THE UNIVERSITY OF MANITOBA

A PROFILE OF THE SOURIS RIVER SPORTS FISHERY: ANGLER CHARACTERISTICS, ANGLING PRESSURE, SUCCESS AND HARVEST

by

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Of course, while recognizing that many people contributed to the study, the author assumes full responsibility for its contents.

ABSTRACT

The study, conducted from May 15th, 1976 to August 15th, 1976, uses information obtained from questionnaire returns and a creel census to determine characteristics of the Souris River sport fishery. The Souris River is a tributary of the Assiniboine River in south-western Manitoba.

Angler characteristics as defined by the questionnaire returns include age distribution, sex, distance travelled to fish on the Souris, success by species, preferred species, and annual expenditures. Anglers also indicated preferred management options which, in their opinion, would enhance the sport fishery.

Angling pressure over the study period is estimated as 16,900 angler/hours. The catch per unit effort is estimated as .49 (fish kept per hour). The total harvest over the study period is estimated as 8,280 fish. Estimates of reliability for these data are found in the main text.

The sports-fishing resources is valued at $12,900.00 using the travel-cost technique. Using the total expenditures equals gross benefits approach, the

recreational resource is valued at $13,400 and $16,200 for Game and Fish organization members and interviewed fishermen respectively.

It is stressed that while this study applies recognized econometric tools for valuation of the sports fishery, there are some problems in applying them to this particular case. These pitfalls, discussed in Chapter Five, lead to an underestimate of the sports fishery in terms of the users' valuations.

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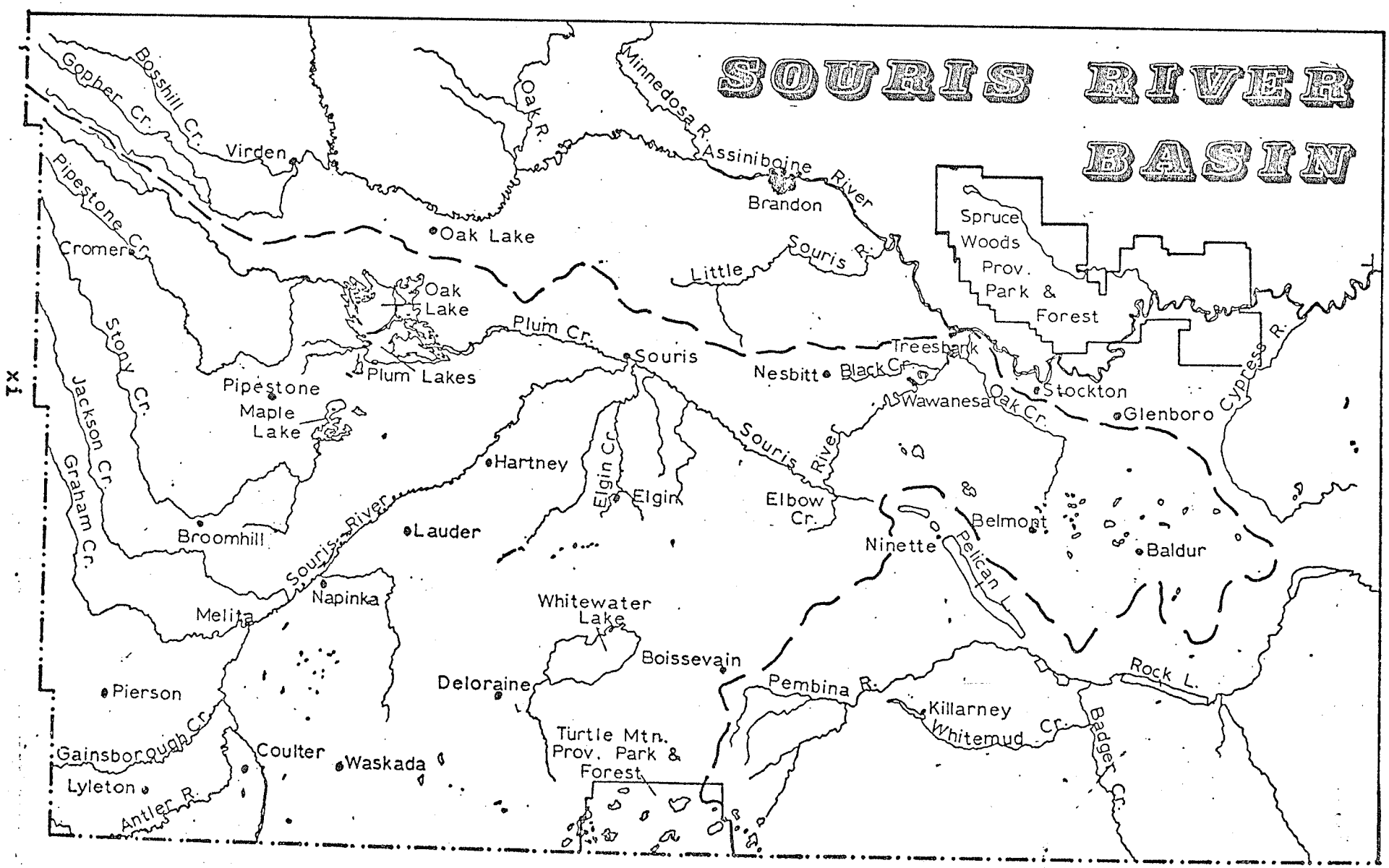

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STUDY AREA

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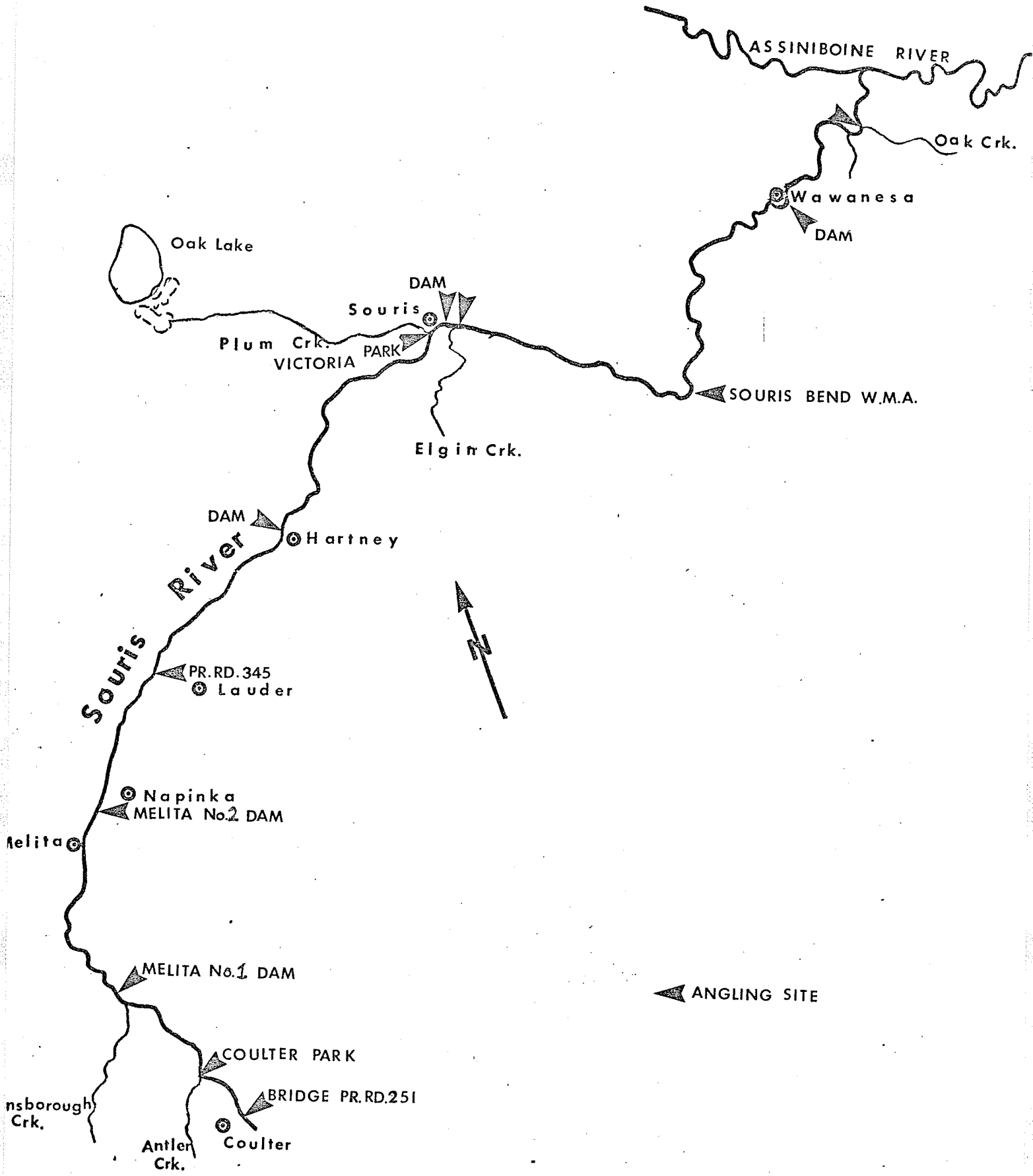


Scale Approx: 1cm=7km

CHAPTER ONE

Introduction

1 - The Problem Statement

The Souris River, a tributary of the Assiniboine system, is located in the extreme south-west corner of Manitoba. The river rises in the Province of Saskatchewan, crosses the International Boundary into the State of North Dakota and then returns across the Boundary into Manitoba where it flows in a north-easterly direction for some 170 miles (Austford, 1964).

The Souris Basin in Manitoba is an area typified by low precipitation and high evaporative loss, with the annual run-off coefficient given as 3% (Kuiper, personal communication). In addition, water flow regimes in the Souris River are erratic, as demonstrated by Table 1-1 (Anonymous, 1972).

TABLE 1-1

MEAN ANNUAL FLOW SOURIS RIVER, MEASURED AT WAWANESA

1954 -	520 CFS.	1961 -	19 CFS
1955 -	1116	1962 -	52
1956 -	833	1963 -	52
1957 -	173	1964 -	123
1958 -	93	1965 -	261
1959 -	44	1966 -	292
1960 -	447	1967 -	121

Low water conditions often preclude fish from overwintering in the river, and winterkill has been noted on several occasions behind existing low-head dams (File information, Department of Renewable Resourses and Transportation Services. Additionally, personal communication - local residents). Existing water regimes not only affect the sport-fishery, but also affect agriculture, water supply, and flood control.

In recognition of these difficulties faced by the people of the Souris River Basin, the Governments of Canada, Manitoba, and Saskatchewan formed the Souris River Basin Study Board on October 28, 1974. Its mandate is to develop a framework for the management of water and water-related resources in the Souris River Basin. Integral to the overall plan of the Study Board are multi-disciplinary reviews of management options designed to mitigate existing problems in the Basin.

As it is likely that sport-fishing on the Souris

will be affected by at least some of the suggested projects, the Board foresaw the need to quantitatively measure the use of the sport-fishing resource. In this manner, either positive or negative effects could be described precisely and included in projections of project impact.

Therefore, the problem statement is to "define characteristics of anglers fishing the main stem of the Souris River, the pressure they exert on the resource, their success and total harvest."

2 - Identification of Sub-Problems

It is hoped that identification of sub-problems at this stage will help clarify not only the problem, but the analyses in following pages.

1. Define characteristics of anglers

   (a) origin (local or tourist)
   (b) age and sex
   (c) frequency of angling trips
   (d) indicated success
   (e) preferred species
   (f) sport-fishing expenditures
   (g) indicated improvements to sport fishery
   (h) preferred angling locations

2. Estimate benefits accruing to fishermen as a result of existence of sport fishery

3. Describe and measure angling pressure in quantitative terms

4. Calculate catch-per-unit effort statistics

5. Calculate harvest

These problems will be dealt with in the above order in the chapters dealing with methodology, results and analyses.

3 - Delimitations

The study area is indicated by the map preceding page 1. Angling sites are also indicated on the map, along with major population centres. The study is limited to the main stem of the river and its tributaries up to one mile from the confluence with the main stem.

The study considers angling activities in the months of May through August. There is evidence, through personal communication, that a spring sucker fishery is pursued to a certain extent on the Souris River. Details of this aspect are not considered in this report.

4 - Definition of Terms

1. Angler - any individual licensed (or less than 16 or greater than 65 years old) to fish within the Province of Manitoba, complying with recognized sport fishing regulations.

2. Angler/hour - one continuous hour of sport-fishing by one individual or two continuous half-hours of sport-fishing by two individuals, etc.

3. Angling day - that amount of time usually utilized by sports fisherman to pursue fishing. For the Souris River, it is that length of time between 700 hours and 2100 hours.

4. Harvest - angling pressure (expressed in angler hours) x success (expressed as catch-per-unit effort) (Olver, 1970).

5. Success (= catch-per-unit effort) - C/f . The catch of fish, in numbers, taken by a defined unit of fishing effort. Also called catch per effort and availability (Ricker, 1975).

