ECONOMIC REGULATION OF NORTHERN ONTARIO INLAND FISHERIES FOR SUSTAINABLE USE

DAVID DEMARE

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ECONOMIC REGULATION OF NORTHERN ONTARIO INLAND FISHERIES FOR SUSTAINABLE USE

BY

DAVID DEMARE

A Thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

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ABSTRACT

This thesis is focused on the planning and regulation of northern Ontario inland fisheries. Its objective is to develop a system of planning and regulation which will provide sustainability and economic development of the fisheries. For this purpose an historical-analytical methodology is applied.

The thesis begins by defining the study area, describing the fishery resources and the management process currently used to control the development of the resources. A review of the development of this management process and case studies illustrate the nature and limitations of the process in terms of sustainable development. A bio-economic model of an inland fishery is then developed to provide an analytical basis for the planning and regulation of fisheries. The model is then incorporated into a system of planning and regulation of a large number of fisheries to ensure their economic development and sustainability.

The thesis answers three questions, first a historical record of the regulatory system that has been used to control the inland fisheries reveals serious limitations and failures in terms of sustainable development. Second, a bio-economic model has been provided which demonstrates the appropriate process for optimizing a fisheries stock and regulating its harvest. Finally, the process of planning and regulation is developed for application of the model to a large scale system of fisheries, such as that in northern Ontario, to ensure sustainability and economic development.

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CHAPTER ONE

INTRODUCTION

1.1 OVERVIEW

The maintenance and control of fisheries has a long history of controversy and the decline and failure of fisheries has been the focus of increasing concern about this natural resource. This thesis examines the economics of the Northern Ontario inland fisheries with a view to sustainable use and economic development. Sustainability means that they are maintained in a healthy state over time. The economic development of the fisheries is concerned with their evolution and use in a manner which achieves their best possible economic contribution to society. This thesis will proceed to examine the developmental process of fisheries in a context of planning, management and regulation.

The inland fisheries under review are noteworthy in a number of respects. First, the resources are under public ownership, a Canadian institutional fact that determines the structural nature of the industry in terms of supply-side control and responsibility. Second, the fisheries as a renewable natural resource benefit from biological growth which impacts the economics of the industry by economizing supply and development. Third, the fisheries are discrete and differentiated in nature. Fourth, demand characteristics typically lead to high levels of price elasticity. This elasticity, when combined with the stock limits imposed by the discrete nature of the fisheries easily leads to "over-fishing". Further, the relatively low marginal private costs of fishing exacerbate the problem. The sustainability which nature provides is easily endangered by excessive harvesting. In sum, there is a conflict between the private user economics and the economic benefit which inland fisheries can provide if properly managed and sustained.

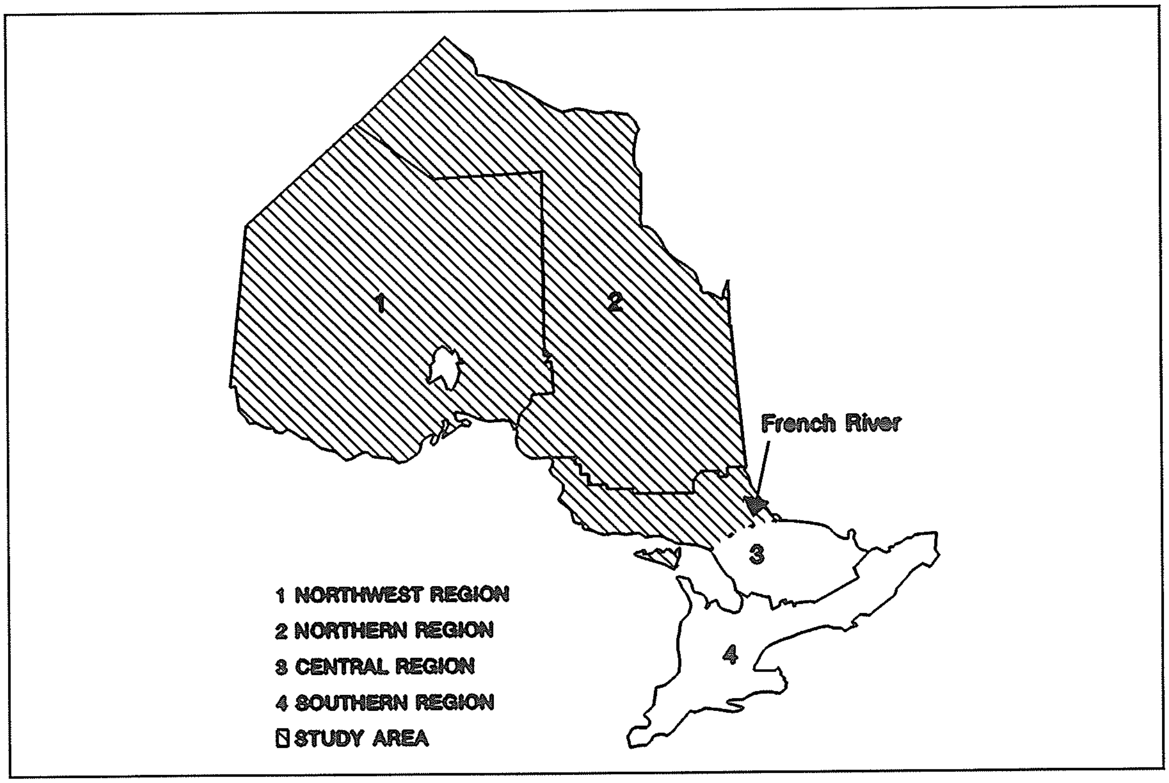
In Canada, it has been settled constitutional law since 1920 that authority over inland fisheries lies with the provinces (DFE 1987). The Federal government delegated administrative responsibilities for Ontario inland fisheries to the provincial government in 1926. Today, the provincial government carries out these responsibilities through the Ontario Ministry of Natural Resources (OMNR). The OMNR exercises central and fundamentally exclusive control over the Ontario inland fisheries. This entails ensuring that maximum benefits are realized from resource use on a biologically sustainable basis.

Ontario possesses a wealth of fishery resources. The province manages 24 per cent of Canada's freshwater - including 40 per cent of the Great Lakes and countless rivers and streams (OMNR 1992, 1). There are approximately 250,000 inland lakes in this province, with between 50,000 and 100,000 fish communities that require management. The inland fisheries of northern Ontario, the study area, are a subset of this resource. They include all those fisheries in Ontario, north west of the French river, north of the great lakes, and south of Hudson and James Bay.

Figure 1 below, a map of Ontario, illustrates the study area. The OMNR has divided the province into four administrative regions which are outlined on the map. The shaded area north of the French river, which passes through the central region, is northern Ontario, the study area.

Figure 1.

OMNR Administrative Regions, 1992-Present



Source: OMNR 1992, 2.

The northern Ontario inland fisheries are an important economic resource. Those who demand fisheries allocations can, based on economic motives and accounting of the benefits derived, be divided into four basic user groups, commercial food, recreational, commercial recreational and native. Commercial food fisherman are profit maximizers which demand fish as an input into the production of food products. The recreational user group is composed of utility maximizing anglers which demand fish as an input into the production of recreational opportunities. Profit maximizing tourist operators demand fish as an input into the production of recreational opportunities or otherwise provide support services to recreational anglers. Finally, the native user group demands fish for commercial, recreational and subsistence purposes, meriting special consideration in fisheries allocation issues due to historical entitlements.

During 1985 approximately 400 commercial food fisherman harvested 1,544,240 kgs of fish with a landed value of $2,074,319.00 (OMNR 1990b, 2). During the same period, 515,000 resident recreational anglers spent 7,049,000 days angling in the study area harvested some 6,085,770 kgs of fish and spent in the order of $109,118,000.00. Similarly, an estimated 429,000 non-resident recreational anglers angled 3,133,000 days in the study area, spending approximately $189,241,000.00 and harvesting 1,559,040 kgs of fish (OMNR 1990f). The commercial recreational user group ran 1,200 commercial operations in the study area (OMTR pers comm), earning $90,668,025.00 in gross revenues (OMNR 1990f). Finally, natives were estimated to harvest 18,825 kgs of fish for subsistence purposes. Native harvests for purposes other than subsistence are attributed to the corresponding user group category.

Allocating the output from the northern Ontario inland fisheries on a biologically sustainable basis which provides an optimum contribution to the economic welfare of society, is the subject of this thesis. First, the performance of the system used to plan and regulate the fisheries is examined in terms of its ability to ensure their sustainable development. Then, a bio-economic model of a typical inland fishery is developed which provides an alternative system of planning and regulating the fisheries for sustainable development. Finally, the alternative system provided by the bio-economic model, is developed and applied to the northern Ontario inland fisheries.

Due to the controversy surrounding aboriginal self government and resource entitlements, a complete treatment of Native use exceeds the scope of this thesis. In some cases native groups may be entitled to exclusive access to fishery resources and should therefore receive planning and regulatory responsibilities. Natives could use the bio-economic model to guide their management activities however, due to the unique cultural institutions characterizing this group, a full treatment of native resource management would represent a suitable topic for an additional thesis. Similarly, the acid rain issue which has a significant bearing on the present and future performance of northern Ontario fisheries is not addressed in this thesis. The focus of this thesis is on the economics of resource use.

1.2 PROBLEM STATEMENT

Ontario fisheries are common property resources managed by the government of Ontario on behalf of the people of Ontario. The Ontario government carries out these responsibilities through the Ontario Ministry of Natural Resources (OMNR). The OMNR manages the use and development of the fisheries with the objective of providing an optimum contribution to the welfare of the people of Ontario through time on a biologically sustainable basis. The system presently used to plan and regulate the fisheries is unable to determine or enforce economically efficient and biologically sustainable patterns of resource use and development.

Historically, the productive capacity of northern Ontario inland fisheries has far exceeded the demands placed on them. Free access to fisheries has therefore seemed to be an appropriate basis for public policy. However even then, free access allowed demand to be focused on particularly attractive fisheries, often diminishing their potential welfare contribution and in some cases causing biological collapse.

Over time, demand has steadily increased along with rising levels of population, income, leisure time, and education. This has lead to an increasing number of fisheries being subject to harvesting pressures which exceed the resource's ability to sustain. The result has been a general decline in the resource and the benefits derived from its use, with numerous specific fisheries subject to biological collapse.

The planning and regulation of northern Ontario fishery resources has accordingly become an important management function. Fisheries planners and regulators must impartially determine and enforce the welfare optimizing allocation of the output from the fisheries across and amongst user groups through time on a sustainable basis. An examination of the system of planning and regulating the fisheries reveals serious limitations in terms of meeting these objectives. Individual fisheries throughout the study area have been, and increasingly are, subject to unsustainable and inefficient patterns of resource use. An alternative system of planning and regulating the fisheries must therefore be developed to control fisheries use in accordance with the tenants of sustainable development.

1.3 THESIS OBJECTIVE

The objectives of this thesis are threefold:

> i) To provide a historical account of the economic development of northern Ontario inland fishery resources.
>
> ii) To provide a bio-economic model for the analysis and development of inland fishery resources.
>
> iii) To develop a planning and regulatory system for the inland fisheries of northern Ontario directed towards their sustainability and economic development.

1.4 THESIS OUTLINE

This thesis is composed of six chapters including the introduction. Chapter Two provides a review of the northern Ontario inland fisheries, their use, and management. The chapter begins with an account of the nature, productivity and use (harvest) of the fishery resources in the study area. Then, the organizational structure of the OMNR is examined along with the management process which governs use and development of the fisheries. The chapter concludes by summarizing the biological nature of northern Ontario inland fisheries, their use and management.

Chapter Three provides a historical account of the development and performance of the fisheries in the study area. First the evolution of fisheries jurisdiction and administration is described from the time of confederation. Next an account of those who have used the fisheries and how they have been managed is provided. A series of case studies are then presented which illustrate the performance of the fisheries and identifies the fundamental shortcomings in the regulatory system governing their use. The chapter concludes by summarizing the development and performance of the fisheries along with the fundamental shortcomings in the present regulatory system.

Chapter Four develops an economic model of an inland fishery, characteristic of those found in the study area, for the purpose of planning and regulating the fishery. The economic model is developed in terms of two fundamental components, a long-run analysis which is related to fishery planning and a short-run analysis which is the focus for regulation. The long-run analysis identifies the biological optimum, the economic optimum and "collapse points" for the fishery which are strategic in fishery planning. The short-run analysis describes the economic forces which exercise pressure on the fishery and determine its economic tendencies. A comparison of the harvest level established by these economic tendencies with the long-run economic optima provides a dynamic for the sustainable and economic development of the fisheries. The model can then be applied to the planning and regulation of the fishery.

Chapter Five develops and applies a system of planning and regulation to the inland fisheries of northern Ontario in accordance with the preceding economic analysis of an inland fishery. First, the planning function is elaborated to the system of fisheries in the study area and a process for establishing priorities in their management developed. A regulatory strategy is then developed which enables regulators to control and adjust fish stocks in accordance with planning recommendations. Consideration then turns to the implications of the new system of planning and regulation for the OMNR. The chapter concludes by summarizing the system of planning and regulation and how the performance of the fisheries will improve.

Chapter Six concludes the thesis. First, the thesis outline is reviewed. Next, the objectives presented earlier in this introduction are revisited and the principle research findings, in lieu of these objectives, are presented. Finally, the thesis is concluded with a summary of these findings.

CHAPTER TWO

NORTHERN ONTARIO INLAND FISHERY RESOURCES

2.1 INTRODUCTION

This chapter provides an overview of the northern Ontario inland fishery resources, their use, and management. The chapter begins with an account of the nature, productivity and use (harvest) of the fishery resources in the study area. Then, the structure of the OMNR is examined along with the management process which governs use and development of the resource. The chapter concludes by summarizing the biological nature of northern Ontario inland fisheries, their use and management.

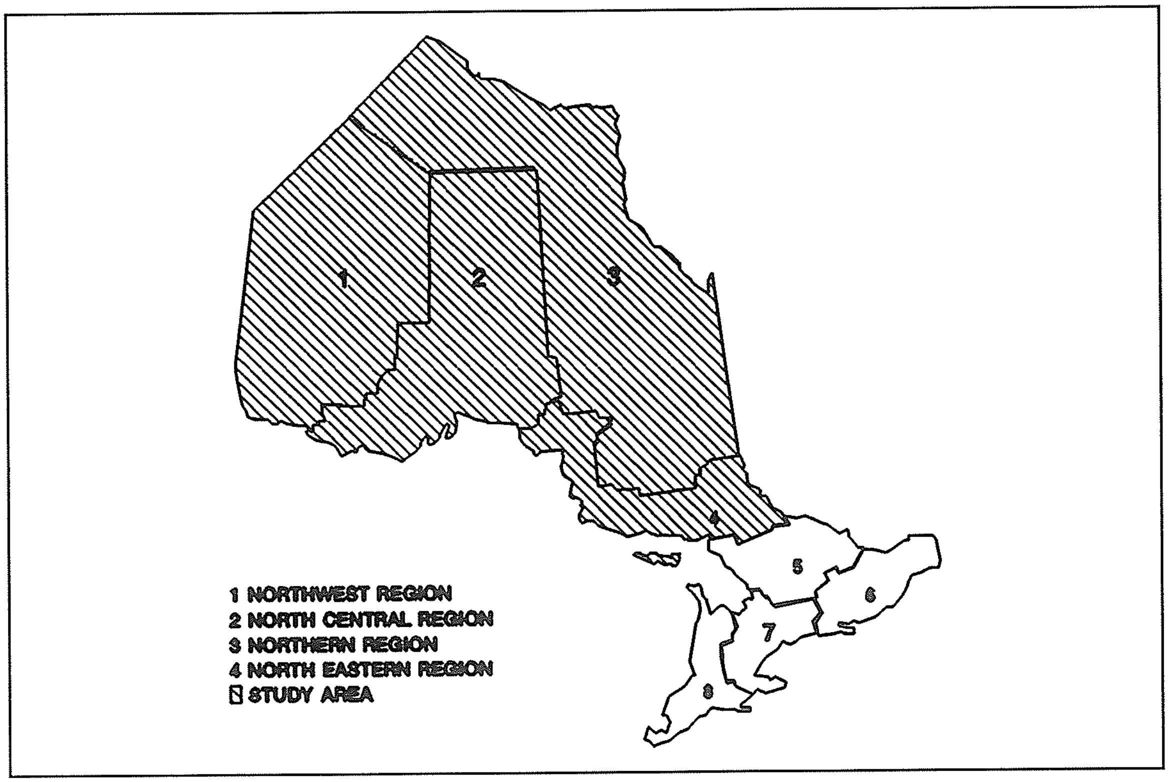
2.2 THE REGION

Ontario manages 24 per cent of Canada's freshwater including 40 per cent of the Great Lakes and countless rivers and streams. There are approximately 250,000 inland lakes in this province located mainly in the Canadian shield, a rugged track of land covered by the Boreal and Great Lakes St Lawrence Forests (OMNR 1992d, 1). The study area, the northern Ontario inland fisheries, is a subset of the province's fishery resource. It is herein defined as all fishery resources in Ontario northwest of the French river, north of the Great lakes, and south and east of Hudson and James bay.

Figure 2, below, is a map of Ontario. Superimposed on the map are the regional boundaries of the OMNR Operations Division prior to the reorganization announced March 1991. The four northern regions, the shaded area, collectively encompass and define the study area. This administrative structure will be used to compile and present resource productivity and harvest data because the data were collected on this basis and in conjunction, the four northern regions encompass the study area.

Figure 2.

OMNR Administrative Regions, 1972-1992.



Source: OMNRd 1980, 4.

2.3 THE FISHERY RESOURCE

This section provides an account of the water resources, fish communities and species found in the study area, their rate of growth and harvest (OMNR 1982c). Each fishery, lake stream or river, in the study area generally possess several species, and often more than one discrete stock within a species. A discrete stock is an aggregation of fish which is reproductively isolated and therefore genetically distinct from other stocks. Collectively, the discrete stocks of fish found in a fishery are referred to as a fish community although some debate surrounds this issue. Some water bodies possess discrete habitats which support both cold and warm water fish species. In these cases more than one fish community is said to be present in the fishery. The composition of the fish community tends to be a complex function of water quality, habitat suitability and the presence of other species (species interactions).

2.31 The Water Resource

Water quality is one of the principal determinants of the fish species (community) present in a fishery. In this regard, lakes are classified as oligotrophic, mesotrophic, and eutrophic which refer to the productivity of the lake and correspond to water quality in terms of phosphate loadings. Oligotrophic water bodies tend to be deep clear relatively unproductive lakes which support trout species although, they often support species found predominately in mesotrophic and eurotrophic lakes. Mesotrophic water bodies tend to be less clear and are shallower than the oligotrophic lakes. They are moderately productive and support walleye, northern pike, whitefish, smallmouth bass and muskellunge. Finally, the eutrophic lakes are shallow, muddy, relatively productive water bodies supporting sucker, black crappie, and northern pike populations. In practice, fisheries are classified as cold, cool and warm water, where cold water fisheries are oligotrophic water bodies which can support trout species.

Habitat suitability is also an important factor which influences the composition of a fish community. Habitat suitability includes such factors as spawning and feeding sites which act as limiting factors on the abundance or presence of a species. If for example a fishery possess all of the characteristics of a lake ideally suited to a given species with the exception of a suitable spawning site, it is improbable that the species will be present in the fishery. Similarly, if a suitable forage base is absent from the fishery, it is unlikely that the given species will thrive regardless of the other conditions present. A fishery's geographical location will also influence the species present. For example, fisheries in the northern half of the study area will not typically support smallmouth bass because, the water temperature may not rise high enough to initiate spawning.

Species interactions also influence the composition of a fish community. For example, muskellunge tend not to fair well in fisheries which have northern pike populations. Muskellunge and northern pike spawn in the same areas although pike spawn approximately one month prior to the muskellunge. The northern pike fry therefore emerge before the muskellunge and are large enough to feed on muskellunge fry when they subsequently emerge. As a result, in fisheries where the two species coincide, the reproductive success of muskellunge is greatly reduced. Similarly, brook trout fisheries in small lakes tend to perform better in areas absent of yellow perch. Once yellow perch have been introduced to a brook trout fishery, they will compete with brook trout for food and habitat as well as prey heavily on the brook trout fry. Often the original brook trout population will be eliminated.

2.32 The Fish Resources

The fish species and communities which collectively make up northern Ontario inland fisheries are therefore complex and diverse. The presence and/or composition of any given fish community is a complex function of water quality, habitat suitability and the presence (absence) of other species (species interactions). Those species which occur in the study area and are economically significant include lake whitefish, lake sturgeon, white and longnose suckers, walleye, lake trout, northern pike, yellow perch, brook trout, smallmouth bass, black crappie, and muskellunge (Scott and

Crossman, 1973).

2.321 Fish Species

Each of the economically important fish species which inhabit the study area possesses a unique set of biological attributes. These biological attributes differentiate the species economically through their influence on both the supply and demand characteristics of each species. A species distribution, its mean size, edibility, tenacity, and ease of capture, will affect the demand expressed for the fish both across and amongst user groups. Similarly, the productivity of the water bodies a species inhabits and it's mean age to maturity affects its productivity and therefore the economics of it's supply.

Among the fish that are caught solely for commercial food are the lake whitefish. They are an important commercial species because they provide excellent table fare, have characteristically dense populations, and are easily harvested by commercial methods although not recreational. They are a cold water species found intermittently throughout the study area in deep clear lakes or water bodies which maintain well oxygenated water at a temperature of 9 degrees celsius. Lake Whitefish reach an average length of about 381 mm and typically attain a weight of about 900-2,250 grams, although specimens exceeding 9,000 grams are occasionally caught. They generally reach sexual maturity between 3 and 5 years of age.

Another important commercial fish is the lake sturgeon. They are an extremely valuable commercial species, providing caviar and considered to be a delicacy. Recently interest in this fish as a sport species has been growing due primarily to its extreme size. It is warm water species which inhabits large rivers and lakes found intermittently throughout the study area. Lake Sturgeon reach an average length of 91.5-142.5 cm and typically attain a weight of 4.5-36.3 kgs although, fish exceeding 100 kgs are caught intermittently. Sexual maturity occurs in females at approximately 20 years of age and in males at 15 years. Females spawn once every 4 to 7 years. Their unusually late age to maturity and sparse breeding frequency cause lake sturgeon fisheries to be particularly vulnerable to overharvesting, whereas the reproductive segment of the population can be readily eliminated.

Of lesser importance, but still of commercial use are the suckers. Two species of suckers, the common white and longnose are commonly found throughout the study area. They are predominantly warm water species although they are tolerant to a wide range of habitat. They reach an average length of 305-508 mm and 305-356 mm respectively and typically attain a weight of 900-1,800 grams although, specimens exceeding 4,530 grams are caught intermittently. Sexual maturity is usually attained between 2 and 3 years of age.

Walleye is a highly prized species, sought after by both commercial food and recreational angler users due to its exceptional quality as a food fish and ease of capture. It is a cool water species found throughout the study area, tolerant of a great range of environmental situations but reaches greatest abundance in large, shallow, turbid lakes. They reach an average length of 330-508 mm long and weight of 400-1300 grams, although specimens exceeding 6,000 grams are caught each year. Male walleye typically reach sexual maturity between 2 and 4 years of age while female walleye reach sexual maturity between 3 and 6 years of age. Due to early age to maturity and the relatively productive waters walleye inhabit it is a relatively productive species resilient to harvesting.

Lake Trout are a valuable species also sought after by both commercial and recreational users. They provide reasonable table fair and exceptional sport due to their relative large size. They are a cold water species typically found in deep clear lakes or water bodies which otherwise maintain well oxygenated water at a temperature of 50 degrees fahrenheit throughout the season. They are found intermittently throughout the study area although notably, 20 to 25% of the lake trout habitat in the world is located in the study area (pers comm. Paul. Bewick, OMNR). Lake Trout reach an average length of 381-508 mm and typically attain a weight of 1200-4500 grams although, specimens exceeding 18,000 grams are caught each year. Sexual maturity is usually attained at about age 6 or 7. This in conjunction with the relatively unproductive waters they inhabit cause lake trout populations to be relatively unproductive and therefore easily destabilized when overharvested.

A third fish with both commercial and recreational value is the northern pike. Northern Pike provide reasonable table fair and excellent sport fishing in reference to their relatively large size and fighting tenacity. They are a cool water fish found throughout the study area in clear, cool, slow, meandering, and heavily vegetated bays of lakes. Northern Pike reach an average length of 457-762 mm and typically weigh 900-4,550 grams although, specimens exceeding 13,600 grams are reported each year. Sexual maturity is reached at age 3 to 4 for females and 2 to 3 for males. Again, due to an early age to maturity and the relatively productive waters they inhabit northern pike are a relatively productive species, resilient to overharvesting.

