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# LAKE SUPERIOR TRIBUTARY SAMPLING GUIDE

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# PREFACE

This guide was prepared for Managers of the North Shore Lake Superior watershed to provide them with fisheries sampling techniques and an activity planning strategy pertinent to the unique salmonid fisheries of the area. The guide recognizes that the diversity of the North Shore fisheries requires special sampling procedures and constant monitoring for effective management.

The authors are indebted to the many individuals in the Section of Fisheries, notably the Area Supervisors of the North Shore, who took the time and effort to provide positive comments on the draft. Their assistance and willingness to implement this guide is the key to proper management of an important Minnesota fishery resource. Comments by the Planning and Programming Supervisor and Lake and Stream Survey Specialist were particularly useful for merging the planning aspects of this guide with more traditional sampling methodologies. Water quality parameters and sampling procedures were updated by the Acid Rain Biologist and Chemistry Laboratory Supervisor of the Ecological Services Section. French River Research Biologists provided invaluable updates to state-of-the-art estimate and analysis procedures.

# LAKE SUPERIOR TRIBUTARY SAMPLING GUIDE

## INTRODUCTION

Streams of the Minnesota Lake Superior watershed (North Shore) are unique ecosystems for fish production. The streams support fisheries for both resident and anadromous salmonid species and provide essential spawning and nursery streams for recruitment of salmonids to Lake Superior. Anglers highly regard the various game fish species and participate enthusiastically in the seasonal fisheries. Fisheries of both long duration and light to moderate intensity and short duration and moderate to heavy intensity have evolved.

The North Shore streams vary significantly among each other and within each stream. Contrasting differences in annual stream discharge, stream length, locations and incidence of natural barriers, gradient and other aspects influence their fisheries.

From a fish manager's perspective, the streams of the North Shore are perplexing. Comprehensive, timely management and evaluation is hampered by the geographic, hydrographic and climatic conditions inherent in the streams as well as the biological characteristics of individual fish species and their life stages. Frequent site by site evaluation and monitoring is further negated by limited budget and manpower resources. Consequently, practical management must rely on infrequent sampling and extrapolation of sample information to entire streams and other stream populations. In light of that necessity, sampling procedures and effort must be comprehensive, pertinent and comparable over time and distance. A standard format for sampling and reporting is necessary to meet these needs.

## FORMAT

The following standardized format relies on the existing methodologies described in the Minnesota Stream Survey Manual, Special Publication No. 120 (SSM) and the Minnesota Statewide Fisheries Lake and Stream Management Planning project [F-29-R (P)]. Some modifications of survey procedures are recommended and additional data pertinent to the unique anadromous salmonids of the North Shore is requested. This format will facilitate utilization of existing data, identify areas of data deficiency and aid in scheduling necessary work on a need-effort basis.

In general, the order of North Shore stream sampling will take the following course:

1. Phase I Survey
2. Fish Management Plan
3. Phase II Survey
4. Creel Survey (census)
5. Management Recommendations
6. Fish Management Plan

## METHODS

### 1. Phase I Survey

Initial survey utilizing map inspection, data of record and general field inspection will identify stream length, similar reach lengths, anadromous and/or sedentary species reaches and the number and location of permanent sampling stations. In addition, an overview of riparian and fishery changes since historical periods of record (Smith and Moyle 1944, Section Files) will be determined.

A. Components of the Phase I survey will include items 1 through 30 D and 39 through 43, pages 4-8 and 21-22 of the Stream Survey Manual (SSM).

B. Procedures for items 11, 12, 20, 24 and 30 of the Stream Survey Manual are adjusted for the North Shore survey.

C. Instructions for completing the Phase I North Shore Stream Survey and the Stream Survey Form.

1. Stream Name

   Use the name given on the appropriate United States Geological Survey (U.S.G.S.) Quadrangle map. If no name is given, use the commonly accepted local name.

2. Alternate Name(s)

3. Tributary I.D. Number

   Numbers have been assigned to the majority of Minnesota streams according to the Minnesota Stream Identification System. Numbers already assigned can be obtained from the Regional Fisheries Headquarters. If no tributary number has been assigned, consult Section II of the Appendix for instructions on assignment of tributary numbers. All new assigned numbers should be submitted to the Regional Headquarters to be entered on the master list.

4. Counties

   List all counties through which the stream passes.

5. Watershed Name and Number

   A map showing the Division of Waters numbering system for watersheds is presented in Section III of the SSM Appendix.

6. Sequence of Waterways to Basin

   List the sequence of waterways leading to major drainage basins (St. Lawrence).

7. Map(s)

   List background information used to prepare the stream map for inclusion with the survey report. Usual sources of data are U.S.G.S. Quadrangle maps and/or aerial photos. List date and name of any Quadrangle map used. Section IV of the SSM Appendix gives instructions for preparation of a stream map.

8. Length of Stream

The stream length should be determined from the largest scale map available or by direct measurement. Measure to the nearest 0.1 mile.

9. Average Width

Average width as determined in SSM 30(f) should be recorded for the uppermost and lowermost sampling station.

10. Mouth Location

List Township, Range and Section and locate on stream map.

11. Flow at Mouth

See Section V of SSM Appendix for details of taking stream flow measurements. For larger rivers or streams, flow data may be obtained from U.S.G.S. or U.S. Army Corps of Engineers. "Water Resources Data for Minnesota" is published annually by U.S.G.S. and contains surface water records and water quality records for many Minnesota streams.

Flow (cfs) should describe the water discharge for the watershed of that stream at the time of work. The flow of each tributary and main stream should be measured at basically the same flow condition (time) to identify tributary importance to stream discharge to Lake Superior.

12. Flow at Gaging Station

On streams where permanent gaging stations are maintained, the minimum, maximum and mean annual discharge should be averaged from the past 15 years of water records.

13. Location of Gaging Station

Describe location as T.R.S. and locate on stream map.

14. Initial Source of Sustained Flow

Describe location as T.R.S. or in terms of miles from mouth. Indicate if source is a spring, surface (bog) seepage, lake, etc. The source should be shown on the stream map if it is a definite point.

15. Gradient

In most cases, stream gradient can be taken from U.S.G.S. Quadrangle maps. The difference in elevation between the source and the mouth divided by the stream length gives the average gradient and should be expressed in feet per mile.

16. Sinuosity

Sinuosity is determined by dividing the down-channel length by the straight line distance between the same points.

17. Description of Watershed

For entire watershed:

a. Soil types - Use general terms, e.g. sand, clay, gravel, sandy silt loam, gravelly clay loam, etc.

Topography - Describe relief of surrounding land, e.g. steep rolling hills, flat grassland, etc.

Land Usage - Use terms such as wooded, open, cropland, pasture, urban or suburban development, industrial, recreation or wild land.

b. For land adjacent to stream (floodplain):

Ownership - Ownership may be private, or local, county, state or federal government.

Cover types - General type of vegetative cover (trees, shrubs, grasses, farmland, etc).

For each of these parameters, approximate percentage breakdowns should be made when several types are involved.

18. Reason for Survey

A stream survey may be conducted for inventory purposes or to solve a specific management problem.

19. Previous Investigations and Surveys

Title, author and date of past investigations and surveys should be listed.

20. Special Problems or Conditions

Factors such as frequent low flows (10% or less of annual average), pollution, erosion, cattle activity, beaver activity, logging activity or logjams which have caused a deterioration of fish habitat or water quality should be noted.

21. Sources of Pollution

Indicate sources of industrial, agricultural or domestic pollution in terms of miles from the mouth and list the substance discharged on the form provided. Show point sources of pollution on the stream map.

22. Erosion

Streambank, gully or sheet erosion which adds a substantial amount of sediment to the stream should be indicated on the form provided. The degree of erosion should be listed as light, moderate or severe and the affected reach indicated in terms of miles from the mouth. Severely eroded stream banks should be shown on the stream map.

23. Stream Alterations

State the location of man-made stream alterations that adversely affect salmonid habitat (excepting dams) and if possible the approximate date the alterations were made. Locate the altered area on the stream map. Logging should be included if activity has degraded fish habitat.

24. Dams, Natural Geologic Barriers and Other Obstructions (include beaver dams)

Type of dam may be earthen, log, concrete, masonry or beaver. Each dam should be listed in terms of miles from mouth and located on the stream map. The "head" is the difference in water elevation above and below the dam. Type of control structure may be gates, flashboards or stoplogs.

Use refers to power, irrigation, recreation, water diversion, etc. Note if the dam is a barrier to fish movement.