6. Sport fish - For the Souris River, sport fish include Northern Pike (Esox lucius)), Walleye (Stizostedion vitreum) and Yellow Perch (Perca flavescens). Other species that potentially could be considered game species include Brown

Bullhead (Ictalurus melas), White and Redhorse Suckers (Catostomus commersoni) (Moxostoma macrolepidotum), have not yet been accepted as game species in the Souris River area (excluding the dip-net fishery).

7. Variance $(s^2) = \frac{\sum (x_i - \bar{x})^2}{n - 1}$

where $\bar{x}$ = mean of observations

x_i = individual observations

n = sample size

8. Standard deviation (s) = the square root of the variance.

9. Standard error (SE) - the estimated sampling error of a statistic such as the sample mean. Also referred to as the standard deviation of the distribution of sample means, $(o_{\bar{x}})$, Larkin, 1975).

5 - Assumptions

The Angling season of 1976 was atypical with record flows of water recorded throughout the main stem of the Souris River. For example, a peak flow of 26,200 CFS was recorded at Wawanesa on April 11 the previous all-time record being 4,907 (Anonymous, 1972, 1976).

Initially, these record flows caused difficulties for anglers. Throughout the entire Upper Souris in May, angling pressure was virtually non-existent because of access difficulties and the amount of area over which the existing fish stock was spread. The only locations that supported any angling pressure were below the Wawanesa

Prairie Farm Rehabilitation Act Dam and at the crossing of Highway #2 and Plum Creek (a major tributary of the Souris). Only in the reach of the river below the town of Souris was channel capacity sufficient (greater than 15,000 CFS [Mr. B. Harrison, Water Resources - personal communication]) to permit fishing along the banks of the river.

During the latter part of the summer, flow levels were still unusually high. Although levels of 171 CFS are the average for August (Anonymous, 1972), 723 CFS was still passing through the river (Anonymous, 1976) on August 15th, 1976. All flow rates were recorded at Wawanesa.

These conditions resulted in improved fish habitat with more fish than usual remaining in the system. Angling pressure and success were accordingly higher through the month of August than was the case in previous years as noted in questionnaire responses and individual contacts in the field.

Hence, the point is made that the 1976 angling season was not typical. It is tempting to speculate that low initial angling pressure would be cancelled by higher pressure later in the season as personal communication with anglers suggests. Moreover indications were that lack of angling sites was not a deterrent to many fishermen who would prefer to fish "elbow-to-elbow" than not fish at all.

Although information from contacts in the field and questionnaire returns indicate that the study length of May 15th to August 15th would comprise the bulk of the angling season in normal years, angling will probably continue into the fall of 1976 at an unprecedented level. Further elaboration on this point will be made later in the report.

CHAPTER TWO

Literature Review

As noted earlier, this chapter will abstract pertinent articles or publications relevant to the methodology or analyses employed in the study. In some cases, the cited literature was central to the experimental design. In others, the cited literature is useful in the sense that it presents alternate views or techniques not employed in this paper. The reader may then determine the relative validity of each. It is hoped that after reading this chapter, the reader will be facilitated when reading the following chapters on methodology.

1 - The Questionnaire

A copy of the questionnaire in its final form as distributed, is shown in the appendices. Pages 1 and 2 of the questionnaire are based entirely on questionnaire design utilized by various government agencies. The questions contained therein are conventional in nature and will require no further discussion at this stage. On page 3 of the questionnaire, there are the means of evaluating the benefits accruing from the sport-fishery in two separate ways. Each technique has its proponents,

and a number of interesting criticisms have arisen concerning the relative validity of both. The next paragraphs are devoted to these criticisms.

Question #11 directs the respondent to place what he/she considers to be a fair dollar value on a day's sport-fishing on the Souris River, in view of other recreational opportunities available. This type of question falls under the category of "benefits estimated by imputed prices and values," (Schellenberg and Craddock, 1971). This technique represents an attempt to evaluate, in monetary terms, the more esoteric aspects of a recreational resource. These aspects might include the vicarious satisfaction a sportsman might derive from the knowledge that a species of sportsfish is being perpetuated in his locale. Another example might be the release of tension a businessman might experience when sport-fishing.

While the objective of measuring intangible benefits would seem a desirable end, practical methods that have been proposed thus far are fraught with numerous conceptual and practical problems.

An especially formidable conceptual difficulty associated with the technique in question is identified by Schellenberg (1973). He notes that the use of consumers' surplus (measurement of intangibles alluded to in previous paragraph) is misleading when comparing alternatives, notably private versus public development. As he further suggests, if consumers' surplus is used on

the benefit side, it must also be used in the cost side. Schellenberg concludes by stating that the costs involved include the value of private alternatives foregone. Hence, one would need to assess the impact upon every good and service in the economy.

Norton (1968) casts further doubt upon the technique stating that it is difficult to see the basis of comparison between recreational resources and other products that do not have consumer's surpluses associated with them, in allocative questions. He further states that if the evaluation is considered in the allocation of the fiscal budget, it follows that the social opportunity cost associated with other public investment possibilities is mensurable and recorded.

The practical problems associated with the technique are no less formidable. Schellenberg and Craddock (1971) indicate that the utmost care should be applied when framing the question to the respondent. Meyer (1975) suspects when the respondent is asked "what would you pay" he implicitly considers "existing institutional arrangements" before answering. By existing institutional arrangements, Meyer means the relative degree to which property rights are incorporated in the public sector. In Manitoba, for example, where property rights in recreation are largely vested with the public, institutional arrangements are such that the desired recreation is supplied to the user at nominal cost. In such a case, Meyer suggests that the respondent's reply would reflect the institutional adjustment of implicit price. Meyer further states that given the respondent's evaluation of

a particular recreational product - and his awareness of existing institutional costs - the greater his valuation of the recreational resource will be.

Laub (1969) feels that the limited number of outdoor recreational resources that are market-priced implies great difficulty in finding an acceptable degree of correspondence between private and public projects. Further to Laub's comment, it is noted that several bona-fide private recreation-resource based enterprises may receive direct or indirect subsidies from the public purse.

Meyer (1975) has investigated the results that various forms of the valuation question yield in the field. He utilized four variants, including the traditional questions of "what would you pay" and "what would I have to pay you", the "community decision making" question, and a "judicial award of damage" question. The "judicial question was first used by Brown (1970), cited in Meyer (1975).

Meyer's results are summarized below.

1. The "what would you pay" question can be expected to produce the lowest value response.

2. The "what would I have to pay you" question can be expected to produce the highest value response.

3. The "Community decision making" question, and the "Judicial Award" question can be expected to produce values between these two responses listed above, and may tend towards statistical similarity.

Bowden (1972) suggests some guidelines which may be used in deciding which of the above questions is most

appropriate to the situation:

> ....We may be interested in establishing what fishermen would be willing to pay for access to fishing opportunities if in fact prices were charged. Alternatively it may be appropriate to determine the minimum amount which recreationists would accept as compensation for being denied access to a fishery. These two different approaches will give estimates of value which are both defensible on theoretical grounds, but which are unlikely to be equal because they measure different forms of the "consumer surplus" or value accruing to fishermen. Generally, what fishermen would be willing to pay for access to a fishery is the appropriate basis for evaluation when new fishing opportunities are being created and the resources which must be devoted to the creation of the fishery have to be diverted from alternate uses. On the other hand, where fishermen are presently enjoying access to a fishery which requires little cost for its maintenance, and where a competitive use of the water would displace those fishermen, it is appropriate to value the fishery on the basis of the amount required to adequately compensate the fishermen for the loss of their recreational opportunities.

Schellenberg and Craddock (1971) feel that the interview techniques discussed are severely limited by the costs of the procedure and the difficulty in getting adequate replies. They state that the hypothetical question framed by the interviewer may be met by a hypothetical answer and, in practise, the respondent may not react as he/she stated in the interview.

Two groups of individuals may give misleading responses to the valuation question. The first group, as noted by Schellenberg and Craddock, will give replies that are deliberately low because they consider themselves limited by the amount of money that they have available for recreation.

The second group of individuals consider sports fishing to be their 'natural right' (Bryan, 1975). These individuals consider the notion of putting pecuniary values on sport-fishing as being wholly abhorrent. Accordingly, if they respond to the question at all, they will tend to give a very large value.

From the discussion preceding this, it should be clear that a number of significant conceptual and technical problems are associated with the direct question for valuation technique. This discussion will be referred to later in Chapter Four.

Turning now to the discussion of question #12 in the questionnaire, it is apparent that another avenue for evaluating the sport-fishing resource is facilitated by this question. The question represents the technique referred to by Schellenberg and Craddock as the "benefits equal expenditures" method. In this case, visitor expenditures for such goods and services related to the overall recreational experience are equated to the benefits attributable to the sport-fishing resource (Crutchfield, 1962; and Trice and Wood, 1958).

One of the key difficulties associated with this approach is indicated by Capel (1974). He states that the gross expenditure method is analogous to measuring the value of a meal at an expensive restaurant by examining the travel costs incurred between the place of residence and the restaurant.

Schellenberg and Craddock (1971) and Laub (1969) point out another weakness in the approach. They state that the benefits may be overestimated by using the cost of all recreation related items to justify the particular proposed project of facility. The rationale they offer is that when the users of a particular recreational resource are denied its facilities, they will likely continue to spend the same amount of money on alternate facilities. However, there is a "welfare loss" as a result of being forced to utilize their second choice. The proponents of this criticism note that it is the welfare loss that measures the value of recreational benefits and it cannot be quantified with gross expenditure techniques.

However, on the positive side, the gross expenditure is simple to apply and can be useful under certain circumstances. Both Spargo (1971) and Laub (1969) acknowledge that expenditure data are relevant for evaluating the economic impact on a community attributable to a recreational resource. Laub adds the qualifier that the extent to which these expenditure are directly attributable to the resource and the costs incurred by the community to service the recreationists must also be taken into account.

Finally, there is one other technique that should be discussed in the current context. Although the data required by the method are not solely derived from the questionnaire, it is probably best discussed at this point for purposes of comparison with techniques already outlined.

The technique alluded to is the so-called "travel cost" technique. The basis for the method was first described by Harold Hotelling in 1949, in a letter to the Director of the United States National Parks Service. The letter, quoted by Brown, Singh and Castle (1964) is reproduced below:

> "Let concentric zones be defined around each park so that the cost of travel to the park from all points in one of these zones is approximately constant. The persons entering the park in a year, or a suitably chosen sample of time, are to be listed according to the zone from which they come. The fact that they come means the service of the park is at least worth the cost, and this cost can probably be estimated with fair accuracy. If we assume that the benefits are the same no matter what the distance, we have, for those living near the park, a consumers' surplus consisting of the differences in transportation costs. The comparison of the cost of coming from a zone with the number of people who do come from it, together with a count of the population of the zone, enables us to plot one point for each zone on a demand curve for the service of the park. By a judicious process of fitting, it should be possible to get a good enough approximation to this demand curve to provide, through integration, a measure of the consumers' surplus (calculated by the above process with deduction for the cost of operating the park) which measures the benefits to the public in the particular year. This, of course, might be capitalized to give a capital value for the park, or the annual measure of benefit might be compared directly with the estimated annual benefits on the hypothesis that the park area was used for some alternate purpose.
>
> The problem of relations between different parks can be treated along the same lines, though in a slightly more complicated manner, provided people entering the park will be asked which other national parks they have visited that year.....
>
> This approach through travel costs is one of several possible modes of attack on this problem. There are also others, which should be examined, though I think the method outlined above looks the most promising."

Clawson (1959) further refined the Hotelling model by developing a "demand schedule" for recreation at the site in question. However, he relaxed the Hotelling requisite of grouping individuals by some character. In place, individuals are grouped as to their origin and their associated travel costs can then be easily computed. A diagram of the Hotelling-Clawson "demand schedule" is shown on the next page, and is derived from Schellenberg and Craddock (1971).

As with any abstraction, there are difficulties when the concept must produce results in a real-life condition. Capel and Pandey (1973) note that the question remains unresolved as to whether recreationists would react the same way to travel costs as they do to admission fees. This concern is certainly a legitimate one, as the basis of the whole technique is that travel costs may be used as a proxy for admission fees. Another concern they raise is that the demand curve derived will be biased if time spent travelling had a cost and if people's choice of where to live depended on the location of recreation sites and the admission fees charged.

Pearse (1968) carries Capel and Pandey's first criticism further, stating that the recreationists should be grouped according to socio-economic standing. However, as is rightly pointed out by Schellenberg and Craddock (1971), by removing Clawson's assumption of homogeneity

the value obtained for the consumers' surplus must be compared with the consumer surplus associated with other market goods in order to be useful. This is the same argument that Schellenberg (1973) pursued earlier in the Section.

The review of related literature with respect to the valuation of the resource is now complete. Each of the three techniques were incorporated in the experimental design. The data generated by each and the results are discussed in Chapter Four.

2 - The Creel Census

Two of the most helpful papers concerning creel census problems are papers by H. A. Regier of Cornell University, published in January and February of 1966. In the first paper, Regier introduces a total of ten different designs for a creel census. The first group of four are applicable to situations where it is practical to obtain total tallies of both catch and total effort for at least part of the fishing season. The second group, consisting of two designs, can be used where it is practical to obtain tallies of daily catch and effort statistics by sub-sampling techniques. The third and final group of five designs are likely to be the cheapest to implement but the designs are only valid in special situations where a great deal of prior information has been gathered about the fishery (Regier, 1966b). The ten designs

are now summarized over the following pages. The text, unless noted, is drawn largely from Regier's 1966b paper.

