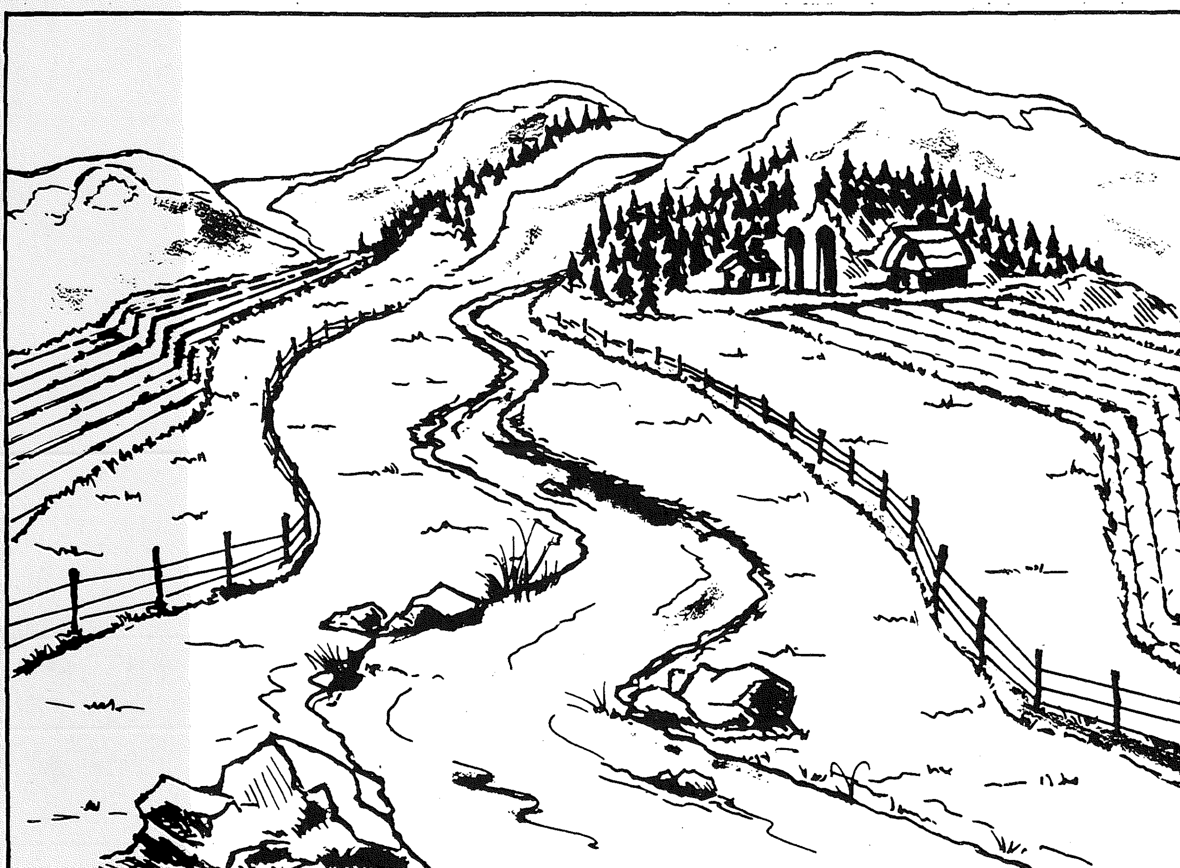
Special Publication
No. 148
May 1993



# Fisheries Management Planning Guide

# For Streams and Rivers





Division of Fish and Wildlife
Section of Fisheries

## TABLE OF CONTENTS

## PREFACE

This publication was prepared as a companion to the Lake Management Planning Guide (MDNR 1982). The purpose is to guide DNR Fisheries in the management of fish populations in the streams and rivers of Minnesota. The guide forms the basis for developing management plans for individual waters. The plans provide for an inventory of the resource, the establishment of management goals, identification of specific techniques that may be used, and evaluation of management efforts. The guide encourages flexibility and is designed to allow managers to reach sound decisions regarding management of the streams and rivers of Minnesota with the cooperation of other jurisdictions and interests.

I would like to express my sincere appreciation to the task force who made this guide possible. Members included Tim Brastrup, Henry Drewes, Mark Ebbers, Larry Gates, Mike Hayes, Steven Hirsch, Dennis Johnson, Rick Nelson, Dirk Peterson and William Thorn.

Thanks also to the office staff, Jack Wingate, Ron Payer and Charles Anderson, who reviewed this publication. I hope it will intensify fisheries management of streams and rivers in Minnesota, in cooperation with other jurisdictions that need to be strong partners in protecting the stream environment.

Jack Skrypek
Chief of the Fisheries Section
December 1992

# INTRODUCTION

Minnesota's stream and river resource is large and diverse. There are 15,000 mi of fishable streams, including 2,600 mi of designated trout water. The diversity and size of this resource make it necessary to have guidelines flexible enough to manage streams statewide (Waters 1977).

Until recent years, management of Minnesota's streams and rivers has been confined to trout streams. During the 1980's, interest in the management of cool and warmwater streams has developed in Minnesota and surrounding states. In 1988, the River and Stream Committee of the North Central Division of the American Fisheries Society was formed to transfer stream information and identify problems needing additional research.

The objectives of the stream management planning guide are similar to those established for the management of Minnesota lakes (MDNR 1982):

1) to provide guidelines for managing Minnesota's stream fish populations in a cost effective manner;
2) to provide program continuity;
3) to promote comprehensive management of Minnesota's stream resource; and
4) to integrate stream management information into an electronic data network.

## 1. OVERVIEW

Stream management planning requires an approach emphasizing habitat and community rather than the emphasis on key species described in the Lake Management Planning Guide (MDNR 1982). Warmwater stream community interactions are more diverse and less understood than those of coldwater streams. Watershed management is the most comprehensive approach to managing streams statewide. A flow chart for stream management planning is illustrated in Figure 1.

The stream management planning process begins by developing a planning priority list. Work plans should rank streams based on resource management significance.

The next step is to inventory the stream resource and develop goals. The Minnesota Stream Survey Manual (Sternberg 1978) instructs the collection of physical, chemical, and biological data. Creel/recreational use surveys describe the sport fishery and other recreational uses.

The stream survey identifies potential limiting factors for the fishery. Specific management goals address these factors. The manager then selects appropriate fish management techniques to achieve goals.

Stream management techniques fall in five general categories: habitat protection, habitat improvement, regulations, access development, and stocking. When developing a stream management plan, the manager will likely select techniques that focus on achieving goals.

A key component of stream management planning is evaluation. This step enables the fisheries manager to assess the effectiveness of management techniques in achieving goals. Evaluation may include redefining limiting factors, revising management goals, or selecting alternative management techniques.

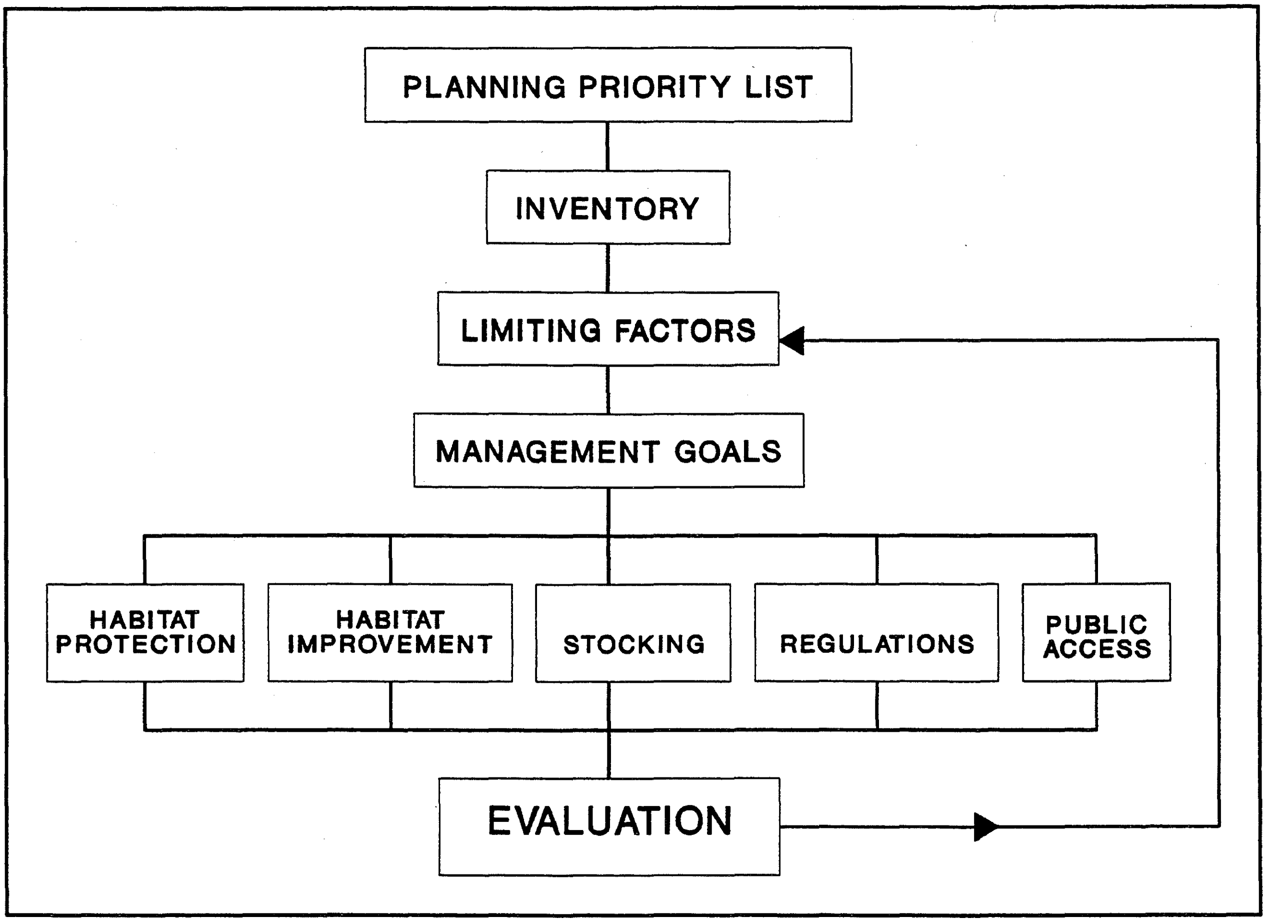



Figure 1. Flow chart for stream management planning.

