THE WALLEYE SPORT FISHERY OF THE LOWER RED RIVER

by
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"THE WALLEYE SPORT FISHERY OF THE LOWER RED RIVER"

A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfilment of the requirements of the degree of Master of Natural Resources Management.

By

Mr. Keith Kristofferson

Abstract

The lower Red River provides one of the best trophy walleye (stizostedion v. vitreum) sport fisheries in Manitoba. Anglers claim that trophy walleye catches have declined due to the Lake winnipeg commercial fishery. This study examined the relationship between angling catches of trophy walleye in the lower Red River and impacts from commercial, recreational and subsistence fisheries and changes in the aquatic environment.

Angling catches of trophy walleye decreased from 1985 to 1992, mainly as the result of reduced flows in the Red River and declining angler effort. Impacts by the recreational fishery are minimized by the increasing use of catch and release fishing practices. Live-release walleye tournaments may require monitoring and guidelines to assess and mitigate future impacts. Native subsistence fishing on the lower Red River is not affecting trophy walleye catches, but may require further monitoring to determine sustainable harvest levels. Monitoring of commercial gillnet locations and catches of trophy walleye, indicate that walleye are much more vulnerable to commercial fishing impacts than in the recreational or subsistence fisheries. Trophy walleye reside primarily within the south basin of Lake Winnipeg and occupy the lower Red River for brief time periods in spring and fall. This is reflected in the vast differences in trophy walleye harvests between the sport and commercial fisheries. Angling catches of trophy walleye in the lower Red River comprise less than one percent of commercial south basin catches.

Trophy-sized walleye constitute part of the spawning stock which contribute to future walleye recruitment and yield. Management should ensure that commercial harvests are sustainable and establish maximum mesh size limits and delay the opening of spring seasons to protect this size range. Increasing concentrations of toxic un-ionized ammonia and sudden changes in water turbidity, emphasize the need for an ecological approach to manage the aquatic environment.

The results of this study were used to evaluate the Red River Management Plan. The plan was developed in 1988 and based on the biology of a river-resident population of channel catfish and generalized to include walleye. The plan was not effective in preventing the present resource conflict. A single species "trophy" approach may have created expectations among anglers for consistent and numerous catches of walleye, which vary annually with river flow rates. The recommendations of this study will be used to modify and supplement the Red River Management Plan, as part of a more comprehensive and co-ordinated approach to ensure the sustainability of the valuable fish resources of the lower Red River.

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Chapter 1

Introduction

The lower Red River (fig. 1) is Manitoba's most popular angling fishery (Lysack 1986a). The 1985 Canadian Sport Fishing Survey estimated that 9% of total angler days in Manitoba were spent in this area. The lower Red River produced more trophy size walleye than any other river system in Manitoba (Janusz and O'Connor 1985). Lysack (1986b) reports that anglers catch an average of 15000 kg of walleye annually.

Scaife (pers. comm.) used the expenditure method to estimate the annual value of the Red River angling fishery at approximately 7.4 million dollars. Angling can be consumptive (catch and eat) or non-consumptive (catch and release). Anglers are becoming more specialized in their use of boats, fishing gear and fishing techniques. This trend may impact the resource base through increasing catch efficiency and a species specific approach.

Commercial fishing on Lake Winnipeg impacts the walleye resource base through the intensity and volume of operation. Walleye stocks of the lower Red River are subject to increasing demands from sport, commercial and subsistence user groups. The aquatic environment is also being impacted by industrialization and urban development. These impacts are complicating management of this multiple-use resource base.

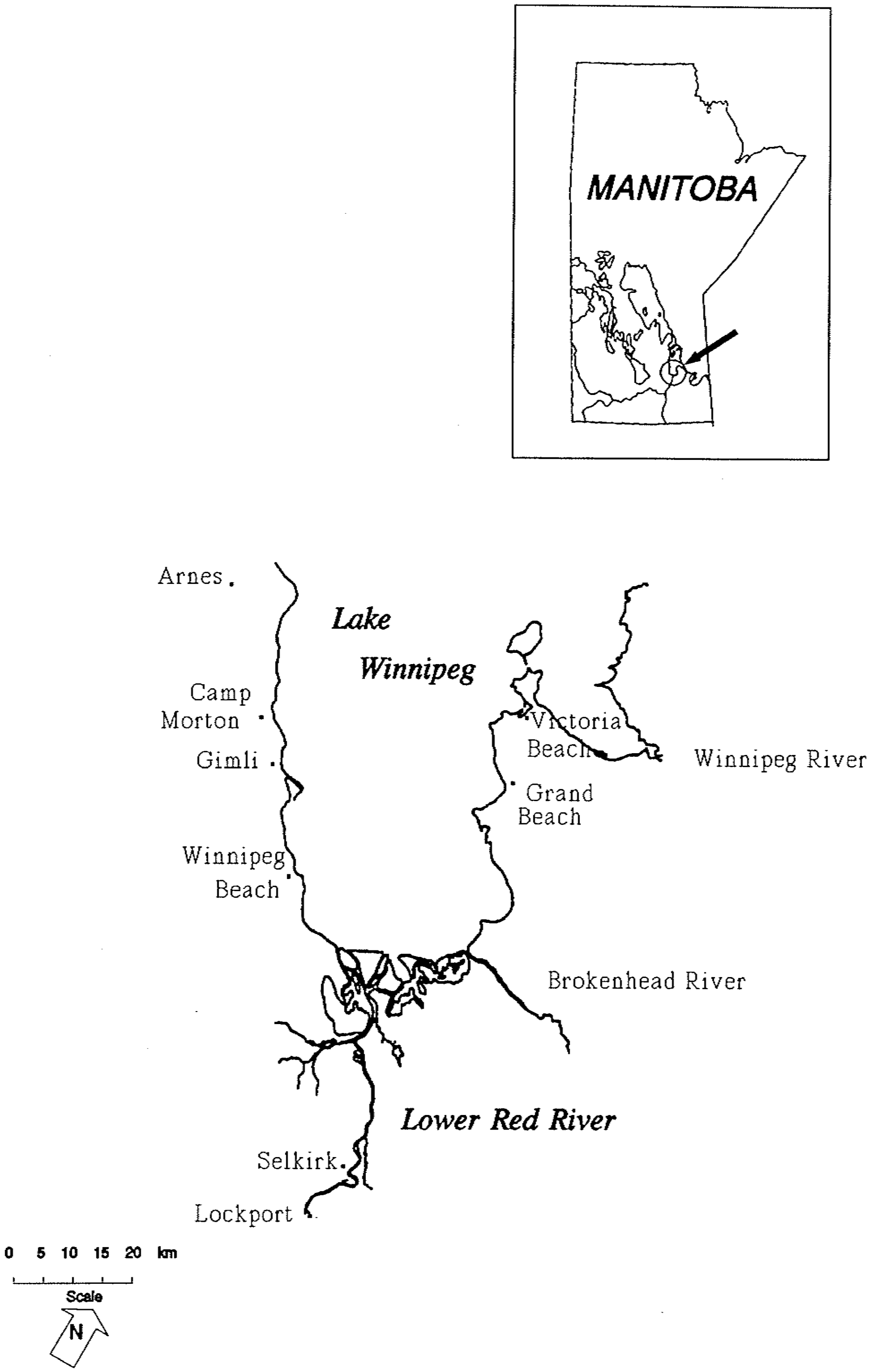

Fig. 1. The lower Red River - Lake Winnipeg study area.

1.1 Problem Statement

Anglers on the lower Red River have complained of decreasing catches of large walleyes in recent years. They focus on the Lake Winnipeg commercial fishery for causing the decline, through obstruction of fish movements into the mouth of the Red River and over-harvest. Information is required to assist in the resolution of this sport-commercial resource conflict. Current management practices may require revision to achieve a solution.

The problem has three components:

1) to determine if angling catches of large walleye, have decreased in the lower Red River in recent years.

2) to relate decreases in angling catches of large walleyes to changes in abundance and/or distribution patterns as the result of:

   (i) impacts by the recreational angling fishery

   (ii) impacts by the Lake Winnipeg commercial fishery

   (iii) environmental fluctuations

3) to make management recommendations to improve the existing situation.

1.2 Objectives

Specific objectives include collecting and analyzing historical and current information to:

a) describe walleye abundance and distribution patterns in the lower Red River - Lake Winnipeg study area from:

- master angler catch records
- tag and recapture studies

b) determine recreational, domestic and commercial fisheries impacts on the walleye stocks of the lower Red River from:

- angler creel survey studies
- angling derbies
- native subsistence walleye harvests
- Lake Winnipeg commercial walleye harvests
- commercial gillnet sets near the Red River mouth
- radio-telemetry tracking of walleye movements

c) document environmental changes in the lower Red River over the course of the study period in:

- monthly flow rates
- water quality parameters

d) review and revise current management practices, to aid in the resolution of the resource conflict and to sustain future multiple resource use

1.3 Limitations

The present study is limited by the lack of long term, catch/effort data, for anglers on the lower Red River. Monitoring of walleye movements was confined to daylight sets, to avoid creating a navigational hazard. Gillnet mesh sizes used in floy-tagging, could not be standardized. The study was primarily restricted to two, six month open water seasons.

Chapter 2
Literature Review

2.1 Background

2.1.1 The Red River

Lysack (1987) describes the Red River as a slow flowing prairie river, originating in Minnesota and draining an area of 287,500 km². The Red River flows through the Netley-Libau Marsh before emptying into Lake Winnipeg. The marsh represents a deltaic flood-plain containing 17 major lakes which comprise an area of 12,141 ha (Janusz and O'Connor 1985). The shallow lakes and interconnecting channels have a high potential for fish production (Janusz and O'connor, 1985). Red River hydrology has been described by Brunskill et al. (1980).

2.1.2 The lower Red River Walleye Sport Fishery

Wall (pers. comm.) describes the following components of the lower Red River sports fishery. A fall and winter walleye (Stizostedion v. vitreum) fishery concentrates on large (>1.6 kg) walleye that move into the river in September and October. A channel catfish (Ictalurus punctatus) fishery occurs during May and June. Other species are angled the rest of the year.

Janusz and O'Connor (1985) report that angling, commercial bait fishing, commercial rough fishing and native domestic fishing occur in the lower Red River. The bait fishery on the lower Red River has been described by Lysack (1987) and the catfish sport fishery by Macdonald (1990).

Macdonald (1990) found that the city of Winnipeg and the town of Selkirk currently exert the greatest fishing pressure on the Red River sport fishery.

2.1.3 Sport Fishing Mandate

Management of Manitoba's sport fisheries includes protecting, maintaining and enhancing the fisheries resource base, while providing recreational angling opportunities for residents (Macdonald 1990). It also represents generating an acceptable economic benefit to the Province from the use of the resource by industry and non-resident anglers (Macdonald 1990). This is accomplished primarily through regulations controlling harvest limits, barbless hooks, catch and release, size limits and user involvement in management decisions.

2.1.4 Walleye Sport Fishing Regulation Changes

Special regulations were designed for the Red River in 1989 and included a maximum annual possession limit of one walleye over 70 cm and the mandatory use of barbless hooks. Catch and release fishing practices were promoted to reduce angling mortality on walleye in the Red River. Provincial maximum size limits remain at 55 cm for walleye and the use of barbless hooks was mandatory in 1990. Walleye daily angling limits were reduced from eight to six, in Manitoba in 1990.

2.1.5 The Red River Management Plan

A fisheries management plan for the lower Red River was developed in 1988, to provide a basis for resource allocation and management decisions. The plan was designed to maximize benefits from the fishery, while minimizing resource use conflicts. The plan calls for the management of the Red River sport fishery as a high quality trophy fishery.

This requires maintaining a "sufficient" population through a fairly distributed, combined harvest among sport, commercial and domestic fisheries. The plan advocates making management decisions in the absence of biological information, which is difficult to collect due to fish community complexity, budgetary, staffing and time constraints. The plan was to be implemented by identifying and assigning various levels of responsibility to representative user groups.

2.1.6 Lake Winnipeg

Lysack (1986a) describes Lake Winnipeg as the thirteenth largest freshwater lake in the world. It is 436 km long, 111 km wide and covers a surface area of 23,750 km^2. The lake consists of three distinct areas based on physical shape: the north basin, channel and south basin (Lysack 1986a).

Lysack (1986a) reports that Lake Winnipeg is comparable to a river system with a relatively short (3-5 yr) water retention time, where physical and biological processes are closely tied to the water-flow characteristics of connecting rivers. Brunskill et al. (1980) have previously described the physical and hydrological features of Lake Winnipeg.

Remnant (1991) described the fish community of Lake Winnipeg as consisting of 16 families, 28 genera and 48 species. He lists the species composition by trophic level.

Heuring (1993) notes the introduction of four new species into Lake Winnipeg: common carp (Cyprinus carpio) in 1938, white bass (Morone chrysops) in 1963, black crappie (Pomoxis nigromaculatus) and rainbow smelt (Osmerus mordax) in 1990.

2.1.7 Lake Winnipeg Commercial Fishery

Gislason et al. (1982) report that Lake Winnipeg is the site of Manitoba's most important commercial fishery, harvesting 41 % of Manitoba's total production and 10 % of the freshwater catch in Canada. Walleye and sauger (Stizostedion s. canadense), are harvested extensively in the south basin and walleye and whitefish (Coregonus clupeaformis) in the channel and north basin.

Remnant (1991) reports the annual commercial harvest quota is set at 6.4 million kg for these three species and that catches have averaged 85% of this quota in recent years.

The commercial fishery is regulated by limited entry, individual catch quotas, fixed seasons and by gill net mesh size and length restrictions. Campbell (pers. comm.) indicates that approximately 2,100,000 kg of walleye has been harvested annually from these areas. Scaife (pers. comm.) has valued the Lake Winnipeg commercial fishery at $34.3 million.

Lake Winnipeg commercial fisheries have been described by Kennedy (1954), Doan (1959), Hewson (1959, 1960), Davidoff et al. (1973), Lysack (1980, 1981, 1982, 1983, 1984, 1986), Remnant (1991) and Heuring (1993).

2.1.8 Commercial Fishing Mandate

The Five Year Report to the Legislature (1989) describes establishing a commercial fishing mandate to maintain a viable commercial fishing industry, where participants can earn a reasonable return for their investment and time with limited social disruption. The report states that individual operators should have the opportunity to earn incomes comparable to that received by their counterparts in other resource-harvest industries, in order to remain economically viable.

An individual quota entitlement system replaced a former "point" system in the spring of 1986, as part of a new allocation process. The new system acknowledges tenure in user access rights. The Lake Winnipeg quota entitlement system has been described by Wysocki (1981) and Scaife (1991).

2.1.9 Lake Winnipeg Regulation Changes

Lake Winnipeg regulations have been described by Beyette (1980), Heuring (1993) and annually in the Manitoba Gazette.

2.1.10 Lake Winnipeg Commercial Fisheries Management Plan

Swanson (pers. comm.) reports that a management plan is currently being developed for Lake Winnipeg. Specific goals include improving the biological and economic sustainability of the commercial fishery, meeting community needs through effective management and minimizing conflicts between commercial, sport and aboriginal users.

2.2 Walleye Biology

2.2.1 Walleye Habitat Requirements

Kitchell et al. (1977) found ideal walleye habitat to occur in large, temperate rivers with sand or gravel bottoms, low current velocity, reduced light penetration, optimum temperatures for growth and reproduction, and well-oxygenated spawning grounds. Christie and Regier (1988) observed that walleyes prefer an average water temperature of 20 degrees C, for maximum growth. Conditions for walleye are optimal in the Red River and Netley-Libeau marsh (Janusz and O'Connor 1985).

Machniak (1975) reported that water temperature appears to be the controlling influence for the walleye spawning run. Both walleye and sauger exhibit negative phototropism (light avoidance), with sauger reacting more strongly than walleye (Ali and Anctil 1968). This results in walleye feeding at twilight in clearer water, while sauger inhabit more turbid waters and feed throughout the day (Ali and Anctil 1968).

2.2.2 Walleye Diet

Carpenter et al. (1985) describe predators such as walleye, as playing an important role in structuring aquatic ecosystems, both directly through consumption of prey populations and indirectly through the alteration of energy flow and nutrient cycling at lower trophic levels. Knight et al. (1984) conclude that spottail shiners (Notropis hudsonius), emerald shiners (Notropis atherinoides) and yellow perch (Perca flavescens) constitute the major portion of the walleye diet in areas where they are abundant. Scott and Crossman (1973) report that these three species are the most important forage species in Canadian lakes.

2.2.3 Walleye Movement and Migration

Machniak (1975) describes the extensive distribution of walleye, from as far north as the Mackenzie delta and south to Texas. Machniak (1975) found that walleyes may display homing behaviour, returning annually to particular spawning sites, in addition to seeking a suitable spawning area. Dickson (1963) found that in addition to spawning movements, walleye may also make regular feeding movements which can correspond with certain forage species runs.

Lysack (1986a) reports that Red River walleye stocks are not distinct and originate from Lake Winnipeg . Clarke et al. (1980) observed that walleye move in and out of the Red River and Lake Winnipeg with regular frequency. The timing of spawning runs and feeding migrations appear to be key biotic factors which seasonally affect fish community structure (Janusz and O'connor 1985).

Derksen (1978) found the general pattern of walleye movements to coincide with the prevailing lake currents on Lake Manitoba. Edwards and Howard (1980) demonstrated that walleye stocks were attracted and maintained in the Waterhen River system during periods of high continuous flows.

2.2.4 Walleye Diseases

Margenau et al. (1988) describes lymphocystis as a chronic, slowly developing viral disease of connective tissue cells, commonly found in walleye populations as a result of infection. This infection is characterized by a proliferation of uncontrolled tissue growth, often visible as pinkish-white blobs of varying size, which may occur over the entire body of a walleye or sauger. They report that this disease does not significantly increase walleye mortality. Robert (1992) found increased bacterial infections on walleye following the use of improper handling procedures by anglers.

2.2.5 Population Dynamics in an Intensive Commercial Fishery

Lysack (1976) describes the population dynamics (production and yield) of exploited walleye stocks as being based on estimates of mortality, growth, population size, and fishing effort. Other parameters of stock assessment include a description of maturation, reproduction, and recruitment (Lysack 1976).

Lysack (1976) observed that yield was extremely variable at all levels of exploitation, due to changes in the environment of the stock. He concluded that recruitment of walleye year classes varies annually. Wolfert (1969) found that prolonged over-harvest of fish stocks resulted in compensatory responses involving increases in: growth rate, volume of eggs produced and sexual maturity.

Regier and Loftus (1972) observed that an growth rate increases cause younger fish to enter the fishery. As yields decrease, a new equilibrium yield is determined by abundance, growth and mortality. They found that as growth and mortality rates stop increasing, fishing yield and catch per unit effort begin to oscillate from year to year. This may result in fish stocks decreasing to the point where the fishery collapses.

2.2.6 Habitat and Environmental Changes

Lysack (1986a) reports that over-harvest and increasing pollution of rivers flowing into Lake Winnipeg's south basin, are deteriorating the stability of the percid community. Other impacts on the aquatic environment of the Red River include changes in the hydrological flow regime. Macdonald (1990) noted reductions in the mean monthly flow rates of the Lower Red River beginning in 1988.

Stewart (pers. comm.) believes that lower water flows have resulted in more river dredging, which has consequently increased turbidity levels. Changes in water turbidity can effect the local distribution patterns of walleye (Stewart pers. comm.).

Kennedy (1948) concluded that increased turbidity levels in Lake Manitoba during the drought of the 1930's, caused an increase in sauger production over walleye production. O'Connor (pers. comm.) contends that reduced flow rates may have altered forage fish production and distribution in the Netley-Libeau marsh.

Gurney (1991) studied the effluent concentrations of untreated raw sewage which flows into the Red River from the City of Winnipeg during heavy rainstorms, as retention ponds overflow. She found that this resulted in elevated levels of coliform bacteria and un-ionized ammonia in the lower portions of the Red River. Un-ionized ammonia concentrations have exceeded provincial water quality standards with increasing frequency over the last ten years, with maximum levels occurring during the fall and winter. Shepherd and Bromage (1988) report that un-ionized ammonia can be toxic to fish.

2.3 Current Fisheries Management Practices

2.3.1 Canadian Fisheries Management Policies

Charles (1992) describes fisheries management approaches as including three basic types: biological yield-maximizing (conservation of fish stocks) objectives, economic value-maximizing (efficiency/productivity) objectives and social-communal (community values) objectives.

Three Canadian examples have been included for comparison to the current Red River resource conflict. Examples include the freshwater fishery of the Great Lakes in Ontario (Eastern Lake Erie and Lake St. Clair), the marine salmon fishery of the Pacific coast and a sport-commercial conflict on Rainy Lake, Ontario.

In all cases, primary users consisted of commercial, sport and native domestic groups. The commercial harvest usually comprises the bulk of total harvest, followed by sport and domestic use. The fish species involved are short-lived and migratory and are comprised of multiple stocks of uncertain stock size.

Whillans and Berkes (1986) observed that direct competition between sport and commercial users over walleye stocks in the great lakes situation, is minimized by the use of management regulations which separate the two user groups in space and time. Allocation consisted of establishing quantitative harvest rights between user groups. They concluded that the resource allocation conflict was largely perceptual and culturally based.

Fisheries royalties or resource "rents" were collected from the sport and commercial groups to compensate the public owners of the resource and pay the cost of managing the resource (Whillans and Berkes 1986). Native domestic harvests, consisted of providing community food requirements.

Charles (1992) describes the pacific salmon fishery where sport and native fisheries comprise only 4 % to 6 % each of the total salmon harvest. Sport fisheries receive the greatest allocation of prized Chinook salmon. Charles (1992) contends that the principle management objective be based on the premise that sport caught fish produce more benefits to the economy than those caught in the commercial fishery.

He observed that allocations among all three user groups was maintained by controlling fishing openings and closings, season lengths and gear restrictions. A co-management approach was used, which was based on shared responsibility and shared decision making between government and commercial users Charles (1992) also noted that native gillnet fisheries were managed on a communal rights allocation basis.

Wepruk (1981) carried out a general assessment of jointly exploited fish populations on Rainy Lake, in Ontario. Several broad-based biological indicators of fishing yield were used to document stock declines in both the sport and commercial fisheries. He blamed over-harvest of a common fishery for contributing to the depletion of the walleye resource.

Wepruk (1981) recommended that the solution to the conflict should involve the re-allocation of existing fish stocks among the principal user groups. He acknowledges that this management recommendation may result in short-term disturbances, but maintains that it will be less socially, economically, and biologically disruptive in the long-term.

2.3.2 Manitoba Fisheries Policies

a) Scope of management input

The 1991 Manitoba Fisheries strategy focuses upon an integrated approach, where user groups will share in the decision making process. The primary responsibility of the Fisheries Branch is to ensure that fish harvests are managed on a biologically sustainable basis. Consultation is to include native groups and to involve users in the management of the domestic fishery.

b) Resource allocation

Legislation and policy objectives are to be used in allocating fish resources among various user groups. A "resource maintenance allocation" shall precede all other allocations to ensure sustainable yield. Native domestic use has priority over all other allocations. Allocations to non-consumptive use are justified "where appropriate". Conflict resolution will be facilitated through "consultation, negotiation and management agreements".

c) Resource sustainability

The principal of sustainable yield, is to form the basis of fisheries management. Multiple use fisheries are permitted in situations which maximize potential benefits from resource use. Commercial gillnet fisheries are not compatible with trophy or high quality sport fisheries in most circumstances. Less-consumptive and non-consumptive resource use opportunities should be promoted. Habitat conservation, enhancement and restoration is required to maintain the health, stability and viability of the fisheries.

d) Legislative and/or regulatory controls

Resource allocations should be quantified for all user groups. Management of trophy quality fisheries may require reductions in current harvest levels. Sport fishing regulations are required to maintain the quality of angling experiences by the preservation of fish species diversity and abundance. Enforcement is critical to maintain compliance with regulations. Native domestic harvest levels should also be monitored for effective management.

e) Resource access rights

Current commercial user groups have tenure with respect to resource access rights.

f) Socio-economic considerations

Increased participation of resource users and the general public in fisheries management is recommended to maximize the social and economic benefits from resource use. Local economic benefits are to be a major criteria for commercial allocation.

2.3.3 Economic Valuation

Jacobsen et al. (1983) argue that fisheries management should be directed to protecting fish stocks and that allocation should be based on an economic evaluation of net contributions to regional and local economies. They recommend collecting accurate statistics on stocks, yields, effort and economic and public values towards the fisheries resource.

Rettig et al. (1989) maintain that court interpretations of user rights may not be the best forum for deciding the complex issues of resource allocation questions. This view is shared by Sutinen (1980) who states that economic principles should be used for determining the best allocation, between commercial and recreational users.

Copes and Knetch (1981) have observed that integrated management of commercial and recreational fisheries have encountered difficulty in measuring the benefits of recreational fisheries. They found that comparisons can be made between total output (catch/unit effort) in the two fisheries, but determining the "angling enjoyment" benefit, often proved to be difficult.

Copes and Knetch (1981) determined that the economic value of a product (fish) or service (sports fishing opportunity) may be calculated by what people are willing to give up to obtain it (willingness to pay).

Hushak et al. (1986) caution that sportfishing may not hold an economic advantage over commercial fishing, for species which are angled primarily in the spring or fall.

2.3.4 Resource Management Policy Development

Torgerson (1990) describes the traditional command and control approach to resource management as "limiting the ways problems are defined, by reducing ambiguity and diversity to something manageable and familiar". Torgerson (1990) believes that this approach creates and enhances conflict in a society with multiple interests and values. He observes that conflicts arise out of the gains and loses of stakeholders as a result of policy outcomes.

Berkes (1988) states that resource management policy development and implementation should begin by viewing resource problems or issues in a much broader configuration. He recommends that a collective overview should include examining interactions and relationships across systems. Berkes (1988) believes that "emphasis should be on a comprehensive integrated approach, involving public participation within an ecological perspective".

Beanlands and Duinker (1983) stress the importance of identifying the level of biological uncertainty and the significance to the problem at hand. Patton and Sawciki (1987) maintain that this level of risk should be identified at the outset and used to develop evaluation criteria for alternative solutions to the problem. They argue that policy analysis should include predictions of expected trends "with and without the policy".

Patton and Sawciki (1987) note that one alternative may not be the best one, in view of changing decision criteria and different perceptions and attitudes about risk and uncertainty. They add that the no-action alternative may be the best solution in cases where the problem is difficult to define and/or the problem does not have an optimal solution.

Lannan (1988) recommends a proactive approach which anticipates societal needs and goes beyond responding to the concerns of special interest groups. He argues that this may require going beyond the regional perspective, to adopt a comprehensive, integrated, participatory co-management approach, to maintain resource sustainability.

Chapter 3
Methods

3.0 Study Area

The study area was confined to the lower Red River and the south basin of Lake Winnipeg (fig. 1). Initial research activities were based in part on an evaluation of previously collected historical information on the lower Red River and Lake Winnipeg. Additional research objectives were identified following two public meetings with representatives from the principal stakeholder groups (sport and commercial).

Primary research began in May of 1990 and was completed in August, 1993. The bulk of the study took place during the open water season, from May to October of each year. Winter work was confined to aerial tracking of walleye movements. The concept of "stock" is used in this study to identify a management unit, rather than a genetically distinct population. Large walleye are fish > 3.5 kg.

3.1 Walleye Abundance and Distribution

3.1.1 Angler Catches of Large Walleye on the lower Red River

Information on angler catches of large walleye over the last 19 years, was obtained from master angler records, published annually by the Provincial Department of Industry, Trade and Tourism. Up until 1990, anglers submitted their name, address, date, location, and weight of the species caught or released, in exchange for a "master angler" crest. The qualifying weight for walleye was 3.5 kg or more.

After 1990, only length is recorded to avoid stressing the fish before release and a certificate is issued instead of a crest. The current qualifying length for a master angler walleye is 70 cm. A length-weight regression equation, developed by Lysack (pers. comm.), was used to convert fork-length measurements to weight measurements for comparative purposes. Information was collected up to September of 1992.

3.1.2 Walleye Movements and Resource Use

A walleye tagging program was conducted on the lower Red River in the summer of 1988 by Macdonald (pers. comm.). The program was continued in the fall of 1988 and from May to October of 1989, by the author.

Originally, ninety meter commercial gillnets were used, which ranged in mesh sizes from 95 mm to 126 mm. Gillnets were set during daylight hours, at selected sites along the lower Red River. Gillnets were lifted every 15 to 30 minutes, to recover and tag the entrapped walleyes. All captured walleyes were kept in a plastic tub, filled with oxygenated water, to ensure recovery before and after tagging.

Tagging sites were selected to be representative of more long-term, instream, migratory movements of walleye, as opposed to the short-term movements between the river mouth and the south basin. The tagging nets were generally set over a 3-4 hour duration, to avoid the heavy boat traffic on the river and to reduce the large numbers of rough fish caught. Night sets were prevented by safety considerations to staff.

Walleye were tagged with a Floy FD-67 (21 mm exposed monofilament) anchor tags using a Dennison Mark II tagging gun. The tag was inserted on the left side of the fish below the dorsal fin, with the anchor passing between the interneural spines (Macdonald 1990). Fork lengths were recorded for each tagged fish along with the date and location of capture. A few scales were removed below the dorsal fin on the left side of the fish, to determine age. Recapture information was submitted to the Provincial Fisheries Branch and included the tag number, the name and address of the recapturer and the date and location of recapture.