A - Designs for randomly selecting days on which to obtain total catch and total effort data.

1. Simple Random Design - if the investigator knows very little about how the effort or catch is likely to vary from day to day or week to week during a season, or if he has information that these sorts of variations are small, then he may efficiently use a simple random design. If the season is 140 days long and he has sufficient resources to sample 80 days, he can simply select 80 of the 140 days completely at random.

2. One-way stratified random design, stratified in time - if the investigator knows that fishing effort and catch tend either to be more variable or different, or both, on Fridays, Saturdays, and holidays than other days of the week, then he may decide to divide his season into three-day weekend + holidays and four-day mid-week periods. He would then devote half his resources to sampling weekend periods and half to the mid-week period. The sampling days are chosen at random.

3. Two-way stratified random design, stratified in time - If, in addition to knowledge referred to in Design #2, the biologist has reason to believe that data will be more variable in the first month of the angling season, as compared with the remainder, he may wish to stratify on a monthly basis.

B - Designs for randomly selecting days and area segments and/or recognizable groups of fishermen.

4. One-two- or three-way stratified random design, stratified in time, area segments, groups of fishermen - This is simply an extension of Designs 1-3 to include random sampling of various area segments, or groups of fishermen or both. The more variable and/or higher the catches in a particular segment are, the higher should be the relative allocation of resources to sample the area in question.

5. One segment total sample, other segments partial samples - A biologist may be in a position where it is practical to get complete tallies of all fishermen in a particular segment of a lake, or

all fishermen using a particular boat launching area, or a particular group of fishermen. If he can also obtain total catch and effort data for all other segments (or groups of fishermen) on part of the days he can use a ratio estimate to obtain total catch and effort statistics for the whole season.

C - Designs using estimated effort ratio.

6. Total effort sample, partial catch sample - It is usually simpler and much less costly to obtain data on effort than catch. A biologist may be in a position to obtain total effort data for the whole season but only partial data on catch.

   (a) If the days on which both effort and catch data are to be collected are chosen completely at random (as in design 1) then the estimated total catch for the whole season is:

$$\left(\frac{\text{total effort for the whole season}}{\text{total effort for the catch-effort census days}} \right) \times \left(\begin{array}{c} \text{total catch for} \\ \text{the catch-effort} \\ \text{census days} \end{array} \right)$$

   (b) The catch-effort census days may be stratified in one of many ways, some of which have already been indicated, and an estimate of total catch is obtained in an analogous manner to that described in 5.

7. Total effort from one segment, partial effort and catch samples from remaining segments - Sometimes it is possible to obtain data on effort (i.e. boat trips) very cheaply from particular boat liveries, or state boat launching sites. All segments of the lake may be censused in randomly selected periods to obtain data on total catch and total effort. This partial sample (i.e. total data from part of the available time strata - parts of day or days or weeks etc.) may be obtained by simple random or stratified random sampling.

8. Total effort and partial catch samples on some days - A biologist may not be in a position to use any of the preceding designs due to cost and must restrict himself to partial samples of both catch and effort. If he has resources or is in a position to obtain total effort data (i.e. without error) on some days and partial catch data on those days, he can randomize days (either simple or stratified designs) and also area segments within days to obtain total season estimates of catch and effort.

9. Estimated total effort and partial catch samples, both on only some of the season's days - With more limited resources or on fisheries difficult to census, it may be possible to estimate total effort either by periodic instantaneous counts or by a rover, and also obtain total catch and effort data (without error) from randomly chosen segments of the lake. Of course, various stratification procedures may be employed within the framework.

10. Estimated catch rate and estimated effort, both on only some of the season's days - If it is possible to select a truly random sample of fishermen and obtain from them data on catch and effort for selected days, and also estimate total effort for those days, then the following are the basic calculations:

Estimated season total effort is

$$\left(\frac{\text{number of days in season}}{\text{number of days censused}}\right) \times \left(\begin{array}{c}\text{estimated total effort} \\ \text{on censused days}\end{array}\right)$$

Estimated season total catch is

$$\left(\begin{array}{c}\text{estimated season total} \\ \text{effort, as above}\end{array}\right) \times \left(\frac{\text{total catch of randomly sel. f'men}}{\text{total effort of randomly sel. f'men}}\right)$$

Once again, the basic design may be stratified in various ways already described. However, with respect to Design #10, Regier notes the design is the conceptual basis for the roving creel census to estimate both total effort and catch rates. Used in this way it is usually subject to biases of various sorts, and one would not feel safe in using it unless critical preliminary studies have been made (Regier, 1966b).

These designs listed above represent the basic outlines of the plans considered for the Souris River census. In each case, they are drawn almost exactly from the Regier article. In certain instances, the equations that Regier gave for calculating harvest and pressure are deleted for the sake of brevity. The interested reader is referred to the original article.

At this point it is worth noting that none of the ten designs listed above are intended to give 100% coverage of all anglers throughout the season. It is apparent that such a procedure would be extremely demanding of both time and money. Yet, such a technique has been used in censuses of National Parks conducted by the Canadian Wildlife Service. This system, as noted by Cuerrier and Ward (1952) was initiated in 1933 and continued at least until 1951. The methodology presupposed anglers completing cards describing their activities and their success. Although Cuerrier and Ward note that not all anglers return their cards, the system provides very accurate data. The obvious drawback, however, is cost. Regier's March 1966 paper evaluates the relative efficiency of creel census methods by producing the following table: (first developed by Carlander et al, 1958).

TABLE 2-1

RELATIVE EFFICIENCY OF CENSUS DESIGN

Data obtained and submitted by	Type of Sample			
	Complete enumeration	Partial		
		Haphazard	Purposive	Random
Fisherman	A	C	E	G
Interviewer	B	D	F	H

Regier considers the overall efficiency of the above designs to be: H, B, F, E, A, G, D, C. (from

highest efficiency to lowest) Regier considers efficiency in terms of biases, precision and cost.

Finally, Olver (1970) has developed a general creel census manual for field workers. This work was drawn on repeatedly during the creel census design and formed the framework of the design that was finally chosen. Further reference will be made to this paper throughout the remainder of this study.

CHAPTER THREE

Methodology

1 - The Questionnaire

The distribution of the questionnaire was achieved by two methods. Firstly the researcher attended four regular meetings of Game and Fish Associations in the Souris River Basin. These meetings were held on the following dates:

TABLE 3-1

GAME AND FISH MEETINGS
SOURIS BASIN, SPRING 1976

Wawanesa	March 4
Souris	March 10
Melita	March 18
Hartney	April 10

At these meetings, individuals who fished the Souris River were instructed to complete the questionnaire on the spot, and return them to the researcher. Any queries regarding the questionnaire were answered at this time. The need for caution in responding to questions in a "leading" fashion was observed. The questionnaire generally took ten minutes to complete. Usually, some other questionnaires were left with the executive to distribute to other anglers they know who were absent.

The primary purpose of the researcher attending the Game and Fish meetings was to gain some preliminary appreciation of the nature and scope of the sports fishery through the questionnaire returns. The creel census design would, of course, be aided by such information. Also important is the fact that Game and Fish members represent a group with a vested interest in the Souris River sports fishery. As such, it was felt that these respondents would provide interesting information especially when contrasted with interviews conducted during the creel census.

The second method by which the questionnaire was distributed was during the creel census circuit. As it was often impossible to administer the questionnaire to all anglers at the site, and remain on schedule for the remainder of the census, it was necessary to subsample individuals for the questionnaire distribution. The method by which anglers were chosen was essentially a random process, with every second or third angler chosen depending on the number of fishermen at the site.

In addition, fifty questionnaires were sent to the Brandon Wildlife Association, with instructions to return the completed forms. In total, approximately three hundred questionnaires were distributed throughout the study area.

For the majority of the questionnaire analyses, the description will be in the form of either frequency

distributions or arithmetic means. In the case of arithmetic means, the standard error is calculated where applicable.

For the valuation of the sport-fishing resource, the problem becomes more involved. As noted in Chapter Three, there are several techniques by which a pecuniary value may be derived for recreational resources. Built into the questionnaire design, there are three potential avenues to attack the problem:

1. Benefits equal gross expenditures
2. Benefits estimated by imputed prices and values (question #11)
3. Benefits calculated by travel-cost data

The travel cost technique involves an estimation of a demand curve function for the site under investigation. In order to derive the curve, travel costs are used as a proxy for entrance fees (Capel and Pandey, 1973). The visitation rate on a per capita basis, is a dependent variable with respect to travel cost, the independent variable. When both variables are plotted, a demand function is generated similar to the Clawson model (1959). Further elaboration on this technique is given in the latter part of Chapter Four.

The researcher has attempted to circumvent the problem associated with the gross expenditure technique described by Schellenberg and Craddock (1971) and Laub (1969) on page 14. By including the latter part of question #9 in the questionnaire, some attempt is made to

measure the apportionment of available leisure time to the sports fishery under investigation. The percentage value gained from the question may be used as a multiplicative factor in the determination of gross expenditures for the individual.

2 - The Creel Census

The need for careful design in this part of the study is necessitated by the large geographic area encompassed by the Souris Basin in Manitoba. Additionally, there have been no other creel census surveys conducted on the Souris River apart from spot checks by Conservation Officers.

Olver (1970) recognizes this need stating,

> "A large number of man-days is spent each year in Ontario by Conservation Officers, biologists and other field men interviewing anglers and sampling their catches. However, the lack of written reports on this subject leads one to speculate that the real objective was to spend a pleasant afternoon on a lake or stream talking to anglers. If true, it is indeed unfortunate because with some advance planning, specific objectives could have been realized with very little extra effort."

The need to develop a systematic routine that may be subject to statistical analyses, with a minimum of bias input from the researcher, is demonstrable. The antithesis to a statistically sound census design is the haphazard sample. Regier (1966b) notes that haphazard samples are of little value except to determine if fish are indeed being taken. He further states that the appeal of this type of design is perhaps related to the fact that

it may be undertaken whenever the spirit moves. For example, if work is dragging in the office on a beautiful day, the need for census data may suddenly become irresistable. To fail to conduct a census in one's favourite trout stream would, of course, constitute a mistake. Regier concludes that when the day is over, such data should be tenderly laid to rest in a place where they will cause the researcher no embarrassment.

It is obvious that data gathered on haphazard censuses conducted only on beautiful days would be significantly biased. Olver (1970) cites Neuhold and Lu (1957) as stating that the weather, while not predictable, has a definite effect on the number of anglers fishing during any particular day. Hence, this is the major justification for determining the census design and the actual work days in advance. Olver (1970) further observes that the purpose of such a procedure is to minimize potential sources of error by applying mathematical theory to the selection of census days rather than relying upon the whims and wishes of the census worker.

Conversations with Messrs. John Peterson and George Cockle, Conservation Officers at Killarney and Brandon respectively, information from questionnaire returns, and other sources proved to be invaluable in determining the design of the census. Most sources indicated that a working day of fourteen hours commencing

at 700 hours, and concluding at 2100 hours would encompass the bulk of fishing activity on the Souris River. Key angling areas were also identified. Anglers apparently congregated in discrete areas, where they felt fishing opportunity was good. Access is also an important determinant for angling sites. It was further indicated that angling pressure may be significantly different on weekends, as compared to weekdays.

With this information at hand, the census was designed using Olver's model, with some modifications. A roving creel census was deemed most applicable, given the fact that anglers tend to disperse in well-defined locations. Consistent with Olver's design, randomized starting locations for each working day were chosen in advance, as were the working days. The details concerning how these locations and working days were chosen is described later in this chapter. The creel census was also stratified with respect to weekends and weekdays. The working day was designed in such a fashion that the researcher visited each angling site on the creel census circuit once. It was calculated that given the number of angling sites, approximately one-half hour should be spent at each site before proceeding to the next location. This allowed for travel time between sites, and permitted for completion of the circuit at 2100 hours.

The starting location of the creel census circuit was randomized, and the remainder of the circuit was

followed in a systematic fashion. The direction followed around the circuit was also the same throughout the study period.

Once at the site, an instantaneous count was made of the anglers present and interviews were conducted. Anglers arriving after the initial count were not considered. During the interview, the following questions were addressed to the fisherman:

1. Angler origin
2. What time fishing activities commenced that day
3. Success

Although incidental to this study, the anglers' catch were weighed, measured and sexed, where possible. Scale samples were taken for age determination. More relevantly, anglers were subsampled for the questionnaire distribution.

The method by which the working days were chosen is essentially that suggested by Olver (1970). As noted earlier, there was a probability that angling pressure on weekends may be higher than on weekdays. Correspondingly, it was determined that a higher proportion of effort would be devoted to the census on weekend days compared to weekdays. Olver (1970) suggests that having determined the number of days available to the researcher for conducting the census (in this case, three days of the seven day week were available), it would be desirable to

randomly select the first weekend day by simply tossing a coin. Thereafter, the weekend day to be worked would alternate from a Saturday to a Sunday or vice-versa. Statutory holidays (included in the weekend strata) were also alternated after the first holiday day was chosen at random.