Ownership, if possible, should be determined. Condition should be indicated as good, fair or poor for man-made dams.

Status of beaver dams should be listed as active or inactive.

All man-made dams should be shown on the stream map.

Natural geologic barriers should be listed in terms of miles from mouth and located on the stream map. Each should be identified as to its severity as a barrier to upstream fish movement (complete, partial) and the height of fall indicated as % slope (100%, 75%, 40%). The height of vertical falls

(100% slope) and length of falls of lesser slope should be indicated in feet.

25. Use of Water

Each type of water use should be checked in the blanks provided.

26. Access (location and ownership)

Access areas such as public roads, boat ramps and government lands should be listed on the form and shown on the stream map. The approximate percentage of each similar reach covered by easements should be given.

27. Shoreline Developments

Any man-made development that affects the natural character of the streambanks should be noted. Examples are resorts, homes, parks, campgrounds, picnic areas, etc. Important developments should be shown on the stream map.

28. Recreational Boating

a. The navigable reach capable of accommodating recreational boating should be described in terms of miles from the mouth.

b. The type of boating (fishing, hunting, canoeing, power boating, etc.), if any, should be given.

29. Tributaries and Springs

Numbers have been assigned to tributaries of many Minnesota streams according to the Minnesota Stream Identification System. Section 11 of the SSM Appendix provides instructions for determination of existing numbers and for assignment of new numbers. All flowing tributaries should be numbered. The water source should be listed as springs, surface runoff, etc. The bank from which the tributary enters should be designated as right or left, when facing upstream. The length of the tributary should be determined with a map wheel if a sufficiently accurate map is available or by pacing. The width at the mouth can be measured with a tape or an optical range finder. If the tributary is abnormally wide at the mouth, the width should be measured upstream. The location where the tributary enters the main stream should be recorded as miles above the mouth of the mainstream. Flow should be measured as described in Section V of the SSM Appendix. Water stage should be noted as low, normal or high. Record the time, air and water temperatures at the mouth and, if possible, the source. Record the date the tributary was surveyed. If the tributary has fisheries value, this should be discussed under remarks. All tributaries should be shown on the stream map.

30. Stream Physical Conditions

Before physical conditions at a station are surveyed, the Phase I portion of the survey should be completed to determine similar reaches. Similar reaches are portions of the stream without abrupt changes in gradient or predominant bottom type, sinuosity, land use, width, flow, water temperature or water quality. Similar reaches should be designated in terms of miles from mouth. At least one sampling station should be established in each similar reach. If the similar reach is 2 miles or more in length, two sampling stations should be established by dividing the reach into sections and randomly selecting. However, stations in adjacent similar reaches must be far enough apart to reflect changes in stream characteristics. The following data should be recorded at each sampling station. If more than four stations are established, extra forms will be needed.

a. Station no. - Stations will be numbered (lowest to highest) starting at the mouth and progressing upstream.

b. Date - The date(s) on which station data was collected.

c. Location - The downstream boundary of each sampling station should be described in terms of miles from the mouth. Note nearby landmarks to facilitate identification of the station in subsequent surveys.

d. Length of station - Usually 528 feet (0.1 mile) measured along the thalweg but this may be adjusted to include entire pools for fish sampling purposes. Sampling stations may be longer (1,000 feet) on larger rivers or shorter (264 feet) on small brushy or otherwise inaccessible streams. A minimum of three replicates of pool-riffle cycles should be included.

31. History of Stream and Fishing Conditions

a. Comparison with past investigations and surveys - Information from previous investigations and surveys or from knowledge of management personnel should be compared with data collected on the present survey. Changes in physical, chemical or biological characteristics of the stream should be noted.

b. History of fishing conditions - Creel census data or information received from fishermen knowledgeable about the stream should be used to describe changes in fishing success and fishing pressure. Observations on angling during the survey should also be noted.

c. Records of past management -

Fish stocking - All fish stocked over the past 10 years should be listed by year, species, size and number or pounds stocked. Fish stocked prior to 10 years ago should be summed by species and size from the first year of recorded stocking and the first and last year of that period indicated.

Special regulations - Portions of the stream designated as trout water, closed areas or areas subject to any other special regulations including continuous fishing should be listed in terms of miles from the mouth.

Habitat improvement - Information on existing habitat improvement structures should be listed by year of installation on the form provided. The number of each type of structure, the stream reach location, the cost of installation, if available, and the present condition of the structures should be noted. Information on past habitat improvement may be found in stream files.

32. Discussion of Fishery

a. General characteristics - The species most commonly sought and/or taken by angling, the quality of fishing and fishing intensity should be discussed.

b. Fish management problems - This discussion should include only problems related to fish or fishing. Problems such as competition from rough fish, slow growth or low numbers of gamefish, lack of access for anglers or poor fishability due to heavy alder growth should be discussed.

33. Ecological Classification of the Waterway

The stream should be classified according to the species or combination of species for which it is best suited. The Minnesota

Stream Classification System along with a short discussion of each stream type is presented in Section X of the SSM Appendix. A different ecological classification may be applied to different reaches of the stream. Each reach should be delimited. A verbal description of the stream type should be given in addition to the numerical classification. If the stream does not fit any category, give an explanation.

34. Summary

This discussion should summarize the survey findings relating to the physical, chemical and biological characteristics of the stream. If additional information is needed for management purposes, this should be recommended.

35. Credits and Signatures

Sources of funding, names of principal survey personnel, name and title of person(s) preparing the final survey report and signatures of responsible Area and Regional Fisheries Supervisors are to be listed.

## 2. Fish Management Plan

The fish management plan will be a second and ongoing step for application of survey data to fisheries resource management. As the second step of the North Shore stream sampling format, the fish management plan uses Phase I survey data to determine the status of the data base, to identify needs for further sampling, to develop a stream reach and watershed program for completion of initial or current surveys and to establish priorities for continual updating. The initial plan will provide a baseline for evaluation of the planning effort and Federal project objectives. The Section's Fish Management Planning Procedure [F-29-R (P)] provides guidelines for completion.

A. F-29-R(P) Fish Management Planning Procedure

1. Study 1: To formulate fisheries management plans.

   a. List availability of data (Appendix Table A-1).

   b. Develop a schedule for completion of plans (Appendix Table A-2).

   c. Develop a schedule for completion of outdated, partial or unavailable surveys (Appendix Table A-2).

   d. Develop a schedule for completion of outdated, partial or unavailable creel census and new data base (Appendix Table A-2).

2. Plan and action will be completed within the current F-29-R(P) time frame of segments 4-8 ending 31 March 1989.

3. Submit proposed survey planning schedule 15 February 1986 for segment 5 and annually thereafter.

4. Complete and report Management Plans as per SSM Appendix A-4 (pp. 37-38).

3. Phase II Survey

The Phase II survey will provide current physical and biological fisheries information specific to appropriate management of the anadromous and sedentary fish stocks of the North Shore. This survey will encompass the sample stations for streams and stream reaches identified through Phase I surveys. Annual survey will be completed via the schedules of the Fish Management Plan and North Shore Survey Planning Report.

A. Stream Survey Manual Items 30-43 (p. 8-22) are the components of the Phase II Survey (SSM Appendix A-5).

B. Adjustments to procedures include items 30d, 30k, 32, 34e, 34f, 34g, 36 and 37.

C. Instructions for completing the Phase II survey.

1. Stream Physical Conditions

The following data should be recorded at each sampling station. If more than four stations are established, extra forms will be needed. Information items a-d below should correspond to stations and reaches identified and be reported during Phase I survey.

a. Station no. - Stations should be numbered starting at the mouth and progressing upstream.

b. Date - The date(s) on which station data was collected.

c. Location - The downstream boundary of each sampling station should be described in terms of miles from the mouth. Note nearby landmarks to facilitate identification of the station in subsequent surveys.

d. Length of station - Usually 528 feet (0.1 mile) measured along the thalweg but this may be adjusted to include entire pools for fish sampling purposes. Sampling stations may be longer (1,000 feet) on large rivers or shorter (264 feet) on small brushy or otherwise inaccessible streams. A minimum of three replicates of pool-riffle cycles should be included.

e. Percentage of station in pools, riffles and rapids or runs - The length of each type of water in the station should be measured and converted to percentage.

f. Station average width - Average width of the station is determined by calculating weighted average widths (avg. width of each type of water x % of each type by length as determined in 30e) for pools, riffles, rapids and runs and then summing these weighted averages. Example 1 illustrates this procedure.

Individual widths are measured at one-half the length of the pool, riffle, etc. The station in these examples has 3 pools, 3 riffles and 2 runs.