A form letter was then sent back to the recapturer, indicating the date, location, length and age of the fish at the time of the tagging. A tag return crest was also enclosed, as a reward for the recapture information.

Tag return information was used to plot the temporal and spatial distribution of walleye following release. The tagging program was continued during the open water seasons for 1991 and 1992.

3.1.3 Lower Red River Gillnet Monitoring

Gillnet monitoring occurred during the floy-tagging study. Initially, gillnet sets were standardized by mesh size, which ranged from 95 mm (3.75 in) to 126 mm (5 in). Gillnets sustained considerable damage during the study period, from abundant catches of diverse fish species caught in the lower Red River. Gillnets were subsequently replaced with non-standardized mesh sizes, which included nets as small as 76 mm (3 in) and as large as 144 mm (5.5 in).

3.2 User Group Impacts

3.2.1 Lower Red River, Angler Creel Surveys

A random stratified creel census, developed by Lysack (1986a), was conducted on the lower Red River from May to October in 1982, 1988 and 1989. Information on walleye catch per unit effort (CUE), during the months of September and

October, was extracted from all three surveys for comparison.

The creel surveys of 1988 and 1989 involved two sampling stations, as opposed to the four stations included in the 1982 study and have been previously described by Macdonald (1990). The 1982 creel census included a larger proportion of shore anglers than subsequent surveys. Creel census data was analyzed using a computer program developed by Lysack (1986a).

A similar creel census was carried out in September and October of 1992. Several large fishing derbies were also sampled during this census.

3.2.2 Angling Derbies

Historical information on past fishing derbies was obtained from the Provincial Fisheries Branch. This information dated back to 1986 and contained primarily administrative data such as the date, location and name(s) of derby organizers. Requests were made to individual derby organizers for additional catch per unit effort data, for walleye derbies held on the lower Red River.

3.2.3 Native Subsistence Fisheries

The lower Red River falls within the jurisdiction of the Provincial Department of Natural Resources, Operations Division, Central Region, located in Gimli Manitoba. The Regional Fisheries Manager and local Conservation Officers were interviewed for information pertaining to the native subsistence fishery on the lower Red River. A literature search was conducted for additional information on this area.

Currently, native subsistence users are issued special fishing permits (at no charge) in an effort to determine seasonal harvest levels (Campbell pers. comm.). But native subsistence users are not legally obligated to follow this policy and most (> 90%) do not comply (Campbell pers. comm.).

Additional information on native subsistence fisheries on the Red River was obtained from interviews with local conservation officers, who are responsible for enforcing fisheries regulations under the Federal Fisheries Act. Wagner (1986) examined subsistence fish harvest levels on three communities near Lake Winnipeg. Berkes (1990) has reported on subsistence fishing in Canada and Heuring (1993) on historical subsistence fishing estimates around Lake Winnipeg.

3.2.4 Lake Winnipeg Commercial Catches of Large Walleye

Commercial catch data for Lake Winnipeg was collected from the Freshwater Fish Marketing Corporation (FFMC) located in Transcona. The corporation was established in 1969 as the sole marketing agency for freshwater fish (Heuring 1993). Commercial catch information was analyzed by weight, fishing area and season, to assist in the identification of past trends in the Lake Winnipeg commercial fishery. Size categories were based on weight ranges established by the marketing corporation: small (<.6 kg), medium (>.6 kg - <1.6 kg) and large (>1.6 kg).

Walleye weights were calculated as round weight equivalent, to approximate live or unprocessed weights. Estimates of commercial fishing effort was based on the number of deliveries in any particular time frame. Information was collected up until the fall of 1992.

3.2.5 Commercial Gillnet Monitoring - Red River Mouth

Monitoring of commercial gillnet set locations, near the mouth of the Red River (fig. 1), began in September of 1988 and continued in May, June, September and October of 1989. Monitoring consisted of random lake patrols, carried out within a 5 km radius of the Red River mouth area, during commercial seasons.

Commercial gillnet numbers, locations and identification numbers were recorded for each "gang" (group) of nets. Mesh sizes were not recorded due to the hazard of handling the nets in rough weather and the potential objection by the owners.

Daily commercial catch information was obtained from the Freshwater Fish Marketing Corporation using the gillnet identification numbers recorded on the lake. Monitoring was resumed in May of 1991 and continued throughout September and October for 1991 and 1992, as part of the current study.

Commercial catches of large walleye (> 1.6 kg) were randomly sampled at the Freshwater Fish Marketing plant in Selkirk Manitoba. Individual walleye were measured (fork-length), weighed and scale samples were taken for determining age in accordance with Provincial Fisheries Branch standard catch sampling procedures.

3.2.6 Radio-telemetry Tracking of Large Walleye Movements

Walleye were selected by size, to be representative of the "large" walleye that were under study. Six walleye, ranging in weight from 2.7 to 4.5 kg, were captured in gillnets in the lower Red River near the End of Main, from October 10 - 21, 1991. The walleye were fitted with an externally attached, radio transmitter (standard transmitter model no. 6.) which was purchased from Advanced Telemetry Systems (ATS), in Isanti, Minnesota.

The transmitters weighed 30 grams and had a minimum (lithium) battery life of 250 days. Transmission frequency ranged from 48.032 Mhz to 48.320 Mhz, with a 2 Mhz band separation. Five additional walleye, ranging in weight from 3.1 to 4.2 kg, were caught and fitted with radio transmitters, from May 4 - May 9, in 1992.

A Radio Station Licence was obtained from the Federal Department of Communications, to ensure non-interference with other broadcasting frequencies. An ATS Model R2000, programmable, multi-scanner receiver was used to locate the radio signals. Each individual frequency was programmed into the receiver and could be identified in flight in the scanning mode.

Aerial reception range was rated at 8 kilometres, at a height of 1500 meters and a transmission water depth of 6 meters. In practice, optimal signal reception occurred at a range of 2.5 km, a height of 600 meters, and water depths of less than 4.5 meters.

Aerial monitoring was conducted with Golden Eagle Flying Academy, in either a single engine Cessna 150 or Cherokee 140 aircraft, flying at an airspeed of 150 km/hr. An external ATS directional loop antenna was mounted to the aircraft, which conformed to Federal Ministry of Transport specifications.

Aerial monitoring flights followed a prescribed search pattern, based on selected transects (5 km apart) over the study area. Transects followed an east-west search pattern across the south basin of Lake Winnipeg up to Hecla Island.

The Lower Red River was routinely flown up to the northern boundary of the City of Winnipeg. Additional flights covered the Brokenhead and Icelandic Rivers and the Winnipeg

River up to Pine Falls. Aerial monitoring was carried out during the open water and winter seasons.

Once a walleye transmitting frequency was detected, the transmitter was switched over to that frequency from the scanning mode. The precise location of the signal was then determined by flying a circular flight pattern in reference to various landmarks on the ground.

Routine testing of transmission and reception were carried out under different levels of ice cover, using a reference transmitter which was lowered under the ice cover. Tests were carried out prior to each survey flight to verify the proper functioning of both the receiver and external aerial. This consisted of flying over the reference transmitter and confirming the signal. Aerial monitoring continued into June of 1993.

3.3 Environmental Impacts

3.3.1 Red River Monthly Flow Rates

Monthly flow-rate data on the lower Red River was calculated from daily discharge rates, measured at the Federal Department of Public Works water control structure, at Lockport, Manitoba. The basic information was obtained from the Water Resources Branch of Environment Canada.

3.3.2 Red River Water Quality

Information on water quality changes in the lower Red River were obtained from the Manitoba Department of Environment. Routine water samples have been taken from this area over the last 12 years (Beck pers. comm.). Two water quality parameters were examined in this study, un-ionized ammonia and water turbidity. Changes in the levels of either variable could potentially effect walleye abundance and distribution.

a) un-ionized ammonia

Un-ionized ammonia discharges and effluent concentrations in the lower Red River were monitored by Gurney (1991).

b) dredging

The Canadian Coast Guard, of the Federal Ministry of Transport, requires selective dredging activities to maintain the Red River as a navigable waterway (Colp pers. comm.). Dredging is carried out on the Red River by the Federal Department of Public Works (DPW). Dredging of the lower Red River has been ongoing since 1900 (Colp pers. comm.).

c) disease

Lymphocystis infections were noted on the scale envelopes used to record data for each individual walleye caught during the tagging portion of the present study.

3.4 Current Management Approaches

3.4.1 Red River Management Plan

Fitzjohn (pers. comm.) advises that Provincial Department of Natural Resources staff (Fisheries Branch) held a series of public meetings in 1986, to examine the kinds of issues that were being raised on the lower Red River sport fishery, and to identify stakeholders and their interests. An advisory group was subsequently established as a forum for conflict resolution.

Macdonald (1990) describes the membership as consisting of individuals nominated from the following groups: Lockport Merchants Association, Fish Futures, Department of Natural Resources - Fisheries Branch, Lake Winnipeg commercial fishery, Red River anglers, retail tackle industry, Manitoba Wildlife Federation, Conservation Officers, fishing guides and outfitters, local businessmen, University of Manitoba (Department of Zoology) and the Selkirk Town Council.

Fitzjohn (pers. comm.) observed that issues focused primarily on: communication of fisheries management information and principles, increasing violations of fisheries regulations, overly complex angling regulations and over-harvest of trophy walleye and catfish stocks.

A management plan was subsequently developed in 1988 to address these issues. Consultation on issues often included: Federal Department of Public Works, Federal Ministry of Transport (Coast Guard), Federal Department of Fisheries and Oceans, Manitoba Environment, Provincial Water Resources Branch, and the Provincial Department of Industry, Trade and Tourism (Fitzjohn pers. comm.).

Fitzjohn (pers. comm) refers to the Red River Advisory Board as basically an issue oriented group. Additional roles include public education and participation, and policy reviews in related areas.

The Red River Management Plan was examined in more detail and the results are presented in Chapter 4 of this paper.

3.5 Calculations

Routine statistical analysis was carried out with a computer software program, titled statistix version 4.5.

Chapter 4
Results

4.1 Walleye Abundance and Distribution

4.1.1 Angler Catches of Large Walleye on the lower Red River

An historical review of angler catches of large walleye on the lower Red River was obtained from provincial master angler catch records. A nineteen year comparison of master angler records, shows increasing catches of large walleye from 1973 to 1986 (fig. 2). This increase parallels the rising public popularity with the walleye trophy sport fishery (Fitzjohn pers. comm.).

Angling catches appear to have declined after 1986, with lower catches being observed in 1988 and 1990 (fig. 3). Angling catches of large walleye began to increase again, beginning in 1991 (fig. 3).

An examination of master angler walleye weight distributions over the last ten years, shows that greater numbers of larger sized walleye were being caught (table 1). The largest size ranges (> 6.0 kg) of master angler walleye were recorded in 1990, 1991 and 1992 (table 1). The drop in total numbers of master angler walleye being caught, appears to be confined to the lower size ranges (table 1).

Seasonal maximums for angler catches of large walleye on the lower Red River, can be seen to occur in the months of September and October (figs. 4, 5). Lower angler catches of large walleye were recorded in the winter sport fishery, from November to March (figs. 4, 5). The spring and summer fishery have the lowest catches of large walleye in comparison to the two other seasons (Figs. 4, 5).

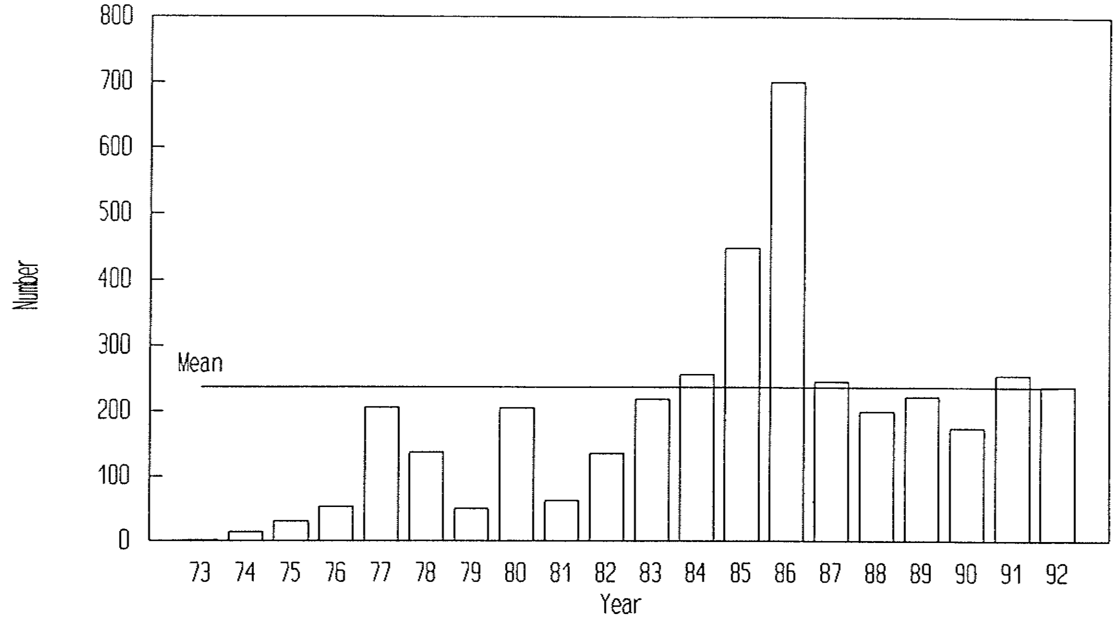

Fig. 2. Master angler records for walleye, from the lower Red River, 1973-1992.

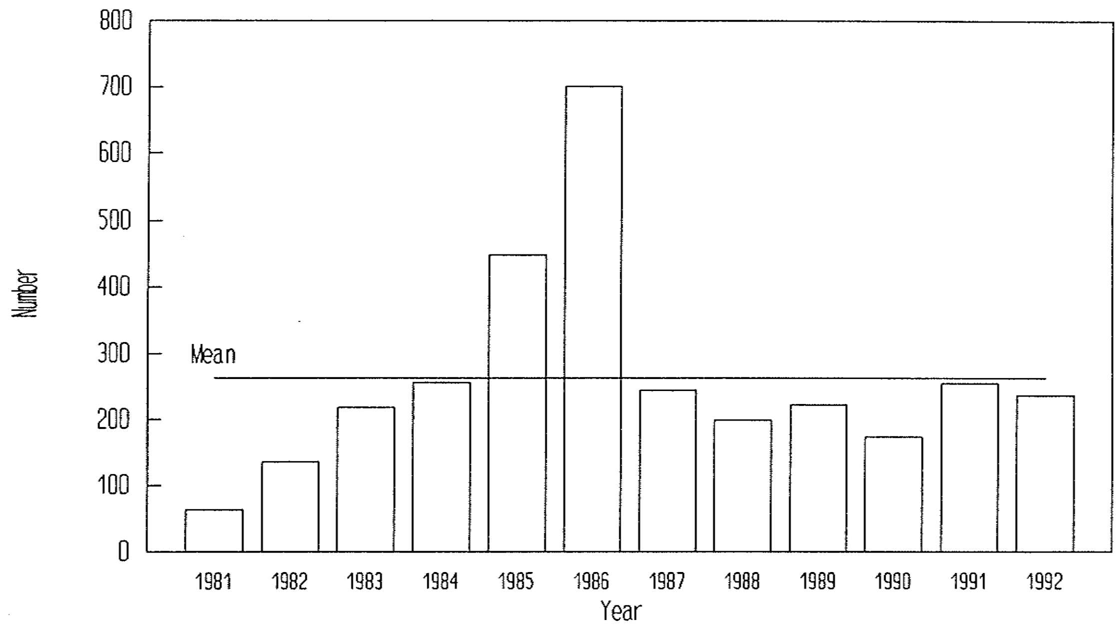

Fig. 3. Master angler records for walleye, from the lower Red River, 1981-1992.

Table 1. Master angler walleye weights, 1981-1992.

Wt Rge. (kg)	81	82	83	84	85	Year 19__ 86	87	88	89	90	91	92
3.49 3.99	20	68	98	109	198	306	96	58	71	25	0	0
4.00 4.49	22	40	59	74	136	211	57	56	62	52	50	0
4.50 4.99	14	26	43	45	82	110	62	47	50	46	93	60
5.00 5.49	4	1	16	19	24	44	16	24	22	20	25	77
5.50 5.99	3	0	0	7	6	22	9	9	12	16	47	39
6.00 6.49	0	0	2	2	2	7	4	4	4	10	24	39
6.50 6.99	0	0	0	0	0	1	1	1	1	2	10	14
7.00 7.49	0	0	0	0	0	0	0	0	0	3	4	6
7.50 7.99	0	0	0	0	0	0	0	0	0	0	1	2
8.00 8.49	0	0	0	0	0	0	0	0	0	0	1	0
Tot.	63	135	218	256	448	701	245	199	222	174	255	237

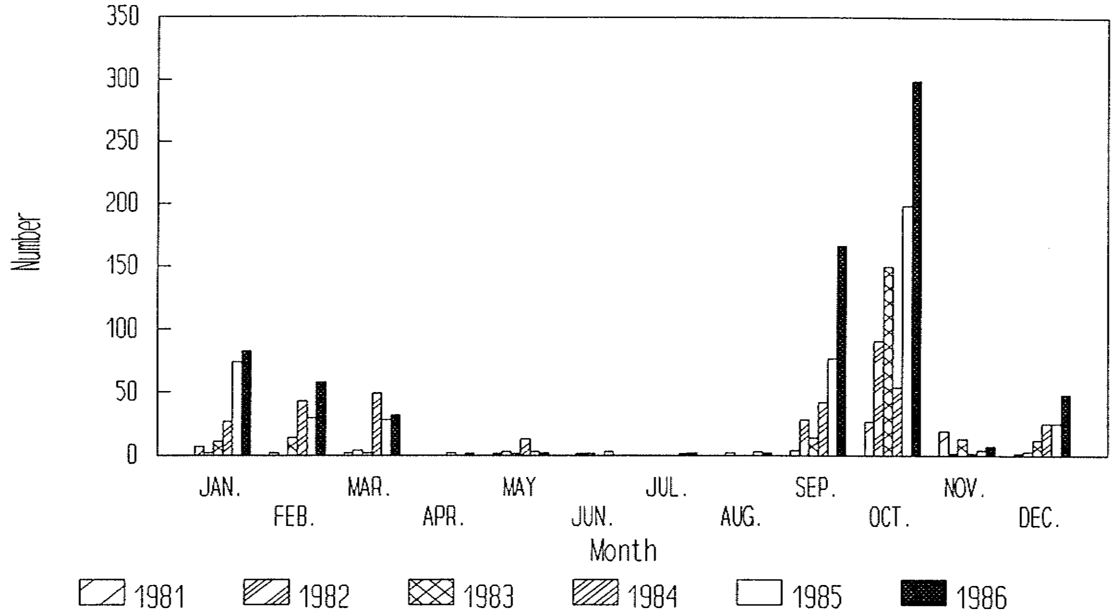

Fig. 4. Master angler catches of Red River walleye, 1981-1986.

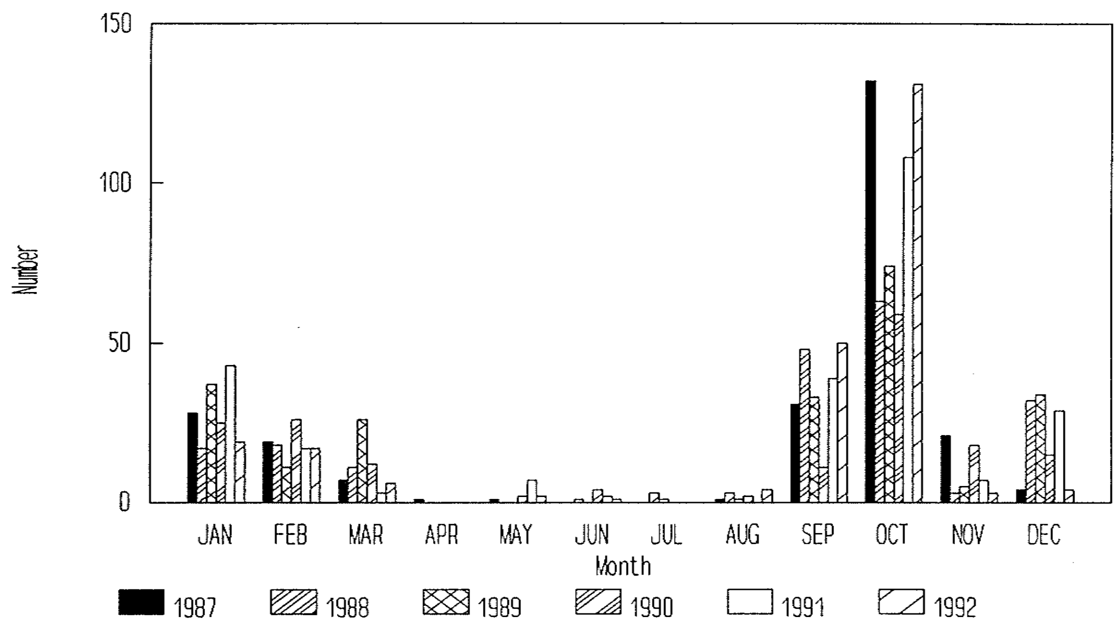

Fig. 5. Master angler catches of Red River walleye, 1987-1992.

4.1.2 Walleye Movements and Resource Use

A total of 1611 walleye were tagged in the lower Red River from 1988 to 1992 (table 2). An additional 175 walleye were tagged in the south basin of Lake Winnipeg near the mouth of the Red River, in August of 1991 (table 2). The results are grouped by time and recapture area, to localize possible management action.

Thirty one walleye were recaptured by anglers within six months of tagging (fig. 6). Tag returns indicate the presence of walleye in the lower Red River from October to March (table 3). Eighteen tagged walleye were recaptured by anglers in the lower Red River (fig. 7) at intervals of 235 days or greater (table 4). Nineteen walleye were recaptured by commercial users in the south basin of Lake Winnipeg and three in the channel area (fig. 8). One tagged walleye was recaptured by an angler in the Roseau River (fig. 8). Recapture times ranged from 4 to 719 days (table 5).

In August of 1991, 175 walleye were tagged in the south basin of Lake Winnipeg, to determine the level of migration into the Red River, during the fall season (fig. 9). Four walleye were later recaptured by anglers and seven by commercial users in southern Lake Winnipeg. River recaptures ranged from 26 - 430 days (table 6).

Table 2. Walleye tagging dates and numbers, lower Red River: 1988, 1989, 1991 and 1992.

Month	1988	Year 1989	1991	1992	Total
May		20	47	364	431
June		4	15	19	38
July			2	27	29
August	9	9	38	49	280
			175*		
September	69	120	86	12	287
October	230	266	132	93	721
Total	308	419	495	564	1786

* tagged in the south basin of Lake Winnipeg near the mouth of the Red River

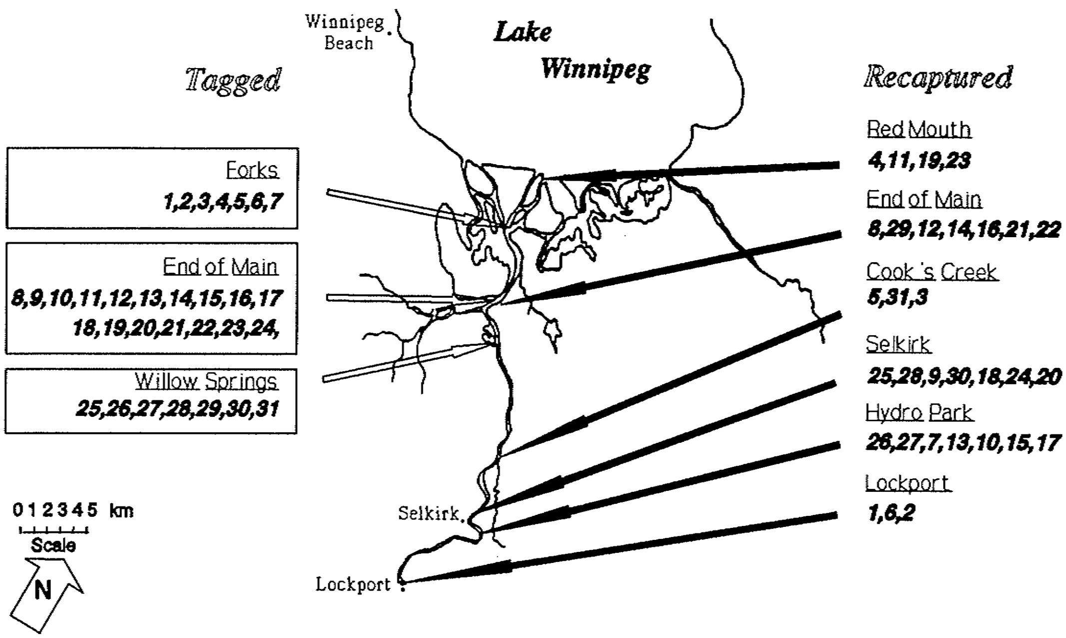

Fig. 6. Tagged walleye recapture locations from lower Red River anglers, < 6 months after fall tagging.

Table 3. Walleye tag return data for lower Red River, < 6 months after fall tagging.

#	Date Tagged	Date Caught	Days at Large	#	Date Tagged	Date Caught	Days at Large
25	11/10/89	11/10/89	0	11	27/09/91	25/01/92	120
26	10/11/89	16/12/89	66	12	02/10/91	28/11/91	57
27	11/10/89	21/01/90	102	13	02/10/91	16/02/92	137
28	19/10/89	04/03/90	136	30	07/10/91	03/03/92	148
01	23/08/91	23/11/91	92	14	02/10/91	21/12/91	80
02	30/08/91	16/02/92	170	15	21/10/91	15/02/92	116
03	09/09/91	10/02/92	154	31	28/10/91	18/12/91	51
04	09/09/91	03/10/91	24	16	04/08/92	01/10/92	58
05	09/09/91	19/09/91	10	17	25/08/92	05/09/92	11
06	10/09/91	01/02/92	144	18	25/08/92	02/11/92	69
07	11/09/91	15/02/92	157	19	27/08/92	13/12/92	108
08	18/09/91	21/09/91	3	21	24/09/92	02/10/92	8
09	18/09/91	06/01/92	110	22	24/09/92	01/10/92	7
10	18/09/91	28/02/92	163	23	14/10/92	18/12/92	65
20	18/09/91	06/01/92	110	24	14/10/92	27/12/92	74
29	18/09/91	06/10/91	18				

= Tag number for each individual walleye, re-numbered and sorted chronologically for graphical presentation

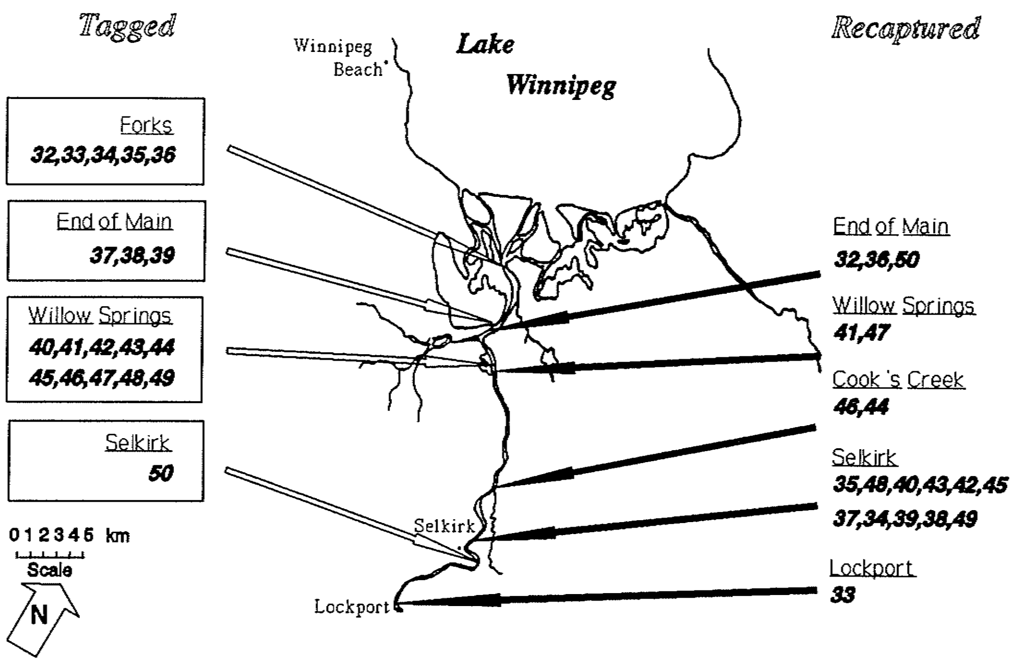

Fig. 7. Tagged walleye recapture locations from lower Red River anglers, > 6 months after fall tagging.

Table 4. Walleye tag return data for lower Red River, > 6 months after fall tagging.

