MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
SECTION OF FISHERIES

Manual of Instructions for Lake Survey

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1993

PREFACE

This publication represents the third release of a manual of instructions for conducting lake surveys. The original manual was prepared by John Moyle and Charles Burrows in 1954. The first revision of the manual was released in 1970 (W.C. Scidmore, MN DNR Special Publication No. 1). The current release represents a change in the way some elements of lake surveys are conducted. These changes are based on an increased commitment to habitat monitoring and data management and retrieval. This document is meant to serve as a companion to the Stream Survey Manual and the management planning guides for lakes and streams. This manual, and the lakes data base which was developed concurrently, will serve as the cornerstone on which management decisions are based.

I would like to personally thank the committee which made this revision possible. Members included Tim Schlagenhaft-Chair, Harlan Fierstine, Steve Persons, Kit Nelson, Dave Coahran, Brad Koenen, Gary Grunwald, Bruce Gilbertson, and Dennis Schupp. Others who contributed significantly to the preparation of the manual include Tom Narum, Dave Wright, Tim Brastrup, Joe Marcino, Jeff Gorton and Henry Drewes. Thanks also to Charles Anderson for editing the manual, and to Ron Payer and Steve Hirsch for providing project oversight.

Jack Skrypek
Chief of the Fisheries Section
March, 1993

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INTRODUCTION

Surveys are the foundation of Minnesota's lake management program. They are needed to collect physical, chemical and biological information concerning habitat, water quality, and fish population characteristics. Surveys allow us to develop lake specific management plans, evaluate management techniques such as stocking and harvest regulations, and help monitor long term changes or trends in aquatic environments.

This document provides instructions for conducting "standard" lake surveys. A computerized data base has been developed to store, analyze, retrieve and report information collected following methods described in this manual. In recognition that a "standard" survey may not always yield the information needed for each lake situation, the option of "special sampling" is also provided, and in most circumstances will be supported by the data base.

Forms provided in this manual allow collection of field data. Field data will be entered into the data base from which a variety of final reports (completed survey report, historical net catch summary, etc.) can be generated.

Several publications describe other sampling methods and techniques used to manage Minnesota's fisheries resource. These include: **Lake Management Planning Guide**, Special Publication No. 132 (Section of Fisheries 1983), **Large Lake Sampling Guide**, Special Publication No. 140 (Wingate and Schupp 1985), **Minnesota Stream Survey Manual**, Special Publication No. 120 (Sternberg 1978); "**Stream Management Planning Guide**," (in press); and "**Lake Superior Tributary Sampling Guide**," Special Publication No. 141 (Pitman and Wingate 1986).

SURVEY TYPES

Two types of surveys are standard, **full surveys** and **population assessments**. Deviations from standard surveys are considered **special sampling**. New sampling techniques, more effective equipment, special management investigations, and greater emphasis on ecosystem management dictate the need for special sampling. A brief overview of each of the three survey types is provided below.

Full Surveys:

Full surveys involve a detailed evaluation of a lake's physical, chemical and biological characteristics. They are the most comprehensive surveys conducted.

Full surveys are of two types, **1) initial** or **2) resurvey**. Initial surveys are the first step in lake management. Management activities cannot be implemented until an initial survey has been conducted. Resurveys are completed when it is necessary to document changes that have occurred since the last full survey. If major changes have not occurred or are unknown, a resurvey should be conducted a minimum of once every third time the lake is sampled. If a lake is sampled annually, a full survey should be completed at least once every 5 years.

Full surveys require completion of the following sections of this manual:

- General Information
- Mapping
- Habitat Evaluation
- Water Quality
- Electrofishing - (required only for lakes where largemouth or smallmouth bass are the primary species in the lake management plan)
- Gill Netting
- Trap Netting
- Seining
- Age and Growth

All field data collection forms in Appendix 2 (Forms 1-13) are required (excluding Form 10 if electrofishing is not conducted). Instructions and example forms are also provided in each chapter.

Population Assessments:

Population assessments are condensed versions of full surveys and concentrate primarily on water quality and fish population characteristics. They are less time consuming and expensive than full surveys, yet they allow us to continue to collect updated information needed to evaluate management activities and monitor long term trends. Population assessments should be conducted when a full survey is not required.

Population assessments require completion of the following sections of this manual:

- Water Quality - (in most cases, water samples are not required for laboratory analysis - see Water Quality Sampling section)
- Electrofishing - (required only for lakes where largemouth or smallmouth bass are the primary species in the lake management plan)
- Gill Netting
- Trap Netting
- Age and Growth

In addition, if conditions have changed from the previous survey, the Habitat Evaluation Section should be completed for Water Levels (page 3-2), Erosion or Pollution (page 3-8), and Additional Field Notes (page 3-24). Aquatic vegetation sampling is encouraged but not required. Seining is optional.

Population assessments require completion of Forms 9, 11, and 13. Forms 10 (electrofishing) and 12 (seining) are optional. Instructions and example forms are provided in each chapter as well as Appendix 2.

Special Sampling:

Special sampling is designed for specific management situations (winterkill evaluations, species specific sampling, natural reproduction monitoring, etc.) where standard sampling is either not sufficient or unnecessary. Most special sampling will be supported by the data base. Methods for special sampling will vary among Areas, however examples of current special sampling techniques are provided in this manual (page 11-1) as guidelines.

Use the same forms for special sampling as for standard sampling (Appendix 2). Each special sampling method will list what forms to complete.

Additional Considerations:

Areas planning creel surveys or other special investigations not covered in this manual should consider conducting these activities simultaneously with lake surveys.

SAMPLING CONSIDERATIONS

Sampling Frequency:

Sampling frequency is dependant upon the number of lakes in a particular management area, priority ranking of each lake, and the number that can be surveyed annually. Statewide, each lake is surveyed an average of once every 8.9 years. Ideally, highest priority lakes will be sampled a minimum of once every three years, with lowest priority lakes sampled at least once in 20 years. A sampling schedule should be developed for each Area that identifies the years in which each lake will be surveyed, as well as the type of survey. Survey frequency should be listed on the lake management plan.

If possible, each area should coordinate it's efforts such that management plans for specific lakes are developed or revised within one year following completion of lake surveys. This will ensure management plans are evaluated using current data and will simplify designing a sampling schedule.

The number of lakes that can be sampled annually is dependent upon the type of survey, available equipment and personnel, and estimated data entry time. Careful planning can improve the efficiency of survey crews and increase the number of lake surveys that can be completed during a given year.

Sampling Effort:

Sampling involves collecting a portion of a population that adequately represents the entire population. The reliability of a sample is often dependent upon it's accuracy and precision. Accuracy reflects how close the sample is to the true value, while precision is determined by how closely the sample can be repeated. Accuracy and precision increase when the sample size and number of sampling occurrences increase. For example, estimates of fish size structure will generally improve if you increase the number of fish in the sample and the number of habitats and stations sampled. The same holds true with catch per unit effort data, where increasing the number of net sets will generally improve the reliability of the mean number of fish

per set. There comes a point however, when increasing the sample size results in a limited gain in reliability. The objective of sampling therefore, is to obtain a large enough sample size to produce reliable data, yet limit the effort expended in order to save time and money and still produce reliable results. Sampling efforts required in this manual for specific gear types were developed based upon this objective.

Sampling Stations:

Selection of sampling stations requires careful consideration and is dependent upon the type of information desired. When collecting standard survey data (full surveys and population assessments), the investigator must avoid selecting only those stations they feel will catch the most fish. The objective of this type of sampling is not to collect a lot of fish, but rather a representative portion of the population. By randomly sampling a variety of habitats, the investigator can reduce the biases associated with selective sampling and provide a more representative picture of the "overall" fishery.

On the other hand, when a specific type of information is desired (for example, size distribution of largemouth bass), the investigator should concentrate their effort in appropriate habitats. This does not mean collecting fish from only one sample station with a known concentration of fish, but rather selecting several sampling stations that represent the types of habitats that the species prefers. In these situations, sampling habitats in which the species is not located will result in lost time and small sample sizes.

Once adequate sampling stations are established, **THEY MUST REMAIN CONSISTENT FROM YEAR TO YEAR**. For most lakes, sampling stations have already been determined. All sampling stations must be permanently recorded on the "Sampling Station" map with location descriptions recorded on Form 2 and entered into the data base. The "Mapping" section provides instructions and information on completing the Sampling Station map.

Standardized Sampling:

Consistency within sampling is essential. Because fish movements and location change seasonally and by life stage, Areas should plan sampling schedules such that a particular lake is surveyed within the same time frame (within 2-3 weeks) and in a similar manner (gear selection and methods) from survey to survey. This applies to lakes under long-term special sampling projects as well. Consistent sampling will reduce the biases associated with specific methods and improve our reliability on year-to-year comparisons within specific lakes.

Gear Selectivity:

Four standardized gear types or methods are used to sample fish populations during lake surveys: 1) gill nets, 2) trap nets, 3) seines and 4) electrofishing. Additional gear (trawls, electric weirs, hydroacoustics, etc.) or modifications to standard gear (non-standard gill nets, trap nets, and seines) may also be used for special sampling.