## 2. PRIORITIZING STREAM MANAGEMENT PLANNING

Because most streams are within Regional boundaries, planning priorities should be developed at the Regional level. Stream order, angler use, and conflict potential are variables used in developing the planning priority list. Stream order is an indicator of fish community structure and diversity (Vannote et al. 1980). Watershed size can be substituted for stream order. Angler use is determined either directly from creel surveys or indirectly by observations. Conflict potential is a subjective index that assigns a rating to the level of activities that may degrade the stream resource. Sources of conflict may include water appropriation, logging, hydropower, mining, and municipal, agricultural, or industrial uses.

A conflict potential index involves the principal threat(s) to fish habitat. If no single area of conflict is dominant, a composite index may be necessary. For example, an agricultural region may use appropriations for irrigation as the primary threat. An indicator of conflict potential could be:

$$\text{Conflict Potential} = \frac{\text{Peak Permitted Appropriation}}{\text{Mean Annual Discharge}}$$

Once the range of values is developed, they are partitioned as low, moderate and extreme.

The formula to be used in establishing the planning priority number is:

Priority = Stream Order + Angler Use + Conflict Potential

Values for each of these categories are identified in Table 1.

Two priority lists should be developed within each Region: one for coldwater streams and one for warmwater streams. This is necessary because the priority ranking for trout streams will be biased due to the low stream order component.

Table 1. Values used to determine stream priority number.

| Stream Order | Value | Angler Use | Value | Conflict Potential | Value |
|---|---|---|---|---|---|
| 1-2 | 1 | Light | 1 | Low | 1 |
| 3-4 | 2 | Moderate | 2 | Moderate | 2 |
| $\geq$ 5 | 3 | Heavy | 3 | Extreme | 3 |

## 3. STREAM INVENTORY

The stream inventory collects physical, chemical, and biological data. Physical and chemical parameters include water quality, hydrologic records, stream morphology, and watershed characteristics. Biological parameters include fish, aquatic macrophytes, invertebrates, and riparian vegetation. Other important data are recreational and offstream uses.

### Stream survey and assessment

The Minnesota Stream Survey Manual (Sternberg 1978), Lake Superior Tributary Sampling Guide (Pitman and Wingate 1986), and other publications (e.g., Platts et al. 1983) describe survey and assessment techniques and procedures. Appropriate documents should be reviewed before starting the survey.

Stream survey and assessment frequency will vary according to the management priority. Population assessments monitor long term population trends and evaluate success of management.

### Creel/recreational use surveys

Creel surveys describe fishing pressure, catch rates, catch, harvest, fishing quality, and angler demographics; and help evaluate management projects.

Recreational use surveys describe the amount and types of recreation, and identify high use areas which need further study. Economic value of stream recreation can also be estimated from a recreational use survey.

Creel/recreational use surveys on streams can be roving or access based and will incorporate some form of stratified sampling.

Clerks in a roving creel move throughout a water body or defined section, making instantaneous or progressive counts and conducting complete or incomplete trip interviews. Clerks in an access based survey are stationed at a particular access or activity site, and count and interview anglers (complete trip) leaving the stream. The type of survey used depends on factors such as feasibility, number and location of access/activity sites, and distribution of angling pressure (Malvestuto 1983).

Stratified sampling involves partitioning the population into sub-populations. Stratification will reduce sampling variance if the sub-populations are internally more homogeneous than the population as a whole. Stream reach, day of week (weekday vs. weekend day/holiday), time of day, and time of year are commonly stratified.

Nonuniform probability surveys sample sampling stations with different frequency. Usually, higher use stations are sampled more often than lower use stations. Caution should be used when including a low use, low probability station in a non uniform probability creel because it may yield unreliable data.

Probabilities can be developed from past creel survey data or knowledgeable qualitative observations when no data or observations are available. If there is no information available, sampling with equal probabilities is recommended.

Fishery characteristics and management needs should be considered when deciding what to include in the creel survey interviews. All creel surveys will include questions regarding the length of time fished, and the numbers and sizes of each species caught and harvested. It is important to collect the numbers and sizes of each species released. Consider collecting the following additional information: aging structures, indices of fishing quality (e.g., Weithman and Anderson 1978; Weithman and Katti 1979; Wiechman 1990), species sought, angler techniques, and demographics. Creel surveys also may collect data for some species that are not sampled adequately by standard survey techniques.

Compared to lakes, few creel surveys have been done on streams in Minnesota. The basic methods employed on lakes can be used on streams; however, streams have unique characteristics that should be carefully addressed during survey design (Tureson 1978; Close and Siesennop 1984; Thorn 1984; Hirsch and Peterson 1987). Project managers should consult a qualified biometrician or other experienced persons.

# 4. DEVELOPING STREAM MANAGEMENT GOALS

The inventory will define limiting factors to formulate stream management goals.

## Limiting factors

To identify limiting factors, the fish manager must have a thorough understanding of the life history and habitat requirements of target species. Potential limiting factors and their sources may be identified by using Table 2. Once this process has been completed, the management plan can be developed. The plan should include specific strategies addressing those problems identified as limiting factors. The next five chapters outline the management techniques that can be used in achieving goals.

Fish habitat requirements can be divided into macrohabitat and microhabitat requirements. Macrohabitat includes temperature, dissolved oxygen, and stream discharge. Microhabitat includes current velocity, water depth, substrate, and cover. Some species or certain life stages of fish have very specific habitat requirements while others are ubiquitous.

Habitat Suitability Index (HSI) models are literature reviews of life histories and graphic representations of habitat suitability for key variables (Rosenthal 1985). The library of HSI models is more complete for coldwater than for warmwater species. Ongoing research in Minnesota and several other midwestern states is defining habitat requirements of important warmwater fish.

Water quality and quantity problems may be difficult to identify. Detailed water quality monitoring or site specific instream flow studies can identify these problems.

## Setting management goals

Stream management goals should reflect the biological potential of a stream, consider desired angling characteristics, and be specific and measurable. An example of a well defined long range goal would be: To provide a smallmouth bass fishery in similar reaches one and two with 500 fish/mi where 25% are >14 inches TL. Specific management goals may need to be developed for each similar reach.

Table 2. Checklist of water quality limiting factors.

Check all applicable categories and indicate Major or Minor in each category checked.

| A. LIMITING FACTOR (Water Quality) | Major | Minor |
|---|---|---|
| ___Temperature too high | ___ | ___ |
| ___Temperature too low | ___ | ___ |
| ___Turbidity | ___ | ___ |
| ___Salinity | ___ | ___ |
| ___Dissolved oxygen | ___ | ___ |
| ___Gas supersaturation | ___ | ___ |
| ___pH too acidic | ___ | ___ |
| ___pH too basic | ___ | ___ |
| ___Nutrient deficiency | ___ | ___ |
| ___Nutrient surplus | ___ | ___ |
| ___Toxic substances | ___ | ___ |
| ___Other (specify below) | | |
| ________________________ | ___ | ___ |

| B. PROBABLE SOURCE | Major | Minor |
|---|---|---|
| ___Point source discharge | ___ | ___ |
|     ___Industrial | ___ | ___ |
|     ___Municipal | ___ | ___ |
|     ___Combined sewer | ___ | ___ |
|     ___Mining | ___ | ___ |
| ___Nonpoint source discharge | ___ | ___ |
|     ___Urban runoff | ___ | ___ |
|     ___Landfill leachate | ___ | ___ |
|     ___Construction | ___ | ___ |
|     ___Agriculture | ___ | ___ |
|     ___Feedlot | ___ | ___ |
|     ___Silviculture/logging | ___ | ___ |
|     ___Mining | ___ | ___ |
|     ___Natural | ___ | ___ |
|     ___Unknown | ___ | ___ |
| ___Dam release | ___ | ___ |
| ___Individual sewage disposal | ___ | ___ |
| ___Other (specify below) | | |
| ________________________ | ___ | ___ |

Table 2. Checklist of water quality limiting factors (continued).

| C. LIMITING FACTOR (Water Quantity) | Major | Minor |
|---|---|---|
| ___Below optimum flows | ___ | ___ |
| ___Above optimum flows | ___ | ___ |
| ___Loss of flushing flows | ___ | ___ |
| ___Excessive flow fluctuation | ___ | ___ |
| ___Occasional low flow | ___ | ___ |
| ___Other (specify below) | | |
| ______________________ | ___ | ___ |

| D. PROBABLE SOURCE | Major | Minor |
|---|---|---|
| ___Dam (power) | ___ | ___ |
| ___Dam (flood control) | ___ | ___ |
| ___Dam (storage) | ___ | ___ |
| ___Diversion (agriculture) | ___ | ___ |
| ___Diversion (municipal) | ___ | ___ |
| ___Diversion (industrial) | ___ | ___ |
| ___Natural | ___ | ___ |
| ___Other (specify below) | ___ | ___ |
| ______________________ | ___ | ___ |

## 5. HABITAT PROTECTION

Stream habitat protection addresses water quality and quantity, riparian vegetation and watershed management, and maintenance of channel integrity. Habitat can be protected through watershed and corridor planning.