#	Date Tagged	Date Caught	Days at Large	#	Date Tagged	Date Caught	Days at Large
37	13/09/88	15/01/92	1219	44	11/10/89	15/09/91	734
50	13/09/88	15/09/92	1493	45	11/10/89	12/09/91	731
32	29/09/88	08/09/91	1074	46	11/10/89	15/09/91	704
40	24/10/88	18/09/90	694	36	16/10/89	16/02/92	853
33	31/08/89	13/06/90	286	47	16/10/89	25/09/90	344
34	28/09/89	18/01/92	842	48	28/10/89	29/06/90	249
35	28/09/89	21/05/90	235	49	24/10/89	17/09/93	328
41	11/10/89	16/09/90	340	38	27/09/91	03/09/92	372
48	11/10/89	28/09/90	382	39	07/10/91	27/09/92	356
43	11/10/89	24/09/90	378				

= Tag number for each individual walleye, re-numbered and sorted chronologically for graphical presentation

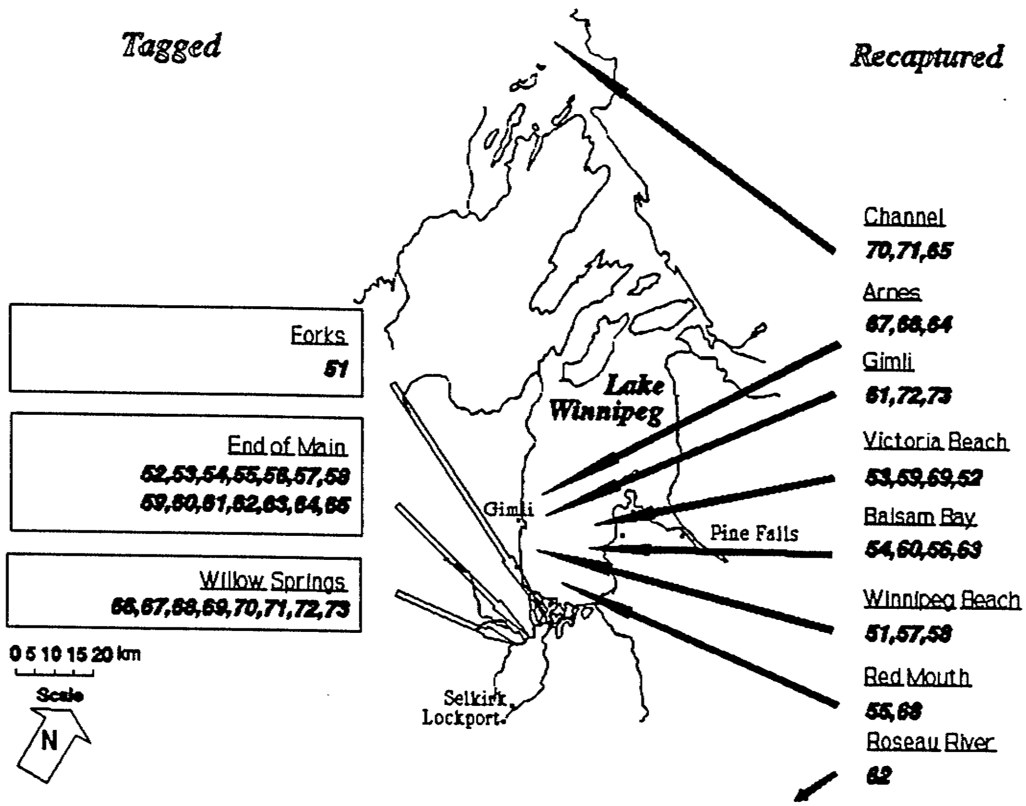

Fig. 8. Tagged walleye recapture locations on Lake Winnipeg and the Roseau River, after fall tagging in the Lower Red River.

Table 5. Walleye tag return data from Lake Winnipeg and the Roseau River, after fall tagging in the lower Red River.

#	Date Tagged	Date Caught	Days at Large	#	Date Tagged	Date Caught	Days at Large
70	17/10/88	15/06/90	606	55	27/09/91	05/10/91	8
66	19/10/88	23/12/89	430	56	27/09/91	15/10/91	18
67	11/08/89	12/10/90	396	57	27/09/91	14/06/92	261
52	29/09/89	26/03/90	178	58	02/10/91	05/07/92	277
68	04/10/89	21/06/90	437	59	07/10/91	04/06/92	241
69	11/10/89	15/10/89	4	60	07/10/91	10/06/92	247
71	30/10/89	19/10/91	719	61	16/10/91	31/05/93	593
72	30/10/89	31/05/90	213	62	21/10/91	19/09/92	334
73	30/10/89	31/05/90	213	63	14/05/92	24/09/93	498
51	23/08/91	14/10/91	52	64	02/10/92	19/09/93	352
53	11/09/91	29/05/92	261	65	09/10/92	07/06/93	240
54	13/09/91	19/10/91	36				

= Tag number for each individual walleye, re-numbered and sorted chronologically for graphical presentation

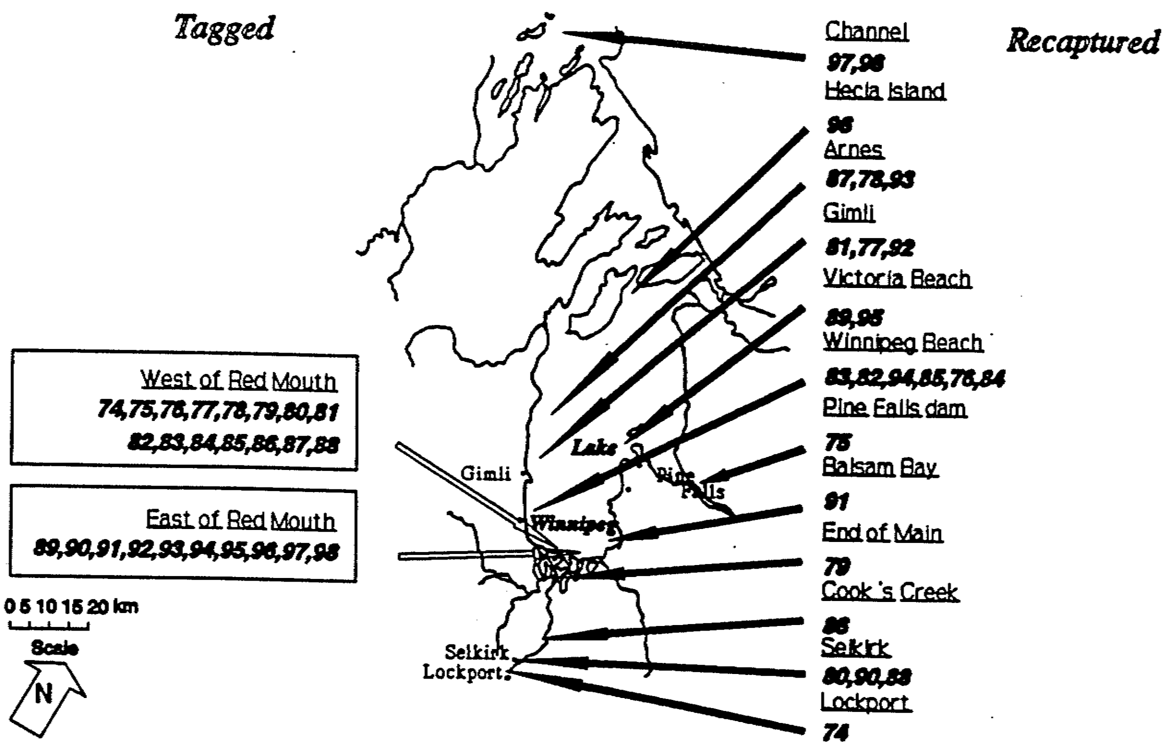

Fig. 9. Tagged walleye recapture locations from anglers and commercial users, after fall tagging, east and west of the Red River mouth.

Table 6. Walleye tag return data from anglers and commercial users, after fall tagging, east and west of the Red River mouth.

#	Date Tagged	Date Caught	Days at Large	#	Date Tagged	Date Caught	Days at Large
76	10/08/91	02/10/91	43	83	28/08/91	17/09/91	20
89	19/08/91	29/05/92	284	84	28/08/91	02/10/91	35
74	20/08/91	23/10/92	430	85	28/08/91	19/09/91	22
75	20/08/91	24/09/91	35	86	29/08/91	18/12/91	111
77	20/08/91	10/10/91	51	87	29/08/91	07/09/91	9
78	20/08/91	08/09/91	17	92	29/08/91	12/10/91	44
88	20/08/91	05/10/93	776	93	29/08/91	06/10/91	38
79	22/08/91	11/10/91	50	94	29/08/91	09/09/91	21
90	26/08/91	21/09/91	26	95	29/08/91	02/06/92	278
91	27/08/91	23/09/91	27	96	29/08/91	10/06/92	286
80	28/08/91	12/10/91	45	97	29/08/91	11/06/92	287
81	28/08/91	18/12/92	112	98	29/08/91	11/06/92	287
82	28/08/91	10/09/91	13				

= Tag number for each individual walleye, re-numbered and sorted chronologically for graphical presentation

Tagged walleye recaptures in Lake Winnipeg ranged from 9 to 287 days (table 6). The results indicate that not all of the walleye present near the river mouth, migrate into the river channel and remain for any length of time. Spring tagging of walleyes resulted in a similar river and lake dispersal pattern (fig. 10). Recaptures by both anglers and commercial users, ranged from 0 to 383 days (table 7).

4.1.3 Lower Red River Gillnet Monitoring

Walleye can begin entering the lower Red River as early as August, and may move back and forth between the Red River and Lake Winnipeg, during the months of September and October (fig. 11). This movement pattern may vary annually in terms of timing, frequency and intensity (fig. 12). Catch/effort data for the open water season (May to October), lends support to this annual spring and fall migratory pattern (figs. 13, 14).

Gillnet monitoring of walleye movements in the lower Red River was used to provide estimates of relative abundance and size range. Comparisons of walleye weights from lower Red River gillnet catches and creel surveys, show a proportional relationship between walleye abundance and the various size ranges of walleye, caught by both types of fishing gear (figs. 15, 16). This is an indication that both types of catch statistics provide good estimates of relative abundance.

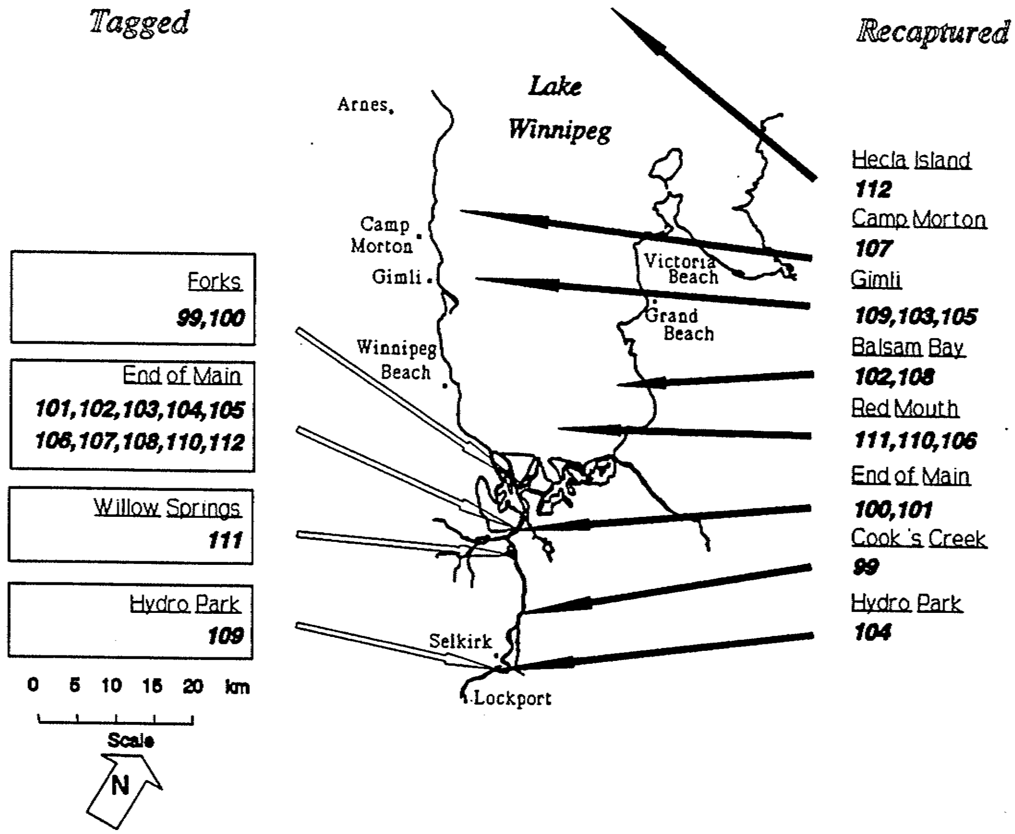

Fig. 10. Tagged walleye recapture locations from anglers and commercial users, after spring tagging in the lower Red River.

Table 7. Walleye tag return data from anglers and commercial users, after spring tagging in the lower Red River.

#	Date Tagged	Date Caught	Days at Large	#	Date Tagged	Date Caught	Days at Large
99	11/05/91	16/05/91	5	102	07/05/92	16/09/92	132
100	29/05/91	29/05/91	0	103	14/05/92	08/09/92	117
108	04/06/91	10/10/91	128	104	14/05/92	30/09/92	169
109	04/06/91	24/09/91	112	105	14/05/92	01/06/93	383
110	12/06/91	17/06/91	5	106	15/05/92	08/06/92	24
111	12/06/91	12/06/91	0	107	28/05/92	08/10/92	133
101	06/05/92	13/12/92	221	112	30/07/92	07/06/93	312

= Tag number for each individual walleye, re-numbered and sorted chronologically for graphical presentation

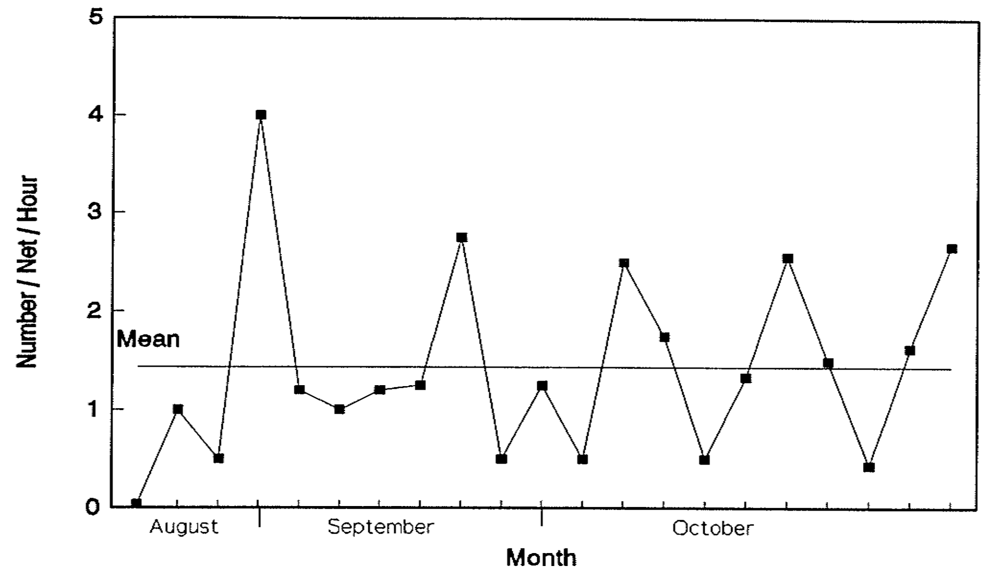

Fig. 11. Walleye catch per unit effort from gillnet sets in the lower Red River, fall 1988.

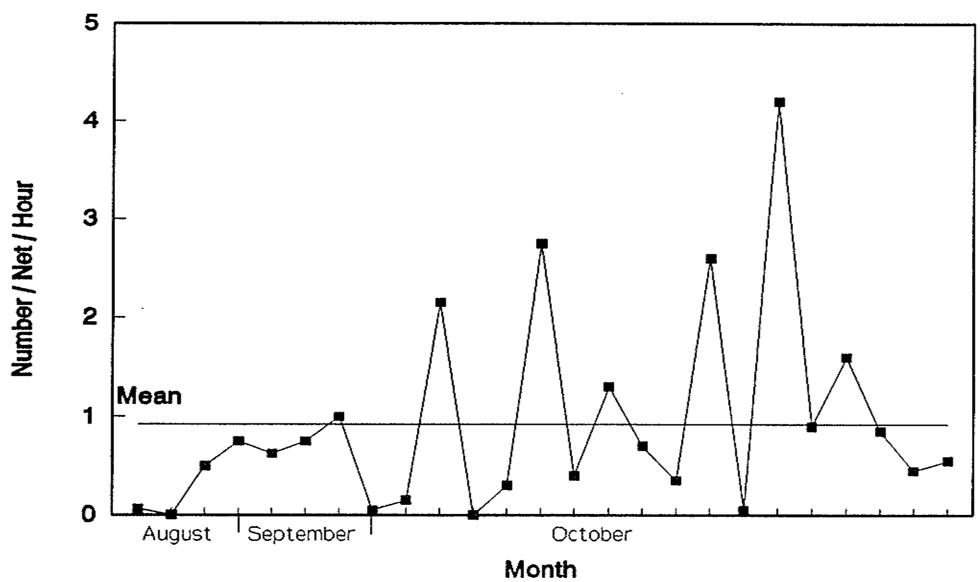

Fig. 12. Walleye catch per unit effort from gillnet sets in the lower Red River, fall 1989.

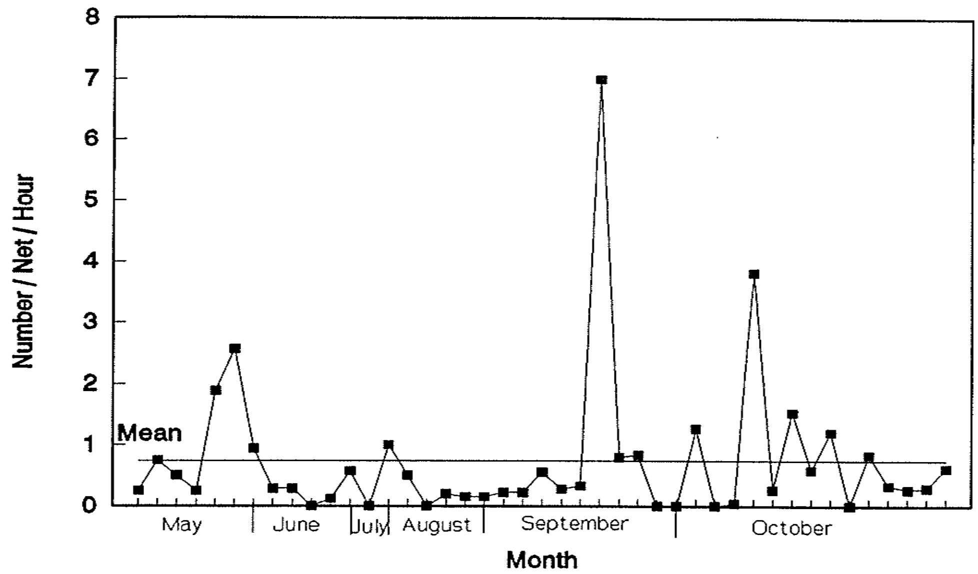

Fig. 13. Walleye catch per unit effort from gillnet sets in the lower Red River, spring to fall 1991.

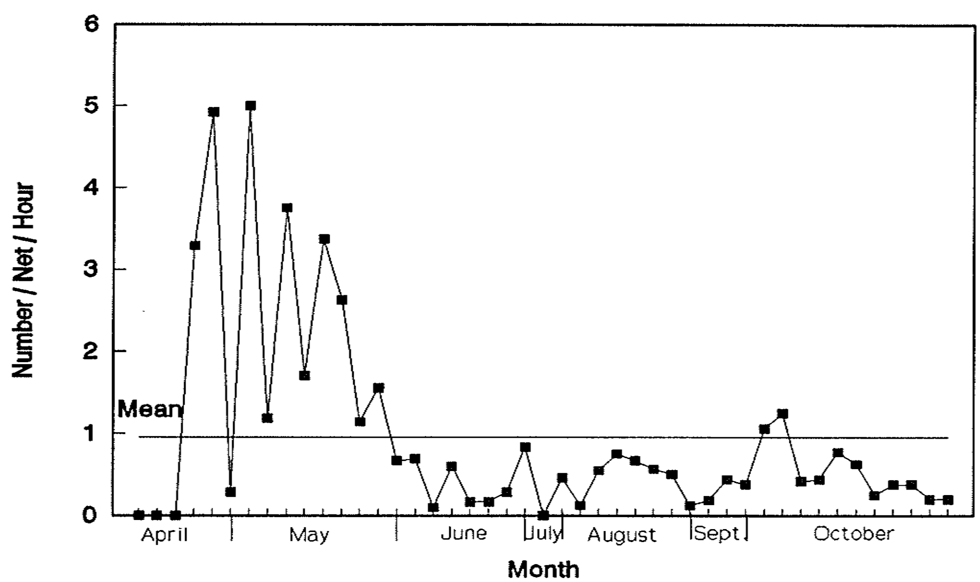

Fig. 14. Walleye catch per unit effort from gillnet sets in the lower Red River, spring to fall 1992.

4.2 User Group Impacts

4.2.1 Lower Red River Angler Creel Surveys

Total walleye catches for 1988 and 1989, were lower than the 1982 and 1992 creel survey levels (fig. 17). Total angler effort however, showed a proportional decrease for each corresponding survey year (fig. 18). Walleye catches decreased with an increase in weight range (fig. 19).

Weight comparisons for each of the survey years, shows the highest walleye catches in the < 1.6 kg range in 1992 and the lowest in 1989 (fig. 20). In the > 1.6 kg range, 1982 was the highest and 1988 the lowest (fig. 21). In the > 3.6 kg range, the 1989 and 1992 survey years exceeded the 1982 and 1988 survey years (fig. 22).

Catch per unit of angler effort estimates show the different results that can occur between September (fig. 23) and October (fig. 24), when walleye distributional movements and angler effort (figs. 25, 26) changes.

Statistical confidence limits are included in figures 17, 18, 20, 21, 22, 25 and 26 to assist in the interpretation of the results. The confidence intervals represent the upper and lower 95 % probability limits, for the calculated data means.

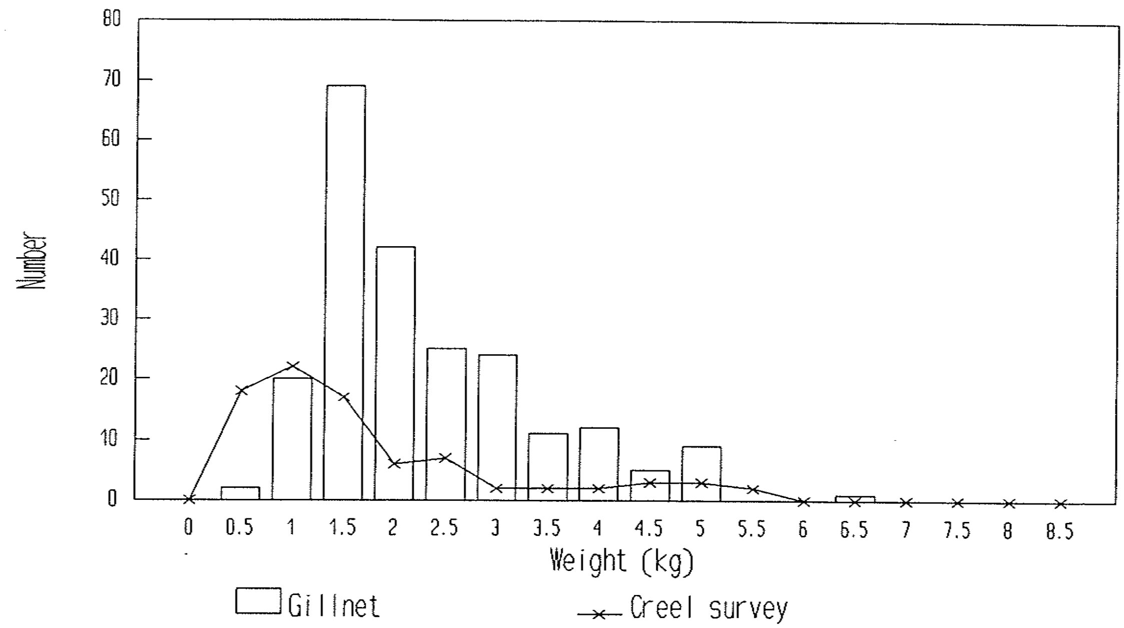

Fig. 15. Walleye weights from angler creel and gillnet surveys, lower Red River, fall 1988.

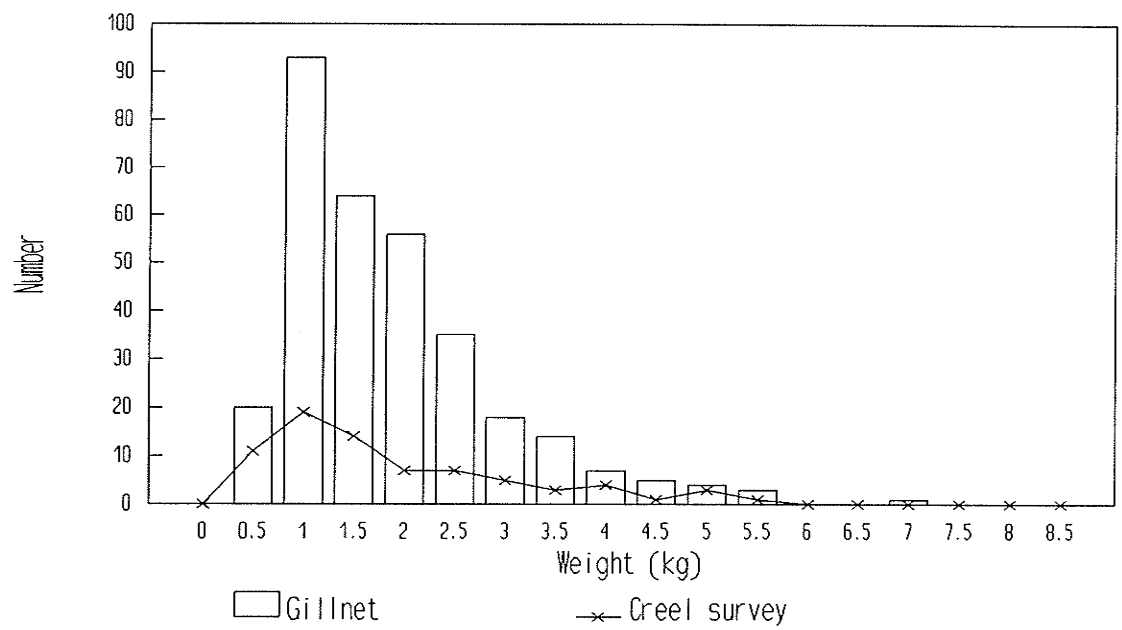

Fig. 16. Walleye weights from angler creel and gillnet surveys, lower Red River, fall 1989.

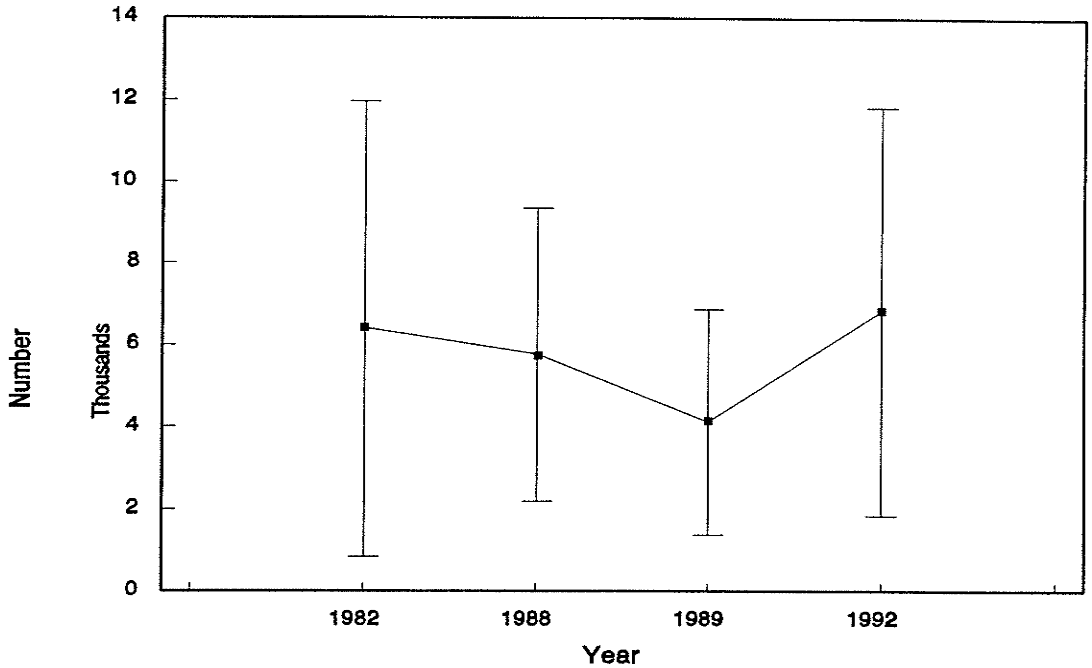

Fig. 17. Angler survey estimates of walleye catches on the lower Red River, fall: 1982, 1988, 1989, and 1992.