Example 1

| Individual widths | 1 | 2 | 3 | Avg. width | Weighted avg. width |
|---|---|---|---|---|---|
| Pools (55%) | 12.5 ft. | 10.3 ft | 6.9 ft | 29.7/3=9.9 ft | 0.55 x 9.9=5.45 ft |
| Riffles & rapids (20%) | 6.8 ft | 4.2 ft | 5.5 ft | 16.5/3=5.5 ft | 0.20 x 5.5=1.1 ft |
| Runs (25%) | 4.2 ft | 3.8 ft | --- | 8.0/2=4.0 ft | 0.25 x 4.0=1.0 ft |
| | | | | | Station avg. width = 7.55 ft |

g. Station average depth - Average depth of the station is determined by calculating weighted average depths for pools, riffles and rapids and runs and then summing the weighted averages.

Two depth measurements should be taken along the line crossing each pool, riffle or rapids or run at one-half its length. The deepest point along this line is located and the depths are measured at one-half the distance to each shore from this point. Example 2 illustrates this procedure.

If the station is not characterized by pools, riffles and rapids and runs but instead has similar habitat throughout, a randomization system should be used for width and depth determinations. Generally, the station is divided into segments 100 feet in length. Then, using a table of random numbers, a two digit number is chosen for each segment representing the number of feet from the start of the segment where width and depth measurements should be taken.

Example 2

| Individual depth | 1 | 2 | 3 | Avg. depth | Weighted avg. depth |
|---|---|---|---|---|---|
| | 3.2 ft | 1.6 ft | 4.1 ft | | |
| | 1.8 ft | 2.0 ft | 1.7 ft | | |
| | 5.0/2= | 3.6/2= | 5.8/2= | 7.2/3= | |
| Pools (55%) | 2.5 ft | 1.8 ft | 2.9 ft | 2.4 ft | 0.55 x 2.4=1.32 ft |
| | 1.0 ft | 1.2 ft | 0.8 ft | | |
| | 0.6 ft | 0.6 ft | 0.6 ft | | |
| Riffles & | 1.6/2= | 1.8/2= | 1.4/2= | 2.4/3= | |
| rapids (20% | 0.8 ft | 0.9 ft | 0.7 ft | 0.8 ft | 0.20 x 0.8= .16 ft |
| | 1.5 ft | 1.4 ft | --- | | |
| | 1.3 ft | 1.8 ft | --- | | |
| | 2.8/2= | 3.2/2= | | 3.0/2= | |
| Runs (25%) | 1.4 ft | 1.6 ft | | 1.5 ft | 0.25 x 1.5= .38 ft |
| | | | | | Station avg. depth = 1.86 ft |

h. Flow - Instructions for measuring stream flow are given in Section V of SSM Appendix.

i. High water mark - Expressed as inches or feet above normal. Water lines on trees or streambank vegetation, debris on trees or fences or bank erosion can provide evidence of previous high water conditions. Reliable local sources may also provide information.

j. Present stream stage - Expressed as high, normal or low.

k. Banks - Height of banks is estimated from visual observation or measured and the slope estimated in degrees (90, 60, 45, 30, etc.). The degree of bank erosion should be measured and expressed as a percent of total bank length (both banks). The degree of altered banks due to unnatural activity should be measured and noted as a percentage. Bank alteration due to unnatural activity should be measured and noted as a percentage. Bank alteration due to mechanical channelization (C), livestock grazing (G) or logging (L) should be listed individually. Bank or streamside cover should be denoted as a percent composition. Streamside cover is the material on or above the stream bank which influences the aquatic environment by providing bank protection from erosion, stream shading, or escape or resting security for fish. Major streamside cover elements should be classified as shrub vegetation, tree vegetation, grass or herb vegetation, or exposed bare material (soil, rock, concrete).

l. Shade - The portion of the station shaded by a vegetative canopy or by nearby bluffs or hills should be expressed as follows:

| | |
|---|---|
| light: | 0-25 percent shaded |
| moderate: | 26-75 percent shaded |
| heavy: | over 75 percent shaded |

m. Pools - Pools have low velocity (usually less than 1.0 fps at normal summer flows), a surface that appears smooth on a calm day, fine bottom materials (silt, sand, small gravel) and may be deep or shallow. Shallow pools are sometimes referred to as bars or flats. Pools are classified as follows:

Type A - Good cover, 3 feet or deeper

B - Good cover, less than 3 feet

C - Poor cover, 3 feet or deeper

D - Poor cover, less than 3 feet

The number of pools of each type in the station should be listed on the form.

Widths and depths should be measured and averages determined as described in 30f and 30g. Average width, width range, average depth and maximum depth for pools should be recorded in the space provided on the form.

Bottom types in pools should be listed and percentages estimated for each station. The following bottom types should be used:

Ledge rock - large mass of solid rock

Boulder - over 10" in diameter

Rubble - 3" to 10" in diameter

Gravel - 1/8" to 3" in diameter

Sand - less than 1/8" in diameter

Silt - fine material with little grittiness

Clay - compact, sticky material

Muck - decomposed organic matter, usually black

Detritus - organic material composed of sticks, leaves, decaying plants, etc.

Marl - calcareous material

n. Riffles and rapids - usually have velocities greater than 1.0 fps at normal summer flows, coarse bottom materials (gravel, rubble, boulder), are 2 feet or less in depth and show at least slight turbulence on the surface on a calm day. Rapids are more turbulent than riffles and usually have greater velocities.

In addition to average width, width range, average depth and maximum depth, maximum velocity should be measured in all riffles or rapids in the station and the range of measurements shown on the form. Bottom types should be listed and percentages of each estimated for all stations.

o. Runs - Runs are usually deeper than 2 feet and have a velocity greater than 1.0 fps at normal summer flows. Width, depth and velocity information required for runs is the same as required for riffles and rapids.

Bottom types should be listed and percentages of each estimated for all stations.

p. Other - Other types of habitat may occur in streams that do not fit in any of the above categories. A short verbal description should be used to describe other types of habitat. Cascades or bedrock areas are recognized as separate habitat types by some investigators (Seehorn 1970). Tailwaters below dams would also fall in this category. The same parameters are measured as for riffles and rapids and runs.

q. Location - The location of each similar reach as determined by the Phase I survey should be expressed as follows: 0 to 1.6 miles above the mouth, 1.6 to 2.4 miles above the mouth, etc.

r. Gradient - Station data is intended to be representative of the entire similar reach. Gradient measured over short stations may vary considerably, therefore, gradient should be measured over the entire similar reach and expressed as inches/100 ft., ft./mile or percent.

s. Sinuosity - As with gradient, sinuosity can vary considerably over short distances and should be measured for the entire similar reach. Sinuosity is calculated by dividing the length of the stream course within the similar reach by the straight line distance from the upper to the lower end of the similar reach.

t. Channel changes - During the phase II survey, evidence of past channel changes should be noted. Recent aerial photos may also provide evidence of channel braiding or shifting or may reveal old channels or oxbow lakes. The approximate percentage of the existing channel which shows evidence of past channel changes should be indicated for each similar reach. If it is not feasible to calculate a percentage, describe channel changes as slight, moderate or extensive.

2. Characteristics of Water

Water samples are collected and analyzed to give a general description of water quality and productivity potential in the stream, to help identify specific sources of pollution and to measure sensitivity or influence of acid precipitation. Most water quality parameters are measured at the Division's Chemistry Laboratory but simple water quality measurements may be made in the field using appropriate analytical field kits or the techniques in Section VI of the SSM Appendix.

Water quality records are available for some Minnesota streams and published annually by U.S.G.S. in "Water Resources Data for Minnesota." The Minnesota Pollution Control Agency, Division of Water Quality, Section of Surface and Ground Waters, also maintains computerized records of water quality for various streams. If current records are available, water samples may be unnecessary.

The specific water quality parameters to be checked will vary with the situation. Where general information on water quality is desired, the following parameters will be determined:

a. pH

b. Total alkalinity

c. Turbidity

d. Total phosphorus

e. Total nitrogen

d. Nitrates

g. Ammonia

h. Chloride

i. Sulfate

Streams determined to have low alkalinity ($\leq$10 mg/1 $CaCO_3$) should be sampled for acid precipitation input. Water sampling at peak snowmelt to monitor the worst case should be completed in addition to each general water quality sample. Water quality parameters, significance and necessary procedures include:

a. Total alkalinity - laboratory gran plot titrations on all waters that are extremely sensitive to acid inputs ($\leq$5 ppm $CaCO_3$);

b. Total acidity - determine the nature of the acid (organic/inorganic);

c. Color - provide further information on the origin of acidity. Measured in cobalt/platinum units for standardization with acid precipitation research;

d. Aluminum - evaluate toxicity and dose-exposure threat (labile aluminum concentrations of 0.3-0.5 mg/l can be acutely toxic to fish at pH 5.5 or less and more toxic at pH 5.5 than 4.5 for most species). Measured by the 8-hydroxyquinoline method to separate labile and total aluminum; and

e. Calcium - important cation in the determination of acid sensitivity and the interpretation of other parameters.