Of lesser importance is the yellow perch which is also used by both commercial and recreational users. They are found throughout the study area, with the exception of the Hudson Bay Lowlands in the extreme north. They are very adaptable and able to utilize a wide variety of warm and cold water habitats from large lakes or ponds to quiet rivers. Yellow Perch caught in the study area reach an average length of 102-254 mm, seldom exceeding 250 grams in weight although specimens exceeding 450 grams are caught regularly. Sexual maturity is reached at an age of 2 to 4 years.

For recreational purposes only, a popular fish is the brook trout. They are a highly prized species due to their flamboyant coloration, excellent food quality and tenacious fight. Although they represent a desirable fish for commercial food use, due to the relatively small population sizes and high recreational demand for their use, allocations to the commercial food industry are negligible. They are a cold water fish species found intermittently throughout the Northern, Northeastern and Central regions, in clear cool well oxygenated streams and lakes. Brook Trout average between 254-305 mm long and do not frequently exceed 1,200 grams although, specimens exceeding 2,300 grams are reported each year. Brook Trout reach sexual maturity between 2 and 3 years of age and are therefore relatively productive, resilient to overharvesting.

Another popular recreational fish is the smallmouth bass. They have a reputation of being a reasonable food fish which is easy to catch and provides a tenacious fight. They are widely distributed throughout the southern half of the study area primarily in rocky sandy areas of lakes and rivers in moderately shallow water. Smallmouth Bass reach an average length of 203-381 mm and typically weigh between 450-1,350 grams with specimens exceeding 2,250 grams reported every year. Smallmouth Bass reach sexual maturity at an age of 2 to 3 years and are a productive species, resilient to overharvesting.

A rather special recreational fish is the black crappie. They are a prized sport species due to their excellent food quality, attractive coloration and ease of capture. They are native to Lake of the Woods, Rainy Lake, and the tributary lakes of Georgian Bay, although like smallmouth bass their range has been expanded through stocking. They are found primarily in rocky sandy areas of lakes and rivers in moderately shallow water across the southern third of the study area. Black Crappie caught in the study area have an average length of between 178-254 mm and typically weigh 200-400 grams with specimens exceeding 900 grams caught each year. Sexual maturity is reached at an age of 2 to 4 years.

Finally, the muskellunge is a rather unique recreational fish. Muskellunge are a highly valued species due to their exceptional size, fighting tenacity and relative scarcity. They are a trophy fish typically caught and released, seldom harvested for food although exceptional specimens are frequently harvested for trophy mounts (display). Due to their relative scarcity, high recreational demand, and only moderate quality as a food fish use by commercial food fisherman is negligible. They are found intermittently in the southern third of the study area in heavily vegetated lakes, stumpy weedy bays, and slow heavily vegetated rivers. Muskellunge reach an average length of 711-1220 mm and typically weigh 3,600-16,200 grams although, specimens exceeding 20,250 grams are reported each year. Muskellunge reach sexual maturity at an age of 3 to 5 years. Although they inhabit relatively productive bodies of water, their relatively late age to maturity and the characteristically sparse nature of discrete stocks causes this species to be relatively unproductive and easily overharvested.

The fish species found in the study area are biologically differentiated and as such are also economically differentiated. Some species of fish, such as walleye, northern pike, and lake trout possess characteristics which include large mean size, edibility, ease of capture, and distribution which make them desirable for both commercial food and recreational uses. Other species such as smallmouth bass, muskellunge, brook trout and black crappie possess characteristics which make them attractive to recreational anglers and only marginally attractive to commercial food interests. Similarly, there are species such as lake sturgeon, whitefish and the suckers which are only marginally attractive to recreational anglers although certainly viable commercial food species. Biological attributes which define the productivity of a given fish species and its resilience to destabilization also exert an economic influence on the supply side characteristics of a species.

2.322 Fisheries Growth and Yield

Fisheries are renewable natural resources capable of providing a flow of output (fish) through time on a sustainable basis. Each year, a discrete stock of fish will carry out a life cycle; the existing stock of fish will grow, reproduce and be subject to natural mortality. The fish stock's annual growth, which is analogous to production or output, is equal to the growth of the existing stock plus the growth of new individuals recruited to the stock via reproduction, less those fish lost to natural mortality over the course of the year. Stock growth, reproduction and fatality are all measured in terms of biomass.

Cetrius paribus, annual growth or the flow of output is a function of the size (biomass) of a fish stock, at the outset of each year, in relation to the carrying capacity of the fishery. At very low stock levels, there are too few fish to grow and reproduce resulting in a net annual production that is generally small. Similarly, at large stock levels the competition for food or favourable breeding sites may reduce growth and net annual recruitment such that annual production may also be small. These considerations suggest that moderate stock sizes may support the greatest rate of annual production. Finally, the possibility exists that if stock size declines below some critical threshold, annual production may become negative due to unsuccessful reproduction, causing the stock to decline to extinction.

If over the course of one year, a growth cycle, annual production is harvested the size of the fish stock will remain constant through time. Further, if annual harvest is less than (greater than) annual production, the fish stock will increase (decrease) in size at the end of each year equal to the difference between annual growth and harvest. In 1965, Richard Ryder published (Ryder 1965) the morphoedaphic productivity index (MEI) which provided for the first time, a practical method of making a first approximation of the maximum annual sustainable yield[1] of fish which could be harvested from a fishery annually without destabilizing[2] the fishery over time (OMNR, 1982). The index was estimated by regressing the yield from a number of fisheries, thought to have been harvested close to or at their maximum sustainable yield through time without destabilizing, against the physical characteristics of the fishery. Ryder found that the surface area of the lake in conjunction with the latitude, mean depth and mean level of dissolved solids provided a relatively reliable estimate of the fisheries maximum annual allowable yield of fish per hectare of surface area.

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[1] The theoretical maximum yield that can be harvested annually from a fishery, measured in terms of weight, without exhausting the ability of the fish community to sustain the yield through time via compensatory biological responses.

[2] A destabilized population of fish is one which due to overharvesting is depleted to a level whereby annual recruitment begins to become increasingly irregular, compensatory biological responses fail, and consequently harvest yields and consistency begin to decline.

The index did not however partition the annual yield amongst species within a fish community. In 1982 the Ontario Ministry of Natural Resources developed a set of guidelines to partition the potential yield, provided by the morphoedaphic index, into allowable yields for several economically important species in multi-species fish communities (OMNR 1982). Following a detailed examination of the existing data describing harvest of multi-species communities, the guidelines presented in Table 1 were recommended for partitioning the potential fish yield into individual species yields.

Table 1.

Recommended Partitioning of MEI

Species	Sport Fisheries	Commercial Fisheries
Walleye	32%	20%
Lake Trout	25%	25%
Brook Trout	25%	N/A
Northern Pike	25%	10-20%
Lake Whitefish	24%	24%
Smallmouth Bass	17-50%	N/A
Yellow Perch	13%	?

Source: OMNR 1982c, 37.

A number of qualifications were placed on the above estimates. First, sport and commercial fisheries are subject to separate guidelines because, the method of capture can have a potentially significant effect on the productivity of a fish stock. As a species age-to-maturity increases, the potential productivity is assumed to decline because of the increasing potential that the reproductive segment of the population will be eliminated. Anglers can be highly selective when harvesting fish whereas commercial fisherman are more often indiscriminate. As such, regulations can be introduced which explicitly protect key segments of a fish stock and thereby increase the stocks potential yield. Therefore recreational fisheries can often sustain greater harvests.

Secondly, in most cases, the sum of the total potential yield from only the economically significant species in a fish community will not equal 100%. In these cases it is recommended that guidelines be scaled up or down so that the sum of species yields equals 100%. Also, where stocks have been subject to heavy exploitation (stock size has declined) or habitat stresses such as water pollution or loss of spawning grounds potential productivity estimates should also be reduced.

Finally, species interactions (community dynamics) and or competition can also influence productivity estimates. For example, when one species of fish is exploited to the point where its numbers are significantly reduced, other less heavily fished species may increase in numbers and\or size to maintain overall total productivity. This is called density-dependent compensation. The increased competition for habitat may reduce the productivity of the exploited species reducing its potential productivity. The productivity estimates must therefore be qualified with underlying knowledge of long term species interactions or community dynamics.

In practice, the morphoedaphic productivity index has been found to be accurate to within plus or minus 300% of the fisheries maximum sustained yield. Fisheries biologists use the morphoedaphic index as a method of first approximating the fisheries potential yield and then subsequently monitor the fishery under different levels of harvest to refine productivity estimates. Typically, indexed gill nets will be set in a fishery, and the relative composition of the fishery used to determine its status, in terms of biological productivity. Generally, as the mean age of fish caught approaches the mean age to sexual maturity, reproductive success becomes increasingly unreliable.

During the mid 1980s the OMNR conducted a comprehensive planning exercise for Ontario's fishery resources. As a consequence, each district was required to produce a district fisheries management plan (DFMP) and, in doing so estimate fisheries productivity, using the MEI, and harvest by species to appraise the productive status of the resource. These estimates have been compiled on a regional basis from the DFMPs. Estimates of the maximum annual sustainable yield (MSY) and use (harvest) by species, are provided in Tables 2 and 3 for each of the four regions depicted in Figure 2.

Table 2.

Productivity and Harvest Estimates for Northern Inland Fisheries by Species and Region in Thousands of Kgs

Regions	Northwest Region			North Cental Region		
Species	**Harvest**	**MSY**	**Net**	**Harvest**	**MSY**	**Net**
Lake Trout	202	463	261	111	119	8
Walleye	2048	3412	1364	617	1013	396
Northern Pike	1200	2642	1442	347	940	593
Lake Whitefish	578	2291	1712	313	960	647
Smallmouth Bass	122	707	585	46	57	11
Black Crappie	18	0	-18	0	0	0
Yellow Perch	7	1144	1137	0	189	189
Lake Sturgeon	14	0	-14	0	41	41
Brook Trout	0	1	1	0	1886	1886
Other	38	240	202	146	87	-59
Total	4227	10900	6672	1717	5296	3579

Source: Compiled from District Fisheries Management Plans; OMNR

Table 3.

Productivity and Harvest Estimates for Northern Inland Fisheries by Species and Region in Thousands of Kgs

Regions	Northern Region			Northeast Region		
Species	Harvest	MSY	Net	Harvest	MSY	Net
Lake Trout	29	39	9	192	154	-38
Walleye	291	309	18	374	390	16
Northern Pike	257	337	80	63	279	216
Lake Whitefish	152	88	-64	5	124	119
Smallmouth Bass	8	9	1	3	137	134
Yellow Perch	5	20	15	0	63	63
Other	6	6	0	0	0	0
Muskellunge	64	240	176	296	179	-118
Brook Trout	9	17	8	2	18	16
Total	822	1065	243	935	1343	408

Source: Compiled from District Fisheries Management Plans; OMNR.

Tables 2 and 3 indicate that for each species, harvest is below the resource's capacity to sustain production through time with the exception of lake trout and muskellunge, which are being harvested 25% and 66% above their maximum sustainable yield respectively in the northeastern region. These data however overlook the distribution of harvest in relation to fisheries productivity and therefore understate the degree of harvesting pressure on the resource. For example 46% of the districts in the study area reported that walleye are being overharvested (by as much as 236% per annum in Dryden). 42% of districts indicate that trout are being overharvested, and 19% of districts indicate that northern pike are being overharvested. Further, this scenario extends to individual fisheries in virtually every district in the study area with catastrophic (by fishery) results. The following quote taken from Ontario's strategic policy for fisheries resources (OMNR 1992d, 11) illustrates.

> Another major cause of the reduction in the numbers of fish is overharvesting, because of unrestricted access to lakes and rivers - even when laws of possession, gear and licence are obeyed, certain waterbodies can be so heavily fished that the fish stocks cannot be sustained; and seemingly insignificant losses of local fish populations are accumulating and leading to an over all decline in the resource."

Or, as stated in the Kirkland Lake District Fisheries Management Plan (OMNR 1986e, 7), among others:

> There are six documented walleye lakes in the District which are being overstressed to varying degrees by sport fishing (Gowganda, Long, Howard, Obushkong, Wendigo, Pensassi). These lakes represent 24% and 23% of water area and allowable yield respectively of all known waters containing walleye in the District. Similarly, there are three lake trout lakes int the District which are being overstressed by sport fishing (Larder, Watabeag, St. Anthony). These lakes represent 73% of the total area of lake trout waters in the District and 69% of the total allowable yield."

Moreover, many of the fisheries in the study area are underproducing due to past over-exploitation. The above estimates of sustained yield reflect the resource's theoretical yield. In practice, due to the depressed status of many of the fisheries in the study area, their potential yield is significantly below their theoretical yield. Therefore the above table also overestimates the resources present maximum sustainable yield and thereby under estimates the degree of pressure on the resource. For example, the Timmins District Fisheries Management Plan (OMNR 19871, 15) states that there are a minimum of 4 lakes in the District which are underproducing, listing the annual loss of potential output at 2122.7 kgs of walleye.

Adding urgency to this situation, each of the discrete stocks of fish in the study area tend to be biologically unique. As such, they can not be replaced by any other means than themselves. The Strategic Plan for Ontario's Fisheries II (SPOF II) had this to say regarding resource management principles (OMNR 1992d, 12-13):

> Unique genetic material is irreversibly lost when fish populations are reduced or eliminated. This hinders rehabilitation efforts and increases ecological instability.
>
> There is a limit to the natural productive capacity of aquatic ecosystems and, hence, a limit to the amount of fish that can be harvested from them.
>
> Over 95 percent of the fish caught in Ontario are the result of natural reproduction. Most are native species, which have evolved since the last ice age and adapted to the ecosystems in which they live. As a result, they are very predictable, cost-effective to manage,

> and have little risk of failure. These species will continue to form the basis of Ontario fisheries.

Stocking fish in response to increasing demand for fishing opportunities is not considered to be a viable means of increasing the availability of fish or sustaining fish stocks. First, the productivity of a lake in terms of the biomass of fish it can produce annually is fixed by physical factors and cannot generally be increased through stocking. Secondly, the introduction of hatchery fish with a genetic history which differs from that of the fish present in the given fishery can dilute the genetic makeup of the wild stock. This can therefore impact negatively on the biological performance and therefore productivity of the fishery over the long run. SPOF II had this to say regarding stocking fish and the resource management issues currently confronting Ontario's fisheries (OMNR 1992d, 10):

> Stocking hatchery fish can dilute the genetic makeup of wild stocks. It can also displace the gene pool of wild stock with hatchery stock which has less genetic variability and therefore, less ability to adapt to a changing environment.

As such, sustaining the fishery resource is defined as maintaining each discrete stock of fish in the study area above the minimum stock size required for the fishery to persist in a healthy state through time. Therefore, given the apparent distribution of harvesting effort in relation to discrete stocks of fish, it would appear that present patterns of fisheries use are not sustainable.

2.4 MANAGEMENT ORGANIZATION AND OPERATION

In Canada provincial governments are responsible for managing natural resources, including inland fisheries. In Ontario these responsibilities are carried out through the Ministry of Natural Resources (OMNR). It is a large decentralized organization with a staff of approximately 5,000 and an annual budget in excess of 600 million dollars (1993). This section of Chapter Two describes the OMNR's mandate, its organizational structure, and the land use planning process used to deliver resource management, focusing specifically on those components responsible for delivering fisheries management.

Since April, 1989, the OMNR has been undergoing a major reorganization. This reorganization, which is not yet complete, has affected both the structure and function of the OMNR. The organization which is currently in place (May, 1993) will be presented, emphasizing those components which are responsible for delivering fisheries management programs (OMNR 1993a, 1993b). Those elements of the former system which were in part responsible for delivering current fisheries management programs and have since been dropped from the organization will also be identified and described.

2.41 Organizational Structure

The senior office of the Ministry of Natural Resources is held by the Minister of Natural Resources, an elected member of the Legislative Assembly of Ontario. The position is filled by appointment of the Premier, and is responsible for defining and directing the Ministry, its portfolio of policy development and program delivery. The Minister ensures that the OMNR's mandate, policies and programs are in line with the current Government's agenda and that of other Ministries. The present mandate of the Ministry of Natural Resources (OMNR 1991e, 2) is:

> To contribute to the environmental, social and economic well-being of Ontario through the sustainable development of natural resources.

The senior civil servant in the OMNR is the Deputy Minister, who acts in the capacity of Chief Executive Officer. The Deputy is responsible for providing advice to and acting on direction from the Minister, leading strategic planning and ensuring that Ministry policies and programs are responsive to Provincial needs. The Ministry is organized into four divisions; Policy, Operations, Information and Corporate Services. Each division is headed by an Assistant Deputy Minister (ADM) which reports to the Deputy Minister.

The Policy Division leads OMNR's progress towards developing sustainability in the management of Ontario's natural resources by developing policy and programs in a way that is responsive to the province's environmental, social and economic needs. Information resources contributes to the pursuit of sustainable development by providing leadership and service excellence in information resources management through the provision of technology, tools, services, and information products. The Corporate Services Division performs financial, legal, human resource management and administrative functions. The Operations Division is the Ministry's front line organization, responsible for implementing program delivery through a highly decentralized organizational structure with offices located across the province. In short, the Policy Division formulates a management framework within which the Operations Division develops and implements resource management programs. The Corporate Services and Information Resources Divisions provide essential support services to the Policy and Operations Divisions.

The Policy Division is mandated to provide leadership and excellence in defining natural resource policies and programs to accomplish sustainable development. The Division carries out these responsibilities through seven branches and an office of Native Policy. Each branch deals with a specific program area and is responsible for developing policy and legislation, and working in concert with the Operations Division, developing programs and procedures that guide resource management activities in accordance with political objectives. The seven branches are; compliance policy, fisheries policy, corporate policy and planning secretariat, forest policy, lands and waters policy, provincial parks and natural heritage policy, and wildlife policy. Each policy branch is further divided into sections, each responsible for carrying out specific functions related to the branch mandate. The corporate policy and planning secretariat and fisheries policy are primarily responsible for formulating fisheries policy. The compliance policy and lands and waters policy branches also play important supporting roles while the remaining branches exercise an indirect influence through the process of policy formation and integration.

The Corporate Policy and Planning Secretariat (CPPS) provides planning leadership in the pursuit of sustainable development by ensuring the integration of the policies produced in other policy branches. The CPPS branch mandate is to stimulate and facilitate development of integrated, future-oriented policies and plans that will lead to sustainable development of Ontario's natural resources. The branch carries out it's mandate through five sections which are, strategic planning and analysis, policy coordination, planning, policy liaison and economics, trade and intergovernmental affairs. The strategic planning and analysis section focuses on the design and development of the Ministry as well as monitoring the corporate system. The policy coordination section is responsible for developing and coordinating the policy development system. The planning section develops and maintains the land use and integrated resource management system. The policy liaison section identifies and resolves policy operations interface issues, and coordinates multi-program, cross-divisional initiatives. The economics, trade and intergovernmental Affairs section identifies and interprets emerging trends, and external proposals.

The mandate of the fisheries policy branch is the conservation and sustainability of the province's fisheries and aquatic ecosystems. The branch is divided into four sections which are; aquatic ecosystems, fisheries research, sustainable use, and policy development and transfer. The aquatic ecosystems section of fisheries policy is designed to provide the branch with expertise regarding fish communities and their aquatic ecosystems. The fisheries research section is designed to conduct research on fisheries and fisheries ecosystems to provide a solid basis of scientific information on which to base policy development and management strategies. The sustainable use section is designed to ensure that policy ensures human use is sustainable and contributes to the effective functioning of a diverse aquatic ecosystem and a human social system. Finally, the policy interpretation and transfer section ensures that policy is effectively communicated to field staff and the public.

The compliance policy branch is responsible for providing leadership in the development of compliance related policy and planning in support of sustainable development. The branch ensures compliance with the principles, practices, rules and regulations that constitute good conservation management, the constitutional, and other, rights of resource users related to resource use and protection and the public interest. The lands and waters branch provides policy direction, legislation, regulation, program development, and policy interpretation and transfer, for Ontario's public land, water, aggregate and petroleum resources and the conservation authorities. It is worth noting that a reorganization of the policy division has been announced which may consolidate many of the branches and their functions. The actual structure of the policy division is expected to be announced during the summer of 1993.

The professional staff of the policy division is composed of biologists, foresters and geographers. Fisheries and forestry policy branches (staff number in the hundreds) are each complemented by a single economist. Representation of this profession is markedly absent in other policy branches and due to their numbers in fisheries and forestry branches are largely ineffective.

The operations division is responsible for the delivery of resource management programs and policy through five branches and four regions. The branches include aviation flood and fire, forest resources, Greater Toronto area, Great Lakes and operations integration. Aviation flood and fire are responsible for fire and flood forecasting, control and emergency response. The forest resources branch monitors the status of the forest and the forest products industry. The great lakes and the greater Toronto area branches are designed to deal with special issues associated with the respective areas. The operations integration branch provides a single focus for divisional budget management, program analysis, advice and co-ordination, and some special services within the operations division. The regions provide the vehicle through which the Minister translates provincial direction into applied field level resource plans and programs, thereby filling the lead role in the delivery of fisheries management.

The regions (northwest, northeast, central and southern) provide general management and leadership in the areas of resource planning and technology development and transfer in addition to a myriad of support and service functions. Their principal functions are to produce strategic land-use plans for the region, approve area resource management plans, develop and disseminate science and technology applications, operate the provincial parks system and provide emergency response services such as fire. These functions are then further developed by, and delivered through, 27 district offices and 24 area offices on the basis of 136 management areas which collectively encompass the province.

The district and area offices are responsible for delivering field level resource management programs, managing local issues, and providing support and public services. Each district is subdivided into several areas based primarily on ecological considerations. Each area is managed by a multi-disciplinary team which is responsible for collecting and managing natural resource data (monitor state of resource), develop and implement resource management plans, carry out public consultation, issue permits and licences, and provide advice to public enquiries regarding resources. Like the policy division, the professional staff of the operations division (which numbers in the thousands) is comprised of biologists, foresters and geographers. At this time there are no economists working in the operations division.

The last round of strategic land use planning took place before the present regional structure was introduced. Prior to reorganization 8 regional offices carried out these functions through 47 district offices on the basis of program areas which included Fish and Wildlife, Timber, Lands and Waters, Fire and Aviation, Human Administration, Enforcement and Outdoor Recreation. Individual programs were responsible for producing district level resource management plans integrated with the other programs via the district planning team. The fisheries management plans currently guiding resource management activities were produced on this basis.

2.42 Management Process

The OMNR uses a hierarchial land use planning system to manage northern Ontario's natural resources, including fisheries. The planning system translates provincial policies (goals and objectives) into regional policies and targets and then into district targets, actions and processes (OMNR 1986g). The management system is made up of five elements; strategic planning and policy, land use planning, resource planning, work planning and operations, and finally evaluation. The elements are designed to work together systematically to lead to decisions which determine how the organization will run and how goals and objectives will be accomplished.

Strategic planning and policy set out in the broadest terms what the Ministry of Natural Resources is to accomplish, and the process of implementation. The corporate policy and planning secretariat branch (CPPS) of the policy division is responsible for setting overall policy direction consistent with political objectives. This function was most recently preformed with completion of Direction 90's (OMNR 1991e), a policy document released April 1991. This document presented a new set of goals, objectives and strategies to guide the development of policies and programs for resource management into the 1990s, which are:

Goal:

To contribute to the environmental, social and economic well-being of Ontario through the sustainable development of natural resources.

Objectives:

i) to ensure the long-term health of ecosystems by protecting and conserving our valuable soil, aquatic resources, forests and wildlife resources as well as their biological foundations.

ii) to ensure the continuing availability of natural resources for the long-term benefit of the people of Ontario; that is, to leave future generations a legacy of the natural wealth that we still enjoy today.

iii) to protect natural heritage and biological features of provincial significance.

iv) to protect human life the resource base and physical property from the threats of forest fires, floods and erosion.

Strategies:

i) Partnerships in resource management

ii) Valuing natural resources

iii) Improving knowledge base

Subject to the broad direction provided by CPPS, most recently through Direction 90's, the remaining policy branches develop strategic plans in accordance with broad policy direction for their respective program areas. The strategic plans state goals, objectives, guiding principles and strategic management actions essentially, setting the bounds within which resource managers must operate. The fisheries policy branch has twice produced Strategic Fisheries Management Plans, first in 1976 in conjunction with the Federal Department of Fisheries and Oceans, and then again in 1992 with a broad range of government and non-government organizations.

Strategic Fisheries Management Plans lay out an overall goal for Ontario's fisheries resources, objectives which have to be meet in order to achieve that goal, and finally guiding principles which form the foundation for fisheries management. The second Strategic Plan for Ontario's Fisheries, SPOF II, (OMNR 1992d, 11) provided the following goal and objectives for managing Ontario's fisheries resources:

> Goal:
>
> Healthy aquatic ecosystems that provide sustainable benefits, contributing to society's present and future requirements for a high-quality environment, wholesome food, employment and income, recreational activity, and cultural heritage.
>
> Objectives:
>
> i) to protect healthy aquatic ecosystems
>
> ii) to rehabilitate degraded aquatic ecosystems; and
>
> iii) to improve cultural, social and economic benefits from Ontario's fisheries resource.