### Watershed planning

A stream reflects the nature and use of its watershed. Watershed planning is a proactive, long-term approach for protecting habitat. Short term results may not be measurable. When watershed uses degrade stream habitat, an interagency work group may be needed to address the problems.

To protect instream water quality and habitat, cooperation is needed with agencies and individuals that impact watershed activities. These groups may include: Soil Conservation Service (SCS), Soil and Water Conservation Districts (SWCD), watershed districts, local zoning and planning commissions, private land owners, water quality agencies, fish and wildlife agencies, forestry agencies, U.S. Army Corps of Engineers, county and municipal governments, and Departments of Health, Transportation, and Agriculture. Problem areas will be identified and delegated to the appropriate agency for implementation of the remedial plan. For instance, if erosion from a sub-watershed is the major source of sediment to the main stem, agencies like SCS or a local SWCD can focus efforts to reduce erosion.

Comprehensive local water plans can protect stream habitat (M.S. Ch. 110B, Comprehensive Local Water Management Act; Lundberg and Wells 1987). This legislation encourages counties to prioritize water management problems, and assess opportunities, solutions, and strategies for watershed improvement. The water plan is updated every five years offering an opportunity to input stream habitat concerns and suggest methods of implementation. For example, if extensive logging is degrading water quality, the county water plan could recommend the creation of buffer zones.

Fish kills often occur in watersheds with agricultural, industrial, or municipal development. The objectives of a fish kill investigation are to determine the cause and extent of the kill and develop a mitigation plan. Investigations should be prompt to assess numbers of dead fish and the cause of the kill accurately. Guidelines for conducting fish kill investigations are contained in Appendix 1.

**Corridor planning**

Corridor planning is often a reactive process. Agencies, groups, or individuals apply for permits that would alter stream habitat. The fisheries manager has the responsibility to review permit applications and recommend approval, denial, alternatives, or mitigation, depending on its impact on stream habitat (e.g., Schnick et al. 1982; Gore 1985).

The goal of environmental review is to maintain the natural character of the stream. When reviewing permit applications, immediate and cumulative habitat changes should be predicted. For example, a permit application to operate a hydropower dam in a store-and-release mode may have multiple impacts including downstream stranding of fish and invertebrates, and dewatering fish spawning areas. Reservoir fluctuations may drain northern pike spawning marshes. Also, downstream fluctuations will increase bank scour resulting in increased sediment and nutrient loading in the stream and receiving reservoirs or lakes. Major permitting activities are listed in Appendix 2.

Acquisition is a proactive method of corridor protection that can enhance stream habitat. Special funding such as Reinvest In Minnesota and Environmental Trust Fund may provide monies for acquisition.

## 6. HABITAT IMPROVEMENT

Stream habitat improvement should address limiting factors for all life stages of target species. Habitat modeling can identify habitat deficiencies and predict benefits from habitat modifications. The Instream Flow Incremental Methodology (IFIM) can model chemical and physical parameters (Bovee 1978). For guidance in using IFIM models, contact Ecological Services or Fisheries staff.

When stream habitat quality prevents achievement of management goals, appropriate habitat improvement techniques may overcome limiting factors. Before initiating habitat improvement projects there must be public control of the stream corridor and a Division of Waters permit issued.

Some methods alter physical characteristics (microhabitat) to benefit target species, while other techniques provide water quality benefits. Barrier removal or installation, riparian management, installation of instream structures, and flow modifications are the major improvement categories.

### Barrier removal or installation

Removal or modification of barriers can improve or increase habitat and improve water quality. Obstructions that may be removed include beaver dams, log jams, debris, man made dams and natural barriers (McConnell et al. 1983). The area supervisor should weigh the possible effects of species introductions on upstream fauna when considering the removal of natural barriers (refer to MDNR policies and AFS guidelines; Kohler and Courtenay 1986). Construction of fish barriers may be a necessary part of a reclamation project. Refer to the Developmental Procedure Manual (MDNR 1979) for project guidance. Removal of dams will generally improve stream fish populations.

**Riparian management**

Maintenance and improvement of riparian areas reduce bank erosion, narrow channel width, increase water velocity, decrease sedimentation, and improve water quality. Various references may aid in choosing the correct technique (White and Brynildson 1967; Duff et al. 1988; Vetrano 1988; Gresswell et al. 1989).

Stream management goals should emphasize protecting and enhancing native vegetation. Trees provide large woody debris for pool/riffle formation and fish cover, and shade to reduce stream warming. Herbaceous vegetation can be used to stabilize banks and provide overhanging cover. Riparian vegetation may be protected by restricting conflicting uses in the zone (Pajak 1992; Johnson and Ryba 1992).

Bank stabilization improves habitat by narrowing the channel, reducing erosion, and increasing fish cover. Eroding banks can be stabilized with rock, woody vegetation, and by sloping and seeding. Banks are often stabilized in conjunction with the placement of cover structures. Rock placement should be aesthetically pleasing, and only natural materials should be used. Woody vegetation placed into the bank can slow velocities, promote deposition of sediment, and increase bank vegetation. Commonly used techniques are tree revetments, brush bundles, and dormant stubs.

**Instream structures**

Placement of instream structures may enhance channel morphology and provide fish cover. Structures should be built with natural materials and be aesthetically pleasing. Common instream structures include current deflectors, cover rocks, cover logs, ramps and dams, and shelters. The use of instream structures is a well developed science for managing trout streams but has received limited application in warmwater streams.

**Flow modification**

Flow modifications affect the quantity and quality of fish habitat. Habitat disturbances occur from dam operations, appropriations and discharges, and changes in watershed land use. Natural flow regimes (run-of-the-river) should be the goal for regulated streams. Fish habitat can be improved by modifying dam operating plans that are subject to periodic review, when fisheries concerns can be negotiated.

Dam safety reports from the Dam Safety Section of the Division of Waters provide another opportunity to address flow manipulation. Recommendations for structural changes, such as minimum release valves, can be incorporated into reconstruction plans at this time.

Hydroelectric dams can seriously affect stream habitat, and require a Federal Energy Regulatory Commission license or permit. Therefore, relicensing is an opportunity to incorporate habitat improvement recommendations.

Beneficial flow modifications include establishment of seasonal flows, flow stabilization during critical life stages, and flow augmentation. Assistance from Ecological Services and Division of Waters personnel is available for developing the flow modification plan.

## 7. STOCKING

The primary objective of stocking is to provide a fishery where reproduction and abundance is inadequate. Stocking recommendations are based on biological, physical, and social factors. Stocking rates and chronology should be in the stream management plan.

Stocking may be generally categorized as introductions, reintroduction, maintenance, and put-and-take. Introductions establish new species and reintroduction reestablish fish populations. Managers should follow AFS protocol (Kohler and Courtenay 1986) and MDNR policies for the introduction of aquatic species. Maintenance stocking supplements reproduction that is inconsistent or lacking. Put-and-take stocking provides an immediate and short-term fishery.

Size of fish to stock depends on management objectives. Adults are generally used for introductions or reintroduction. Catchable size fish are stocked for put-and-take fishing or maintenance stocking (MDNR 1992). Fry and fingerlings are used for maintenance stocking.

General guidelines for stocking are described in the Policy on Fisheries Management (MDNR 1990 draft) and include:

1) Stocking will not be approved prior to a survey.
2) Fish will not be stocked in streams without public access.
3) Results of stocking will be periodically

evaluated.

4) Genetic integrity of wild stocks should be maintained.

5) Disease status of wild stocks should be determined prior to interbasin transfer.

Stocking guidelines are based on stream ecological classification (Sternberg 1978):

**Class IA (wild trout)**

Reproduction is adequate and these streams generally do not need stocking. Reintroduction are sometimes necessary where populations have been extirpated.

**Class IB (cold water tributary)**

Tributary streams often provide nursery habitat and can be stocked with fry or fingerlings if not being utilized by wild fish.

**Class IC (semi-wild trout)**

Generally these waters have inconsistent reproduction and can be stocked with any size-class.

**Class ID (marginal trout)**

Marginal trout streams lack suitable habitat and water quality for reproduction and year round survival. Stocking rates and sizes will vary within the state depending on local management priorities. Recommended stocking rates for trout streams are based on habitat quality, productivity, reproduction, and fishing pressure (Tables 3-6). These guidelines should be adjusted as more information becomes available.