Each gear type and method is selective for the species, size, sex or life stage of fish it captures. Because of this selectivity, standard lake surveys require a variety of gears in order to adequately sample the various fish species and sizes within a specific lake. Where information on only one species is desired (special sampling), it is acceptable to use the gear type most efficient at sampling that particular species.

Considerable research has been conducted on the sampling bias and selectivity associated with various gear types (Appendix 1). From this research, target species have been identified for specific gears. A description of each gear type, including target species, sampling considerations and required sampling methods, are provided in this manual.

GENERAL INFORMATION

General information concerning lake size, area, depth, public accesses, lake classification, etc. is needed to describe each lake, and should be recorded on Form 1. Instructions are provided on page 1-2.

In most cases, this information is available from previous surveys. Once completed, the information on Form 1 should not need revision (other than listing the type of survey) unless major changes occur (such as addition of a new public access). Additional information (such as shoreline development index and percent littoral area) will be calculated by the data base from information provided on Form 1. The data base will include information from Form 1 in the survey report.

INSTRUCTIONS FOR FORM 1 - GENERAL INFORMATION

1) Lake Name:

List the most common or accepted lake name.

2) Alternative Name:

List any additional names the lake is known by.

3) DOW Number:

Division of Waters lake identification number from "An Inventory of Minnesota Lakes", Bulletin No. 25.

4) Survey ID (Starting Date):

Date in which field work began for the entire survey or assessment.

5) Area Code:

Fisheries area code.

6) Map ID#:

List the number of the most recent lake sounding map.

7) Type of Survey:

Check the appropriate box. If special sampling, briefly describe it's type (for example, spring trap netting for muskie).

8) County(ies):

List the county(ies) in which the lake is located.

9) Nearest Town:

List the nearest town (include approximate distance and direction, for example 1 mile N and 3 miles E of Hibbing).

10) Legal Description:

List township(s), range(s) and section(s) in which the lake is located. Space is available for up to nine descriptions.

11) Access - ID#:

List the identification number for each access. Accesses should be identified as AC1, AC2, etc. The location should also be marked on the sampling station map with location coordinates recorded on Form 2.

12) Access - Ownership:

List the access owner from the following codes:

(DNR) DNR owned
(UFS) US Forest Service
(COU) County
(COE) US Corp of Engineers
(FWS) US Fish and Wildlife Service
(CIT) City
(TOW) Township
(NPS) National Park Service
(O) Other
(X) Unknown

13) Access - Type:

Choose the type of access from the following codes:

(CA) Carry-in
(EA) Earthen ramp
(CO) Concrete ramp
(GR) Gravel ramp
(O) Other (describe in comments section)

14) Access - Location Description/Comments:

Written description of the location of each access and any additional comments of interest.

15) Previous Surveys and Investigations:

List the year of each previous initial survey, resurvey, population assessment, creel or other sampling. Once this is completed the first time, the data base will update for subsequent surveys.

16 Total Lake Area:

List the surface acreage (planimetered) from the most recent lake sounding map. For border waters, list both the total surface acreage (entire lake) and the Minnesota surface acreage (Minnesota portion only).

17) DOW Acres:

List lake acreage from "An Inventory of Minnesota Lakes", Bulletin No. 25.

18) Watershed Size:

List the size of the watershed in acres from Division of Waters data. Leave blank if unknown.

19) Maximum Depth:

List the maximum depth in feet from the most recent lake sounding map. If a lake sounding map is unavailable, do not record maximum depth.

20) Mean Depth:

List the mean depth in feet from the most recent lake sounding map. If a lake sounding map is unavailable, do not record mean depth.

21) Littoral Acres:

Record the number of littoral acres (area of the lake 15 ft deep or less) from the most recent lake sounding map. If a lake sounding map is unavailable, do not record littoral acres.

22) Shoreline Length:

Record shoreline length in miles from the most recent lake contour map, or using a map wheel on a USGS quadrangle map. Do not include islands.

23) Maximum Fetch and Orientation:

Record the maximum fetch in miles and tenths at any given point across the lake from the most recent lake contour map, or using a map wheel on a USGS quadrangle map. Maximum fetch is the greatest straight line distance that does not cross islands or other land masses. Also describe orientation using a 16 pt. compass (e.g. NNW-SSE).

24) Lake Class Number:

Lake classification number from "A Limnological Classification of Minnesota Lakes and Associated Fish Communities (Schupp, in press)."

25) Alternate Lake Class Number:

Alternate lake classification number from "A Limnological Classification of Minnesota Lakes and Associated Fish Communities."

26) Major Watershed Number:

List the major watershed unit in which the lake is located (see Appendix 7).

27) Minor Watershed Number:

List the minor watershed unit in which the lake is located, if known.

28) Primary USGS Quad Map (7.5) Code:

List the USGS quadrangle map code in which the lake is located.

FORM 1 - GENERAL INFORMATION

Data Recorder(s) _____

1) Lake Name: _____ 2) Alternative Name: _____

3) DOW #: _____ 4) Survey ID (Starting Date) _____ 5) Area Code: _____ 6) Map ID#: _____

7) Type of Survey: Initial ☐ Resurvey ☐ Population Assessment ☐

Special Sampling ☐ (describe special sampling): _____

8) County(ies): _____ 9) Nearest Town[a]: _____

10) Legal Description

Township	Range	Section(s)

Township	Range	Section(s)

Township	Range	Section(s)

Access

11) ID #	12) Ownership[b]	13) Type[c]	14) Location Description / Comments
AC			
AC			
AC			
AC			
AC			
AC			

15) Previous Surveys and Investigations: Initial Survey: _____ Resurvey(s): _____

Population Assessment(s): _____ Creel(s): _____

Other (describe): _____

16) Total Lake Area: _____ acres, Area in MN: _____ acres 17) DOW Acres: _____ 18) Watershed Size: _____ acres

19) Max. Depth: _____ ft. 20) Mean Depth: _____ ft. 21) Littoral Acres: _____ 22) Shoreline Length[d]: _____ mi.

23) Max. Fetch[e]: _____ mi., Orientation: _____ 24) Lake Class #: _____ 25) Alt. Lake Class #: _____

26) Major Watershed #: _____ 27) Minor Watershed #:_____ 28) Primary USGS Quad Map (7.5) Code: _____

(a) Include angular distance and direction to lake in parenthesis (e.g., 3 miles North and 1 mile East).

(b) (DNR), (UFS), (COU)nty, (COE), (FWS), (CIT)y, (TOW)nship, (NPS), (O)ther (describe in comments), (X) Unknown.

(c) (CA)rry-in, (E)arthen, (CO)ncrete, (G)ravel, (O)ther (describe in comments).

(d) Do not include Islands.

(e) Longest straight line without intersecting any land mass. Orientation from 16-point compass (e.g., NNW-SSE).

*Include access locations (AC1, AC2, etc.) on Habitat Evaluation map and record location description on Form 2.

FORM 1 - GENERAL INFORMATION

Data Recorder(s) P. Hogan

1) Lake Name: Elbow 2) Alternative Name:

3) DOW #: 69-744 4) Survey ID (Starting Date) 6/1/1992 5) Area Code: 250 6) Map ID#: 8425

7) Type of Survey: Initial ☐ Resurvey ☑ Population Assessment ☐

Special Sampling ☐ (describe special sampling):

8) County(ies): St. Louis 9) Nearest Town[a]: 8 miles east and 3 miles south of Orr, MN

10) Legal Description

Township	Range	Section(s)
64N	18W	11,14,15,16,19,20, 21,22,27,28,29,30

Township	Range	Section(s)

Township	Range	Section(s)

Access

11) ID #	12) Ownership[b]	13) Type[c]	14) Location Description / Comments
AC 1	DNR	6	On NE side of lake off of the state forest road south of Co. 23.
AC 2	COU	6	On SW side of lake off of Co. 426.
AC			
AC			
AC			
AC			

15) Previous Surveys and Investigations: Initial Survey: 1969 Resurvey(s): 1981

Population Assessment(s): 1990, 1988, 1986, 1983, 1978, 1974. Creel(s):

Other (describe): Lake Survey 1954. Shoreline Seining 1987, 1985, 1982, 1980. 0.25" Trapnets 1986

16) Total Lake Area: 1659 acres, Area in MN: 1659 acres 17) DOW Acres: 1528 18) Watershed Size: acre

19) Max. Depth: 60 ft. 20) Mean Depth: ft. 21) Littoral Acres: 664 22) Shoreline Length[d]: 19.8 mi

23) Max. Fetch[e]: 4.2 mi., Orientation: NE-SW 24) Lake Class #: 7 25) Alt. Lake Class #:

26) Major Watershed #: 76 27) Minor Watershed #: 28) Primary USGS Quad Map (7.5) Code: F19C

(a) Include angular distance and direction to lake in parenthesis (e.g., 3 miles North and 1 mile East).

(b) (DNR), (UFS), (COU)nty, (COE), (FWS), (CIT)y, (TOW)nship, (NPS), (O)ther (describe in comments), (X) Unknown.