The stipulation was made that having assigned one working day to the weekend, no more than two working days were to be assigned to the weekday strata. In order to randomly chose the working days, it was necessary to use a random numbers table with appropriate coding for the various weekdays. Olver utilized the following code in his creel census handbook:

let	0	and	1	represent	Monday
"	2	"	3	"	Tuesday
"	4	"	5	"	Wednesday
"	6	"	7	"	Thursday
"	8	"	9	"	Friday

Of course, the method by which the researcher choses to use the random numbers table with respect to the above coding is entirely at the discretion of the individual, providing he is consistent in his application of the table.

These simple techniques were applied and generated the work schedule shown on the following page. The work schedule was met throughout the summer, with one exception described in the results.

The starting location was chosen in an analogous fashion utilizing random numbers. The various angling

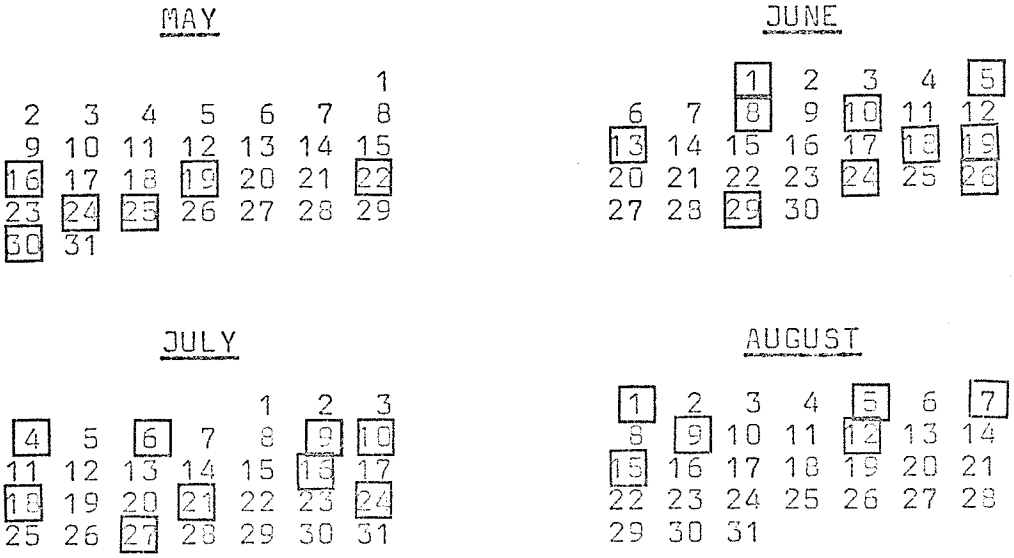
sites were assigned codes, and the starting location for each working day was chosen in reference with a random numbers table.

The census method described in latter paragraphs may be described as "systematic, with random beginning." Regier (1966b) describes how the method generates useful data:

> "A rover can traverse the fishery on a well-defined route and according to a well-defined time schedule and simply count fishermen as he passes them, or count them instantaneously from selected vantage points within clearly delimited area segments of the fishery. The total count obtained in a single circuit is an unbiased estimate of the average number fishing during this period, or if multiplied by the length of the interval it becomes an unbiased estimate of number of angler-hours during the interval."

FIGURE 3-1

CREEL CENSUS DAYS WORKED



It is stressed that although the Souris design is an instantaneous design with respect to angling pressure

estimates, other parameters of the sport-fishery are to be measured also. They include success rates (non-instantaneous) and harvest.

3 - Aerial Surveys

Finally, it seemed desirable to ascertain how much of the sport-fishery was encompassed by the census circuit. In other words, it was advisable to determine how many anglers were fishing in areas other than those covered by the creel census. In order to determine this, three flights were made over the main stem of the river in Manitoba.

The flights were made in a single engine Cessna aircraft with a high-wing arrangement that facilitated observation. The flights originated from Brandon, joined the Souris River at the confluence with the Assiniboine, then proceeded south as far as the Coulter Bridge. The air speed was 70 knots, at an altitude of 300 feet. Flying at those conditions, counting anglers did not present a problem. The flight (one-way) generally took one and one-half hours to complete.

Whenever possible, the flights were chartered at such a time as to coincide with peak angling pressure on the Souris River. At these times, it seemed most likely that anglers would disperse to sites other than those commonly used. In such cases, the researcher could monitor the extent of this dispersal.

Three flights were made. The first took place on

Sunday, July 11th, at 6:00 P.M.; the second on Sunday, August 1st at 6:00 P.M.; and the third on Saturday, September 11th at 11:30 A.M. The third and final flight represented an attempt to measure the extent of angling pressure beyond the study period.

CHAPTER FOUR

Results

1 - The Questionnaire

i - Distribution

The questionnaire distribution was completed as indicated in the table below. Note that 64 questionnaires were completed during the Game and Fish meetings; and 47 were administered verbally during the creel census circuit. Additionally, 13 questionnaires were completed by students of Grade 9 at the Souris School.

TABLE 4-1

QUESTIONNAIRE DISTRIBUTION - GAME AND FISH MEETINGS

	Wawanesa	Souris	Hartney	Melita
Complete	17	17	17	9
Incomplete	1	-	-	1
Do not fish	2	2	5	3
TOTAL	20	19	22	13

The origins of anglers who received the questionnaire when encountered on the creel census circuit are shown below.

TABLE 4-2

QUESTIONNAIRE RESPONDENT ORIGINS - CREEL CENSUS

Waskada	- 5	Napinka	- 1
Melita	- 3	Lauder	- 2
Wawanesa	- 2	Killarney	- 1
Brandon	- 2	Boissevain	- 1
Pierson	- 2	Souris	- 2
Deloraine	- 3	Glenboro	- 2
Goodlands	- 1	Not complete	- 20
		TOTAL	47

ii - Membership Composition

Of the people who attended the Game and Fish meetings, 82% (45 respondents) were members of Game and Fish organizations. The respondents were 100% male (50 respondents). Of the individuals interviewed on the creel census circuit, only 13% (46 respondents) indicated that they belonged to Game and Fish organizations. Again, the vast majority of respondents were male (96%, 43 respondents).

iii - Age Composition

In Table 4-3, the age composition of respondents is given. Naturally, not all people were willing to indicate their age, and some incidence of non-response occurred.

TABLE 4-3

AGE DISTRIBUTION - QUESTIONNAIRE RESPONDENTS

Age Group	Creel Census	Game & Fish
< 18	3 (7%)	5 (10%)
18 - 25	3 (7%)	2 (4%)
26 - 35	2 (5%)	10 (20%)
36 - 45	6 (14%)	10 (20%)
46 - 55	5 (11%)	10 (20%)
> 55	24 (56%)	13 (26%)
	43	50

iv - Alternate Angling Locations

The following sites were identified by Game and Fish members as locations at which they spend at least part of their total sport fishing time: Oak Lake (14 individuals), Waterhen River (2), Killarney Lake, Pelican Lake, Duck Mountain, Shellmouth Dam, Minnedosa River and Northern Manitoba.

People interviewed during the creel census stated the following preferences: Oak Lake (7), Waterhen River (2), Pipestone Creek, Gainsborough Creek, Elgin Creek, Turtlehead Creek, Crane River, Winnipeg Narrows and the Assiniboine River.

v - Trips per month

Table 4-4 on the following page indicates the total number of fishing trips Game and Fish members undertook in a usual year. The number of responses for the question was 47.

TABLE 4-4

FISHING TRIPS PER MONTH (GAME & FISH)

January	25	July	97
February	24	August	80
March	14	September	93
April	6	October	75
May	73	November	27
June	127	December	37

The corresponding data as supplied by individuals encountered during the creel census is supplied in Table 4-5.

TABLE 4-5

FISHING TRIPS PER MONTH
(CREEL CENSUS RESPONDENTS)

January	12	July	259
February	1	August	192
March	6	September	65
April	0	October	43
May	257	November	4
June	357	December	5

Note that peak months for fishing are from May through August, with very little fishing attempted after freeze-up. There would also seem to be a discrepancy in the two results with respect to angling pressure in the months of September and October. Game and Fish members indicated that they continued to fish the river at the same rate as they did in earlier part of the season whereas individuals questioned during the creel census indicated that angling pressure dropped significantly from August to September. Further secondary data, including interviews

with local conservation officers would seem to corroborate the second view, that is, angling pressure drops significantly in the fall. This is a function of water levels however: in exceptionally high-water years, angling pressure probably extended into the fall of 1976 with little drop in intensity. This, as demonstrated later in this chapter, would seem to be the case for the angling season of 1976.

vi - Mean Length of Time Spent per Trip

Members of Game and Fish organizations indicated that they spent a mean of 3.58 hours per outing. However, the computed variability associated with this figure is high (50 respondents, standard deviation = 2.17). This high standard deviation would indicate that individuals spend a variable amount of time fishing.

People interviewed during the creel census stated that they spent on the average, 3.25 hours per trip. However, in this case the variability associated with the sample average is somewhat more restricted. The calculated standard deviation is 1.39, with 42 respondents.

vii - Number of Anglers in Group

The second part of question #6, dealing with the number of anglers travelling in the respondent's vehicle, was also answered with a degree of variability. The mean for Game and Fish members was 2.42, and the mean for the creel census individuals was 1.98 with 45 and 43 individuals responding, respectively. The standard deviation for the

Fish and Game sample was computed to be 1.06, and for the creel census respondents, 0.51.

viii - Indicated Angling Success

For question #7, the angler is asked to recall approximately how many fish, by species, he or she caught in 1975. This question was generally not well received, the prevalent feeling being that they could not recall exactly how many fish they had caught. No anglers admitted to having kept any bullheads or suckers that they had caught, and when queried to how many they had caught, the usual response was "lots". Invariably, fish of these species are returned to the water, or more frequently, left on the shoreline to rot.

Only 35 Game and Fish members attempted to answer this question. Coincidentally, only 35 individuals interviewed in the creel census circuit were willing to complete this question. Table 4-6 summarizes the results for the two modes of response, showing fish caught and fish kept, by species, on a monthly basis.

TABLE 4-6

ANGLING SUCCESS BY SPECIES

	Game and Fish			Creel Census		
	Pike	Walleye	Perch	Pike	Walleye	Perch
Jan.	55- 6			41-10		
Feb.	28- 1		2-0	41-10		
Mar.	81-38		2-1	50-30		
April	0					
May	140-47	15-3	16-4	445-148	33-4	
June	209-50	8-0	9-3	483-142	17-1	
July	122-28	7-0		400- 67	6-0	
Aug.	109-37	12-0	2-0	163- 38	7-0	
Sept.	172-41	3-0		138- 43		
Oct.	130-54	6-0		100- 43		
Nov.	107-66		4-0	3- 3		
Dec.	86- 0			3- 3		

The number which precedes the dash indicates the total number of fish of a particular species caught in that month. The number after the dash represents the number of fish released in the appropriate month. Total caught minus total released would equal total harvest.

Although there are some apparent discrepancies between the two sets of data illustrated above, it must be stressed that the two groups or samples are not drawn from the same population. (The term "population" is meant to be interpreted here in its statistical sense.)

ix - Preferred Species

Question #8 was designed to determine which species of fish the angler prefers to catch. Since it was a relatively unambiguous question data from both sources, the creel census and the game and fish meetings are com-

bined. Seventy-four individuals responded to this question.

TABLE 4-7

PREFERRED SPECIES OF QUESTIONNAIRE RESPONDENTS

	1st choice	2nd choice	3rd choice	4th choice
Pike	31	29	9	0
Walleye	41	16	0	2
Perch	2	18	28	1
Bullhead	0	0	3	4

From the above table it is apparent that most people preferred either pike or walleye. Those who picked pike as their first choice made reference to the game fight the fish puts up when hooked, and those who chose walleye as their initial choice commented on the fish's table qualities. Invariably, those who preferred walleye commented on the species' relative scarcity in the Souris system.

In addition, many respondents commented that they enjoy yellow perch for its table qualities. However, they further stated that it was uncommon for them to catch a perch they would consider large enough to keep. Incidentally, this observation contradicts findings in the field this summer when several yellow perch individuals over the "Master Angler" limit (1 lb. 4 oz. in Manitoba) were collected in nets set near the town of Souris.

x - Anglers' Estimation of Fair Dollar Value of Day's Sport Fishing

This question was designed to gain some appreciation

of the extent to which an angler values a day's fishing on the Souris River. However, preliminary appraisal of the results indicated significant variance. For example, the mean value members of Game and Fish organizations placed upon a day of fishing was $11.36, with a computed standard deviation of $10.00. The fact that only 28 individuals belonging to the Game and Fish organizations attempted to complete this question further exemplifies the problems associated with it.

In attempting to administer this question verbally to people encountered in the creel census, field personnel often found themselves "coaching" the respondents. This, of course, is inadmissible. Therefore, in view of the reasons given, it was decided to delete this part of the questionnaire from further analysis.

xi - Gross Expenditures

As indicated in question #12, the respondent is asked to indicate how much money he/she allocates to:

1. Food and lodging
2. Transportation
3. Fishing gear

The results of this question have been tabulated, and the answers are displayed in Tables 4-8 and 4-9, for Game and Fish members and individuals interviewed during the creel census respectively.