Free carbon dioxide should be measured below heavy ground water sources if fish are not present. Carbon dioxide levels decline rapidly after the water comes in contact with the air. Measurements of free $CO_2$ and dissolved oxygen should always be made in the field.

If a source of organic pollution is suspected, biochemical oxygen demand (BOD) should also be measured. Where discharges from industries are involved, the situation should be discussed with the Chemistry Laboratory to decide what additional parameters should be measured.

The frequency and number of water samples is determined by the length of stream or river being surveyed and the number of suspected pollution sources. Where the length of the stream being surveyed is long, it may be desirable to collect a water sample in each similar reach. Where a source of pollution is evident, water samples should be collected upstream and downstream of the source and a sample of the effluent obtained. With the exception of acid precipitation samples, water should always be collected during periods of normal or near normal flow. Appropriate sample containers may be obtained from the Chemistry Laboratory. Each container should be rinsed at least once with water from the point of collection. Samples for general water quality analysis should be kept cool and in the dark until they reach the laboratory. The use of chloroform is no longer recommended. Samples should be delivered to the Chemistry Lab within 48 hours of collection and preferably on the day of collection. Each sample bottle must be labeled so that the scientist at the lab can document where the sample was collected, the collection date, the name of the collector and the name of the report recipient. Detailed instructions listing the water quality parameters to be measured need only accompany non-routine samples. Analytical work and non-routine samples should be discussed and scheduled by calling the laboratory well in advance.

The following data should be recorded at each sampling station:

Station no. - Should correspond to stations established under Stream Physical Characteristics.

Date - The date(s) on which station data was collected.

Location - Same as 30 C.

Length of station - Same as 30 D.

Time - Refers to the time at which air and water temperatures were recorded.

Air temperature - Should be taken with a pocket thermometer, absolutely dry and shaded from the sun at a site where the water temperature does not affect the air temperature.

Water temperature - Should be taken in a place shaded from the direct rays of the sun.

Color - State whether the water is colorless, brown, green, etc., and to what degree it is stained.

Cause of color - Color may be caused by suspended silt, bog drainage, algae, pollution, etc.

Secchi disc - See instructions in Section VI of the SSM Appendix. Blanks are provided on the "Characteristics of Water" form for most water quality parameters for which information may be desired. Extra lines are provided for other parameters not listed. Water samples are not necessarily collected at each station, so only one or two columns of the form are normally used.

Section VII of the SSM Appendix provides general information on interpretation of various water quality parameters. Moyle (1952) is a useful reference for explanation of the significance of various water quality parameters in fisheries management.

3. Temperature Profile

Continuous chart recorders provide continuous temperature information and can delimit the duration of maximum and minimum temperatures as well as those extremes. The units are submerged (hidden) in the streambed and left unattended. These units should be utilized where preliminary information suggests a problem may exist to determine the severity of temperature limits within the stream. Chart ranges should encompass 0 to 30 C (32-86 F). Temperature information reported should include daily recordings of minimum and maximum data for the warmest two week period of the summer. If water temperatures exceed the maximum threshold of a species, the minimum, maximum and stress event data should be recorded each day. The stress event data includes the number of hours the temperature exceeded the maximum for a species each day and the total number of degrees exceeding the maximum for the species during that interval. A stress unit description is estimated by combining both data (Appendix A-3).

Salmonid Extreme Temperatures

| Species | Fish Survival | Egg Incubation Max. | Egg Incubation Min. |
|---|---|---|---|
| Rainbow | 21C (70F) | 19C (66F) | 2.8C (37F) |
| Brown | 24C (75F) | 19C | 1.0C (34F) |
| Brook | 20C (68F) | 12C (54F) | 4.0C (39F) |
| Chinook | 25C (77F) | 14C (57F) | 0.6C (33F) |
| Pink Salmon | 25C | 14C | 0.6C |

4. Biological Characteristics

Aquatic plants and invertebrates are indicative of the water quality and general condition of the stream. Aquatic plants provide cover for fish and harbor many food organisms. Invertebrates are the major food for many fish species and include insects, annelids, molluscs, flatworms, roundworms and crustaceans.

a. Station no. - Should correspond to stations established under Stream Physical Conditions.

b. Date - The date(s) on which station data was collected.

c. Location - Same as 30 C.

d. Length of station - Same as 30 D.

e. Aquatic plants or filamentous algae - emergent, floating - leaf or submerged aquatic plants or filamentous algae should be recorded for each station on the form provided and abundance of each indicated as follows:

A - abundant　　R - rare

C - common　　P - present

O - occasional

Aquatic plants and filamentous algae can be readily identified to genera and some to species in the field or they may be preserved for later identification. Carlson and Moyle (1968) or Fassett (1960) are useful references for identification of aquatic plants. Prescott (1962) is often used for identification of algae.

When listing aquatic plants, use scientific names or the common names given in Carlson and Moyle (1968).

f. Distribution of aquatic plants - Distribution of aquatic plants throughout the length and cross section of the stream should be described. If distribution differs in pools and riffles, this should be noted.

g. Common invertebrates - Invertebrates in streams can be examined using techniques varying with the type of stream and the desired degree of precision. In most cases, only qualitative data is needed for a basic stream survey. In small streams, drift nets are excellent for collecting a sample of invertebrates but such collections do not indicate the source of the organisms. Elliot (1970) discusses methodology for sampling invertebrate drift in running water. A sample of invertebrates can also be obtained by overturning rocks upstream from a net or a section of common window screen which collects the dislodged organisms. A Surber sampler is useful for collecting invertebrates in riffles (less than 18" deep).

In larger streams and rivers, grab samplers such as the Ekman or Peterson dredge may be useful. Descriptions of these devices are given in Standard Methods (1971).

Artificial substrates such as multiple-plate samplers or rock basket samplers may also be used but require a long exposure period (about 6 weeks).

Invertebrates should be sampled in early summer since many forms have emerged by mid-July.

Most samples can be stored in small vials but large bottles are required for dredge samples. The sample should be preserved in 70% ethanol.

Identification to order or family is sufficient for general survey purposes and can usually be done with a binocular microscope (50X magnification). For species identification, mount all or part of the organisms on a glass slide and examine it with a compound microscope. Identification to genus or species is usually not necessary for a basic stream survey.

Hilsenhoff (1975) provides an excellent key for identification of aquatic insects. Pennak (1953) is a commonly used reference for identification of aquatic invertebrates.

5. Fishery Characteristics

Fish, like aquatic plants and invertebrates, are indicative of the water quality and general condition of the stream. Species composition, abundance and condition of the fish population indicate what management measures are needed.

a. Station no. - Should correspond to stations established under Stream Physical Conditions.

b. Date - The date(s) on which station data was collected

c. Location - Same as 30 C.

d. Length of station - Same as 30 D.

e. Gear

Electrofishing gear is used for sampling fish populations. Since conductivity is low for streams of this watershed, direct current electrofishing although most desirable will be least effective. Consequently, two options should be followed for effective sampling. Salt should be distributed by either broadcasting directly above the electrofishing effort or by placing a perforated bucket of crushed salt or a solid block of salt above the sampling reach sufficiently far to permit salt to mix across the entire stream channel. Enough salt to maintain sufficient amperage (0.8-1.5 amp small streams, 1.0-3.0 amp larger streams) for fish capture should be used. In some cases a higher voltage (600V, AC) can be used without salt to give the desired amperage. Backpacks or other electrofishing power supplies and systems can be modified for an electric seine. Electric seines can be used effectively in low conductivity water with or without salt and are inexpensive and rapid. Electric seines consist of a power supply, a brail and electric cord electrode system (Appendix A-4). The electric cord electrode provides a larger field in low conductive water than probe type electrodes and can be visibly directed for more effective "fishing".

f. Amount of Sampling Effort

Electrofishing collection of fish will be conducted to provide a repeatable (precise) and accurate estimate of game fish numbers, biomass and size structure. Estimates of each parameter within each sampling station will indicate abundance within each similar reach. Estimates will be made by either the removal method (small-moderate streams) or mark-recapture technique. Removal methods are recommended because they are very efficient, are completed during one visit, provide results comparable through time (statistical) and have simple calculations. An interactive BASIC computer program using the Zippin (1956) method is described by Higgins (1985). In addition, a modified Zippin method was demonstrated by Carl and Strub (1978). The modifications are advantageous where successive catches become larger rather than smaller or where total capture is apparent. A computer program has been developed in-house for this method (S. Colvin, French River Research, personal communication 1985). Details of this method are not included here. Also, movement of some species out of the sampled reach may make recapture estimates invalid.