Table 3. Habitat quality rating based on standing stock biomass (lb/acre) for trout streams in Minnesota.

| Habitat Quality | lb/acre Southern | Central | Northern |
|---|---|---|---|
| Excellent | > 200 | > 100 | > 50 |
| Good | 100 - 200 | 50 -100 | 30 - 50 |
| Fair | 50 - 100 | 30 - 50 | 10 - 30 |
| Poor | < 50 | < 30 | < 10 |

Table 4. Recommended trout spring fingerling stocking rates (number/acre) for streams in Minnesota based on reproduction and habitat quality.

| Reproduction | Location | HABITAT QUALITY Poor | Fair | Good | Excellent |
|---|---|---|---|---|---|
| None | Southern | 0-500 | 1,000 | 1,500 | 2,000 |
| | Central | 0-500 | 750 | 1,000 | 1,500 |
| | Northern | 0-500 | 500 | 750 | 1,000 |
| Poor-Inconsistent | Southern | 0-500 | 750 | 1000 | 1,500 |
| | Central | 0-500 | 500 | 750 | 1,000 |
| | Northern | 0-500 | 250 | 500 | 750 |
| Good-Inconsistent | Southern | 0-500 | 500 | 750 | 1,000 |
| | Central | 0-500 | 250 | 250 | 500 |
| | Northern | 0-500 | 250 | 250 | 250 |
| Good-Consistent | Southern Central Northern | NONE | NONE | NONE | NONE |

Table 5. Recommended trout fall fingerling stocking rates (number/acre) for streams in Minnesota based on reproduction and habitat quality.

| Reproduction | Location | Poor | Fair | Good | Excellent |
|---|---|---|---|---|---|
| | | HABITAT QUALITY | | | |
| None | Southern | 0-100 | 200 | 400 | 500 |
| | Central | 0-100 | 100 | 200 | 400 |
| | Northern | 0-100 | 100 | 100 | 200 |
| Poor-Inconsistent | Southern | 0-100 | 100 | 200 | 400 |
| | Central | 0-100 | 100 | 100 | 200 |
| | Northern | 0-100 | 100 | 100 | 100 |
| Good-Inconsistent | Southern | 0-100 | 100 | 100 | 200 |
| | Central | 0-100 | 100 | 100 | 100 |
| | Northern | 0-100 | 100 | 100 | 100 |
| Good-Consistent | Southern<br>Central<br>Northern | NONE | NONE | NONE | NONE |

Table 6. Recommended stream stocking rates of catchable trout (number/acre) based on annual angling pressure (h/acre) and habitat quality.

| Annual Angling Pressure (h/acre) | Poor | Fair | Good | Excellent |
|---|---|---|---|---|
| | Habitat Quality | | | |
| < 50 | 10 | 10 | NONE | NONE |
| 50-200 | 15 | 15 | NONE | NONE |
| 200-500 | 20 | 20 | 50 | NONE |
| > 500 | 50 | 50 | 100 | NONE |

**Class IIA - IIE (warmwater)**

Recruitment should be identified as a limiting factor before stocking warmwater streams. Most warmwater stream stocking has reintroduced target species. For most warmwater species, stocking information is scarce.

Smallmouth bass have been stocked in suitable habitat with limited success (Fajen 1975; Loska 1982). Reintroductions have been successful in southeast Minnesota at fingerling stocking rates of 50-100/acre (MDNR files).

Iowa recommends that stocking rates for walleye in inland rivers not exceed 2,000 fry/acre (Miller and Hudson 1978) and Illinois suggests a rate of 20 fingerling/acre (D. Salee, IL Dept. Cons., personal communication 1989).

Iowa recommends that stocking rates for northern pike fry not exceed 1000/acre (Iowa DNR files).

Channel catfish stocking has been successful in many areas of the United States (Miller 1966). In Iowa, stocking rates of fingerlings do not exceed 250/acre (Iowa DNR files).

Introductory stockings of adult flathead catfish have established populations in some cases (Guier et al. 1980).

Muskellunge survival is related to length at stocking and stocking of age-0 fish at 8-10 inches is recommended (Seelbach 1988).

Missouri (G. Farabee, Missouri DOC, personal communication) and Minnesota (M. Ebbers, Minnesota DNR, personal communication) are evaluating stocking of 8-10 inches lake sturgeon in larger rivers and initial results are favorable.

<u>**Class III, IV, and V streams**</u>

These streams are used as spawning and rearing habitat for some species. Although not usually stocked due to limited game fish habitat, successful stocking of fry and fingerlings may be possible.

## 8. REGULATIONS

Recent regulation changes for Minnesota streams have focused on increasing abundance, altering harvest, restructuring size distributions, and providing more diverse angling opportunities. Regulations are based on biological, sociological, economic, or political considerations. The major goal of a biologically based regulation is to protect or improve some segment of a fish population. Reasons for initiating regulation changes include:

1) to reduce or increase harvest;
2) to maintain optimal predator/prey relationships;
3) to alter size class distribution;
4) to reduce or increase catch rates;
5) to allocate harvest;
6) to protect spawning fish; and
7) to provide diverse angling opportunities.

Regulations include seasons, size limits, bag limits, and gear restrictions. Parameters that influence regulations include species composition, fishing pressure, vulnerability, growth, mortality, and life expectancy. Regulations can affect angler expectations and perceptions and these can modify success of regulations.

Proposed regulation changes must follow the requirements developed during the 1992 Legislative session. These requirements are found in Minnesota Statutes, Chapter 97C, section 97C.001 for experimental waters and section 97C.005 for special management waters. Two committees (coldwater and warmwater species) review proposed regulations and make recommendations.

Population data and pertinent literature should be reviewed to select a regulation. Regulations should be evaluated because changes in abundance due to environmental factors may limit effectiveness of the regulation. Numbers and biomass in streams are determined by environmental factors (Moyle and Li 1979), and can fluctuate widely (Platts and Nelson 1988).

Regulations will not be effective if angler compliance is poor (Gigliotti and Taylor 1990). Public involvement in the regulation setting process is essential and should include land owner contacts, media releases, public input meetings, and informal contacts with anglers and special interest groups (Behnke 1987). Other disciplines within MDNR and other agencies should be involved in this process.

## 9. ACCESS AND ACQUISITION

Access is acquired on streams to provide angling opportunity. Acquisition can be an important component of a habitat development and protection plan. The stream easement program is administered by the Section of Fisheries, and the Trails and Waterways Unit is responsible for point access acquisition and development. Opportunities for handicapped accessible fishing should be identified in the management plan.

Access development should consider the sensitivity of the fish population to exploitation and angler expectations. For example, a large productive system should have more access than a small stream with low productivity. Refer to Guidelines for Trout Stream Easement Acquisition (MDNR 1992 draft) for information on access development.

## 10. **DEVELOPING A STREAM MANAGEMENT PLAN**

A stream management plan (Appendix 3) is developed after the initial survey, and is refined as more information becomes available. The plan should detail management options for each similar reach. Each reach should be listed on the plan with the river miles, stream type (coldwater or warmwater), ecological classification, and species managed. Ecological classification and similar reach should be taken from the most current stream survey.

The primary components of the plan are the long range goal, operational plan, mid-range objective, potential plan, and the narrative. The long range goal has a time frame of 10 to 20 years, should be specific, and should address limiting factors identified in surveys. The operational plan should outline specific activities to occur in the next 10 years to achieve long range goals. The mid-range objective should define measurable goals attainable by implementing operational plans. Potential plans include projects that could be accomplished with expanded funding and alternatives to operational plans. Where appropriate, cost estimates should be provided for each item listed in the potential plan. The narrative should summarize historical information and support long range goals and operational plans. It should include the following items where relevant:

Past surveys and investigations: stream surveys and population assessments, research projects, creel and recreational use surveys.

Past management: stocking, habitat improvement, acquisition, special regulations, fish removal.

Stream and watershed alterations: past permits, channelization, major reconstructions, dams, hydroelectric developments, impoundments, irrigation, agricultural impacts, and logging.

Social considerations: proximity to major population centers, conflicts and controversies, public access, special designations (e.g., Wild and Scenic Rivers, designated trout stream, canoe route), recreational use, commercial fishing.

Cultural and natural elements: archaeological sites, historical sites, species of special interest including plants, invertebrates, fish, and other animals.

Limiting factors: list of identified and suspected limiting factors.

Survey needs and evaluation plans: describe the survey and assessment schedule as outlined in the operational plan. List additional surveys identified in the potential plan.

Land acquisition needs: list access and easement needs and concerns related to excessive development. Acquisition for habitat protection should be identified.

Habitat development needs: describe instream habitat improvement projects, erosion control, pollution abatement, riparian habitat development.

Habitat protection needs: document measures needed to protect habitat.

Stocking: document proposed stocking plan.

Regulations: discuss proposed regulation changes.

The above items should be listed in block form with the subject headings underlined to allow the reader quick access to information. Add additional pages to the narrative if necessary.

## LITERATURE CITED

Behnke, R. J. 1987. Catch-and-release - the last word. Pages 291-299 in R. A. Barnhart and T. D. Roelofs, editors. Catch-and-release fishing a decade of experience. Humbolt State University, Arcata, California.

Bovee, K. D. 1978. The incremental method of assessing habitat potential for coolwater species, with management implications. American Fisheries Society Special Publication 11:340-346.

Close, T. L., and G. D. Siesennop. 1984. Angler census of the North Shore spring stream fishery, 1981-1982. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Fish Management Report 26, St. Paul.

Duff, D. A., N. Banks, E. Sparks, W. E. Stone, and R. J. Poehlmann. 1988. Indexed bibliography on stream habitat improvement. USDA-Forest Service, Intermountain Region, Ogden, Utah.

Fajen, O. 1975. Population dynamics of bass in rivers and streams. Pages 195-203 in H. Clepper, editor. Black bass biology and management. Sport Fishing Institute, Washington, D. C.

Gigliotti, L. M., and W. W. Taylor. 1990. The effect of illegal harvest on recreational fisheries. North American Journal of Fisheries Management 10:106-110.

Gore, J. A., editor. 1985. The restoration of rivers and streams: theories and experience. Butterworth Publishers, Boston, Massachusetts.

Gresswell, R. E., B. A. Barton, and J. L. Kershner, editors. 1989. Proceedings of the practical approaches to riparian management workshop. U.S. Bureau of Land Management, Billings, Montana.

Guier, C. R., L. E. Nichols, Jr., and R. T. Richels. 1980. Biological investigation of flathead catfish in the Cape Fear River, N. C. North Carolina Wildlife Resource Commission, Coastal Fisheries Investigation. F-22-4, Raleigh.

Hill, D. M. 1983. Fish kill investigation procedures. Pages 261-274 in L. A. Nielsen and D. L. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

Hirsch, S., and D. Peterson. 1987. The Cannon River: recreational use of a warmwater stream. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Fish Management Report 28, St. Paul.

