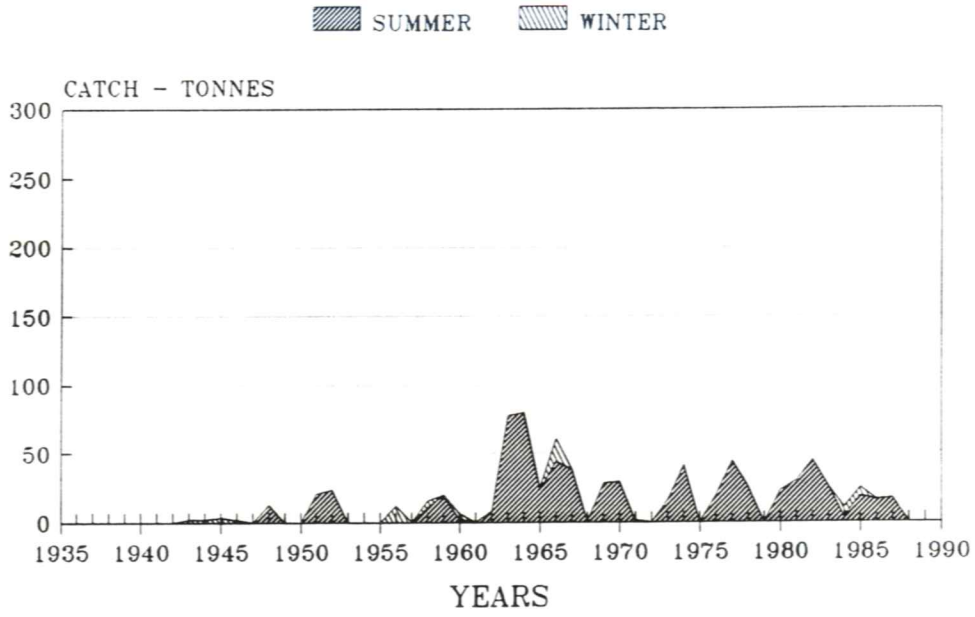

Fig. 25. Summer and winter commercial fishery, Nelson House zone, on-system.

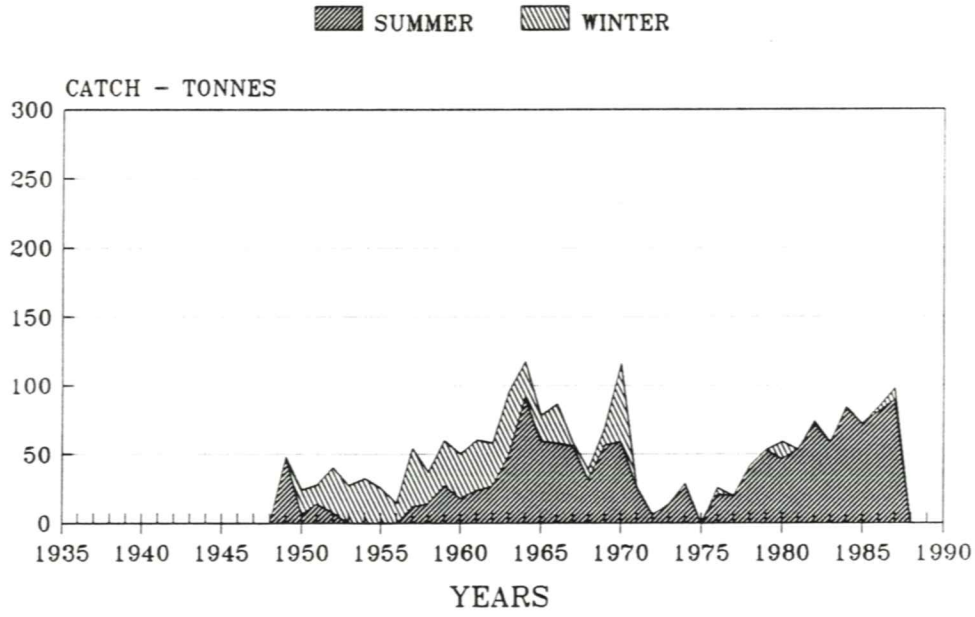

Fig. 26. Summer and winter commercial fishery, Nelson House zone, off-system.

TRAPPING

This section examines the utility of existing data for evaluating the effects of LWR/CRD on the trapping sector of the harvest economies of the NFA communities. A preliminary analysis of the effects of LWR/CRD on the trapping sector, comparable to the discussion of commercial fishing impacts in the previous chapter, has not been attempted because the task of organizing a data base of this magnitude and complexity was beyond the scope of this project.

Although the primary emphasis of this report is on project effects on Native fisheries, all forms of resource harvesting in northern Native communities are fundamentally interconnected activities. One key link is the production of food for the table and commodities for sale using the same equipment, often on the same occasions. This is especially true of trapping. Beaver and muskrat are major food resources, and other fur bearers may also be eaten. Access to good fishing, for immediate consumption and to supply families on return to the village, is a major consideration in deciding on trapping camp locations.

BACKGROUND

Trapping has acted as a focus for resource harvesting and, more generally, for the economic organization of Subarctic Indian communities during the colder part of the year since the early days of European contact. For many people and family groups, trapping has remained part of the way of life. It is regarded as a traditional activity and an expression of Indianness. One reason for this may be that trapping as an economic endeavour lends itself to greater autonomy at the producer or household level than does commercial fishing, which because of such factors as higher capital and transport costs has been more heirarchically organized. Although there are market and other economic considerations, as an activity the motivation for trapping in Indian communities does not rely primarily on profit. There is a desire to "come out ahead", but other motivations, such as provision of food and simply living in the bush, may have priority.

Trapping was absorbed into the seasonal round of resource harvesting. It was conducted by multi-family hunting/trapping groups whose composition might change within and between seasons, as families and individuals tried out different social and economic living arrangements and the hunting/trapping areas of relatives and friends. The provision of food for family needs was central to the organization of all harvesting activities; and trapping was an important part of the supply of food in those areas of the Subarctic with abundant beaver and muskrat habitat.

Flexibility has been a key attribute of the economic and ecological adaptations of native harvesters of the Subarctic. Animal populations and market conditions vary. The primary non-variable condition is family needs. The organization of harvesting and sale of commodities has varied to suit particular social, economic, and biotic conditions. Consequently, patterns of land use may be along a number of different organizational lines, from individual use to mixed family trapping groups using a number of adjacent traplines (Levson and Kabzems 1981). (The latter form diminishes the accuracy of existing records at the level of the individual trapline.)

Fur pelt prices have undergone several major fluctuations during the 20th century. In the early part of the century, trapping in winter and casual employment in summer were the primary means of obtaining cash. Consequently, changes in the demand for furs has influenced not only short-term participation in trapping, but to an important degree the history of northern Indian communities.

Two serious declines in the value of furs affected native communities across the north during the middle years of the century (Fig. 27). The most recent decline occured immediately after World War II. The value of most pelts dropped precipitously, and demand remained low until the mid-1970s - the same time that hydro-electric mega-developments were being constructed in northern Manitoba and Quebec. For Indian communities across the north, the 1950s and 1960s were times of deep economic stress. At the same time that fur prices dropped, many sea-sonal jobs disappeared. Trapping persisted as an economic activity in native Manitoban communities largely because of its ties to food production and the fishery, and because it remained a source of income when alternatives were scarce.

Recovery was led by increased demand for the long-haired species, particularly lynx. Beaver and mink, former staples, have never regained their past value, although in the mid-1970s there was a sharp rise in beaver prices for the first time in over 25 years, which led to renewed trapper interest. (This price rise in actual dollar value was apparent to trappers in comparison with previous years, although it appears insignificant in Fig. 27 in which a constant dollar scale is used.) Yet, beaver has remained an important species because of its abundance and sedentary habits, and because it provides significant amounts of food as well as cash. (Muskrats have also remained important for the same reasons.)