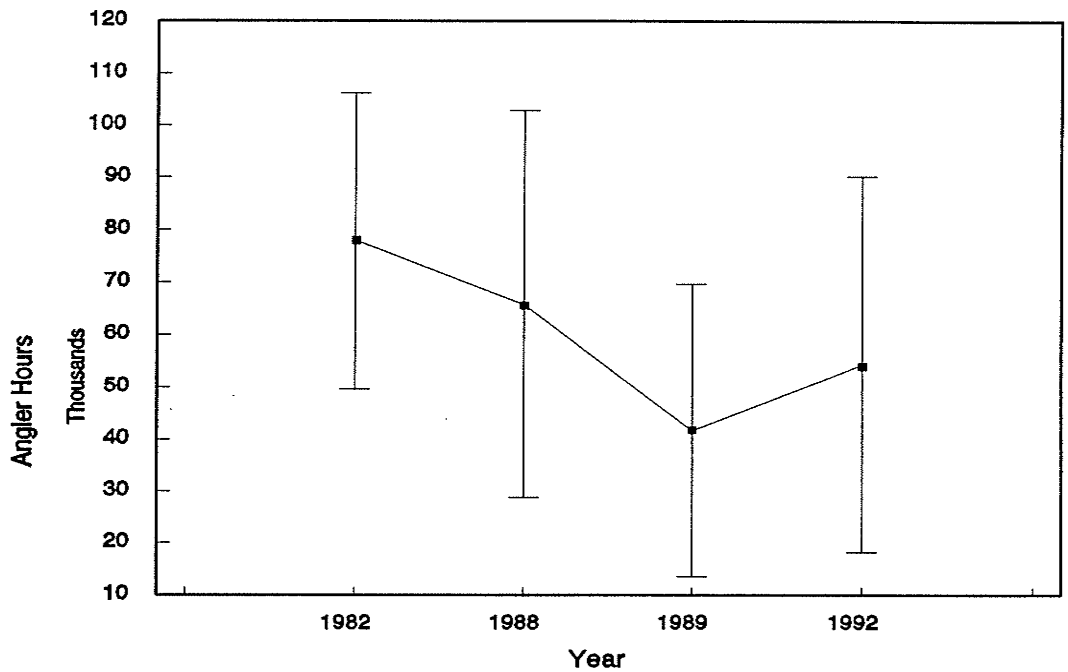

Fig. 18. Angler survey estimates of total effort on the lower Red River, fall: 1982, 1988, 1989, and 1992.

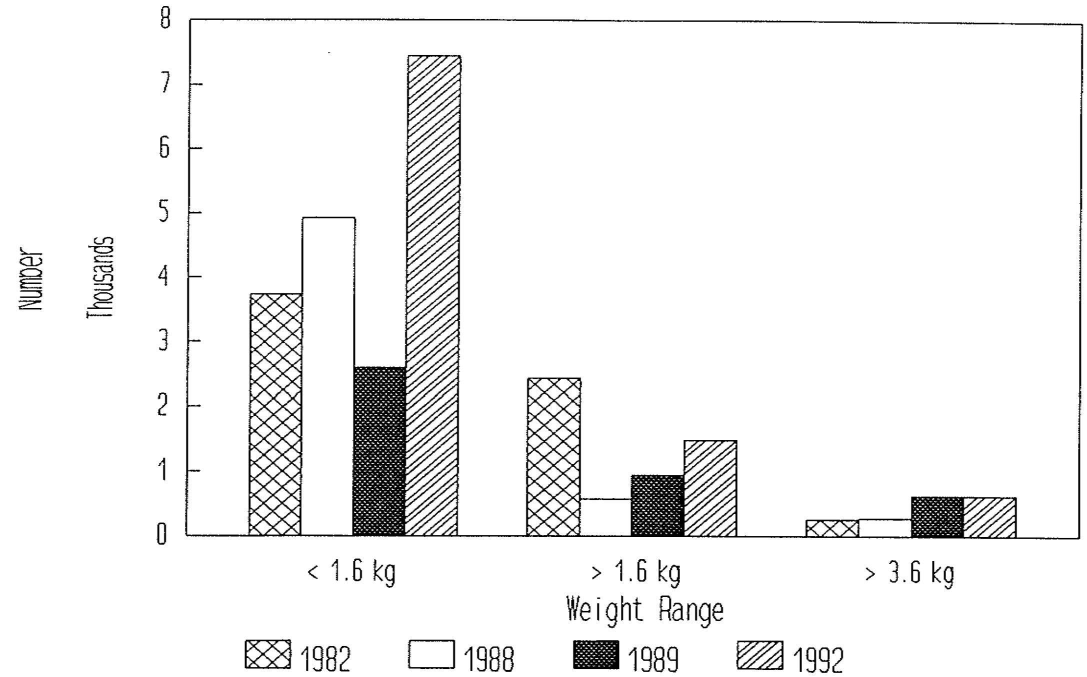

Fig. 19. Angler survey estimates of walleye catches by size, lower Red River, fall: 1982, 1988, 1989, and 1992.

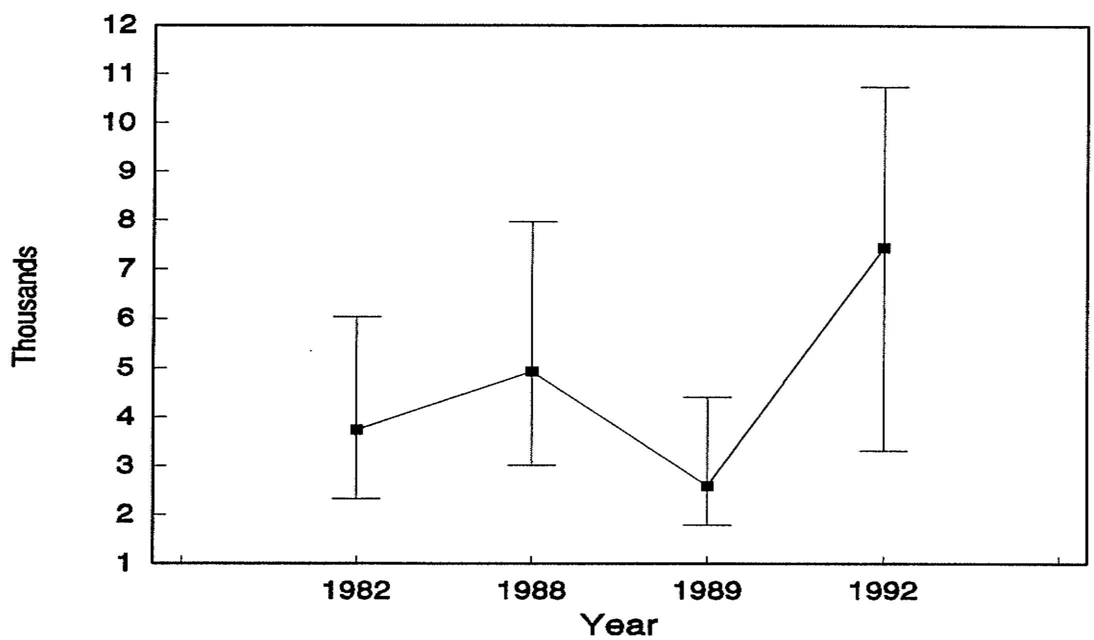

Fig. 20. Angler catch estimates of walleye < 1.6 kg., lower Red River, fall: 1982, 1988, 1989, and 1992.

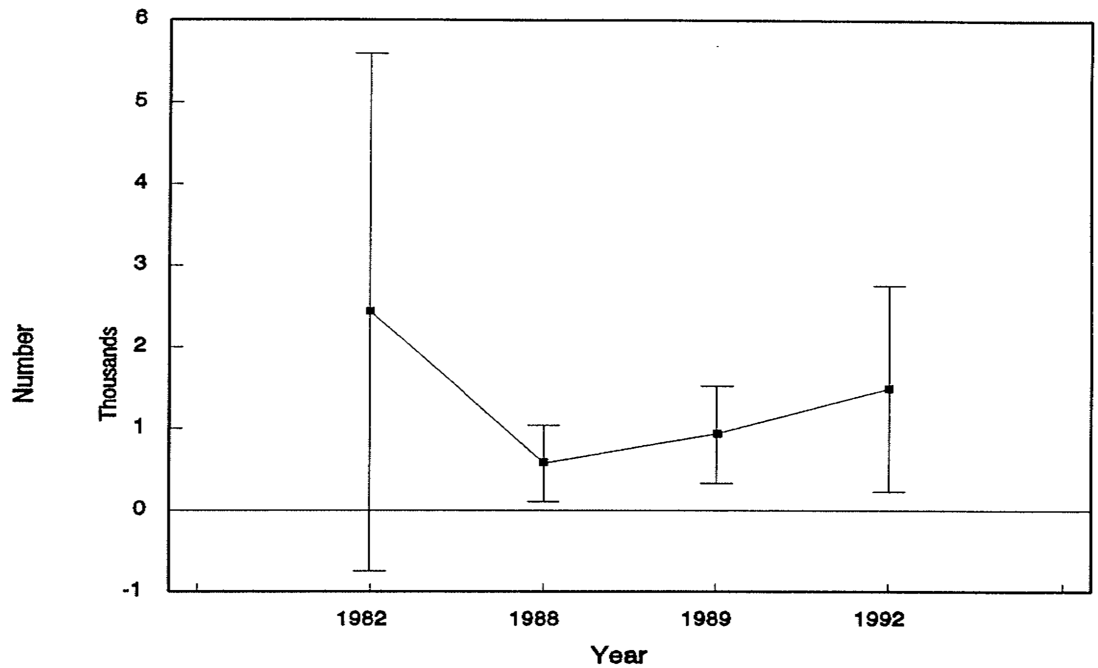

Fig. 21. Angler catch estimates of walleye > 1.6 kg., lower Red River, fall: 1982, 1988, 1989, and 1992.

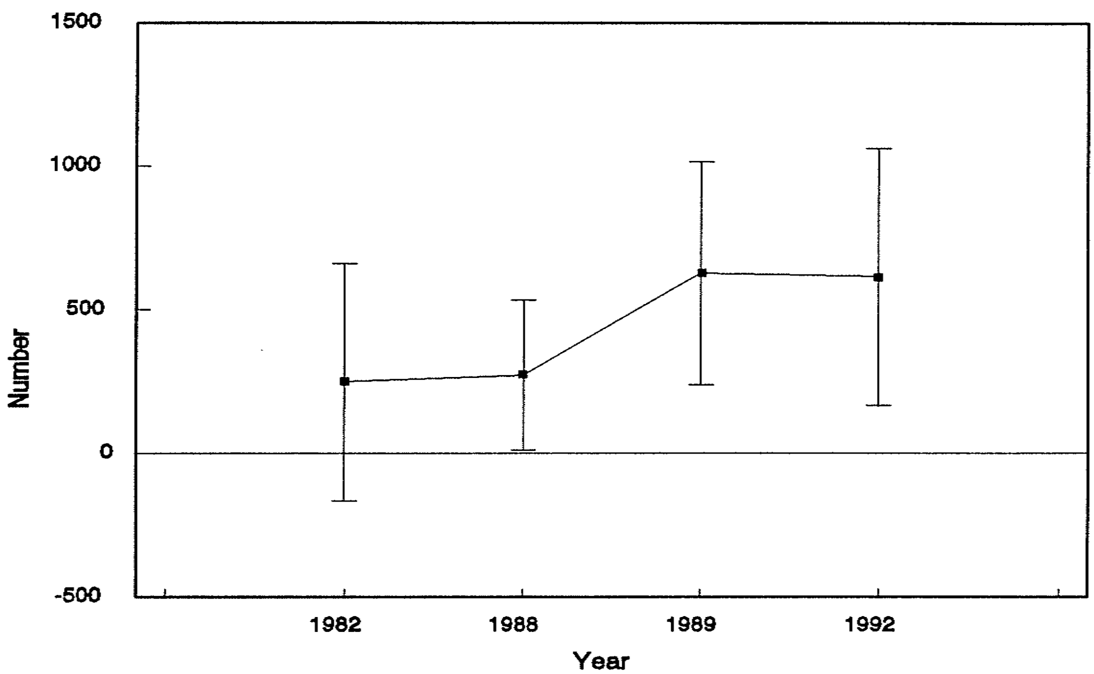

Fig. 22. Angler catch estimates of walleye > 3.6 kg., lower Red River, fall: 1982, 1988, 1989, and 1992.

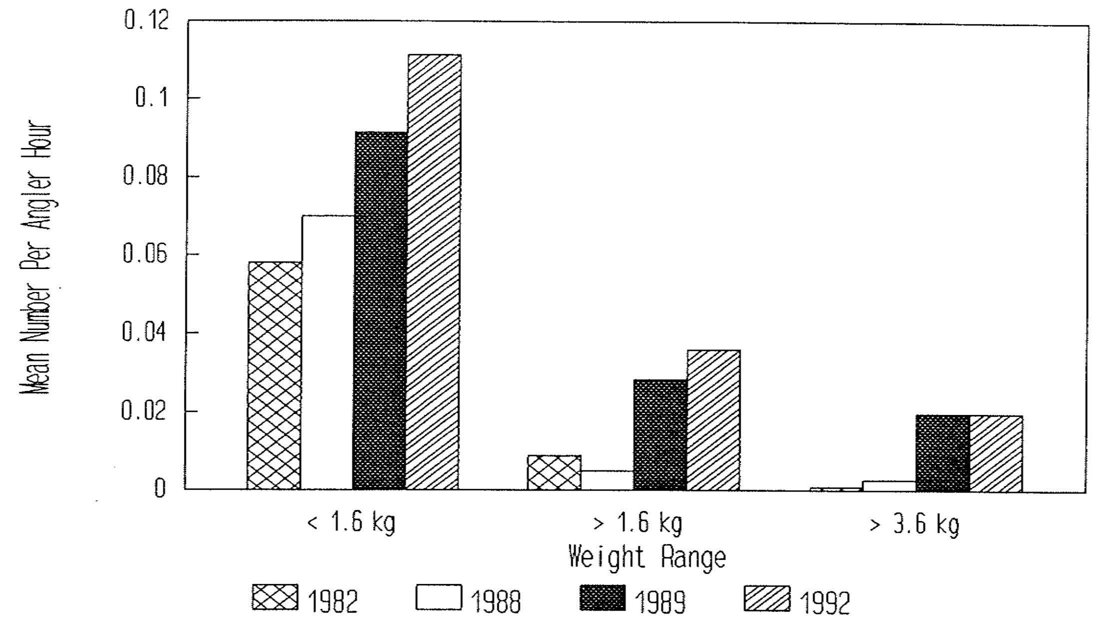

Fig. 23. Angler catch/effort estimates of walleye, lower Red River, September: 1982, 1988, 1989, and 1992.

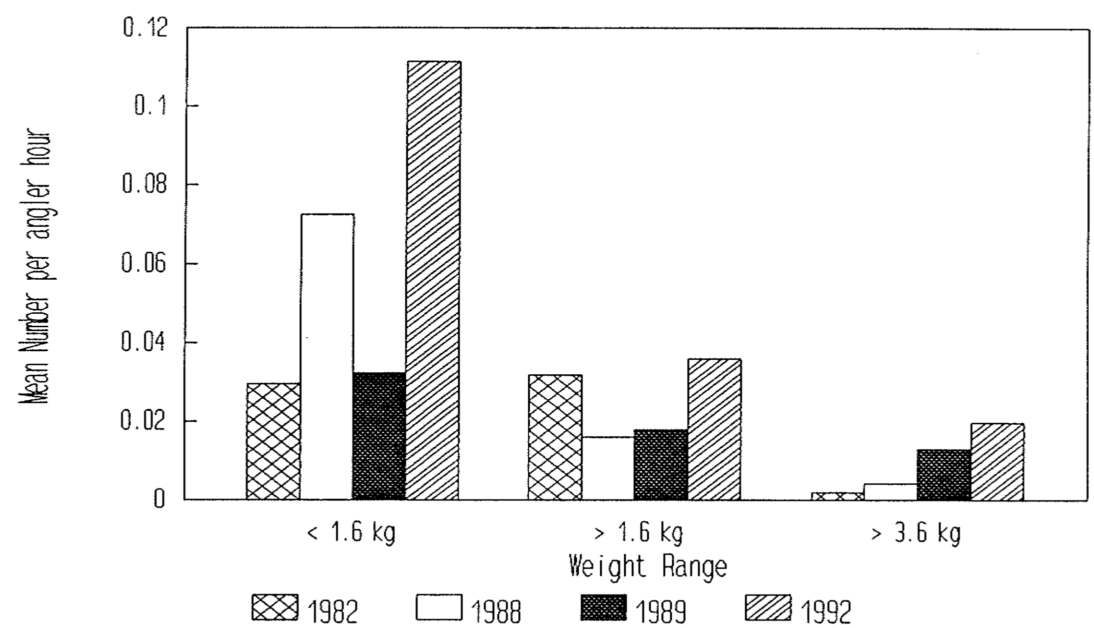

Fig. 24. Angler catch/effort estimates of walleye, lower Red River, October: 1982, 1988, 1989, and 1992.

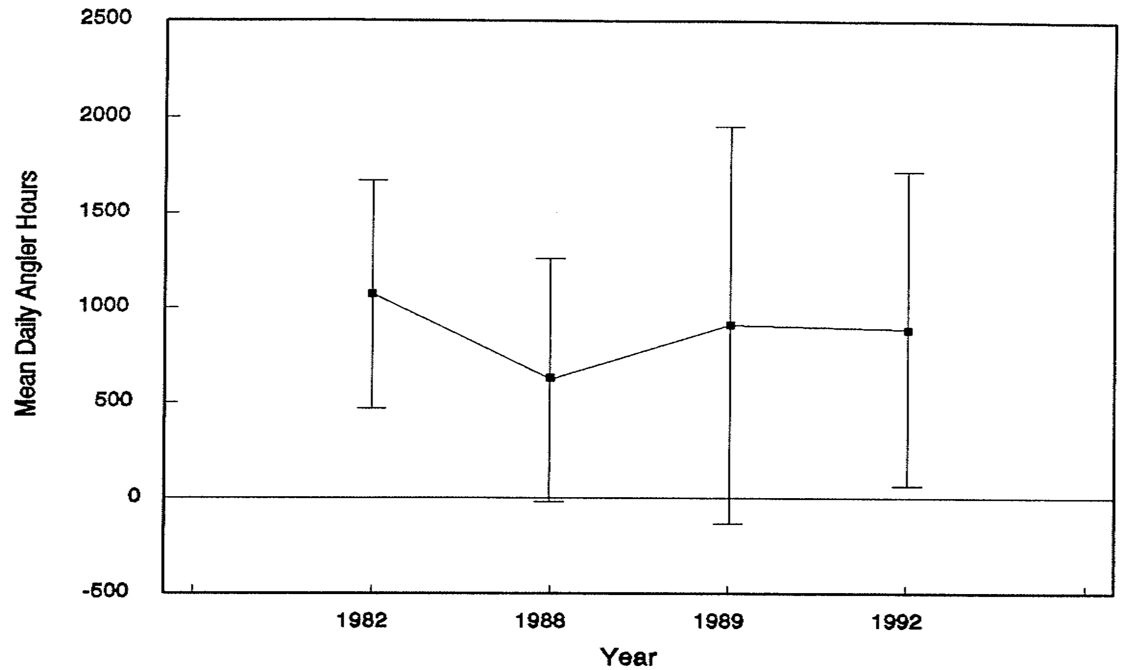

Fig. 25. Mean daily angler effort estimates for the lower Red River, September: 1982, 1988, 1989, and 1992.

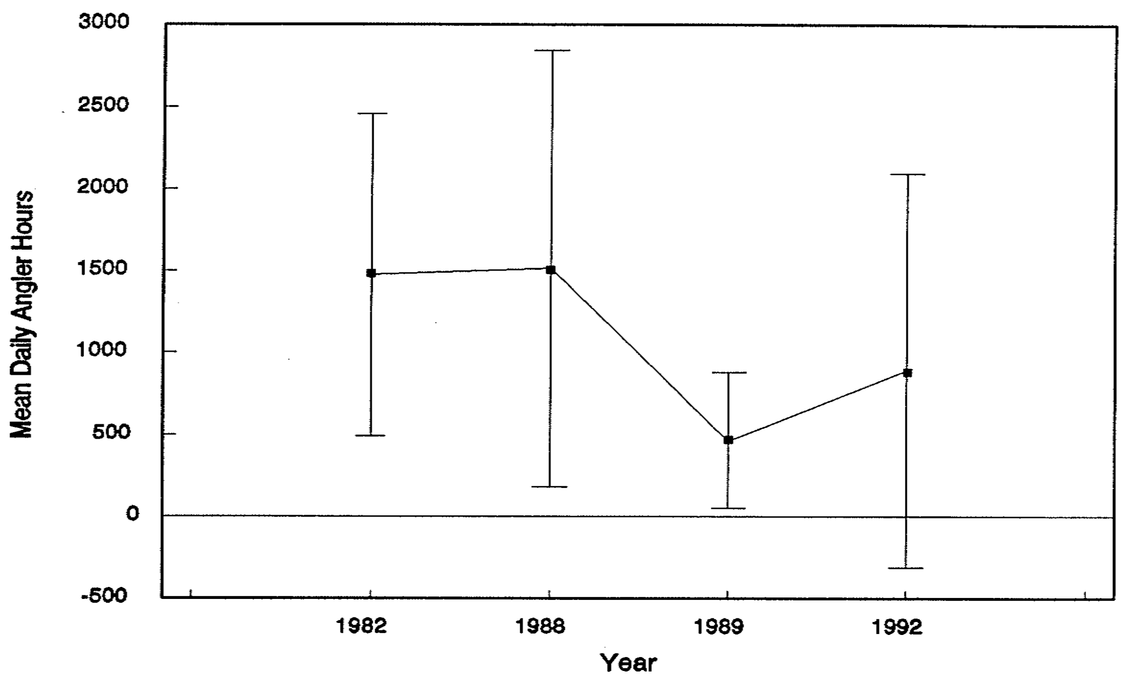

Fig. 26. Mean daily angler effort estimates for the lower Red River, October: 1982, 1988, 1989, and 1992.

Catch and release statistics from the angler survey years, indicate increasing releases of larger walleye (fig. 27).

4.2.2 Lower Red River Angler Derbies

The number of angling derbies decreased on the lower Red River between 1987 and 1992 (table 8). This was not consistent with the provincial trend, where derbies are increasing in both number and size (Wall pers. comm.). This result supports the decreased angler effort found in the angler creel surveys.

Specialized fishing derbies target single species such as walleye and catfish. There have been 145 registered fishing derbies held on the lower Red River since 1986 (table 8). Summer is the most popular derby time, followed by fall and winter. There are concerns about the resource impacts from such derbies. Substantial numbers of large walleye are caught in fall derbies on the lower Red River (fig. 28).

4.2.3 Native Subsistence Fisheries

Native subsistence fishing on the lower Red River, is currently very limited (Campbell pers. comm.). There is however, a growing tendency for treaty indians to gillnet large walleye as they move into the mouth of the Red River, to spawn in the spring (Maxwell pers. comm.).

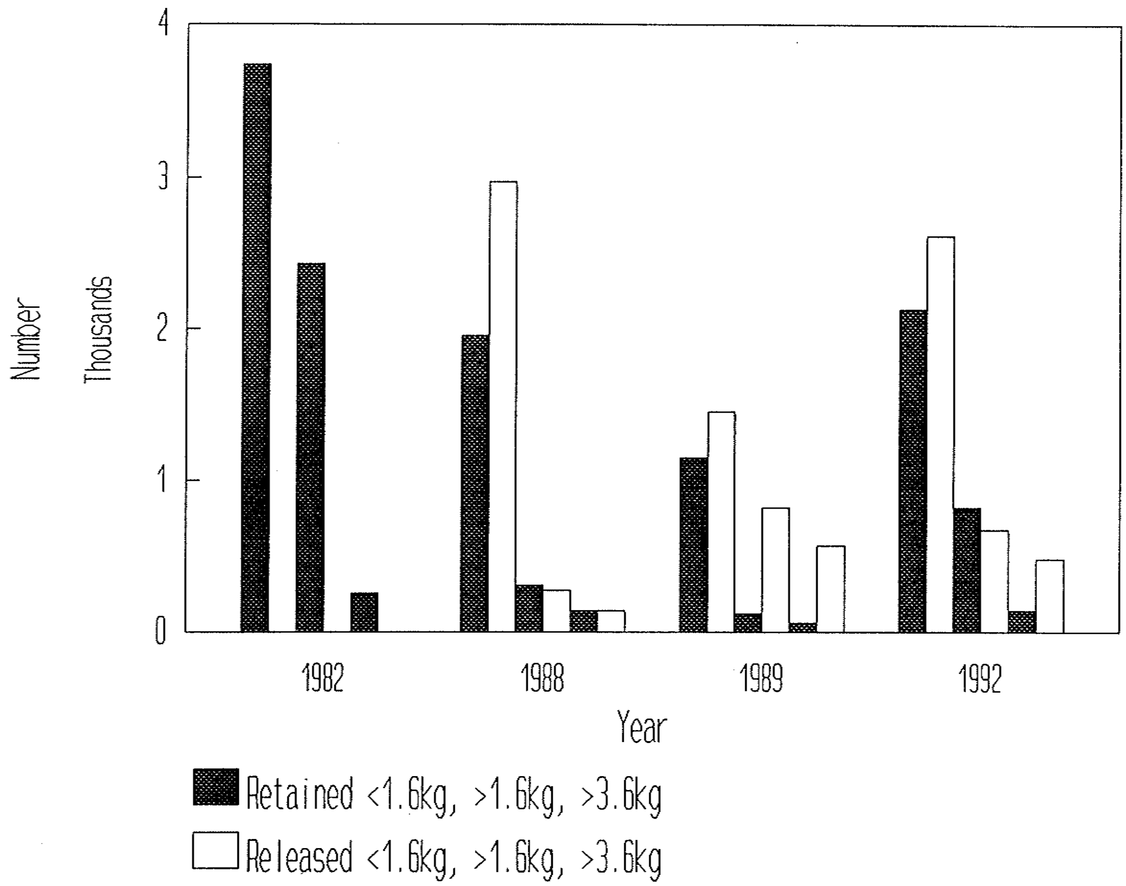

Fig. 27. Angler catch and release estimates for walleye, lower Red River, fall: 1982, 1988, 1989, and 1992.

Table 8. Derby applications for the lower Red River, 1986 - 1993.

	Year							
	1986	1987	1988	1989	1990	1991	1992	1993
Jan.1 to Mar.31	NA	13	8	5	2	0	3	4
May 1 to Aug.31	11	8	12	5	6	9	6	10
Sept.1 to Oct.31	3	9	7	6	6	3	4	5
Total	14	30	27	16	14	12	13	19

NA - Data not available

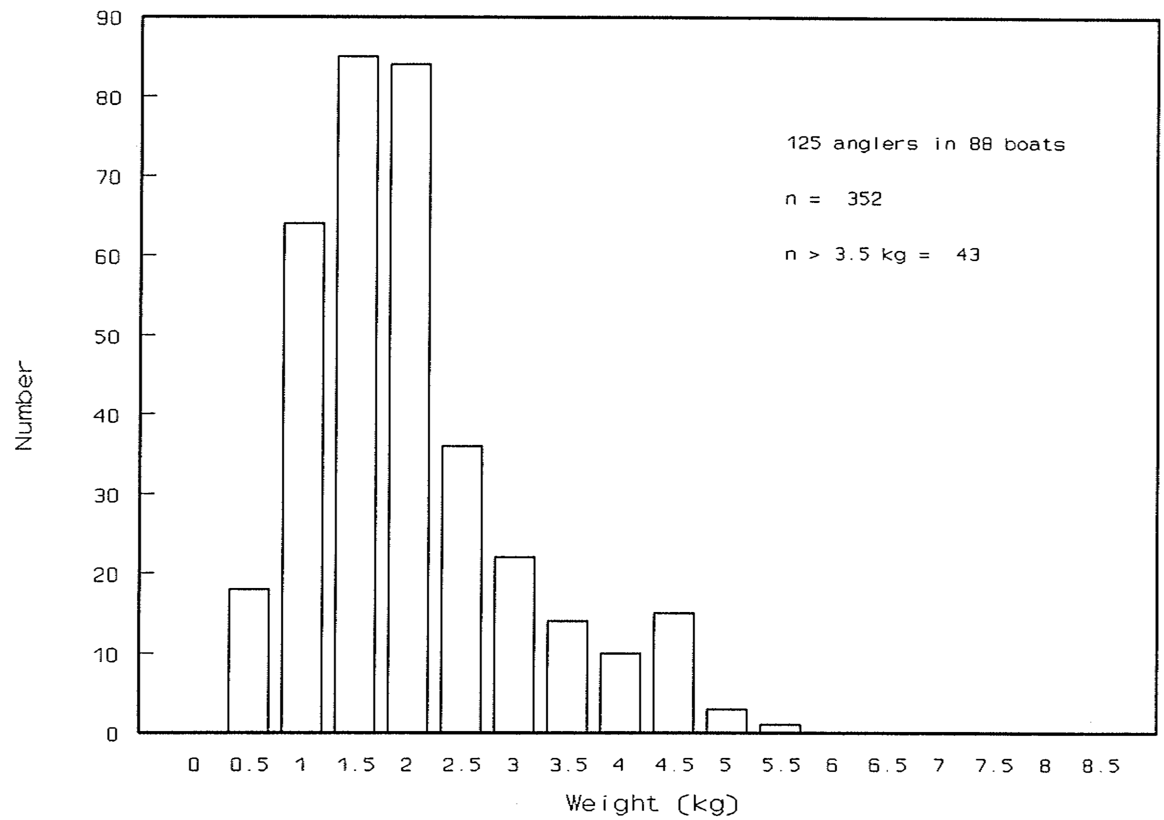

Fig. 28. Walleye catches in a lower Red River angling derby, the "Keystone Classic", October 4-5, 1992.