Johnson, A.W., and D.M. Ryba. 1992. A literature review of recommended buffer widths to maintain various functions of stream riparian areas. Prepared for King County Surface Water Management Division.

Kohler, C. C., and W. R. Courtenay, Jr. 1986. American Fisheries Society position paper on introduction of aquatic species. Fisheries (Bethesda) 11:(1)39-42.

Loska, P. M. 1982. A literature review on the stocking of black basses (Micropterus spp.) in reservoirs and streams. Georgia Department of Natural Resources, Study Number:SE-1, Atlanta.

Lundberg, M. D., and Wells, J. R. 1987. The handbook for comprehensive local water planning. Minnesota State Planning Agency, St. Paul.

Malvestuto, S. P. 1983. Sampling the recreational fishery. Pages 397-419 in L. A. Nielsen and D. L. Johnson, editors. Fisheries Techniques, American Fisheries Society, Bethesda, Maryland.

McConnell, D., A. Binns, E. Claire, D. Duff, J. Karr, G. Montegomery, D. Parsons, J. Sedell and M. Seehorn. 1983. Stream obstruction removal guidelines. Wildlife Society and American Fisheries Society, Bethesda, Maryland.

Miller, E. E. 1966. Channel catfish. Pages 440-463 in A. Calhoun, editor. Inland Fisheries Management. California Department of Fish and Game, Sacramento.

Miller, L., and J. Hudson. 1978. Evaluation of walleye fry stocking in the Little Sioux River. Iowa Conservation Commission, Job Completion Report, Project 78-I-C-6, Des Moines.

Minnesota Department of Natural Resources. 1979. Developmental procedures manual statewide lake and stream improvement project lake rehabilitation. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, St. Paul.

Minnesota Department of Natural Resources. 1982. Lake management planning guide. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of

Fisheries, Special Publication 131, St. Paul.

Minnesota Department of Natural Resources. 1990 (draft). Policy on fisheries management. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, St. Paul.

Minnesota Department of Natural Resources. 1992. Catchable trout stocking. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Staff Report, St. Paul.

Minnesota Department of Natural Resources. 1992 (draft). Guidelines for trout stream easement acquisition. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, St. Paul.

Moyle, P. B., and H. W. Li. 1979. Community ecology and predator-prey relations in warmwater streams. Pages 171-180 in H. Clepper, editor. Predator-prey systems in fisheries management. Sport Fishing Institute, Washington, D.C.

Pajak, P. 1992. Developing integrated fisheries objectives for land and water resource management: the Milwaukee River experience. Pages 175-196 in R.H. Stroud, editor. Fisheries management and watershed development, American Fisheries Society Symposium 13, Bethesda, Maryland.

Pitman, D. R., and P. J. Wingate. 1986. Lake Superior tributary sampling guide. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Special Publication 141, St. Paul.

Platts, W. S., and R. L. Nelson. 1988. Fluctuations in trout populations and their implications for land-use evaluations. North American Journal of Fisheries Management 8:333-345.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian and biotic conditions. USDA Forest Service Intermountain Forest Range Experimental Station, General Technical Report INT-138, Ogden, Utah.

Rosenthal, T., editor. 1985. FWS/OBS annotated bibliography: Western Energy and Land Use Team products. U.S. Fish and Wildlife Service, Biological Report 85(13).

Seelbach, P. W. 1988. Considerations regarding the introduction of muskellunge into southern Michigan rivers. Michigan Department of Natural Resources, Fish Technical Report 88-5, Ann Arbor.

Schnick, R. A., J. M. Morton, J. C. Mochalski, and J. T. Beall. 1982. Mitigation and enhancement techniques for the Upper Mississippi River system and other large river systems. U.S. Fish and Wildlife Service, Resource Publication 149.

Sternberg, R. B. 1978. Minnesota stream survey manual. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Special Publication 120, St. Paul.

Thorn, W. D. 1984. Evaluation of fall stocked rainbow trout fingerlings in southeast Minnesota streams. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Fish Management Report 27, St. Paul.

Tureson, F. 1978. A creel census and water surface use study of the Mississippi River from the Coon Rapids Dam to the mouth of the Minnesota River, May 8 to September 30, 1976. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Fish Management Report 3, St. Paul.

Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

Vetrano, D. M. 1988. Unit construction of trout habitat improvement structures for Wisconsin coulee streams. Wisconsin Department Natural Resources, Administrative Report 27, Madison.

Waters, T. F. 1977. The streams and rivers of Minnesota. University of Minnesota Press, Minneapolis.

Weithman, S. A., and R. O. Anderson. 1978. A method for evaluating fishing quality. Fisheries (Bethesda) 3(3): 6-10.

Weithman, S. A, and S. K. Katti. 1979. Testing of fish quality indices. Transactions of the American Fisheries Society 108:320-325.

White, R. J., and O. M. Brynildson. 1967. Guidelines for management of trout stream habitat in Wisconsin. Wisconsin Department of Natural Resources, Technical Bulletin 39, Madison.

Wiechman, J. D. 1990. Evaluation of fishing quality indices and sizes of brown trout preferred by anglers in southeast Minnesota. Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Investigational Report 403, St. Paul.

## ADDITIONAL REFERENCES


American Fisheries Society. 1982. Monetary values of freshwater fish and fish-kill counting guidelines. American Fisheries Society Special Publication 13.

Colt, J., and R. J. White, editors. 1991. Fisheries bioengineering symposium. American Fisheries Society Symposium 10.

DuBois, R. B. 1989. Bibliography of fishery investigations on large salmonid river systems with special emphasis on the Bois Brule River, Douglas County, Wisconsin. Wisconsin Department of Natural Resources, Technical Bulletin 166, Madison.

Fleener, G. C. 1971. Recreational use of the Platte River, Missouri. Pages 63-78 in E. Schneberger, editor. Stream channelization, a symposium. American Fisheries Society, North Central Division Special Publication 2.

Fontaine, T. D., III and S. M. Bartell, editor. 1983. Dynamics of lotic ecosystems. Ann Arbor Science Publishers, Ann Arbor.

Gores, J. A., and G. E. Petts. 1989. Alternatives in regulated river management. CRC Press, Inc., Boca Raton, Florida.

Heggenes, J. 1987. Random, stratified creel surveys in three Norwegian Rivers with low fish intensities. North American Journal of Fisheries Management 7:363-368.

Hunt, R. L. 1988. A compendium of 45 trout stream habitat development evaluations in Wisconsin during 1953-1985. Wisconsin Department of Natural Resources, Technical Bulletin 162, Madison.

Hunt, R. L. 1992. Evaluation of trout habitat improvement structures in three high-gradient streams in Wisconsin. Wisconsin Department of Natural Resources, Technical Bulletin 179, Madison.

Hunter, C. 1991. Better trout habitat, a guide to stream restoration and management. Island Press, Washington, D.C.

Hynes, H. B. N. 1972. The ecology of running waters. University of Toronto Press, Toronto.

Lyons, J. L., and C. C. Courtney. 1990. A review of fisheries habitat improvement projects in warmwater streams, with recommendations for Wisconsin. Wisconsin Department of Natural Resources, Technical Bulletin 169, Madison.

Malvestuto, S. P., W. D. Davies, and W. L. Shelton. 1978. An evaluation of the roving creel survey with nonuniform probability sampling. Transactions of the American Fisheries Society 107:255-262.

Meehan, W. R., editor. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19.

Nielsen, L. A., and D. L. Johnson, editors. 1983. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Osborn, L. L., and thirteen other authors. 1991. Stream habitat assessment programs in states of the AFS North Central Division. Fisheries (Bethesda) 16(3):28-35.

Rivers and Streams Technical Committee. 1990. The restoration of midwestern stream habitat. Rivers and Streams Technical Committee, North-Central Division, American Fisheries Society.

Seehorn, M. E. 1992. Stream habitat improvement handbook. USDA Forest Service, Southern Region, Atlanta, Georgia, Technical Publication R8-TP 7.

## CONTENTS OF APPENDIX

## APPENDIX 1. INVESTIGATING FISH KILLS

### Methods

After a fish kill, the Regional Fisheries Manager, Section of Ecological Services, and Minnesota Pollution Control Agency should be informed. Information such as location, suspected cause (if any), and general magnitude of the kill should be reported (Hill 1983).

A "Fish and Wildlife Kill Report" should be completed for each investigation. Dead fish should be counted, measured, and inspected externally for unusual appearance, and other dead organisms should be noted. Dissolved oxygen, temperature, and pH should be measured and general water conditions (turbidity, stage) should be noted. Photographs of the kill area should show dead fish.

If the causative agent is believed to be present, water samples should be taken and sent to the chemistry lab. Water samples should be collected within four hours of the kill, if possible, and should be taken below and above the discharge point. Freshly killed or stressed fish should be collected and sent unfrozen to the pathologist.

Parties responsible for a fish kill can be billed for the value of dead fish and the cost of the investigation. Statistically valid sampling methodology must be used in the investigation. All dead fish should be counted and measured when possible; however, if the kill area is large, a stratified random sampling regime should be used (see outline).

Sampling a kill area with electrofishing gear or nets may determine the magnitude of the kill if pre-kill survey data are available. This information cannot be used to estimate dead fish numbers for mitigation; however, it may support results of a fish kill investigation.