Since the 1970s, fur harvests and trapper participation have also been influenced by joint federal/provincial trapping assistance and development programs, and later by Manitoba Hydro's compensation program for trappers affected by the

development (P.M. Associates 1979). In some communities, participation and harvests were also influenced by employment available due to the LWR/CRD development. For example, Waldram (1983) found that many South Indian Lake trappers took seasonal employment with Hydro during the early 1970s, leaving only the least able trappers working the traplines.

TRAPLINE TENURE

During this century's period of high beaver prices, the species was nearly trapped to extinction throughout Canada. Manitoba government conservation measures for beaver resulted in the development of the system of Registered Traplines (RTLs) which, ironically, came into effect at the same time that market demand for the species dropped. RTLs in northern Manitoba were first designated on lands adjacent to the Hudson Bay Railway in the mid-1940s. Proposals to extend the RTL system onto lands traditionally trapped by Indians, as a means of protection against the uncontrolled access by non-resident trappers that prevailed during periods of high fur prices, are said to have met with enthusiasm from the Indian bands (Carmichael 1973). Beaver populations and production increased dramatically after 1950 (Fig. 28), presumably as a result of the RTL system.

Since the establishment of the RTL system, access to trapping areas in northern Manitoba has been organized on an exclusive or semi-exclusive basis. Licenced trappers and their assistants have the exclusive right to harvest fur mammals on their registered traplines.

It is likely, however, that some form of aboriginal or fur-trade based tenure system for resource harvesting existed before the provincial system, as it did in many other areas of the Canadian north, but details of the Indian trapping management regime, and the related systems of fishery and wildlife management, in northern Manitoba during the pre-trapline registration period are lacking.

Research elsewhere (e.g. Leacock 1954) indicates that there was considerable flexibility in tenure rules under the aboriginal system. The rules often varied with the relative population abundance of sedentary and mobile animals (e.g. caribou), and with human needs.

Trapline registration has had an effect on territoriality and the traditional tenure system among many Native groups in Canada, in particular on the sense of attachment to a fixed "home" territory (see e.g. Hutchins 1987). For some groups, this resulted from an historic cultural struggle to regain traplines allocated by the state to non-Natives when registration began (Weinstein 1980; Brody 1981). Generally, trapline registration has represented a more rigid set of rules imposed on a familiar use structure.

Trapline registration may have resulted in similar ideological changes in how Indian people in northern Manitoba think about their traplines, although this has not been documented. Provincial records from the early stages of the RTL system indicate that the new system was seen by managers as a tool to convert Manitoba Indians to biological ideas of resource management (Manitoba 1953-61). It was also seen as a means to get Indians to comply with contemporary ideas of "proper use" (e.g. abandoning the domestic sturgeon fishery in favour of a small species commercial fishery). The records indicate that the trapline registration period in northern Manitoba was one of intense discussion about land use and management by all parties (Wells 1946; Manitoba 1953-61).

The province regards trapline holders as having only use rights to fur bearers, although some authorities believe that aboriginal trapping rights include a broader set of collective or individual interests (Hutchins 1987). Under Manitoba regulations, traplines cannot be sold or transferred by the trapper. When a line is relinquished, the rights revert to the province for re-allocation. Normally, preference is given first to immediate family members, second to other community residents, and last to outsiders. This is given greater force in the NFA sections by article 15.1 of the NFA.

The basic unit of tenure and use within each section is the trapline. Not all of the individual lines within each section, however, are necessarily registered to members of those communities. Tenure information on Map 3 is based on government records (annual trapping returns, lists of trappers, and band lists), and verification with community members and local trapline officers.

The Cross Lake, Norway House, and Nelson House communities have a strong sense of territoriality about the RTL sections that bear their names. People at Norway House and Cross Lake indicated that, to the best of their knowledge, all of the traplines in these two sections have been registered to members of these communities since the start of the program. The same has been true for the Nelson House Section (except for one line adjacent to Thompson that was converted to a "community youth line" in the late 1960s to provide trapline training for interested Thompson youth).

The Cross Lake traplines are considered extended-family resource harvesting areas and are generally transferred within family groups. This is likely true for the other RTL sections as well.

The situation in the Split Lake section is more complicated. Lines there are registered to trappers from five different communities (see Map 3), three of which are not signatories of the NFA. York Landing trapping interests in this Section are limited to one community trapline. When the York Factory Band was relocated to York Landing in the mid-1950s, local trapline officers attempted unsuccessfully to obtain additional traplines for the band in the Split Lake Section (Manitoba 1953-61). The band also retains a trapline in the Shamattawa RTL Section, on the Hudson Bay coast.

As is the case with commercial fishing, the priority rights granted by article 15 of the NFA are, in practice, subject to existing tenure.

TRAPPING RECORDS

The Department of Natural Resources and its predecessors have been responsible for collecting and compiling fur statistics since the inception of the RTL program. Over the years, there have been major changes in record keeping. As a result, there are essentially three different sets of records: (1) 1950s; (2) 1960s-early 1980s; and (3) a computerized record beginning with the 1984 trapping season. (The trapping season begins in fall and ends in spring, and is designated here by the year in which it begins, i.e. 1984 = 1984-85.)

Data from the earliest period are limited to compilations for RTL sections as a whole, in the Registered Trapline Annual Reports series (Manitoba 1953-61). These contain separate descriptions for each RTL section, including fur species statistics for the entire block of traplines and estimates of the value of the furs harvested based on the average price paid to trappers for pelts in Manitoba during that season. Some of the reports contain estimates of community bush food harvests (see "SUBSISTENCE HARVESTING"), and idiosyncratic descriptions by trapline officers of the local administration of the trapline program and the communities' resource economies.

The report series was abandoned during the early 1960s, and replaced with a system of individual trapline record keeping. This system, irregular in the early years, underwent substantial improvement during the 1970s (as fur prices and interest in trapping as an economic venture increased) primarily due to funding from the implementation of the Wild Fur Development Program. (In recognition of the importance of these records for assessment and other purposes, the Department of Natural Resources is, at this writing, creating a computerized database of the 1965-1983 trapline statistics.)

Since 1984, a comprehensive computer trapping database has been developed, listing the trappers licenced for each trapline, their addresses, and their fur sales by species. Another computer database, developed at the request of the Department of Indian Affairs as a means to assess the effectiveness of trapline development programs, includes information about the treaty status of licenced trappers.

The fur statistics in these records are based on royalties, and records of fur purchases kept by fur buyers, rather than actual harvest figures. At the time of transaction, fur buyers record the trapper's name and licence number on their royalty statements. This is the basic system that dates from the 1940s.

Earlier problems of irregular reporting by fur dealers have been remedied during recent years by the increased enforcement efforts of trapline officers. Under the improved system, the trapline officer writes a monthly report of activities based in part on fur dealers' records and in part on their own estimate of harvests. The latter estimates are based on informal surveys and contact with trappers, and an unofficial tally of furs sold to dealers in each community. This more active involvement of COs provides a cross-check for the fur buyer records and results in a significant improvement over past record keeping. Generally, recent records are considered more accurate than the older ones.

IMPACT INDICATORS

The provincial fur record fulfills many of the criteria for impact indicators identified above. It is a potential record of harvesting for an important sector of the communities' resource economy. The data have considerable historical depth, both prior to and following LWR/CRD. The traplines can be aggregated by category of physical and biological impact, allowing the data to be used for hypothesis testing.

A database of trapline records available in government offices was not compiled as part of this project due to the large size and complexity of the data set, and the unavailability of most of it as a computer file. There are about 226 traplines within the four RTL sections. Each trapline may have several licenced trappers, some of whom shift between lines, who harvest up to 15 species of fur bearers.

An added complication in using the trapping record as an impact indicator is the lack of a meaningful measure of general trapping productivity equivalent to total annual weight used for the commercial fishery data. The differential value of fur species and the way this has changed

historically prevents the use of annual dollar value as a convenient measure.

Consequently, the use of this record for indicator purposes requires a species-by-species examination, an approach also necessitated by the different habitat requirements of, and hence differential project impacts on, each species.