(c) (CA)rry-in, (E)arthen, (CO)ncrete, (G)ravel, (O)ther (describe in comments).

(d) Do not include Islands.

(e) Longest straight line without intersecting any land mass. Orientation from 16-point compass (e.g., NNW-SSE).

*Include access locations (AC1, AC2, etc.) on Habitat Evaluation map and record location description on Form 2.

MAPPING

Mapping is critical to the lake survey program. Maps are needed to locate sampling stations, identify resorts, dams, access points and other man-made structures, erosion or pollution sites, and fish habitat (vegetation, substrate, etc.). Without accurate maps, we would be unable to relocate sampling stations and be less able to identify and monitor changes in fish habitat.

For most lakes, maps are already available. Map symbols and scale often differ by Area, making map interpretation somewhat difficult. To improve consistency, three types of maps are recommended: 1) sampling stations, 2) habitat evaluation, and 3) bottom substrate.

The most recent lake contour map (produced by Ecological Services) should become the **base map** from which all others are created. If a bottom contour map is unavailable, sketch or trace the shoreline from an alternative map (occasionally ASCS or other agencies maintain lake maps) or by freehand. All maps should use standard codes as listed on page 2-4.

Maps should be revised, if needed, following full surveys. Revised maps should be attached to the lake survey report. Each map should be labeled with the appropriate title (Sampling Stations, Habitat Evaluation, or Bottom Substrate), and if possible fit onto one 8 1/2 x 11" sheet of paper. For large lakes, Areas can produce larger maps if needed.

When mapping, do not spend a lot of time determining the exact location of items being mapped. Locate them as best you can, understanding that the location on the map is intended to provide a general picture of where that item is located. If greater detail is needed, consider using a video recorder to document vegetation occurrence (in addition to the map) or a range finder to improve map accuracy.

Sampling Station Map:

This map requires sampling station and vegetation transect locations for all gear types and sampling methods. The location (latitude and longitude), if available, of each sampling station

and transect should be described on Form 2. Instructions are provided on page 2-5. This information is critical to relocating sampling stations and transects in subsequent surveys. An example map with appropriate symbols is provided at the end of this chapter. For gill nets, trap nets, electrofishing and seining, station locations can also be recorded on Forms 10-12 to reduce the number of forms needed in the field.

Habitat Evaluation Map:

This map identifies the general location and size of aquatic vegetation beds (emergent and submergent), dams, resorts, accesses, inlets, outlets, wetlands, erosion or pollution sites, benchmarks, water level gauges, and known spawning areas. This information is needed to monitor changes in aquatic vegetation and water level, help determine available fish habitat, assist in permit review concerning vegetation control or removal, and document changes in shoreline development or access.

When mapping vegetation, cruise the shoreline, mid-lake reefs and islands to determine the location of emergent and submergent beds. Map, as accurately as possible, the extent of vegetation along the shoreline and its distance from shore. Visual observation is your best tool, however, depth finders should be used to help determine the extent of the vegetation bed and maximum depth of plant growth. Occasionally sample vegetation with a grapple (if needed) and record major species on the map and their location. Identify species from codes in Appendix 5. Additional information concerning vegetation sampling is presented in the "Habitat Evaluation" section, page 3-4. Other characteristics (dams, resorts, inlets, etc.) should be identified as they are encountered in the survey. An example map with appropriate symbols is provided at the end of this chapter.

Bottom Substrate Map:

Bottom substrate can be included on the habitat evaluation map if it can be interpreted clearly. If, however, the habitat evaluation map is cluttered and difficult to read, a separate

bottom substrate map is required. Bottom substrate maps identify the general location and distribution of bottom substrates. This information is needed to identify potential spawning areas, monitor long-term changes in substrate (such as siltation from inlets), and assist in permit review of dredging or other activities that impact substrate.

When mapping, cruise the shoreline, mid-lake reefs and islands to determine the location of substrate types. Map, as accurately as possible, the extent of each substrate along the shoreline to a maximum depth of 4 feet. Visual observation is your best tool, however, substrate can be sampled with a grapple, oar, dredge or other device, if needed. Record major substrate types using codes provided on page 2-4. Additional information concerning bottom substrate mapping is presented in the "Habitat Evaluation" section, page 3-8. An example map with appropriate symbols is provided at the end of this chapter.

Standard Map Codes:

Sampling Station Map Codes (special sampling stations should be preceded by an S):

(VT) Vegetation Transect
(GN) Gill Net
(TN) Trap Net
(SE) Seining
(EF) Electrofishing
(WQ) Water Quality
(FMI) Flow Measurement at Inlet
(FMO) Flow Measurement at Outlet
(WDI) Width, Depth Measurement at Inlet
(WDO) Width, Depth Measurement at Outlet

Habitat Evaluation Map Codes:

(IN) Inlet
(OU) Outlet
(AC) Access
(GA) Water Level Gauge
(BM) Benchmark
(RE) Resort
(DAM) Dam
(ER) Erosion Site
(PO) Pollution Site
(SP) Known Spawning Areas
(WE) Wetlands (marshes, bogs, etc.)

Bottom Substrate Map Codes:

(LR) Ledge rock- large mass of solid rock
(BO) Boulder - diameter over 10 in
(RU) Rubble - diameter 3 to 10 in
(GR) Gravel - diameter 1/8 to 3 in
(SA) Sand -diameter less than 1/8
(SI) Silt -fine material with little grittiness
(CL) Clay - compact, sticky material
(MU) Muck -decomposed organic material, usually black
(DE) Detritus - organic material (leaves, twigs, etc)
(MA) Marl -calcareous material

INSTRUCTIONS FOR FORM 2 - SAMPLING STATION AND HABITAT EVALUATION LOCATIONS

1) Station Code:

Record the station or identification code and number from the appropriate map. Sampling stations and vegetation transects should be on the sampling station map, while all other items should be on the habitat evaluation map. Special sampling codes for each gear are preceded by an S (for example, special trap netting would be coded STN). Codes are as follows (be sure to include station number on the Form):

Sampling Stations

(VT) Vegetation Transect
(GN) Gill Net
(TN) Trap Net
(SE) Seining
(EF) Electrofishing
(WQ) Water Quality
(FMI) Flow Measurement at Inlet
(FMO) Flow Measurement at Outlet
(WDI) Width, Depth Measurement at Inlet
(WDO) Width, Depth Measurement at Outlet

Habitat Evaluation

(IN) Inlet
(OU) Outlet
(AC) Access
(GA) Water Level Gauge
(BM) Benchmark
(RE) Resort
(DAM) Dam
(ER) Erosion
(PO) Pollution

2) GPS Coordinates:

List latitude and longitude (if available) at the beginning and end of each station. For most sampling methods, only the beginning coordinates are needed (gill and trap nets, seines, etc.). For electrofishing, however, coordinates at the beginning and end of the station are needed. Loran C can also be used to determine location coordinates (be sure to note in the comments section that Loran was used) if desired.

Field testing of GPS receiver's in 1992 indicated poor results due to satellite availability. As more satellites become available, GPS use will become more practical. The Fisheries Survey and Systems Coordinator can be contacted to determine the use of GPS systems within Fisheries.

3) Gill Nets:

Record mesh size, depth to bottom, and direction of net (orientation, e.g. W for west) for each end of the net. For suspended sets, under the depth column record the depth to the lead line on the top space and the depth to the lake bottom on bottom space for each end of the net. This information can also be included on Form 11.

4) Location Description:

Describe any additional information that will help relocate or identify that sampling station or item. Include township, range and section for inlets and outlets.

FORM 2 - SAMPLING STATION AND HABITAT EVALUATION LOCATIONS

DOW # _____ Data Page ____

Body of Water _____ Survey ID (Starting Date) _____ Recorder(s) _____ of ____

1) Sta. Code[a] #	2) GPS COORDINATES Start Latitude	Start Longitude	End-if applicable Latitude	End-if applicable Longitude	3) GILLNETS[b] Mesh	Depth	Dir	Mesh	Depth	Dir	4) Location Description/Comments (include Twp.,R.,S. for inlets, outlets)

(a) VT, WQ, FMI, FMO, WDI, WDO, IN, OU, AC, GA, BM, RE, DAM, ER, PO, TN, GN, EF, SE, STN, SGN, SEF, SSE.

(b) Record mesh size in inches.hundredths for both ends. Record bottom depth (feet) for standard sets in bottom area (leave top area blank); for suspended sets, record lead line depth in top area and bottom depth in bottom area. Record direction that each gillnet end is facing (N,S,E,W,NE,NW,SE,SW).

*After station locations have been established, only describe new or alternate station locations.

**All locations should be identified (Code and Station Number) on Sampling Station (VT,WQ,FMI,FMO,WDI,WDO,GA,BM,TN,GN,EF,SE, STN,SGN,SEF,SSE) or Habitat Evaluation (IN,OU,AC,RE,DAM,ER,PO) maps.