Total expenses for the group of respondents interviewed during the creel census were almost double that of

the Game and Fish members. Correspondingly, people interviewed during the creel census indicated that they spent a larger proportion of their total angling time fishing the Souris than did members of the Game and Fish associations.

In three cases, respondents noted that they made major capital expenditures in the form of a boat (and motor, in two of three cases). The capital expenditure was converted into an annual cost, using a capital recovery factor of 0.1627 assuming a discount rate of 10%, and an operating life of ten years. Edge (1971) notes that the total recovery factor makes allowance for depreciation and return on investment, had the money been utilized in an alternate fashion.

In the parts of question #12 dealing with food an lodging, and transportation, the respondent is asked to state those expenses solely associated with the Souris River sport fishery. However, in the section dealing with fishing gear, expenditures in this category cannot be isolated as solely attributable to one fishery, unless the respondent indicates that 100% of his/her time is spent fishing on the Souris. In recognition of this problem, expenditures under the "fishing gear" category, and other expenses, such as boat and motor, are multiplied by the fraction of total sport-fishing time that the respondent states is spent fishing on the Souris. An adjusted value is then attained.

TABLE 4-8

ANNUAL GROSS EXPENDITURES - GAME AND FISH MEMBERS

Questionnaire	Food and Lodging	Transport	Fishing Gear	Other	Percent[2]	Corrected Expenditure[3]	Individual Totals
1	$200.00	$100.00	$100.00	$ -	75%	$ 75.00	$375.00
2	30.00	10.00	50.00	-	50	25.00	65.00
3	-	-	40.00	-	50	20.00	20.00
4	-	-	-	-	-	-	-
5	50.00	50.00	50.00	-	20	10.00	110.00
6	-	6.00	50.00	1350.00[1]	10	26.97	32.97
7	-	-	200.00	1000.00[1]	75	272.03	272.03
8	-	-	-	-	-	-	-
9	2.00	-	5.00	-	5	.25	2.25
10	80.00	25.00	20.00	-	25	5.00	110.00
11	-	10.00	-	-	-	-	-
12	-	25.00	50.00	-	35	17.50	42.50
13	-	-	-	-	-	-	-
14	10.00	10.00	20.00	-	10	2.00	22.00
15	15.00	10.00	15.00	-	50	7.50	32.50

TABLE 4-8 - CONTINUED

Questionnaire	Food and Lodging	Trans-port	Fishing Gear	Other	Percent[2]	Corrected Expendi-ture[3]	Individual Totals
16	$ -	$ 5.00	$ 15.00	$ -	20%	$ 3.00	$ 8.00
17	40.00	45.00	20.00	-	67	13.40	98.40
18	-	-	10.00	-	25	2.50	2.50
19	-	20.00	-	-	75	-	20.00
20	-	10.00	10.00	-	10	1.00	11.00
21	-	-	15.00	-	75	11.25	11.25
22	10.00	2.00	4.00	-	10	.40	12.40
23	-	25.00	25.00	10.00	100	35.00	60.00
24	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-
26	10.00	12.00	2.00	-	20	.40	22.40
27	-	-	-	-	-	-	-
28	-	20.00	10.00	-	20	2.00	22.00
29	-	3.00	4.00	-	33	1.33	4.33
30	-	10.00	30.00	-	75	22.50	32.50
31	-	10.00	-	-	10	-	10.00
32	40.00	20.00	30.00	-	10	3.00	63.00
33	-	25.00	50.00	-	20	10.00	35.00

TABLE 4-8 - CONTINUED

Questionnaire	Food and Lodging	Trans-port	Fishing Gear	Other	Percent[2]	Corrected Expendi-ture[3]	Individual Totals
34	$ 20.00	$ 25.00	$ 20.00	-	75%	$ 15.00	$ 60.00
35	-	-	-	-	-	-	-
36	-	25.00	60.00	-	50	30.00	55.00
37	-	-	-	-	-	-	-
38	-	10.00	5.00	-	20	1.00	11.00
39	-	-	25.00	-	10	2.50	2.50
40	-	-	-	-	-	-	-
41	-	-	25.00	-	50	12.50	12.50
42	-	25.00	30.00	-	50	15.00	40.00
43	10.00	3.00	3.00	-	5	.15	13.15
44		20.00	40.00	-	60	24.00	44.00
45	15.00	5.00	20.00	-	50	10.00	30.00
46	-	-	-	-	-	-	-
47	-	1.00	10.00	-	50	5.00	6.00
48	-	-	100.00	-	75	75.00	75.00
49	20.00	25.00	15.00	-	50	7.50	52.50

TABLE 4-8 - CONTINUED

Questionnaire	Food and Lodging	Transport	Fishing Gear	Other	Percent[2]	Corrected Expenditure[3]	Individual Totals
50	$ -	$ 2.00	$ 5.00	-	25%	$ 1.25	$ 3.25
TOTAL	$552.00	$594.00				$765.00	$1911.93

1 - boat and motor
2 - percent of total sport-fishing time spent on Souris
3 - includes sum of columns headed "fishing gear" and "other" corrected for above factor. (See text p. 44).

TABLE 4-9

ANNUAL GROSS EXPENDITURES - INTERVIEWED FISHERMEN

Questionnaire	Food and Lodging	Transport	Fishing Gear	Other	Percent[2]	Corrected Expenditures[3]	Individual Totals
1	$ -	$ 20.00	$ -	-	50%	$ -	$ 20.00
2	2.00	125.00	25.00	-	90	22.50	149.50
3	-	100.00	10.00	-	25	2.50	102.50
4	200.00	100.00	20.00	-	50	10.00	310.00
5	-	46.20	100.00	-	75	75.00	121.20
6	-	54.00	30.00	-	80	24.00	78.00
7	49.00	6.00	55.00	-	75	41.25	96.25
8	-	5.00	30.00	-	75	22.50	27.50
9	-	20.00	10.00	-	90	9.00	29.00
10	-	10.00	15.00	-	75	11.25	21.25
11	-	120.00	20.00	-	75	15.00	135.00
12	50.00	25.00	20.00	-	15	3.00	78.00
13	-	-	-	-	10	-	-
14	-	20.00	50.00	-	50	25.00	45.00
15	-	2.00	2.00	-	25	.50	2.50

TABLE 4-9 - CONTINUED

Questionnaire	Food and Lodging	Transport	Fishing Gear	Other	Percent[2]	Corrected Expenditures[3]	Individual Totals
16	$ 5.00	$ 3.00	$ 2.00	$ -	10%	$ .20	$ 8.20
17	5.00	3.00	10.00	-	50	5.00	13.00
18	-	-	20.00	-	90	18.00	18.00
19	40.00	20.00	30.00	-	40	12.00	72.00
20	5.00	5.00	10.00	-	10	1.00	11.00
21	-	25.00	35.00	-	80	28.00	53.00
22	100.00	-	25.00	-	75	18.75	118.75
23	-	20.00	5.00	-	30	1.50	21.50
24	5.00	5.00	5.00	-	50	2.50	12.50
25	-	20.00	35.00	-	100	35.00	55.00
26	50.00	204.00	15.00	-	100	15.00	269.00
27	-	25.00	65.00	-	60	39.00	64.00
28	5.00	72.00	50.00	-	20	10.00	87.00
29	-	75.00	100.00	-	75	75.00	150.00
30	-	3.00	165.00	400.00[1]	67	110.60	113.60
31	-	20.00	25.00	-	75	18.75	38.75

TABLE 4-9 - CONTINUED

Questionnaire	Food and Lodging	Transport	Fishing Gear	Other	Percent[2]	Corrected Expenditures[3]	Individual Totals
32	$ 2.00	$120.00	$ 30.00	$ -	75%	$ 22.50	$144.50
33	20.00	172.80	50.00	-	100	50.00	242.80
34	-	125.00	35.00	-	100	35.00	160.00
35	-	13.00	13.00	-	100	13.00	26.00
36	-	15.00	20.00	-	50	10.00	25.00
37	-	50.00	40.00	-	90	36.00	86.00
38	2.00	8.00	15.00	-	60	9.00	19.00
39	-	34.00	20.00	-	100	20.00	54.00
40	-	150.00	90.00	-	10	9.00	159.00
41	-	67.20	100.00	-	75	75.00	142.00
42	-	25.00	100.00	-	80	80.00	105.00
43	-	15.00	30.00	-	80	24.00	39.00

TABLE 4-9 - CONTINUED

Questionnaire	Food and Lodging	Transport	Fishing Gear	Other	Percent[2]	Corrected Expenditures[3]	Individual Totals
44	$ -	$ 115.00	$ 50.00	-	75	$ 37.50	$152.00
45	-	48.00	13.00	-	100	13.00	61.00
46	-	10.00	20.00	-	15	3.00	13.00
TOTAL	$540.00	$2121.20		$400.00		$1088.80	$3750.00

1 - boat
2 - percent of total sport-fishing time spent on Souris
3 - includes sum of columns headed "fishing gear" and "other" corrected for above factor. (See text p. 44).

Game and Fish organization members spent an average of $38.24 on sport fishing. The range of expenditures was from nil to $375. For fishermen interviewed during the creel census, average expenditure was $81.52 with a range of nil to $310.

xii - Future use of the Sport-fishing Resource

Question #13 pertained to the future use of the fishing resource, given changing conditions. As such, results of this question are not in the scope of this study. A future report to the Souris River Basin Study Board will document the results of this question.

xiii - Preferred Options for Enhancing the Sport-fishery

In question #14, the respondent was asked to identify projects that would enhance sport-fishing opportunity on the Souris River, in their opinion. This information, along with field reconnaisance, has provided the basis for a report to the Study Board by J. F. O'Connor and J. D. Neilson. Projects identified by respondents interviewed during the creel census, Game and Fish members and students attending Grade 9 at Souris School are displayed in Table 4-10 below.

TABLE 4-10

PREFERRED MANAGEMENT OPTIONS
QUESTIONNAIRE RESPONDENTS

Project	Game and Fish	Creel Census	Souris School	Total
stocking - unspecified species	2	6	1	9

TABLE 4-10 - CONTINUED

Project	Game and Fish	Creel Census	Souris School	Total
stocking - walleye	3	3	4	10
stocking - pike	0	2	3	5
stocking - perch	1	0	2	3
stocking - trout	0	1	1	2
more fish	4	2	4	10
pollution abatement	4	3	2	9
water level stabilization	5	4	0	0
black fly control	9	0	0	9
coarse fish control	0	1	2	3
clean up debris in river	2	2	0	0
lengthen season	0	1	0	1
site improvement	0	2	3	5
large reservoir construction	0	1	0	1
increased education of young anglers	0	1	0	1
fish ladder at Wawanesa Dam	3	2	0	5
extension work regarding under-utilized species	0	1	0	1
small weir construction	0	1	0	1
international cooperation for improving sport fishery	0	2	0	2

TABLE 4-10 - CONTINUED

Project	Game and Fish	Creel Census	Souris School	Total
correction of sewage effluent situation at Wawanesa	2	2	0	4

In addition to what is presented above, eight individuals stated that they did not want to see any change.

xiv - Questionnaire Results from Souris School

Fourteen questionnaires were completed in February, 1976 by students of Grade 9 at the Souris School under the direction of their teacher, Mr. Phil Brown. These questionnaires are dealt with separately because the students were asked at the time to complete an earlier draft of the questionnaire. The final draft, as given out during the creel census and to members of the Game and Fish associations, is considerably more complete. Furthermore, expenditures, angling pressure and other parameters defined by the questionnaire are likely to be different for these young anglers.

From the fourteen returns, only one individual indicated that he did not fish. All respondents were male, and they indicated that they will go fishing 23 times on average, in a usual year. They will spend 2.96 hours fishing on average, and will catch about one fish every two hours. Although they indicated that they consider walleye and pike equally desirable, walleye are very rarely taken. With the exception of one young fisherman who must

travel ten miles to fish on the Souris, all of them fish locally. They estimated their annual sport-fishing expenses as falling in the $5-$10 range.

2 - The Creel Census

The creel census encompasses the period commencing May 15th, continuing through to August 15th. The reader is referred back to Figure 3-1 for details of the days worked. With only one exception, the work schedule generated by the method outlined in Chapter Three was followed throughout the summer. The exception referred to was that the researcher was under obligation to man a weigh-in station for the Souris Game and Fish Association. Important information regarding the fish stock of Oak Lake was gathered coincidentally. However, the Fish Derby fell on Sunday, June 27th, a day that was originally assigned as a creel census day. The alternate arrangement that was settled on meant that Saturday, June 26th was substituted as a creel census day.

As noted earlier in Chapter One, the angling season encompassed by the study period was abnormal in that record flows were recorded throughout the summer. This manifested itself upon the creel census in a negative fashion, as many of the angling sites that were to be included in the census were inaccessible. These sites were those above the town of Souris, where channel capacity is considerably lower than reaches of the river below Souris. These sites remained inaccessible, at least in part, until the end of

June.

Hence, the circuit was in a continuous state of flux as new angling sites opened up and the census was expanded to accommodate them. General impressions of anglers were that this year was an unusually good one for fishing. This is attributable, at least in part, to the ability of upstream migrants to circumvent the Wawanesa PFRA dam (the most formidable barrier to upstream migration) and move into the upper reaches of the river.