Data reliability

Although the fur records satisfy many of the criteria for indicators, they have some limitations. For example, as mentioned above, the data do not represent harvests, but the sales of furs. Recorded sales figures are an indicator of harvests, but the sources and degree of bias must be understood.

The basic variables of the fur record are numbers and location. The recording of this information assumes that trapping is organized as an individual or nuclear family economic activity, that furs are sold by the people who have caught the animals, and that the animals were caught on the trapline for which the trapper held a licence. Actual practice may be quite different. People may trap on a line for which they have no licence - individually with permission, or as part of a trapping group - and register the furs they take as coming from their own line (Levson and Kabzems 1981). Internal community use arrangements can result in skewed trapline location harvest records, depressing the record of one trapline and elevating another. The flexibility of resource-use rules in Native communities poses problems for the more rigid rules of licencing and record-keeping systems.

Other problems in the accuracy of the available trapline-by-trapline record may result from the way trappers sell their furs. Furs exchanged internally within the communities may be recorded as trapped on other traplines. Furs trapped on the community trapline may be registered as coming from a trapper's individual line. Some inactive trappers have been known to buy furs and sell them under their own RTL licence. Where poaching is a problem, these furs, of course, would be recorded on a different trapline (Levson and Kabzems 1981).

Generally, the records must be considered as minimum harvest levels, since they represent sales of fur to official fur buyers. Other uses, such as fur sales to tourists or furs used for clothing or craft manufacture, are excluded from the record. There are undoubtedly also instances of poor record keeping on the part of fur buyers, and irregularities such as furs traded late in the season not being counted because the records had already been closed (Levson and Kabzems 1981).

Changes in the record keeping system itself add a further complication. The Special Rural Development Agreement (Special ARDA) and Manitoba Hydro compensation programs provided incentives for trappers to record their own harvests, thereby aiding the reliability of the record (I. McKay, Manitoba Department of Natural Resources, Winnipeg, pers. comm.) and reducing many of the problems noted above. These improvements, however, affect the post-project records, not those of the critical pre-project period. Two different types of data are useful for comparisons - absolute and relative - of which the latter have a constant level of error. The available trapping data are relative, since they represent fur sales rather than actual harvests. Improvements in record keeping mean that the relation of the fur sales record to actual harvests has changed, i.e. the level of error in the record is not constant.

Data limitations

Although these data will never represent a literally accurate portrait of change, an understanding of the communities' trapping, land use, and fur sale practices over time can enhance considerably the utility of the record as an impact indicator by enabling an estimate of the disparity between recorded and actual harvests.

In considering the usefulness of the trapping record, it should be kept in mind that production data alone are not sufficient to indicate impact. As in the case of commercial fishing, or as Waldram (1983) noted in the case of South Indian Lake, one response to reduced or less accessible supply is to increase effort, with the effect that the harvest remains constant. Harvesters report that travel to trapping areas has become a major problem for the people of some bands as a result of LWR/CRD (see also Gerard 1989). However, increased travel and effort costs as measured by labour time, for example, are indicators not measured in any institutional record-keeping system.

The fur recording system also does not measure the variety of interrelated social and environmental factors that influence involvement with trapping. These include migration, alternative employment opportunities, the influence of government programs, weather conditions, forest fires, and logging activities (I. McKay, Manitoba Department of Natural Resources, Winnipeg, pers. comm.).

For these reasons, caution is essential in using fur records as an indicator of fur bearer populations. For example, Manitoba Hydro's examination of the fur record for impacts to the Cross Lake community trapline concluded that an increase in beaver and otter harvests on Cross Lake and Norway House community traplines signified that these animals "...do not seem to be

detrimentally affected by the altered water regime" (Manitoba Hydro 1983, p. 13). Although this may have been the case, the records by themselves cannot be taken as evidence for animal population change, since the other factor involved is trapper choice and decision making (Weinstein 1977).

Decisions about when, whether, and what to trap are influenced by many human factors, some economic and some not. For example, perceptions of poor meat quality may result in reduced muskrat harvests, even when the population is relatively high (Hilderman et al. 1982). Similarly, high levels of beaver harvest on a community trapline could have resulted from a combination of high pelt prices, the relatively large amount of food obtained from a beaver, and the presence of large numbers of easily caught, displaced beaver wandering around looking for new shelter.

The fur records are thus a necessary but not sufficient tool for understanding change. Indicators are needed for other aspects of trapping determinants, and for the mixed economy as a whole.

RESULTS

The value of furs harvested on the four RTL sections under consideration increased several-fold following LWR/CRD (1976 onward; Fig. 29). This was likely due to the rapid increase in fur prices during the late 1970s, as well as the trapping incentives created by Manitoba Hydro's fur compensation program. Trapping participation also increased at the same time, as can be seen from changes in the number of trappers registered on the four RTL sections (Fig. 30). Increases were most dramatic in Cross Lake and Norway House, where declines during the 1950s and 1960s had also been the most pronounced.

As discussed above, fur value changes by themselves are poor indicators of changes in harvests, since they combine harvest numbers and price changes. The large increases in pelt prices during the late 1970s are capable of masking changes in harvest. To examine actual changes in harvests of fur species, we constructed representative graphs of annual harvests of the six most important fur mammals trapped on one of the RTL sections, Cross Lake, generally acknowledged as the traplines most directly affected by the LWR/CRD (Fig. 31).

There are no obvious signs of decline at the time of the development, on the RTL section as a whole, for beaver, mink, otter, lynx and fisher harvests. Although some changes in muskrat harvests are evident, it is not possible to distinguish them from the general trend of decline for this species, which is likely due to a combination of low prices and natural changes in animal populations. However, what is missing from these kinds of gross representations of harvesting is an ability to differentiate between affected and unaffected traplines, traplines with different kinds of project-induced effects, and any changes in trapper effort.

PREVIOUS USE OF FUR RECORDS

The provincial fur record has been used in a number of studies (Teillet et al. 1977a, b; Teillet 1979; Levson and Kabzems 1981; Hilderman et al. 1982; Manitoba Hydro 1983; NRG 1986). Most of these were limited to an examination of gross production or value on the RTL sections as a whole. All relied on the provincial fur record, and in no case was independent data generated from surveys or secondary sources.

The use of fur data for LWR/CRD impact assessment has been limited to the studies done by Hilderman et al. (1982), Manitoba Hydro (1983), and NRG (1986) on the Cross Lake RTL section, and for less formally documented investigations for mitigation and compensation purposes under the NFA (C. Koenig, Manitoba Hydro, Winnipeg; pers. comm.).

The studies by Hilderman et al. (1982) and Manitoba Hydro (1983) (prepared for Claim 13 under the NFA) were restricted to the Cross Lake community trapline (CL56, a small area adjacent to the reserve). The evaluation by Hilderman et al. (1982) included losses to food production and indirect effects to cultural values and the community as a whole, in addition to fur production. The assessment of loss to fur harvesting was based on grouping harvests of four aquatic species of fur mammal (beaver, otter, mink, and muskrat) and fisher before and after the construction of Jenpeg, calculating an average harvest, and then estimating value based on average Manitoba fur prices for the 1980 trapping season. This was compared to similar calculations for the Cross Lake RTL section as a whole, the adjacent RTL sections, and province-wide fur harvests.

Harvests of the RTL sections had increased in value by 29-73% after construction of Jenpeg, whereas CL56 decreased by 20%. The value of aquatic furs from the Cross Lake RTL section as a whole increased by 60% during the post-Jenpeg period. Problems experienced on CL56 could also be seen in the changes in trapper participation. Although the total number of licenced Cross Lake trappers increased by 21% (to 1980), the number of trappers licenced on CL56 had declined by a corresponding amount.

Manitoba Hydro (1983) conducted their own assessment of impacts to CL56 using the provincial trapping record. Methods were similar to those of Hilderman et al. (1982), but differed in

detail. The report concluded that since 1976, when the changed water regime resulting from the LWR was in place, there had been a decline in the "total average yearly production and the average annual return per trapper of mink and muskrat" (p. a), which had not been experienced on the community traplines of nearby communities. Manitoba Hydro (1983) also found a decrease in the number of trappers using the community line, and a drop in value of aquatic species harvest of 27% since the construction of Jenpeg. The report posed a variety of questions, requiring information from the community, about the reasons for the change in the record.