Although sustainable development was established as the OMNR's fundamental goal and has accordingly been reiterated in the strategic plan for the province's fisheries its definition lacks substance. Sustaining the fisheries requires maintaining the stock size, by fishery, above the minimum level required to ensure successful net annual growth. Development of the fisheries requires conducting economic analysis of the benefits derived from different stock sizes and allocation of the resultant flow of output in order to optimize their contribution to societies welfare. This definition has only been alluded to, demonstrating a clear lack of focus and analytical substance.

Subject to the strategic plans produced by the various policy branches the operations division produces strategic land use plans (SLUPs). SLUPs begin the process of translating broad policy directions into field level resource management actions. They provide a framework for resource planning and\or program direction for optimizing resource use, stating in the broadest terms what is to be done, where, and how. Specific targets are developed for each of the program areas in each district. Local and provincial needs are considered in conjunction with the resource potential of each district, over a twenty year time horizon.

For the purposes of producing SLUPs the province was divided into three planning regions (the northwest, northeast and southern regions). The northwest planning region encompassed the northwest and north central operations regions. The northeast planning region encompassed the northern and northeastern planning region. The southern planning region encompassed the remaining 4 regions. In conjunction, the northwest and northeast planning regions encompass the study area. SLUPs were produced by planning teams composed of regional representatives from the each of the program areas, the regional planning coordinator and a representative from CPPS. CPPS was responsible for integrating the entire process. The process began during the late 1970s and was completed in 1982 with the release of SLUPs for the northwest and northeast planning regions. The southern planning region was unable to produce a SLUP due to the preponderance of private land in southern Ontario. The most recent SPOF II document has not as of yet factored into regional planning initiatives.

The next step in the process is to produce District Land Use Guidelines (DLUGs). DLUGs identify the specific lands and waters and resource management programs and processes required to achieve the targets and objectives assigned to the district by the SLUP. The DLUGs are produced by multi-disciplinary planning teams with district representatives from each of the program areas. The first series of DLUGs were produced in 1983. There are currently 42 approved DLUGs in the province covering 70 percent of Ontario's land mass. Both SLUPs and DLUGs plan land-use and resource management activities over a 20 year time horizon and are subject to a constant process of amendments as new issues and challenges arise.

Subject to the strategic policy directions, regional

SLUPs and DLUGs the districts produce field level resource management plans. These take objectives, targets, location and direction from the land use plan and define in more detail how the resources are going to be managed. The result is detailed plans which describe how the OMNR's field organization will carry out resource management programs. To ensure integration with other resource management plans the district planning team monitors plan development as well, a member from each of the other program areas sits on the planning team.

District Fisheries Management Plans (DFMPs) were produced in the mid 1980s following the release of the DLUGs. The DFMPs outline long term fisheries management direction to the year 2,000 and provides specific 5 year management plans. The five year management plans include management strategies and tactics which will be carried out over the next five years including, a timetable for implementation. The management strategies and tactics addressed, include enforcement, regulation, research and monitoring functions which are carried out by district staff.

Since the publication of the first set of district fisheries management plans, the OMNR has been reorganized (currently an ongoing process). The pre-1991 operations (field) organization, which consisted of 8 regions and 47 districts, has been replaced with 4 regions, 27 districts, 24 area offices and 136 management areas. Further, the program oriented structure of the districts has been replaced with an integrated area approach. Rather than developing program specific management plans for each district, multi-disciplinary planning teams produce integrated plans for each of the 136 management areas. These multi-disciplinary teams will be responsible for producing 5-year integrated resource management plans, and annual work plans, on an area basis however as of June 1993 none have been produced.

Producing work plans is the next step in the land use planning process. They are produced annually, stating what will be accomplished in a given year with the available funds. The results to be achieved and techniques to be used are those defined in the resource management plans. The development of the Ministry's annual work plan begins with the people in each work unit. Proposals for projects to implement resource management plans, given current priorities are submitted to supervisors who then choose what is to be forwarded on up the management hierarchy for approval. The approved work plan is the key link between all preceding planning and the job to be carried out on the ground, otherwise described as the operations. Prior to reorganization these plans were produced by the district program staff and approved by program supervisors. These annual work plans, along with the resource plans, will now be produced by the area teams and approved by the respective area supervisor.

Once operations are underway managers throughout the organization must be assured that plans are executed, commitments met and policies adhered to. To achieve this the Ministry has set up processes for monitoring and assessment. Monitoring is routine reporting and the comparison of planned with actual performance. In addition, managers must be sure that individual employees are contributing their share to program achievement. Towards this end employee performance reviews are carried out by each employees supervisor annually. As well as exercising these routine reviews it is also necessary to periodically conduct program evaluations to ensure the adequacy and continuing relevance of it's objectives, design and results. In theory, the results of monitoring, audit and program evaluation feed back through the system to ensure that appropriate revisions and corrections take place. However, given the vague definition of objectives (sustainable development) and the clear lack of a definitive process to translate these objectives into actions (planning process, a definitive linkage between planning objectives and regulatory actions) this outcome is unlikely.

Finally, over the course of time conditions which provided the foundations or reasons for the development of resource management plans change. When a new issue or problem is identified, a district committee composed of members of the respective area team is formed to investigate the issue and propose a course of action. This recommendation is then approved by the district manager for presentation to the regional management committee for approval. If approved, the proposed course of action is incorporated into the five year work plan.

Although the planning system is intended to translate provincial policies into regional policies and targets and then into district targets, actions and processes this is not the result. There is no clear operational definition of sustainable development or a process for the achievement of sustainable economic development. The economic dimension of the planning system is generally very weak. The following quote (OMNR 1978c, 3) illustrates:

> It is with some trepidation that the Committee profers this report on the allocation of fishery resources, not because we lack confidence in the recommendations we make but because allocation involves social-economic inputs, an area in which this Ministry has not traditionally developed expertise. In this the Committee proves the rule rather than the exception.

This situation has not changed and has resulted in the present situation which can be best described as an ad hoc proliferation and application of regulatory strategies\techniques to achieve sustainable development of the system of fisheries which is itself lacking in analytical substance.

2.5 CONCLUSION

The inland fishery resources of northern Ontario are vast and diverse. Those species present in the study area which are economically significant include, lake trout, brook trout, walleye, northern pike, muskellunge, smallmouth bass, whitefish, crappie, yellow perch, lake sturgeon, and two species of suckers. Collectively, the fishery resource in the study area produces 18,604,000 kgs of fish annually. During 1985, resource users were estimated to harvest approximately 7,701,000 kgs of fish. These estimates indicate that less than half of the resource's annual sustainable yield is being harvested thereby suggesting that resource use (harvest) is not a significant management issue\concern.

In practice however, harvesting tends to be concentrated on particularly attractive fisheries and, due to past patterns of use, many fisheries are underproducing. The productivity and harvest data therefore under-estimate the degree of harvesting pressure on the resource. Adding urgency to this situation, each discrete stock of fish tends to be unique and cannot therefore be replaced once liquidated or otherwise destroyed. Taking these considerations into account, use and management of Northern Ontario's fishery resources has approached a critical juncture, present patterns of resource use do not conform to the tenants of sustainable development.

The Ministry of Natural Resources (OMNR) manages these resources on behalf of the people of Ontario. The stated objective is (OMNR 1992d, 11):

> Healthy aquatic ecosystems that provide sustainable benefits, contributing to society's present and future requirements for a high-quality environment, wholesome food, employment and income, recreational activity, and cultural heritage.

The OMNR is a large decentralized organization which employees an hierarchial land use planning system to regulate resource use. The fisheries policy branch of the Policy Division first formulates a strategic plan for managing Ontario's fishery resources. This policy is then integrated with that of other policy branches through the Corporate Policy and Planning Secretariat (CPPS), also a branch of the Policy Division. The CPPS in conjunction with the regional branches of the Operations division then begin the process of translating these broad directions into field level resource management programs. The Branches deliver these resource management plans through 27 district offices, 24 area offices and 136 management areas.

In viewing the OMNR in terms of the objectives of this thesis, certain preliminary comments are appropriate with respect to fisheries planning and regulation. First, the OMNR staffing is substantial. Expertise is however almost entirely concentrated in biological science with economics largely neglected. The biological strength is obviously necessary but the deficiency in economics is a serious shortcoming. Second, while the OMNR has a planning function, it is based on land-use and lacks focus on economic development and sustainability of the fisheries in analytically significant terms. Third, there is no systematic linkage between the planning function and the regulatory function. These functions need systematic linkage to provide a dynamic for fisheries development and sustainability.

CHAPTER THREE

DEVELOPMENT OF THE FISHERY RESOURCES

3.1 INTRODUCTION

This chapter provides a historical overview of the development and performance of the fisheries in the study area. The first section briefly describes the evolution of fisheries jurisdiction and administration. The next section then provides an account of those who have used the fisheries and how they have been managed. The third section presents a series of case studies which illustrate the performance of the fisheries and identifies the fundamental shortcomings in the regulatory system governing their use. The chapter concludes by summarizing the development and performance of the fisheries, and the fundamental shortcomings in the present regulatory system.

3.2 FISHERIES JURISDICTION AND ADMINISTRATION

Prior to Confederation, the administration of commercial fisheries in Ontario was a secondary responsibility of the Commissioner of Crown Lands for Upper Canada (Department of Fisheries and Environment 1987). At the time of Confederation by virtue of the British North America Act[a] "Sea Coast and Inland Fisheries" came under the jurisdiction of the Federal Government of Canada. In 1868, during the first session of the new Federal Parliament, the Federal Fisheries Act was

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[a]The document which assigned to Canada her constitution.

passed and the Department of Marine and Fisheries, the first of its kind ever to exist, was established. The fisheries act required that all commercial users possess a licence to harvest fish from the waters of Ontario.

The limits of federal jurisdiction over inland fisheries were not clearly defined in the B.N.A. Act and it was not long before several provinces, including Ontario, challenged the right of the Federal Government to enact regulations and collect revenue. Provincial fishery legislation was passed by Ontario and by other provinces, and while this did little to detract from the powers being exercised by the Federal Government, it caused the matter of fishery rights to be taken before the highest courts. In 1898 the Privy Council in London ruled that property rights over inland fisheries and, in consequence, the issue of leases and licences, are vested in the Province. However, Ottawa retained the power to enact fisheries legislation.

With this decision, the Provincial Government entered actively into certain aspects of the administration of inland commercial fisheries. The organization entrusted with newly gained responsibilities was a five man commission known as the Game and Fish Commission. This commission had been created by an act passed by the Provincial Legislature in 1892 but lacked the authority to deal positively with fisheries matters during the first six years of its existence. In 1898, a fisheries branch subordinate to the commission was established to take over Dominion records and documents and the granting of licences. In addition, provincial fishery officers were appointed.

Soon after, Quebec and British Columbia further claimed proprietary rights over not only inland waters but also coastal waters. This question was settled in two further references to the Imperial Privy council in 1913 and 1920. The Privy Council ruled that proprietary fights exist only over inland waters and that the coastal fisheries are public fisheries and no proprietary rights exist therein. As a result of these judgements, it is now settled constitutional law (DFO 1981, 1 - 24) that the Federal Government has exclusive legislative authority over fisheries as such, both coastal and inland, (2) that in non-tidal waters, there is a right of property in fisheries, and that the province, having power to legislate in respect of property and civil rights, may make laws as to the disposal of such fisheries by conveyance, lease, succession, etc. (3) that in tidal waters, there are no rights of property in the fisheries and, therefore, the provincial legislature is entirely without jurisdiction.

In 1926, the Federal Government delegated the administration responsibilities of the fisheries resources to the province of Ontario. Although the provinces had thereby gained most of the responsibilities for fisheries management, Provincial legislation must not contradict or convene existing legislation. The Federal government under section 91 of the BNA, 1867, has constitutional responsibility to provide for the regulation, protection and preservation of all fisheries in Canada however, proprietary rights to the fishery through the ownership (in trust) of the bed of any watercourse has been established in section 92 and 109 of the BNA, 1867, and through various court rulings during the late 1800s and early 1900s to be a provincial responsibility.

The Government of Ontario carried out these responsibilities through the Department of Lands and Forests from 1926 through 1972. The mandate of the Department (ODL&F 1970, 3) was:

> To provide from Crown lands and waters, and to encourage on private lands and waters, a continuing combination of renewable resource production and outdoor recreation opportunities most consistent with the social and economic well-being of the people of Ontario.

The Department's mandate has evolved over time in response to changing public and professional attitudes to resource management. In 1973, the Department of Lands and Forests was replaced by the Ministry of Natural Resources, which continues to manage northern Ontario's fisheries today (OMNR 1993, 3). The new Ministry's mandate (OMNR 1974, 1) was:

> To provide from Crown lands and waters, and to encourage on private lands and waters, a continuing combination of renewable resource production and outdoor recreation opportunities for the social and economic well-being of the people of Ontario.

This mandate continued to evolve with the passage of time. Today, the mandate of the OMNR (OMNR 1991a, 3) is:

> To contribute to the environmental, social and economic well-being of Ontario through the sustainable development of natural resources.

3.3 FISHERIES DEVELOPMENT

This section provides an overview of the development of the fishery resource. Fisheries resources have been used, and therefore valued, since before the arrival of the first Europeans in North America. Native groups used fish as an important source of food, cultural reaffirmation, and for barter. With European settlement of the new world, the fishery resource first became an important commercial good and then later, as the population and it's affluence grew, gained prominence as an input into the production of recreational opportunities. Fisheries development, or more specifically the control of resource use became increasingly complex, and urgent, as new user groups emerged and aggregate resource use increased. Free access, as the initial basis for public policy governing fisheries use was gradually replaced with managed access.

3.31 The Early Fisheries

Natives were using fish as an important source of food and barter prior to the arrival of the first Europeans.

Although native people participate in all aspects of fisheries use, the term native fisheries will be used here to refer to the traditional subsistence fisheries to which native people have special rights. Subsistence use describes native harvesting of fish for personal consumption. Pearce (1988) stated that:

> Most of the aboriginal land in Ontario has been surrendered by written treaties. In general, the treaties covering southern Ontario do not make reference to the taking of fish and game on the surrendered land. Those in northern Ontario contain terms that provide Indians with the right to hunt and fish over the unoccupied portion of the surrendered land.

Natives have therefore retained the right to largely unrestricted access to hunt and fish for subsistence purposes throughout the study area.

Fisheries were also an important food source for the early European settlers (Department of Fisheries and Environment 1987). By the 1860s due to the influx of permanent settlers in both Ontario and the United States, along with improvements in nets and the storage of winter block ice for use during the summer, a commercial food fishing industry developed. Profit seeking fisherman began harvesting fish for sale in retail markets locally and in the north-eastern United States. The profit derived from fishing and therefore the demand expressed for fish by commercial fisherman is a function of the revenues derived from sale less the costs of production.

A typical commercial fishing operation in the study area consisted of an individual harvesting fish with the use of gill nets and in some instances pound nets. This has changed little over the course of time. Today, during the summer, fish harvesting is carried out primarily by gill netting from skiffs less than 20 feet in length. These are normally operated by one man capable of a daily production of up to 200 pounds per day depending on time fished, number of nets set and number of lifts per day. During the winter, fish harvesting through the ice is carried out as well, with a snowmobile providing the usual means of transportation.

Initially, the fisheries resource was considered to be plentiful, almost limitless, and user groups other than commercial food were negligible in terms of numbers and harvest. Commercial fisherman therefore received pervasive and largely unrestricted access to fisheries resources although, records indicate that by 1903 (OMNR 1989a, 1991c) it was common practice to refuse new licences. The report of the Committee on Modernizing Ontario's Commercial Fishery (OMNR 1982a, 8) stated:

> In an effort to ensure that societal benefits resulted from the allocation of the fish resource, government has limited the number of licences issued to that which it deemed the resource could provide with acceptable economic returns. There has never been any recognizable formula for determining this number nor any public data upon which to base what must always have been a "judgement call". Generally, it has been popular to issue additional licences when this seemed

> possible but efforts to reduce the number of licences has always been meet with unpleasantness."

The earliest available records indicate that in 1872, commercial fisherman harvested 500,000 lbs of fish in the study area (OMNR 1974b, 19). Total commercial harvest gradually increased to a peak of 8,234,136 lbs of fish in 1960 (ODL&F 1961, 131). Harvest has since tapered off to 1,713,719 lbs (OMNR 1990b, 1) due to a combination of market conditions, allocation reductions, aboriginal activity to improve living conditions and eroding fish stocks (pers comm. John Tilt, OMNR).

3.32 The Mature Fisheries

Following World War II, an increasingly affluent and numerous population began recreational angling. Recreational anglers are utility maximizers who use or consume fish as an input into the production of recreational opportunities. The activity can be described as an individual taking a fishing rod and reel, possibly complemented by a boat, going to a fishery and then catching fish. The utility derived from resource use depends on a multitude of factors. A survey of anglers in Ontario conducted by the OMNR in 1985 (OMNR 1988j, 8) found that water quality was considered to be the most important resource attribute by 14.6% of anglers, beauty of surroundings by 13.6%, escape routine by 11.4%, weather conditions by 11.2%, privacy by 9.1%, access to wilderness by

8.8%, species desired by 7.9%, wild fish by 7.3%, number of fish caught by 6.8%, size of fish caught by 6.7% and as a source of food by 2.6%.

The number of angling licences sold to non-resident anglers increased from 89,291 in 1944 (ODL&F 1968, 27) to 622,117 in 1985 (OMNR, 1990f, 5-2)[4]. Similarly, the number of angling licences issued to resident anglers increased from 562,604 in 1969 (ODL&F 1972, 5) to 1,019,960 during the fiscal year 1991-92 (pers comm. Rob McGregor OMNR)[5]. Further, the observed growth in the number and\or popularity of recreational angling is expected to continue. The OMNR (OMNR 1980b) had this to say regarding the anticipated growth in recreational angling:

> A 20 percent increase in angling demand is anticipated by the year 2000.

A commercial recreational user group evolved simultaneously along with the interest in recreational angling. The commercial recreational user group consists of tourist operators which actively market angling opportunities or otherwise provide support services to recreational anglers. A typical operation can be described as a lake side resort which provides food, lodgings, angling equipment such as boats and motors and guiding services to recreational anglers.

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[4] This estimate includes both active and inactive licences. For example, in some cases a spousal licence may be purchased and only one marriage partner will angle.

[5] Unpublished OMNR Statistical Report 1991-92.

Earliest records indicate that in 1936, 427 tourist outfitter camp licences were issued in Ontario. This gradually increased to 660 in 1945 and then jumped to 1,068 in 1947 (ODL&F 1953, 20). Today there are an estimated 1200 licensed tourist outfitters operating in the study area (pers comm. Bob Ridge OMTR).

Cunningham (1985, 269) attributed the growth in the popularity of recreational angling to increased leisure time, personal disposable income, mobility, population and urbanization, levels of education and a changing appreciation of the value of recreation, specifically in a natural setting. The following quote taken from Pearce (1989, 11) characterizes the development of this activity in Canada:

> The most significant increase in fishing during the last 20 years has been in the recreational fisheries. There are no limits on the number of licences issued. This open-endedness of fishing pressure is a major problem. The popularity of fishing in an increasingly affluent population has been compounded by improvements in access to fishing places through the opening of remote areas by highways and forestry and mining roads, the development of better and cheaper off-road transport by all-terrain and snow vehicles, and improvements in air travel. Technical improvements in fish-finding and fish-catching gear, widely advertised and adopted, have further increased the effectiveness of fishing pressure. Up to now, little effort has been made to control the growing number of sport fisherman. Instead, the effort has been directed at controlling catches by reducing bag limits and making fishing regulations more stringent, but with only limited success.

Following WWII, the operation of fisheries had therefore evolved into a multiple use problem. Distinct user groups had emerged which required a different accounting of the economic benefits derived from fisheries use. The Department of Lands and Forests controlled fisheries use through a hierarchial management framework. Control was exercised across all user-groups, with the exception of natives, primarily through the issuance of licences which define the terms under which the harvesting of fish could be conducted. With respect to recreational anglers this included daily catch and possession limits, size limits, access availability, and restrictions on angling techniques. These restrictions varied (to the present) by species and location across the province and were introduced on an incremental basis as allocation issues, generally unsustainable levels of harvesting, developed. Commercial fisherman were controlled in terms of the area they were licensed to fish, the gear they could use, and in some instances quotas by species. Commercial recreational users were controlled via the issuance of land-use permits.

In 1972, when the OMNR replaced the Department of Lands and Forests it proceeded by developing an integrated land use planning system to manage the province's natural resources (OMNR 1993, 3). The land use planning system translated provincial policies into regional policies and targets and then into district targets. The planning system culminates with District Fisheries Management Plans which provide five year management plans. These management plans lay out the management strategies and tactics which will be carried out over the next five years including a timetable for implementation.

3.33 Present

During 1985, OMNR undertook a survey of angling activity across the province. This in conjunction with incidental and external reports can be used to provide a comprehensive, albeit approximate, estimate of the current dimensions of fisheries use by user group and the methods used to control their use. In 1985 approximately 225 licensed commercial food fisherman (pers comm. John Tilt, OMNR) harvested 1,566,260 kgs of fish with a landed value of $2,076,255.00 (OMNR 1985c, 1). By 1990 however, the number of licensed fisherman had declined to 150, located primarily in the Northwest region, harvesting 1,713,719 lbs of fish with a gross landed value of $1,269,315.57 (OMNR 1990b, 1). Table 4 breaks this harvest down by species:

Table 4.

Commercial Food Industry Harvest in Northern Inland Water Bodies, 1990, in lbs

Species	Harvest lbs	Gross Value
Burbot	22,800	2,453.76
Black Crappie	9,237	19,505.50
Lake Herring	193,662	39,624.76
Lake Trout	1,136	1,224.00
Lake Whitefish	528,154	381,369.92
Northern Pike	168,334	127,597.90
Sauger	110,558	143,716.40
Lake Sturgeon	21,060	63,488.42
Suckers	385,029	76,273.64
Walleye	227,271	334,329.93
Smallmouth Bass	439	309.30
Yellow Perch	45,834	68,742.00
Caviar	89	10,680.00
TOTALS	1,713,719	$1,269,315.57

Source: OMNR 1990b, 1

In 1984 in response to a general recognition that the current licensing system used to control harvest by commercial food fisherman was inadequate, the OMNR introduced a quota system across Ontario (OMNR 1990c, 1991d). The quota system attached quotas measured in terms of weight, by species, to each licence. This provided a means through which the OMNR could control resource use by this user group. In 1986, a willing-seller willing-buyer program was then introduced.

This program restricted commercial fisherman from selling their commercial quotas to anyone outside of their immediate family. If a commercial fisherman wished to retire, the government (OMNR) may purchase the licence from the commercial fisherman at twice the present market value of one year's quota plus the market value of the fishing equipment. Restrictions on the type and quantity of gear a commercial fisherman can use have been maintained.

The catch and harvest by resident anglers was reported in terms of the numbers of fish caught and kept, not weight. Further, the data includes those fish harvested and days angled on the Great lakes directly adjacent to the study area. The data are not therefore directly comparable to the data describing resource growth or commercial food harvests. Nonetheless, during 1985, 515,000 resident anglers angled in northern Ontario for 7,097,000 days for an average of 12.3 days per angler (OMNR 1990f, 4-20). Of this activity 10.5% took place in the Northwest region, 15.9% in the North Central region, 16.0% in Northern region and 57.0% in the North Eastern region. Resident anglers caught and harvested a total of 27,648,000 fish in the study area[6] (OMNR 1990f, 4-31). Of this, 6,949,000 were walleye, 6,511,000 were smelt, 4,239,000 were northern pike, 3,704,000 were perch, 2,335,000 were brook and lake trout, and 1,800,000 were smallmouth bass. The

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[6]This includes angling conducted on Lake Superior and Lake Huron.

remaining 2,100,000 fish harvested were a combination of largemouth bass, muskellunge, panfish, salmon, rainbow trout, whitefish and other.

During 1985, 429,000 non-resident anglers spent 3,133,000 days angling in northern Ontario, 1,170,000 days in the northwestern region 481,000 in the north central, 252,000 in the northern, and 690,000 in the north eastern (OMNR 1990f, 5-8). The origins of these anglers were 15.0% Ohio, 14.9% Michigan, 12.6% New York, 9.9% Pennsylvania, 8.7% Minnesota, 6.8% Wisconsin, 5.9% Manitoba, 5.8% Illinois, 3.6% Indiana, 3.6% Iowa, and 12.8 % other (OMNR 1990f, 5-55). Non-resident anglers caught and kept 24,094,000 fish in the study area(OMNR 1990f, 5-27). Of this, 10,128,000 were walleye, 7,049,000 were northern pike, 3,331,000 were perch, and 1,800,000 were smallmouth bass. The remaining 1,786,000 fish harvested were a combination of largemouth & smallmouth bass, muskellunge, panfish, perch, lake brook and rainbow trout, salmon, whitefish and other.