DOW # 69-744 FORM 2 - SAMPLING STATION AND HABITAT EVALUATION LOCATIONS

Body of Water Elbow Survey ID (Starting Date) 6/1/1992 Data Recorder(s) P. Hogan Page 1 of 5

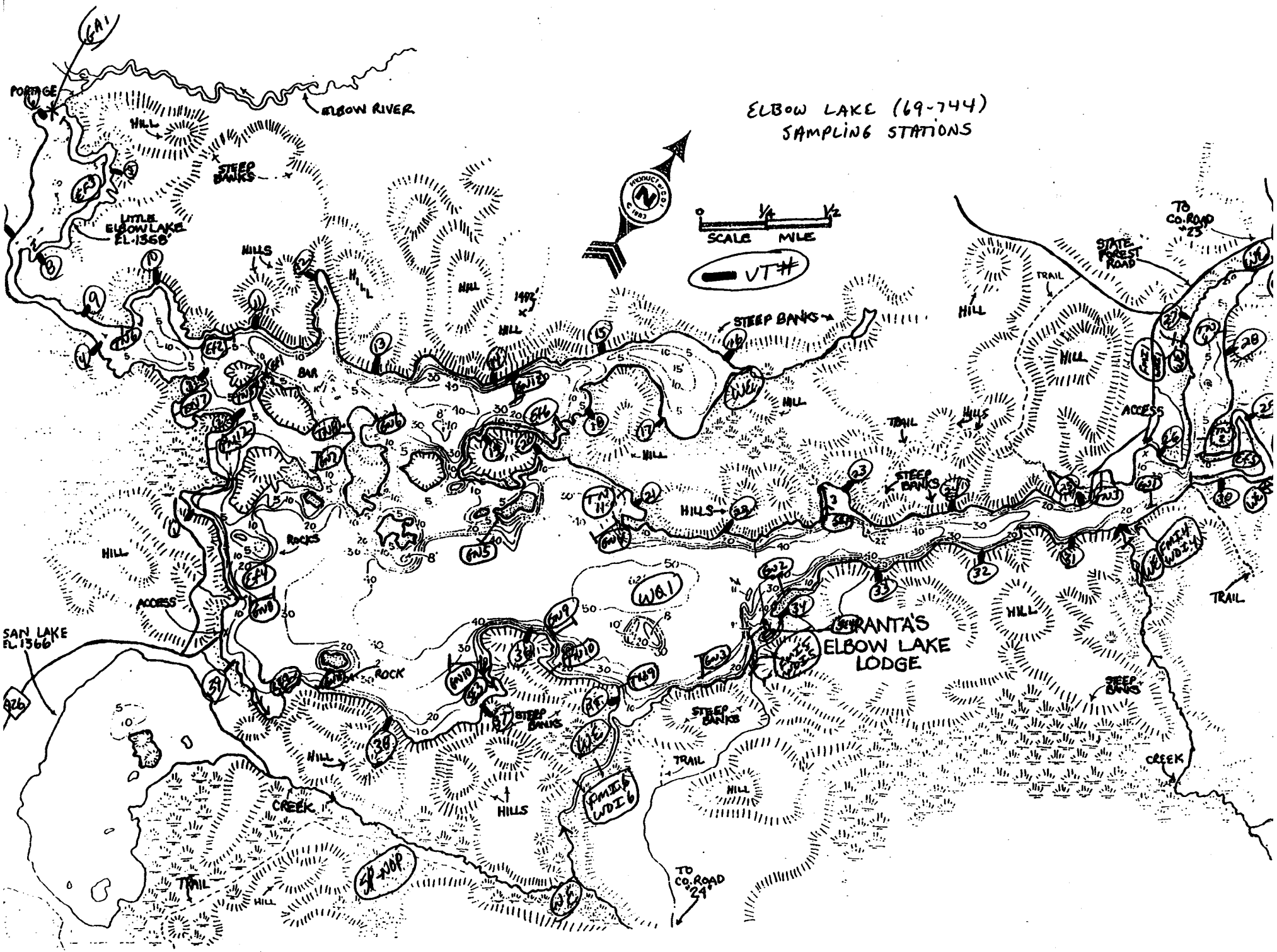
1) Sta. Code[a]#	2) GPS COORDINATES Start Latitude	Start Longitude	End-if applicable Latitude	End-if applicable Longitude	3) GILLNETS[b] Mesh	Depth	Dir	Mesh	Depth	Dir	4) Location Description/Comments (include Twp.,R.,S. for inlets, outlets)
Ef 1	48°00'10"	92°40'30"	48°00'10"	92°40'30"		—			—		Started at north tip of island. Went around 1 time clockwise.
Ef 2	48°00'12"	92°40'50"	48°00'07"	92°41'00"		—			—		Started in front of 2-story cabin and ended at point before narrows.
Ef 3	48°00'08"	92°41'35"	48°00'25"	92°41'50"		—			—		Started when narrows opens up to L. Elbow Lake area. Shocked east shore to outlet.
Ef 4	47°59'50"	92°40'05"	47°59'41"	92°39'30"		—			—		Started at tip of point and ended at dock on tip of point.
Ef 5	48°01'28"	92°36'30"	48°01'38"	92°36'30"		—			—		Started where trail comes down at tip of point. Went around bay and ended at tip of point.
Ef 6	48°00'30"	92°39'00"	48°00'35"	92°38'55"		—			—		Started in back of small bay, went around point. Ended at small point with huge boulder on shore.
WQ 1	48°00'25"	92°37'50"				—			—		60 foot max. depth.
GN 1	48°01'25"	92°36'32"			0.75	— 10	SE	2	— 28	NW	approx. 150 ft. up from inlet 4.
GN 2	48°00'37"	92°37'46"			2	— 12	SE	0.75	— 40	NW	Just south of small point.
GN 4	48°00'31"	92°38'41"			0.75	— 10	NE	2	— 36	SW	Off of tip of point.
TN 2	48°00'02"	92°40'06"				—			—		In middle of shoreline in back of bay.
TN 7	48°00'04"	92°41'02"				—			—		In-between 2 biggest boulders.
TN 6	48°00'09"	92°41'32"				—			—		100 ft. west of tip of point.
GN 3	48°00'16"	92°37'39"			0.75	— 25	E	2	— 43	W	In-between 2 small points.
GN 5	48°00'10"	92°38'57"			0.75	— 8	N	2	— 40	S	approx. 25 feet out from island.

(a) VT, WQ, FMI, FMO, WDI, WDO, IN, OU, AC, GA, BM, RE, DAM, ER, PO, TN, GN, EF, SE, STN, SGN, SEF, SSE.

(b) Record mesh size in inches.hundredths for both ends. Record bottom depth (feet) for standard sets in bottom area (leave top area blank); for suspended sets, record lead line depth in top area and bottom depth in bottom area. Record direction that each gillnet end is facing (N,S,E,W,NE,NW,SE,SW).

*After station locations have been established, only describe new or alternate station locations.

**All locations should be identified (Code and Station Number) on Sampling Station (VT,WQ,FMI,FMO,WDI,WDO,GA,BM,TN,GN,EF,SE, STN,SGN,SEF,SSE) or Habitat Evaluation (IN,OU,AC,RE,DAM,ER,PO) maps.