A reliable group of personal contacts gave the researchers up-to-the-minute information when new angling sites became accessible as the flood waters receded. Furthermore, in addition to this information, regular reconnaissance of the angling sites were made.

Eventually all anticipated angling sites became productive as fishermen moved in. As an aside, it was amazing to observe the "grapevine" between anglers of the study area in operation. For example, it was not unusual to drive by an angling site with only one fisherman occupying it, and repeat the operation the following day at the same time only to find some ten to fifteen anglers at the site simply because they had heard that the individual fishing on the preceding day had had some luck. Equally impressive was the drop in attendance at each site as anglers felt it had become unproductive.

Prior to all angling sites becoming accessible, the researcher maintained his pre-determined work regimen, only with increased surveillance of those sites that were

available. By the end of June, the creel census circuit included those sites shown on Figure 1-2. This was the final form of the creel census circuit.

During the study period, 519 anglers were interviewed and data was collected with respect to angler origin, angling pressure and success. This information is presented and analyzed in the following pages. With the kind consent of the Department of Renewable Resources and Transportation Services, Province of Manitoba, the researcher was able to attend a week-long workshop on statistical methods as applied to creel censuses. The workshop was conducted by Dr. Dave Bowden, University of Colorado. In the following pages, formulae presented in the workshop are utilized extensively in arriving at statements of data reliability. Where they are used, the formula or equation is cited as: Dr. D. Bowden - personal communication.

i - Estimation of Angling Pressure

Although it was originally intended that angling pressure estimates be stratified by month, it was found that stratification into "early summer' and "late summer" estimates was more useful. The division of creel census results is shown on Table 4-11 on the following page. The rationale behind such a division is clear-cut. Up to June 24th, anglers wishing to fish in the Coulter Bridge area were precluded from doing so by flooded conditions. Only after June 24th were stream flow conditions flow

enough to permit intensive use of the river banks for sport fishing. Once this area opened up, the site experienced heavy angling pressure as it is close to the population centres of Melita, Coulter, Pierson, Lyleton, Waskada and Deloraine. Hence, daily angler counts were

TABLE 4-11

DAILY ANGLER COUNTS DURING CREEL CENSUS

Month	Weekends	Weekdays
May	19 anglers	7 anglers
	12	3
	24	7
		Early Summer
June	12	4
	13	8
	7	8
		2
		6
	24	25
July	34	20
	19	14
	20	7
	17	23
		10
		Late Summer
August	46	5
	27	20
	19	7

inflated accordingly. Inclusion of angling pressure estimates for the creel census days falling on the 26th and 29th of June would have introduced considerable variance to the overall June estimate.

The possibility that stratification with respect to weather conditions would lead to further reduction in variability was explored. However, angling pressure variation estimates did not decrease appreciably with this method.

A further source of variance is the occasional group of picnickers who decide they want to make a day trip for fishing, usually in a group of 4-10 people. Of course, the inclusion of such parties in the estimate of average daily angling pressure leads to inflated results for that day. However, they cannot be ignored as such groups contribute significantly to the overall angling pressure exerted on the resource.

The data presented in Table 4-11 represent the number of anglers encountered per creel census circuit. In cases where more than one visit was made to each angling site, an average was calculated. Based on this information, angling estimates are now calculated for

1. Weekend, early summer
2. Weekday, early summer
3. Weekend, late summer
4. Weekday, late summer

Let the mean of weekend early summer angler counts be $\bar{y}_{i,es,wd}$. As noted earlier, the total count obtained in a single circuit multiplied by the length of the interval becomes an unbiased estimate of angler/hours within the interval. If, in turn, the daily estimate is multiplied

by the number of weekend days and statutory holidays within the time segment, an estimate is obtained for the period. This is done below:

$$\bar{y}_{i,es,we} = 14.5$$

$$N_{es,we} = 13$$

$$K_{es,we} = 14$$

where

$N_{es,we}$ = number of weekend days and statutory holidays within early summer

$K_{es,we}$ = length of angling day

Hence, an unbiased estimate of weekend angling pressure during the "early summer" is:

$$E_{es,we} = (N_{es,we}) \times (K_{es,we}) \times (\bar{y}_{i,es,we})$$

$$= 2600 \text{ angler/hours}$$

Similarly, an unbiased estimate of weekday angling pressure can be obtained:

$$\hat{E}_{es,wd} = (29) \times (12) \times (5.63)$$

$$= 2\bar{0}00^{*} \text{ angler/hours}$$

Note that the length of the angling day, from experience in the field, is only 12 hours for the weekdays, compared to 14 for weekend days.

Having derived both weekend and weekday angling pressure estimates, it is a simple matter to combine them for an estimate of total angling pressure during the

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* The bar over the zero indicates last significant zero.

"early summer"

$$E_{es,total} = (E_{es,we}) + (E_{es,wd})$$

$$= 4600 \text{ angler/hours}$$

It remains to attach some measure of reliability to this piece of information. It must be remembered that since the creel census was based on an instantaneous count technique, estimates of variance will reflect this fact. The equation given below produces an <u>overestimate</u> of variance associated with data obtained from instantaneous counts: (Dr. D. Bowden - personal communication)

$$\text{Variance}_{\text{sample}}^{\text{instantaneous}} = N^2K^2\left(\frac{s^2_{y_i}}{n}\right)$$

where:

s^2 = variance within sample

N = number of days to be sampled from

n = number of creel census days

y_i = mean of daily counts

K = length of interval (hours in angling day)

The above equation is now employed to measure the variance within early summer weekend days.

$$s^2_{es,we} = N^2_{es,we} \times K^2_{es,we}\left(\frac{s^2_{y_{i,es,we}}}{n}\right)$$

[1]

where: $y_{i,es,we} = 14.5$

$s = 36.3$
$K = 14.0$
$N = 13.0$
$n = 6.0$

$s^2_{es,we} = 3,100,000$

Similarly, an estimate for variance with respect to early summer weekdays may be obtained from equation 1 utilizing the following data:

$$y_{i,es,wd} = 5.63$$

$$s = 5.41$$
$$K = 12.0$$
$$N = 29.0$$
$$n = 8.0$$

Hence:

$$s^2_{es,wd} = 461,000$$

To obtain a variance estimate for the entire early summer period, the two variance estimates may be added:

$$s^2_{es} = 3,570,000$$

The standard error is the square root of the variance. Hence, $S.E._{es} = 1890$.

It is possible to describe a confidence interval for the estimate of angling pressure that has been obtained. The following expression from Larkin (1975), describes the appropriate confidence interval:

$$\bar{x} + t_{\alpha/2,\ df=n-1}(s_{es}) < M < \bar{x} - t_{\alpha/2,df=n-1}(s_{es})$$ 2

where $t_{/2,df=n-1}$ is the value of t at the confidence level chosen (90%) for the appropriate number of degrees of freedom (n - 1). In this case, degrees of freedom = 13 and the t value = 1.771. Hence, the confidence interval for the early summer angling pressure estimate is given by the following expression:

$$1250 < M < 7950$$

Late Summer

Repeating the procedure for estimation of angling pressure using late summer data, the following data is generated:

$$E_{ls,we} = 6200$$

$$E_{ls,wd} = 6100$$

$$E_{ls} = 12,300 \text{ angler/hours}$$

Applying equation 1 to late summer data, the following data is generated:

$$s^2_{ls,we} = 23,800,000$$

$$s^2_{ls,wd} = 16,600,000$$

$$s^2_{ls} = 40,000,000, \text{ therefore } S.E._{ls} = 6360.$$

Applying equation 2 to the preceding data, degrees of freedom = 15, the following expression is obtained:

$$1200 < M < 23,400$$

This is the confidence interval for the late summer angling pressure estimate.

ii - Estimation of Catch-per-Unit Effort

In this section, estimates of angler success for both weekends and weekdays are calculated. In addition, estimates of angler success are calculated using fish kept. This, of course, will lead naturally into the next section dealing with harvest. An important assumption to note at this point is that all fish returned to the water by anglers

survive.

Estimates of angler success based on fish caught are now computed. Bowden (personal communication) notes that an estimate of the catch per unit effort ratio (R) is given by total catch/total hours. The weekend estimate for the Souris River is R = .60. Given this ratio, the equation for determining the reliability of the estimate is given as: (Bowden - personal communication)

$$\text{Standard Error } (\hat{R}) = \sqrt{\frac{N-n}{N\bar{x}^2} \cdot \left(\frac{\sum(y_i)^2 + R^2\sum(x_i)^2 - 2R\sum x_i y_i}{n(n-1)} \right)}$$

3

where: (weekends)

$N = 30$

$n = 13$

$\sum x^2_i = 27{,}230$

$\sum y^2_i = 9{,}160$

$\sum x_i y_i = 15{,}020$

$\bar{x}^2 = 1{,}575.48$

TABLE 4-12

ANGLING SUCCESS OF FISHERMEN ENCOUNTERED IN CREEL CENSUS

Weekend			Weekdays		
Hours fished	caught	kept	Hours fished	caught	kept
81	172	33	13	18	7
49	39	18	3	3	1
47	35	22	16	5	2

TABLE 4-12 - CONTINUED

Weekend			Weekdays		
Hours fished	caught	kept	Hours fished	caught	kept
16	8	5	5	4	4
13	1	1	8	2	0
7	11	11	10	2	1
37	15	11	2	0	0
95	35	35	6	8	8
29	20	14	51	19	19
21	23	22	25	23	23
52	26	23	18	11	11
62	42	38	12	9	9
39	25	23	23	12	9
49	28	25	12	7	4
			5	0	0
			43	20	15
			8	8	8

Applying those figures listed above to equation 3, generates a standard error for the ratio = .05. Using data from the weekdays section of Table 4-12, an estimate of .59 for catch per hour is derived. Applying equation 3 to data obtained during the weekdays indicates a standard error of the ratio = 0.07.

One qualification with respect to the above calculations is that catch per unit effort statistics for the first weekend day shown in Table 4-12 is not included. The reason for this is that these statistics were obtained on May 16th for a tributary called Plum Creek. This tributary is an important spawning channel for nothern pike. However, for some reason, upstream migrants concentrated below a culvert at the Highway #2 Bridge near the town of Souris. Anglers were quick to notice this

fact, and enjoyed unusual success accordingly. As statistics obtained on this particular day were not representative of the situation at large, it was decided to ignore them.

The same statistics as calculated above using fish caught, are now computed using fish kept. Estimates of success using these data are .54 and .47, for weekends and weekdays respectively. Calculated standard errors of the ratio are .05 and .06 for weekend days and weekdays respectively.

Weighting the two estimates on the basis of number of weekend days and weekdays in the study period, a catch per unit effort estimate is equal to 0.49 (fish kept). The standard error of the estimate is close to 0.05.

iii - Harvest Estimates

From preceding sections dealing with angling pressure, it has been determined that estimates of angling pressure for the "early summer" interval and the "late summer" interval are 4600 and 12,300 angler/hours, respectively. Combining the two estimates, an estimate for the entire study period is given as 16,900 angler/hours.

In an analogous fashion, it may be shown that the standard error associated with the above estimate is 6640.

Given the information computed over the last two sections, it is now possible to make an estimate of the harvest (total number of fish retained by anglers, assuming

released fish suffered no mortality). An estimate of the harvest is given by: (C.U.E.) x (# of angler/hours). In this case, the harvest estimate is 16,900) x (.49) = 8280 fish. Given this estimate, Bowden (personal communication) notes that the following equation gives an estimate of the variability associated with the estimate:

$$S.E.(\hat{n}\hat{\theta}) = \sqrt{\hat{\theta}^2 (SE[\hat{n}])^2 + (\hat{n})^2 (SE(\theta)^2 - (SE[\theta])^2 (SE[\hat{n}])^2} \quad (4)$$

where $\hat{\theta} = 0.49$ (catch per unit effort

$\hat{\theta}^2 = 0.24$

$SE\ \hat{\theta} = 0.05$

$SE\ \hat{\theta}^2 = 0.0025$

$\hat{n} = 16,900$

$\hat{n}^2 = 286,000,000$

$SE\ \hat{n} = 6640$

$SE\ \hat{n}^2 = 44,000,000$

Solving equation 4 using the above data yields a figure of 3300 as an overestimate of the standard error of the product of angler hours times catch per unit effort. Inserting the standard error estimate into equation 2, the following confidence interval is derived: ($\alpha = .10$, degrees of freedom = 30)

$$2670 < M < 13,900$$

During creel census circuits, interviewed anglers had caught and kept a total of 402 fish. Three hundred and sixty-two of these were Northern Pike, 34 were walleye, six

were Yellow Perch, and two were saugers. Average weight by species is shown in the table below.

TABLE 4-13

AVERAGE WEIGHT OF FISH, BY SPECIES

	N. Pike (50)	Walleye (30)	Perch (6)	Sauger (2)
$\bar{x}$	796 grams	861	260	411
Standard Deviation	474	508	164	100
Range	255-2523	113-2155	113-567	340-482

The number bracketed after the species name is the number of fish in the sample.