4.2.4. Lake Winnipeg Commercial Walleye Harvest

Commercial catch sampling of large walleye took place at the Selkirk FFMC plant in the fall of 1988, 1989, 1991 and 1992. A weight frequency index was used to compare master angler and large commercial walleye catches. A small amount of overlap was found in both groups (fig. 29). Walleye scale ages were innaccurate for walleye over 2 kg.

Annual commercial walleye harvests are presented from 1931-1992 (fig. 30) and from 1977-1992 for the total lake (fig. 31) and south basin (fig. 32). Commercial catches were not sustainable in the early 1950's (fig. 30). A lower sustainable threshold may now exist due to the interactions of exotic species introductions and changes in water quality.

Commercial walleye catches vary over the last ten years, with the 1987/88 year being the lowest (fig. 31). Catches of large walleye declined from 1982/83 to 1988/89 and increased in the lake and south basin from 1989/90 to 1991/92 (fig. 32).

4.2.5. Commercial Gillnet Monitoring - Red River Mouth

Monitoring of commercial gillnets off the mouth of the Red River was carried out in September and October of 1988, 1989, 1991 and 1992. Additional monitoring was carried out in

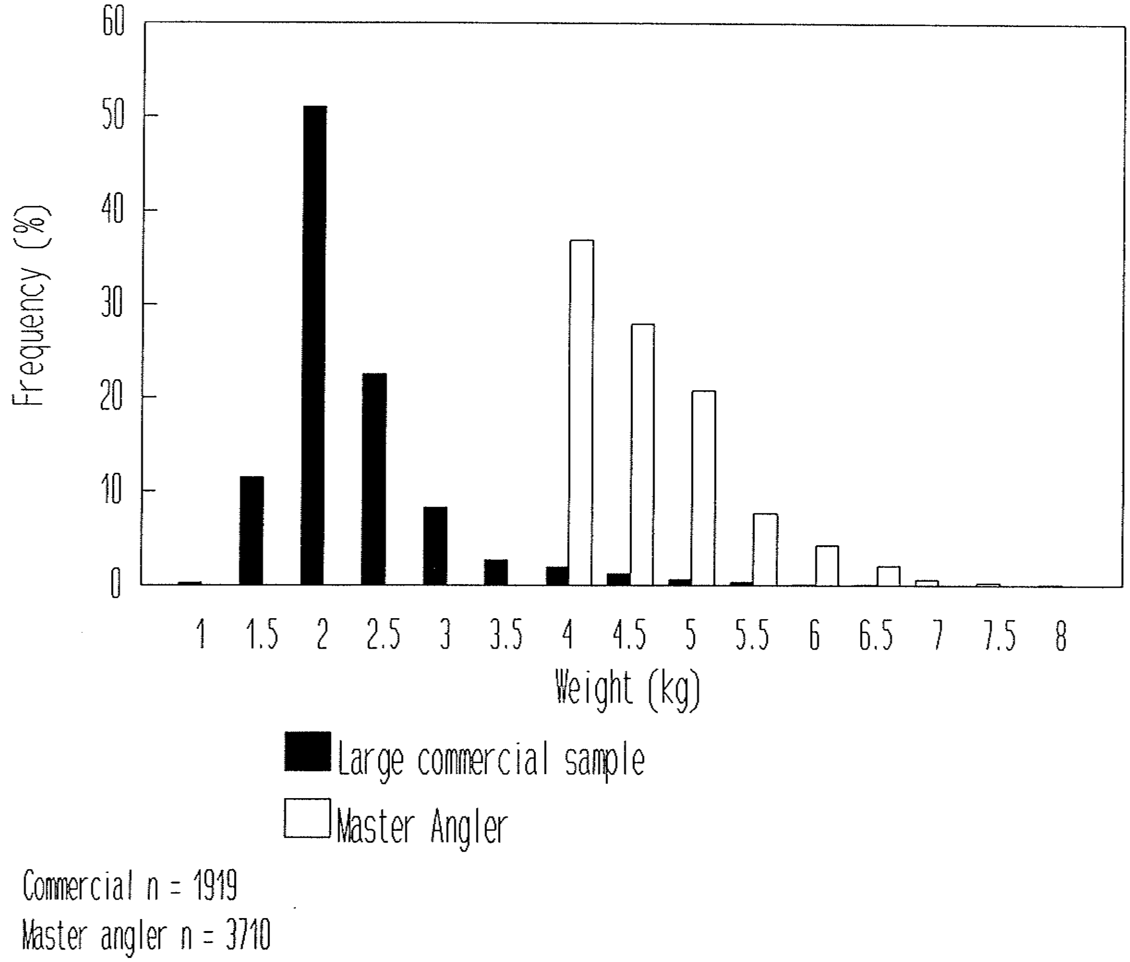

Fig. 29. Weight overlap between large commercial walleye samples and master angler walleye records.

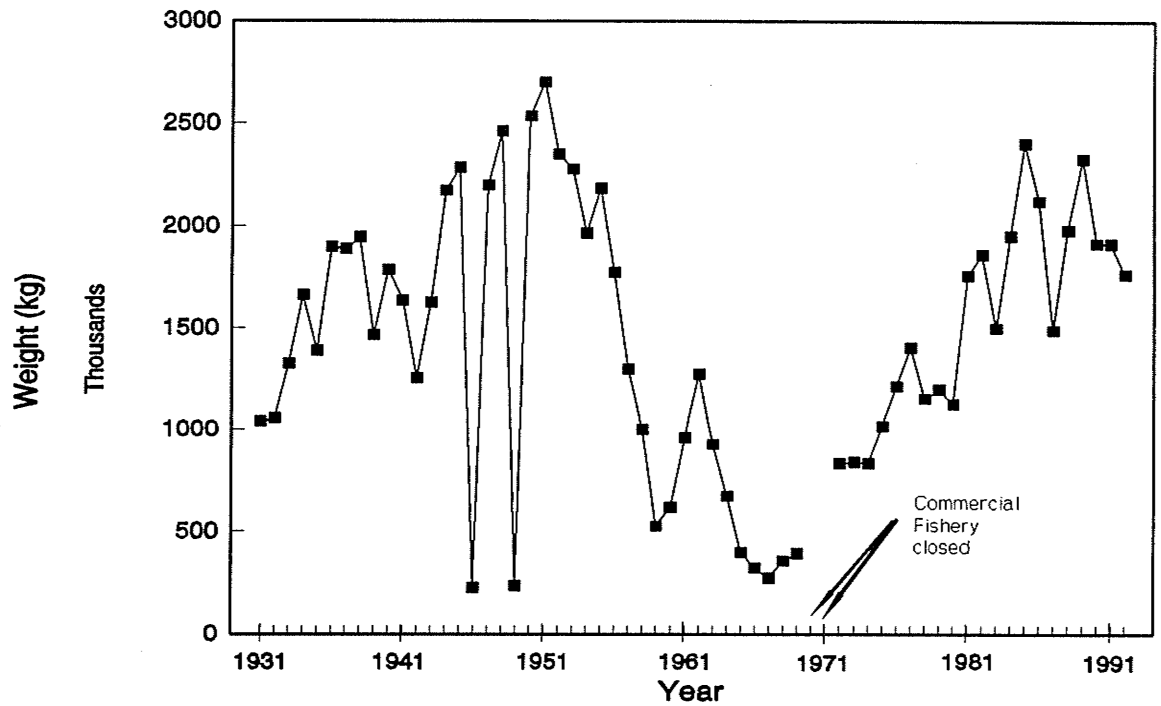

Fig. 30. Annual commercial walleye harvests on Lake Winnipeg, 1931-1992. (FROM Lysack, unpublished report).

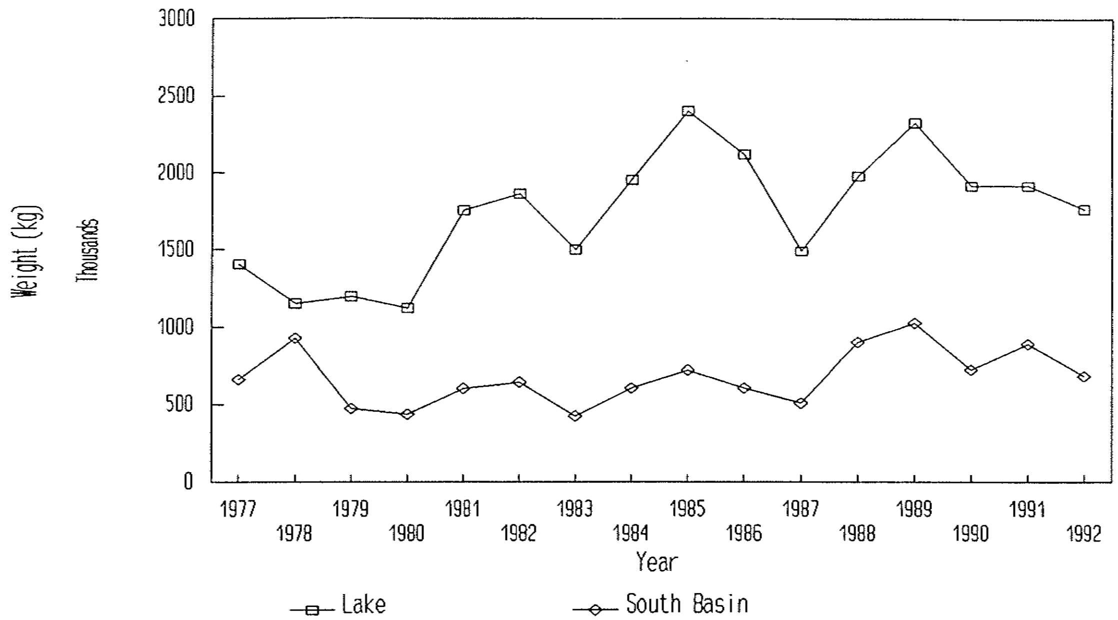

Fig. 31. Annual commercial harvests of walleye on Lake Winnipeg, 1977-1992.

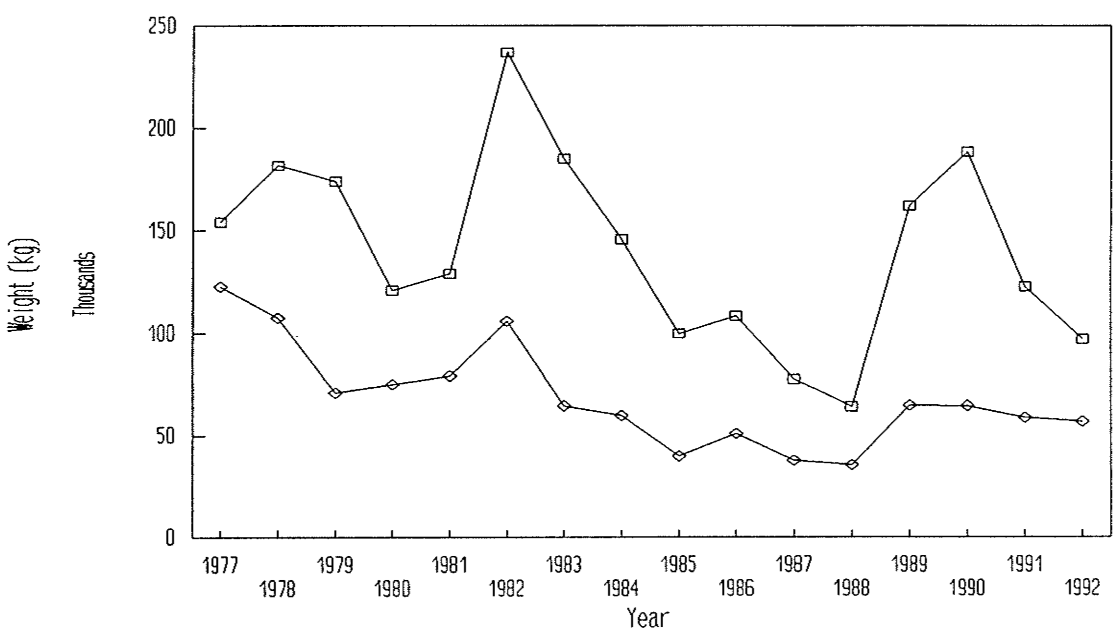

Fig. 32. Annual commercial harvests of large walleye on Lake Winnipeg, 1977-1992.

May and June of 1991 and 1992. Monitoring examined the effects of commercial gillnetting near the mouth of the Red River, on angler catches of large walleye. Impacts were measured by the number and size of walleyes caught in the commercial gillnets, in comparison to angling catches.

The highest number of recorded gillnets was 104, on May 21, 1991 (fig. 33). The scaled drawing shows the limited potential for complete blockage of walleye movements, in and out of the Red River mouth. A more detailed, close-up view, is shown in figure 34. The fall gillnet sets were less numerous than in the spring (figs. 35, 36). Gillnet numbers declined steadily throughout the season and varied from year to year (figs. 37, 38).

Commercial catch sampling was used to calculate walleye weight distributions from the "large" (> 1.6 kg) component of the commercial catch records, for each individual commercial user. Commercial catches of walleye appear to be equally numerous in both the spring and fall time periods (fig. 39).

Commercial catches of large walleye (> 1.6 kg) were higher in the fall season, near the Red River mouth (fig. 40). Maximum walleye catches (> 3.5 kg) were estimated for this area in the spring of 1991 (fig. 41). South basin walleye catch estimates (> 3.5 kg) were even more numerous (fig. 42).

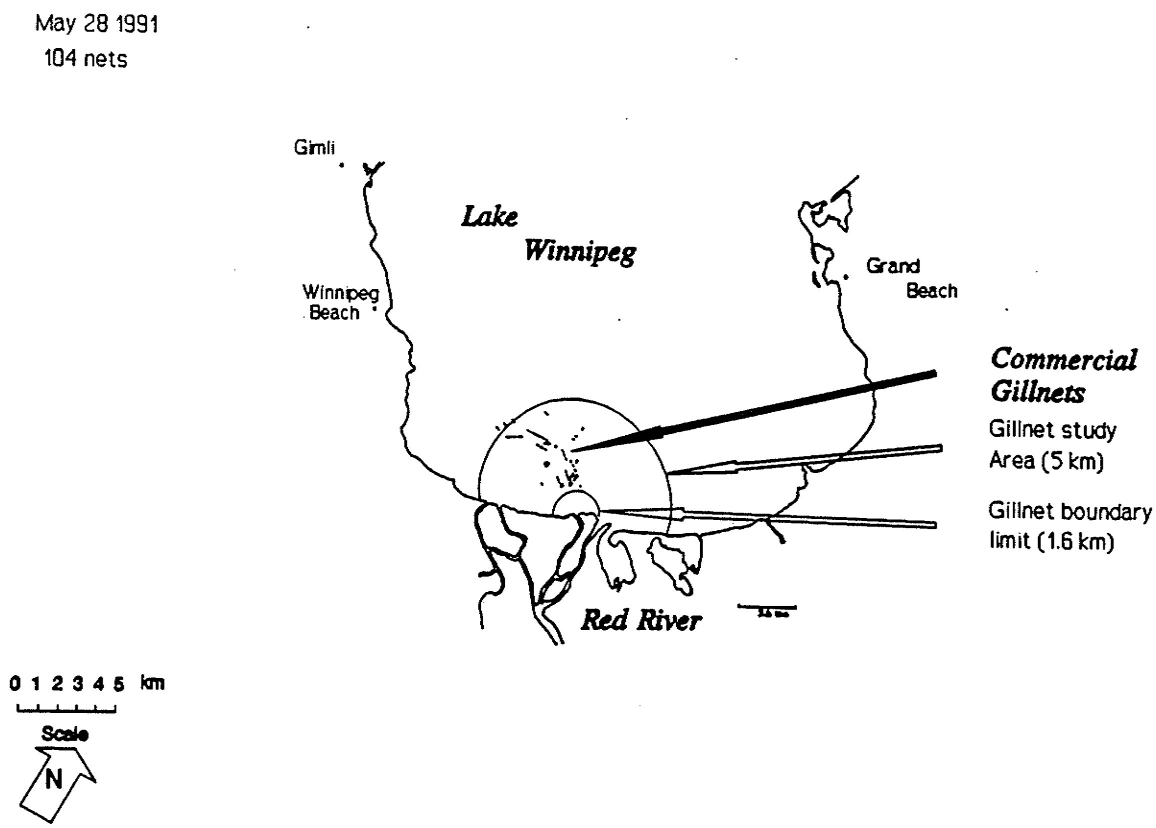

Fig. 33. Gillnet monitoring off the Red River mouth, May 28, 1991. Basin view to scale.

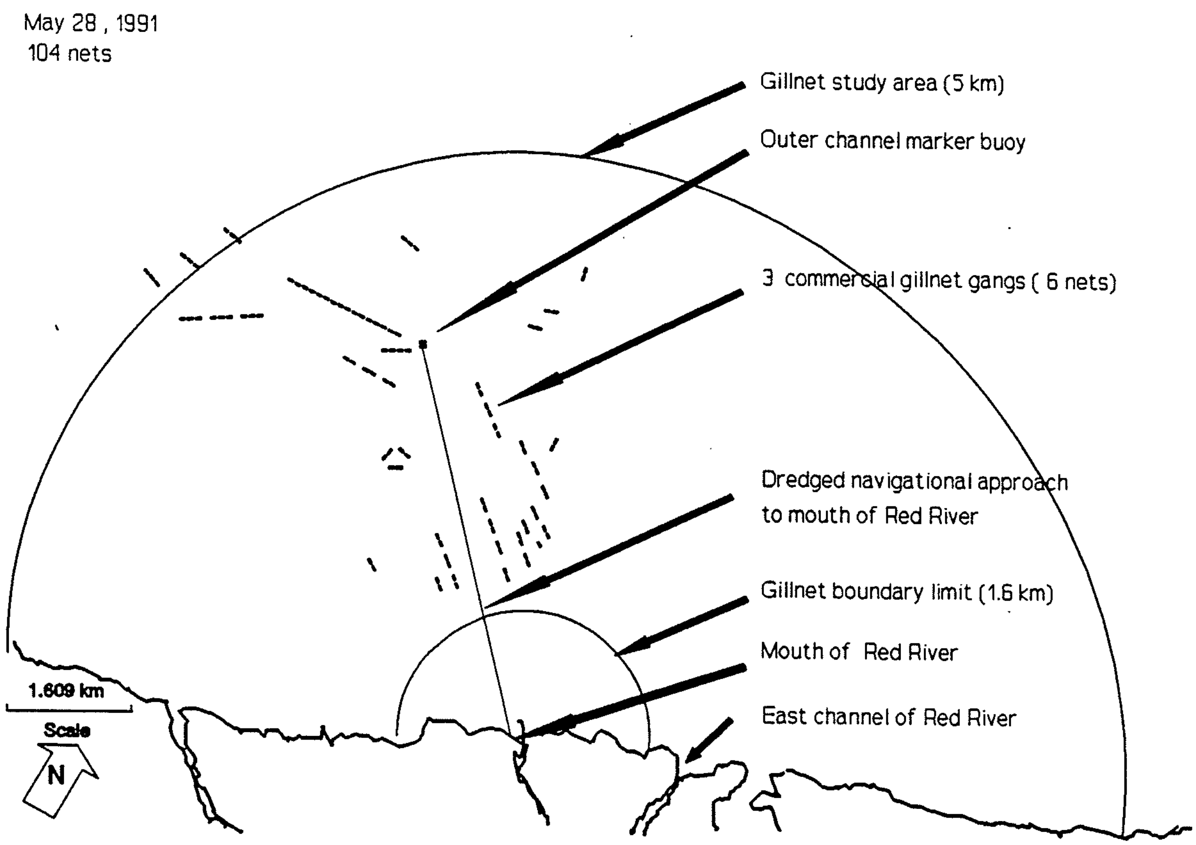

Fig. 34. Gillnet monitoring off the Red River mouth, May 28, 1991. Close-up view to scale.

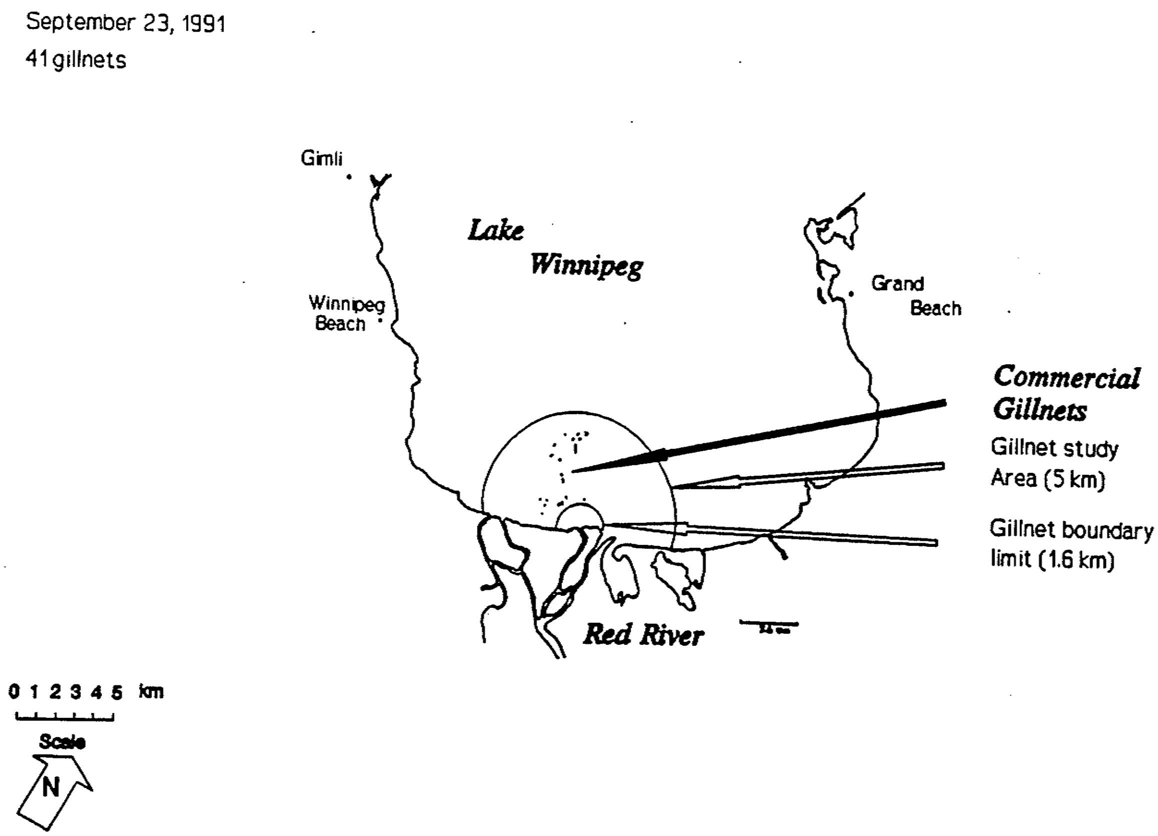

Fig. 35. Gillnet monitoring off the Red River mouth, September 23, 1991. Basin view to scale.

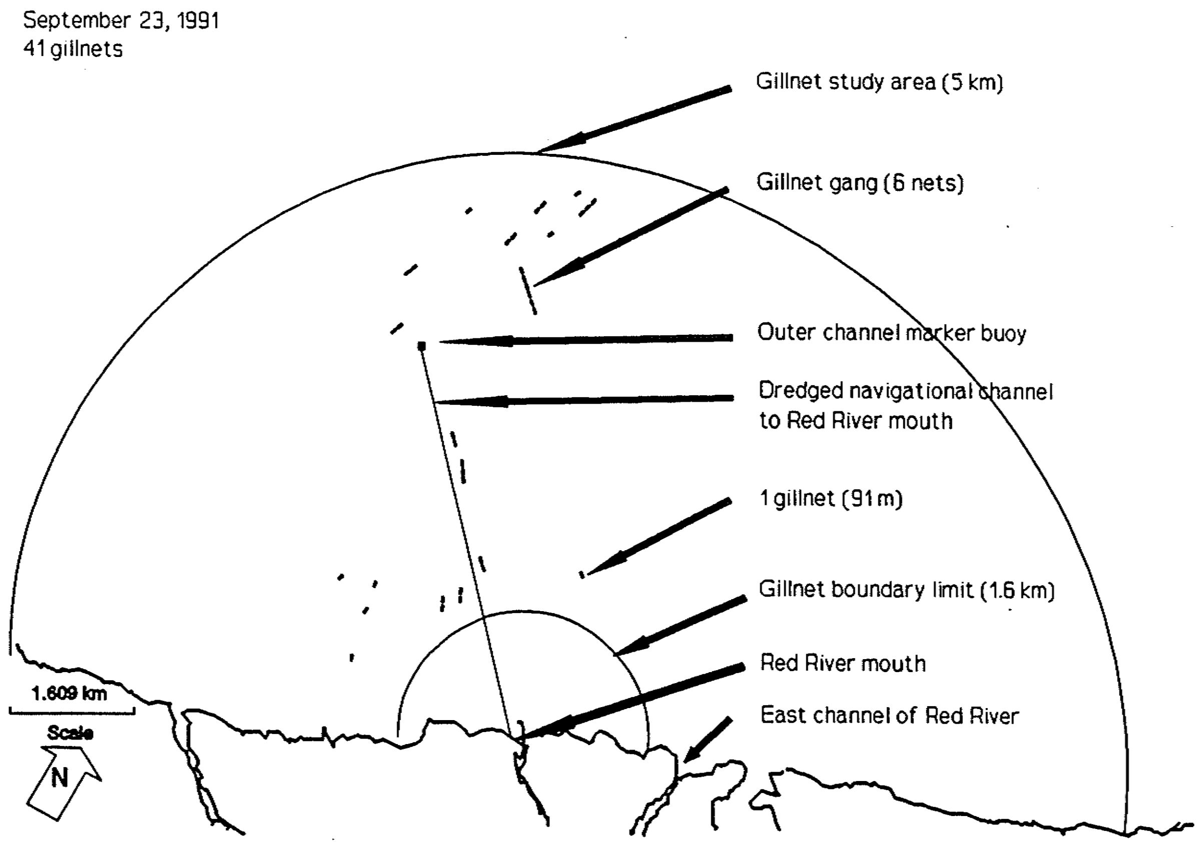

Fig. 36. Gillnet monitoring off the Red River mouth, September 23, 1991. Close-up view to scale.

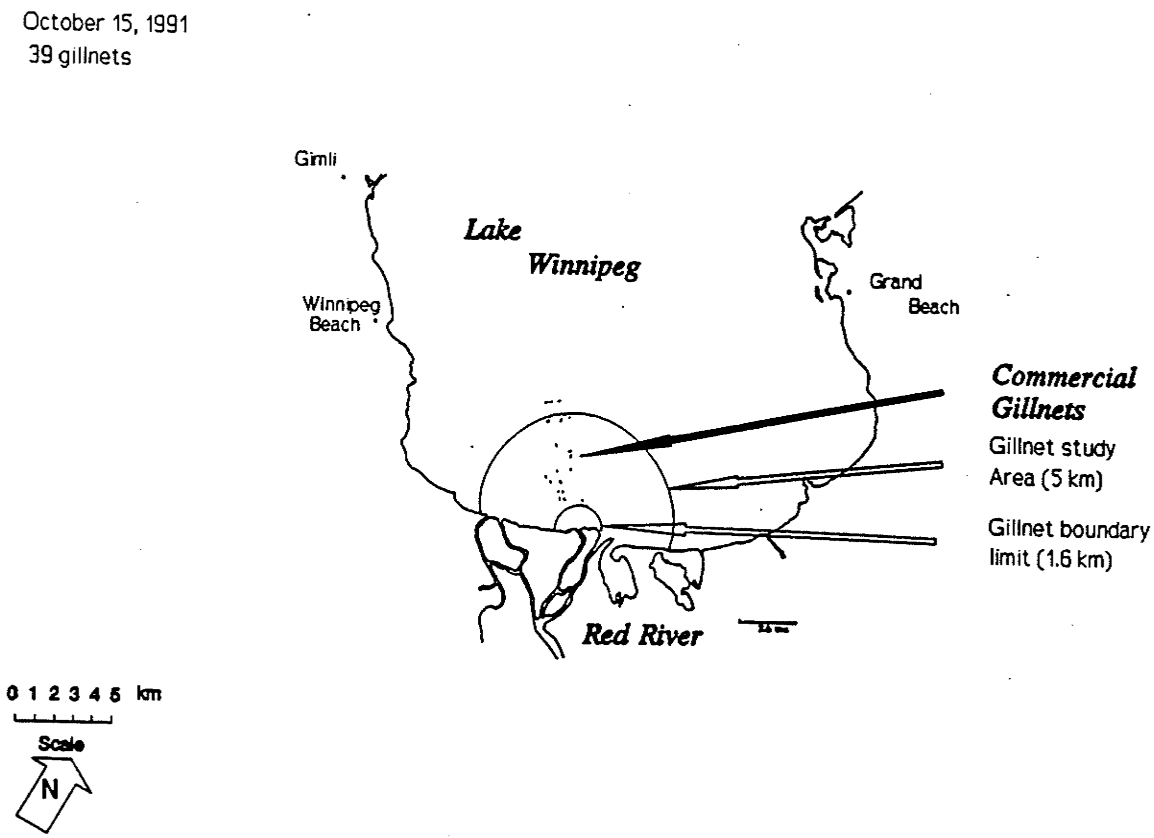

Fig. 37. Gillnet monitoring off the Red River mouth, October 15, 1991. Basin view to scale.