ELBOW LAKE (69-744)
SAMPLING STATIONS
SCALE MILE
VT#
PORTAGE
ELBOW RIVER
LITTLE ELBOW LAKE EL. 1368'
SAN LAKE EL. 1366'
GRANTA'S ELBOW LAKE LODGE
TO CO. ROAD #23
TO CO. ROAD #24
STATE FOREST ROAD
STEEP BANKS
HILL
HILLS
TRAIL
ACCESS
ROCKS
ROCK
BAR
CREEK
WQ1
WQ2
WQ3
WQ4
WQ5
WQ6
WQ7
WQ8
WQ9
WQ10
WQ11
WQ12
WQ13
WQ14
WQ15
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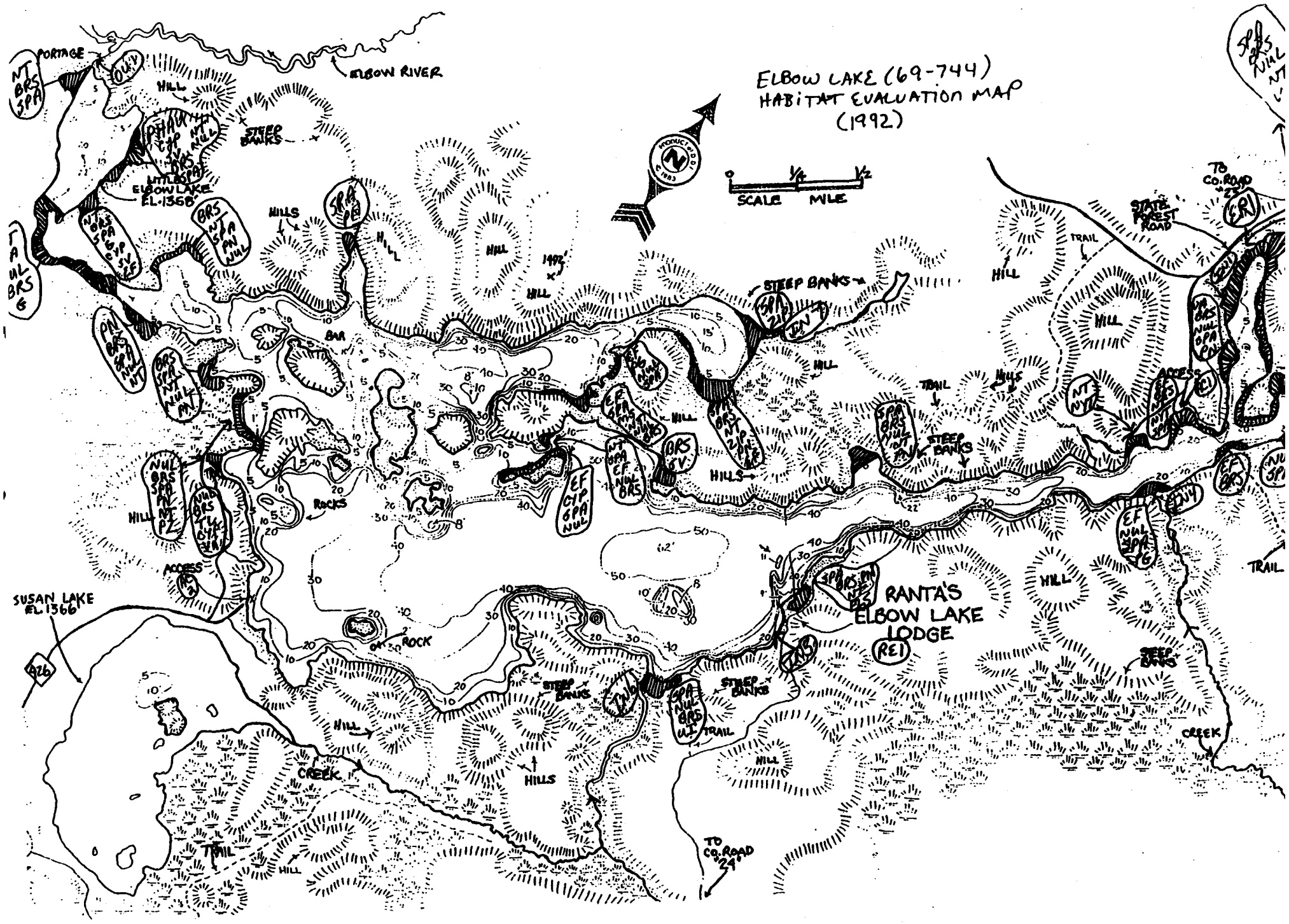
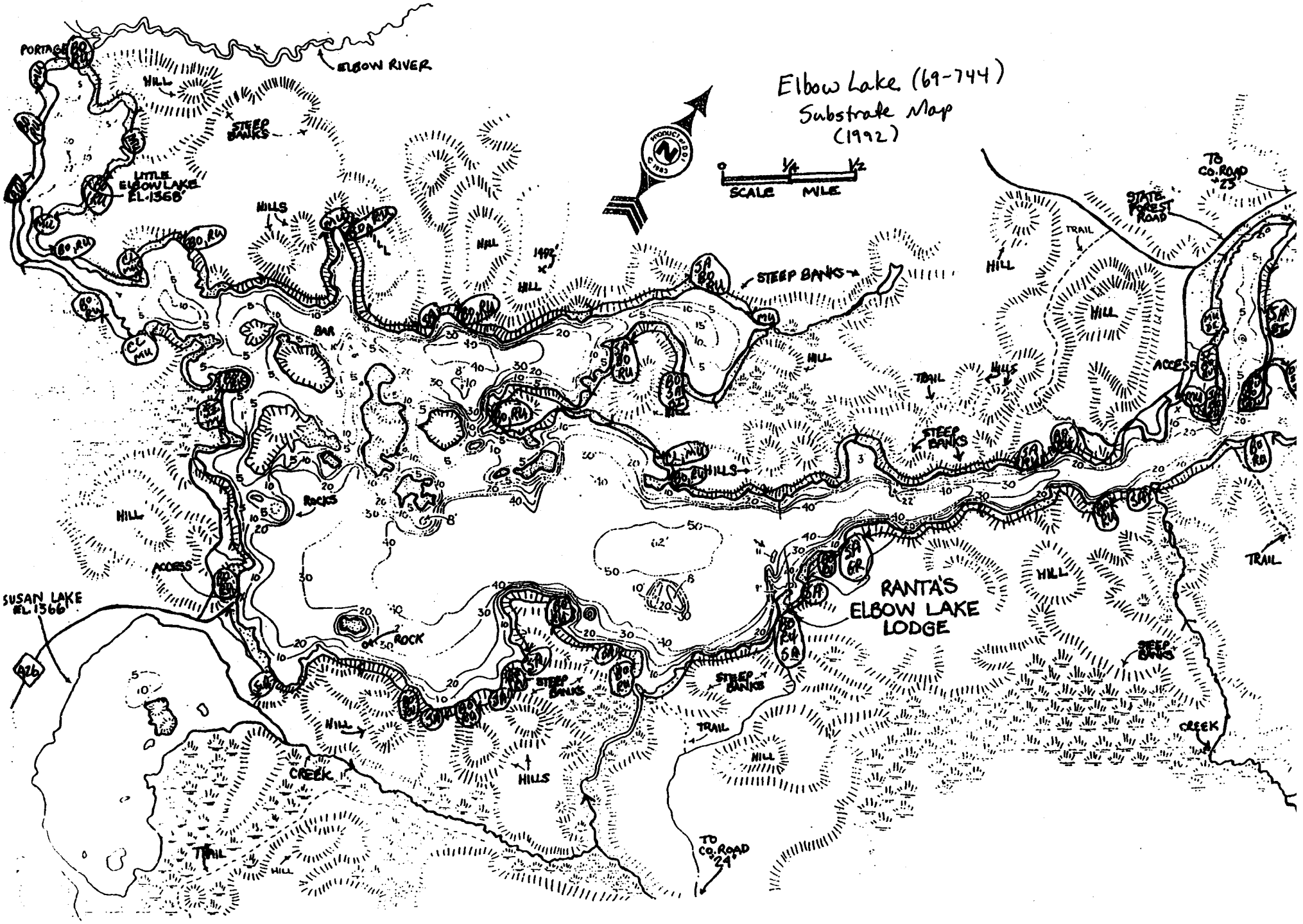
WQ99
WQ100


ELBOW LAKE (69-744)
HABITAT EVALUATION MAP
(1992)
SCALE MILE
ELBOW RIVER
PORTAGE
ELBOW LAKE EL. 1368'
SUSAN LAKE EL. 1366'
RANTA'S ELBOW LAKE LODGE
TO CO. ROAD 24
STATE FOREST ROAD
TRAIL
CREEK
ROCK
ROCKS
BAR
HILL
HILLS
STEEP BANKS
ACCESS


Elbow Lake (69-744)
Substrate Map
(1992)
SCALE
MILE
ELBOW RIVER
PORTAGE
LITTLE ELBOW LAKE EL. 1360'
SUSAN LAKE EL. 1366'
RANTA'S ELBOW LAKE LODGE
ACCESS
TRAIL
STATE FOREST ROAD
TO CO. ROAD #25
TO CO. ROAD #24
CREEK
ROCKS
BAR
HILL
HILLS
STEEP BANKS

HABITAT EVALUATION

Habitat evaluations are required for all full surveys. Forms 3-8 should be completed for each habitat evaluation. Instructions are provided beginning on page 3-11.

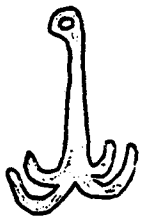
Habitat evaluations are needed to collect information on a lake's physical and biological characteristics. Some information will be noted on survey maps, and some will be compiled and reported on survey forms. To conduct a habitat evaluation, the survey crew will cruise the entire shore of the lake, including major islands. The following information will be collected (each will be discussed individually):

1) Water levels
2) Inlets and Outlets
3) Watershed and Shoreline Characteristics
4) Aquatic Vegetation
5) Bottom Substrates (Shoal Waters)
6) Erosion or pollution
7) Fish spawning habitat

On a large lake, it will be necessary to set aside a full day (or more) to do a thorough job of conducting the shoreline survey. The following tools may be needed:

- Habitat evaluation map, preferably on waterproof paper
- Bottom substrate map, preferably on waterproof paper
- Several pencils of different colors (helps keep map notations clear)
- Notebook, preferably waterproof, with Forms 3-8
- Tape measure or ruled staff (stadia rod)
- Hand level
- Spikes, or star drill and hammer
- Spraypaint
- Stopwatch, or current meter
- Three feet of barbed wire (or equivalent)
- Aquatic vegetation key
- Small magnifying lens
- GPS unit
- Camera or Video Recorder
- Depth finder
- Grapple - a standard grapple is constructed of seven, 18 inch lengths of 0.25 inch diameter steel rod. One rod is in the middle and the other six rods are welded together around the center rod. The outer six rods are bent out to form the grapple, which should be 10 inches in diameter. The tip of the middle rod, which should

extend above the tips of the other six, is bent to form an eyelet. A 25 foot rope, marked at 15 feet, is attached to the grapple.