As of 1992, the licensing system is the principal vehicle through which use (harvest) by recreational anglers is controlled, although regulations specific to individual fisheries such as sanctuaries, limits and reduced seasons are applied across the province via the land-use planning process. Angling licences, and therefore the terms contained therein, are differentiated across anglers based on residency status; resident, Canadian resident and non-residents of Canada (OMNR

1991b). A resident is defined as a resident of Canada who has lived in Ontario for seven months or longer. Resident anglers must possess a licence to angle unless they are under 18 years of age, over 65 years of age, disabled or a status Indian. Licences are issued for one year or for 4-day periods, costing $11.50 and $6.50 respectively.

A Canadian resident is a person who has resided in any part of Canada outside the province of Ontario for a period of seven consecutive months during the twelve months prior to the time the licence is purchased. A Canadian resident must have a licence unless they are under 18 years of age and are angling with a licensed family member, and if so, any fish caught and kept are part of the possession limit of the person who holds the licence. Licences are issued for 4-day or one year periods. Seasonal licences cost $23.00 per year and 4-day licences cost $16.25 per year. Further, special tags must be purchased in addition to the licence if a non-resident Canadian wishes to angle for trout or muskellunge. These additional tags cost $6.50 a piece.

Non-residents of Canada are subject to the same terms and conditions as Canadian residents with the exception of licence fees. Licences are issued for 4-day, 21-day or one year periods. Seasonal licences cost $34.00, 21-day tags cost $28.75 and 4-day licences cost $16.25 per year. Daily tags are required in addition to all other non-resident licences for non-residents of Canada who depart each day from an origin outside of Canada.

Control is now exercised over the establishment of new tourism facilities catering to recreational anglers on Crown land, via the issuance of land use permits as determined through the OMNR's land-use planning process. No control however is established on the expansion of existing facilities or the establishment of facilities on private land.

In 1985, the native people of Ontario harvested 842 tonnes or approximately 842,000 kgs (Pearce 1988, 77) of walleye, northern pike, and whitefish, with incidental catches of lake trout and sturgeon. This figure covers all of Ontario and is therefore greater than native subsistence harvesting in the study area. By subtracting the harvests of the other three user groups from the total harvest reported by the DFMPs the residual, which is 18,825 kgs, should reflect the relative magnitude of this user group's harvest in the study area. Native harvesting for subsistence use is presently unrestricted. Use of fisheries resources for uses other than subsistence harvesting is subject to the same restrictions as placed on the general population.

Providing an accurate statement of the relative dimensions of resource use in terms of harvest across user groups is therefore difficult because, the harvest by recreational anglers is reported in terms of numbers of fish caught and not weight, and estimates include some angling activity conducted on the Great lakes. By subtracting the harvest estimates provided for commercial and subsistence fisherman from the total harvest estimates provided in Tables 2 & 3 and then dividing the remaining harvest between resident and non-resident anglers based on the reported numbers of fish caught a relative estimate of harvest across user groups can be derived. Resident anglers would therefore have harvested 6,085,770 kgs of fish and non-resident anglers 1,559,040 kgs. Overall therefore, in 1985 commercial food fisherman represented 16.7% of the fish harvested in the study area, commercial recreational fisherman 16.9%, recreational fisherman 66.1%, and native subsistence 0.2%.

Finally, in terms of expenditures, resident anglers spent $109,118,000.00 in the study area in part for the purpose of angling (OMNR 1990f, 4-55) and $29,456,000.00 on package sport fishing trips (OMNR 1990f, 4-54). At the same time, non-resident anglers spent $189,241,000.00 in the province in part for the purpose of angling (OMNR 1990f, 5-54) and $57,567,000.00 specifically for package sport fishing trips (OMNR 1990f, 5-8). Since 57.5% of the non-resident angling in the province was conducted in the study area (OMNR 1990f, 5-8), it would be reasonable to assume that non-resident anglers spent $108,813,000.00 in part for the purpose of angling and $33,101,025.00 on package sport fishing trips in the study area. Moreover, given that the more expensive angling trips, such as fly-in trips, would be concentrated in the remote areas of the province, one might expect these figures to be marginally higher.

3.4 FISHERIES PERFORMANCE

Public policy governing the use and development of the fisheries has evolved over time along with the demands placed on the fisheries. During the initial years of exploitation, due to the tremendous productivity of the resource relative to demand, free access characterized public policy towards fisheries. Over time, as demand increased, managed access replaced free access in order to control demand such that the fisheries would be sustained and continue to provide a contribution to society's welfare. This section of the chapter presents and discusses a series of case studies which illustrate the extent to which these objectives have been met.

3.41 Case Studies

Although the fishery resource's aggregate productivity has always exceeded use, the basis for public policy has been free access. This has allowed effort to be concentrated on the most attractive fisheries frequently leading to degraded if not collapsed fish stocks. Although data describing historical use is limited, evidencing the degree of control which has been absent from fisheries management, the Lake of the Woods sturgeon fishery at the turn of the century provides a documented example of the consequences of largely unregulated exploitation of a large standing stock of commercially valuable fish.

The commercial fishery for lake sturgeon was established on the south basin of Lake of the Woods in 1892 on both the American and Canadian sides of Lake of the Woods (OMNR, 1989e, 1991c). The fishery developed rapidly on both sides of the border, although the American fishery consistently accounted for two-thirds of the total catch. Sturgeon harvests peaked at 809,600 kgs in 1893 and 806,000 kgs in 1895. Within a decade, 1893 - 1903, total annual harvests had declined by over 95%.

No gear restrictions, other than a prohibition on the use of gill nets, governed the American fishery until 1895. At this time, regulations were introduced which limited the number of pound nets to 50 per fisherman. The Canadian fishery was restricted from the beginning to 1 pound net and 914 m of gill net per licensee. In response to fluctuations in harvest success in 1911 the number of pound nets American fisherman could use were reduced to 25 and by 1925 to 5. Canadian fisherman on the other hand were allowed to utilize an additional 5 pound nets per licensee.

Annual harvests continued to decline to the point that a sturgeon fishery was virtually non-existent by the 1930s. It was recognized early in this century, that the collapse of the sturgeon fishery in Lake of the Woods was chiefly due to overfishing. OMNR, (OMNR 1988e, 51) stated that:

> The rapidity and magnitude of the decline of this sturgeon population is evidence of the effects of a largely unregulated fishery on the large unexploited standing stock which was present in Lake of the Woods.

and (OMNR 1991c, 1) stated that:

> The dramatic decline of lake sturgeon in this area was primarily due to overfishing, although pollution of spawning areas and other critical habitat on the Rainy River downstream from pulp and paper mills at Fort Frances-International Falls probably prevented subsequent recovery.

The licensing system governing commercial fisheries did little to ensure commercial fisheries would be sustained. Licences did not place an upper limit on the quantity of fish which could be harvested from a specific fishery. Rather, restrictions were placed on the number of commercial fisherman which could harvest fish from a given fishery and on the type and quantity of gear which could be used. By reducing the efficiency of the fisherman enough, this would effectively limit harvest to sustainable levels. These restrictions did not however take into account the effects of increased prices or reduced costs on equilibrium levels of output. For example, the Shoal lake walleye fishery located on the Ontario Manitoba border approximately twelve miles north of Minnesota, was recently (1979a) harvested to biological collapse following changes in the economic profitability of harvesting fish (OMNR, 1988i, 1987j, 1985a, 1981a, 1980a, 1979a).

The commercial fishery was first established on Shoal

Lake in 1899. The fishery was divided into seven areas each licensed to a commercial fishing operation. The commercial fisherman were restricted only by the type and quantity of gear which could be used, no direct limit was placed on the quantity of fish which could be harvested. Total commercial harvests were thought to be within the biological capacity of the resource until 1959. At that time, road access to Shoal lake was established. This greatly reduced the industry's transportation costs which were previously much higher due to the necessity of having to transport the fish by water to Kenora. This along with increasing prices for walleye increased profitability and therefore sponsored a dramatic increase in the commercial harvest.

As early as 1961 Ontario OMNR officials had evidence that Shoal lake was being overharvested and the fish community destabilized. However, the Ministry had no tangible evidence to prove its suspicion and it was evident that none of the commercial fisherman were in agreement. The commercial fishery therefore continued to operate at it's current status. Ryder's morphoedaphic productivity index, published in 1965, was first used to the estimate potential yield of Shoal Lake in 1969. The estimate was only approximate but over fishing was clearly evident. By 1974 a contour map was completed and more accurate productivity estimates derived. It was then clear that Shoal Lake was being and had been overharvested since at least 1959. The OMNR study of Shoal Lake in 1979, had this to say (OMNR 1979a, 1):

> This translates into 276,660 lbs. of annual fish yield for Shoal lake. At 1/3 to percids, 92,220 lbs. are allotted to walleye. ... Average annual commercial Shoal Lake walleye harvest alone has been close to double that during the decade from 1959 to 1967 (173,800 lbs.) and (156,600 lbs.) during the last decade 1968 to 1977.

The continuing decline in fish stocks, particularly walleye led the OMNR to institute a quota system on the commercial fishery in 1979, five years prior to their general introduction across the inland lakes of northern Ontario (the study area). The quotas were based on historical harvest levels and were to be reduced annually until harvests were brought in line with maximum sustainable yields. Both walleye and northern pike were subject to the quota restrictions. Unfortunately, continued destabilization and eventual collapse of the walleye stock finally forced the OMNR to close the walleye fishery to both commercial and recreational fishing in 1983. As of 1993 the Shoal Lake walleye fishery has not recovered and may, even with the complete elimination of walleye harvesting, continue to be declining (pers comm. Val Macins, OMNR).

Resource managers therefore had established the means to control resource use by commercial food fisherman by 1984. However, during the years following World War II, recreational angling grew dramatically in popularity, confounding efforts to control aggregate resource use. To the extent that commercial food harvesting pressure was controlled and reduced, harvesting by recreational user groups increased to maintain or actually increase total harvesting pressure placed on northern Ontario's fishery resource.

Eagle Lake provides a documented example of a fishery which has been harvested to the point of biological collapse due to incremental increases in harvesting pressure by recreational and commercial recreational user groups during this period, in the absence of a commercial fishery. Eagle Lake (OMNR 1986d) is a large (27,691 hectares) and commercially important fishery located in northwestern Ontario approximately 80 miles north of the Ontario Minnesota border and 70 miles east of the Ontario Manitoba border. A commercial food fishery operated on the lake from 1924-41. The annual walleye harvest was 25,834 kgs per annum, marginally below the maximum annual allowable yield for the lake of 26,600 kgs, lake trout were also harvested 10% above their maximum allowable yield of 1,600 kgs per annum. The commercial food fishery was closed in 1942, and reopened in 1950, restricting harvest to lake whitefish.

The closure of the commercial food fishery coincided with the development of a sport fishery although, there is no official record of the sport fishery prior to 1973. In 1973, the commercial recreational industry expanded from the northwest portion of the lake, to the central and southern areas. According to the Ministry of Tourism and Recreation lodge and commercial camp facilities continued to expand between 1980 and 1985 by increasing capacity 25.8% and occupancy by 10%. Today, the annual harvest of walleye is 61,397 kgs of which, commercial food fisherman account for 2.2% of the harvest, local residents 13.4%, Ontario residents 3.8%, Canadian residents 1.9% and residents of the United States 78.7%. The harvest of lake trout is 3,190 kgs of which commercial food fisherman account for 3.6%, local resident 8.0%, Ontario resident 4.0%, Canadian resident 2.0% and resident of the United States 82.0%.

Two discrete walleye stocks have been identified on the lake. The larger of the two has been subject to study, the population monitored via creel surveys in 1972, 1979 and 1985. Biological indicators effectively measure whether a fish stock is stressed, with walleye stocks this includes increased growth rates, lower mean age and age to maturity and a declining mean size per fish. In 1972, the mean size of a walleye caught was 0.97 kgs, declining to 0.71 kgs in 1979 and 0.37 kgs in 1985. To summarize, the OMNR (OMNR 1986d, 16) had this to say about the fishery:

> Currently walleye are harvested at 117% above maximum allowable yield... this allowable yield has been exceeded to varying degrees for the past 60 years.. The yield of walleye at this level of exploitation can not be sustained. Therefore the walleye harvest must be reduced toward the target yield and spawning populations protected.. and rehabilitated.. to sustain this fishery over the long term."

The lake trout population has not been studied since 1972 at which time (OMNR 1986d, 26):

> a small population with a high proportion of older individuals existed. The mean age of lake trout sampled was 12 years and mean weight 4 kg. (8.8 lbs.). The fact that no young fish were caught may indicate low recruitment".

Fisheries management had become more complicated. Not only were incremental increases in harvesting pressure deteriorating the sustainability of the fisheries but the evolution of multiple user groups introduced new questions regarding the allocation of limited fisheries output. Fisheries managers had to determine the allocation of output not only within user groups but also across user groups of disparate nature.

Rainy Lake provides a thoroughly documented example of a fishery which has been harvested to the point of collapse and the management problems associated with a multiple use setting (1992a, 1991a, 1990e, 1989a, 1988f, 1987k). The lake is located on the Canada-U.S. border between northwestern Ontario and north-central Minnesota. It covers approximately 92,050 hectares of which 75% lie within Ontario and 25% in Minnesota. It supports a warm water fish community dominated by yellow pickerel, northern pike, lake whitefish and smallmouth bass. Three geographically distinct basins, the North Arm, the South Arm and Redgut Bay form the lake. Each basin supports a discrete fish community requiring individual management.

Accounts of early exploration reference extensive fish harvests by local Indian bands (IJC 1917). Commercial fishing for lake sturgeon was an important source of income for local residents as early as 1885. Following the rapid demise of the Lake's Sturgeon fishery, yellow pickerel and whitefish began to dominate the catch. Recreational anglers were reported to use the fishery also as early as 1890. This activity began to expand rapidly during the 1930s and sometime during the 1950s recreational angling overtook commercial fishing as the single largest use of the fisheries aquatic resources. A tourism industry developed between 1940 and 1960, with 22 individual tourist camps operating today. Recreational angling has however continued to grow, between 1970 and 1986, the number of angler days on the lake increased by approximately two and one-half times.

As the fishery has developed, the fish communities making up the lake began to destabilize and decline. For example, in the North Arm, during the early 1960s walleye abundance declined severely and rapidly. The representation of walleye in commercial landings declined from 9.8% by weight in 1965 to an alarming 3.2% in 1988. The Redgut Bay walleye fishery also followed a similar pattern of decline. The decline of important fish species in Rainy lake is most likely a result of several factors including habitat alteration and species interactions. However the OMNR (OMNR 1992a, 24) stated that:

> Overharvest, past and present, remains the most likely reason for the observed changes in stock and community status of walleye.

The need to reduce harvest levels, particularly walleye had become apparent by the late 1960s. In an effort to stabilize and subsequently rehabilitate the fish communities, walleye quotas were imposed on the commercial fishery. They were introduced in Redgut Bay in 1970, in the North Arm during 1971 and in the South Arm during 1986. The willing-seller willing-buyer program was also introduced in 1986. The commercial food industry was thereby reduced from 25 individual fisherman harvesting 25 licensed areas to 3 individual commercial fisherman harvesting 5 licensed areas possessing only one walleye quota. OMNR policy is to reduce the commercial harvest of walleye to zero (OMNR 1988f).

Elimination of the commercial harvest of fish from the fisheries alone has not however reduced harvest of target species to the desired levels. Regulation to control recreational angling harvest has included introduction of the DAVT in 1985 to reduce harvest by the non-resident segment of the angling user group. Maximum size limits for walleye and pike have also been introduced to protect the breeding segment of the stock, as part of a Northwestern Region initiative, in order to enhance the productivity of the remaining stock. Catch and release angling and alternative species have also been promoted via the promotion\education of angler ethics. Finally, the expansion of the tourism industry in Ontario has been limited by controlling the disposition of Crown Lands.

Despite these efforts to reduce harvest, the Rainy Lake fishery in general has continued to destabilize and the benefits derived from its use have declined. The tourism industry has depreciated and there are an increasing number of conflicts across and amongst user groups over fisheries allocation issues. A recent analysis of the Rainy Lake fishery (OMNR 1992a, 24) described the status of the fisheries as follows:

> Some indigenous fish stocks, particularly walleye are in a state of decline (Wepruk 1981; Yeager et al 1984; OMNR 1984; Mcleod 1988; OMNR 1988; Meritt & McLeod 1989; OMNR 1991; OMNR in prep.) On the north arm, walleye, cisco and whitefish have declined dramatically and are now poorly represented in the fish community. In Redgut Bay walleye are stressed, cisco have declined and northern pike seem to be declining slightly. On the South Arm, cisco have declined and indications are that the walleye harvest cannot be sustained at current levels. A continuation of these trends will result in a further loss of fish community stability, and a decrease in the contribution these fisheries make to the well-being of local residents and the Ontario economy.

The Clearwater Bay lake trout fishery on Lake of the Woods provides a documented example of the effects of an increasingly large and mobile group of recreational anglers on an attractive fishery. Clearwater Bay is a 9,900 hectare oligotrophic body of water which comprises the northwestern most corner of Lake of the Woods. It was a moderately exploited fishery until the late 1970s when it become public knowledge that the fishery routinely produced trophy sized lake trout, frequently exceeding 30 pounds (OMNR 1987a, 1989b). Harvesting pressure subsequently skyrocketed from 4300 man-hours in 1982 harvesting 800 kgs (1800 lbs.) to 15,500 man-hours in 1987 harvesting over 2400 kgs (5300 lbs.). The fisheries maximum sustained yield of lake trout is 1150 kgs. During the 1986 and 1987 winter ice fishing seasons, the entire maximum sustainable yield from the fishery was harvested within the first three weeks. Further, between 1982 and 1987 the mean size of the fish harvested declined from about 5 kgs (11 lbs.) to less than 3 kgs (6 lbs.), indicating that the fishery was indeed stressed and was at risk. In the words of the OMNR (OMNR 1987a, iii):

> Continued overexploitation and deterioration of lake habitat will likely result in the loss of this naturally reproducing population.

The utility derived from angling on the Clearwater Bay fishery was great enough to continue to attract more harvesting pressure than the fishery could sustain even though angling quality was declining. As given in the 1989 "Clearwater Bay Lake Trout Strategy" (OMNR 1989b, 5):

> By 1987, the number of local residents of Ontario had not changed appreciably but they now represented less than 45% of all anglers, while Manitoba and American fisherman comprised 35% and 20% of the total, respectively.
>
> Anglers were being drawn from as far away as 400-500km to the Clearwater Bay area by its growing reputation as a trophy lake trout producing area.

The winter lake trout fishery was therefore closed in 1990, and a limited number of tags (100 per year) were made available annually to anglers in subsequent years via a draw. The 100 tag restriction was intended to provide a sustained trophy fishery for anglers to enjoy and further, serves to underscore the need for quality sensitive fisheries management.

Another common overharvesting scenario resulting from an increasingly mobile and numerous recreational angler user group is the rapid drawing down of newly accessed fisheries. The OMNR will, for example, create an access road into a wilderness area, usually for timber or mineral extraction, which provides access to previously inaccessible lakes. These lakes will typically support large standing stocks of fish (high quality fisheries) due to their remote location and therefore previously limited use. The high net benefit available per unit effort offered by these fisheries will attract the attention (harvesting pressure) of recreational anglers. Additional anglers and angling effort will continue to be attracted to the fisheries as long as they provide a higher net benefit per unit of effort than that offered by other fisheries. If harvesting cost and therefore the net benefit derived is insensitive to stock density, the fisheries may be harvested to the point of biological collapse, let alone to the welfare optimizing stock size.

An example of this scenario was documented when the Detour lake road was developed in the OMNR's Cochrane district, of the northern region (OMNR 1990d, 1984a, 1983b).

The road was extended in 1981 providing access (within 300 meters) to four lakes which were previously fly-in lakes supporting commercial recreational outpost camps. The OMNR set up a monitoring program to assess the status of the fish communities (principally walleye and northern pike) in the affected lakes because (OMNR 1983, 1):

> The developed road will provide angler access to many previously fly-in lakes, greatly increasing angler pressure and harvest and possibly resulting in overexploitation of the desirable fish species and changes in fish community composition.

The Ministry reviewed a variety of management options to control the expected increase in harvest which included, access control, seasonal closures, quota or limit restrictions, size limits, gear restrictions, and population manipulation (stocking). Each technique was evaluated in terms of its public acceptability and ability to maintain a high quality fishery. Size limits were chosen as the preferred technique because it was felt that shielding that segment of the population principally responsible for reproduction would have the best chance of maintaining fisheries quality and would be subject to the least public opposition. An assessment of the slot limit regulation imposed on the Detour lake road in 1990 (OMNR, 1990d) had this to say about the success of the slot limit regulation:

> We have not been able to support our hypothesis that a slot regulation will maintain stable CUE values. ... The decrease in the CUE:HUE ratio noted after road access may reflect the increased proportion of local anglers using these lakes.

If a predetermined limit had been placed on the newly accessed lakes, thereby preventing overharvesting, road access would have represented a benefit to the fisheries. Access reduces the cost of using the fisheries thereby increasing the benefit derived from their use, as evidenced by the increased demand for use of the fisheries following the provision of road access. However, because a predetermined harvest limit is not placed on these fisheries the increased demand for their output (fish) will often precipitate their degradation and possibly destruction (collapse). In consequence, the OMNR therefore frequently directs resource access roads away from fisheries to prevent access and\or destroys and allows roads to prematurely deteriorate.

Finally, the deterioration of fisheries leads to a reduction in the welfare derived from their use. A clear example of this welfare loss is illustrated by the effect of a deteriorating fishery on the value of a tourist operation predicated on its use. The value of a commercial operation is measured by its sale value. As the quality of the fishery on which the tourist operation is predicated declines so to does the utility derived by recreational anglers from its use. This in turn reduces their willingness to pay for an angling opportunity at the given operation and thus the value of the operation. The welfare loss incurred as a result of a fisheries deterioration is therefore reflected in markets.

Gammon Lake is located in the Woodland Caribou Provincial Park on the Manitoba Ontario border approximately 65 kilometres north of the Canada U.S. border. A fly-in tourist operation is located on the lake which markets angling opportunities to recreational anglers. During 1985-86, the OMNR investigated the fishery. They found that:

> 1. abundance (of walleye) was low, reflected by poor catch per unit of effort (CUE) data;
>
> 2. individual fish growth was the fastest in the park data set for ages 2-10 years and the second fastest for ages 11-19 years;
>
> 3. extremely low abundance of fish older than 10 years old.

The OMNR subsequently concluded that these data and others suggested that walleye had exhausted their ability to maintain their position in the Gammon Lake fish community. Creel information also indicated that although the number of guests staying at Gammon Lake was the third highest in the park, which included three mainbase camps, anglers spent a disproportionate amount of time fishing other lakes near-by. The OMNR concluded that this may be a result of the walleye fishery providing an average catch per unit effort (CUE) in the range of 0.23 fish/man-hour of angling on Gammon lake, a value not considered good nor expected for this type of remote fly-in lake. Further, the estimated level of walleye harvest was 1.58 kgs per hectare, which was considered to be above the level that could be sustained.

No remedial management actions were taken although it was thought that if such actions were not taken the fishery would deteriorate to an unmarketable level. There was no control of the tourist operation even though such operations are purely commercial. The tourist operation was sold in 1983, 1985 and again in 1990. Over this time the nominal market value of the tourist operation declined by 60 percent. Over-use of the Gammon lake walleye fishery had deteriorated the quality of the fishery and therefore the quality of the angling experience it provided. This welfare loss was captured or realized by the decline in the value (capital loss) of the tourist operation.

3.42 Case Study Evidence

The historical record of the use and development of the northern Ontario inland fisheries has revealed serious failures in terms of sustainable development. The regulatory system has failed to ensure that the fisheries are sustained let alone provide an optimum contribution to the welfare of society. The hierarchial planning system which the OMNR uses to govern use of the fisheries is reactive in nature and has resulted in an ad hoc and incremental application of regulatory techniques to achieve overall provincial planning objectives.

With respect to sustaining the fisheries, an open ended allocation policy has essentially always been the basis for public policy governing use of northern Ontario's fisheries resources (OMNR 1976, i). Although commercial food fisherman are restricted by quotas (an upper limit is imposed on annual harvest) recreational anglers and natives continue to receive effectively open ended allocations. The OMNR has not therefore developed a regulatory system which can limit harvest in accordance with the biological productivity of each discrete fish stock. This has resulted in the present situation where, as given is section 2.322, fisheries in virtually every district across the province are subject to unsustainable levels of use, are underproducing and in some cases have collapsed. Given the implications for discrete stocks of fish which tend to be genetically differentiated and therefore unique, past and present patterns of fisheries use have been and are, unsustainable.

Over the last 15 years this fundamental conservation issue, its consequences and its need to be addressed has been identified repeatedly throughout the OMNR's fisheries management and/or policy documents. In 1978 when the OMNR was preparing it's first Strategic Plan for Ontario's Fisheries Resources, one of the background documents it published, "An Allocation Policy for Ontario Fisheries, report on SPOF (OMNR 1978b, 3, 6), stated:

> Free, open access to the fisheries resource must be replaced by a system which establishes value and limits access at levels required for resource maintenance.
>
> Demands are often unrealistic, and can easily lead to overharvesting. Managers are unable to influence, measure or forecast demand.
>
> Harvest control is currently inadequate.