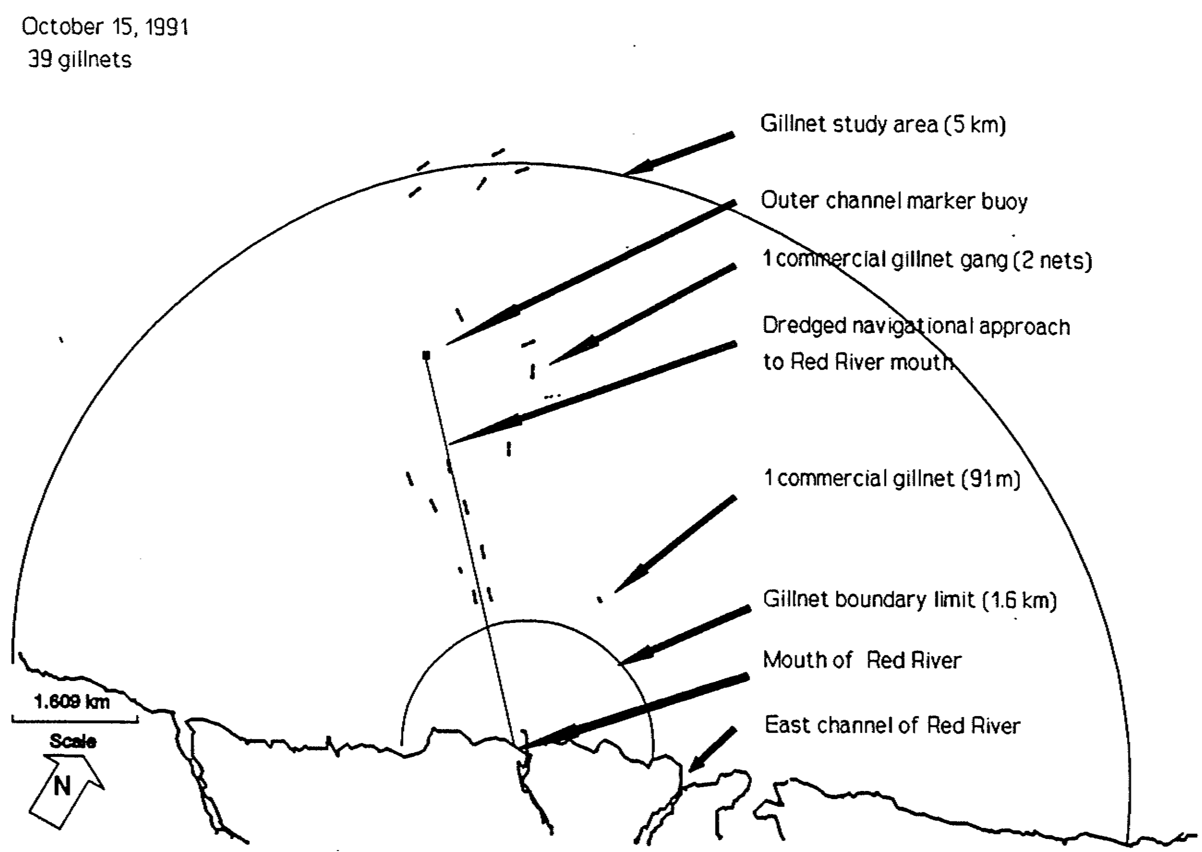

Fig. 38. Gillnet monitoring off the Red River mouth, October 15, 1991. Close-up view to scale.

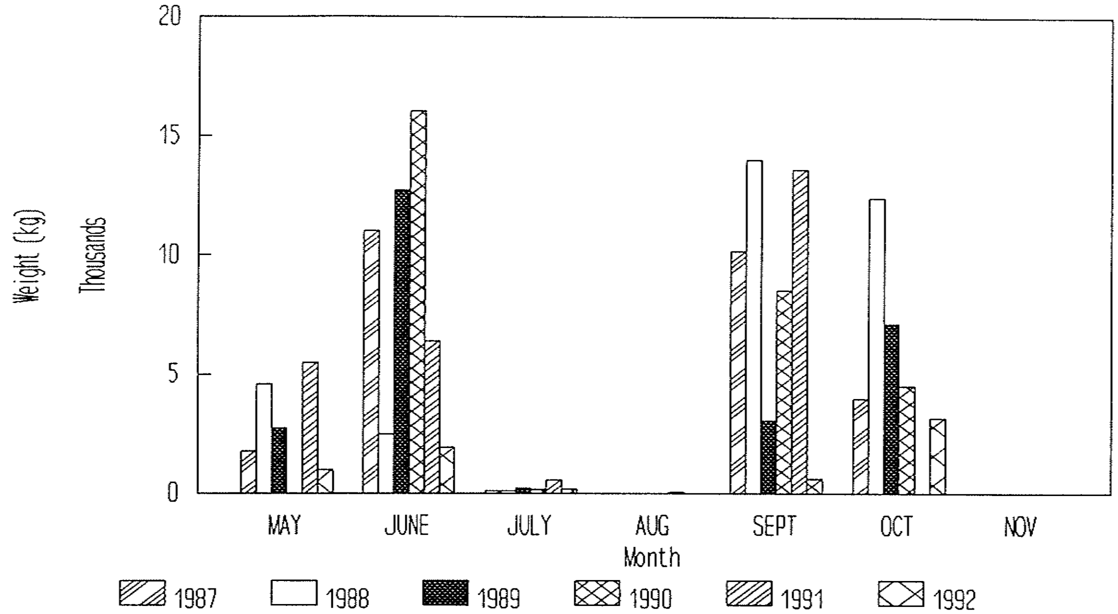

Fig. 39. Commercial catches of walleye, near the mouth of the Red River, 1987-1992.

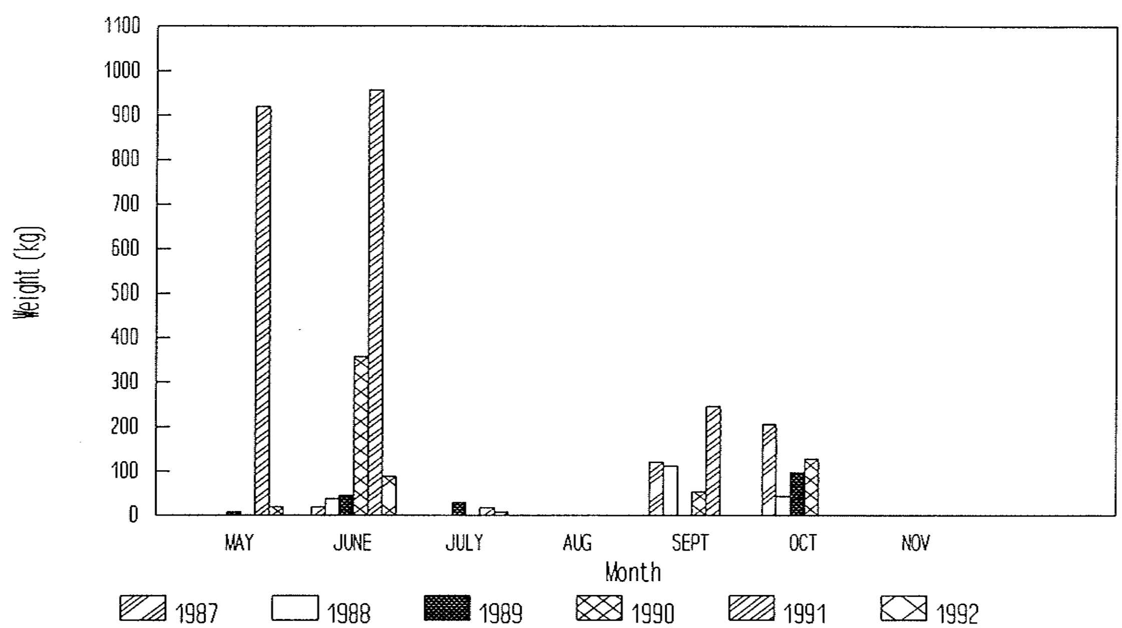

Fig. 40. Commercial catches of large walleye, near the mouth of the Red River, 1987-1992.

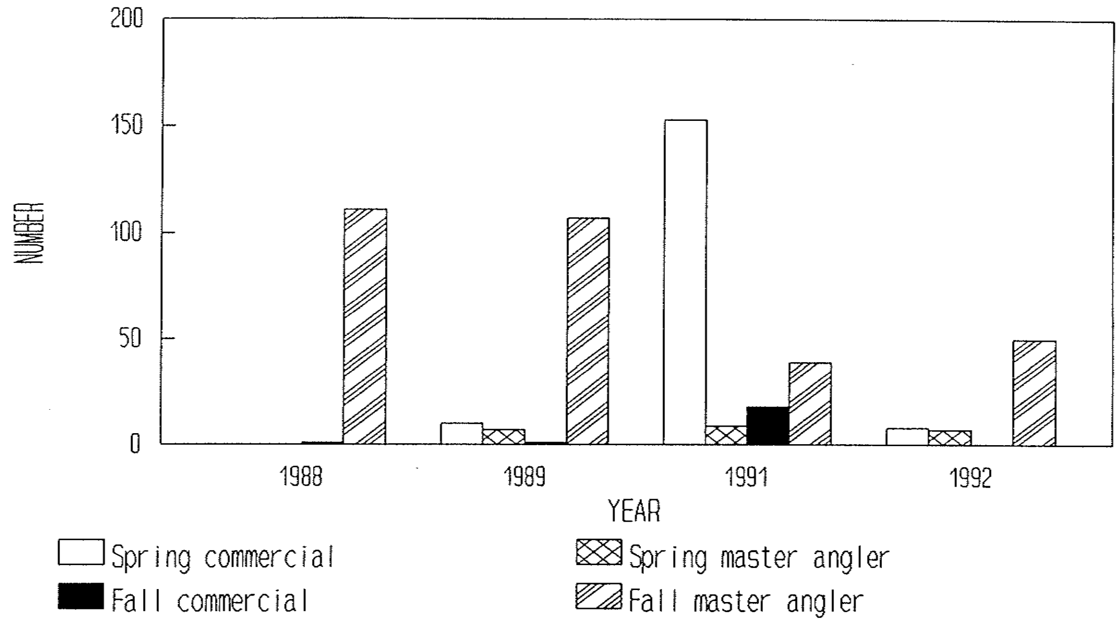

Fig. 41. Commercial estimates of walleye > 3.5 kg., caught near the mouth of the Red River, 1988-1992.

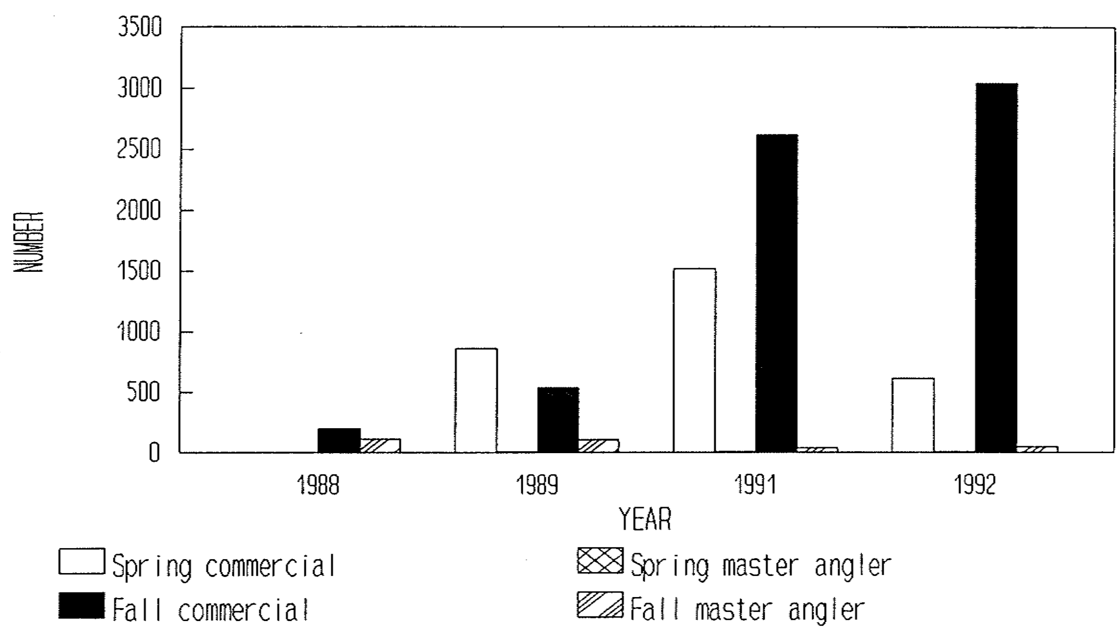

Fig. 42. Commercial estimates of walleye > 3.5 kg., caught in the south basin of Lake Winnipeg, 1988-1992.

4.2.6. Radio-telemetry Tracking of Walleye Movements

More precise information was needed to interpret the results from the floy-tagging study and to describe the timing and dispersal patterns of walleye, within the south basin of Lake Winnipeg and the lower Red River.

The first attempt to determine how long walleye remained in the lower Red River, began in the fall of 1991. Six radio-tagged walleye returned into the south basin of Lake Winnipeg by November 25, and another walleye was caught in the lower Red River in a research test net on December 18, 1991 (fig. 43). Aerial tracking in the winter of 1991/92, succeeded in locating only one walleye (transmitter frequency 48.240 Mhz), in the south basin of Lake Winnipeg (fig. 43). Signal reception was limited by water depth and conductivity in the south basin of Lake Winnipeg, but not in the Red River.

All 6 remaining walleye were eventually found in the spring of 1992, three in the lower Red River and three in the south basin of Lake Winnipeg (fig. 44). The three walleye in the lower Red River were first detected on April 7, 1992 (fig. 44). One walleye was tracked into the salamonia channel, where it was last located on May 28, 1992. Another walleye left the Red River and remained near the shoreline, in an area east of the Red River mouth (fig. 44). The third walleye was

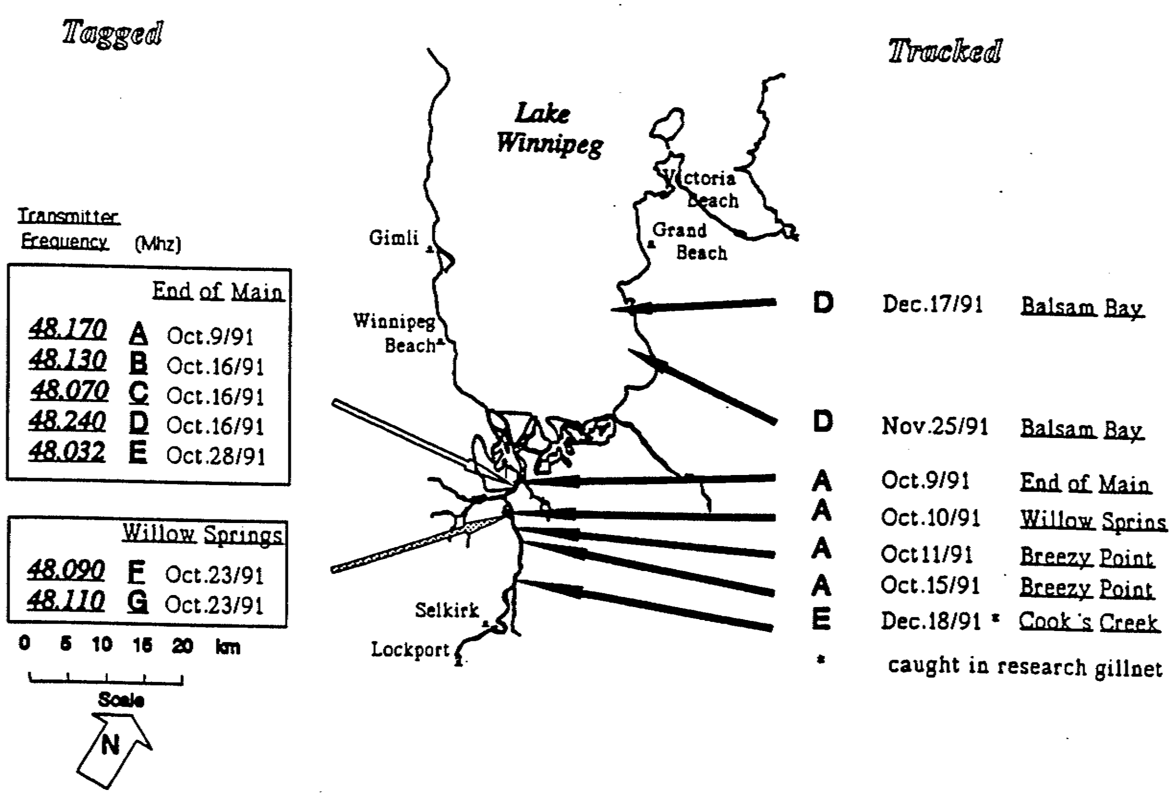

Fig. 43. Aerial tracking locations of 7 radio-tagged walleye, in the fall and winter of 1991.

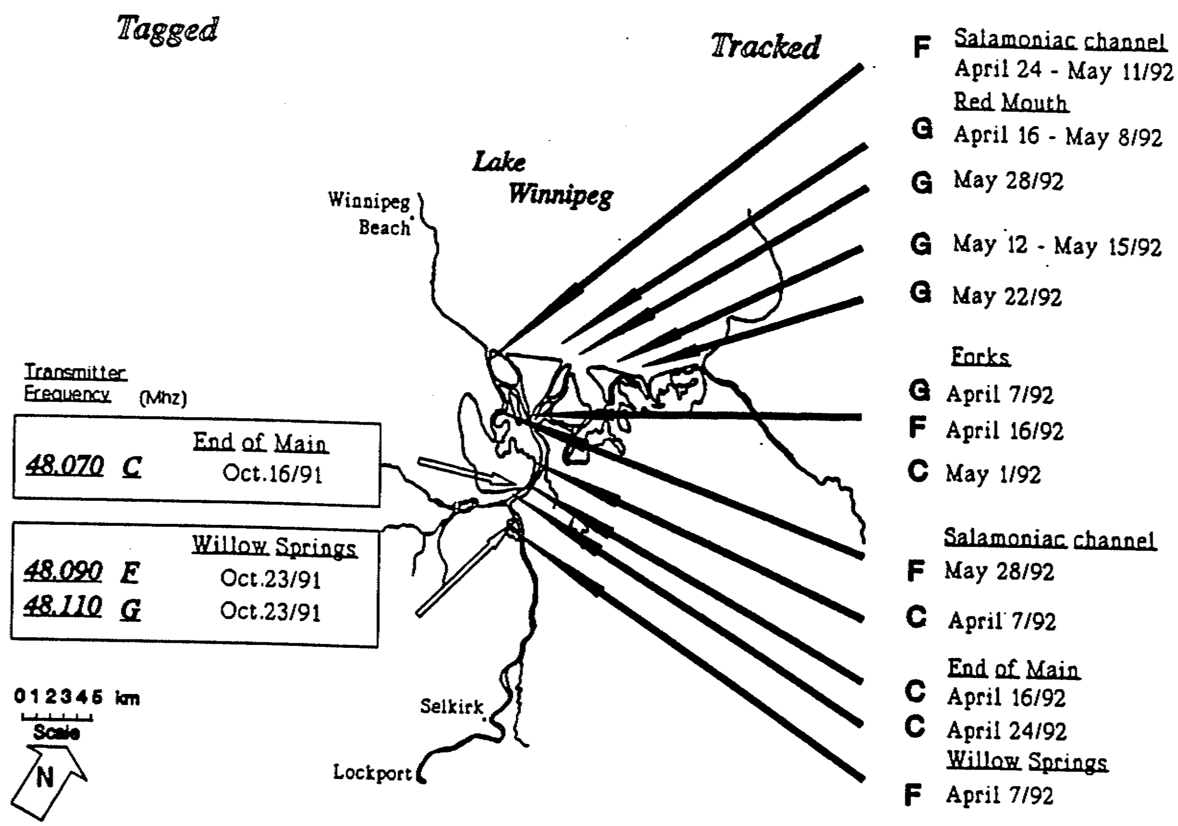

Fig. 44. Detailed aerial tracking of 3 radio-tagged walleye, in the lower Red River, spring 1992.

tracked in the lower Red River up to May 1, 1992 (fig. 44).

Five additional walleye were radio-tagged in the lower Red River between May 4 and May 7, 1992 (fig. 45). Four of the walleye were tracked moving outward into the south basin of Lake Winnipeg, between May 8 and May 15, 1992 (fig. 45). One large walleye (transmitter frequency 48.260 Mhz) was still in the lower Red River as late as May 22, 1992 (fig. 45).

Another walleye (transmitter frequency 48.150 Mhz) moved out of the river system and was tracked into the south basin of Lake Winnipeg on May 15, 1992 (fig. 45). This same walleye then moved back into the lower Red River near the Salamonia channel on May 22, 1992 (fig. 45).

None of the radio-tagged walleye were located within the lower Red River in the fall of 1992 (fig. 46). Four walleye remained along the eastern inshore area of the south basin and another one was located along the western shoreline (fig. 46).

Commercial gillnets eventually accounted for two known mortalities of radio-tagged walleye. One large walleye (transmitter frequency 48.260 Mhz.) was caught off Belair on September 16, 1992 and another large walleye (transmitter frequency 48.240 Mhz.) was recaptured north of Gimli on May 31, 1993 (fig. 46).

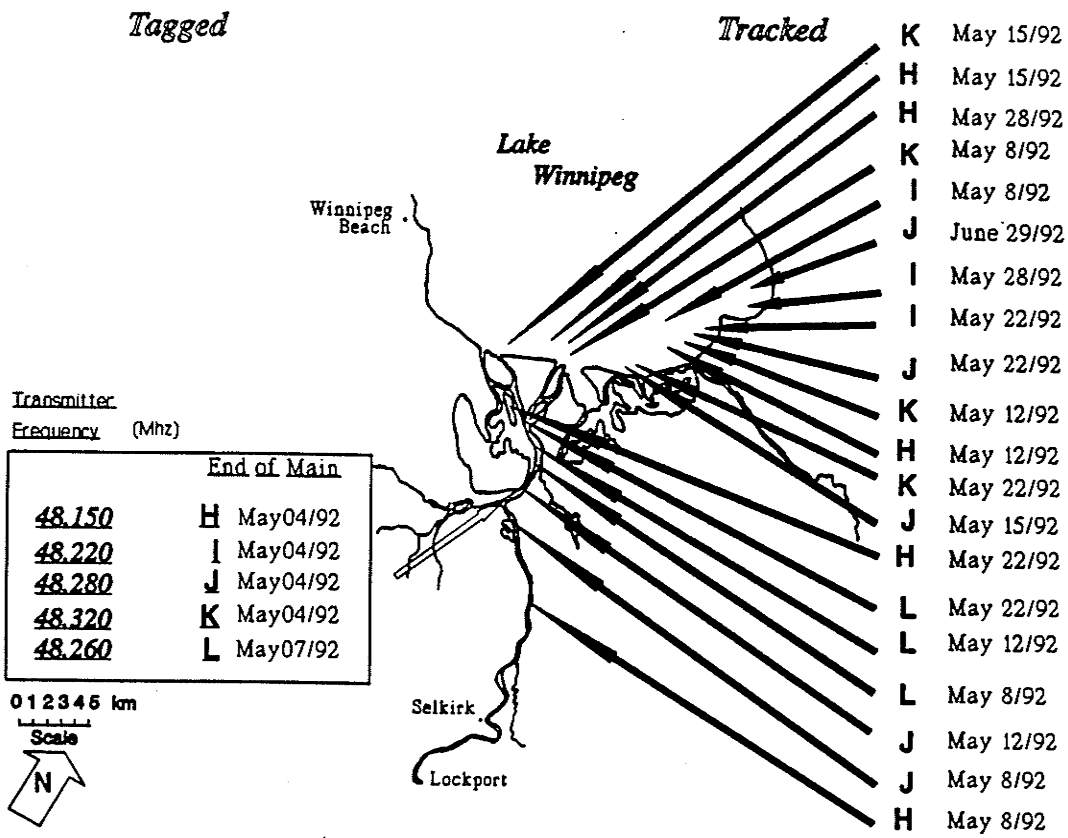

Fig. 45. Aerial tracking locations of 5 additional radio-tagged walleye, in the spring of 1992.

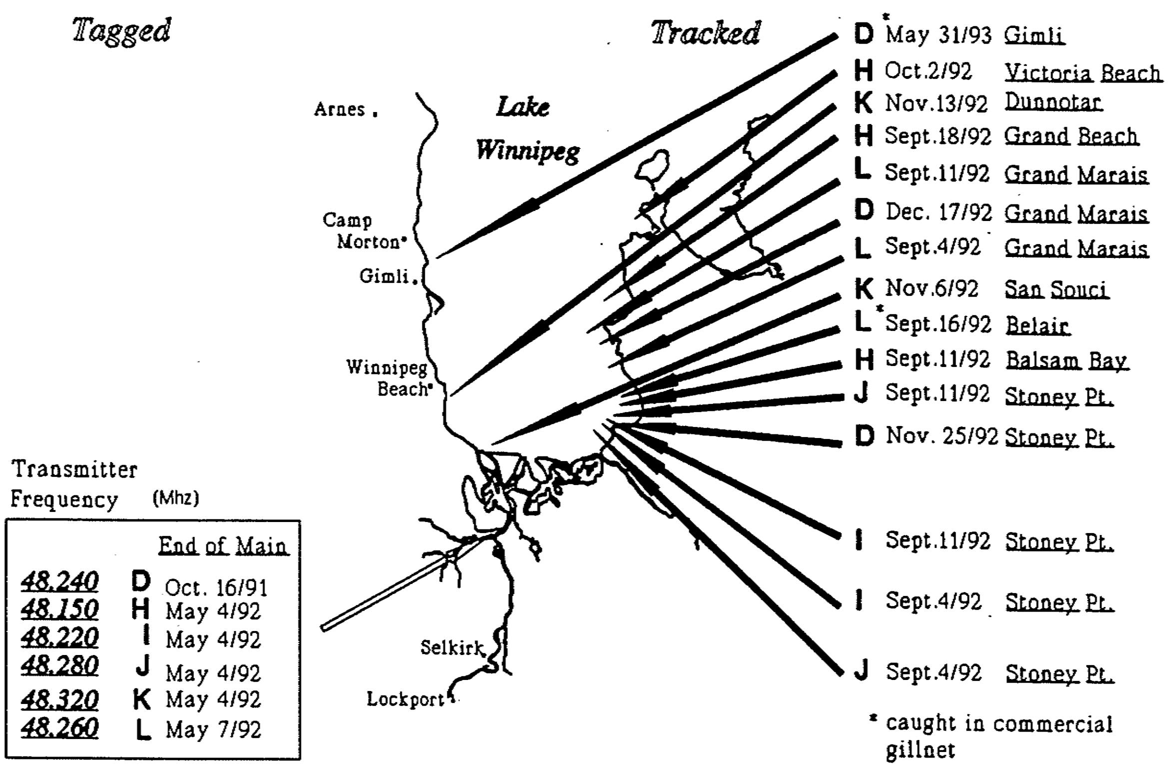

Fig. 46. Aerial tracking locations of 6 remaining radio-tagged walleye, in the fall of 1992.

4.3 Environmental Impacts

4.3.1 Red River Monthly Flow Rates

Historical water flow rates for the lower Red River are presented from 1980 to 1992 (table 9). Maximum spring flows (April and May) were recorded in 1986 (table 9). Maximum fall flows (September and October) were recorded in 1985 (table 9).

Lower than average spring water flows occurred in the lower Red River in 1981, 1988, 1990 and 1991 (table 10). Lower than average fall water flows occurred in the lower Red River in 1987, 1988, 1989 and 1990 (table 10). This information is graphically depicted in figures 47 and 48.

Annual flow calculations for the lower Red River, indicate that the years from 1980 to 1981 and 1988 to 1992, were below the mean flow rates for the 12 year time period (fig. 49). Higher than average flows occurred from 1982 to 1987. Least squares linear regression of master angler catches on mean annual Red River Flow rates is shown in figure 50.

4.3.2 Red River Water Quality Changes

Three additional influences on walleye abundance were also examined: dredging, un-ionized ammonia and disease.

a) un-ionized ammonia

Gurney (1991) has reported that un-ionized ammonia levels have increasingly exceeded provincial water quality standards in the lower Red River, over the last ten years. Levels typically increase from September to December and then decline to their lowest levels in July and August. Shepherd and Bromage (1988) report that toxicities associated with elevated levels of un-ionized ammonia varies with temperature and pH.

b) dredging

Dredging activities have increased in some of the best walleye angling locations, between Lockport and Selkirk. Dredging in these areas was required to remove mud and silt accumulations that formed during the low flow years, from 1988 to 1991. Colp (pers. comm.) confirmed that most of the dredging activity occurred in the fall season and consisted of localized excavations with a clam-type bucket dredge.