Information collected during habitat evaluations can only be useful if collected conscientiously. Much of the information is subjective, but its collection should follow these guidelines as closely as possible. Do not try to remember details long after the field season has ended; record all information at the time of the survey.

Water Levels (Form 3, page 3-11):

Water level information is needed to monitor changes in habitat and to evaluate the impact of water level fluctuations on fish populations (i.e. spawning success, recruitment, etc.).

Benchmarks are our most common source for measuring water levels. All benchmarks should be measured during full surveys. There should be a minimum of two benchmarks to allow continuous monitoring if one is lost (benchmark locations should be identified on the habitat evaluation map). If a lake has a permanent gauge (usually located at a dam), measuring benchmarks is needed only to relate the water level at the benchmark to the gauge. Once completed, future measurements at benchmarks are unnecessary and the gauge should be used to measure the current water level.

If benchmarks are missing or have not been established, new benchmarks will be needed. New benchmarks should be unobtrusive, easy to locate, and as permanent as possible. Dams, bridges, and culverts make good benchmarks. Often, these structures will have water level gauges attached. If these types of structures are not available, the following method can be used to establish benchmarks:

- Chisel an "X", or drill a small hole in a rock face. The tops of large, distinctive boulders or rock outcrops can make good benchmarks. In many cases, a photograph can be useful for relocating benchmarks.

Benchmark locations should be described on Form 2. When describing the location, be thorough. The benchmark will have to be located again, probably by someone relying solely on your description to find it.

Historical information on water levels can often be obtained from past surveys or from other agencies. For reservoirs, water level information may be available from the agency responsible for the dam. For natural lakes, state agencies, other DNR Divisions (primarily the Division of Waters), homeowner associations or local governments may have records. If available, dam gauge records and past benchmark measurements (or other hard data) should be referenced when discussing water level history. Do not report historical fluctuations unless there is some supporting evidence, as described above.

Inlets and Outlets (Form 4, page 3-13):

Inlets and outlets should be measured as they are encountered during the habitat evaluation. All inlets and outlets should be marked on the Habitat Evaluation map. Information concerning width, depth, flow, barriers to fish migration (or, in some cases, navigation) and spawning habitat in the stream should be described on Form 4.

Flow should be measured on all major inlets and outlets. For most lake surveys, inlet and outlet flows can be adequately measured using the "chip" method (see Manual of Instructions for Lake Survey, Special Publication No. 1). Chips should be either an orange, or a small glass vial, half full of water and capped. Select a section of stream of length L (the longer, the better) in feet. The width, depth, and bottom type of the section should be as uniform as possible. Determine the average width (W) and average depth (D) of the section, in feet. One method to estimate average depth is to take a number of measurements along a transect. Sum the measurements, and divide by the number of

measurements plus one. Using a stopwatch, measure the time (T) in seconds it takes for a floating object to pass through the section. At least three time measurements should be taken at each station and averaged. Flow in cubic feet per second (R) can then be calculated as follows:

$$R = \frac{(W \times D \times L) \quad a}{T}$$

For measuring flow, "a" is a factor related to bottom type; use 0.9 for smooth bottoms, and 0.8 for rough bottoms (rocks, rubble, coarse gravel).

If more precise measurements are needed, a current meter should be used following techniques described in the "Minnesota Stream Survey Manual", Special Publication No. 120.

Watershed and Shoreline Characteristics (Form 5, page 3-18):

The survey crew should estimate surrounding watershed and shoreline type and use as described in Form 5. Use your best judgement when determining the extent of the surrounding watershed or type of shoreline. For example, a fringe of woodland around the entire shoreline may be the only watershed type visible from the lake. As you travel to and from the lake, however, you notice the watershed is dominated by pasture and cropland. In this case, be sure to include pasture and cropland as major watershed types.

For some lakes, other state or federal agencies (e.g. LMIC, ASCS, USGS) may have hard data concerning watershed use. If available, this information is preferred over subjective data as described above.

Aquatic Vegetation (Form 6, page 3-21):

Aquatic vegetation information helps determine the status of fish habitat, aids in monitoring environmental changes and water quality, and tracks the spread (or introduction) of exotic species. Of particular importance are species present (various species act as indicators of water quality), plant community

composition (helps determine plant diversity and health within specific vegetation beds), and maximum depth of aquatic plant growth (helps monitor long term changes in water clarity).

Aquatic plants vary in abundance and distribution throughout the year. It is important to sample aquatic vegetation consistently in order to monitor changes through time. For this reason, all vegetation sampling must occur between 1 July and mid-August. Area Supervisors should select the best week or two week period within this time frame (when aquatic vegetation growth is at a maximum for their area). Once a sampling time is chosen, all subsequent vegetation sampling should occur as close to that time as possible. While this time frame will not allow sampling of all species (for example, curled pondweed reaches its peak in early summer), it will provide the best "all around" sample. Area Supervisors have the option of additional sampling at other times of the year if desired.

Aquatic vegetation should be identified to the species level when possible, using "Key to the Common Aquatic Plants of Minnesota" (Carlson and Moyle 1968), "A Manual of Aquatic Plants" (Fassett 1940), or another suitable key. Plants which cannot be identified in the field should be collected for later identification. Some species (with similar characteristics) have been grouped to aid in identification. While plants should be identified to the species level if possible, this grouping will allow survey crews to quickly identify those species that are difficult to identify individually. If needed, Ecological Services staff can provide assistance in plant identification. A list of species and species groups with codes is provided in Appendix 5. If species are encountered that are not on the list, contact the Fisheries Survey and Systems Coordinator to add that species to the statewide database.

Two types of sampling are required, mapping and determining species composition along transects. Mapping should be completed according to the procedures described in the Mapping Section, page 2-2. For transect sampling, all transects must be determined prior to the survey. To determine transects, first

choose a known location on the map (public access is best). Next determine the number of transects needed based upon lake size as follows:

Lake Size (acres)	Number of Transects
<150	10
150-500	20
501-1000	30
1001-5000	40
>5000	50

Measure the distance around the shoreline (using a map wheel if the distance is unknown) and divide the total length of the shoreline by the number of transects plus 1 (n+1) to determine the distance between transects. For example, a 250 acre lake with 3.7 miles of shoreline would require 20 transects. Dividing 3.7 miles of shoreline by 21 (n+1) would result in 0.176 miles between each transect. Space each transect evenly around the shoreline (in our example, space each transect 0.176 miles apart) in a clockwise direction from the starting point. Do not use the starting point as the first transect. Number each transect consecutively on the Sampling Station map (VT1, VT2, etc.). Additional transects can be established around islands, or in mid-lake areas (especially for larger lakes) if desired. Be sure to include these transects on the Sampling Station Map.

Establishing transects at the lake, based upon their location on the map, will be somewhat subjective. Do not worry about establishing the transect at the exact location on the map, but rather whether or not the transect can be relocated. Latitude and longitude should be recorded, if available, where the transect intersects the shoreline. If other landmarks are nearby (access points, docks,), use them to help locate the transect. Transects, once established, remain permanent for all future surveys.

Transects will run perpendicular from shore to the maximum depth of vegetation growth. If vegetation extends all the way across the lake transects will end at the halfway point, or at the maximum depth in which plants are growing if the distance

across the lake is substantial. At each transect, begin at shore and identify all emergent and submerged species (or species groups) within 10 ft of either side of the boat along the length of the transect. Information should be recorded on Form 6. Most species can be observed visually, however, as depth increases you may need to use a grapple to determine the species present (a standard grapple is described on page 3-1). A depth finder is useful to determine if vegetation is present in deep water and how far it extends from shore. Since transects are spaced evenly, many will be absent of vegetation. Be sure to include these transects on the form to document the absence of vegetation. Your objective is to provide as accurate a list as possible of all species (if any) present at each transect.

Species presence or absence provides a quantitative method for documenting changes in vegetation distribution through time. For example, if Sago pondweed was present at 75% of all transects during one year, and 5% of all transects five years later, we would have a quantitative measure of changes that have occurred in the distribution of this species. While subtle changes would be difficult to measure, more obvious changes (such as establishment of vegetation at transects that previously were absent of vegetation) would be apparent. This type of information is extremely important for evaluating and measuring the effects of watershed improvements or other factors influencing water quality and vegetation.

In addition to transect sampling, all other species encountered or observed should be recorded on Form 6. For example, arrowhead may not have been present at any transects, but was observed while trap netting. In this case, be sure to list arrowhead as an additional species present.

The spread of exotic species of aquatic vegetation is a problem in Minnesota. Survey crews should avoid being part of that problem by ensuring that all traces of aquatic vegetation are removed from their boat, motor, and sampling gear before moving to another lake. See Appendix 10 concerning precautions for preventing the spread of exotic species.