Or, more recently (OMNR 1983c, 12):

> The Ministry's biggest challenge in walleye management has been identified as the control of exploitation

Finally, in 1992, SPOF II (OMNR 1992d, 6) had this to say regarding the control of resource use:

> Another major cause in the reduction in the numbers of fish is overharvesting, because of; unrestricted access to lakes and rivers - even if laws of possession, gear and licence are obeyed, certain waterbodies can be so heavily fished that the fish stocks cannot be sustained; and seemingly insignificant losses of local fish populations are accumulating and leading to an overall decline in the resource.

In addition to the failure of the regulatory system to ensure sustainability, it has also failed to ensure that the fisheries provide an optimum contribution to the welfare of society. The regulatory strategies and tactics which are used to manage resource use can be placed in two general categories, those which enhance biological productivity and those which reduce harvest. Those measures used to increase the productivity of the resource include such measures as slot sizes and fish sanctuaries. However alone these techniques can't control harvest and thereby ensure the fish stock will be sustained let alone optimized.

Those methods used to reduce harvest, often by reducing efficiency, include such measures as the destruction, closure or diversion of access roads, restrictions on gear used to harvest fish etc. Although generally beneficial in terms of sustaining the fish stock (and frequently unsuccessful) these techniques have reduced the value of the fisheries to society and have thereby reduced the welfare derived from many fisheries in addition to that lost from degraded or collapsed fisheries. The Gammon Lake tourist camp which declined 60% in value over seven years due to a declining fishery (sec 3.41, 88) clearly illustrates the reduction in economic benefits resulting from a fishery's decline. In addition, the regulatory system is perceived to be unequitable, due to an inconsistent measure of the benefits derived across user-groups and an ad hoc and incremental application of regulatory techniques (sec 3.41, 78).

The present system of planning and regulating the northern Ontario inland fisheries has not therefore been successful in sustaining the fisheries or optimizing their contribution to society's welfare. In a companion document to the SPOF II, "Allocation of Aquatic Resources, Working Group Report", (OMNR 1990c, 11), the Ministry had this to say regarding the allocation of fisheries resources:

The major issue facing fisheries allocation in Ontario is the lack of an allocation policy and process to guide managers and stakeholders in making allocation decisions. This results in user conflicts over the fisheries. Several components of this problem were identified by the group:

- There is no mechanism to allocate more of the allowable harvest to rehabilitate and protect fisheries which have been depleted and need to be built up to former levels.

- Market changes reflecting changing consumer preferences for one fish over another influence allocation decisions and making long range planning difficult.

- Mechanisms are not in place to make allocation decisions stick.

- There is an inconsistent measurement of the value of the fisheries utilized among various stakeholders.

In terms of why these fisheries regulatory issues have developed Pearce (1989), who appraised the status of fisheries allocation policies across Canada, provided this explanation:

> Fisheries management tends to be seen as work for biologists rather than as an occupation requiring other social, economic, and managerial skills as well. In their preoccupation with managing fish the managers have neglected the management of people. The biological bias, concentrated on fish and their habitat helped persuade a generation of fishermen that hydro dams, forestry, mining, urban development, other physical obstructions, and pollution threats to the aquatic environment and fish stocks were the only serious problems and largely ignored the steadily escalating pressure of fishing by a more numerous, mobile, and affluent population.

> Policy must be broadened to include the management of demand for two compelling reasons. First, providing sufficient supply to meet uncontrolled growth in demand would strain natural stocks, ecosystems and budgets. Second, supply management on its own does not take into account the environmental and other qualitative factors sought by fishermen. What is needed is more attention to demand management to balance the effort in managing resource supply.

3.5 SUMMARY

This chapter has summarized the development of the northern Ontario inland fisheries and the problems which have accompanied that development. Free access of some form has governed resource use since the arrival of the first Europeans. Despite the tremendous productivity of the resource relative to the demands placed on it, this has allowed use to be focused on the most attractive fisheries, often resulting in degraded if not collapsed fish stocks. This situation has persisted to the present.

Over time, the demand for fishery resources has increased and new user groups have emerged. This has exacerbated the problem of sustaining the fisheries and has introduced new considerations to the allocation of fishery resources. In addition to limiting harvest to sustainable levels, resource managers must also derive and enforce the welfare optimizing allocation of fish across and amongst user groups through time on an equitable basis. The OMNR has not succeeded in meeting these objectives.

The fundamental problem with fisheries regulation, which has been identified repeatedly throughout the OMNR's internal policy literature, has been the failure to replace open access as the basis for public policy governing use of the fisheries with a system which establishes value and limits use in accordance with the public interest. The present system is defensive, reactive and results in an ad hoc application of regulatory techniques. As a result, individuals fish stocks across the province are subject to unsustainable harvesting levels, the welfare derived from the resource is below potential, and the system of allocating harvesting opportunities across and amongst user groups is perceived to be unequitable, leading to conflicts over fisheries allocations. This problem will grow more pronounced with the passing of time as the demand for fish continues to increase and fisheries supply is incrementaly reduced due to persistent patterns of over-exploitation.

CHAPTER FOUR

ECONOMIC ANALYSIS OF AN INLAND FISHERY

4.1 INTRODUCTION

This chapter presents the basic components of an economic model for use in the planning and regulation of a fishery with a discrete stock of fish. Such a fishery is characteristic of the fisheries found in the study area. This type of fishery differs from ocean fisheries with their lack of physical boundaries. To analyze an inland fishery a fundamental distinction is made between short-run and long-run analysis. To handle the feature of natural growth found in fisheries the short-run is defined as a harvest year, a single natural cycle for fish. The short run is the focus for fishery harvesting and regulation. Long-run analysis is directed towards planning the developmental process leading to the optimal stock size for the fishery beyond the confines of a harvest year. This long-run analysis identifies the biological optimum, the economic optimum, and "collapse" points for the fishery. These points are strategic in fishery planning and thus are basic to fishery regulation.

To provide a basic context the presentation of the model begins with long-run construction. The first of these is a biologically based diagram which shows the net annual growth (before harvest) of a fish stock at different levels of stock size. It is here that the biological optimum and fishery collapse points are revealed. A long-run average cost curve, with it's derivative marginal cost curve, is then developed. The analysis then turns to anticipated (long-run) price conditions in the general market for fish of the appropriate type or types. This revenue information is then used in conjunction with the long-run cost analysis to establish the economic optimum for the fishery. With the two optima and "collapse" points as data, a planning diagram is then established to provide a basis for short-run fishery management and regulation.

Next, demand curves are derived for the principal user groups in terms of the annual (i.e. short-run) harvest of the fishery. The analysis proceeds to the derivation of the short-run cost curves of the fishery, also in terms of the annual harvest. These short-run demand and cost curves are then combined to show the economic tendencies of the fishery. From the long-run annual growth diagram the net annual growth of the fishery under analysis is established. The growth is then represented by a vertical line on the harvest diagram. A comparison of this line and the harvest level established by short-run economic forces may then be used to reveal possible pressure on the fishery which may impair it's long-run development potential and sustainability.

The model is then ready for application to the planning and operation of the fishery.

4.2 LONG RUN MODEL COMPONENTS

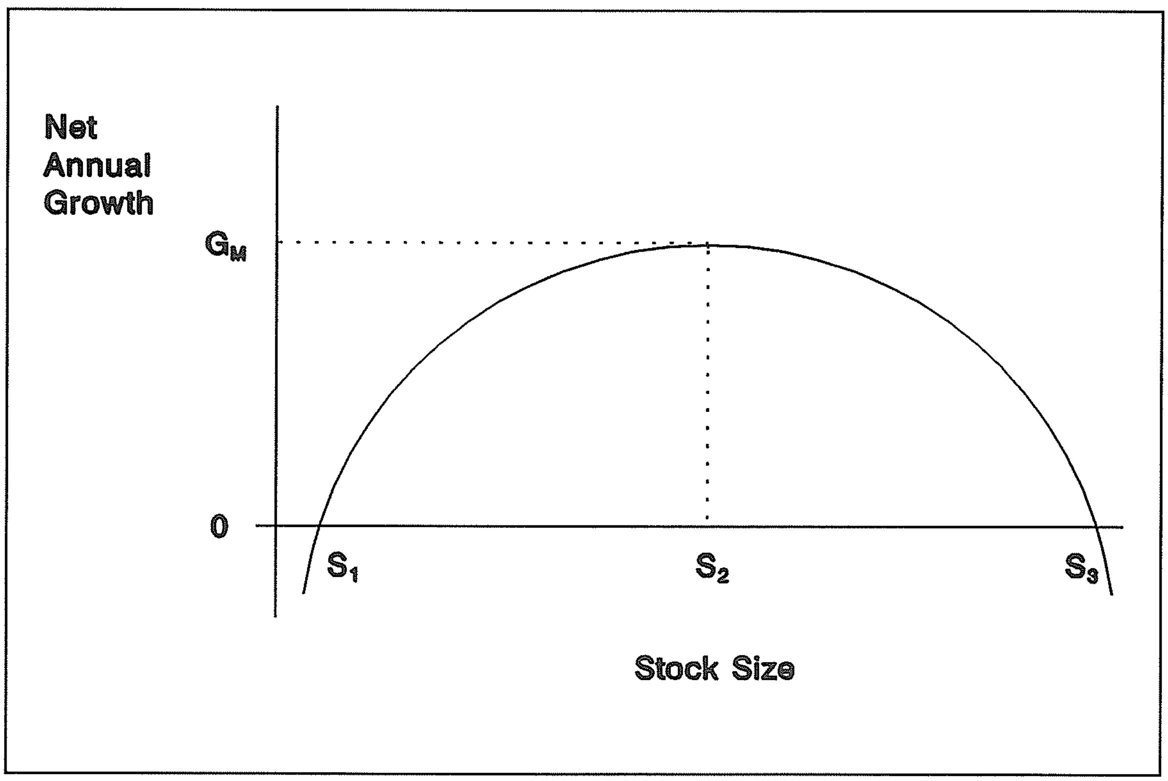
There are five main components of the construction of the long-run model. They are a growth function, a long-run cost curve, long-run price conditions, the long-run economic optimum, and a planning diagram.

4.21 Growth Function

The following figure illustrates the relationship between stock size (biomass) and net annual growth in a fishery.

Figure 3.

Fisheries Growth Function



In a given year the fishery's growth is equal to the growth of the existing stock by reproduction and natural growth less losses to natural mortality. All measurements are in terms of weight (biomass). For ease of illustration the scale of the vertical axis has been enlarged in comparison to the scale of the horizontal axis.

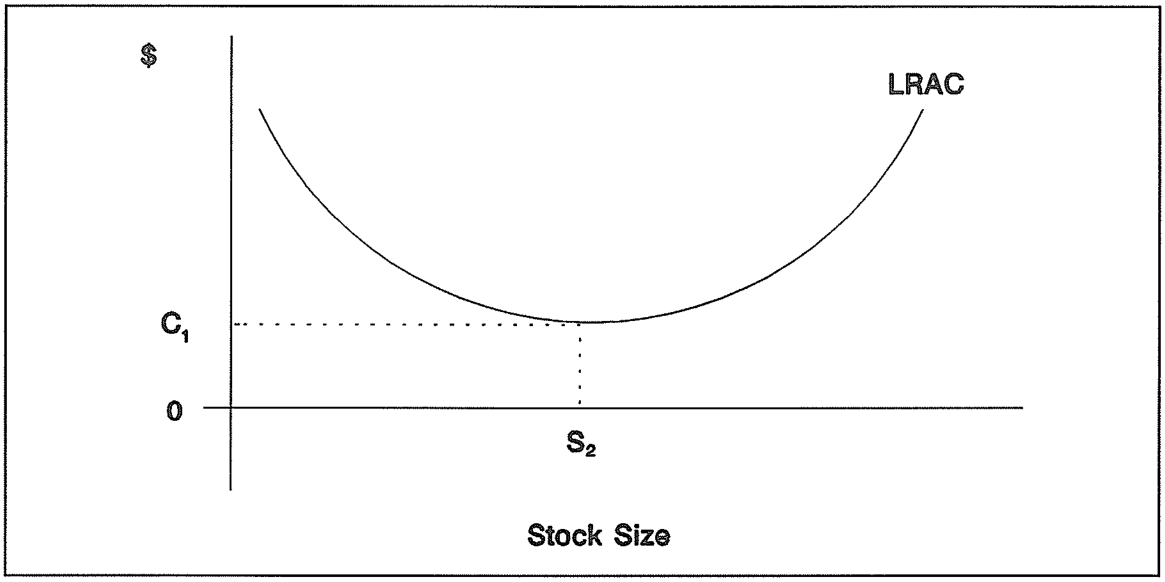
The diagram shows that at S_1 the stock is very low and there is danger of negative net growth (i.e. "collapse") because of inadequate reproductive circumstances in the zone OS_1. Beyond S_1 the annual growth increases at a decreasing rate until S_2 is reached. At this point the net annual growth is at the biological optimum (maximum), G_M. From S_2 to S_3 the annual growth declines at an increasing rate until, once again, a point of zero net annual growth is reached, S_3. This decline is caused by excessive competition for food or favourable breeding areas. S_3 is the second collapse point, the fish stock will not grow beyond S_3.

4.22 Long Run Cost Curves

The long-run cost curve is created by inverting the growth curve diagram, a type of productivity function, and applying constant unit prices to the fishery process. This shows that cost is minimized (C_1) at the stock size (S_2 below) where annual growth is optimal, i.e. S_2 in Figure 3. This point is the biological optimum in terms of the cost curve.

Figure 4.

Long-Run Cost Curve

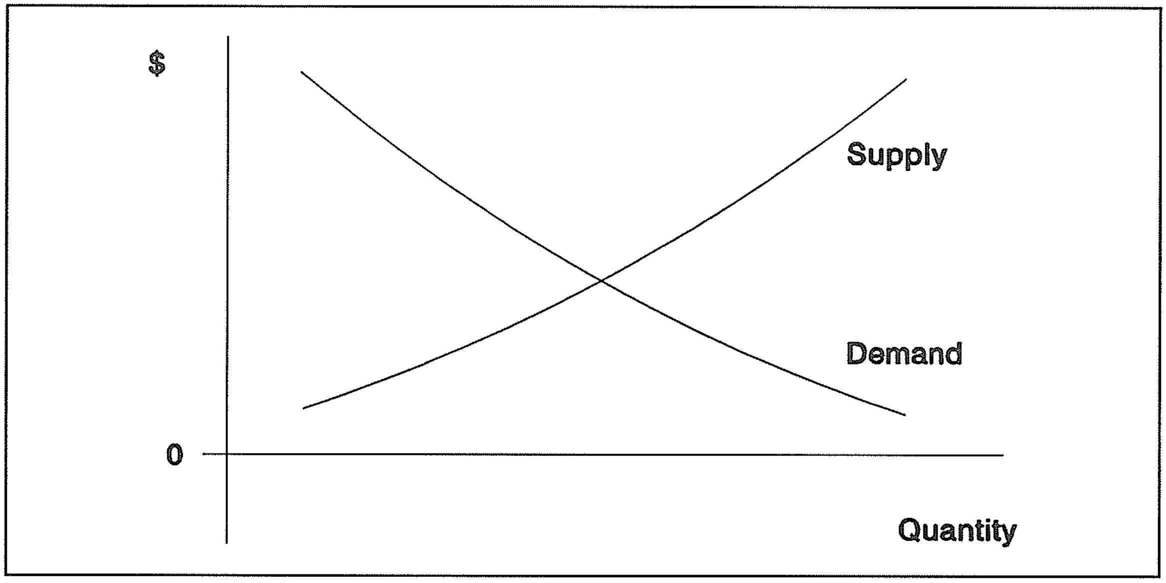


4.23 Long Run Price

The long-run price is essentially a planning variable which will be used to determine the economic optimum for the fishery. The time period of the long run will vary depending on the appropriate time that it is expected will be needed to optimize the stock, perhaps two to five years. With this in mind reference will be made to the supply-demand conditions which relate to the type of fish found in the fishery under analysis. Essentially this is a long run price estimate of the appropriate fish price in terms of time and general region.

Figure 5.

Long Run Price Determination



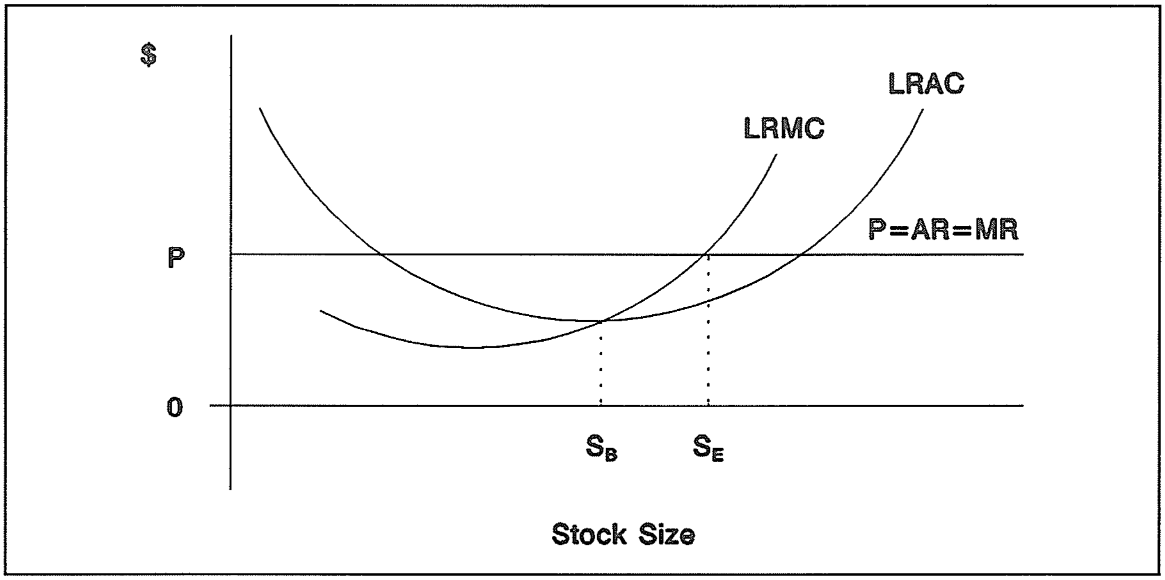
The diagram is a simple orthodox one. The difficulty lies in the timing and forecasting process.

4.24 Long Run Economic Optimum

The information given on the fishery's long run cost and the long run price given, in the preceding sub-sections can now be combined and developed to derive the current economic optimum for the fishery.

Figure 6.

Determination of the Economic Optimum



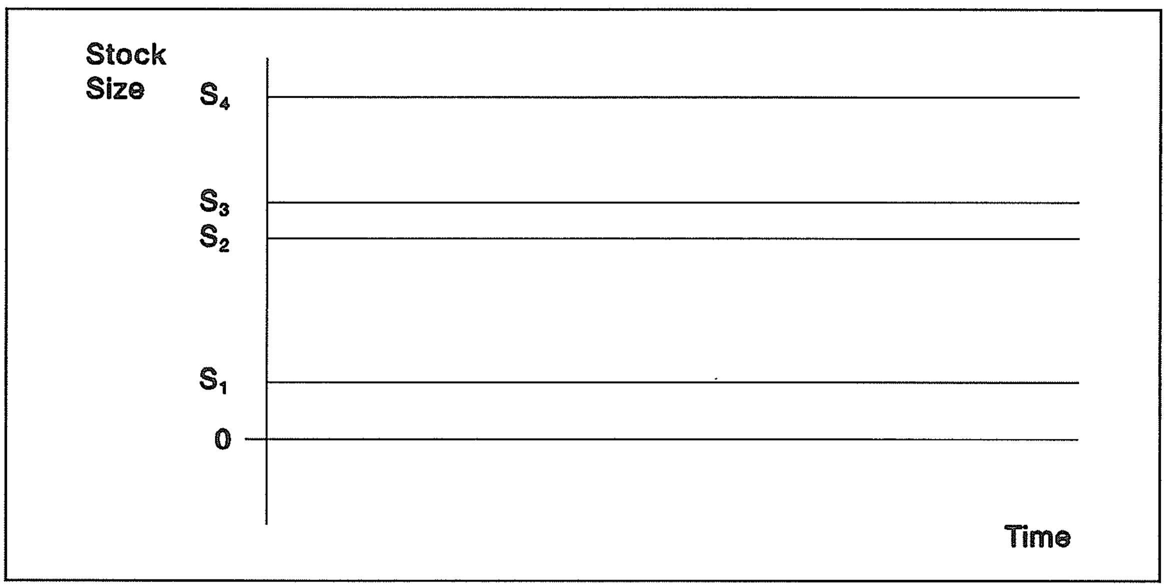
A long run marginal cost curve (LRMC), derivative of the long run average cost curve (LRAC) has been added to the cost curve information. This curve is shown to cut the LRAC curve at its minimum point. The price line from the long run supply and demand diagram, showing anticipated market conditions, has been combined with the cost information. In the circumstances shown, the economic optimum (S_E), where P=LRMC, is to the right of the biological optimum (S_B). This would probably be common for active fisheries but it should be noted that it might cut the curve at its minimum point, or it might be below the curve. The two optima might coincide, as already suggested, but some divergence is much more likely. The economic optimum is probably less stable than the biological optimum as the latter is based on the basic biological circumstances of the fishery while the economic optimum will be flexible in terms on shifts in planning horizon and forecasting decisions.

4.25 Planning

The basic planning diagram with its main parameters may now be presented. Figure 7 shows the two fishery collapse points and the two optima, the biological and economic.

Figure 7.

Fishery Planning



The planning diagram provides a time perspective for the fishery's stock. The two collapse points, S_1 and S_4, show the boundaries where fishery sustainability is seriously threatened while the biological optimum, S_2, indicates the stock level where biological productivity is highest. The current economic optimum, S_3, shows the stock size where maximum economic benefits may be realized from the fishery.

4.3 SHORT RUN COMPONENTS

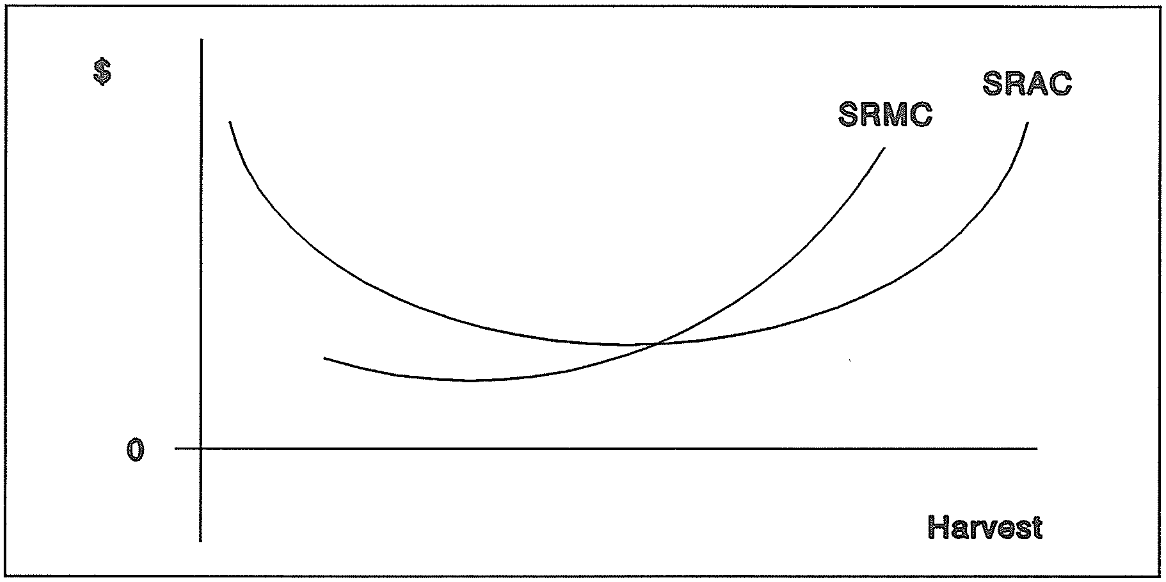
It is now appropriate to turn to the short run components of the model. These short run components are fundamentally cost and demand constructions but an important element, the current fishery growth line, will be derived from the Growth Function (sec. 4.21) for use as a short run indicator.

4.31 Fishery Short Run Cost Curves

The short run cost curves of an inland fishery are determined by fixed cost considerations because of the overall importance of fishery management. The variable cost element tends to enter the picture at higher harvest levels because of increases in management complexity. This leads to cost curves that tend to be relatively elastic as the volume of harvest increases. Figure 8 illustrates this general case.

Figure 8.

Fishery Short Run Cost Curves



Note that the horizontal axis shows the harvest levels. The short run cost curves are designated SRAC for average cost and SRMC for marginal cost.

4.32 <u>Demand Curves of Users</u>

The demand for fish in inland fisheries is based on two sources - commercial fisherman and recreational fisherman.