1) Two-Pass Method (Seber and LeCren 1967)

Requires: two passes with the electrofisher; no fish move into or out of the sample area (use block nets downstream or electric barrier upstream if possible); all fish possible be collected; each pass is given equal effort; two passes remove at least 60% of the population; and N is larger than 200 fish.

Calculations:

a) $$N = \frac{(C_1)^2 - C_2}{(C_1 - C_2)}$$

where: N = fish estimate
$C_1$ = number caught during pass 1
$C_2$ = number caught during pass 2

b) $$SE = \frac{C_1 C_2}{(C_1 - C_2)^2} \sqrt{(C_1 + C_2)}$$

where SE = standard error of the estimate

c) Confidence Interval (P90) = 2SE

Example:

| Length Category | No. collected $C_1$ | $C_2$ |
|---|---|---|
| <6" | 72 | 28 |
| $\geq$6" | 47 | 19 |
| All fish | 119 | 47 |

| | $<6$ in. fish | $\geq 6$ in. fish | All fish |
|---|---|---|---|
| N = | $\frac{(72)^2-28}{72-28}$ = 117 fish | $\frac{(47)^2-19}{47-19}$ = 78 fish | $\frac{(119)^2(47)}{119-47}$ = 197 fish |
| SE = | $\frac{(72)(28)}{(72-28)^2}\sqrt{(72+28)}$ | $\frac{(47)(19)}{(47-19)^2}\sqrt{(47+19)}$ | $\frac{(119)(47)}{(119-47)^2}\sqrt{(119+47)}$ |
| N±2SE = | 117±21 fish | 78±18 fish | 196±28 fish |

2) Multiple-Step Method (Moran 1951; Zippin 1956)

a) Requires: more than two catches to remove 50-70% of the population or N is 50 fish or more; no animals move into or out of the sample area (use block nets downstream or electric barrier upstream if possible); all fish possible are collected; and each pass is given equal effort.

b) Calculations:

(1) $T = C_1 + C_2 + \ldots C_x$

where:
$T$ = total catch
$C_x$ = catch of last pass

(2) $R = \frac{(1-1)\ C_1 + (2-1)\ C_2 + .. + (X-1)\ C_x}{T}$

where:
R = ratio of successive catch to total catches.

(3) Q = the proportion of the fish captured during all removals from Table of Q values.

(4) P = the probability of capture during a single removal from Table of P values.

(5) $N = \frac{T}{Q}$

(6) $$SE = \sqrt{\frac{N(N-T)T}{T^2 - N(N-T)\frac{(XP)^2}{1-P}}}$$

(7) CI(P95) = ± 2SE when N 200
CI(P90) = ± 2SE when N 50-200

Example:

| Catch | $C_1$ | $C_2$ | $C_3$ | $C_4$ |
|---|---|---|---|---|
| N. | 119 | 47 | 54 | 10 |

$T = 119 + 47 + 54 + 10 = 230$

$R = \frac{(1)47 + 2(54) + 3(10)}{230} = 0.8$ Note: (1-1) $C_1 = 0$

$Q_4 = 0.93$ (from Table)

$P_4 = 0.46$ (from Table)

$N = \frac{230}{0.93} = 247$

$X = 4$ (no. of passes)

$$SE = \sqrt{\frac{247(247-230)230}{(230)^2 - 247(247-230)\frac{(4[0.46])^2}{(1-0.46)}}}$$

$$= \sqrt{36.3} = 6.03$$

CI (P95) = 12.06 Note: ± 2SE

N = 247 ± 12 fish

Table of Q values at known R. Multiple pass removal population estimate (Zippin 1956).

| 3 passes | | 4 passes | | 5 passes | |
|---|---|---|---|---|---|
| R | Q | R | Q | R | Q |
| 1.0 | 0.0 | 1.5 | 0.0 | 2.0 | 0.0 |
| 0.9 | 0.36 | 1.4 | 0.3 | 1.9 | 0.225 |
| 0.8 | 0.59 | 1.3 | 0.48 | 1.8 | 0.35 |
| 0.7 | 0.75 | 1.2 | 0.62 | 1.7 | 0.54 |
| 0.6 | 0.85 | 1.1 | 0.74 | 1.6 | 0.65 |
| 0.5 | 0.92 | 1.0 | 0.82 | 1.5 | 0.725 |
| 0.4 | 0.95 | 0.9 | 0.87 | 1.4 | 0.78 |
| 0.3 | 0.975 | 0.8 | 0.93 | 1.3 | 0.845 |
| 0.2 | 0.98 | 0.7 | 0.95 | 1.2 | 0.88 |
| 0.1 | 1.0 | 0.6 | 0.97 | 1.0 | 0.95 |
| 0.0 | 1.0 | 0.5 | 0.98 | 0.8 | 0.97 |
| | | 0.4 | 0.99 | 0.6 | 0.9 |
| | | 0.2 | 1.00 | 0.4 | 1.0 |
| | | 0.0 | 1.00 | 0.0 | 1.0 |

Table of P values at known R. Multiple pass removal population estimate (Zippin 1956).

| 3 passes | | 4 passes | | 5 passes | |
|---|---|---|---|---|---|
| R | Q | R | Q | R | Q |
| 1.0 | 0.0 | 1.5 | 0 | 2.0 | 0 |
| 0.9 | 0.125 | 1.4 | 0.075 | 1.9 | 0.05 |
| 0.8 | 0.25 | 1.3 | 0.14 | 1.8 | 0.10 |
| 0.7 | 0.375 | 1.2 | 0.21 | 1.7 | 0.19 |
| 0.6 | 0.475 | 1.1 | 0.27 | 1.6 | 0.19 |
| 0.5 | 0.57 | 1.0 | 0.35 | 1.5 | 0.225 |
| 0.4 | 0.67 | 0.9 | 0.40 | 1.4 | 0.26 |
| 0.4 | 0.67 | 0.8 | 0.46 | 1.3 | 0.31 |
| 0.3 | 0.75 | 0.7 | 0.525 | 1.2 | 0.36 |
| 0.2 | 0.82 | 0.6 | 0.58 | 1.2 | 0.36 |
| 0.1 | 0.90 | 0.5 | 0.645 | 1.0 | 0.44 |
| 0.0 | 1.00 | 0.4 | 0.70 | 0.8 | 0.52 |
| | | 0.3 | 0.76 | 0.6 | 0.61 |
| | | 0.2 | 0.83 | 0.4 | 0.71 |
| | | 0.1 | 0.90 | 0.2 | 0.84 |
| | | 0.0 | 1.00 | 0.1 | 0.90 |
| | | | | 0.0 | 1.00 |

Estimates should be made for each species and life stage. Life stage should consider Y-O-Y, juveniles and adult fish. Actual lengths will vary but may approach the following scheme (from past records).

| Species | Life stage size increments (in) Y-O-Y | Juvenile | Adults |
|---|---|---|---|
| Brook trout | 2.5 | 2.6-6.5 | 6.5+ |
| Brown trout | 2.5 | 2.6-7.5 | 7.5+ |
| Chinook salmon | 2.3 | 2.3 | --- |
| Rainbow trout | 2.5 | 2.6-8.0 | 8.5+ |

g. Anadromous Adult Stocks

Anadromous adults are only short term components of the North Shore watershed but are an important part of that fishery. Information pertaining to stock abundance in relation to species recruitment and harvest is necessary. Indices of abundance and reach importance can be developed by direct observation. These indices can be useful in establishing long term population trends, stream distribution and reach importance for each species.

1) Adult Counts - Fall spawning species can be readily detected due to water clarity and low discharge. Counts of individuals observed in anadromous reaches should be made annually at the assumed peak of spawning for each species. Pink salmon and chinook salmon should lend themselves to this technique. Other species may be less obvious (brown, rainbow, brook trout) and therefore uncountable.