## FISH KILL EQUIPMENT CHECKLIST

(all items may not be necessary)

- Boat or canoe, outboard motor, paddles, life vests
- Electrofishing gear and/or nets
- Water sample containers
- Pails, tubs, dip nets, shovels
- Tape measure (100 ft), depth pole, range finder, flagging, rope
- Waders or hip boots, rubber gloves
- Formalin, sample jars
- Measuring board, scale, scale envelopes
- Clip board, pencils, ruler
- Field sheets, "kill report" form, random numbers table
- Maps, map wheel, compass, stopwatch
- Current meter, dissolved oxygen meter, pH meter, thermometer
- Camera
- Cooler, ice aluminum foil, plastic bags
- List of contact phone numbers

**APPENDIX 1 (cont.)**

PROCEDURAL OUTLINE FOR FISH KILL INVESTIGATIONS IN NARROW STREAMS.

I. Determine the extent of the kill (length of stream affected).

   A. Sampling can be stratified, if warranted, by describing kill reaches of different intensities within the kill area.

      1) Each stratum must have at least two sampling stations.
      2) Sampling effort should be allocated in proportion to the number of dead fish in each stratum.
      3) Treat each stratum as a separate kill area.

II. Establish intervals between and length of sampling stations.

   A. Examples.

      1) 100 yd sampling station every 1/2 mi.
      2) 100 m station every km.
      3) 10 yd station every 200 yds, etc.

   B. These lengths will vary according to size of the stream and extent of the kill.

   C. Should have a minimum of three stations.

III. Determine sampling station locations.

   A. Randomization possible.

      1) Choose the first sampling station within the first segment randomly and maintain the predetermined interval between successive sampling stations. Example: It is determined that a three mi reach of stream has been affected by a kill. It is further determined that this area will be divided into six, 1/2 mi segments with a 100 yd sampling station in each segment. Within each 1/2 mi segment there are approximately nine successive 100 yd stations possible. The single digit "3" is drawn from a random numbers table. The first sampling station would be the third 100 yd section within the first 1/2 mi segment. Each successive five 100 yd stations is 1/2 mi from the one preceding it.

B. Randomization not possible (difficult access).

1) Begin at a predetermined distance above accesses available and proceed for the distance of the sampling station.
2) Try to space access points as evenly as possible.

IV. Counting fish.

A. Identify, count and record length frequency for all dead fish observed in each sampling station.

1) If very large numbers of dead fish are present, sample a randomly selected fraction of the station.

B. Use the following techniques for fish that are drifting downstream with the current.

1) If numbers of drifting fish are insignificant, ignore them.
2) If drifting fish are moving slowly, include them with your counts of stationary fish. If neither of these conditions are met, use one of the following methods.

3) Investigator moving upstream counting fish.

(a) Collect all drifting fish in the station and measure the time it takes to do this.
(b) Count all fish drifting by a stationary point at the upstream end of the station for an equivalent time.
(c) Calculate correction factor (CF): CF = total collected - total counted/total collected.
(d) Multiply number of drifting fish collected by CF before expanded estimate is made.

4) Investigator moving downstream as fast or faster than the current.

(a) Collect all drifting fish that are overtaken, ignore fish that overtake the observer.
(b) Measure time it takes to cover the station.
(c) Collect all fish drifting past a selected point at the downstream end of the station for an equivalent amount of time.
(d) Corrected station estimate is the sum of the drifting and stationary fish collected.

5) Investigator moving downstream more slowly than the current.

(a) Collect only drifting fish that are overtaken.
(b) Measure the time it takes for water to move through the station (floating chip or current meter).
(c) Collect all drifting fish at the downstream end of the station for an equivalent amount of time.
(d) Corrected station estimate is the sum of the drifting and stationary fish collected.

V. Expanding station estimates of dead fish to the entire kill area.

A. English expansion factor: 1,760 * total stream miles of kill/summed lengths of sampling stations, yds.
B. Metric expansion factor: 1000 * total stream km of kill/summed lengths of sampling stations, m.
C. To calculate total number of fish killed, multiply the summed counts on all stations by the expansion factor.
D. To estimate the total fish killed in each smaller category, such as species, size group, etc., multiply each respective sum by the expansion factor.
E. Keep separate records for each station to allow calculation of a standard error.

PROCEDURAL OUTLINE FOR FISH KILL INVESTIGATIONS IN WIDE STREAMS

I. Determine the extent of the kill.

A. Two sampling strata are usually used; shoreline and open water. Open water zones are sampled by transect.

II. Shoreline zone.

A. Sample the shoreline zone similarly to narrow streams (A2).

1) The width of the shoreline zone should be set to include all of the fish that are visible and easily sampled from shore.
2) The chosen width must be used consistently throughout a given investigation.

B. Estimate numbers of dead fish as with narrow streams.

III. Open water zone.

A. Establish a baseline.

1) If there is appreciable flow, the baseline should parallel the direction of flow (then no allowance for drifting fish is necessary).
2) The direction and length of the baseline must be known.
3) If the stream meanders a lot, a series of baselines along meander arms may be preferred (Fig. 2). This will increase precision in cases where a good stream map is not available. Use the following procedure:

(a) Divide kill area into sections short enough that one end can be seen from the other.
(b) Lines dividing adjacent sections must be identifiable by landmarks, flagging, etc.
(c) Each section will have its own baseline, the length of which must be measured or closely estimated.
(d) There are two possible designs:
(1) Each section can be treated as a separate survey stratum with one or more transect and a separate estimate.
(2) For very extensive kills, where each section cannot be sampled, total length of all baselines is summed and transect

are positioned at stated intervals, regardless of the sections into which they may fall.

(e) Since boundaries usually fall at a bend in the river, the boundary line will not be perpendicular to baselines in either of the adjacent sections. Each baseline must then extend into the next section so that a perpendicular transect at the end of the section will extend only to the section boundary, ending on the water.

B. Set up and run the transect.

1) Transect run from shore to shore but exclude the shoreline zone if shoreline sampling is also done.
2) Choose transect width so that all dead fish floating within it can be collected from a boat.
   (a) A good way to mark your chosen width is to fasten a pole across the bow of the boat with trailer ropes on each end.
3) Decide the number of transect to be used. The more transect, the more precise will be the result (at least three should be run).
4) Determine the gap between transect (baseline length divided by number of transect) and the number of transect widths in a gap (gap distance divided by transect width). Round both calculations to the nearest whole unit.
5) Select one transect at random from all those possible in the first gap at one end of the baseline.
6) Locate the remaining transect along the baseline, one at each successive gap distance beyond the first (measured from center to center of the transect) and mark the starting points along the shore.
7) When transect are interrupted by islands, points, etc., run both arms of the transect and add the resulting counts as if it had been continuous.
8) Run the transect from the premarked locations by compass so that they are perpendicular to the baseline.
9) Collect all dead fish within the predetermined width from each transect.
10) Keep records separately for each transect to allow calculation of standard error.

IV. Computing estimates of dead fish in the open water zone.

A. Good map is not available.

1) Expansion factor: baseline length/transect width * no. of transect.
2) Add the numbers of fish collected on each transect and multiply this sum by the expansion factor.

B. Good map is available.

1) Sketch the distribution of dead fish on the map and delineate the total survey area.
2) Mark the baseline distance on the map and measure it.
3) Measure the water length of each transect (exclude intervening land and the shoreline zone if a shoreline zone was sampled).
4) Sum all transect lengths.

IV. Computing estimates of dead fish in the open water zone (cont'd).

5) Planimeter total survey area.
6) Expansion factor: total survey area/transect width * summed transect lengths (keep units of measurement the same, ie. $yds^2$ - yds or $ft^2$ - ft, etc.)
7) Multiply number of dead fish on each transect by expansion factor.

**APPENDIX 2**. LIST OF MAJOR PERMITTING ACTIVITIES ON STREAMS.

The following is a listing of the major permitting activities that are reviewed to protect stream habitat:

1) DNR Protected Waters Permits (administered by the Division of Waters) - Areas encompassed by these permits include: 1) dam construction,repair and removal; 2) excavations, channelization, and other channel modifications; 3) filling of protected waters; 4) placement of bridges and culverts; 5) installation of docks, marinas, and breakwaters; and 6) water appropriations and flow manipulations.

2) U.S. Army Corps of Engineers (USCOE) Section 404 (Clean Water Act) Permits - filling of wetlands.

3) USCOE Section 10 (Rivers and Harbors Act) Permits - placement of structures in navigable waters.

4) Preliminary and Final Engineer's Reports - submitted to DNR Waters Division by drainage authorities under Section 106 of the State drainage code.

5) Minnesota Department of Transportation Project Path Reports - descriptions of proposed highway projects.

6) Aquatic Plant Management (administered by DNR-Fish and Wildlife Division) - permits for the mechanical, chemical, and biological control of nuisance plants and animals.

7) USCOE Reservoir Operation Plan Evaluations.

8) Public Utility Crossing Work Plans - electric and telephone transmission line projects.

9) Public Law 566 and 639 Projects - U.S. Soil Conservation Service (SCS) and joint SCUSCOE projects.

10) Federal Energy Regulatory Commission licensing for hydropower development.

11) State and Federal Environmental Assessment Worksheets and Environmental Impact Statements.

12) Minnesota Pollution Control Agency Water Classifications - permits that alter water quality standards.

13) Mussel (and Crayfish) Permit for commercial harvest.

14) Fish Tournaments (see policy).