Commercial fisherman operate on a profit maximization principle. Their demand is based both on their costs and on the net revenue they can obtain from their harvesting of fish. Both cost and revenue characteristics point to an elastic demand for fish. On the cost side, once the fisherman have their equipment, a fixed cost in place, there is every incentive to keep on fishing to spread the cost of setting up and operating the equipment. Their marginal time costs tend to be offset by prospective costs of relocation if they consider leaving for another fishery. The revenue curve of fisherman is very price elastic. It is based on a demand derived from the fish markets where the fisherman individually form a small portion of any one of the markets. As a result of this combination of conditions their price elasticity of demand in the fishery where they are operating is highly elastic.

For different underlying reasons the demand for fish by recreational fishermen also tends to be highly elastic. Here the demand is based directly on user satisfaction and utility maximization is dominant. Also, it should be noted that this type of user demand is based on the fishery activities of a larger number of fishermen in a given fishery. The economic costs of fishing tend to be subordinated to the direct satisfaction of fishing. This includes the time dimension where the benefits of being in an inland fishery are a source of satisfaction in themselves.

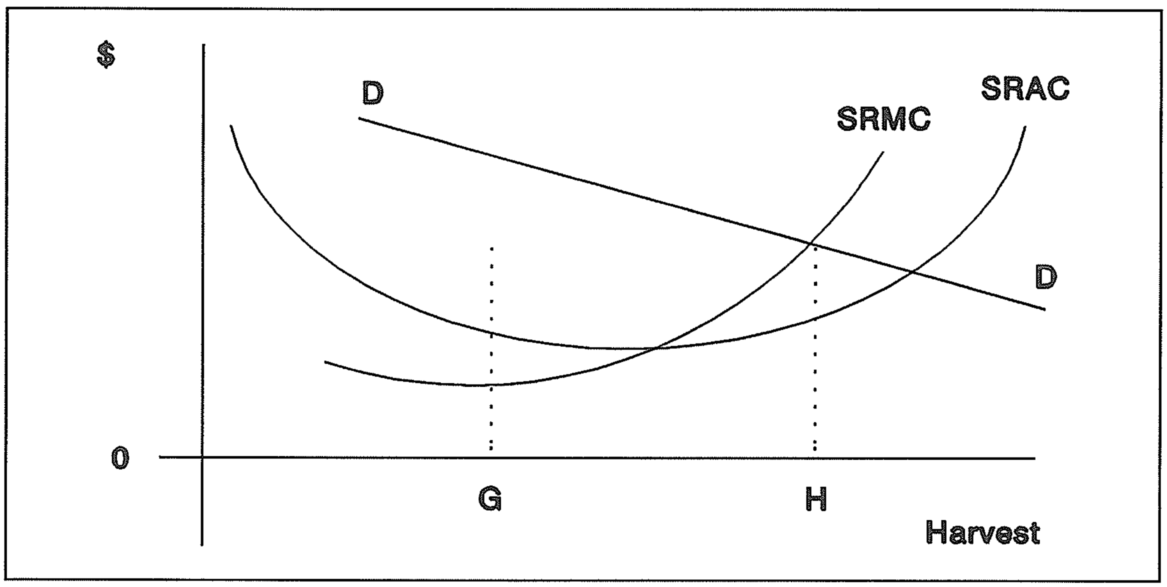
In general the basic demand economics are conducive to high harvest levels in a fishery and this condition is a threat to fishery sustainability.

4.33 Fishery Harvest and Growth

To sharpen the focus on the sustainability issue, introduction of the annual growth in the fishery needs to be integrated with the forgoing cost and demand considerations. A dotted vertical line, derived from the stock level selected for the particular fishery in the growth function diagram (Figure 3) can now be shown in conjunction with the short run cost and demand information developed in the preceding sub-sections. Figure 9 presents these elements of short run fishery economics.

Figure 9.

Fishery Short Run Economics



G, the annual growth of the fishery's stock will vary with the maturity of the fishery as indicated in Figure 3. H, the harvest level shows the result of a pricing approach to fishery use. Both the high levels of demand (DD) and marginal cost (SRMC) tend to produce a harvest result which leads to fishery stock reduction by the amount OH - OG (i.e. GH). This illustrates the underlying sustainability issue facing inland fisheries and highlights the need for planned development and management by suitable regulatory control.

4.4 APPLICATION OF THE MODEL

Following this exposition of the components of the economic model for an inland fishery the next step is to illustrate its application.

4.41 Procedures

These procedures are concerned with planning the stock size and regulation of the harvest. For planning the stock size the procedures are:

1. Determine the long-run average and marginal cost curves of the fishery.

2. Determine the appropriate price line.

3. Establish the economic optimum for the fishery.

4. Establish the current stock size of the fishery.

5. Determine wether the fishery needs to increase, maintain, or decrease its stock size. This will determine the magnitude of harvesting which is appropriate.

For regulation of the harvest the procedures are:

1. Estimate the current demand curve for the fishery.

2. Determine the short-run average and marginal cost curves for the fishery.

3. Apply the estimated planned harvest to the matrix formed by the demand and cost information given by the fishery's economic curves

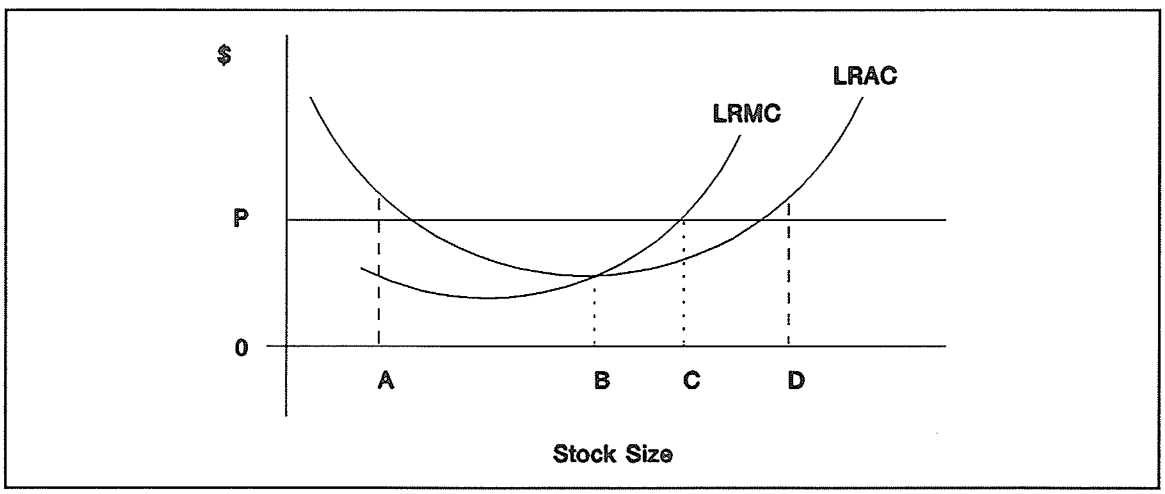
These procedures provide the basis for the following discussions of planning and regulation. These discussions will proceed on a comparative basis using three hypothetical circumstances. These circumstances are differentiated by the developmental stage of the fishery, i.e. a "young", "mature", and "old" fishery. They give a sequence of increasing size where maturity is determined by the economic optimum.

4.42 Planning Optimization

For this comparative analysis it is appropriate to present the long-run economic model of the fishery.

Figure 10.

Stock Size Adjustment



The three developmental stages of the fishery are given in ascending order, OA for the young stage, OC for the mature stage, and OD for the old stage. The biological optimum for the fishery is indicated as OB (see also Figure 4). It is possible that the economic and biological optima might coincide, but usually they will not. Planning for harvest regulation is now possible. In the case of the young fishery, OA, the harvest should range from zero to a moderate amount which will allow the stock size to develop towards the economic optimum. If A is near the vertical axis the decision should be zero otherwise, the precise determination of the harvest will need to reflect the type of fishery under consideration and its place in the total system. These planning elements will be discussed in Chapter 5.

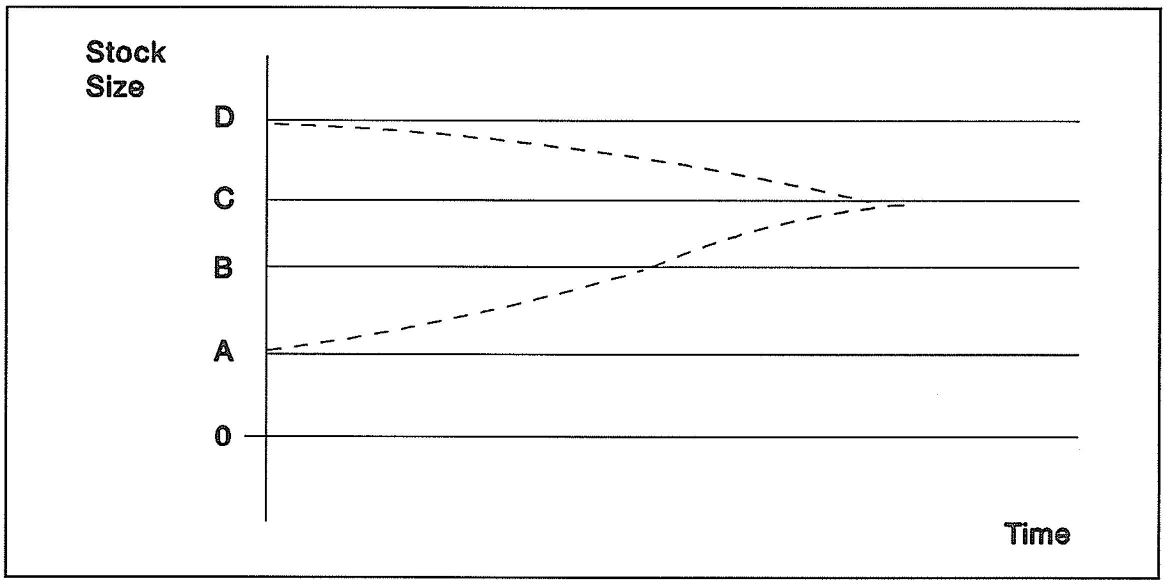
In the case where the fishery has reached maturity, i.e. at OC, the decision is relatively simple. The economic optimum should be the control point for establishing a steady state stock size. This will require that the harvest should equal the annual growth of the stock at the level of the economic optimum.

Finally, for a fishery at an old stage of development, i.e. OD, it is desirable to reduce the stock size towards the economic optimum. This requires that, at the stock size OD, harvesting should exceed the annual growth of the fishery stock at that level. In this case the excess permitted may be substantial.

The planned optimization strategy applied to these three cases can be seen with a longer time horizon by reference to a planning diagram. The precise configuration of the optimization paths will vary according to policy decisions but the essential nature of the process is shown in Figure 11.

Figure 11.

Planning Optimization



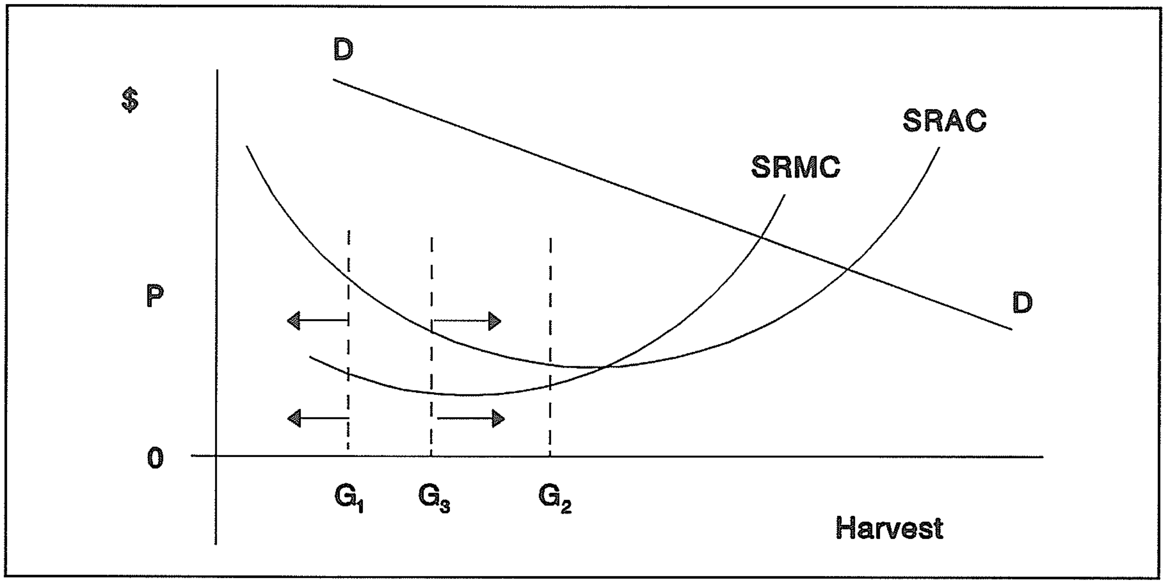
OA and OD, as in Figure 9, are the stock sizes that need adjustment. The dotted lines give examples of the adjustment paths needed for sustainability and economic optimization for these stock size examples.

4.43 Harvest Regulation

Discussion of three hypothetical annual harvest levels may now proceed based on the three stock sizes used for comparison. For this discussion Figure 12 is useful.

Figure 12.

Harvest Regulation



In Figure 12, OG_1 represents the annual growth for a young fishery, OG_2 the growth for an economically mature fishery while OG_3 (which might be to the left, the right or coincide with OG_1) is the annual growth for an old fishery. Harvesting on a steady state basis should be done at G_2 for the mature fishery while the directional arrows for the young and old fishery examples are shown in relation to the relevant annual growth lines.

Revenue capture possibilities from users of the fishery are limited by the demand curve. For commercial fisherman, full exploitation will probably be practised. For other fisherman, prices and/or charges will probably be set at lower levels. Allowance for price/charge discrimination on equity and/or externality grounds can be instituted by the regulators on the basis of planning policy. These issues and a range of regulatory practices will be discussed in Chapter 5.

4.5 SUMMARY

This chapter has established the analytical components of a model for a discrete inland fishery. Three scenario's which encompass the range of possibilities have been developed for comparative purposes. The next chapter will proceed to discuss development of fishery planning and regulation in terms of a total system of fisheries. The focus shifts from the strictly analytical work shown in the model to a political economy orientation.

CHAPTER FIVE

PLANNING and REGULATION

5.1 INTRODUCTION

This chapter develops and applies a system of planning and regulation to the northern Ontario inland fisheries in accordance with the preceding economic analysis of an inland fishery. The first section, planning, elaborates the planning function to the system of fisheries in the study area and develops the process for establishing priorities in their management. The next section, regulation, then develops a regulatory strategy which enables regulators to control and adjust fish stocks in accordance with planning recommendations. The following section, then investigates the implications of the new system of planning and regulation for the OMNR. The chapter concludes by summarizing the system of planning and regulation and how the performance of the fisheries will improve.

5.2 PLANNING

Chapter four developed a bio-economic model of a typical inland fishery in northern Ontario. The model provided an alternative method of planning for such a fishery. Planning has to do with the long term adjustment and optimization of a fish stock. This section will build on the analysis by elaborating the planning function to the system of fisheries and developing the process for establishing priorities in their management. Within this larger context, planning will also be used to set relative prices and charges for use of the individual fisheries.

5.21 Northern Ontario Fisheries

Planning is concerned with the long-run adjustment and optimization of fish stocks. Planners must determine the optimum size for each discrete stock of fish in the study area and when the actual deviates from the optimum, recommend a harvesting strategy which will cause them to coincide. In the study area there are in the order of 250,000 individual fish communities and an uncounted number of discrete fish stocks. These discrete stocks of fish, are not only numerous but also diverse in terms of the species present, size of the fishery, aesthetic quality, location and accessibility.

There are approximately eleven economically significant species of fish in the 250,000 fisheries which comprise the fishery resource. The fish species differ in terms of their average size and appearance, ease of capture, abundance, food quality, productivity, habitat preferences etc. In addition, there is also significant variance in the attributes across discrete fish stocks of the same species. Due to these differences each discrete stock is subject to differing levels of demand both across and amongst user groups. Across species for example, whitefish are generally only considered attractive by commercial users, smallmouth bass are only considered attractive by recreational anglers and walleye are attractive to both. Across discrete fish stocks, the lake trout found in Clearwater Bay are considered more attractive to recreational anglers than other lake trout stocks (fisheries) found in the surrounding area due to their relatively easy access and large mean size.

The discrete stocks of fish which collectively inhabit a fishery are generally referred to as a fish community, although some debate surrounds this issue. The composition of the fish communities found in the study area range from single species[7] communities to complex multi-species communities and even multi-community fisheries. Brook trout fisheries found along the north shore of lake Superior or northern pike or lake trout fisheries scattered intermittently across the study area are common examples of single-species communities. Multi-species communities, which are the most common example, are composed of warm and cool water fishes or warm, cool and cold water fishes. Multi-species, multi-community fisheries are also occasionally found in the larger water bodies such as Lake of the Woods or Lake Nipigon located in the south western corner and south central areas of the study area respectively. Generally the more diverse the composition of a fish community the greater the demand for its use

Fisheries also vary greatly in size, a factor which is often positively correlated with the complexity of the fish

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[7]Where only economically significant species are considered.

community. There are fisheries such as Lake of the Woods or Lake Nipigon which cover hundreds of thousands of hectares and possess discrete stocks of most of the economically significant species found in the study area. In direct contrast there are also many fisheries as small as only a few hectares in size which often support single species fish communities. Most common however are intermediate sized fisheries ranging from a few hundred to thousand hectares in size which support a single multi-species community. Larger fisheries are generally considered to be more attractive by both user-groups due to the increased likelihood of the presence of one or more desirable species and an anticipation of larger denser fish stocks which provide superior catch rates and mean average size.

Fisheries also differ in terms of their aesthetic attractiveness. The aesthetic attractiveness of a fishery generally refers to the surrounding forest cover and topography, in conjunction with such factors as the fishery's water quality and character in terms of islands, inlets and tributaries. Forest cover and topography generally differ among fisheries as does water quality. All fisheries are unique in terms of their individual character. Although the aesthetic character of a fishery doesn't affect the profitability of commercial food fisherman, it has a significant bearing on the attractiveness of the associated angling (fish) to recreational fisherman. For example, the northern half of Lake of the Woods, which is located on the Canadian shield, is considered to be aesthetically attractive while the southern half, which is located on the prairies, is not. Commercial fisherman have expressed demand for use of both areas whereas recreational angling has traditionally been focused on the northern area. This product differentiation for recreational fishing has significant implications for relative pricing when charges are established for recreational users. For recreational fisherman the fish and their environment resemble a joint product.

Location describes a fishery in terms of its position relative to population or tourism centres. A separate but related attribute, accessibility, refers specifically to the transportation infrastructure surrounding a fishery. In terms of location, the study area encompasses fisheries in the most sparsely populated and remote areas in the province, as well as fisheries adjacent to relatively large populations such as Thunder Bay, Sault Ste Marie and Sudbury or, tourism centres such as Red Lake, Kenora and Sioux Lookout. Location has a negligible effect on commercial food fisherman who are generally residents of the local, albeit small, population. It has a greater effect on recreational anglers due to the increased time and travel costs. For example, Rainy Lake and Lake St Joseph are very similar fisheries located in the northwest region. However, because Lake St Joseph is in excess of three hundred kilometres further north than Rainy

Lake it is subject to considerably less use.

With respect to accessibility, some fisheries have direct road access, of varying quality, while others will have water access and still others are only accessible by air or wilderness (canoe) travel. Without direct road access the costs of alternative transportation generally deem, commercial food fishing unprofitable. However, access has a less definitive effect on recreational use. Most recreational fishermen prefer increasingly inaccessible (remote) fisheries due to the probability of encountering denser fish stocks and the perception of a wilderness experience although, this is offset by the higher costs of access. This dynamic has lead to the establishment of many remote tourism facilities whose principle service is the provision of "fly-in" access.

Discrete fish stocks are the basic planning unit for fisheries planners. The discrete fish stocks found in the study area are differentiated by biological and economic criteria. Planners must therefore plan and regulate each stock on an individual basis. Due to the vast number of discrete fish stocks in the study area this requires establishing priorities.

5.22 Planning Priorities

The analysis of an inland fishery in Chapter Four dealt with the special case of a single discrete stock of fish, the basic unit for fishery planning. In practice, consideration must be expanded from a single fishery to a system of fisheries which are differentiated biologically and economically. Due to the number and diversity of the fisheries in the study area, practical considerations dictate that they must be prioritized for attention.

Prioritizing the fisheries requires developing an extensive and detailed information base regarding the biological status of each fish stock and its economic importance. A new information network must be established to collect and store this information. The existing network of regulators operating in the field can provide much of the information required to appraise the biological status of the discrete fish stocks. In addition, the regulatory system can be designed to provide much of the information needed to appraise the economic status of the fisheries.

The biological status of a fish stock refers to the relationship between a fish stock's actual size and its biological collapse point. As the two stock sizes converge the biological status of the fish stock is said to deteriorate. In practice, there are fisheries which are small or relatively unproductive which can be rapidly overharvested following a change in demand. There are also fish stocks which are otherwise productive but have nonetheless been fished down to the point where sustainability is threatened. These fisheries would therefore receive priority in order to avoid the deterioration or loss (ensure sustainability) of the fish stock.

The economic importance of a fish stock describes the welfare benefits derived from its use. There are fisheries which due to their attributes are focal points for fishing activity or are otherwise ideally suited to segments of the angling market. These fisheries provide significant welfare contributions to society and as such optimization of these fisheries would receive priority.

Therefore, in terms of setting relative priorities, the first criterion which must be satisfied is that of sustaining the fisheries. Those fisheries which are at risk in terms of biological sustainability would therefore receive top priority. Having sustained the fisheries managers then strive to optimize their economic contribution to society. Those fisheries which are operating below potential would receive priority due to the significant loss of benefits. Finally, a balance must be struck across and amongst fisheries. For example if a regionally important fish stock must be temporarily closed to allow the stock size to increase, as a result, other tertiary fisheries may receive additional attention (such as the development of access) to temporarily divert user effort.

Having prioritized and analyzed the important stocks of fish, resource planners must then recommend an appropriate short-run (annual) harvest policy. The analysis and resulting policy recommendation can result in one of three outcomes.

Either the actual stock size is greater than the optimum, in which case the policy recommendation would be to set annual harvest above annual growth to reduce stock size over time. The actual stock size is below the optimum, in which case the recommendation would be to set annual harvest below annual growth so as to increase the stock size. Or, the actual and optimum stock sizes coincide, in which case the harvest recommendation would be to set annual harvest equal to growth and thereby steady state the fishery.

Frequently, the actual stock size will be below the optimum such that short-run harvest will have to be restricted. If harvest must be reduced (stock size increased) planners must determine the optimum rate of adjustment. Completely eliminating harvesting will cause the actual fish stock to converge with the optimum most rapidly although, at the cost of greatest disruption in supply and therefore use. The rate of adjustment is an additional policy consideration which in practice may best be resolved with input from resource regulators.

Planners therefore prioritize the fish stocks for attention, based on biological and economic criteria, and then recommend a harvesting strategy which accords with long-run stock optimization. Resource regulators are responsible for controlling resource use in accordance with planning recommendations. Controlling use requires the application of regulatory techniques. Because fisheries users are differentiated in terms of the benefits derived from resource use and equitable entitlements, the regulatory techniques have distributional, political economy, implications. Planners will therefore also have a role to play in determining the application of regulatory techniques similar to the role regulators play in setting policy related to the optimum rate of adjustment of a fish stock.

5.3 REGULATION

Fisheries planners therefore forecast long-run optimum stock conditions, for those fish stocks which merit consideration, and then recommend optimum short-run (annual) harvest levels and relative prices. Fisheries regulators are responsible for ensuring use (or harvest) and charges accord with these guidelines. This section develops a regulatory strategy which allows resource regulators to control fisheries use in accordance with planning recommendations, to move fish stocks to optimum levels and to operate on an appropriate revenue basis in terms of overall policy.

5.31 User Groups and Their Economic Nature

The northern Ontario inland fisheries are an important economic resource. Those who demand resource allocations can, based on economic criteria, be divided into four principal user groups; commercial food, recreational, native and in some capacity commercial recreational. Each group is differentiated in terms of the nature of their activities, economic benefits derived and equitable entitlements.

Commercial food fisherman are profit maximizers which harvest fish for the production of commercial food products. The appropriate measure of the net public welfare derived from allocations to this user group is economic rent. Economic rent is the residual profit remaining after all costs of production, including the market rate of return on the capital and labour resources invested, have been deducted from revenues.

Commercial fisherman prefer fisheries with ready access and high value product, unconcerned with the aesthetic appeal of a fishery. Commercial food fisherman cannot generally control harvesting by other user groups and the capital and labour invested in a commercial fishing operation is almost perfectly mobile. Individual commercial fisherman are small producers relative to the market and can not influence price. The opportunity cost of harvesting fish is therefore nil such that the demand function for fish is extremely elastic. This easily leads to overfishing as described in Chapter Three (sec 3.41, 71, 73, 78) and demonstrated in Chapter Four (sec 4.33, 105).