Neither assessment can be considered to have made adequate use of impact indicators, according to the principles discussed in this report, because, at a minimum, they lacked any parallel data for changes in trapping effort. As the questions raised in Manitoba Hydro's report indicate, the data by themselves are inadequate to explain the changes observed.

The NRG (1986) study made the most thorough use to date of the fur record for assessment of LWR/CRD effects. They examined beaver and muskrat data for changes to the Cross Lake RTL section as a whole. However, for reasons unstated, they did not differentiate between affected and unaffected traplines. Their approach to assessing impacts differed conceptually from usage problems actually experienced by trappers. Rather, they regarded impact as change to the productive potential of the traplines.

NRG (1986) examined the fur record for relationships between pelt price, trapper participation, and harvest levels. They concluded that when beaver prices were high more people went trapping and generally caught more beaver, although Manitoba Hydro's compensation program appeared to elevate the number of trappers after 1980. On the other hand, there was no clear relationship between the price of muskrats and the level of harvest, suggesting that harvests were more likely affected by the impacts of water-level fluctuations on muskrat populations.

The study also examined the provincial records of use of the Community Trapline (CL56). There the numbers of trappers declined after the construction of Jenpeg, in contrast to increases elsewhere on the section. However, beaver harvests increased significantly, as did catch per trapper (i.e. there were fewer trappers, but they were trapping more intensively). There was a significant drop in both total and per-trapper muskrat harvests. In a revealing analysis obvious from bare numbers, NRG (1986) examined trappers with different levels of muskrat harvests. Starting in the mid-1970s, there was a decline in the proportion of trappers with high levels of catch (i.e. >50 muskrats per year from the community trapline), which had originally represented about 25% of the people using the line, whereas the proportion of people with middle-range harvests (10-50 muskrat/year) remained constant. This indicates that the trapline had been abandoned for serious muskrat trapping.

GOVERNMENT TRAPPING RECORDS AND HYPOTHESIS TESTING

The objective of retrospective impact assessment is to understand changes experienced by the NFA communities that were induced or significantly influenced by LWR/CRD. Testing hypotheses of development-induced changes requires far more detailed examination of the available data than has been done to date. Some areas of the RTL sections have experienced major physical and biological changes, whereas other areas have been unaffected. The most basic analysis would be to compare fur records from traplines that experienced different categories of physical and biological change (e.g. flooding, dewatering, seasonal changes in water level, etc.) with unaffected traplines.

Isolated data, however, have limited utility, because the scope of the problems discussed above (see "IMPACT INDICATORS", this chapter) are unknown, and because there are important elements of human choice in how economic resources are used. Any examination of fur data as records of trapline harvesting needs a better understanding of the social and economic organization of trapping within the communities, and would greatly benefit from a few long-term historical profiles of trapping groups in the communities. Such studies would need to examine how land and resource use and economic strategies of these groups changed between the 1960s and 1980s and how these changes are reflected in the historical fur record.

Several of the studies cited above used comparisons with traplines and communities unaffected by the LWR/CRD as controls. All native communities in northern Canada have gone through significant change during the period in question. A simple examination of numbers is not an adequate control. Rather, the same technique of exploring the history of selected trapping groups in affected and unaffected communities is necessary to understand what the numbers mean.

Finally, transportation has become a major problem for many trapping groups, including trappers whose traplines are unaffected by the development. Water bodies adjacent to the villages, which historically have been the primary travel routes to trapping, hunting and fishing areas, are now subject to water-level fluctuations, and altered and often unstable ice conditions. Increased effort necessitated by

these conditions means that seemingly unaffected traplines cannot be used as controls without an understanding of the transportation difficulties experienced by user groups, and the way that this has affected their harvesting practices and success.

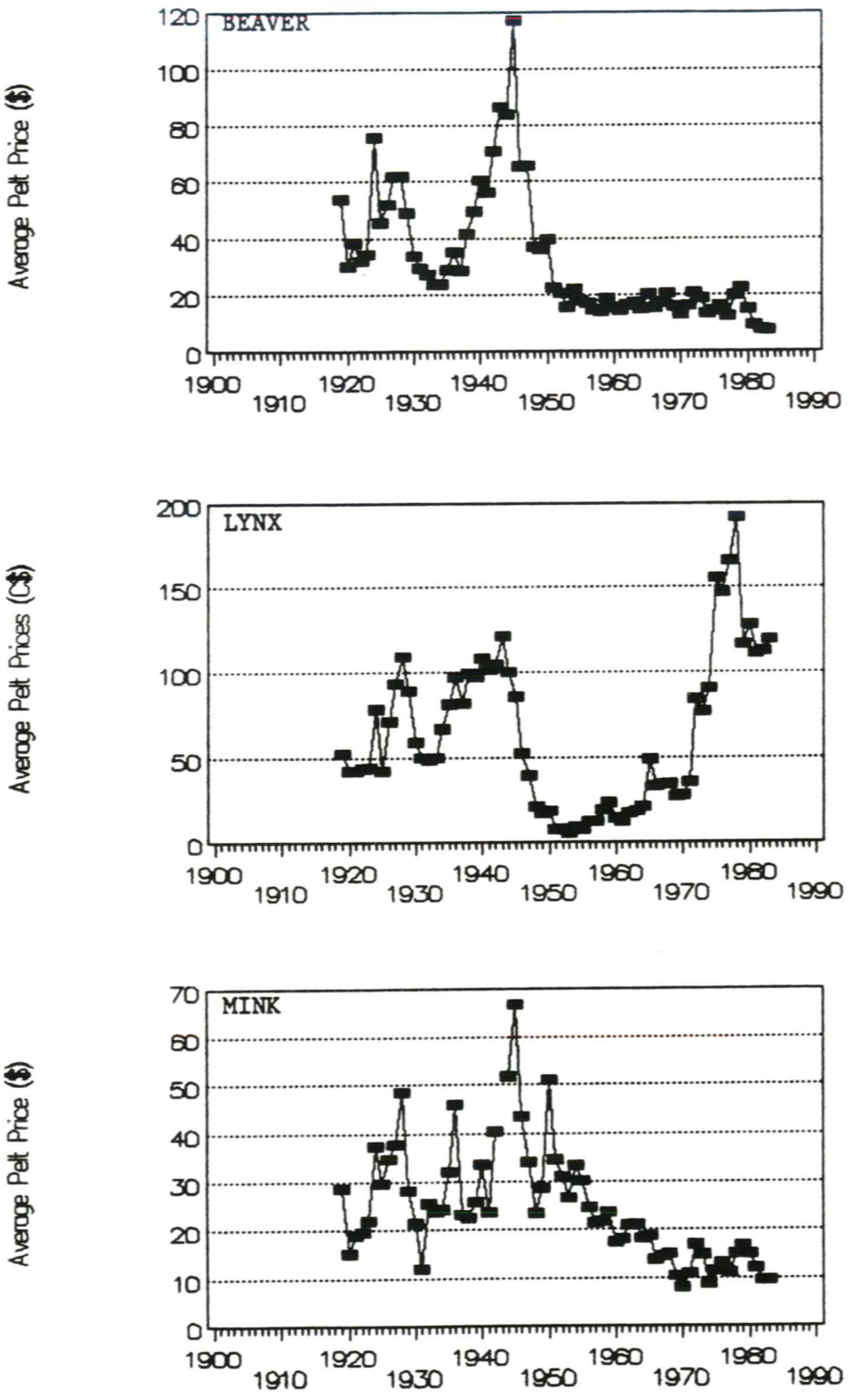

Fig. 27. Average prices paid for beaver, lynx, and mink in Canada, 1919-83, adjusted for inflation by the Canadian Consumer Price Index K8-18 series where 1971 $CDN = 1.00. Source: Novak et al. (1987).