Bottom Substrates (Shoal Waters - Form 6, page 3-21):

Shoal waters, and associated bottom substrates, are important fish spawning and nursery areas. For lake surveys, shoal waters are defined as areas of the lake shallower than 4 feet. Mapping of shoal waters is required during initial surveys, or resurveys if not previously mapped. Once a map is completed, it should be reviewed for accuracy during full surveys and revised only if changes have occurred. Bottom substrates (shoal waters) should be mapped according to the procedures described in the Mapping Section, page 2-2. In addition to mapping, bottom substrate should be recorded at each transect used for aquatic vegetation sampling (see Form 6, page 3-21).

Erosion or Pollution (Form 7, page 3-22):

Lake survey crews may encounter lakes which suffer pollution or shoreline erosion. Pollution can be either point-source (comes from a discrete source such as a discharge pipe) or nonpoint-source (atmospheric deposition, agricultural run-off, etc.). The location of suspected point-sources of pollution and areas with shoreline erosion should be noted on the Habitat Evaluation map. Also be aware of indicators of nonpoint source pollution such as intense algae blooms or fish die-offs, and their suspected cause (i.e. fertilizer run-off, etc.). Pay particular attention to inlets as potential sources of pollution.

Fish kills observed by the survey crew should be immediately reported to the Regional Fisheries Manager, the Minnesota Pollution Control Agency, and Ecological Services Section.

Fish Spawning Habitat (Form 7, page 3-22):

Information concerning the amount and quality of spawning habitat is important in determining the potential for natural reproduction as well as providing data to justify habitat protection. Known spawning areas should be identified on the Habitat Evaluation Map. Spawning habitat should also be rated by species (for all species listed below that were collected during the survey, or any additional species of interest) based upon the following ideal conditions:

1) Largemouth bass, bluegill, and pumpkinseed prefer firm gravel or coarse sand bottoms in 2 to 5 ft of water. Often, the gravel or sand may be overlain by muck or detritus. Soft, unstable bottoms are not commonly used unless sand and gravel are scarce and plant roots or detritus provide a firm substrate. Preferred sites are protected from heavy wave action. Weedy lakes are usually well suited to these species.

2) Crappie usually spawn in water up to 8 ft, in quiet protected bays with firm bottoms.

3) Smallmouth bass prefer clear water lakes with boulder, rubble areas protected from heavy wave action. Nests are usually found in depths of 1 to 4 ft and are often placed where one to three sides are protected by rocks, stumps, etc.

4) Northern pike spawn in shallow, marshy areas, particularly in temporarily flooded meadows or marshlands. Good spawning marshes should have slowly dropping spring water levels, to avoid trapping fry or fingerlings.

5) Walleye prefer clean gravel or rubble shores or shoal areas exposed to wave action. Rivers or streams are also utilized when available. In streams, spawning occurs where the current is moderate, on the best bottom available.

6) Yellow perch spawn in open, shallow water; usually near rooted vegetation, submerged brush, or fallen trees, but sometimes over sand or gravel.

7) Lake trout spawn on clean rubble or boulder bottoms, at depths of 1 to 40 ft (often deeper than can be visually evaluated from the surface). Because lake trout spawning conditions can be difficult to assess visually, it can usually be assumed (in a natural population) that conditions are good if several age classes are present in the lake.

8) Channel catfish prefer firm bottom areas with natural cavities (such as logjams, undercut banks, burrows, etc.) for nest building.

Spawning habitat for game fish species not listed above should be evaluated if those species are present, or may be considered in future management. Spawning requirements for most fish species can be found in Northern Fishes (Eddy and Underhill 1974), Freshwater Fishes of Canada (Scott and Crossman 1973), or

Fishes of the Minnesota Region (Phillips, et al. 1982). Fish spawning history can be obtained from Area or Regional records of spawning runs, or by inquiring locally.

INSTRUCTIONS FOR FORM 3 - WATER LEVEL

1) Station Code:

List station code as (GA) if gauge, or (BM) if benchmark, followed by the number of the gauge or benchmark as identified on the habitat evaluation map (for example, BM2 would be benchmark number 2)

2) Reading:

Water level as listed on gauge in feet above sea level or as determined from benchmark. Record + for water levels above the benchmark and - for water levels below the benchmark. For example, water levels 2.4 feet below the benchmark would be recorded as -2.4, while water levels 2.4 feet above the benchmark would be +2.4 (water levels can be above the benchmark under high water conditions).

Use a hand or string level to measure water levels at benchmarks. To use the hand level, one crew member holds a tape measure or ruled staff at the water surface. The other member places the level on the benchmark, and sights through it to the tape. When the bubble is centered, the water level (at the cross hair) is read and reported as number of feet and inches below the benchmark.

To use the string level, tie a string to the benchmark. Stretch it tight and place the level on the string over the water and move the string until the bubble in the level is centered. Measure the distance from the string to the water surface using a tape measure or ruled staff and record as number of feet and inches below the benchmark.

If water levels are above the benchmark, use a tape measure or ruled staff to measure the distance from the benchmark to the water level and record as feet and inches above the benchmark.

3) Current Water Level:

Record the current water level as (L) low, (N) normal or (H) high. Flooded terrestrial vegetation or exposed sediment are good indicators of high and low water levels, respectively.

4) Date:

Record month, day and year water levels were measured.

5) Comments:

Describe additional information related to current water level, or to gauge or benchmark locations. Include new or lost (removed) benchmarks or gauges. Under "data recorder" list the name of the individual recording water level information.

6) Normal Water Level:

The "normal" runout elevation of the lake as determined by the Division of Waters. Use only data available from the Area Hydrologist (Division of Waters). Record normal water level in feet at the gauge or in feet above (+) or below (-) the benchmark. For example, a normal water level of 3.5 feet above benchmark 1 would be recorded as "+3.5 feet at BM1." Leave blank if normal water level is unknown.

7) Average Annual Fluctuation:

Record average annual fluctuation in feet (mean of yearly differences between high and low water levels). Also record the number of years of data, total number of readings used to determine the average annual fluctuation, and data source. Use known records only. See water levels, page 3-2 for information on sources of data.

8) Long Term Fluctuation:

Record the highest and lowest water levels ever measured. Known records should be used (gauges). See water levels, page 3-2 for information on sources of data. If other sources are not available, record the highest and lowest water levels ever measured in feet above and below benchmark elevation. Record the water level in feet, location (benchmark or gauge number) and date when water levels were measured. If recording highest and lowest water levels from benchmarks, include a (+) if water level is higher than the benchmark and a (-) if water level is lower than the benchmark.

9) Water Level History:

Briefly describe the past history of water level fluctuations, include source of information.

FORM 3 - WATER LEVEL

DOW # _____ Body of Water _____ Survey ID (Starting Date) _____ Page ____ of ____

1) Station Code[a] #	2) Reading[b]	3) Current Water Level[c]	4) Date (mo/day/year)	5) Comments (Include new or lost/removed BM or GA)	Data Recorder

WATER LEVEL DESCRIPTION (Completed by:_____)

6) Normal Water Level (obtain data from D.O.W. Area Hydrologist) = _____ feet[b] at _____

7) Average Annual Fluctuation (mean of yearly differences between high and low readings) = _____ feet

Data Source: _____ # of years of data = _____

_____ Total # of readings = _____

_____

8) Long-Term Fluctuation (highest and lowest recorded water levels):

High[b] = _____ ft. at _____ (Location) on _____ (Date) Low[b] = _____ ft. at _____ (Location) on _____ (Date)

Data Source: _____

_____

_____

9) Water Level History (include sources): _____

_____

_____

_____

_____

_____

_____

_____

(a) (BM) Benchmark, (GA)uge.

(b) If measuring at a benchmark, include a (+) if water level is higher than BM and a (-) if lower.

(c) (L)ow, (N)ormal, (H)igh.

*Show gauge (GA1, etc.) and benchmark (BM1, BM2, etc.) locations on Sampling Station map and record location description on Form 2.

FORM 3 - WATER LEVEL

DOW # 69-744 Body of Water Elbow Survey ID (Starting Date) 6/1/1992 Page 1 of 1

1) Station Code[a] #	2) Reading[b]	3) Current Water Level[c]	4) Date (mo/day/year)	5) Comments (Include new or lost/removed BM or GA)	Data Recorder
GA 1	1368.9	N	8/17/1992		P. Hogan

WATER LEVEL DESCRIPTION (Completed by: P. Hogan)

6) Normal Water Level (obtain data from D.O.W. Area Hydrologist) = 1368.5 feet[b] at GA 1

7) Average Annual Fluctuation (mean of yearly differences between high and low readings) = 2.5 feet

Data Source: Dow Lakes database. # of years of data = 15

Total # of readings = 124

8) Long-Term Fluctuation (highest and lowest recorded water levels):

High[b] = 1371.2 ft. at GA 1 (Location) on 5/18/1985 (Date) Low[b] = 1366.1 ft. at GA 1 (Location) on 8/4/1988 (Date)

Data Source: Dow Lakes database.

9) Water Level History (include sources): Water levels have been relatively stable in this lake. Beaver dams at the outlet have caused increases in lake water levels in the past.

(a) (BM) Benchmark, (GA)uge.

(b) If measuring at a benchmark, include a (+) if water level is higher than BM and a (-) if lower.