Recreational anglers are utility maximizers, who use or consume fish as an input into the production of recreational opportunities. Utility is equal to the benefits derived from harvesting fish less the costs of harvesting fish, and is the appropriate measure of the welfare derived by this user group. The appropriate measure of the net public welfare derived by this user group is however dependent upon residency status which influences the appropriate application of regulatory techniques. The utility derived from resource use depends on a multitude of factors which include, the composition of the fishery (species), the quality of the fishery (catch rate), ease of access or location, and the surrounding aesthetics. There are significant differences across recreational anglers in terms of their preferences for species, angling quality, ease of access, and the surrounding aesthetics.

Recreational anglers are extremely mobile and will actively seek out fisheries which provide the greatest rate of return, or utility per unit effort expended. Individually a recreational angler's harvest tends to be insignificant although collectively they are the single largest user group in Ontario. Because they can't individually influence harvesting levels and are extremely mobile the opportunity cost of harvesting fish is nil. If the rate of catch is unaffected by reducing stock size demand for the fish stock will be elastic. If however demand is sensitive to stock density the fishery will be fished down to the point where the utility derived from angling will be equilibrated across all substitute fisheries. Therefore, recreational anglers may, depending on the elasticity of demand harvest the stock to extinction (sec 3.41, 76, 78, 81, 83) and are unlikely to select the welfare optimizing stock size.

Native groups harvest fish for commercial, recreational, cultural and subsistence (food) needs. Their aboriginal rights have significant implications for the planning and regulation of fisheries. In some instances native groups may be, or are, entitled to exclusive and unrestricted access to fishery resources. Where these rights pertain, it may be that, based on discussions, the native groups can be provided with information and methods which will help them to control these fisheries on a sustainable economic basis.

More generally, natives have secured the right to conduct subsistence food harvesting of fishery resources throughout the study area. Here, the native groups may be encouraged to participate in, and cooperate with, the overall planning and regulatory process. The objective would be to provide a cooperative basis for native fishing activity without diminution of native rights and priorities. In any event, the role of native groups will obviously need to be given full recognition for a regulatory system for fisheries to be fully effective.

Finally, the role of resort operators in the provision of access to users of the fisheries should be noted. In effect the tourist operators act commercially to provide recreational users access to some fisheries, sometime for trophy fishing. It is surely appropriate that these activities related to fishing should be clearly brought into the scope of regulation and accountability of the resort operators be established.

5.32 Techniques

Fisheries regulators have a number of techniques at their disposal to control resource use. These techniques differ in terms of their ability to control resource use or collect the benefits derived. In this sub-section each of these techniques will be defined and appraised in terms of its ability regulate resource use.

5.321 Licences

Licences refer to a contract which specifies the rights and conditions under which a resource user can harvest fish. It can be thought of as an umbrella technique because it provides a vehicle for the administration of other, more specific, regulatory actions. In Ontario, all resource users, with the exception of natives are required by law to possess a licence in order to harvest fish. The terms and conditions attached to each licence vary significantly across user groups and within the commercial food user group.

A review of hunting and fishing licences carried out by the OMNR in 1992 had this to say about the intended role of licences in fisheries regulation and their success in meeting this role (OMNR 1992, 2).

> In our view there are three primary reasons for licensing:
>
> 1. generating revenue

2. collecting information
3. managing resource use ...

Fishing licences, for the most part only generate revenue.

Given the stated role of licensing in the management and regulation of northern Ontario inland fisheries, this quote can be taken to describe the general performance of the regulatory system, as well as application of the licensing technique.

5.322 Pricing

Pricing establishes the principal monetary terms whereby a purchase of a product by a buyer from a seller occurs. In this regulatory system the role of pricing is to set the terms for the relative cost of using different fisheries and to raise revenues to finance their operation and development. Prices are used to reflect the relative attractiveness of individual fisheries for recreational use and to charge commercial fisherman a fair and full commercial price. The price level for recreational fishing may well be, of course, set at a level below a full commercial price.

5.323 Quotas

A quota is an allocation of fish to a resource user, which places an upper limit on the quantity of fish which can be harvested, by species, from a fishery over a specified time period. In Ontario quotas are used to manage the harvesting activities of all user groups with the exception of natives. Typically, licensed commercial food fisherman receive quotas, by species, for a fishery. Instances where more than one fisherman is harvesting the fishery the quota allocations will be accompanied with area restrictions, whereby typically only one fisherman will be able to harvest a quota in the given area. Quotas are also used to manage the harvest (resource use) of recreational anglers (resident and non-resident). Daily and possession limits are imposed by species and by fishery across northern Ontario. Finally, tourist operators are constrained in terms of their occupancy capacity so as to limit angling effort and therefore harvest.

Quotas allow resource regulators to directly control harvest by commercial food fisherman. The use of quotas has not however been successful in controlling total use because of an ineffective application to the recreational user group. Although total harvest is controlled by angler, total angling effort, the number of anglers, is uncontrolled. Fees can be attached to quotas such that they can be used to capture the benefits derived from resource use and/or generate revenue.

5.324 Tags

Tags are a regulatory technique whereby resource users must possess a tag to harvest a specific fishery and then affix the tag to any harvested fish. It is largely a method of applying or enforcing quotas on the recreational user group. A potential user will be issued a tag, typically by direct purchase or lottery, which entitles the participant to harvest a specified species from a specific fishery. This technique has received little use although their are isolated examples such as the Clearwater Bay lake trout fishery (sec. 3.41, 80).

This technique can provide information regarding total harvest and a direct means of controlling that harvest. A fee can be attached to the tag such that it can also generate (collect) revenue. In addition, other techniques may in some circumstances be needed as an alternative.

5.325 Slot Sizes

The slot size technique eliminates or reduces the harvest of a specific segment of a fish stock. The regulation is based on biological rationale which dictates that if the most productive segments of a fish stock are protected from harvest, the fish stocks growth potential, or productivity, can be enhanced. Application of this regulation is also, in some cases, based on economic rationale. Trophy commercial recreational fisheries will impose harvesting restrictions on fish of trophy size so as maintain a high quality catch and release fishery which can support more angling activity although less harvest.

This technique, like closed seasons, possess significant strengths and weakness which must be evaluated on a case by case basis. From both an economic and biological perspective, the technique can improve the performance of a discrete fish stock. The technique does not however allow resource regulators to directly control harvest by fishery or collect revenue (capture benefits) (sec. 3.41, 84).

5.326 Restricted Access

Restricting access is a technique which reduces use of a fishery by intentionally reducing access. For example, resource access roads typically built for timber or mineral extraction activities often greatly reduce the cost of accessing fisheries and therefore increase the effective demand for these fisheries. In order to prevent harvest levels from increasing, these roads will be diverted away from desirable fisheries, destroyed, or simply closed to public use. Land use permits are also a common form of access restriction used to control the activities of commercial recreational fisherman. Land use permits are required by tourist operators to establish and develop facilities. By refusing issuance, potential developments can be indefinitely forestalled.

Restricted access does indirectly limit harvesting activities on a fishery however it does not provide direct harvest control or generate revenue. The use of this technique is also unequitable and inefficient. Restricting access reduces the value of the fishery to the people of

Ontario and effectively destroys an asset paid for by the people of Ontario. Although, there are situations where restricting access can cause a fishery to retain a "remote attribute" considered to be desirable to many recreational anglers and thereby enhance a fisheries value to certain segments of the public.

5.327 Gear Restrictions

Gear restrictions limit the techniques which resource users can use to harvest a fishery. For example, commercial fisherman are restricted in terms of the yardage of net used, mesh size, and the use of alternative techniques such as trap netting. Anglers are restricted in terms of the number of fishing lines that can be used, the kind of bait which can be used, angling techniques etc.

The effect of this technique differs across user groups and fisheries, such that its application must be examined on a case by case basis. Gear restrictions do not directly control use (harvest) or generate revenue. Further, restricting the harvesting strategies resource users would otherwise use increases (reduces) the cost (benefit) of resource use. However, some harvesting techniques employed by commercial food fisherman unintentionally harvest other species or target important segments of a fish stock which reduces a stocks growth potential. Also, in some cases, restricting harvesting techniques which recreational anglers would use, but are considered to be unsportsman like, maintains the integrity of angling as a recreational activity and therefore enhances the value of angling across all fisheries.

5.328 Closed Seasons

Closed seasons are a regulatory technique which specifies when, generally over the course of a year, a fishery may or may not be harvested. The objective has traditionally been to allow for uninterrupted spawning or reproduction, and otherwise eliminate access to stocks when they are extremely vulnerable to harvesting due to biological or economic factors. Season closures are in place for most species during their reproductive period, and for numerous specific fisheries which are subject to intense harvesting pressure during certain times of the year.

This technique possess significant strengths and weakness which must be weighed on a case by case basis. In some instances, harvesting pressure can interfere with reproductive success and will therefore carry hidden costs by reducing the fisheries growth potential. However, this also restricts harvesting during periods when costs (benefits) are minimized (maximized) and therefore reduce the welfare derived from the fishery. Finally, the technique does not allow resource managers to directly control harvest or generate revenue (capture benefits).

5.329 Public Education

Public education programs are also used to control resource use informing resource users of the effects of their activities and otherwise encouraging ethical behaviour. Application of this technique is directed primarily at recreational anglers. The principal objective is to encourage selective harvesting so as to bias harvests away from the most productive segments (breeders) of fisheries populations and simply to reduce harvesting by promoting catch and release angling.

This technique provides no direct control over resource harvesting nor does it generate revenue. The technique is however essential in generating public support for resource management efforts and compliance with regulatory actions. It can also be used to foster new attitudes with respect to resource use regarding the voluntary release of fish etc.

5.33 The Political Economy of Regulation

Across Ontario's 250,000 fisheries and uncounted discrete fish stocks exists a vast range of possible allocation scenarios. Based on the economic nature of resource users they can be divided into four major user groups, commercial food fisherman, tourist operators, recreational anglers and natives. These user groups are differentiated in terms of their harvesting practices, the benefits derived and equitable entitlements. Regulators are responsible for controlling harvest by these user groups in accordance with planning recommendations and allocating the output to those users which derive the greatest net benefit from use. Their are a variety of regulatory techniques, each with strengths and weaknesses which differ across user groups.

The native user group merits special consideration in fisheries allocations due to their special status. In some case, natives have a legitimate claim to exclusive access to the fishery, or discrete stock(s). In these situations, proprietary rights are assumed to be delegated to the affected native group. Fisheries planning and regulatory functions cease to be the OMNR's responsibility. This model could be used to formulate a management system for native fisheries however the cultural institutions determining equitable treatment and defining the appropriate measures of benefit are different. As such this question exceeds the scope of this thesis and will not therefore be considered further. A complete treatment or analysis of resource management by aboriginal self-government is a suitable topic for an additional thesis.

More generally natives have secured the right to harvest fish for subsistence purposes, free of restriction, across the unoccupied portions of Crown land throughout the study area. It seems appropriate therefore to provide natives allocations of fish for these purposes gratis. However use must be monitored by discrete stock, in those areas which merit attention, in order to include this groups harvest in total harvest estimates and control native subsistence harvesting where alone it may exceed MSY. Regulatory functions could be carried out by native groups however again, consideration of aboriginal self-government exceeds the scope of this thesis. Native use for purposes other than subsistence will be treated as indistinguishable from other residents of Ontario.

Commercial food fisherman are profit maximizers which harvest fish for sale in retail markets. The appropriate measure of the economic welfare derived by the public from allocations to this user group is economic rent. It is therefore appropriate to charge of fee for fish harvested by this group and collect the economic rent. Quota's represent an effective means of controlling use by this group. Their are historical allocation commitments to this user group which should be honoured. The willing-seller willing-buyer program should be continued so as to equitably eliminate these commitments. Subsequently, discretionary allocations to these users should proceed in accordance with welfare optimization. That is to say, discretionary allocations should be offered to commercial fisherman where the economic rent derived, and collected, from use exceeds that if the allocation were made to any other user.

Commercial recreational fisherman, tourist operators, are profit maximizers who market angling opportunities or otherwise provide support services to recreational anglers.

Tourist operators do not directly harvest fish, rather the anglers which they accommodate harvest the fish. Regulation should therefore be directed towards the anglers which utilize their services.

The angling recreational user group is highly differentiated. All anglers derive satisfaction from harvesting fish however the economic accounting of the benefits derived is a function of their residency status and with respect to resident anglers other socio-economic criteria. It would for example be appropriate to place a fee on non-resident anglers equivalent to the net utility or satisfaction derived. It would not however be appropriate to charge a resident or local angler a fee equal to the utility derived as they are members of the society which jointly owns and controls the fisheries. Similarly, seniors or children may merit special consideration due to social considerations. A tag system would be an effective means of controlling use by recreational users. Pricing would also represent a suitable means of rationing use and generating revenues. The pricing mechanism should however discriminate across segments of the angling user group based on socio-economic criteria which include residency and age to accommodate political economy, distributional, considerations.

An overall systematic regulatory strategy could be based on a system of tags and quotas which identify the discrete stock to which an allocation has been granted in conjunction with a differentiated pricing mechanism. First tags (allocations) would be granted to native subsistence users in accordance with their needs and then quotas to commercial food fisherman in accordance with outstanding commitments. Following the distribution of these tags, additional tags to harvest a specific fish stock can be acquired in lieu of a fee. The fee (pricing mechanism) would be differentiated across users based on socio-economic criteria which include such considerations as residency status and age. The number or quantity of tags available for each discrete stock is determined in the planning process.

The tag and quota system would therefore allow resource regulators to directly control harvest. The fee for tags would ration use and generate revenues. The setting of the fee could be based on a ratchet mechanism whereby each period the cost of a tag will be subject to a marginal increase where excess demand, applications to harvest the fishery exceed the available supply of tags, exists. The differential pricing policy, in conjunction with other discretionary restrictions such as limiting the total number of tags an individual can purchase for a fishery or adjusting daily limits on a fishery, can be used to address distributional considerations. Overtime as the relative pricing mechanism is phased in and historical allocation commitments phased out, access to fisheries allocations can be liberalized.

5.4 FISHERIES OPERATION

This section investigates the implications of the new system of planning and regulating northern Ontario inland fisheries for the OMNR. New functions have been introduced to the fisheries management process and therefore, roles and responsibilities. First, a pro-active planning function has been introduced whereby Ministry personal will be actively engaged in the long-term forecasting and optimization of fish stocks. This function will require the collection and storage of new information, development of analytical capabilities and the establishment of new lines of communication. Secondly, a systematic regulatory system has been developed. Fisheries regulators will administer new regulatory procedures and participate in the fisheries planning process. Finally, the OMNR will have to acquire new skill sets and attitudes in order to support these roles.

5.41 Planning Implications

A new pro-active planning function has been introduced which requires carrying out new analysis and therefore collecting new data. The collection and analysis of data is based on fisheries planning priorities. To recapitulate, fisheries planners must first ensure that the fisheries are sustained and then, for those stocks which merit attention, optimize the fish stock's size. In order to ensure the fisheries are sustained, data must be collected regarding each fish stock's productivity, it's annual harvest and stock status.

Data describing the maximum sustainable yield of species by fishery have already been approximated by the MEI. This data will not change overtime and provides an important baseline for fisheries planners. In the absence of all other biological data, harvest can be maintained below the MEI productivity estimate and the stock thereby sustained. Harvest data can be expected to change from year to year but can be closely monitored through the use of tags and quotas. For those fish stocks which merit direct or immediate attention, stock status can be monitored overtime with established fisheries assessment programs and techniques. This data in conjunction with the harvest data will allow for the rapid refinement of productivity estimates and quantification of fisheries growth functions.

Data must also be collected which will allow fisheries planners to determine if a fish stock, once sustained, is also optimized. This data will be collected largely through the limited application of a pricing mechanism. The pricing mechanism will provide the information needed by economists to appraise the value of a fish stock, establish a price line, and thus determine the stock's optimum size. Depending upon biological and economic factors it may be necessary to increase or decrease the fish stock's size. Harvest will then generally be reduced (increased) through a reduction (increase) in the number of tags available for the fishery, creating what would be described as a seasonal shortfall (excess demand) or an increase (decrease) in the cost of a tag.

Discretionary planning decisions, policy, must also be made. This would include determining the rate of adjustment of a fish stock or the degree of price differentiation across user groups based on socio-economic criteria including residency status and age. In short, fisheries planners are responsible for ensuring the distribution of the costs and benefits of managing and using the fisheries is equitably distributed.

5.42 Regulatory Implications

Fisheries regulators are responsible for controlling harvesting, pricing and charges in accordance with planning recommendations to contribute to the optimization of fish stocks and beneficial economic development of the fisheries. A new systematic regulatory strategy has been developed to carry out these responsibilities. The new regulatory strategy is based primarily on a system of tags and quotas, to control use in conjunction with the application of pricing to raise revenue, ration use, and equitably distribute the benefits and costs of use.

Operating this system will require developing, managing and enforcing a distribution system for tags. Tags which entitle an angler to harvest a fish stock will be made available for a fee. Data collection, will also become a more important regulatory function. Much of the necessary data on harvest and demand can be collected through the operation of the tag system. Fisheries regulators will also have to continue traditional monitoring responsibilities to gather further data on the biological status of fisheries at different rates of harvest and assist in the identification of fisheries which otherwise require immediate or ongoing priority attention. The recent conversion of hunting and fishing licences to a credit card format offers interesting possibilities in terms of the actual operation of a tag distribution and revenue collection system.

Finally, some policy decisions will be made with input from fisheries regulators. For example, identifying fisheries specific regulations, determining the optimum rate of adjustment of a fish stock, the degree of price discrimination across user groups or the rate of price increases are all policy/planning judgements which may best be made with input from field level fisheries regulators. A clear path of communications must be established and maintained between planners and regulators to allow for the transmission of data and input from regulators to planners and the transmission of harvest recommendations from planners to regulators.

5.43 Personnel

Implementing the new system will not require an unduly large number of public service personnel because of efficiency and effectiveness in personnel use. In addition to the capacity to conduct biological analysis, which will continue to play a fundamental role, the capacity to conduct economic analysis must be introduced and developed. Economic analysis of fish stocks is required to determine their long-run optimum size and thereby conduct fisheries planning. The capacity to conduct economic analysis will also have to be developed in order to properly interpret and account for political economy, distributional, issues in the regulatory system.

Fisheries regulators will have to develop and apply a new system of tags to allocate and control fisheries use as well as consult with fisheries planners regarding its operation. Other important functions such as stock monitoring and enforcement will essentially be continued unchanged although, the allocation of resources to these functions may undergo some adjustment as new priorities are identified and funds made available through the operation of the fisheries.

With respect to the location of the staff which carries out these functions, the majority of the planning analysis can occur at either central or field level locations although some central coordination is required. Fisheries regulators will continue to operate primarily at the field level although some staff could conceivably work during the summer, when fisheries use is greatest, as regulators and during the winter, when fisheries use declines, as planners.

Finally the system of planning and regulation is a multi-disciplinary undertaking which requires input from biologists, economists, administrators, technologists and conservation officers. Each should be aware of the others functions and their relationship to one another. Efforts must also be made to reduce and if possible eliminate the animosity which has traditionally characterized professional relationships between fisheries biologists and economists if fisheries management can be expected to improve.

5.5 SUMMARY

This chapter has developed and applied a system of planning and regulating the northern Ontario inland fisheries. Fisheries planners actively forecast the long-run optimum stock size for each fishery to carry through time and recommend optimal harvesting strategies. Due to the diversity across discrete fish stocks, each fish stock will have to be optimized independently because it will possess a unique optimum stock size. However, because there are in excess of 250,000 individual fisheries and an uncounted number of discrete fish stocks, fisheries planners must prioritize fish stocks for attention based on biological and economic criteria.

Fisheries regulators control and adjust fish stocks in accordance with planning recommendations. The new regulatory system is based on the use of tags and quotas, which allow resource managers to directly control resource use and thereby ensure sustainability, and a relative pricing mechanism to ration use and collect revenue. The pricing system is differentiated across and amongst user groups and fisheries based on social equity criterion. This in conjunction with regulations by fishery or user regarding daily harvest limits allows for the interpretation and incorporation of political equity objectives.

The new system of operation will allow for the setting of politically appropriate and economically feasible revenue levels and pricing structures within a system of sustainable development. Resource regulators will use a system based primarily on tags and quotas to directly control resource use and a differentiated pricing mechanism to ration output to those who derive the greatest net benefit from use and collect revenue. In conclusion, the substantive application of a relative pricing mechanism may be seen as a radical departure from traditional resource regulation practices. However, the OMNR recently stated that "opportunities to incorporate beneficiary pay principles and mechanisms into the management of Ontario's aquatic resources be investigated further" (OMNR 1992d, 17).

CHAPTER SIX

CONCLUSION

6.1 REVIEW

This thesis has conducted an economic analysis of the developmental process governing the northern Ontario inland fishery resources. Specifically, the thesis has been directed towards the economics of sustainable development for the inland fishery system of northern Ontario. Substantive review and analysis of the problem begins in Chapter Two with an account of the nature, productivity and use (harvest) of the fisheries resources in the study area. Then, the structure of the OMNR is examined along with the management organization and process which governs use and development of the resource. The chapter concludes by summarizing the biological nature of the northern Ontario inland fishery resource, its use and management.

Chapter Three provides a historical overview of the development and performance of the fisheries in the study area. The first section briefly describes the evolution of fisheries jurisdiction and administration. The next section then provides an account of those who have used the fisheries and how they have been managed. The third section presents a series of case studies which illustrate the performance of the fisheries and identifies the fundamental shortcomings in the regulatory system governing their use. The chapter concludes by summarizing the development and performance of the fisheries, and the fundamental shortcomings in the present regulatory system.

Chapter Four develops an economic model of an inland fishery, characteristic of those found in the study area, for the purpose of planning and regulating the fishery. The economic model is developed in terms of two fundamental components, a long-run analysis which is related to fishery planning and a short-run analysis which is the focus for regulation. The long-run analysis identifies the biological optimum, the economic optimum and "collapse points" for the fishery which are strategic in fishery planning. The short-run analysis describes the economic forces which exercise pressure on the fishery and determine its economic tendencies. A comparison of the harvest level established by these economic tendencies with the long-run economic optima provides a dynamic for the sustainable and economic development of the fisheries.

Chapter Five then develops and applies a system of planning and regulation for the whole system of fisheries in accordance with the preceding economic analysis of a single inland fishery. The first section, planning, elaborated the planning function to the system of fisheries in the study area and develops the process for establishing priorities in their regulation. The next section, regulation, then develops a strategy which enables regulators to control and adjust fish stocks in accordance with planning recommendations. The following section, then investigates the implications of the new system of planning and regulation for the OMNR. The chapter concludes by summarizing the system of planning and regulation and how the performance of the fisheries will improve in terms of the stated objectives.

6.2 PRINCIPAL FINDINGS

The focus of this thesis is directed towards three questions. To recapitulate, they are:

> i) To provide a historical account of the economic development of the northern Ontario inland fishery resource.
>
> ii) To provide a bio-economic model for the analysis and development of inland fishery resources on a sustainable basis.
>
> iii) To develop a planning and regulatory system for the inland fishery resources of northern Ontario directed towards their sustainability and economic development.

This section presents the principal results of the thesis in response to these questions.

First, the analysis of the historical record of the system used to regulate the inland fisheries of northern Ontario has revealed serious limitations and failures in terms of sustainable development. During the initial years of exploitation, due to the tremendous productivity of the resource relative to demand, free access characterized public policy towards fisheries. However even then free access allowed harvesting pressure to be focused on particularly attractive fisheries frequently reducing their net contribution to society and at times resulting in biological collapse.

Overtime, as demand has grown, managed access has replaced free access as the basis for public policy. The OMNR developed a hierarchal land use planning system to regulate the use and development of the fisheries. The system operates on a reactive, incremental basis and is unable to impartially determine and enforce resource allocation decisions. The result has been an ad hoc application of regulatory strategies and techniques which has led to the current situation where fisheries in virtually every district across the study area are being overharvested or are already under-producing due to over-exploitation.

Secondly, a bio-economic model of a typical inland fishery has been developed for the analysis of inland fishery resources. The model is developed in terms of two fundamental components, a long-run analysis which is related to planning and a short-run analysis which is the focus for fishery regulation. The analysis of planning deals with the long run adjustment and optimization of fish stocks. The short-run analysis, which is defined by the annual growth period, provides the basis for regulatory control of a fishery. Annual harvest is controlled in relation to annual growth in order that long run planning objectives, optimal economic development, are achieved. The model can then be applied to the planning and operation of the fishery.