## APPENDIX 3.

STREAM MANAGEMENT PLAN FORM AND EXAMPLES

NA-00000-00

# STREAM MANAGEMENT PLAN

| Region | Area | Stream Name | Tributary No. | Length |
|---|---|---|---|---|
| | | | | |

| Similar Reach | Stream Miles | Stream Type | Ecological Classification | Species Managed |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Long Range Goal:**

**Operational Plan:**

**Mid-range Objective:**

**Potential Plan:**

Total $________________

| Area Supervisor's Signature | Date: | Regional Manager's Signature | Date: |
|---|---|---|---|
| | | | |

(see reverse side)

| Stream Name: | Tributary No: | Date: |
| --- | --- | --- |
| Narrative: | | |

Add additional pages if needed

NA-00000-00

# STREAM MANAGEMENT PLAN (EXAMPLE)

| Region | Area | Stream Name | Tributary No. | Length |
|---|---|---|---|---|
| 2 | Grand Marais (240) | Junco River | S-67 | 8.9 mi |

| Similar Reach | Stream Miles | Stream Type | Ecological Classification | Species Managed |
|---|---|---|---|---|
| 1 | 0.0-1.9 | Coldwater | IA | Brook trout |
| 2 | 1.9-7.1 | Coldwater | IA | Brook trout |
| 3 | 7.1-8.9 | Coldwater | IA | Brook trout |
| | | | | |

**Long Range Goal:**

Improve (or maintain) adult brook trout numbers to at least 500 fish/mi with 15% of the population greater than 10 in.

**Operational Plan:**

1) Conduct annual mark-recapture electrofishing assessments, targeted at brook trout, through 1992 in stations one (mile 0.2; control) and two (mile 0.6; improved). Include stations four (mile 7.1) and five (mile 8.3 in 1991.
2) Annually stock 1,000 adipose clipped brook trout yearlings at mile 3.6 (Cook County Road 27 crossing) through 1992, after which stocking will be discontinued.
3) Instruct USFS personnel in enhancement of existing habitat improvement work in 1990.

**Mid-range Objective:**

Determine if habitat improvement work has increased the number of brook trout over 10 in.

**Potential Plan:**

1) Conduct a habitat improvement project on the unimproved portion of similar reach one (miles 0.7 to 1.9), if assessments show increased numbers of 10 in brook trout in existing improved area ($60,000).
2) Conduct creel surveys at five year intervals ($2,000/survey)

Total $ see above

| Area Supervisor's Signature | Date: | Regional Manager's Signature | Date: |
|---|---|---|---|
| Steven A. Hirsch | 2-06-90 | | |

(see reverse side)

| Stream Name: | Tributary No: | Date: |
|---|---|---|
| Junco River | S-67 | 2-06-90 |

Narrative:

Past surveys and investigations: An initial survey in June and July, 1986 utilized electrofishing gear and gill nets and sampled brook trout, central mudminnow, common shiner, finescale dace, fathead minnow, blacknose dace, longnose dace, creek chub, pearl dace, white sucker, YOY yellow perch, and mottled sculpin. A temperature profile was not taken, however, stream temperatures up to 70°F were recorded during periods which were not representative of maximum levels.

During the initial survey brook trout were distributed throughout the stream, except in the uppermost station at stream mile 8.3. Brook trout size distributions included fish up to 13 in with a few larger fish of 14 and 16 in. Thirty five percent of the adult brook trout sampled were over 10 in. Many of the larger fish were taken with gill nets in impounded areas.

Additional data collected during the initial survey included a phase one survey (reconnaissance) of a tributary which entered at stream mile 6.0 and had its source at Musquash Lake, and electrofishing at one station in a tributary which entered at stream mile 0.6 and had its source at Olson Lake. Good numbers of YOY brook trout were sampled in the Olson Lake tributary.

Assessments were done in August-September, 1987-1989, to collect baseline data for evaluation of habitat improvement work which was completed in 1989. Mark-recapture estimates of brook trout populations were done with electrofishing gear in two stations at stream mile 0.3 (control section) and 0.6 (improved section).

Adult brook trout population estimates have shown steep declines since 1987 in both the control and improved stations (Figure 1). The control station declined from 3,809 fish/mi in 1987 to 333 fish/mi in 1989. These are considered to be pre-habitat improvement data. YOY brook trout numbers were fair in 1987, and low in 1988 and 1989. Very few brook trout over 10 in have been sampled during assessments.

Assessments have sampled YOY northern pike, YOY walleye, and slimy sculpin, in addition to species sampled during the initial survey. The lower similar reach of Junco Creek is a major walleye spawning inlet for Devil Track Lake.

Past Management: Brook trout fingerlings and yearlings were stocked frequently from the mid-1950's through 1980. Annual stocking of 800 to 1,000 brook trout yearlings has been done from 1987 through 1989, at the Cook County Road 27 crossing.

Brown trout yearlings were stocked frequently from 1971 through 1982, but apparently failed to establish a population.

A trail was constructed in 1985 from mile 0.6 to mile 3.6, to facilitate angler access and habitat improvement work.

(continued on next page)

Add additional pages if needed

| Stream Name: | Tributary No: | Date: |
|---|---|---|
| Junco River | S-67 | 2-06-90 |

Narrative:

Past management: (cont'd)
Habitat improvement work was done in 1988 and 1989 from stream mile 0.3 to 0.7. Work included construction of crib shelters, half logs, digger logs, deflectors, one channel block, and one Hewlett ramp.

Stream and watershed alterations: Extensive logging has taken place in the Junco River watershed, however, possible impacts have not been documented.

Social considerations: The Junco River is a popular brook trout stream located about 10 to 15 mi from Grand Marais. Most of the stream is fairly accessible by various bridge crossings, primitive roads, and trails. The lower 2 mi of stream are close to a USFS campground, and probably receive moderate to heavy fishing pressure. The section of stream near the Cook County Road 27 crossing also receives substantial fishing pressure. The remainder of the stream probably receives light fishing pressure.

Limiting factors: Assessments appear to indicate that adult brook trout numbers are extremely variable in stations one and two. Possible causes of this are variable reproductive success, marginal water temperatures, and fishing pressure.

The initial survey found good brook trout reproduction throughout most of the stream. Assessments indicate, however, that reproductive success varies from year to year in some areas. Brook trout growth is slow; fish from the 1985 survey averaged 7.9 and 10.0 in at annuli II and III, respectively.

Evaluation of existing habitat improvement work is needed before it can be determined if cover is limiting the number of large brook trout. Fishing pressure is substantial in the lower reach, and may mask potential benefits of existing habitat improvement work.

Data collected during the initial survey indicate that portions of the stream may have marginal temperatures during extreme periods in summer and winter. Numerous springs provide refuge areas when water temperatures are marginal, however, usable brook trout habitat is reduced at these times.

Habitat degradation is minimal, however, there are some concerns with human activities. The 1985 survey found two areas which had been clear cut to the edge of the stream, potentially aggravating problems with marginal water temperatures. In addition snowmobile trail construction activities caused excessive turbidity in the Olson Creek tributary during the brook trout spawning and egg incubation period in 1987.

Survey needs and evaluation plan: Mark-recapture electrofishing assessments targeted at brook trout will be done annually in stations one (mile 0.2; control) and two (mile 0.6; improved), through 1992. Assessment data will be used to determine if habitat improvement has increased the number of brook trout over 10 in.

(continued on next page)

Add additional pages if needed

| Stream Name: | Tributary No: | Date: |
|---|---|---|
| Junco River | S-67 | 2-06-90 |

Narrative:

Survey needs and evaluation plans: (cont'd)
In 1991, mark-recapture assessments will also be done at electrofishing stations from similar reaches two and three. This will include stations four (mile 7.1) and five (mile 8.3).

Creel surveys at five year intervals would be useful, however, this has not been included in the operational plan because of budget constraints.

Land acquisition needs: The stream corridor is almost entirely in public ownership.

Habitat development needs: The USFS will enhance two structures, and add several anchor logs in the existing improved area in 1990, as part of a training process for their crews. MDNR personnel will supervise the work.

No other habitat improvement is recommended (except maintenance as needed) until the existing work has been evaluated.

Habitat protection needs: All proposed timber sales must be reviewed to incorporate fisheries concerns. Buffer zones of at least 100 ft must be left adjacent to each side of the stream and all important tributaries, to prevent water temperatures from become unsuitable for brook trout.

Road/trail construction activities must also be regulated so that they are done when brook trout spawning and egg incubation are not occurring.