2) Redd Counts - Redds of fall spawning species may be readily visible in clear streams. Newly formed redds are lighter in color than the undisturbed channel. Counts made at the end of spawning by chinook salmon, brown trout and brook trout can be used as indices. Spring spawning steelhead redds may be less obvious due to high, turbid water conditions during spawning. Careful observation of probable spawning sites at the ends of pools can detect redds. Smaller tributaries may provide valuable trend reaches for a larger stream system.

Redd detection can be learned; however, experienced personnel should provide supervision and training of inexperienced observers. Polaroid sunglasses should be worn to reduce surface glare.

All direct counts should be completed at regular intervals and at times repeatable in future years. Counts should be recorded by 0.25 mile segments of longer streams or reaches and 0.1 mile segments of short reaches. Poor visibility may limit counts to short sections of total reaches. Also, after initial counts, key reaches of spawning concentration may be identified and selected as trend count sections for entire reaches. A form for recording observations is provided (A-5).

h. Species present - All fish collected, including young-of-the-year, should be identified in the field if possible, weighed and measured, and game fish released unharmed. Additional copies of the "Fishery Characteristics" form should be obtained for recording data in the field. An approved anesthetic may be used to handle larger game fish without injury, especially during warm weather. Live cars should be used when fish are held for removal estimates. Individual total lengths should be recorded for each species of game fish. A representative sample of weights of game fish including the smallest to the largest fish should be collected for length-weight regression. The age and growth sample should include fish weight. Nongame species should be measured and a total weight determined for each species. An estimate of percent capture success should be indicated and whenever possible these species should be included in removal method population estimates.

Fish that cannot be identified in the field must be retained for later identification. A fixative-preservative such as 10% formalin may be used for long or short term storage. Alcohol preservation (70-75% ethanol or 50% propanol) is satisfactory for short term preservation and makes working with the specimens more pleasant. Ten to 15 days after preservation in 10% formalin, the specimens should be rinsed in tap water and transferred to 70% ethanol or 50% propanol. Eddy and Underhill (1974) is a useful reference for identification of Minnesota fishes.

When listing fish on the form, use scientific names or the common names recommended in Special Publication No. 6, American Fisheries Society (1970) or its successor. Section IX of the SSM Appendix lists the common and scientific names for

Minnesota fish species.

6. Length-Frequency Distributions

   The number of individuals in each length category should be recorded for all game fish species on the form provided.

7. Age and Growth of Game Fish

   Age and growth should be a feature of Phase II initial survey following the SSM guidelines. A periodic review of age and growth features of each stream population should be completed at least every 6 years (three year rotational scheme).

   It is usually not necessary to read all scales collected for general survey work. The following procedure as outlined in the Section's Manual of Instructions for Lake Survey (Scidmore 1970) should be used to choose a subsample for age and growth analysis.

   Take scale envelopes and arrange in order of increasing length. Subdivide into 0.5 or 1.0 inch length groups. Use 0.5 inch interval for species which usually do not exceed 12.0 inches total length and 1.0 inch intervals for species which commonly reach a larger size. Choose a subsample as follows:

   For length groups with 5 scale samples or less - read all samples;

   For length groups with 6-10 scale samples - read 5 samples;

   For length groups with 11-20 scale samples - read every other sample from smallest to largest; and

   For length groups with 21 or more scale samples - read 10 samples selected at equal intervals throughout that length group.

a. Age-class distributions - After the subsample has been chosen, scales are then pressed, aged and the number of fish in each age group recorded on the form provided.

b. Growth rate - growth of a fish's body is usually assumed to be directly proportional to growth of its scales, bones or spines. The length at each annulus can be calculated using the formula $L_n = \frac{Sn}{S}(L-a) + a$

where:

$L_n$ is the length of the fish at annulus n

$S_n$ is the length from the scale focus to annulus n

S is the length from the scale focus to the anterior margin

L is the length of the fish at time of capture

a is a body scale constant.

"a" values can be calculated from a sample by linear regression:

$$a = \frac{L - b\Sigma S}{N} \quad \text{where } b = \frac{SL - \Sigma S \Sigma L}{S^2 - \frac{(\Sigma S)^2}{N}}$$

Growth calculations can be simplified by utilization of computer software such as Disbcal.

Calculate average length at last annulus for each year class represented by at least five individuals and record on the form provided. The number of fish (N) in the sample should be recorded in parentheses after the average length at last annulus.

8. Escape Cover for Game Fish

For each sampling station the amount of cover should be measured and indicated. Cover is defined as sheltered areas in a stream channel where a trout can rest or hide from predaceous enemies (Arnette 1976). Such things as log jams (LJ), overhanging vegetation (OV), undercut banks (UB), instream vegetation (IV), boulders (B), water depth (WD), rough water surface (WS), channel debris (CD) or other elements (OE) of fish cover should be noted and measured (square feet). The square feet of available cover should be converted to a percent of the stream channel area and listed.

9. Portion of Stream Suitable for Game Fish

If game fish are present in the stream, the portion of the stream where each species is found should delimited in terms of miles from the mouth. Occasional individuals should be ignored in making this determination. If game fish are not present but the habitat appears suitable, the apparent suitable habitat reach should be delimited in terms of miles from the mouth.

10. History of Stream and Fishing Conditions (Phase I instructions item 31)

    a. Comparison with past investigations and surveys.

    b. History of fishing conditions.

    c. Records of past management - Fish stocking, special regulations, habitat improvement or other activity.

11. Discussion of Fishery (Phase I instructions item 31).

    a. General characteristics

    b. Fish management problems

12. Ecological Classification of the Waterway (Phase I instructions item 33).

13. Summary

This discussion should summarize the survey findings relating to the physical, chemical and biological characteristics of the stream. If additional information is needed for management proposes, this should be recommended.

14. Credits and Signatures

Sources of funding, names of principal survey personnel, name and title of person(s) preparing the final survey report and signatures of Area and Regional Fisheries Supervisors are to be listed.

D. Phase II Survey, Frequency

1. Complete Phase II surveys need updating at least every 10 years to monitor any changes in physical and chemical factors of the environment that influence the fish population or associated biota.

2. Fish assessment portions of the survey should be completed annually for all stations of major streams and triennially for minor streams. A rotational scheme should be developed to sample small streams each year to meet the triennial survey requirement.

| Major Streams | Management Area |
|---|---|
| Lester River | 202 |
| Sucker River | 202 |
| Knife River | 202 |
| Cascade River | 204 |

| | |
|---|---|
| Temperance River | 204 |
| Brule River | 204 |
| Baptism River | 206 |
| Gooseberry River | 206 |
| Split Rock River | 206 |

3. Special assessment of specific objectives may be required more frequently or more often during a year. Priorities will be determined during the Management Planning process.

4. Creel Survey (Census)

   Angler use and consumption of the resource must be understood in light of its relationship to resource supply and angler allocation. Harvestable surpluses of juvenile and adult stocks are limited by the low productivity inherent in North Shore streams. At the same time, anadromous fisheries are highly visible. Proper management for sustained yield goals, equitable angler distribution and for establishing anadromous and resident species management priorities requires periodic assessment of angling intensity and quality biologic impact.

   a. Factors to be estimated

      1) Harvest by species
      2) Harvest by stream reach
      3) Harvest by number and weight
      4) Size composition in creel
      5) CPUE
      6) Angling effort by stream reach
      7) Angler perceptions
      8) Angler satisfaction

b. Frequency of Census (Appendix A-6)

1) Anadromous Fishery - spring

a) Major streams - 6 of 9 years

(1) Knife River

b) Secondary streams - 4 of 10 years

(1) Nemadji-Blackhoof (3 of 10 years)

(2) Sucker River

(3) Stewart River

(4) Split Rock

(5) Baptism River

(6) Cascade River

(7) Devil Track River

(8) Brule River

c) North Shore watershed - twice each 8 years (Close and Siesennop 1984)

d) Other streams and frequencies as needed for specific objectives - F-32-D(S).

2) Anadromous fishery - fall (1 September-15 November)

a) North Shore watershed - twice each 10 years.

b) Major streams - 4 of 10 years

(1) Lester River (202)

(2) Sucker River (202)

(3) Knife River (202)

(4) Stewart River (202)

(5) Temperance River (204)

(6) Cascade River (204)

(7) Devil Track River (204)

(8) Brule River (204)

(9) Gooseberry River (206)

(10) Beaver River (206)

(11) Baptism River (206)

(12) Caribou River (206)

(13) Cross River (206)

3) Resident trout fishery (15 April-30 September or opening to closing)

a) Major and secondary streams - once each 5 years

b) Tertiary streams - once each 10 years.

c) Establish design by clustering (Appendix A-7, A-8)

(1) By stream system

(2) By access convenience

(3) By census periodicity

(4) By combination of objective, logistics and stream significance.

d) Census objectives

(1) Levels of use and harvest

(a) Initial

(b) Trend

(2) Secondary and tertiary streams

(a) Relative use - average anglers/count

(b) Relative harvest - catch rates, species composition

4. Management Recommendations

The culmination of the preceding survey procedure is development of recommendations for optimal management of the North Shore stream fishery resources. Recommendations are by necessity an ongoing process adapting to resource and angler flux. They serve as records of future direction and need and past events.