Colp (pers. comm.) reported that the excavated material or "spoil" was barged away from the sites and dumped in areas to minimize contributions to future navigational problems. Stewart (pers. comm.) observed local changes in turbidity levels following the dumping of the spoil material, within a few hours. He believes the turbidity changes may have been more pronounced during the low flow years of the Red River, from 1988 to 1991.

Mckay (pers. comm.) reported dramatic decreases in the angling catches of walleye in the fall of 1991, near Lower Fort Garry on the lower Red River, shortly after dredging activities began.

Several confrontations subsequently developed between various angling groups and the Federal Department of Public Works over the alleged effects of dredging on angling catches of walleye and other species in the lower Red River.

c) disease

Lymphocystis infection rates as high as 25 % were observed in the gillnet catches during walleye tagging operations, on the lower Red River in 1988 and 1989 (author). The infection rate dropped to around 5 %, in tagging operations in 1992.

Macdonald (pers. comm.) reported a bacterial infection (*Aeromonas hydrophila*), in channel catfish (*Ictalurus punctatus*), in the lower Red River during this time period. The infection rate in catfish dropped in 1991, with higher spring flow rates and greater water volumes in the Red River.

Table 9. Red River mean monthly flow rates measured at Lockport, 1980-1986.

	Year						
Month	1980	1981	1982	1983	1984	1985	1986
March	64.63	75.7	60.7	350.4	90.69	266.7	274.9
April	466.6	84.01	813.6	787.9	644.4	469.8	1195
May	99.15	59.3	495.5	333.4	173.1	376.6	985.8
June	60.65	83.46	240.7	265.7	405.7	342.2	331.5
July	45.27	108.4	164.5	272.5	155.7	265.8	209.3
August	37.55	51.64	108.4	115.8	60.85	285.3	101.5
September	45.03	88.12	64.74	124.3	42.87	239.6	93.67
October	43.57	107.7	158.9	120.7	75	178.5	131.2
November	44.43	82.99	104.2	121.1	87.54	116.5	83.74

Table 10. Red River mean monthly flow rates measured at Lockport, 1987-1992.

	Year					
Month	1987	1988	1989	1990	1991	1992
March	188.8	67.75	25.79	56.11	32.61	216.7
April	1139	263.6	652.3	280.9	137.4	807
May	205.9	104.8	323.2	115.6	120.3	316.3
June	154.9	86.16	101.9	141.7	107.2	134.3
July	116.3	48.59	61.41	82.84	234.3	121.6
August	115.7	22.07	21.85	36.57	70.75	53.3
September	51.65	22.53	43.11	25.05	71.88	106.1
October	48.61	26.23	37.49	35.78	64.88	65.39
November	36.08	15.58	20.04	35.78	55.52	42.3

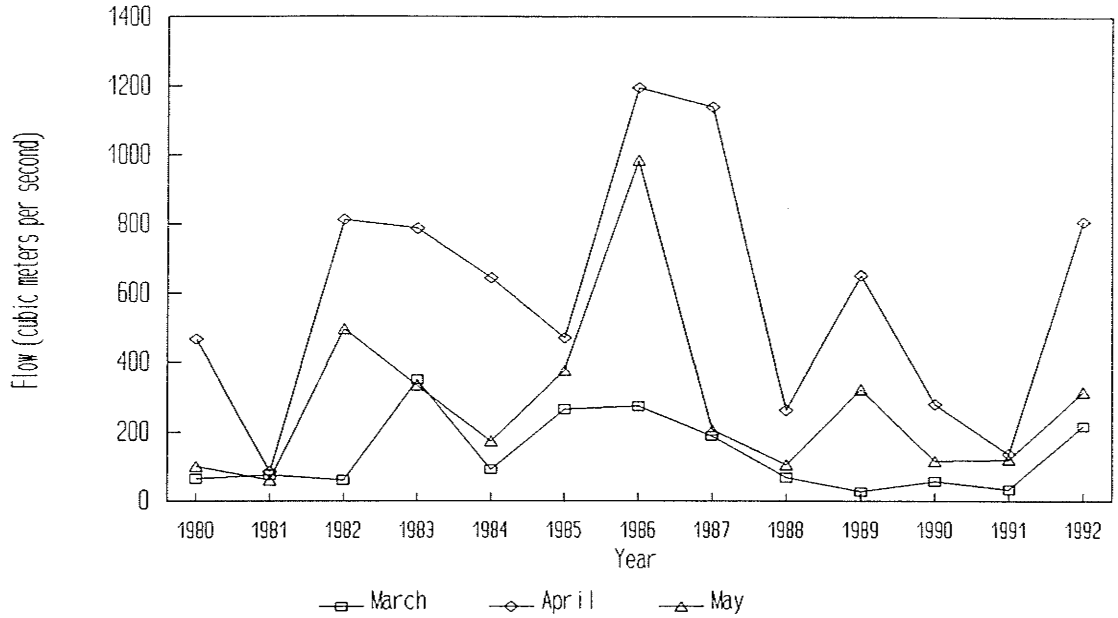

Fig. 47. Red River mean monthly flow rates measured at Lockport, March to May, 1980-1992.

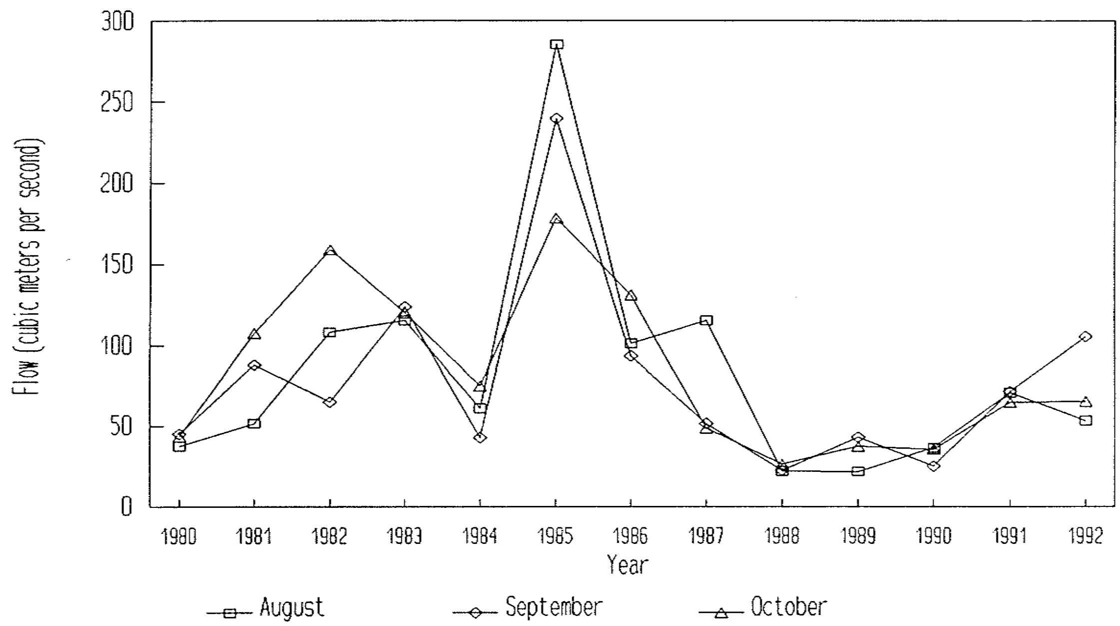

Fig. 48. Red River mean monthly flow rates measured at Lockport, August to October, 1980-1992.

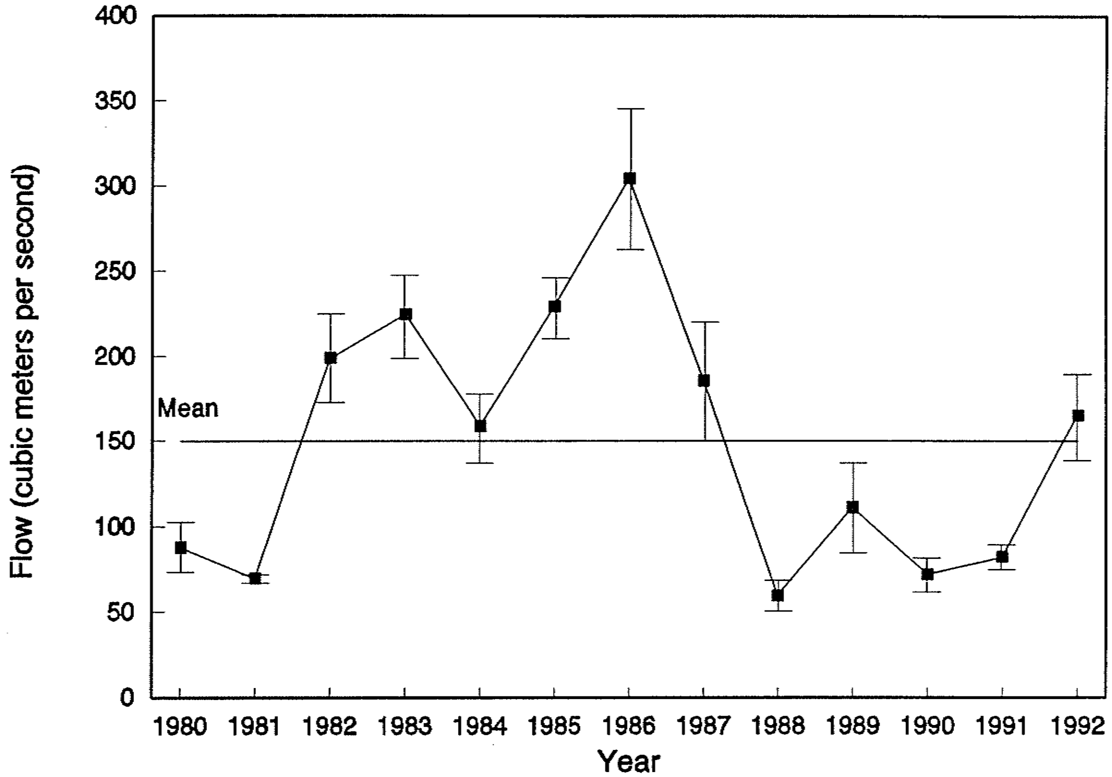

Fig. 49. Red River mean annual flow rates measured at Lockport, 1980-1992.

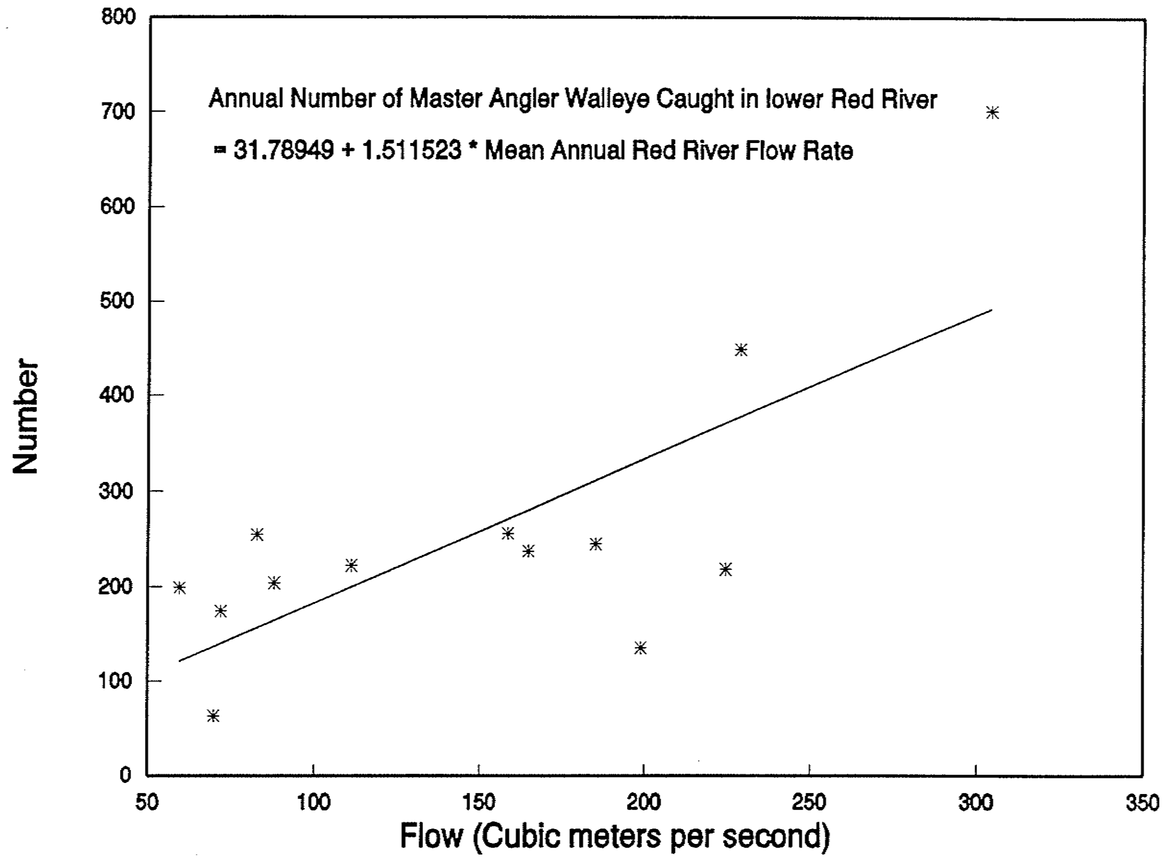

Fig. 50. Least squares linear regression of annual master angler catches in the lower Red River on mean annual flow rates in the Red River, 1980-1992.

4.4 Multiple Regression Analysis

4.4.1 Best Model Selection

Master angler catch records were used as an indicator of large walleye abundance in the lower Red River. These records also served as a benchmark of angler success, for comparative evaluations of various impacts discussed earlier in the paper.

A statistical evaluation of these impacts was conducted using least squares linear regression of master angler catch numbers as the dependant variable, on the independent variables listed in table 11.

The "best" regression model was selected using a forward inclusion and backward elimination process for the regression coefficients of the independent variables at the 95% probability limit, as described by Snedecor and Cochran (1980).

Contribution to the overall model was judged by increases in R^2 (R square), which measures the proportion of variation in the dependant variable accounted for by the independent variables (goodness of fit). Adjusted R^2 was used to correct for R^2, which automatically increases as the number of independent variables in the model increases (Snedecor and Cochran 1980). Student's t values for the regression coefficients (slopes) of the independent variables were used to test the null hypothesis that the coefficients (slopes) of the independent variables were equal to 0 at the 95% probability level.

The ratio of the mean square of the deviations from the regression and residuals are distributed as an F statistic. The resulting F values generated from inclusion of each additional independent variable in the model, were used to test the null hypothesis that the deviations are distributed with a mean of 0 and a given standard error at the 95% probability level. Maximum F value was also used along with adjusted R^2 for selecting the "best" model.

The standardized residuals of the "best" regression model were tested for: randomness-normality using the Runs Test, for linearity by Wilk-Shapiro/Rankit Plots and for auto-correlation by the Durbin-Watson statistic, as described by Snedecor and Cochran (1980). The results of all three tests confirmed that these conditions were valid for the model.

Two independent variables were selected from the process of forward inclusion and backward elimination (table 12):

A. mean annual Red River flow rates

B. Annual commercial catches of large walleye in the south basin of Lake Winnipeg

The resulting regression model is described by the following linear relationship:

Annual Number of lower Red River Master Angler Walleye = 31.78949 + 1.511523 * Mean Annual Red River Flow Rate - .0032816 * Annual Commercial Large Walleye Catch in the South Basin of Lake Winnipeg

The numerical amounts represent the Y intercept and slopes respectively. Analysis of variance of the dependant variable is presented in table 13.

Mean annual Red River flow rates contributes 0.4876 to the adjusted R^2 of the model, while commercial catches of large walleye in the south basin of Lake Winnipeg add only .1311. The combined total from both sources indicates that 0.6187 of total variability in the dependant variable is explained by the regression model at the 95% P level (table 12).

The Pearson correlation coefficient is also highest for mean annual Red River flow at + 0.7282 (table 12). A negative Pearson correlation coefficient of -0.4313 for commercial catches of large walleye in the south basin of Lake Winnipeg, indicates the inverse linear relationship of stock removal on large walleye abundance in the lower Red River.

Table 11. Independent variables used in the selection of the best model for least squares regression of master angler catches in the lower Red River (various dates).

Lake 1980	Winnipeg - 1992	Commercial	Catches	in kg	1977-1992
A	**B**	**C**	**D**		
Total Walleye Entire Lake	Total Walleye South Basin	Large Walleye Entire Lake	Large Walleye South Basin		
+0.5174	**+0.0094**	**-0.4074**	**-0.4313**		

Red 1980	River - 1992	Flows in	cubic	m/sec.	1980-1992
E	**F**	**G**			
Mean Annual Flows	Mean Spring Flows	Mean Fall Flows			
+0.7282	**+0.7248**	**+0.4796**			

Red 1988	Mouth 1992	Commercial	Catch	in kg	1987-1992
H	**I**	**J**	**K**	**L**	**M**
Total Walleye Spring	Total Walleye Fall	Large Walleye Spring	Large Walleye Fall	Total Walleye Season	Large Walleye Season
-0.2376	**-0.3561**	**+0.4163**	**+0.1892**	**-0.4166**	**+0.4209**

(+/-) 0.0000 - Pearson correlation coefficient

Table 12. Un-weighted least squares linear regression of master angler catches in the lower Red River, 1980 - 1992.

	Coefficient	Std. Error	Student's t	P	r
Constant	246.15	115.85	2.12	0.0595	
E	1.4212	.37229	3.82	0.0034	+0.7282
D	-.00328	.01506	-2.19	0.0536	-0.4313

	R^2	Adjusted R^2	Residual Mean Square (MSE)	Standard Deviation
Model	0.6823	0.6187	9611	98.04

Source	DF	SS	MS	F	P
Regression	2	206360	103180	10.74	0.0032
Residual	10	96110	9611		
Total	12	302470			

Table 13. Stepwise analysis of variance of the linear regression of master angler catches in the lower Red River, 1980 - 1992.

Source	Indiv. SS	Cumult. DF	Cumult. SS	Cumult. MS	Adjusted R^2
Constant	866880				
E	160400	1	160400	160400	0.4876
D	45961	2	206360	103180	0.6187
Residual	96110	12	302470	25206	

E - Mean Annual Red River Flows (cubic meters per second)
D - Commercial large walleye catches in the south basin of Lake Winnipeg (kg), P = probability of a larger value
r = Pearson correlation coefficient

4.5 Present Management Approaches

4.5.1 Red River Management Plan

The present Red River Management Plan was developed to provide a long-term resource allocation framework, to maximize user benefits and to minimize resource use conflicts. The primary aim of the Red River Management Plan is to maintain the present high quality, trophy status, of the lower Red River sport fishery. This requires maintaining "sufficient" walleye and catfish stocks within the lower Red River, to provide anglers with "a reasonable expectation" of catching a trophy fish.

The Red River Management Plan recommends the allocation of an "optimal" quantity of valued fish stocks, among the three current user groups: sport, commercial and domestic. The plan requests that the provincial Fisheries Branch devise and implement a fair and equitable allocation system, so that the combined harvest does not exceed an optimum sustained yield. An integrated management approach is recommended.

The Red River Management Plan also acknowledges the need for identifying, protecting and improving the existing spawning habitat for walleye, catfish and other valuable fish species in the lower Red River.

Chapter 5

Discussion

5.1 Walleye Abundance and distribution

5.1.1 Angler Catches of Large Walleye on the lower Red River

Angler catches of large walleye increased on the lower Red River from 1973 to 1986 (fig. 2) and then declined below a ten year mean, from 1987 to 1991 (fig. 3). Although total walleye numbers have declined, there has been an increase in the number of larger sized walleye being caught (table 1).

This is the first indication that a decline in angling catches of large walleye, may have occurred over the last six years on the lower Red River. This apparent decline however, may reflect changes in angler effort and/or walleye abundance and distribution, rather than a decrease in walleye abundance alone.

The seasonal peaking of angler catches of walleye in the fall, seems to suggest an underlying migratory pattern, between Lake Winnipeg and the lower Red River (Figs. 4, 5). The present study examines the extent and variability of these distributional movements as a necessary first step in developing future strategies to manage the resource.

5.1.2 Walleye Movements and Resource Use

Information from the gillnet tagging sets was used to describe the temporal movements of walleye within the lower Red River - Lake Winnipeg study area. This information was used to help determine potential and existing impact by various user groups.

The results of the walleye floy-tagging studies, confirms the seasonal distributional pattern found in the master angler catch records for the lower Red River. Walleye entering the lower Red River tend to remain within the river system from September to March (fig. 6), (table 3).

There is also evidence for a migratory return to the river in the spring (fig. 7), (table 4). Most of the walleye tagged in the lower Red River, eventually dispersed back into Lake Winnipeg and were recaptured in the commercial fishery (fig. 8), (table 5).

Only a few of the walleye found near the Red River mouth, may enter during the fall season and become vulnerable to angling (fig. 9), (table 6). This may lower the potential impact of commercial gillnetting off the Red River mouth in the fall.

Walleye floy-tagged in the spring, followed the same general dispersal pattern back into Lake Winnipeg, as in fall tagging (fig. 10), (table 7). This evidence seems to suggest that the lower Red River walleye stocks spend most of their time in the south basin of Lake Winnipeg.

The floy-tagging results demonstrate that the lower Red River walleye stocks are "jointly" harvested by both the commercial and recreational user groups. This collective resource use remains spatially and temporally separated.

A total of 1786 walleye were tagged from 1988 to 1992, and 112 walleye were subsequently recaptured. This represents a combined recapture rate of only 6.27%. The combined harvest mortality on the jointly utilized Red River-Lake Winnipeg walleye stocks therefore, appears to be low.

Recreational anglers accounted for 60 walleye tag returns (3.36%) and commercial users 52 walleye tag returns (2.91%). Both user groups appear to capture walleye in approximately equal proportions, assuming that all tag recaptures were reported.

Moshenko (1980) found that commercial tag returns for walleye tagged in the south basin of Lake Winnipeg averaged 10.4 % during a previous tagging study in 1973-76. This compares with a commercial tag return rate of only 2.9 % for the present study.

At least three floy-tags were discovered on packed walleye by Natural Resources staff during routine sampling of commercial catches at the Selkirk FFMC plant. These tags may not have been visible to commercial users in poor light conditions and/or rough weather. This may have resulted in an underestimate of commercial tag returns in the present study.

The majority of the commercial tag returns were from the south basin of Lake Winnipeg, which supports the previous tagging results of Moshenko (1980) and Rybicki (1962).

5.1.3 Lower Red River Gillnet Monitoring

Catch per unit effort estimates from gillnet tagging sets in the lower Red River, confirmed this seasonal trend in walleye movements during the spring and fall time periods (figs. 11-14). Considerable variation in the timing and duration of these movements was found to occur from year to year.

Variation in the seasonal timing of walleye movements, can be critical in determining the extent of the potential impact from each of the current user groups.

Comparisons in the relative abundance of walleye from one year to the next in the lower Red River could not be made due to the use of non-standardized gillnet mesh sizes. Comparative estimates of walleye abundance and size distribution, could be made to angler catches during the same time periods (figs. 15, 16). The results indicate that gillnetting is a good index of what is available for anglers to catch in the lower Red River.

5.2 User Group Impacts

5.2.1 Lower Red River Angler Creel Surveys

Analysis of the four angler creel surveys carried out in 1982, 1988, 1989, and 1992 supports the results of the master angler walleye catch records. Both research results confirm a general decline in angler catches of large walleye for the years 1988 and 1989 (fig. 17). Total angler effort however, showed a proportional decrease for each corresponding survey year (fig. 18).

Large confidence intervals resulted from extracting out the September and October estimates from the total creel census results for 1982, 1988 and 1989.

The lower walleye catches in 1988 may have initiated a chain reaction which resulted in fewer anglers and less effort in 1989, and thus began and perpetuated the current misconception among anglers of reduced catches.

Walleye weights > 3.5 kg, are higher in the 1989 and 1992 survey years than in the 1982 and 1988 survey years (fig. 22). This supports the trend of increasing angler catches of larger walleye in 1991 and 1992 (table 1).

Wall (pers. comm.) hypothesizes that such changes may simply reflect a decrease in the number of master angler walleye that are being reported by anglers, as they seek to "better" their previous catch records.

Catch per unit of angler effort estimates demonstrate the unexpected results that can occur between September (fig. 23) and October (fig. 24), when walleye distributional movements and angler effort (figs. 25, 26) simultaneously changes. The combined effect of both variables on angler catches of large walleye are impossible to predict and precludes the measurement of any absolute changes in stock abundance. This finding may also contribute to the present angler perception of decreased walleye catches.

Angling impact on walleye mortality is much lower than the general commercial impact on walleye in the south basin of Lake Winnipeg, due to the growing tendency among anglers to release the larger walleye (fig. 27). Catch and immediate release of walleye is effective and results in low mortality (Goeman 1991).

Commercial catches result in 100% walleye mortality and are vastly disproportionate in total harvest.

5.2.2 Lower Red River Angling Derbies

Live release derbies are becoming increasingly popular in Canada and the United States (Goeman 1991; O'Neil and Pattenden 1992). Kampke and Bruch (1991) distinguish between major, minor and junior angling tournaments based on the number of contestants and/or entrance fees charged and dollar value of the prizes.

An increase in the number of "specialized" walleye fishing tournaments or derbies could impact the large walleye resource of the lower Red River (table 8). These events typically attract many highly skilled anglers, who employ state of the art technology, to capture substantial numbers of a single species such as walleye (fig. 28).

Goeman (1991) emphasizes distinguishing between live-release walleye tournaments and recreational catch-and-release. The general practice of catch and immediate release results in very low mortality levels (Goeman 1991). Angling tournaments on the other hand can result in both weigh-in mortality (dead on arrival) and delayed mortality (after 5 or more days) due to the stress of holding and handling walleye.

Goeman (1991), Boland (1991) and O'Neil and Pattenden (1992) found variable mortality rates from both sources, 1-67% for weigh-in mortality and 3-94% for delayed mortality. The researchers found total mortality to increase as a function of: wind and wave action (increases stress in walleye by agitation in boat live-wells), water temperature (> 21 degrees centigrade), low o^2 levels in the live-wells (< 5.0 mg/l), and depth of capture (anglers puncture the air bladder to release expanded air - "fizzing").

The daily catch and release figures for some tournaments, can be quite high (fig. 28). Maximum impacts can occur when the derbies coincide with the peak walleye movements into the lower Red River, in late September and early October. The cool fall water temperatures and minimal wind fetch on the lower Red River may help to mitigate many potential impacts.

Robert (1992) observed that anglers require further training in the proper use of catch and release practices. This will require more public education by derby organizers. Derby guidelines should be improved to address such issues.

5.2.3. Native Subsistence Fisheries

Heuring (1993) reports that subsistence fishing around Lake Winnipeg was primarily confined to streams, rivers and spawning areas where fishing was easiest. This particular harvest strategy has been retained in the present situation.

Local conservation officers have observed increasing numbers of native gillnets being set in the lower Red River. Maxwell (pers. comm.) has observed substantial numbers of large walleye being caught in native domestic gillnets during the early spring.

Walleye are particularly vulnerable to gillnets set near the mouth of the Red River, as they congregate in large numbers during the spawning run.

Wagner (1986) estimated annual native subsistence harvest levels to range from 7.3 - 12.9 kg per person for three Lake Winnipeg communities. Berkes (1990) reports annual subsistence harvests in sub-arctic and arctic Canada to average about 60 kg per person. Wagner (1986) recorded an annual harvest for the Brokenhead community (near the Red River mouth) at 2450 kg for walleye and freshwater drum (Aplodinotus grunniens).

There have been no attempts to quantify the present harvests of large walleye (> 3.5 kg) at the mouth of the Red River and the participating communities. Campbell (pers. comm.) maintains that subsistence fishing at the mouth of the Red River involves individuals of native ancestry, that are not currently affiliated with any particular band.

Maxwell (pers. comm) advises that subsistence use is increasing on the lower Red River. The future effect on walleye stocks may require further study. At present, commercial users are denied access to the bulk of this migratory movement by a controlled opening date of the spring commercial season. Native subsistence users are not bound by a similar restriction.

5.2.4. Lake Winnipeg Commercial Walleye Harvest

Heuring (1993) reports that Lake Winnipeg commercial harvests have fluctuated over the years due to variations in fishing technology, regulations, fish markets, prices, weather and fishing effort. This is particularly evident in the long-term commercial catch trends for walleye on Lake Winnipeg from 1931-1992 (fig. 30).

Lake Winnipeg was closed to commercial fishing from 1970-1971, due to elevated mercury levels in fish (Heuring 1993). Lysack (1986a) reports that commercial walleye harvests on

Lake Winnipeg have exceeded the long-term sustainable yield. Lysack (1987) found increasing catch per unit effort values in the lower Red River and south basin of Lake Winnipeg bait fishery from 1970-1986. He contends that greater forage fish abundance may be due to decreases in predation.

Lysack (pers. comm.) has also found further evidence of population stress as shown by biological and effort indicators from annual experimental gillnetting carried out on Lake Winnipeg from 1979-1992.