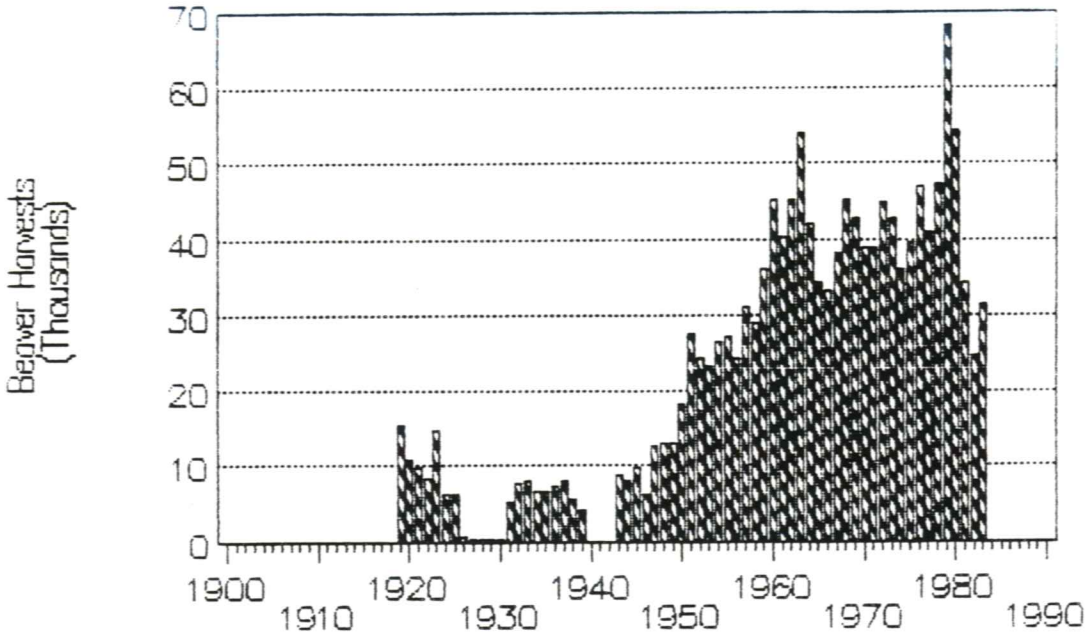

Fig. 28. Manitoba beaver harvests, 1919-83. Source: Novak et al. (1987).

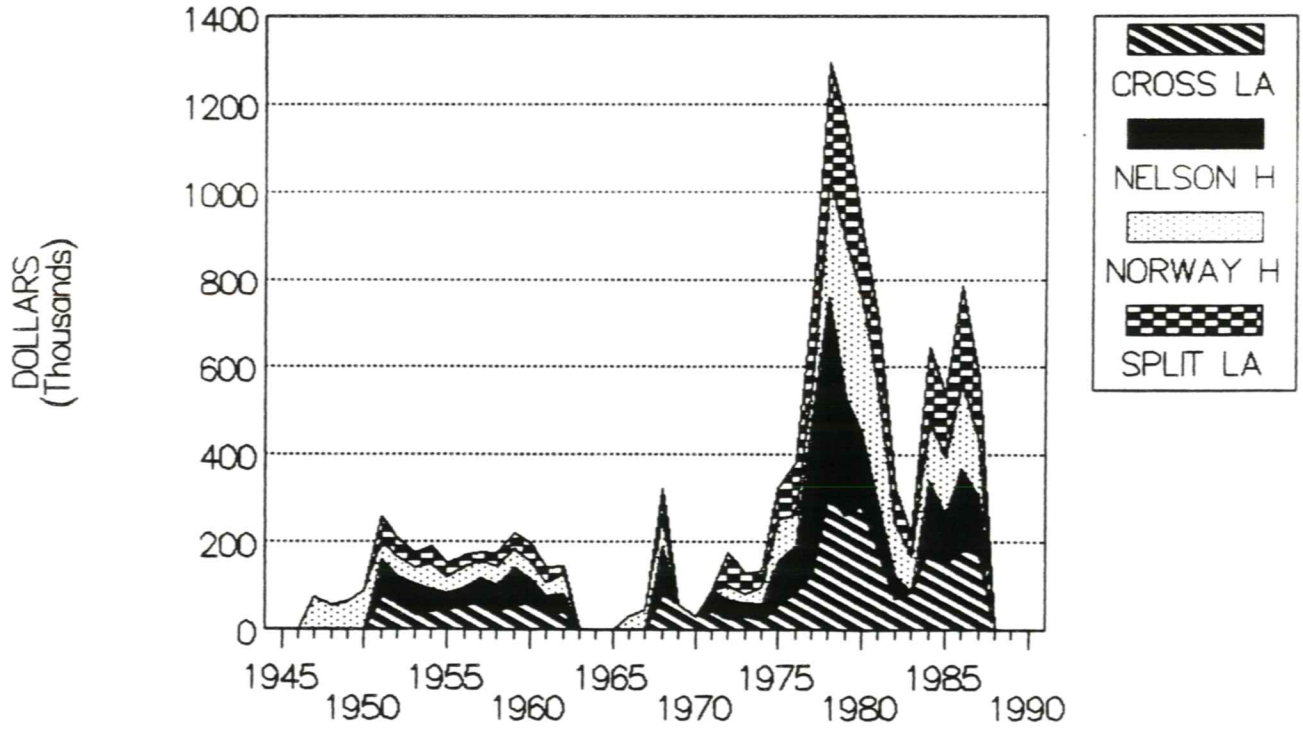

Fig. 29. Value of furs harvested on Cross Lake, Nelson House, Norway House, and Split Lake Registered Trapline (RTL) sections, 1946-88. From Manitoba (1953-61) and Manitoba Department of Natural Resources records. Note: Dollar values are based on average province-wide pelt values. Data for some or all RTL sections for the mid-1960s are missing from, or were not totalled in, the records.