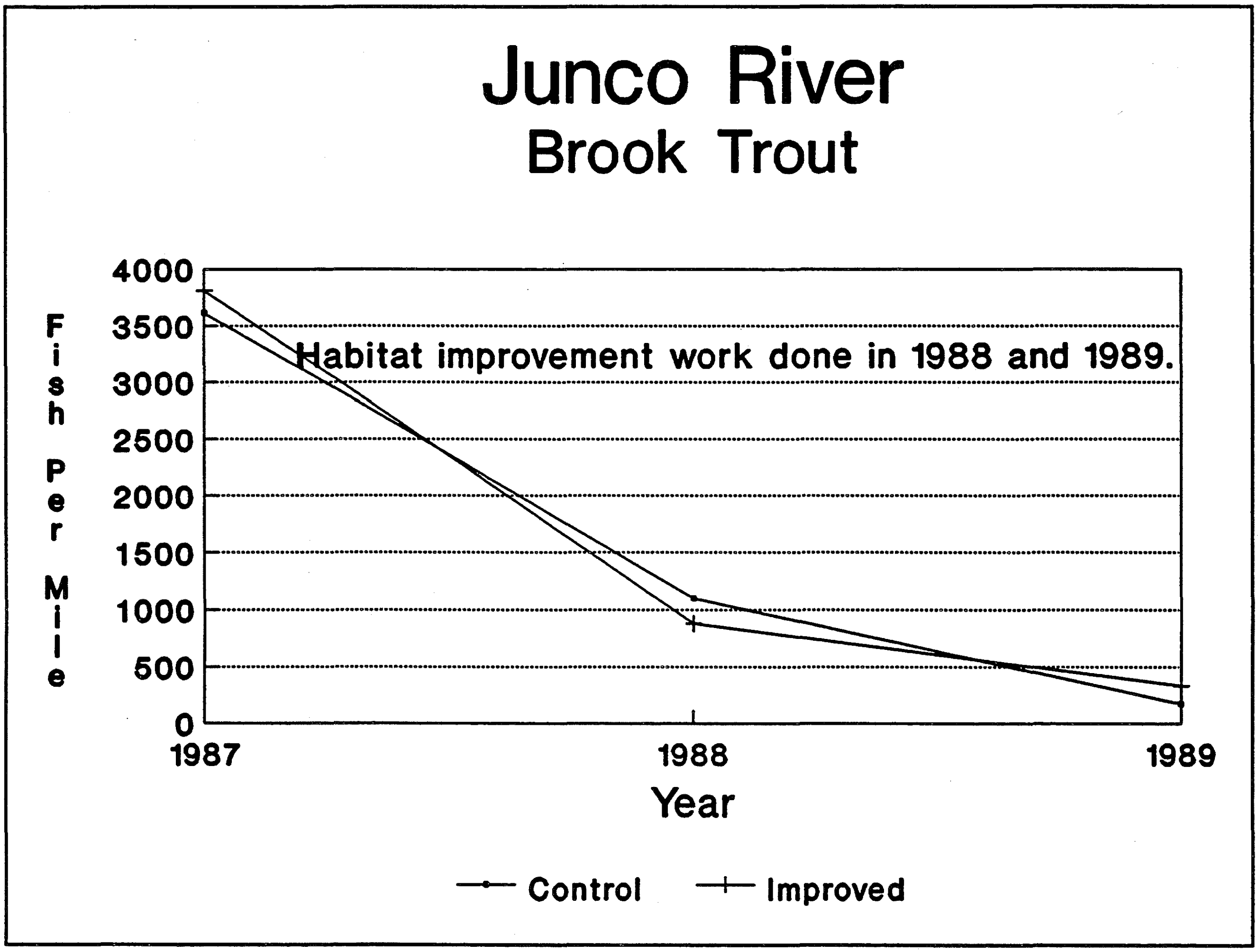
The lower reach must be kept free of barriers so walleye spawning activity is not adversely affected.

Stocking: Annual stocking of 1,000 adipose clipped brook trout yearlings will continue at the Cook County Road 27 crossing (mile 3.6) through 1992, after which stocking will be discontinued. This stocking is unnecessary, but is being continued for the sake of consistency until the current improvement evaluation is done.

Add additional pages if needed

| Stream Name: Junco River | Tributary No: S-67 | Date: 2-06-90 |
|---|---|---|

Figure 1. Brook trout population estimates (fish/mi) from mark-recapture data in a control and improved station on the Junco River, Cook County, Minnesota, 1987-1989.



NA-00000-00

# STREAM MANAGEMENT PLAN

| Region | Area | Stream Name | Tributary No. | Length |
|---|---|---|---|---|
| 5 | Lake City (510) | Cannon River | M-48 | 14.4 mi |

| Similar Reach | Stream Miles | Stream Type | Ecological Classification | Species Managed |
|---|---|---|---|---|
| 2 | 12.7-27.1 | Warmwater | IIA | Smallmouth bass (SMB) |
| | | | | |
| | | | | |
| | | | | |

**Long Range Goal:**

Establish a SMB population that averages 10 lb/acre with 10% of SMB ≥ 12.0 in (of SMB ≥ 9.0 in) for all stations. Improve water quality by participating in the Cannon River Watershed Project.

**Operational Plan:**

1) Assess SMB and channel catfish (CCF) populations in stations 2 and 52 in a minimum of three consecutive years out of every five beginning in 1990.

2) Stock 10,000 CCF (Cannon River or Mississippi River strain) yearlings in 1991 and odd numbered years until 1995, if available.

**Mid-range Objective:**

Assess contributions of CCF stocking. Investigate the utility of implementing SMB special regulations, acquisition and/or easements, and the applicability of habitat improvement techniques.

**Potential Plan:**

Conduct creel/recreational use survey every 10 years on this reach.

Total $ 15,000

| Area Supervisor's Signature | Date: | Regional Manager's Signature | Date: |
|---|---|---|---|
| Larry Gates | 02-07-90 | | |

(see reverse side)

| Stream Name: | Tributary No: | Date: |
| --- | --- | --- |
| Cannon River | M-48 | 02-07-90 |

Narrative: (Reach - Lake Byllesby to Welch Dam)

Various surveys: The first stream survey for the Cannon River, Lake Byllesby to Welch Dam was completed in 1977. The survey reported a considerable smallmouth bass population with good numbers of SMB > 12.0 in supporting moderate fishing pressure. The draining of Lake Byllesby in winter for dam repair in 1977 resulted in a fish kill that severely reduced the SMB population. Recovery has been slow, but has been recently improving.

Population assessments have been conducted in 1970, 1978, 1980 and from 1982-1989. Data from the 1989 assessment showed increased numbers of SMB, but few fish > 12.0 in. The first evidence of substantial SMB reproduction since 1977 was found in 1989. Small populations of other gamefish are present, and abundant in the area immediately below the Byllesby dam.

Recreational use was surveyed for this reach from April-September, 1984 (Hirsch and Peterson 1987). The following pressure estimates were made:

1. Angling 11,804 h
2. Canoeing 21,921 h
3. Tubing 31,661 h
4. Misc. 2,410 h

Harvest rates in this reach were 0.80 fish/h. SMB harvest rate was 0.01 fish/h. Species with high harvest rates were BLB (0.32 fish/h), CRP (0.14 fish/h), and CAP (0.12 fish/h). Harvest rates for other gamefish were less than 0.05 fish/h. Most fishing pressure occurred below the Byllesby Dam with bait fishing predominating (71%). Thirty-two percent of anglers and 66% of canoeists traveled more than 25 mi to visit the Cannon River.

A study of water quality in the Cannon River in 1972 (Colman and Kopach 1972) indicated high levels of nitrogen and phosphorus and a high biochemical oxygen demand at Cannon Falls. The study concluded that the major problems associated with poor water quality were derived from feedlots and farming practices although some urban derived sources were not examined.

An analysis of the historical, cultural, and biological resources were made in 1979 to determine the Cannon Rivers' qualifications for inclusion in the Wild and Scenic River Program (MDNR 1979).

A 1987 survey documented the historical and current distribution of freshwater mussels in the Cannon River drainage (Davis 1988).

Past management: Management has been targeted towards SMB and CCF and these species have been stocked periodically since 1979.

(continued on next page)

| Stream Name: | Tributary No: | Date: |
|---|---|---|
| Cannon River | M-48 | 02-07-90 |

Narrative: (continued)

Stream and watershed alterations: The Cannon River has a protected flow of 97 cfs at Welch. A hydropower facility is operated at Lake Byllesby in a run-of-the-river mode. There are two DOW water appropriation permits. Extensive agricultural use of the watershed reduces water quality. Industrial and urban development may degrade water quality, however, vast improvements in point source pollution have occurred in the last three decades.

Social considerations: The Cannon River is a designated wild and scenic river and canoe route with two designated access sites in this reach. Although most of the land along the Cannon River is privately owned, access is available at several locations along public roads and in Cannon Falls. A bicycle trail runs from Red Wing to Cannon Falls and provides some access to the river.

The Cannon River Project is an organization of public agencies and private individuals concerned about the Cannon River. The project was initiated in 1989 to examine methods that might be implemented throughout the watershed in the next decade to improve the rivers resources.

Cultural and natural elements: Cultural and natural elements are documented in the Cannon River Resource Analysis (MDNR 1979). It is described as one of the most important archaeological sites in Minnesota. Aquatic species of special interest include the wood turtle, Blanding's turtle, and snapping turtle.

Limiting factors: Water quality may limit the distribution of some species. Two fish kills occurred as a result of dam repair operations, and have impacted fish populations. A lack of large, deep pools may limit overwinter habitat for smallmouth bass and channel catfish. The Welch dam limits fish movement from the lower Cannon River and the Mississippi River except during very high discharges.

Survey needs and evaluation plans: The Cannon River will be resurveyed in 1997 to document the effects of land-use changes on the fishery. Recreational use should be surveyed every 10 years to measure changes and anticipate future needs. Population assessments should be conducted in three consecutive years out of five to evaluate management activities.

Land acquisition needs: None are currently recommended, but acquisition should be investigated if it is determined that habitat improvements are desirable. Access is limited in a few areas.

Habitat development needs: No habitat improvement projects are recommended.

(continued on next page)

Add additional pages if needed

| Stream Name: | Tributary No: | Date: |
|---|---|---|
| Cannon River | M-48 | 02-07-90 |

Narrative: (continued)

Habitat protection needs: The most important aspect of habitat is protecting and improving the water quality. The main concerns are improving water quality in tributaries and upstream locations, and ensuring proper operation of the Lake Byllesby dam.

Stocking: Smallmouth bass stocking will be considered in the future if assessments show consistently poor reproduction. Channel catfish will be stocked with Cannon River or Mississippi River strains in 1991 and in odd number years until 1995.

Regulations: Special regulations to improve the fishing quality for smallmouth bass will be investigated.

Literature cited:

Colman, J. and K. Kopach. 1972. A study of the state of pollution of the streams of the Cannon valley watershed. Pub. 3. Cannon Valley Development Association.

Davis, M. 1988. Freshwater mussels of the Cannon River drainage in southeastern Minnesota. MNDNR Nongame Wildlife Report.

Hirsch, S. and D. Peterson. 1987. The Cannon River: recreational use of a warmwater stream. MNDNR Fish Mgmt. Rep. 28.

MNDNR. 1979. Cannon River Resource Analysis. Wild and scenic rivers program.

Add additional pages if needed