A. Stream Survey Manual, pages 38-40

B. Recommendations

   1. By reach
   2. By stream
   3. By stream system
   4. By area

C. Reporting

   1. F-29-R(P) annually 14 February, St. Paul

5. Fish Management Plan

This aspect of the Fish Management Plan ties back to the original plan developed in Step Two. Accumulation and application of data obtained during preceding activities may result in changes in management direction or response to resource dynamics. Management plans, schedules, etc. will be redeveloped to guide activities within realistic time frames to continually monitor the resource for wise management and evaluate management recommendations and resultant actions.

6. Future Activities

Recent developments in physical habitat description, measurement procedures and aerial enumeration of fish stocks offer potential for comprehensive monitoring programs in addition to the field survey techniques. Remote sensing techniques using aerial photography, computer interpretation of physical habitat and spawning stock enumeration are available for testing. This program should be explored and assessed for application to our North Shore fishery management program. Advantages would mean rapid and comprehensive assessments of habitat and anadromous stocks of fish.

Telephone survey methodology utilizing the trout and salmon stamp as a data base should be explored to minimize the creel survey efforts required of area personnel. In addition to or in lieu of a stamp survey program, an anadromous permit system for the Lake Superior watershed should be explored to provide a data base for telephone survey and estimates of Lake Superior and anadromous North Shore stream fisheries parameters.

The Section is making strides in computerizing our resource data base. As that capability develops, the data recording format may change to expedite data entry, retrieval and utilization.

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APPENDIX

NORTH SHORE STREAM SURVEY STATUS REPORT
Sheet 1

Area: Name____________________ Code__________

Date_______________

| I.D.No. | Stream | Reach | Survey station | Status of Activity | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Phase I survey | Fish Mgt. plan | Phase II survey | Creel survey | Management rec. |
| | | | | | | | | |
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# NORTH SHORE STREAM SURVEY STATUS REPORT

## INSTRUCTION SHEET

I.D. No. - Minnesota Stream Identification System number. Listed in sequence, lowest number to highest.

Stream - Stream name

Reach - Description of similar reach by miles (nearest 0.1 mile). One line each reach.

Survey Station - Give survey station number or numbers required to describe the stream reach. List consecutive numbers proceeding from the downstream confluence upstream to its headwater beginning.

Status Activity - Give status of the management activity and date of most recent activity.

N - No information

C - Complete

P - Partial data, partial completion

Month/year - Month/year of most recent data or activity.

Example:

| Phase I survey | Fish mgt. plan | Phase II survey | Creel survey | Management rec. |
|---|---|---|---|---|
| 2/85-C | 2/85-C | 4/69-P | N | N |

Interpretation:

Phase I survey and fish management plan was completed from historical record and partial Phase II survey data April 1969. Creel survey is lacking for a comprehensive management plan. The February 1985 fish management plan should indicate deficient areas of information and activities needed.

NORTH SHORE SURVEY PLANNING REPORT
Sheet 2

Schedule of Activity

| I.D.No. | Reach | Survey station | FY ____ I P II C R | FY ____ I P II C R | FY ____ I P II C R | FY ____ I P II C R | FY ____ I P II C R |
|---|---|---|---|---|---|---|---|

NORTH SHORE STREAM SURVEY PLANNING REPORT

INSTRUCTION SHEET

Identification - corresponds to Sheet 1 to schedule activities indicated lacking on Sheet 1.

I.D. No. - Minnesota Stream Identification number

Reach - Description of similar reach by miles (nearest 0.1 mile). One line each reach.

Survey Station - Survey station number or numbers defined in Sheet 1.

Schedule - Fiscal year schedule of anticipated activity to complete and update survey and management information. Fiscal years should be indicated beginning with FY 85-86 through FY 89-90, and a check made indicating which activity is planned for completion each fiscal year.

I - Phase I Survey
P - Fish Management Plan
II - Phase II Survey
C - Creel Survey
R - Fish Management Recommendations

Example:

| FY 85 | | | | | FY 86 | | | | | FY 87 | | | | | FY 88 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | P | II | C | R | I | P | II | C | R | I | P | II | C | R | I | P | II | C | R |
| | | X | | X | | | | X | X | | | | X | X | | X | | | |

Interpretation:

In conjunction with the Appendix A-1 example, Phase II survey is scheduled for completion during the 1985 field season and management recommendations initiated. Creel census activity is scheduled for 1986 and 1987 with management recommendations incorporating harvest implications. A revised and current fish management plan will be completed in 1988 considering all information pertinent to the stream and watershed systems.

32. Thermograph Temperature Profile

STREAM ______________________________

| Date[1] | Location | Daily Min. | | Daily Max. | | Extreme Event[2] | |
|---|---|---|---|---|---|---|---|
| | | Time | Temp. | Time | Temp. | Hrs. | Stress Units |
| | | | | | | | |

1. Warmest 2 week period or entire period of excessive or restrictive temperatures if longer. Show daily temperatures.
2. Extreme event is calculated for primary species. Example: brook trout (BRT) 68F max:

| | | | | | | |
|---|---|---|---|---|---|---|
| time (p.m.) | 3 | 4 | 5 | 6 | 7 | 8 |
| temp (F) | 68 | 70 | 73 | 77 | 73 | 68 |
| Stress Units | 0 | 2 | 5 | 9 | 5 | 0 |

hrs - 5; stress units = 21 BKT

# A DEPENDABLE BACKPACK ELECTROFISHING UNIT

by

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Through the years those of us using backpack electrofishing units as a sampling tool for trout streams in North Carolina have encountered numerous problems with the units now on the market. We have now built what we believe to be a highly dependable backpack electrofishing unit by mounting the Echo SRM-302-ADX motor of the Echo SRM-202-D motor to an alternator. The motors are distributed by the Kioritz Corporation of America, 350 Wainwright, Northbrook, Illinois, 60062. The alternators are manufactured by Holly Products Corporation, P.O. Box 96, Cass City, Michigan, 48726.

The motors, both the SRM-302-ADX and the SRM-202-D, are Echo motors used to run a power scythe. Both engines are two-cycle air-cooled with flywheel magnetos, recoil starters and utilize a 20;1 gas-oil mixture. The SRM-302-ADX is a 30.1 cc engine while the SRM-202-D is a 20.9 engine. The alternators are self-contained units and are pre-wired for an output of 220 volts A.C.

A milled adapter was needed to connect the engine and the alternator. Once the engine and alternators were connected they were mounted to a custom built backpack frame with a shelf at its base. The throttles on both motors were adjusted to run the alternator at 220 volts A.C. The completed SRM-302-ADX unit weighs 9.2 kg (Fig. 1) while the SRM-202-ADX and SRM-202-D electrofishing units weighs 12.1 kg and each has proven to be highly dependable. Both start quickly when either hot or cold, will not leak gas, will run at any angle and require very little maintenance. If trouble does develop with the motors, they can be repaired by an Echo dealer.