Given that the estimate of total harvest for the study period was 8280 fish and the observed proportion of species caught during the creel census, the estimate for total Northern Pike caught during the study period is 7456. Given the average weight of pike displayed in Table 4-13, biomass harvested is 5935 kilograms. Similarly, total walleye taken during the study period is 700, representing a harvest of 603 kilograms. An estimated 124 perch were taken during the study period, accounting for 32 kilograms. Finally, 41 sauger were taken, representing a harvest of 17 kilograms. Total biomass harvested during the study period is 6587 kilograms. It is stressed that this figure represents an estimate at best, given the variability associated with the total harvest figure and the average weights of the species.

iv - Angler Origin

Reference to Table 4-13 on the following page will reveal angler origins with respect to the angling site

visited. The angling site at Coulter Bridge sustained the heaviest angling pressure. This is perhaps attributable to the fact that the location is one of the few sites in the extreme south-western corner of Manitoba that is amenable to sport-fishing.

TABLE 4-14

ANGLER ORIGIN

FISHING SITE / ORIGIN	Coulter Bridge	Coulter Park	Lauder Bridge	Melita #1 Dam	Melita #2 Dam	Melita	Plum Creek	Souris Dam	Victoria Park	Elbow	Wawanesa Dam
Alexander	-	-	-	-	-	-	5	-	-	-	-
Boissevain	1	-	1	-	1	-	-	-	-	-	-
Brandon	1	3	-	5	-	-	16	6	1	3	45
Coulter	5	17	-	1	-	-	-	-	-	-	-
Deloraine	59	-	-	-	2	-	-	-	-	-	-
Dominion City	-	-	-	-	-	-	-	-	-	-	1
Dunrea	-	-	-	-	-	-	3	-	-	-	-
Elgin	-	-	1	-	-	-	-	-	-	-	-
Glenboro	-	-	-	-	-	-	-	-	-	-	5
Goodlands	3	-	-	-	-	-	-	-	-	-	-
Hartney	-	-	2	-	-	-	-	-	-	-	-
Hilton	-	-	-	-	-	-	-	-	-	-	1
Killarney	-	-	-	-	-	-	-	-	-	-	1
Lauder	-	-	7	-	-	-	-	-	-	-	-
Lyleton	3	-	-	-	-	-	-	-	-	-	-

TABLE 4-14 - CONTINUED

FISHING SITE / ORIGIN	Coulter Bridge	Coulter Park	Lauder Bridge	Melita #1 Dam	Melita #2 Dam	Melita	Plum Creek	Souris Dam	Victoria Park	Elbow	Wawanesa Dam
Melita	33	28	1	13	1	15	1	-	-	-	-
Napinka	-	-	1	-	-	-	-	-	-	-	-
Ninette	-	-	-	-	-	-	-	-	-	-	4
Portage	-	-	-	-	-	-	2	-	-	-	-
Pierson	18	8	-	3	-	-	-	-	-	-	-
Shilo	-	-	-	-	-	-	-	-	-	-	14
Souris	1	-	-	-	-	-	48	13	11	-	-
Stockton	-	-	-	-	-	-	-	-	-	-	1
Tilston	1	-	-	-	-	-	-	-	-	-	-
Waskada	39	-	1	-	-	-	-	-	-	-	-
Wawanesa	-	-	-	-	-	-	-	-	-	2	37
Winnipeg	-	2	-	-	-	-	-	1	-	-	2
Out of Manitoba	3	-	-	11	-	3	1	1	-	-	-
TOTALS	167	58	14	33	4	18	76	21	12	5	111

The Wawanesa Dam was the second most frequently visited site on the circuit. Even though this locale competes with other angling sites not on the Souris, it draws anglers from a large area. The probable explanation for this is that the site is the only angling location on the Souris that consistently produces walleye.

The Plum Creek site, although avidly fished when fish were available, was of ephemereal importance. As noted earlier, anglers from a large area converged on this site in May when few other locations were available.

It is likely that on a more typical year the Plum Creek angling site will not support as many anglers. Furthermore, it was noted that channel dredging operations downstream from the site will likely reduce the size of the pool that previously fish had congregated in before attempting to proceed upstream.

Only 19 anglers stated that they originated from outside the province. Invariably, all anglers stated that angling opportunity supplied by the Souris River was incidental to them taking the trip.

v - The Valuation of the Resource

On the following pages, the travel-cost approach to determining the value of the sport-fishing resource is applied. The southern portion of the creel census including Melita Dam #1 and #2, Melita, Coulter Park and Coulter Bridge were used in this determination. For determining the distance travelled, the approximate geographic centre of the area (Melita #1 Dam Site) was used as the common destination. The area described seemed an appropriate one to choose, as a disproportionate amount of the total angling pressure exerted on the study area takes place there. Furthermore, angling opportunities apart from those supplied by the Souris River, are almost nil. If there

were other angling sites available, the demand curve shown in Figure 4-1 would be considerably distorted.

Using information gathered during the creel census, and population counts from preliminary information from the 1976 Statistics Canada along with information from publications of the Department of Industry and Commerce, Government of Manitoba (see References Cited), the number of trips or visitations per one thousand population of town of origin is computed. The data generated is then compared to travel cost information.

The travel cost data assumes a cost of 10¢ a mile. (Spargo [1971] used 10¢ a mile in his study of the Margaree River sport fishery, in Nova Scotia.) The travel cost rate is based on the variable costs associated with operating the vehicle in order to pursue recreation. Variable costs include gas, oil, wear and maintenance. Apart from the problem of determining "average" wear and maintenance intervals, those constituents listed above are reasonably easy to quantify. Other constituents of total travel cost, such as the time cost, are not so easy to ascertain. Since time costs are the opportunity costs of time spent in travel, they will vary greatly for each individual. Moreover, travel costs for individual fishermen would depend on how many anglers came in the car. Therefore, it would seem that there are great data requirements to accurately determine the travel-cost rate. A round trip is assumed in all cases.

TABLE 4-15

TRAVEL COSTS AND VISITATION RATES

Origin	ln trips/thousand	travel costs ($)
Boissevain	.29	11.00
Hartney	1.65	9.40
Tilston	2.63	6.20
Lyleton	3.58	3.00
Deloraine	4.11	6.00
Melita	4.39	2.40
Pierson	4.85	2.80
Waskada	5.09	2.80

The correlation coefficient (r) for the two sets of data presented above is -.93, significant at the 95% level of confidence (d.f.= n-2 = 6). Using the displayed data points, a semi-logarithmic curve fit using the least-squares method is obtained. The y axis intercept is computed as 11.53, and the slope is -1.83. The curve fit is shown on Figure 4-1, on the following page. The equation of the line is given by:

$$y = (-1.83)\ln x + 11.53 \qquad \text{5}$$

The general form of equation 5 is $y = a\ln x + b$, and the integration of this is given by:

$$\int_c^d y\,dx = (a \cdot \ln x - x + bx)\Big|_c^d$$

inserting the limits of integration:

$$= ad\cdot\ln(d) - d\cdot bd - ac\ln(c) + c - bc \qquad \text{6}$$

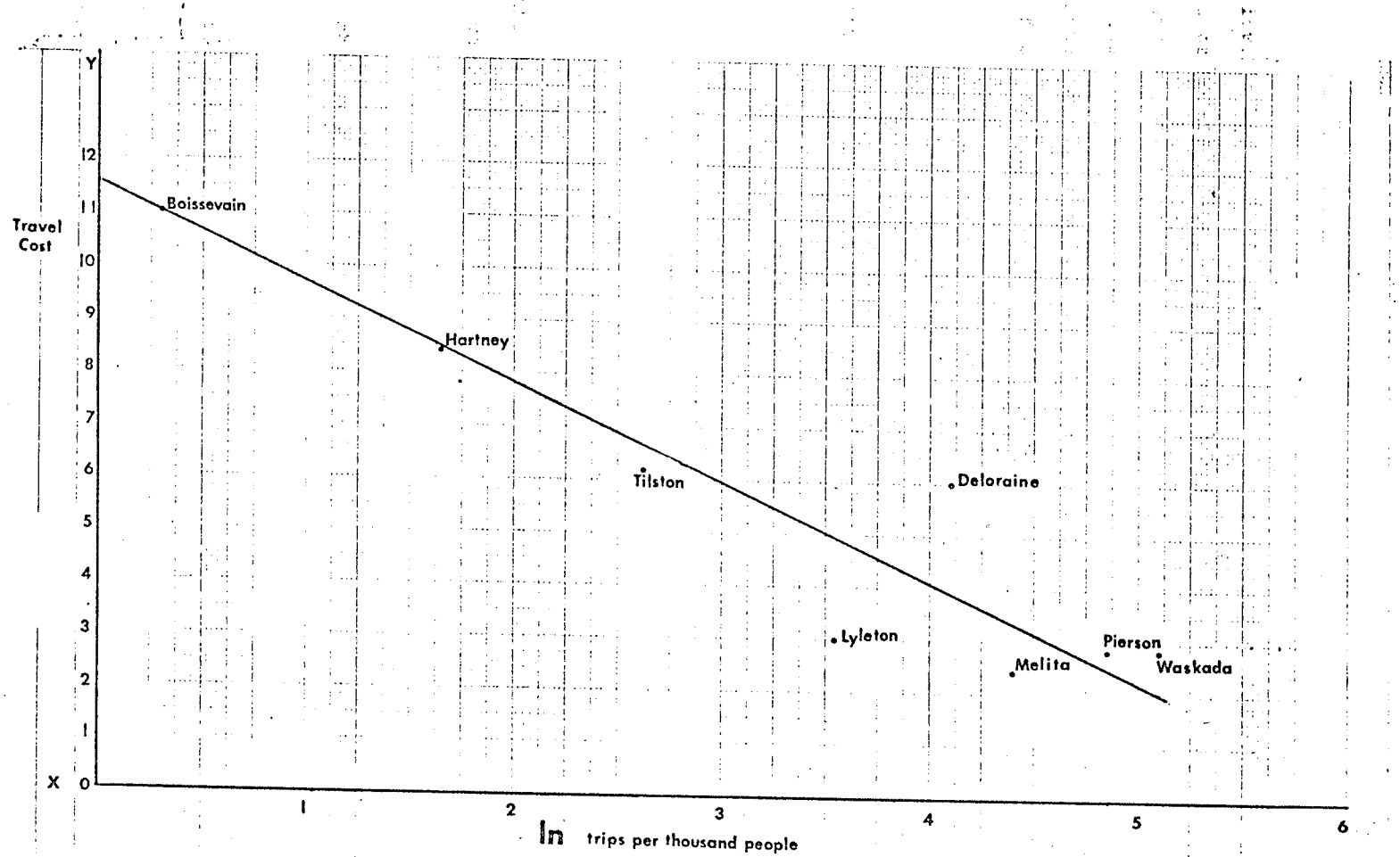
Choosing the limits of integration as 5.09 and 0.29, the definite integral is now calculated using equation 6. A value of $3529.86 is obtained. This, however, is the valuation of the sport-fishing resource for those eight towns shown on Figure 4-1. The total population of those eight towns is 4809, whereas the Basin population is given as 17,593. (Anonymous 1975, 1976). Multiplying by the appropriate factor, the valuation of the sport-fishing resource by the entire Basin population is $12,913.46. This is a valuation for the length of the study period only. (Benefits per angler/hour equal 76¢).

Having applied the travel-cost technique, the gross expenditure method of valuation is now dealt with. Members of Game and Fish organizations indicated on Table 4-8 that their total expenditures attributable to the Souris River sports fishery amounted to $1911.93. They also stated they exerted a total angling pressure of 2427 angler/hours. Using the benefits equals gross expenditures approach, this means a benefit of .79¢ per angler/hour. Multiplying this figure times the estimation of angling pressure exerted on the entire system during the study period yields $13,400.

The technique described in the last paragraph can also be extended to information provided in questionnaires completed by anglers during the creel census. Benefits are equal to 96¢ per angler/hour. Using this information (see Tables 4-5 and 4-9 for angling pressure and gross

TRAVEL COST VS ANGLING TRIPS
PER 1000 POPULATION

Figure 4-1



expenditures respectively), an estimation of benefits is $16,200.

vi - Aerial Survey Results

The purpose of the flights was to determine the extent to which anglers confined themselves to those locations included in the ground survey.

TABLE 4-16

SUMMARY OF AERIAL SURVEY RESULTS

Date of Flight	Inside Creel Census Circuit	Outside Creel Census Circuit
July 11th	52 anglers	11
August 1st	54 "	10
September 11th	6 "	3

Weather conditions on all flights were the same; it was excellent weather for fishing. Sunny skies and moderate temperatures prevailed. Anglers spotted inside the creel census circuit would have been recorded by the ground census whereas anglers outside the circuit would not.

CHAPTER FIVE

Conclusions

It is significant to note that anglers in the 46-55 and > 55 years old age categories form the bulk of fishermen who responded to the questionnaire. Should any improvements be made to the sport-fishery, consideration should be given to this fact. Reduction of stream bank grade to ease access for elderly anglers is one option that could be considered.

Although the average age of anglers in the Souris Basin would seem to be relatively old, there is no reason to expect angling pressure on the Souris River to decrease in the future. Population projections indicate that the 45-54 year old category will decline by one or two percent, while the 55+ category will grow by two or three percent. At present, the 45-54 category comprises approximately 10 percent of the total basin population, whereas the 55+ category comprises about 30 percent (Dr. H. D. Schellenberg, personal communication). This information, plus the likli-hood of increased leisure time, indicate the probability of increased angling pressure on the Souris River in the future.