Third, based on the preceding analysis, a system of planning and regulation is developed for northern Ontario inland fisheries which ensures their sustainable development. The system is developed through further discussions of fisheries planning and regulation within the institutional context of northern Ontario. With respect to planning, the model dealt with the special case of a single fishery. In the study area there are in the order of 250,000 individual fish communities and an uncounted number of discrete fish stocks which are differentiable on both biological and economic grounds. Practical considerations therefore dictate that fisheries planners prioritize fisheries for attention. Fish stocks can be prioritized for their biological condition and economic importance. The range of regulatory techniques is reviewed for application within the political economy context of the fishery system. In direct contrast to the existing management system, the techniques are applied within a systematic framework.

6.3 CONCLUDING REMARKS

This thesis has examined the performance of the management system governing the use and development of the northern Ontario inland fisheries. It has found that the system for planning and regulating the inland fisheries of northern Ontario is unable to determine or enforce economically efficient and biologically sustainable patterns of resource use. An economic analysis of a typical inland fishery has provided an alternative system of planning and regulating the fisheries directed towards sustainable and economic development. The system developed has flexibility to allow for shifting political economy considerations and is designed for long-run economy, efficiency and equity. The need for such a system will become increasingly acute as time passes and the demand for use of the fisheries continues to grow.

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APPENDICES

Appendix A. Fisheries Productivity and Harvest by Species, by User Group, For the Northwest Region, 1985.

Northwest		Fisheries Productivity by Species and Harvest by User Group					
Species	Native	Res	N-Res	Comm F	Total	MSY	Net
L. Trout	19384	38525	142909	1435	202253	463230	260977
Walleye	222402	335439	1225959	264204	2048004	3412960	1364956
N. Pike	81496	127727	745934	242213	1197370	2642821	1445451
W. Fish	142753	3482	10430	422187	578852	2291228	1712376
Sm Bass	5651	14494	101230	466	121841	707269	585428
Crappie	2000	700	4400	11323	18423		
Perch	2136	287	2039	2099	6561	1144159	1137598
Muskie						41922	
Sturgeon	9625			4276	13901		
Brook						980	
Other							
Total	489910	523228	2243328	970783	4227249	10899584	6672335

(Compilation of Northwest Region DFMPs)

Appendix B. Fisheries Productivity and Harvest by Species, by User Group, and by District For the Northwest Region, 1985

Kenora District		Fisheries Productivity and Harvest By Species					
Species	Native	Res	N-Res	Comm F	Total	MSY	Net
L. Trout	3284	7896	60912	835	72927	51400	-21527
Walleye	64534	39565	298356	129071	531526	436517	-95009
N. Pike	30780	13160	109948	172118	326006	366425	40419
W. Fish	12877	732	410	164782	178801	148240	-30561
Sm Bass	3651	4188	36031	466	44336	280680	236344
Perch	2136	250	1832	2099	6317	91039	84722
Other	4463	2574	10427	22580	40044	184815	144771
Total	121725	68365	517916	491951	1199957	1559116	359159

(OMNR 1987i)

Fort Frances District		Fisheries Productivity and Harvest By Species					
Species	Native	Res	N-Res	Comm F	Total	MSY	Net
L Trout		7100	37900		45000	30100	-14900
Walleye	12600	22000	146700	17098	198398	140000	-58398
N. Pike	12600	13300	88800	37897	152597	132100	-20497
W. Fish	12600			45103	57703	70600	12987
Sm Bass	2000	6900	45900		54800	93200	38400
Crappie	2000	700	4400	11323	18432		
Perch						40500	
Total	41800	50000	323700	111421	526921	506500	-20421

(OMNR 1987k)

Red Lake District		Fisheries Productivity and Harvest By Species					
Species	Native	Res	N-Res	Comm F	Total	MSY	Net
L Trout	2900	6900	18400	2300	30500	234600	204100
Walleye	160300	94500	307100	138000	699900	594485	-105415
N. Pike	43700	34400	288700	56900	423700	440640	16940
W. Fish	84500			260600	345100	430440	85340
Sm Bass						61200	
Crappie							
Perch						208080	
Sturgeon						10200	
Total	291400	135800	614200	457800	1499200	1979645	480445

(OMNR 1987f)

Sioux Lookout District		Fisheries Productivity and Harvest By Species					
Species	Native	Res	N-Res	Comm F	Total	MSY	Net
L Trout	14700	1659	9397		25756	75354	49598
Walleye	68068	68154	386203	66895	589320	1923928	1334608
N. Pike	17016	36117	204663	17921	275717	1435951	1160234
W. Fish	76576			182722	259298	1467973	1208715
Sm Bass		3406	19299		22705	202286	179581
Perch		37	207		244	709395	709151
Sturgeon	9625			4276	13901		
Muskie						29308	
Other							
Total	185985	109373	619769	271814	1186941	5834662	4647721

(OMNR 1987e)

Fisheries Productivity and Harvest By Species						
	Dryden District			Ignace District		
Species	Harvest	MSY	Net	Harvest	MSY	Net
L. Trout	38897	31666	-7231	34970	40110	5140
Walleye	511924	151830	-360094	261220	166200	-95020
N. Pike	296942	123775	-173167	142750	143930	1180
W. Fish	57976	100785	42809	18750	73190	54440
Sm Bass	31691	59893	28202		10010	
Perch	19834	45555	25721		49590	
Muskie	14231	12614	-1617			
Brookies					980	
Total	971495	526118	-445377	457690	483470	25780

(OMNR 1987g, 1987i)

Appendix C. Commercial Food Industry Statistics, 1990.

Commercial Food Industry Harvest in Northern Inland Water Bodies 1990			
Species	Harvest (Kg's)	Gross Value ($)	$/Kg
Burbot	23,713	6,025.00	0.25
Crappie	4,140	19,505.00	4.71
Lake Herring	86,456	39,624.00	0.45
Lake Trout	21,989	40,706.00	1.85
Lake Whitefish	463,548	729,485.00	1.57
Northern Pike	86,185	139,489.00	1.62
Sauger	75,532	192,214.00	2.54
Sturgeon	9,424	63,477.00	6.73
Suckers	268,194	115,528.00	0.43
Walleye	141,700	433,153.74	3.06
White Bass	195	309.30	1.58
Yellow Perch	20,497	68,742.00	3.35
Caviar	40	10,680.00	120.00
TOTALS	1,201,613	1,858,937.00	1.54

(OMNR 1990b, 1)

Appendix D. Commercial Recreational Statistics, 1985.

Estimated Effort (1000's of days) By Non-Resident Anglers By Region and Type of Water Body				
	Type of Water Body			
Region	Lake	River	Unknown	Total
North West	1,449.9	226.7	33.1	1,709.7
North Central	408.3	54.6	18.1	481.1
Northern	193.9	46.6	**	251.6
North Eastern	558.9	117.1	**	690.1
Total	2,6111.0	1,095.6	98.3	3,132.5
Provincial Total	4,230.9	1,095.6	98.3	5,452.2

(OMNR 1990f, pg 5-25).

Estimated Percent of Non-Resident Anglers Choosing First Preference Species By Region Fished						
	Region Fished					
Species	North West	North Central	Northern	North Eastern	Total	Provincial Total
Bass	4.2%	7.5%	4.2%	10.8%	6.1%	15.0%
Northern Pike	12.3%	15.4%	18.1%	21.3%	15.2%	13.9%
Perch	0.3%	2.9%	0.5%	5.1%	1.7%	2.3%
Walleye	69.9%	64.2%	69.1%	42.4%	62.1%	54.3%
Trout	6.3%	5.9%	3.5%	10.1%	6.8%	6.1%
Other	3.2%	0.4%	0.6%	4.6%	2.8%	4.0%
No Preference	3.8%	3.8%	4.0%	5.7%	5.3%	4.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

(OMNR 1990f, pg 6-24)

Numbers of Fish Caught (in 1000's), By Non-Resident Anglers, By Region and Species						
	Region Fished					
Species	North West	North Central	Northern	North Eastern	Total	Provincial Total
Bass Lg	38	**	**	117	155	1,393
Bass Sm	862	370	53	515	1800	3,704
Muskie	31	**	**	**	31	71
Panfish	179	14	13	527	733	6,296
Perch	1,004	721	144	1462	3,331	8,301
N Pike	4,118	1,338	764	829	7,049	8,475
Salmon Chinook	**	**	**	**	**	22
Salmon Coho	**	**	**	**	**	12
Smelt	**	**	**	**	**	624
Trout Brook	**	**	**	143	143	220
Trout Brown	**	**	**	**	**	14
Trout Lake	207	46	**	36	289	358
Trout Rainbow	**	**	**	**	**	54
Walleye	6,377	2,059	791	901	10,128	12,906
Whitefish	15	10	26	18	69	118
Other	80	**	**	115	195	844
Total	12,929	4,623	1,819	4,723	24,094	42,603

(OMNR 1990f, pg 5-27)

Numbers of Fish Kept (in 1000's) By Non-Resident Anglers, By Region and Species						
	Region Fished					
Species	North West	North Central	Northern	North Eastern	Total	Provincial Total
Bass Lg	18	**	**	23	41	432
Bass Sm	269	117	18	171	575	1,299
Muskie	5	**	**	**	5	17
Panfish	128	**	**	208	336	3,602
Perch	288	566	90	905	1,849	4,678
N Pike	1,016	340	145	288	1,789	2,160
Salmon Chinook	**	**	**	**	**	9
Salmon Coho	**	**	**	**	**	9
Smelt	**	**	**	**	**	617
Trout Brook	**	**	**	49	49	83
Trout Brown	**	**	**	**	**	10
Trout Lake	126	31	**	25	182	216
Trout Rainbow	**	**	**	**	**	23
Walleye	2,216	614	290	405	3,525	4,897
Whitefish	9	5	**	11	25	70
Other	31	**	**	56	87	380
Total	4,112	1,704	571	2,183	4,872	18,500

(OMNR 1990f, pg 5-28)

Value (1000's of $) of Expenditures made in Ontario in 1985 In Part for the Purpose of Sportfishing	
Expenditure Category	Thousands of Dollars
Accommodation	42,130
Campsite Fee's	9,167
Groceries	36,447
Restaurants	16,453
Alcohol	12,914
Travel Cost	31,786
Boat Rentals	11,659
Owned Boat Costs	11,172
Fishing Supplies	11,062
Guides	4,767
Other Costs	1,683
Total	189,241

(OMNR 1990f, pg 5-54)

Number (1000's) and Value (1000's of $) of Package Deals Purchased for Sport Fishing									
Fly-Inn		Lodge		Charter Boat		Other		Total	
No#	$	No#	$	No#	$	No#	$	No#	$
44	30,107	42	23,676	4	1,608	5	2,176	91	57,5 67

(OMNR 1990f, pg 5-53)

Most Important Resource Attribute, All Anglers	
Resource Attribute	Percent Chosen as First Preference
Water Quality	14.6%
Beauty of Surroundings	13.6%
Weather Conditions	11.2%
Privacy	9.1%
Access to Wilderness	8.8%
Species Desired	7.9%
Wild Fish	7.3%
Number of Fish Caught	6.8%
Size of Fish Caught	6.7%
Source of Food	2.6%

(OMNR 1988j)

Appendix E. Recreational Angling Statistics, 1985.

Estimated Effort (1000's of days) By Resident Anglers By Region and Type of Water Body				
	Type of Water Body			
Region	Lake	River	Unknown	Total
North West	620.2	123.9	**	749.5
North Central	861.5	240.7	**	1,132.5
Northern	856.8	274.8	28.5	1,160.4
North Eastern	3,117.6	851.8	82.4	4,055.1
Total	5,456.1	1,491.2	110.9	7,097.5
Provincial Total	19,670.5	8,678.9	652.2	29,001.5

(OMNR 1990f, pg 4-25).

Estimated Percent of Resident Anglers Choosing First Preference Species By Region Fished						
	Region Fished					
Species	North West	North Central	Northern	North Eastern	Total	Provincial Total
Bass	3.5%	5.7%	5.7%	10.2%	8.0%	18.2%
Northern Pike	0.0%	2.2%	9.3%	5.8%	5.15%	4.7%
Perch	0.0%	0.0%	0.6%	3.2%	1.9%	3.3%
Walleye	72.0%	70.3%	55.4%	42.5%	51.7%	33.4%
Trout	15.3%	19.0%	20.2%	28.3%	23.8%	27.4%
Other	4.6%	1.6%	3.4%	3.2%	3.1%	5.3%
No Preference	4.5%	1.2%	5.5%	6.8%	6.35%	7.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

(OMNR 1990f, pg 6-23)

Numbers of Fish Caught (in 1000's) By Resident Anglers By Region and Species						
	Region Fished					
Species	North West	North Central	Northern	North Eastern	Total	Provincial Total
Bass Lg	**	**	**	253	253	4,291
Bass Sm	96	190	259	1,252	1800	10,567
Muskie	**	**	**	10	10	268
Panfish	**	**	**	520	520	6,785
Perch	322	195	348	2,839	3,704	22,669
N Pike	563	1,007	1,224	1,445	4,239	7,587
Salmon Chinook	**	**	**	97	97	1,049
Salmon Coho	**	**	**	51	51	533
Smelt	**	1,522	**	4,989	6,511	18,310
Trout Brook	**	166	129	739	1,034	3,610
Trout Brown	**	**	**	42	42	508
Trout Lake	148	213	66	874	1,301	2,408
Trout Rainbow	**	85	31	145	261	2,503
Walleye	1,446	1,904	1,385	2,214	6,949	12,737
Whitefish	**	24	87	100	211	631
Other	**	42	58	565	665	7,017
Total	2,958	5,404	3,769	16,134	27,648	101,473

(OMNR 1990f, pg 4-31)

Numbers of Fish Kept (in 1000's) By Resident Anglers By Region and Species						
	Region Fished					
Species	North West	North Central	Northern	North Eastern	Total	Provincial Total
Bass Lg	**	**	**	148	148	1,585
Bass Sm	**	70	54	509	633	3,899
Muskie	**	**	**	**	**	71
Panfish	**	**	**	**	**	1,504
Perch	**	65	141	1,182	1,388	12,025
N Pike	95	271	520	634	1,520	2,663
Salmon Chinook	**	**	**	56	56	467
Salmon Coho	**	3	**	36	39	281
Smelt	**	1,506	**	4,836	6,342	16,659
Trout Brook	**	108	95	476	679	1,968
Trout Brown	**	**	**	**	**	237
Trout Lake	106	171	48	662	987	1,703
Trout Rainbow	**	56	29	115	200	1,324
Walleye	901	1,126	935	1,638	4,600	8,501
Whitefish	**	**	48	71	121	474
Other	**	**	**	217	217	2,531
Total	1,420	3,448	2,052	10,678	19,018	55,981

(OMNR 1990f, pg 4-32)

Value (in 1000's of $) of Expenditures, Made By Residents in 1985 in Part for the Purpose of Sportfishing						
	Region of Expenditures					
Expend Category	North West	North Central	Northern	North Eastern	Total	Provincial Total
Accommodat ions	**	**	**	$1,199	$1,199	$47,456
Camping Fees	**	$924	$342	$2,171	$3,347	$32,181
Groceries	2,246	$7,134	$4,105	$16,834	$30,499	$141,786
Alcohol	**	$468	$388	$1,782	$2,638	$37,001
Travel Costs	$2,720	$8,789	$4,991	$18,375	$34,875	$194,157
Boat Rentals	**	**	**	$563	$563	$18,374
Owned Boat Costs	$2,088	$2,563	$1,850	$7,836	$14,337	$75,277
Fishing Supplies	$888	$2,071	$1,680	$5,241	$9,880	$56,403
Guides	**	**	**	**	**	$1,640
Other Costs	**	**	**	$145	$145	$5,099
Total	$9,263	$25,235	$15,388	$59,282	$109,118	$666,982

(OMNR 1990f, pg 4-55)

Number (1000's) and Value (1000's of $) of Package Deals Purchased By Resident Anglers for Sport Fishing									
Fly-Inn		Lodge		Charter Boat		Other		Total	
No#	$	No#	$	No#	$	No#	$	No#	$
16	9,776	29	13,052	36	4,532	**	**	77	29,456

(OMNR 1990f, pg 4-54)

Appendix F. Allocation Priorities.

The Ministry of Natural Resources identified the following allocation priorities and rationale for Ontario's fisheries in SPOF II (Strategic Plan for Ontario's Fisheries), 1992:

1. All residents of Ontario benefit from healthy aquatic ecosystems.

"multiple use presents the best chance to optimize benefits from the fishery. In terms of the allocation process, this does not mean that all stakeholder will have equal access to every waterbody. In some instances, it may be decided by those involved in the allocation process that one or two groups may have sole access to a particular resource."

2. The first allocation is to the conservation of the resource.

"A bank account consists of capital (principal) and interest (surplus) generated by the capital. If benefits from the account are to be sustained indefinitely, the capital must be maintained or increased, and only interest is spent. The concept of sustainable development is intrinsic in this principle."

"In fisheries allocation, we allow fisherman to take only the interest which the group has termed annual allowable harvest. The capital, the number of fish required to maintain fish populations, is maintained or enhanced. Where fisheries have been depleted and are in need of rehabilitation, more fish must be allocated to resource conservation and fewer will be allocated to fisherman until stocks are replenished."

3. Allocation of the resource shall be based on the best scientific information available.

"If gaps occur in the data needed to make a sound allocation decision, then the group felt the allocation process should proceed with the best information available and plan on the conservative side to provide a buffer reserve for resource conservation. Close monitoring after an allocation has been made is required to determine if the original decision was appropriate."

4. After conservation, and the allowance for the buffer reserve where information is incomplete, the first priority of allocation must satisfy all Crown

obligations, such as any native aboriginal rights to the resource.

"It was agreed by the group that Native rights to the resource, where defined, have first priority on all fish allocations. However, where Native rights to the resource have not been defined across the province, then it was agreed by the group that allocation decisions should not be deferred. In these cases, it will be up to the resource managers in conjunction with the affected Native groups to obtain the best information possible concerning Native rights and then proceed with the allocation process. It was also recognized that present allocation decisions may have to be altered in the future as a result of any agreements between Native people and the Government. The amount of the Native people's allocations can only be determined on a case by case basis."

5. Allocation decisions shall be applied on an individual lake\river or watershed basis.

"No single allocation mechanism can be applied across the whole province. There are several reasons for this. Stakeholder pressure on the fishery varies across the province. Some lakes are more productive than others. Some lakes are near large population centres. And some lakes have several stakeholder interests. The group decided that allocation decisions should be made on a lake river or watershed basis. This will place a large burden on the province to carry out the allocation. Consequently, it was suggested that priority for making allocation decisions be given to waterbodies with existing or potential user conflicts, stressed fisheries and waterbodies with competing industrial users."

6. Allocation of the remaining fisheries resources shall be a fair and equitable open public process which will also consider social and economic benefits.

"As shareholders of the fisheries resource, the general public has a right to know about the rationale (e.g. biological, social, economic) for making fisheries allocation decisions. Provision should be made in the allocation process for the involvement of the general public."

"The mechanism for allocation decisions should include the Government, the stakeholder of the resource and the general public. These groups will share information and come to an agreement on the allocation that is to be made. The Ministry as chief steward of resources will ratify the decision. The Minister, in the event of disputes, will make final decisions. Accountability rests with both parties to ensure resource conservation."

A predecessor to the SPOF II report, "An Allocation Policy for Ontario's Fisheries, Report of SPOF" (OMNR, 1978), provided a more explicit discussion of the priorities and\or rights of the various user-groups demanding resource allocations.

1. (pg 6) Resource maintenance, the protection of the self-renewing production of the fisheries resource, must have priority over allocation.

2. (pg 7) Fisheries resources are held in trust for all residents of Ontario by the Crown in right of Ontario.

3. (pg 7) After conservation of resource maintenance, fisheries are to be managed according to stated public priorities to produce optimum sustained benefits.

4. (pg 11) After ensuring the perpetuation of the fisheries resource, the second priority is to make available fish and fishing opportunities according to the needs of Ontario residents. These needs can be assessed by determining (1) the stated rights, if any, of some Treaty Indians requiring an explicit allocation and (2) the optimum benefits which can be allocated after satisfying resource maintenance needs."

5. (pg 13) Of the remaining user groups, people with subsistence and\or traditional needs must be considered a high priority. ... It is expected that very few people will actually qualify for inclusion in this group and most will live in northern areas.

6. (pg 14) Since the resource is held in trust for residents of the Province by the Crown in right of Ontario, it follows that resident fisherman are important clients and must be designated a high priority user group.

7. (pg 15) Business enterprises actually harvesting fish for sale (the commercial food fishery) or business which supply goods and services to the angler (outfitters, tourist operators) contribute fewer overall benefits to the residents of the Province than do the sport fisherman.

It should be pointed out however, that significant proportions of the Great lakes fish stocks, for instance, are not readily accessible to anglers. As well, many fish species which are not desired by sport fisherman can and should be used for commercial purposes. We feel commercial fishing will continue to fill a viable role in many parts of the Province.

8. (pg 15) In allocation decisions, only benefits accruing to residents of Ontario are considered. Non-residents of Ontario have no inherent rights to fish in Ontario. ... This principle will have important consequences in allocation decisions with respect to non-residents, tourist camp operators and fisherman, should competition or conflict occur with residents.

The document then went on to provide the following list of allocation priorities by user group (pg 17):

"Priority Ranking:	Allocate To:
1.	All residents (Maintenance and\or rehabilitation of the resource).
2.	Native people with Treaty fishing rights.
3.	People with subsistence and\or traditional needs.
4.	Resident Sport fisherman.
5.	Business enterprises-priority between commercial fish or sport fishing industries, to be decided on the basis of optimum benefit to the residents of Ontario.

Appendix G. Proposed Allocation Process.

Translating the preceding allocation priorities into resource allocations is the final step in the process. In 1990, the MNR proposed the following process in the SPOF II "Allocation of Aquatic Resources, Working Group Report" (MNR, 1990), set out in seven steps:

1. MNR in consultation with stakeholder would determine what waterbodies in a particular district require a formal allocation. Criteria would be jointly developed to determine the selection of the waterbodies. MNR would prepare the initial listing which would be reviewed by the stakeholder and the public to determine priorities.

2. An allocation committee should be formed. They would prepare terms of reference outlining the purpose, duties, membership, tenure, chairmanship, payment of expenses, etc. for the allocation process. MNR and the stakeholder would review allocation principles. The expectations and demands from each stakeholder would be identified and placed on record. At this stage misconceptions amongst the stakeholder may be identified.

3. MNR in collaboration with stakeholder would quantify the amount required for resource conservation. Constraints to the harvest would be identified. Allowable yields for the species of interest would be determined. These figures would be shared between the Ministry, the stakeholder and the public at large. In some instances, the stakeholder or the public may wish to carry out independent assessments.

4. MNR will aggregate the requirements of the various stakeholder and compare to resource availability. MNR will identify those species where conflicts exist. Conflict resolution may occur without the need for formal allocation of resources. Other options and management techniques to reduce resource overharvests may be available.

5. Where request for fish exceed demand, MNR in cooperation with stakeholder will try to resolve the allocation issue. To achieve this, an analysis will be carried out looking at such factors as current and historical use of the resource and the economic benefits generated by the various stakeholder such as jobs, income, expenditures and investments. It is likely that

data gaps will occur and that in many instances it may be difficult to compare the measures used by the various stakeholder.

6. Where request for fish exceed demand, MNR in collaboration with stakeholder determine options such as compensation, trade-offs, beneficiary pay mechanisms and other techniques to reconcile the demand with fish supplies. Consider future plans, developments and apparent demands on the resource. Build consensus on techniques to be used and management approach. Determine and list the implications of the various options to the resource and the stakeholder.

7. MNR, in collaborations with stakeholder, prepare the final report with recommendations. If consensus exists then the report can be approved at the local\regional level. If not, then the report should be forwarded to the Minister for resolution. In any instance, a pubic review of the options and the rationale for the final decision is required.

Currently a variety of techniques are in place to implement resource allocations. The following describes these by user group.

Since 1984, commercial food fisheries have been managed through a system of licences with quota's by species attached. Prior to this time quota's were not generally attached to individual licences, although some gear restrictions such as mesh size and number of nets were, and are still, enforced. Commencing in 1992 a 2% royalty on commercial harvests will be implemented. There are no longer any new quota's being issued by the MNR for sport species in the northern inland lakes of Ontario. The following quote is taken from MNR 1991 (Final Report on the Commercial Fish Review):

"<u>Northern Inland Waters</u>

District fisheries management plans (DFMPs) are in place in most Districts in the north. DFMPs provide the general direction that no new commercial fisheries will be created. Instead, efforts will be made to convert the use of fish to recreation through tourism to derive greater economic benefits from fish stocks.

The long-term expectation for commercial fisheries in the Northern Inland Waters is an eventual conversion of the majority to more beneficial use by local residents through the tourist industry."

A willing-buyer willing-seller program was also introduced in 1984. Any commercial fisherman who wishes to retire may only sell his quota to a relative or the government, and no one else. The government will purchase the harvesting equipment at market value and the quota at twice the present market value of one years gross landings.

Control is exercised on the establishment of new tourism facilities catering to commercial recreational anglers on Crown land, via the issuance of land use permits as determined through the MNR's land-use planning process. No control however is exercised on the expansion of existing facilities or the establishment of facilities on private land.