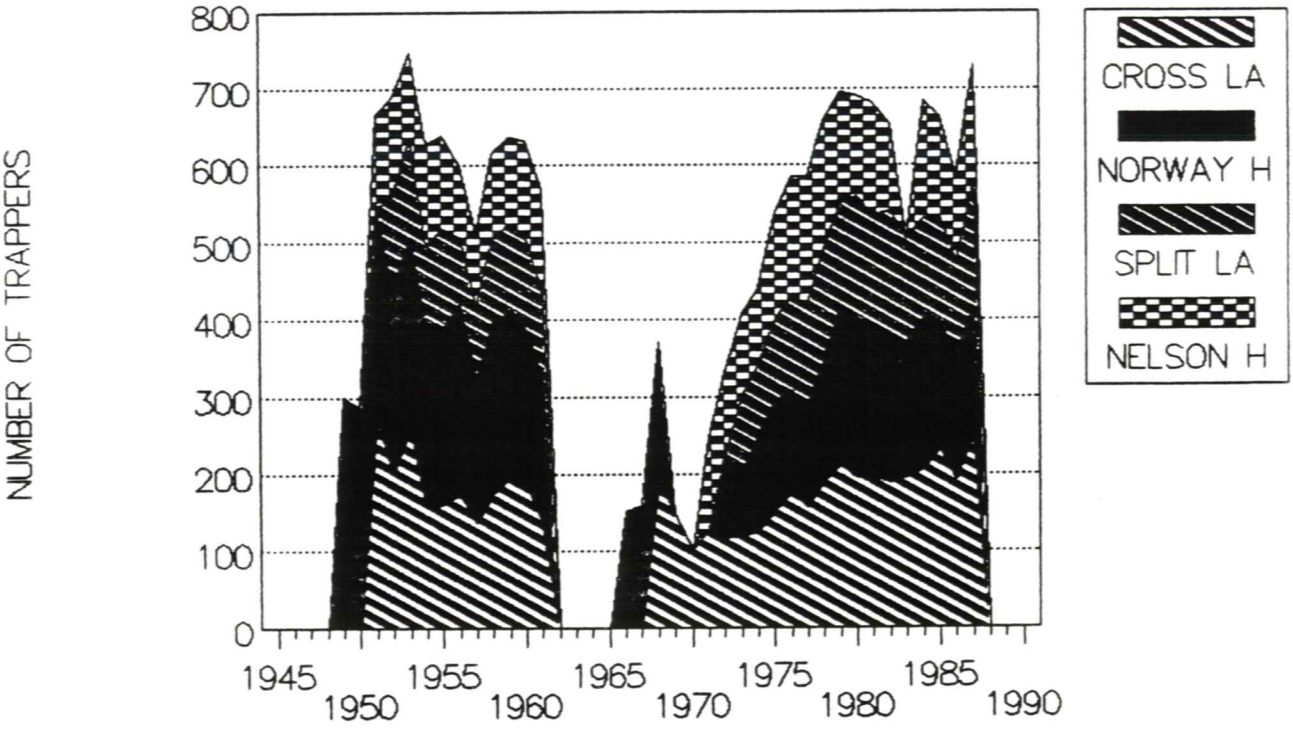

Fig. 30. Number of trappers registered on Cross Lake, Nelson House, Norway House, and Split Lake Registered Trapline (RTL) sections, 1948-88. From Manitoba (1953-61) and Manitoba Department of Natural Resources records. Note: Data for some or all RTL sections for the mid-1960s are missing from the records.

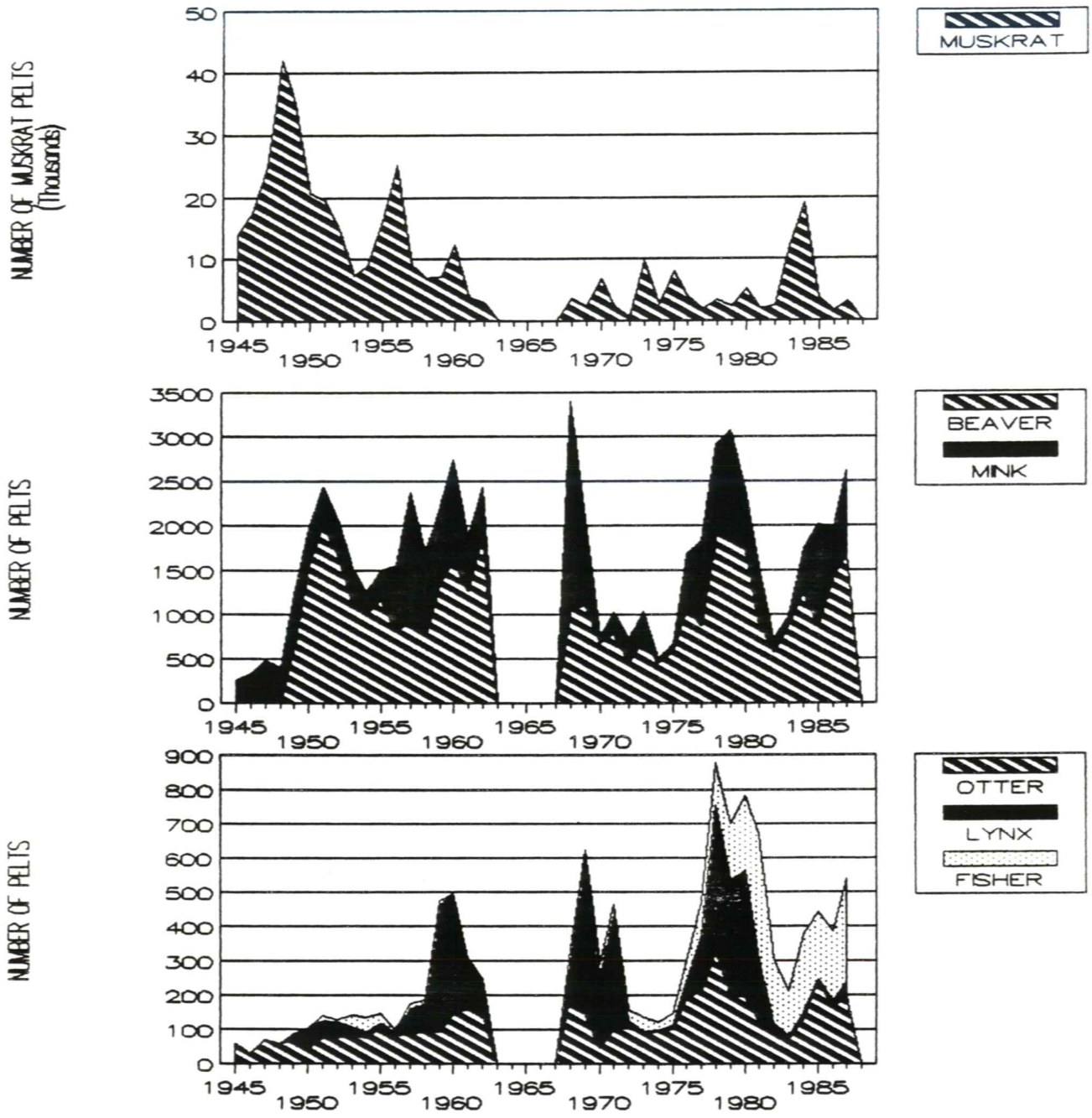

Fig. 31. Fur harvests by species, Cross Lake Registered Trapline section, 1945-87. From Manitoba (1953-61) and Manitoba Department of Natural Resources records. Note: Data for the mid-1960s were not totalled in the records.

CONCLUSIONS

ASSESSING RESOURCE HARVESTING EFFECTS OF LWR/CRD

The ability to verify predictions is a necessary condition for SIA to become an accumulative, self-improving process, and to merit attention in the design and review of major projects. In this respect it is similar to EIA (Hecky et al. 1984). However, in the case of SIA, predictive capacity based on quantification is not alone sufficient for a number of reasons.

First, some social phenomena are not as amenable to quantification as natural phenomena. Second, to the extent that social phenomena are the outcomes of non-repetitive historical forces, they require distinctive modes of analysis. Third, and perhaps most important, development impacts are experienced and responded to differently over time and among individuals because individuals assign different meaning and significance to these changes based on factors of experience, culture, social characteristics, and personality. Although distinctive patterns and tendencies in experience and response are discoverable by social science, iron laws are not. Precise and quantifiable prediction of all social responses to change is not a realistic objective. Nonetheless, there is substantial room for improvement in the predictive capacity of SIA.

Such improvement requires two things. One is an appropriate paradigm of how the phenomena in question actually work (and in a larger sense, of the process of social change itself). It is from this paradigm that hypotheses are generated and indicators are identified. The second is the continued monitoring of conditions following development, not simply to enable pre- and post-project comparisons but to verify, to the extent possible, pre-project predictions. This process of post-project evaluation is what enables improvement in both the paradigm and the more specific design features of subsequent, similar projects.

In "SOCIO-ECONOMIC IMPACT ASSESSMENT OF RESOURCE HARVESTING", we outlined an appropriate paradigm for assessing the impact of change on resource harvesting activities and on subsistence as a social system in northern Native communities. This paradigm requires much additional refinement but the directions seem clear. The continued use of the acculturation/modernization paradigm in SIA, without reference to what we have termed here the subsistence/adaptation paradigm, can no longer be justified. From this latter paradigm, and from a model of the mixed, subsistence-based economy, we identified the probable effects of LWR/CRD on resource harvesting, and the most promising indicators for testing them.