Peak months for fishing on the Souris River are from May through August, with very little fishing attempted after freeze-up. Only two locations were identified by respondents as areas that supported ice-fishing. The first and probably most important site is at the Souris Bend Wildlife Management Area, also referred to as the Elbow in this study. The second site is just north of the Canada-United States border where one respondent noted that the ice was not strong enough to support his car.

Anglers noted that they spend, on average, about three and one-half hours per fishing trip. The estimate, however, varies widely from angler to angler.

The game species walleye and northern pike enjoyed roughly equal status in the eyes of fishermen. More anglers preferred walleye as their first choice whereas more anglers preferred pike as their second choice.

Anglers indicated that northern pike made up the bulk of game fish caught on the Souris River. The creel census would corroborate this piece of information; approximately 95% of game fish caught were pike. The angling site at Wawanesa, particularly during the months of June and July, was a consistent walleye producer. In fact, at only one other site (Coulter Bridge) was walleye ever recorded this summer.

Key angling areas identified by questionnaire respondents did not always support intense angling pressure in 1976. This was due to the unusually high water conditions.

Stop-log dams that in a normal year would provide a fishing site in normal years with the stop-logs in, were left open throughout the study period.

It is interesting to note that the Game and Fish members took part in significantly fewer angling trips than did fishermen encountered during the creel census. Correspondingly, Game and Fish members spent less money to fish on the Souris. However, because Game and Fish members almost invariably lived near the river, their average transportation costs were much greater than fishermen interviewed during the creel census circuit.

One management option suggested by Game and Fish members deserves further comment. During the meeting in Hartney, one rather vocal member complained about black fly problem while fishing. Other members agreed, and not surprisingly this method of enhancing the sports fishery appeared no less than nine times in completed questionnaires. At no other time was this problem brought to the researcher's attention.

The estimate of angling pressure for the study period was computed as 16,900 angler/hours. The variance associated with this estimate is not due to the census design or the execution of it. The variation would seem to be inherent in the fishery and may be due to:

1. Abnormal nature of the fishery this year, with angling sites being available and/or productive only part of the time,

2. A large proportion of anglers interviewed were farmers with definite patterns to their time allocated to work, which would be reflected in the amount of time they have available for sport-fishing.

The catch per unit effort statistic is more precise because it is based on non-instantaneous counts. Harvest figures have a lesser precision because there is an instantaneous element incorporated in them.

The Souris River sport fishery is a resident sport fishery only. Indeed there were some anglers who indicated that their homes were outside the Souris Basin, but invariably they added that the reason that they made the trip was not the angling opportunity afforded by the Souris River. Although some personal contacts suggested that North Dakotans may cross the border to fish in the Coulter area, there is no evidence to support this possibility.

The valuation by the gross expenditure approach and the travel-cost technique is remarkably close. This may be coincidence, as each method has a number of inherent assumptions that make the application bound with qualification. Of the two approaches, the gross expenditures method is preferred because of its relatively defensible theory and its easy application. Its overall utility is perhaps enhanced by the modification suggested in this paper, where a correction factor incorporating the percentage of total angling time attributable to the Souris River is included in the calculations.

Whatever valuation is used, it must be remembered that the estimate of benefits presented in this study are for the period commencing May 15th and concluding August 15th, only.

Furthermore, it is likely that the valuation by the two techniques underestimated the real value of the sports-fishery to the people who use it. There are three reasons for this. The first has already been explained, that the study period encompassed only a fraction of the angling season. An estimate of the completeness would be 75 percent. Secondly, the techniques employed do not take into account the fact that there are very few competing interests for the recreationists' leisure time in this area. In other words, if there was no further opportunity for sport-fishing on the Souris River, there would be few alternatives left to the would-be angler. In view of the fact that many of the interviewed fishermen were retired and devoted considerable amounts of their time to angling, this is a serious consideration and one which is not apparent in the overall valuation. Finally, the Souris sport-fishery is a resident only sport-fishery. Hence, any valuation incorporating costs of transportation to and from the fishing site will understate the benefits.

From the flights over the study area, an approximation of the completeness of coverage for the ground circuit would be 80-90%. This would mean that the estimates of angling pressure and the valuation using the gross

expenditure approach would be understated by 10-20%.

Finally, it is perhaps of interest to discuss how the study might have been improved. It is possible that an aerial survey might be a more cost-effective approach to the census, but such a survey could not supply information on angler success, harvest or origins. However, some combination of flights and ground surveys might be able to supply the necessary information at less cost.

Given the nature of the fishery, with unstable water conditions and concommittant fluctuating habitat for fish, coupled with changing angling pressure throughout the river, a roving creel census is probably still the best design for the situation. If sport fishing conditions stabilize in the future, with angling opportunity uniform throughout the river, then a more simplified design for a creel census may be employed, with perhaps only a section of the fishery monitored at a given time. However, given present conditions, such a design is not practical.

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SOURIS RIVER SPORT FISHING QUESTIONNAIRE
(Your answers will be treated with strict confidence)

The purpose of this questionnaire is to help the Souris River Study Board gather data on the resources in your area in light of recently proposed projects. The objective of this particular study is to learn more about the value of sport fishing in the Souris River and thus enable us to better plan our management activities.

As a resident of this area, your contribution to this important study would be most appreciated.

1) Please print your name _____

and address (optional) _____

Do you belong to a fish and game organization? _____

2) Please indicate your age-group.

	Male	Female
under 18 years -	____	____
18 - 25 years -	____	____
26 - 35 years -	____	____
36 - 45 years -	____	____
45 - 55 years -	____	____
over 55 years -	____	____

3) Did you fish for sport in the Souris River at least once in the last year? _____ If not, where did you go for sport fishing?

_____

4) If yes, indicate approximately how many days (a day is all or any part of a day fished) in a month you would go fishing.

May	_____	September	_____	January	_____
June	_____	October	_____	February	_____
July	_____	November	_____	March	_____
August	_____	December	_____	April	_____

5) About how much time would you spend fishing on each trip? _____ hours.

6) How many miles do you travel from home to fish on the Souris? _____ miles. How many anglers travel in your car? _____

7) About how many fish, by species, do you catch (or release) in a given fishing trip falling in each of the months listed below:

	May		June		July	
	Caught	Released	Caught	Released	Caught	Released
Pike	____	____	____	____	____	____
Walleye	____	____	____	____	____	____
Perch	____	____	____	____	____	____
Bullhead	____	____	____	____	____	____
Others (specify)	____	____	____	____	____	____

	August		September		October	
	Caught	Released	Caught	Released	Caught	Released
Pike	____	____	____	____	____	____
Walleye	____	____	____	____	____	____
Perch	____	____	____	____	____	____
Bullhead	____	____	____	____	____	____
Others (specify)	____	____	____	____	____	____

	November		December		January	
	Caught	Released	Caught	Released	Caught	Released
Pike	____	____	____	____	____	____
Walleye	____	____	____	____	____	____
Perch	____	____	____	____	____	____
Bullhead	____	____	____	____	____	____
Others (specify)	____	____	____	____	____	____

	February		March		April	
	Caught	Released	Caught	Released	Caught	Released
Pike	____	____	____	____	____	____
Walleye	____	____	____	____	____	____
Perch	____	____	____	____	____	____
Bullhead	____	____	____	____	____	____
Others (specify)	____	____	____	____	____	____

8) From the species listed above, indicate what type you prefer to catch, in order of preference: 1) _____ 2) _____

3) _____ 4) _____

9) How often did you fish the Souris River in 1975? _____

_____ What percentage of your total angling time is spent sport fishing on the Souris River? _____

_____

10) Please indicate on the attached map where you do most of your fishing on the Souris River.

11) In view of other recreational opportunities available to you, both public and private, please place what you consider a fair dollar value on a days sport fishing on the Souris River_____

12) Please estimate the amount of money spent by you and your family on sport fishing in the Souris River in 1975 for each of the categories below.

FOOD AND LODGING:	Includes hotels, motels, campsite fees, restaurant meals, food brought from home and liquor	$_____
TRANSPORTATION:	Includes gasoline consumed in travelling to and from Souris River	$_____
FISHING GEAR:	Includes tackle, bait, waders, flies, etc.	$_____
OTHER:	Please list: _____	$_____
	_____	

13) Given the present sport fishing conditions, please predict how much time you will spend fishing the Souris River in the future, and how your fishing expenses will change.

TIME	Increase/decrease by	0%	20%	40%	60%	80%	100%
EXPENSES	Increase/decrease by	0%	20%	40%	60%	80%	100%

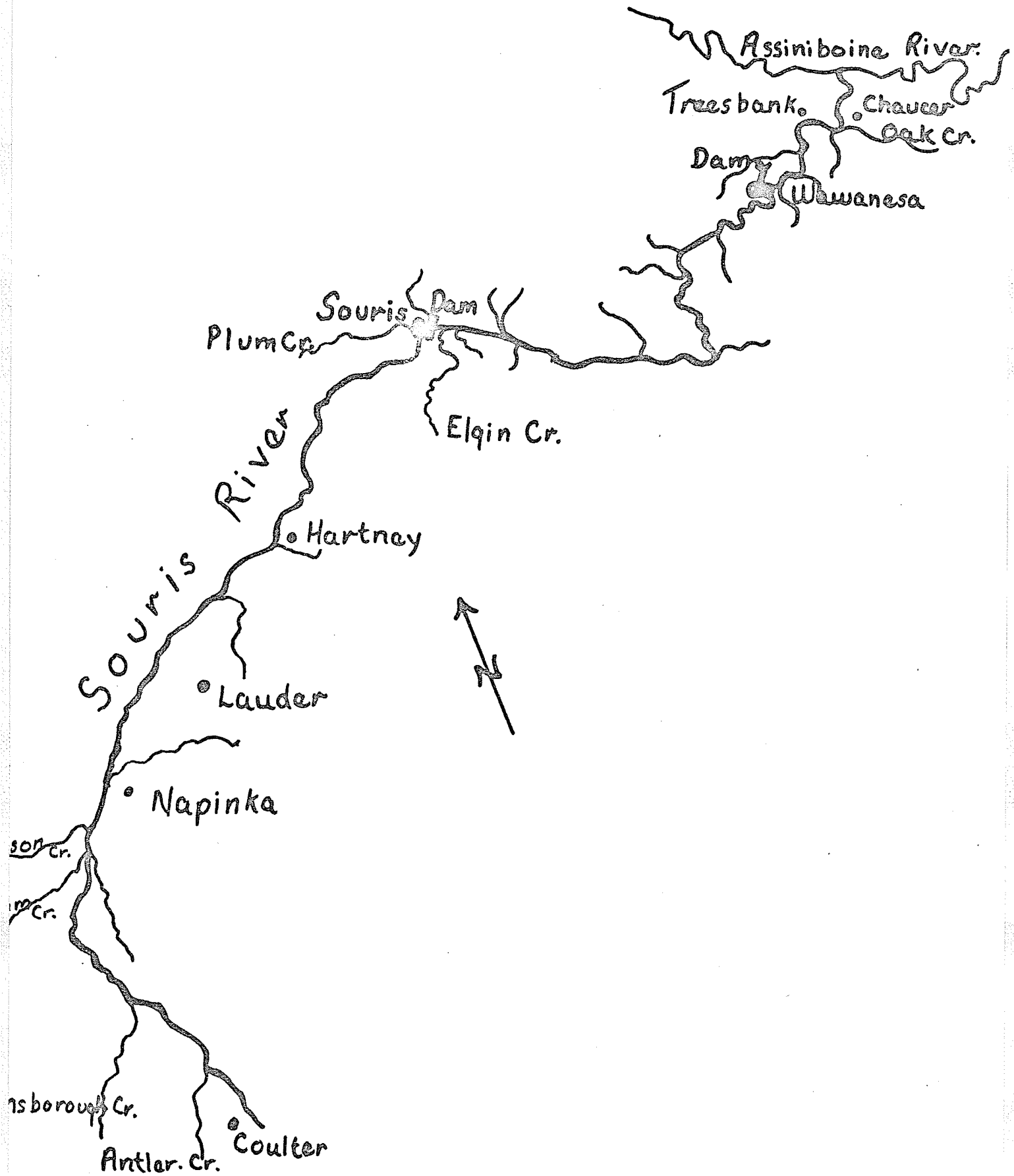
If sport fishing conditions were to decline, please indicate how you will spend your time and money (as above).

TIME	Increase/decrease by	0%	20%	40%	60%	80%	100%
EXPENSES	Increase/decrease by	0%	20%	40%	60%	80%	100%

If sport fishing conditions were to improve, please indicate how you will spend your time and money.

TIME	Increase/decrease by	0%	20%	40%	60%	80%	100%
EXPENSES	Increase/decrease by	0%	20%	40%	60%	80%	100%

14) What changes would you prefer in order that angling on the Souris River might be more pleasant and successful? Explain.


Assiniboine River
Treesbank
Chaucer
Oak Cr.
Dam
Wawanesa
Souris Dam
Plum Cr.
Elgin Cr.
Souris River
Hartney
Lauder
Napinka
son Cr.
m Cr.
nsborough Cr.
Antler Cr.
Coulter
N