Average annual angling catches of walleye have been estimated by Lysack (1986b) at 15,000 kg and average annual commercial south basin walleye catches have been estimated by Campbell (pers. comm.) at 650,000 kg. This represents a proportional breakdown of the total walleye harvest for the south basin of Lake Winnipeg and the lower Red River of 2.25 % for anglers and 97.75% for commercial users.

Commercial catches of large walleye (> 1.6 kg) on Lake Winnipeg declined during the same time period that master angler catches of walleye increased on the lower Red River (fig. 32). Commercial catches of large walleye increased during the 1990/91 production year (fig. 31). Only a portion of this commercial size grade may consist of master angler walleye (fig. 29).

Total commercial catches of large walleye for the entire lake average around 150,000 kg annually and 75,000 kg for the south basin. By comparison, anglers catch less than 1% of the commercial harvest of large walleye in the south basin. Management of this "large" component of the commercial catch could have significant benefits to the recreational walleye fishery, given the great difference in proportional catches.

Lysack (1984) reports that 50% of walleye from the south basin of Lake Winnipeg are sexually mature at 5.12 years (.5 - .6 kg) and 100% mature at 7 years (1.3 - 1.8 kg). Lysack (pers. comm.) confirms that walleye in the master angler size range (> 3.5 kg) could be part of the spawning stock(s), which are responsible for sustaining walleye populations for all three fisheries, sport, commercial and subsistence.

More information is required to clarify the biological significance of master angler sized walleye to the long-term sustainability of Lake Winnipeg and Red River walleye stocks.

Remnant (1991) reported a linear relationship between mercury level (PPM) and walleye weight (kg) in catches from the Lake Winnipeg commercial fishery from 1980-1990. Large walleye may not be desirable for either commercial or subsistence use and may be more appropriately used in a recreational fishery based on catch and release.

Canadian and U.S importation bans exist for fish with mercury levels > 0.5 ppm and > 1.0 ppm respectively, while concentrations > 1.5 ppm have been deemed unfit for human consumption (Remnant 1991).

5.2.5. Commercial Gillnet Monitoring - Red River Mouth.

Commercial gillnet blockage of walleye movements into the Red River was one of the principal allegations made by representatives of the sport fishery. An examination of the numbers and locations of the gillnet sets to scale, indicates that walleye have plenty of room to disperse during the fall season (figs. 35-38). Dispersal however, may have been restricted in the spring season (figs. 33, 34).

Commercial gillnet catches of large walleye in the fall seasons were much lower than master angler catches for the same time period (fig. 41). Commercial catch estimates of master angler sized walleye (> 3.5 kg) were considerably higher in the spring of 1991, than master angler catches in both the spring and fall time periods combined (fig. 41).

The potential commercial impact increases significantly, when extended to include the whole south basin (fig. 42). Such a comparison is statistically valid, as the samples of large walleye come from all over the south basin of Lake Winnipeg.

Currently there is a minimum commercial mesh size limit of 76 mm (3 in) in the south basin of Lake Winnipeg, but no maximum mesh size limit. Campbell (pers. comm.) has observed that commercial users often switch to larger mesh sizes as catches in the smaller mesh sizes decrease. Removal of this component of the walleye spawning stock may be particularly devastating when combined with poor environmental conditions which reduce spawning success (Lysack pers. comm.).

Hamley and Regier (1973) found bimodal selectivity curves for percid catches (walleye) which increase in amplitude as mesh size increases. Data from the Lake Winnipeg experimental gillnetting program still supports mesh size regulation as the most effective way to reduce catches of large walleye.

5.2.6. Radio-telemetry Tracking of Walleye Movements

Aerial tracking of walleye movements, indicate that walleye can move considerable distances in very short periods of time. The radio-telemetry monitoring confirmed the general migratory patterns identified in the floy-tagging studies.

Results indicate that not all walleye entering the lower Red River in the fall, may remain for the duration of the winter (fig. 43) as inconclusively shown by floy-tagging. This finding may indicate the presence of two discrete walleye stocks which may inhabit the lower Red River, a highly mobile lake based stock and a river resident one.

Walleye may begin entering the mouth of the lower Red River in early April while there is still ice cover on Lake Winnipeg (fig. 43). Inward movement would not be impacted by commercial gillnets as the commercial season is closed at this time of year. Walleye may be more vulnerable to commercial gillnets during their outward migration in mid May (fig. 44).

This potential impact is increased by the tendency for walleye to remain concentrated around the Red River mouth well into start of the spring commercial season. Campbell (pers. comm.) reports that the commercial fishing season in the south basin of Lake Winnipeg may begin around the third week in May.

The radio-tagged walleye were expected to move up the river to the St. Andrews lock and dam to spawn in the spring. Stewart (pers. comm.) observed walleye spawning in this area in the past and confirms it's suitability as walleye spawning habitat. Above average river flows during the spring of 1992 may have prevented walleye from reaching this habitat.

Alternatively, the tracking may indicate that walleye use the Netley-Libeau marsh to spawn or for other reasons.
Walleye tended to follow the shallow in-shore areas of the

south basin of Lake Winnipeg, as opposed to a more northerly dispersal pattern (figs. 43-46). This result may be an artifact of the limiting effects of water depth, on the aerial reception of the radio transmission signals.

None of the radio-tagged walleye returned to the lower Red River in the fall of 1992, which seems to suggest that the fall migratory movement may not be an annual event (fig. 45).

Two of the eleven radio-tagged walleye were eventually caught by commercial users and none were caught by anglers (fig. 45). Although the total sample size is too small for statistical validity, this represents a recapture rate of 9.09 %, which is closer to the commercial recapture rates found by Moshenko (1980) of 10.41 %. This may be an indication that commercial tag returns and impacts, were underestimated.

5.3 Environmental Impacts

5.3.1 Red River Monthly Flow Rates

Mean monthly flow calculations indicate that walleye may be attracted by high river flow rates, especially during the spring time period (tables 9, 10). Master angler walleye catches appear to parallel the mean annual river flow calculations (figs. 2, 3, 49). O'Connor (pers. comm.) believes that high spring flow levels may attract walleye in to spawn initially, and may also account for their return to feed in the fall. Low flows in 1988 and 1989 were caused by draught.

Walleye movements may also be influenced by water flows in adjacent river systems. Wall (pers. comm.) reports that anglers had excellent catches of large walleye in the Winnipeg River from 1988 to the present. Flow rates on this river are controlled by Manitoba Hydro and are dependant on an entirely different watershed, which was not impacted by the drought conditions affecting the Red River drainage system from 1988 to 1991.

Walleye may have been attracted by higher flows in the Winnipeg River, which empties into the south basin of Lake Winnipeg in Traverse Bay (fig. 1). Radio-telemetry tracking of walleye in the south basin have demonstrated a tendency for walleye to follow the eastern shoreline which eventually leads into Traverse Bay (figs. 45, 46).

One walleye, floy-tagged (August 20, 1991) in the lower Red River, was recaptured 35 days later (September 24, 1991) by an angler on the Winnipeg River (fig. 9) below the Pine Falls dam (table 6). Walleyes may be attracted into the lower Red River by the late October drawdown of the St. Andrews locks. Opening the lock may not be politically expedient.

5.3.2 Red River Water Quality Changes

a) un-ionized ammonia

Maximum concentrations of un-ionized ammonia reported by Gurney (1991) coincide with the fall migratory patterns of walleye in the lower Red River. Manitoba water quality standards currently regulating the levels of un-ionized ammonia vary with temperature and pH (Williamson 1988). Variable water control standards can complicate enforcement. It is not known if walleye can detect and avoid sub-lethal concentrations of un-ionized ammonia (Stewart pers. comm.)

b) dredging

Dredging may have been particularly disruptive in the low flow years of 1988-1991, when more dredging was required to maintain navigational requirements under reduced water levels.

c) disease

Lymphocystis infections in walleye in the lower Red River were probably effected by the low flow years of 1988 to 1991. Lower infection rates in walleye were found in the spring and fall of 1992. Higher flow rates and cooler water temperatures may have reduced the incidence of the disease.

5.4 Multiple Regression Analysis

5.4.1 Best model selection

In the linear regression model outlined in table 12, a combined total of 0.6187 is contributed by both variables E (mean annual Red River flow rate) and D (commercial catches of large walleye in The south basin of Lake Winnipeg) to the adjusted R^2 value. This indicates that 1 - .6187 = 0.3813 of total variability in the dependant variable (master angler catches) remains un-explained, on a statistical basis (table 13). The remaining residual variability not accounted for by the regression may in part be attributed to the independent variables listed in table 11.

The lack of statistical significance (95% P level) for the majority of these variables is traceable to the small sample sizes which resulted in not enough "good cases" being obtained in the computation of the regression model. It does not rule out their actual significance which may be verified by additional future data collection.

Master angler catches were not corrected for changes in angler effort and are therefore a biased estimate of large walleye abundance in the lower Red River. This is also an additional source of variability in the regression model.

Master angler records were selected as representative of the largest cross-section of anglers over time, in the absence of any long term creel census data and the additional weakness in the remaining data sets.

Multiple regression analysis helps to quantify the effects of river flow and commercial catches on large walleye catches in the lower Red River. Mean spring flows show a stronger correlation (+0.7282) to master angler catches than fall flows (+0.4796), as shown in table 11. Fall flows do appear to play some role, as indicated by the selection of mean annual, as opposed to spring flows in the final model.

5.5 Walleye Management

5.5.1 Red River Management Plan

The Red River Management Plan appears to have been unsuccessful in preventing the current sport-commercial resource conflict. A major failing of the plan has been in the use of such ambiguous terminology as "optimum sustained yield". Larkin (1977) maintains that this concept provides no operational basis for decision making, and is extremely difficult, if not impossible to derive.

The plan also stresses an "equitable allocation" among the three competing user groups. This solution would be difficult to implement given the current variability in walleye distributional movements and stock size uncertainties. The lack of long term catch per unit effort data for the sport fishery and harvest statistics on native subsistence fisheries pose additional problems.

The Red River Management Plan advocates maintaining "sufficient" populations of trophy species, through habitat and water quality improvements in the Red River. This strategy appears impractical given the results of the present study which indicate that lower Red River walleye stocks are at least in part derived from Lake Winnipeg south basin stocks. Their seasonal presence in the lower Red River is the result of a dynamic interaction with river flow rates, which is difficult to predict and control.

Fitzjohn (pers. comm.) reports that the Red River Management Plan lacks "constituency" representation by not including various non-consumptive users (Manitoba Naturalist Society) and members from the native subsistence fishery. He has also observed deep ideological differences between the current sport and commercial fisheries representatives. This has resulted in the establishment of base positions and non-negotiable points on both sides.

Campbell (pers. comm.) believes that staffing and jurisdictional changes within the Fisheries Branch, resulting from recent departmental reorganization, may have created uncertainty as to implementation and evaluation of the Red River Management Plan.

Management of specialized "trophy" sport fisheries may be creating unreasonable expectations among anglers for consistent and numerous catches of these species. This may create new conflicts among future resource users, or may serve to exacerbate existing ones.

5.5.2 Economic Value of the Fisheries

Scaife (pers. comm.) has valued the entire Lake Winnipeg commercial fishery (1988-1989) at $34 million dollars based on landed value of the catch. South basin commercial values were estimated at $10.67 million for quota species (walleye and sauger) based on proportional catch statistics depicted in figure 31 and reported by Heuring (1993).

Scaife (pers. comm.) has also estimated the value of the Red River sport fishery at $7.4 million dollars based on the expenditure method and information from the 1985 Sport Fishing Survey. Consumer surplus values were derived but not included in Scaife's estimate.

It is difficult to compare the economic values of the commercial and recreational fisheries because the commercial fishery consists of the value of the landed catch while the recreational fishery consists of consumer surplus (Copes and Knetch 1981).

Berkes (pers. comm.) advises that the expenditure method used to derive the benefits of the recreational fishery have been misleading and vastly overstates the value, in terms of real income. He advises that expenditures would still be made within the province in alternative recreational opportunities, in the absence of the Red River sport fishery.

The Red River sport fishery is still very important to local and regional economies like Lockport and Selkirk (Macdonald 1990) in terms of real income (Berkes pers. comm.).

The commercial fishery on the other hand, represents a net benefit for Manitoba when viewed from the perspective of the overall economy (Berkes pers. comm.). The current value of the subsistence fishery on Lake Winnipeg has not yet been determined. Wagner (1986) used the replacement value method.

5.5.3 Future Management

The present study was undertaken to begin an examination of the biological and management relationships that are required to resolve the present sport - commercial resource conflict. The results represent a necessary first step in outlining the additional information that is required to ensure the protect of the resource and who should be responsible for the ongoing collection, analysis and implementation of subsequent recommendations.

The primary responsibility for managing the walleye resource rests with the provincial Department of Natural Resources. The Manitoba Fisheries Strategy (1991) emphatically states that the main goal in management is the protection and sustainability of fish stocks.

This requires a comprehensive and integrated approach to management which requires improvement in the present situation. Although management "judgements" are often hastily made in response to user demands the protection of the resource must override all other considerations.

The Red River Management Plan represents a narrow and specialized attempt to manage the recreational walleye resource as a separate entity, in isolation of the fact that Red River walleye stocks are inseparable from the Lake Winnipeg commercial stocks. A great deal of uncertainty seems to exist with respect to the biological status of the stocks in Lake Winnipeg. More information is required to identify the sustainability of commercial harvest levels in the south basin of Lake Winnipeg. The biological significance of large sized spawning walleye requires further clarification in relation to stock sustainability.

Changes in the physical environment of Lake Winnipeg and the Red River with respect to exotic species introductions and changes in hydrology and water quality parameters requires an ecological as well as a biological approach to management. The atlantic cod fishery is a classic example of the dynamic interactions which complicate management and underscore the value of the whole ecosystem. Information in many areas is required to ensure long-term sustainability of all stocks.

More creel census information needs to be collected to develop a complete inventory of anglers sport fishing and the sizes caught so that statistical inferences can be made to more closely link the changes that are going on in the system. Mortality impacts associated with large angling tournaments need to be studied throughout the province.

Commercial yield calculations should be derived for the south basin (kg/ha/yr) to allow comparative estimates with other lakes and river systems to evaluate the effectiveness of management actions. Detailed harvest levels regarding species composition and size estimates need to be determined along with value estimates for the native subsistence fisheries.

5.5.4 Management Options

Several management alternatives are discussed below with the object of achieving the best management "balance" between the user groups in the present resource context. Optimization rather than maximization may be the preferred approach, to reduce the most damaging resource impacts without targeting any particular group (Berkes pers. comm.). As the client of this study is the Department of Natural Resources the final overriding decision will still be a political one.

OPTIONS

1) Do nothing:

The consequences of maintaining the status quo may result in a further escalation of the present conflict as angler catches of large walleye may decline again, due to reduced flows on the Red River under drought conditions and/or commercial over-harvest.

On the other hand, the conflict may subside for a while if catches remain stable. This seems highly improbable given the historical variability in river flows and commercial catches. Not protecting the large walleye may jeopardise all fisheries in the long run through stock collapses brought on by recruitment failure. The growing subsistence fishery may escalate the present conflict or result in the development of a new one.

2) Restrict both the recreational and commercial fisheries:

Both groups are already restricted by regulation. Anglers have had several recent regulatory changes imposed upon them such as reduced catch limits, barbless hooks and maximum size limits. The commercial fishery has not. It is also difficult to regulate the recreational fishery because of the large number of participants, where they are fishing, when they are fishing etc.

This is particularly true of the Red River sport fishery, whose unique attractions are very close to the City of Winnipeg. The lack of up to date creel census information adds to this difficulty. Angling regulations are difficult to enforce and rely primarily on compliancy for effectiveness. The great differences between catches in the sport and commercial fishery would create a perception among anglers, that they were being unfairly treated and result in lower compliance. Additional regulation would not be effective given the limited abundance and time that walleye spend in the lower Red River.

3) <u>Restrict the commercial fishery only:</u>

Control of the commercial fisheries may be easier due to the fewer number of participants. This approach would be favourably received by anglers but not by the commercial group and may result in considerable opposition if not handled appropriately. This approach is the most logical course of action biologically, as the greatest impacts to the walleye resource occurs in the south basin of Lake Winnipeg.

Protection of the large walleye will benefit the commercial fishery by helping to sustain walleye stocks. Large walleye are less marketable than smaller sizes due to cooking requirements (pan size) and there is the added possibility of higher mercury concentrations. Consideration would have to be given to the following optimum additional controls:

a) avoid or delay spring fishing
b) maximum mesh size limits
c) allocation of sustainable quotas

Commercial opposition to these additional controls could be reduced through further negotiation between the regional fisheries manager and the impacted communities as to the actual selection of opening dates, mesh size limits and sustainable quota levels. Biological information already exists (Lake Winnipeg experimental gillnetting program) to underpin these discussions. Mesh size control is effective not withstanding the bi-modal gillnet selectivity curves found for percid catches by Hamley and Regier (1973).

4) Ban commercial fishing in the south basin of Lake Winnipeg:

This approach has been used successfully in parts of the Great Lakes and in other areas of the U.S. The economic contributions of the recreational fishery to the provincial economy have already been described as minimal in comparison to the real income benefits of the commercial fishery.

Such a decision would be politically unacceptable and quickly polarize over the issue of "making a living" versus "having fun" and would create enormous conflict and personal loss. The resulting social costs would far outweigh any potential gains.

The results of the present study have already indicated that there is no guarantee that walleye will regularly migrate into the lower Red River, due to the variability of river flows. Removal of the commercial fishery in the south basin may also result in major changes in the species composition of the lake due to changes in predator/prey relationships.

5) <u>Extend the commercial fishing ban at the Red River mouth:</u>

This idea has been strongly advocated by many members of the recreational fishery. Alternatively this option could be modified by imposing a partial seasonal ban for the spring commercial season only or a portion there of. Although conceptually plausible, this idea may not be feasible given the large variation in walleye movements as indicated in the radio-telemetry tracking portion of the present study.

Additional complications would involve the selection of the optimum size and extent of the restricted area and the enforcement difficulties that may be encountered in an area devoid of geographical markers. The area could be buoyed and referenced with GPS (geographical position system) technology by both commercial users and enforcement staff.

This option would result in additional economic burdens (GPS and travel costs) to commercial users and in combination with being forced out of their traditional fishing areas, raise their opposition to the proposal. The biological protection afforded by this option is questionable, from a management perspective.

6) <u>Designate alternative fishing areas to various user groups:</u>

This option may have merit consideration when addressing the subsistence harvests at the mouth of the Red River in spring. Currently there is no spatial competition between the sport and commercial fisheries so there is no need for separation.

7) <u>Ensure that walleye stocks are equitably allocated:</u>

This would require determination of the sustainable harvest levels for all three fisheries. Re-allocation of commercial quotas among the Red River sport and subsistence fisheries would not be effective because of the difficulty in controlling the movements of walleye to these traditional harvest areas. Fish resources in Manitoba are to be allocated in the following order: native subsistence, recreational and commercial (Manitoba Fisheries Strategy 1991).

Allocation is often perceived as being a management issue and not a biological one. It becomes a biological problem when allocations exceed sustainable levels. It is a management issue in deciding who gets the allocation and how much to give within biologically prescribed limits of sustainability.

Chapter 6

Summary, Conclusions and Recommendations

6.1 Summary

The present study begins a process of collecting vital information to ensure the sustainability of the walleye resource. The study focused on collecting baseline biological information which was used to evaluate existing management strategies and to develop future management alternatives to be implemented by the client, the Manitoba Department of Natural Resources.

The recommendations are intended to supplement and/or modify the existing Red River Management Plan, to provide for a more comprehensive and co-ordinated management approach to sustain the fisheries resources of the lower Red River.

6.1.1 Catch Declines

Master angler walleye catches (> 3.5 kg) were chosen as an index of large walleye abundance in the lower Red River in order to assess potential or existing impacts from various sources under study. This standard is limited by the lack of angler effort and is therefore a biased estimate of large walleye abundance. Master angler walleye catches however, provide the only long-term data base that is representative of the largest cross-section of anglers over the study period.

The study determined that catches of master angler walleye appear to have declined below mean levels on the lower Red River from 1985 to 1992. The decline was partially influenced by decreases in angler effort since 1988.

Stock abundance changes may also have been involved in the decline through user group impacts and/or environmental fluctuations. Stock abundance can involve absolute (population) changes or relative (distribution) changes. Assessment of population changes was beyond the scope of the present study due to time and financial constraints.

The study focused on determining relative changes in walleye abundance by describing the spatial and temporal characteristics of walleye distribution within the study area.

6.1.2 Distribution

Floy tagging results indicate that walleye tagged within the lower Red River, may move into the south basin of Lake Winnipeg, where a portion were recaptured by commercial users. Recaptures by anglers in the lower Red River after varying time periods, suggest the possibility of return movements.

The seasonal peaking of master angler catches and Red River gillnet catches support this observation and suggest that the majority of walleye leave the Red River and return to the south basin of Lake Winnipeg, where they remain for most of the year. A small number of walleye may reside in the Red River all year. This hypothesis is supported by radio-telemetry tracking and seasonal peaks in commercial catches near the Red River mouth.

6.1.3 User Group Impacts

(a) Angling

Anglers accounted for only 3.35% of total walleye tag recaptures, indicating a relatively low harvest level and/or an abundant walleye population. Angler creel survey analysis indicates that angler catches are decreasing along with angler effort. The use of catch and release fishing practices has increased on the lower Red River since 1982 and tends to reduce angling impact on walleye mortality. Catch and immediate release results in mortalities under 5%.

Live-release walleye fishing derbies have catch rates comparable to master angler annual totals. Previous studies have indicated that total mortality can range from 1 - 94% for such tournaments, depending on wind and water temperatures and the aeration capabilities of holding tanks. Presently mortalities are minimized by the small number of such derbies and the cool fall water temperatures and reduced wind fetch which occurs on most portions of the Red River channel.

Additional derby guidelines regarding livewell standards and the timing of derbies may help to mitigate future impacts. Sport fishing impacts on walleye stocks are much lower than commercial impacts, based on the substantial catch differences between the two fisheries.

(b) **Native subsistence fishing**

Native subsistence fishing in the lower Red River is minimal but may be increasing in intensity. Conservation officers have observed substantial numbers of master angler sized walleye in subsistence catches near the mouth of the Red River in spring. The co-operation of native communities and individuals is required to determine current harvest levels.

(c) **Commercial fishing**

Commercial fishing impacts may occur near the mouth of the Red River and in the south basin of Lake Winnipeg.

i) Gillnetting near the mouth of the Red River

Commercial gillnetting is not blocking walleye movements into the mouth of the Red River during the fall season, as originally alleged by anglers. This was determined from monitoring commercial gillnets locations, numbers and catches.

Commercial gillnet numbers and catches of master angler sized walleye were much higher in the spring season than in the fall. Gillnet catches of walleye during the floy-tagging study indicates that fall movements are prolonged over a longer time period than spring movements, which are more concentrated. This may result in walleye being more vulnerable to capture in the spring commercial season than in the fall.

Radio-telemetry tracking indicates that walleye may remain around the mouth of the Red River for several weeks before dispersal into Lake Winnipeg in the spring. Individual walleye may not annually return to the Red River in the fall.

Walleye appear to follow the shallow shoreline areas of the south basin while entering or leaving the river mouth. This may enhance escapement by allowing walleye to avoid the offshore gillnet locations that were observed during monitoring. The limiting signal reception to water depths less than 18 meters, may invalidate this observation.

ii) Gillnetting in the south basin of Lake Winnipeg

Commercial users accounted for only 2.9% of walleye tag recaptures. This recapture rate is well below average walleye tag recapture rates of 10% reported by previous researchers in 1962 and 1982. Commercial impacts were therefore underrated.

Walleye remain primarily within the south basin of Lake Winnipeg after leaving the Red River. This is supported by floy-tagging and radio-telemetry tracking of walleye movements, and by the seasonal peaking of master angler, Red River gillnet and Red River mouth commercial catches.

Commercial catches of large walleye (>1.6 kg) in the south basin of Lake Winnipeg vary inversely with master angler catches in the lower Red River. This was statistically significant and included in the regression model. Commercial sampling estimates also confirmed this finding.

6.1.4 Red River Water Quality Changes

i) Red River flow rates

Multiple regression analysis confirmed the dominant influence of annual Red River flow rates on master angler catches in the lower Red River. Potential bias in master angler catches may have reduced the statistical significance. The positive linear relationship is also supported by previously collected creel survey results. River flows are beyond management control and their effects on walleye distribution may limit future management options.

ii) Un-ionized ammonia and dredging

Changes in un-ionized ammonia and water turbidity were not studied directly and were included to illustrate the increasing level of complexity of variables affecting the aquatic environment. A more comprehensive ecological response is required for effective control. Chlorination of sewage effluent discharges into the Red River was also not examined.

6.1.5 Current Management Practices

Management of the lower Red River sport fishery is based on a management plan developed in 1988. The Red River Management Plan was based on a biological study of a river-resident population of channel catfish. The recommendations of the study were generalized to include walleye, due to a lack of information on walleye at the time the plan was developed.

This approach may not have been appropriate in light of the results of the present study. The management plan must be amended to reflect the fact that lower Red River walleye stocks are integrally linked with Lake Winnipeg commercial walleye stocks.

Additional management examples were reviewed in the literature for relevance to the current situation. Resource allocation and re-allocation appeared to be the preferred management approaches. Other solutions included separating competing user groups in space and time by selective gear restrictions and seasonal opening and closing dates.

The economic and social costs of re-allocation may not be acceptable to current user groups. The economic benefits derived from the commercial fisheries should not be diminished by re-allocation. Uncertain walleye stock sizes and movements in Lake Winnipeg would appear to make this option impractical.

Similarily, the importance of the lower Red River recreational fishery to the local economies of Selkirk and Lockport should be taken into consideration as well. Subsistence use is also valuable to native communities.

An optimal solution would allow all three fisheries to continue operating under sustainable conditions. Further research is required to determine such conditions.

6.2 Conclusions

Questions have been raised on the adequacy of walleye stock(s) to support the combined sport, commercial and subsistence fisheries. Management efforts should be directed to protect the master angler sized walleye to ensure the long-term sustainability of the fishery, so that all user groups can continue to participate into perpetuity.

The current resource conflict is in part perceptually based. A lack of biological information has contributed to the development of misconceptions that prolong the conflict.

A more comprehensive and co-ordinated management response is required to deal with the diverse nature of variables affecting the walleye resource base. This should involve all currently and potentially affected stakeholders.

6.3 Recommendations

The following management recommendations have been priorized for immediate implementation.

1) The results of the current study should be used to educate user groups and help correct the perceptual biases that surround the conflict.

2) Future management efforts should protect master angler sized walleye from the commercial fishery in the south basin of Lake Winnipeg. This could be done by:

a) Delaying the opening of the spring commercial season to allow for a more complete dispersal of large walleye.

b) Establishing a maximum commercial gillnet mesh size to allow more large walleye to spawn.

c) Ensuring that commercial harvests are sustainable.

3) Information should be collected on native subsistence harvests within the lower Red River and mouth area. This will require the co-operation of band members.

4) Imposing additional regulations on the sport fishery may not be effective in sustaining a mobile walleye population and may only increase angler frustration. Current regulation is adequate given the dynamics of the situation.

5) Derby guidelines should be improved to minimize impacts from live-release angling derbies. Tournaments should not be held during the high water temperatures of summer. Standards should be set to improve holding conditions in livewells and fish handling practices established to reduce mortality.

6) Routine creel surveys are required to monitor the lower Red River sport fishery and the effectiveness of various management actions. Mortality studies should be conducted on

live-release derbies to determine present impact.

7) The lower Red River should not be managed as a single species "trophy" fishery for walleye, which are highly mobile and non-resident. This is not the case with channel catfish, which are predominantly river-resident. A multiple species approach needs to be taken for management of all of the fish resources of the lower Red River.

8) More emphasis should be placed on promoting and encouraging anglers to fish for other less desirable sport fish species, such as white bass (<u>Morone chrysops</u>) and carp (<u>Cyprinus carpio</u>), which are abundant. This would reduce the demand for single species and conserve valuable fish stocks.

9) Habitat impacts and changes in water quality in the Red River also require attention. Provincial water quality standards should establish one maximum acceptable level of un-ionized ammonia to improve monitoring and enforcement control over effluent discharges.

10) More communication and cooperation between the provincial Department of Natural Resources and the Federal Department of Public works is required to reduce potential impacts on walleye distribution and habitat, by dredging activities.

11) The research begun in the present study should be continued by the Manitoba Department of Natural Resources to ensure the protection and sustainability of fish stocks.

6.4 Further Study

More information is needed to document and evaluate the increasing native subsistence harvests of large walleye in the Lower Red River. The use of future co-management agreements to control this harvest may merit further consideration.

It is not presently known whether the lower Red River large "greenback" walleye are genetically distinct from other Lake Winnipeg or Red River walleye stocks. The distinction between river-resident and lake-run walleye needs to be clarified through detailed stock analysis using morphometrics and/or electrophoretic techniques.

The effects of water quality changes (from increasing urbanization and industrial development) on fish stocks and fish habitat in the lower Red River requires further study. An ecological approach is required for effective management.

The feasibility of developing alternative, under-utilized sport fisheries should be examined for the lower Red River.

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