In the sections on "SUBSISTENCE HARVESTING", "COMMERCIAL FISHING", and "TRAPPING", we assessed the utility of existing resource harvesting data for the indicators proposed. Our conclusions may be summarized as follows:

1. Few usable subsistence fisheries harvest estimates exist for NFA communities, pre- or post-project, and these are for the most part inconsistent in method, non-repetitive over time, and geographically incomplete. To the extent that comparisons are possible, it would appear that LWR/CRD has adversely affected per capita harvests. However, there are insufficient reliable data on effort, or on the factors that affect it such as changing accessibility, changing fish quality (including the perception of mercury contamination), and disruption of knowledge due to environmental alteration.
2. Usable data for other forms of subsistence harvesting - e.g. big game, small game, waterfowl - are virtually non-existent, except for edible fur bearers whose production can be estimated from fur harvest records.
3. Commercial fishing data are sufficiently comprehensive, uniform, and repetitive over many years to enable a preliminary assessment of LWR/CRD impact on catch and participation. This impact has for the most part been adverse. However, the data do not provide an adequate basis for quantifying changes in cost and effort. One response by fishermen to adverse physical and biological effects appears to have been the intensification of individual effort to maintain production, but this is not revealed by analysis of existing commercial records alone.
4. Fur production and trapping participation data are also, in principle, useful for impact assessment, although they have less historical depth than the commercial fishing data. However, the construction of an analytically useful data set from the existing record is a complex and costly task, and one not undertaken as part of this project. Further, because of certain discrepancies between state-prescribed rules of tenure and actual customary practice, there appear to be significant problems of interpretation at the level of detail necessary for impact assessment. The absence of effort data is also a problem. A significant effect of LWR/CRD has been the disruption of travel routes on land and ice, necessitating increased effort and cost to maintain harvests. This effect is not directly observable from the existing statistical record itself, however.

In all cases, interpretation of existing data requires: (1) a reliable model of resource harvesting systems (on their own and as part of mixed, subsistence-based economies); (2) sound historical knowledge of the evolution of these systems (including their institutional manifestation in tenure and management) in each

community; and (3) an accurate record of the process and perception of the changes induced by LWR/CRD. These provide context as well as essential indications of significance, without which social impact cannot be assessed.

MEASURING ADVERSE EFFECTS

Existing data and their deficiencies

From an economic perspective, the two most readily available institutional data sets that can be used as impact indicators are those relating to commercial fishing and trapping. These provide reasonably reliable indicators of harvest levels that can be identified (for the most part) at satisfactory levels of geographic detail, and they are of substantial historical depth. However, as already noted, the fisheries data provide only limited information on harvesting effort, and the trapping data provide none at all. Commercial fishing effort data for NFA communities have been obtained on an occasional, project-specific basis by special surveys (e.g Gaboury and Patalas 1982; Hilderman et al. 1983), but there are no comparable pre-project data. There are no other continuous records that can be used as impact indicators for resource harvesting. Estimates of subsistence harvesting are discontinuous in time and space, and idiosyncratic in method.

Data and research requirements

In view of the limited range of existing data, several additional lines of quantitative inquiry are required. These include:

1. New or improved catch estimates for country food harvests, including fish, large and small mammals, and waterfowl.
2. Improved effort estimates for the commercial fishery.
3. Effort estimates for domestic fishing and hunting, and for trapping.
4. Historic and recent patterns of land use and resource harvesting, geo-coded at least to the level of waterbody and trapline.
5. Dietary exposure to toxic substances (mercury in particular) in fish and other species, and changes in domestic consumption in response to perceived risks. Although this can be conceived as a separate and distinct research component, there is a direct link with resource harvesting. Levels of exposure should be compared with occupation, income, subsistence participation, and other variables, based on both harvest data and diet surveys (i.e. production and consumption as cross-checks).

The successful employment of these formal, technical categories depends on them also being appropriate and recognizable categories in the minds of the affected harvesters. They cannot be imposed on each new situation on the sole grounds that they are "technically" sound, or familiar. They must be discussed and pre-tested with harvesters. Harmonization of community and external technical categories requires disclosure and mutual understanding of their respective bases in experience, perception, and analysis.

Typically, these quantitative measures become relevant to harvesters' perspectives when placed in the context of accumulated experience. This refers on the one hand to the natural history of the lakes, rivers and forests, of the fish, birds, and animals of these habitats, and of the peoples' experience of this natural history through all aspects of their livelihood, of which harvesting is only one. On the other hand, it refers to the institutional history of harvesting and subsistence: the economic and administrative factors that influenced them over time, and of the peoples' experience of these factors.

What is required is an account of harvesting now and in years past, of the changes in harvesting, and of the explanations for these changes and of the adaptive strategies by which people responded to them, to provide a context for interpreting the purely quantitative data. Such information is more successfully assembled through key informants rather than by survey, and should be compared and integrated with whatever such information exists in the written record. This procedure is also essential for assessing the significance of change. Parenthetically, the reconstruction of quantitative indicators for the pre-project period (i.e. of non-recorded harvests and effort) also requires key informant interviews rather than a survey approach.

Information required includes the "natural history" of the land and resources; changes in harvesting practices; the land tenure and resource management system; the social organization of production; the functioning of the mixed, subsistence-based economy as a system; the development of specific economic activities over time including their promotion and regulation by government; and the emergence of reserve-based economies as enclaves.

Finally, assessment of the social impact of changes in resource harvesting and subsistence requires the compilation of standardized historical data sets of social indicators, coupled with documentation of community perceptions of impact. Trends in social indicators (i.e. with respect to morbidity and social pathology) can be compared with other quantitative indicators. (Assessing the status of these indicators based on institutional records was beyond our terms of reference, however, and existing LWR/CRD impact literature does not include such an assessment, much less the systematic use of such data for testing impact hypotheses.)

Meeting this entire range of data needs would require a combination of survey, extended interview, participant observation, and archival research. Although the basic methodology for these research procedures is well established, the scale and complexity of both LWR/CRD impacts and the communities affected by them require some innovative approaches. These should include a focus on particularly important or indicative (and more manageable) subsystems, as advocated, for example, by Berkes (1988b).

The size of the affected population is a notable problem. The NFA communities are among the largest Native communities in Canada. The total population (status and non-status) of the five communities is presently about 14,000, of which almost 5,000 reside in Norway House alone. The population of the NFA communities exceeds, for example, the entire population of the eight Cree bands of northern Quebec, where the largest community is only half the size of Norway House. It may also be assumed that the NFA communities are now characterized by a highly diverse occupational and income structure. Resource harvesting surveys and related studies have normally been conducted in much smaller communities, using a census or large sample approach. By comparison, research in the NFA communities would require careful attention to sampling procedures, survey design, and survey administration. The volume of data processing would be substantial.

SIA as we have outlined it also requires the use of control groups (e.g. neighbouring communities unaffected by the project), imperfect as they may be given the limited range from which to select. Also, the investigation of cause and effect relationships through such comparative analysis requires much more precise historical documentation than is found in conventional SIA. Without an accurate chronology of events as they were experienced locally, the relationships among physical and biological changes, direct effects on the fishery, and social indicators can be little more than a matter of speculation.

Substantial effort would be required, at an early stage of any SIA research program, on the identification of significant variables and indicators and the development of working definitions, with respect to both change phenomena and the hypothesized agents of change. These are usually inadequately specified in SIA. All of these considerations underline the importance, for successful SIA, of research design and of extensive community involvement in that process.

FROM FRAMEWORK TO IMPLEMENTATION

We now consider a final question: How does one proceed from this introductory consideration of LWR/CRD effects on resource harvesting to a formal, comprehensive SIA? From a community perspective, the purpose of SIA is not only to improve future project design and implementation (and its own methods), but also to determine project effects on the lives and interests of its members, in a manner satisfactory to them. In the case of LWR/CRD, it must assess the physical, chemical, and biological effects of flooding and diversion on the lands and waters used and occupied by the communities, and the effects of these changes on the economic and social life of the communities, in particular on resource harvesting and subsistence.

This, as we have indicated, has not yet been achieved. The reasons include not only a lack of agreement on the objectives and purposes of impact assessment, and on the appropriate framework and methodology for conducting such assessment, but also a lack of communication of existing knowledge to the communities (or to interested parties therein), in a form useful and understandable to them. Similar problems of impact assessment are reported for the James Bay Hydro project in Quebec (e.g. Berkes 1988b). Further impediments have included the narrow focus on dollar evaluation of income and property losses with respect to cash compensation and mitigation programs, and the fact that article 17 of the NFA seems to lock environmental impact policy into the now nearly 20-year old framework established by the Lake Winnipeg, Churchill and Nelson Rivers Study Board report and recommendations (LWCNR 1975).