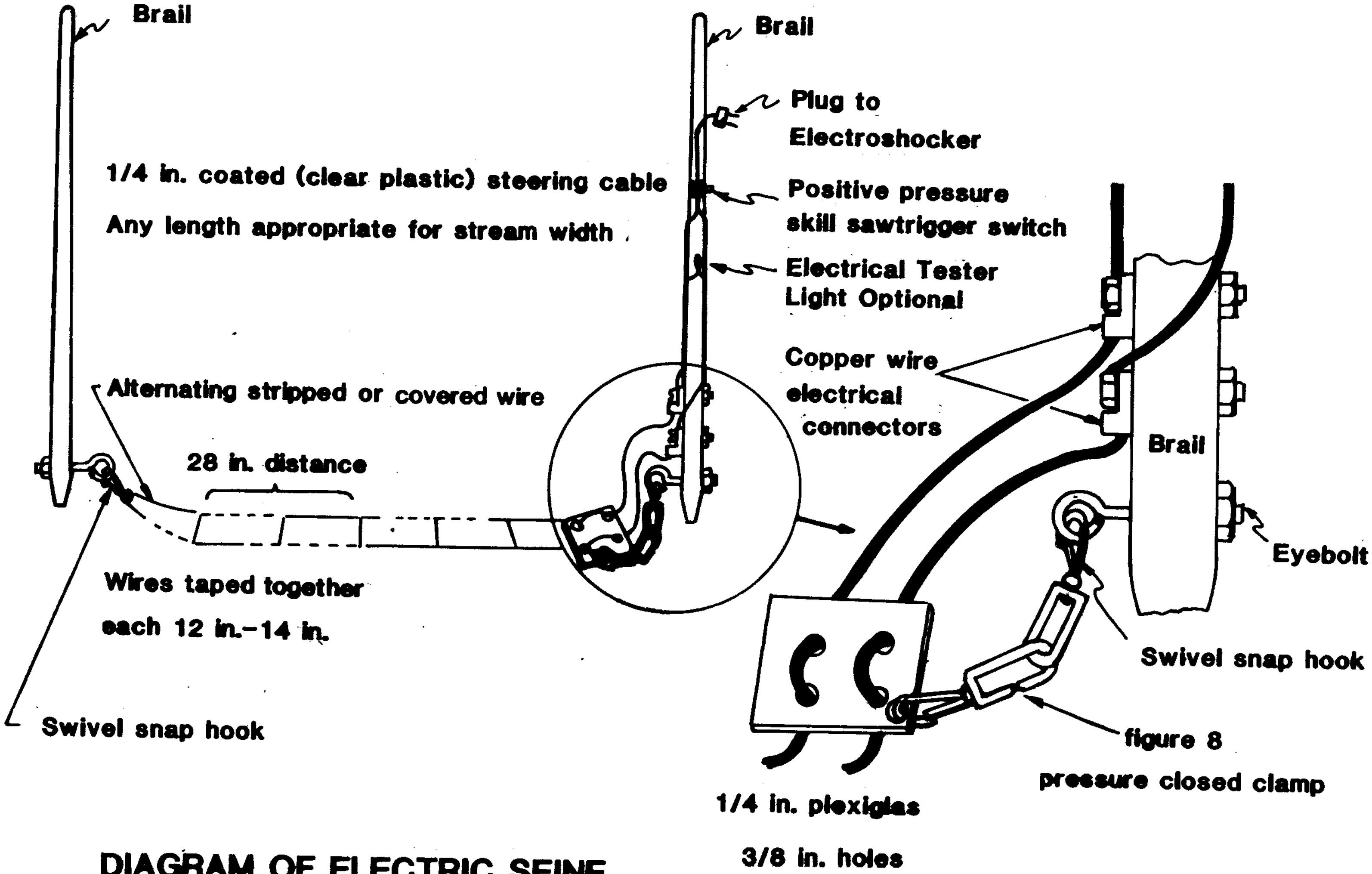


DIAGRAM OF ELECTRIC SEINE

FISH AND REDD COUNT SUMMARY

Salmonid Count Indices ____________________

Stream ____________________ Date __________

Observers ____________________ Time ______

Water: clarity _______________ stage _______________

Species ____________________

| Stream location | No. redds | Fish Observed | |
|---|---|---|---|
| | | Alive | Carcasses |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL | | | |

Remarks:

INSTRUCTIONS: FISH AND REDD COUNT SUMMARY

Stage - Water level general condition (high, low, intermediate).

Species - Single sheet for each species if two or more species are involved.

Stream Location - Distance from mouth of stream by 0.1 mile segments for short stream (  1 mile) or 0.25 mile segments for longer streams, i.e. 0.0-0.1, 0.1-0.2, 0.2-0.3 or 0.0-0.25, 0.25-0.5, 0.5-0.75. USGS quad sheets provide good sources to determine map distance and field locations.

Remarks - May include any pertinent items such as locations and description of barriers to fish migration, descriptions of spawning sites or materials or other items pertinent to fish spawning.

MAJOR STREAM SPRING ANADROMOUS CREEL PERIODICITY - EXAMPLE

| Area | Stream | Census Year 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 202 | Knife River | X | X | | X | X | | X | X | | X | X | | X | X | |
| | Sucker River | | X | | | X | | X | X | | | X | | | X | |
| | Stewart River | | X | | | X | | X | X | | | X | | | X | |
| | Blackhoof (Nemadji) River[a] | | | X | | | X | | | X | | | X | | | X |
| | Other streams | | | | | | | X | X | | | | | | | |
| 206 | Split Rock River | | X | | | X | | X | X | | | X | | | X | |
| | Baptism River | | X | | | X | | X | X | | | X | | | X | |
| | Other streams | | | | | | | X | X | | | | | | | |
| 204 | Cascade River | | X | | | X | | X | X | | | X | | | X | |
| | Devil Track River | | X | | | X | | X | X | | | X | | | | |
| | Brule River | | X | | | X | | X | X | | | X | | | X | |
| | Other streams | | | | | | | | | | | | | | | |
| % of fishery censused[a] | | 30 | 70 | –[a] | 30 | 70 | –[a] | 100 | 100 | –[a] | 30 | 70 | –[a] | 30 | 70 | -- |

[a] Not censused during the 1981-1982 North Shore creel (Close and Siesennop 1984).

POSSIBLE NORTH SHORE CREEL CENSUS CLUSTER SYSTEM

| Census systems | No. streams | Fishery type[a] | | | Fishery impt.[b] | | | System description |
|---|---|---|---|---|---|---|---|---|
| | | S.T. | Rbt | C. | Rbt | S.T. | F. | |
| Nemadji River | 17 | 8 | 2 | 7 | X | X | X | |
| St. Louis River | 15 | 13 | 0 | 2 | | X | | |
| Duluth - metro | 13 | 9 | 0 | 4 | X | X | X | Chester Cr.-Sucker R. |
| Knife River | 8 | 1 | 0 | 7 | X | X | | |
| South Shore, North | 13 | 6 | 2 | 5 | X | X | X | Stewart R.-Gooseberry R. |
| FR. RIVER AREA | 66 | 37 | 4 | 25 | 4 | 5 | 2 | |
| Central Shore, South | 16 | 8 | 3 | 5 | X | X | X | Twin Points Cr.-Palisade Cr. |
| Baptism River | 15 | 11 | 0 | 4 | X | X | X | |
| Central Shore, Central | 11 | 7 | 2 | 2 | | X | X | Little Marais R.-Caribou R. |
| Central Shore, North | 11 | 3 | 6 | 2 | | X | X | Sugarloaf R.-Cross R. |
| FINLAND AREA | 53 | 29 | 11 | 13 | 2 | 2 | 2 | |
| Temperance River | 14 | 13 | 0 | 1 | | X | X | |
| North Shore, South | 12 | 6 | 3 | 3 | | | X | Onion R.-Indian Camp |
| North Shore, Central | 10 | 7 | 1 | 2 | * | X | X | Cascade R.-Rosebush Cr. |
| Devil Track-Upper Brule River | 14 | 12 | 0 | 2 | * | X | X | |
| North Shore, North | 16 | 3 | 7 | 6 | * | X | X | Durfee Cr.-Swamp R. |
| GRAND MARAIS AREA | 66 | 41 | 11 | 14 | 3 | 5 | 4 | |

[a] S.T. - stream trout (brook, brown)
Rbt - anadromous rainbow spring
C - both S.T. and Rbt
F - fall anadromous fisheries

[b] Important stream fisheries occur

RESIDENT STREAM TROUT CREEL CENSUS SCHEDULE - EXAMPLE

| Area | Census system | Year of census 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 202 | Nemadji River | | | X | | | | | | X | | | | | | X |
| | St. Louis River (Lower) | | | | | | X | | | | | | X | | | |
| | Duluth-Metro | | X | | | | | | X | | | | | | X | |
| | Knife River | X | | | | | | X | | | | | | X | | |
| | South Shore, North | | | | | X | | | | | | X | | | | |
| 206 | Central Shore, South | | | | | X | | | X | | | X | | | X | |
| | Baptism River | | X | | | | | X | | | | | X | | | |
| | Central Shore, Central | X | | | | | X | | | | X | | | | | X |
| | Central Shore, North | | | X | | | | | | X | | | | X | | |
| 204 | Temperance River | X | | | | | X | | | | | | X | | | |
| | North Shore, South | | | | X | | | | | X | | | | | | X |
| | North Shore, Central | | X | | | | | X | | | | X | | | | |
| | Devil Track-Upper Brule | | | | | X | | | | | X | | | | X | |
| | North Shore, North | | | X | | | | | X | | | | X | | | |