These problems underscore the fundamental distinction between the objectives and function of this report, and those of a comprehensive SIA of LWR/CRD. The present exercise, which has been to outline a theoretically sound framework for SIA and to assess the utility of certain data for hypothesis testing, is one which can be: (1) sponsored by a single agency, and (2) based primarily on literature and data research, supplemented by only modest field investigation. SIA, in contrast, must be community-based, not only in implementation and execution, but also in design and control. While external agencies can provide technical and financial resources, SIA which meets the requirements of public policy and scientific method will not occur until communities are institutionally enabled to initiate and direct it.

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APPENDIX I

FLOW AND LEVEL EFFECTS OF LAKE WINNIPEG REGULATION AND CHURCHILL RIVER DIVERSION ON NORTHERN MANITOBA RIVERS

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Accompanies Map 1, FLOW AND LEVEL EFFECTS, LAKE WINNIPEG REGULATION AND CHURCHILL RIVER DIVERSION

Map 1 identifies flow and level effects according to six categories, as follows:

Class 1. Flooding due to impoundment.
Class 2. Maintained near high end of natural level range due to impoundment.
Class 3. Flooding, altered seasonal flow regime due to diversion.
Class 4. Decreased overall flow, increased flow range and level range, dewatered lakes due to diversion.
Class 5. Increased flow range and level range (with lower minimum summer levels) due to upstream controls.
Class 6. Altered seasonal flow regime due to upstream controls.

These categories distinguish three causes of flow and level alteration: impoundment, diversion, and upstream controls. Two distinctive effects on flows and levels are identified for each. Within these gross categorizations, the magnitude and significance of effects varies considerably. Level increases due to impoundment, for example, range from several metres immediately behind control structures, to nearly imperceptible at the upstream end of the newly created lake or of backflooded streams. The magnitude and effects of altered flow regimes vary similarly.

Flow refers to the volume of water passing a given point during a specified period; level refers to the height above sea level of the water surface. Under natural conditions, higher flow rates are normally, but not always, associated with higher levels (one exception, for example, being the pre-impoundment regime on the lower Nelson, as noted below). Under the natural regime on the Churchill and Nelson, flows and levels peaked in midsummer following spring runoff in the upper basins, and dropped gradually through the rest of the year.

This regime is approximately reversed under regulated conditions. The Manitoba Hydro operating regime (referred to below), generally involves maximizing storage (and therefore reservoir levels) through late summer and early winter, and maximizing flow (therefore reservoir drawdown) in mid and late winter.

Heads (reservoir elevations above outflow below the dams) listed below are approximate.

For some discussion of the physical and biological effects of flow and level changes resulting from the Churchill River Diversion, see the special issue of the Canadian Journal of Fisheries and Aquatic Sciences 41(4), 1984.

In preparation of these notes, I have given consideration to a review of my preliminary draft by Manitoba Hydro Systems Operating Division personnel; however, I remain solely responsible for the final wording below.

DESCRIPTION OF EFFECTS BY RIVER REACH

Granville Lake (class 2): Unlikely to drain to lower end of natural range due to backwater at Leaf Rapids from Southern Indian Lake impoundment.

Southern Indian Lake (class 1): Controlled with 2.5 m head at Missi Falls (and at Notigi Dam); effect extends upstream to Leaf Rapids. Flooding along shorelines with extensive flooding in a few low regions, backflooding along stream channels, and incorporation and marginal flooding of several adjacent lakes. Total land flooded >200 km^2. Late winter drawdown of ca. 1 m.

Lower Churchill River (class 4): Downstream from Missi Falls mean flow is 0.25x natural flow (i.e. 1/4 of natural flow), with occasional fluctuations up to full natural flow (i.e. total controlled range is ca. 50-1100 m^3/s). On-river lakes typically reduced to 0.2-0.7x natural area during low flow periods. For example, the natural area of Fidler Lake of about 40 km^2 is typically reduced to less than 10 km^2, although it is occasionally flooded back to its prediversion size.

Notigi Reservoir (class 1): Controlled with 15 m head at Notigi Dam, with diverted Churchill River flows through the reservoir of 850 m^2/s. Extensive flooding (>400 km^2) incorporating major lakes of the Rat River valley. Late winter drawdown of 2-3.5 m.

Churchill River Diversion (Notigi River to Split Lake) (class 3): Increased flows (6x natural at Thompson) causing increased lake levels, e.g. Three Point Lake and Footprint Lake mean levels raised 4.5 m, causing flooding along shorelines, backflooding along stream channels, and incorporation and marginal flooding of several adjacent lakes. Total flooded land >35 km^2. Other on-river lakes similarly affected, mostly to a lesser degree. Winter fluctuations subject to Manitoba Hydro system operating regime; winter levels generally higher (1-2 m) than summer due to ice damming.

Lake Winnipeg, Playgreen Lake, Kiskittogisu Lake (class 2,3,1): Controlled at high end of natural range, with flow altered by Two Mile Channel and Eight Mile Channel. Part of the natural flow through northern Playgreen Lake is now diverted through the Eight Mile Channel and on through Kiskittogisu Lake. Flooding of shoreline on lower Kiskittogisu Lake and downstream to Jenpeg Dam (7 m head at dam). Winter drawdown ca. 0.5 m. Little Playgreen Lake and the East Channel of the Nelson River are probably subject to slightly higher than natural flows and levels due to increased average Playgreen Lake levels at the outlets into Little Playgreen Lake.

Kiskitto Lake (class 6): Outlet dammed to prevent flooding from Kiskittogisu Lake impoundment (4 m head at control dam), with outflow diverted through an excavated channel into Minago River. Level maintained within natural range, but seasonal variation reduced due to maintenance of near constant inflow (8.5 m^3/s from the Nelson River at control structure). Level control intended to maximize waterfowl and fisheries benefit.

Outlet of Kiskitto Lake diverted to Minago River (class 3): Flow of Stan Creek into Kiskitto Lake reversed by excavated channel, with small control structure. Altered seasonal flow.

Cross Lake and Nelson River (to head of Sipiwesk Lake) (class 5): Inflow controlled at Jenpeg Dam, and subject to Manitoba Hydro operating regime, causing severe level fluctuations in Cross Lake (up to 2.9 m/yr, causing annual winter flooding/summer drying of >200 km^2), with summer levels well below natural range.

Sipiwesk Lake and Nelson River to Kelsey Dam (class 1): Controlled with 15 m head at Kelsey Dam. Extensive flooding of several lakes flowing into main Nelson River channel, backflooding of stream channels, Sipiwesk Lake level raised 1-2 m.

Split Lake and Nelson River (to head of Stephens Reservoir at Gull Rapids) (class 6): Though flows are 1.3x natural, on average, due to Churchill River diversion, as is the case for all downstream reaches. Average levels are slightly increased; level fluctuations subject to Kelsey/Kettle Dams operating regime, but within natural range. Winter fluctuations have caused unsafe ice conditions at narrow bay mouths.

Stephens Reservoir (class 1): Controlled with a 30 m head at Kettle Dam. Extensive flooding out of Nelson River channel into Moose Lake. Annual range ca 1 m (although designed with a potential range of 3 m).

Reservoirs behind Long Spruce and Limestone Dams (class 1): Controlled with 24 m head at each dam. Flooding is mostly limited to Nelson River channel. Levels subject to Manitoba Hydro operating regime; range ca 1 m (also designed with a potential range of 3 m).

Limestone to Hudson Bay (class 5): Flow conditions subject to Manitoba Hydro system operating regime, resulting in both the shift of the annual peak flows from summer to winter described above, and dramatically increased daily flow range. On the lower Nelson River, especially below Limestone, the Manitoba Hydro operating regime results in large and rapid (sometimes daily) fluctuations in both flow and level. However, for the whole of the lower Nelson River below Split Lake, the highest winter levels, which occurred naturally due to ice damming below rapids, no longer occur because these reaches of frazil ice formation have been flooded.