(c) (L)ow, (N)ormal, (H)igh.

*Show gauge (GA1, etc.) and benchmark (BM1, BM2, etc.) locations on Sampling Station map and record location description on Form 2.

INSTRUCTIONS FOR FORM 4 - INLET/OUTLET

1) Inlet ID #:

Designated number as listed on habitat evaluation map. For inlets, numbers should be recorded on the map as IN1, IN2, IN3, etc. If not listed on map, assign next consecutive number and be sure to mark inlet on map with designated number.

2) Name

Most common name of inlet, if known.

3) Tributary Number:

Known tributary number (for example - M-12-43.)

4) Type:

Choose from the following codes:

(ID) Intermittent/Dry = no flow at mouth
(IF) Intermittent/Flowing = currently has flow at mouth
(C) Continuous Flow
(X) Unknown

5) Origin:

Origin is defined as the first source encountered immediately upstream. If lake, list name if known. If origin is not a lake, choose from the following codes:

(L) lake (list DOW#)
(M) marsh
(B) bog
(S) spring
(W) well
(T) tile
(SS) storm sewer
(D) ditch
(O) other (briefly describe in space provided)
(X) unknown

6) Cover Type/Land Use:

Choose the two most prominent types in order of abundance from the following codes:

(H) hardwoods
(CO) conifers
(MI) mixed forest
(G) grassland
(CR) crops
(P) pasture
(MU) municipal
(R) residential
(MA) marshland
(B) bogs
(O) other (briefly describe in space provided)
(X) unknown

7) Average Width:

Determine the average width of the inlet. If not previously measured, select a 100' stretch that represents typical stream widths and depths. Determine average width in feet by measuring width at the beginning, at 25' intervals, and at the end the stretch selected.

8) Average Depth:

Determine the average depth of the inlet. Measure depths at 3-5 foot evenly spaced intervals across the stream at the same locations stream widths were measured. Record average depth in feet.

9) Flow:

Follow methods described under "Inlets and Outlets", page 3-3 on measuring flows. Record flow measurements in feet per second (fps) and cubic feet per second (cfs). Record method used to calculate flow from one of the following codes:

(F) Floating object
(C) Current meter
(D) Direct time and volume (gpm divided by 15.9 = cfs)

10) Surface Temperature (F)

Record surface temperature in degrees fahrenheit.

11) Inlet ID #:

Continuation of inlet data. Should correspond to inlet number listed in the first section of the form.

12a) Barrier to Fish Movement:

Choose (Y)es, (N)o, (P)eriodic, or (X) unknown. Choose no only if the entire stream is checked. Choose periodic if the barrier is temporary (low flows, beaver dams, etc.).

12b) If Yes or Periodic, Briefly Describe:

Describe fish barrier (for example - beaver dam 100 yards upstream of mouth).

13) Known Spawning Runs:

List species codes for up to four species with known spawning runs up the inlet.

14) Inlet Comments:

Describe additional comments (current water stage, habitat, etc.) if needed.

15) Outlet ID Number

Designated number as listed on Habitat Evaluation map. If not listed on map, assign next consecutive number (OU1, OU2, etc.) and be sure to mark outlet on map with designated number.

16) Name:

Known name of outlet.

17) Tributary or DOW Number:

Tributary or Division of Waters (if lake) number of the outlet.

18) Tributary To (Tributary or DOW Number):

Tributary or DOW Number of the first body of water receiving the outlet flow.

19) Average Width:

Determine the average width of the outlet. If not previously measured, select a 100' stretch that represents typical stream widths and depths. Determine average width in feet by measuring width at the beginning, at 25' intervals, and at the end the stretch selected.

20) Average Depth:

Determine the average depth of the outlet. Measure depths at 3-5 foot evenly spaced intervals across the stream at the same locations stream widths were measured. Record average depth in feet.

21) Flow:

Follow methods described under "Inlets and Outlets, page 3-3 on measuring flows. Record flow measurements in feet per second (fps) and cubic feet per second (cfs). Record method used to calculate flow from one of the following codes:

(F) Floating object
(C) Current meter
(D) Direct time and volume (gpm divided by 15.9 = cfs)

22a) Barrier to Fish Movement:

Choose (Y)es, (N)o, (P)eriodic, or (X) unknown. Choose no only if the entire stream is checked. Choose periodic if the barrier is temporary (low flows, beaver dams, etc.).

22b) If Yes or Periodic, Briefly Describe:

Briefly describe barrier (for example - concrete fish barrier 100 yards downstream from outlet).

23) Water Control Structure (Dam):

Record type of control structure from one of the following codes:

(TC) Type C with stop logs
(SP) Sheet piling
(DI) Drop inlet with stoplogs
(CF) Concrete with fixed sill
(BD) Beaver dam
(N) None
(O) Other - (describe after type)

Record the owner of the dam from one of the following codes:

(DNR) DNR
(DOT) Dept. of Transportation
(UFS) Forest Service
(FWS) US Fish and Wildlife Service
(COE) US Corp of Engineers
(NPS) National Park Service
(TOW) Township
(COU) County
(CIT) City
(PRI) Private (list name after owner)
(N) None (natural dam)
(O) Other (list name after owner)
(X) Unknown

Record the head (height of water above the dam to water below the dam), height over sill (height of water running over the dam), and gauge reading of the control structure in feet.

24) Outlet Comments:

Describe any additional information concerning outlets.

DOW # _____ FORM 4 - INLETS / OUTLET

Body of Water _____ Survey ID (Starting Date) _____ Page ___

Dates of Fieldwork (mo/day/year) _____ through _____ Data Recorder(s) _____ of ___

1) Inlet ID #	2) Name	3) Tributary Number	4) Type[a]	5) Origin[b]		6) Cover Type / Land Use[c]			7) Avg. Width	8) Avg. Depth	9) FLOW fps	FLOW cfs	FLOW Method[d]	10) Sur. Temp.-°F
IN														
IN														
IN														
IN														
IN														
IN														

11) Inlet ID #	12a) Barrier to Fish Mvmt?[e]	12b) If Yes or Periodic, briefly describe	13) Known Spawning Runs[f] Spp. 1	Spp. 2	Spp. 3	Spp. 4	14) Inlet Comments (habitat, current water stage, etc.)
IN							
IN							
IN							
IN							
IN							
IN							

15) Outl. ID #	16) Name	17) Tributary or DOW #	18) Tributary To (Trib. or DOW#)	19) Avg. Width	20) Avg. Depth	21) FLOW fps	FLOW cfs	FLOW Meth.[d]	22a) Barrier to Fish Mvmt?[e]	22b) If Yes or Periodic, briefly describe	23) WATER CONTROL STRUCTURE (DAM) Type[g]	Owner[h]	Head	> Sill	Gauge
OU															
OU															

24) Outlet Comments:

Type:

Owner:

(a) (ID) Intermittent - Dry (no flow at mouth, still may contain water), (IF) Intermittent - Flowing (currently has flow at mouth), (C)ontinuous Flow, (X) Unknown.

(b) (L)ake (give DOW#), (M)arsh, (B)og, (S)pring, (W)ell, (T)ile, (SS) Storm Sewer, (D)itch, (O)ther (describe), (X) Unknown. Consider only to next upstream waterbody.

(c) Give up to the two most common in order of abundance: (H)ardwoods, (CO)nifers, (MI)xed Forest, (G)rassland, (CR)ops, (P)asture, (MU)nicipal, (R)esidential, (MA)rshland, (B)ogs, (O)ther (describe), (X) Unknown.

(d) (F)loating object, (C)urrent meter, (D)irect time and volume measurement (gpm / 15.9 = cfs).

(e) (Y)es, (N)o (record only if entire stream is checked), (P)eriodic, (X) Unknown.

(f) List the species code for up to 4 species with known spawning runs in this inlet.

(g) (TC) Type "C" with stoplogs, (SP) Sheet piling, (DI) Drop inlet with stoplogs, (CF) Concrete with fixed sill, (BD) Beaver Dam, (N)one, (O)ther (describe after Type:

(h) DNR, DOT, UFS, FWS, COE, NPS, (TOW)nship, (COU)nty, (CIT)y, (PRI)vate (list name after Owner:), (N)one (natural dam), (O)ther (list name after Owner:), (X) Unknown.

*Show Inlet (IN1, IN2, etc.), Outlet (OU1, etc.), DAM, Flow Measurement (FMI1, FMO1, etc.), and Average Width/Depth (WDI1, WDO1, etc.) locations on appropriate maps (IN.OU.DAM on habitat evaluation; FMI,FMO,WDI,WDO on sampling station) and record location description on Form 2.

DOW # 69-744

Body of Water Elbow

Dates of Fieldwork (mo/day/year) 8/17/1992 through 8/18/1992

FORM 4 - INLETS / OUTLET

Survey ID (Starting Date) 6/1/1992

Data Recorder(s) P. Hogan

1) Inlet ID #	2) Name	3) Tributary Number	4) Type[a]	5) Origin[b]		6) Cover Type / Land Use[c]			7) Avg. Width	8) Avg. Depth	9) FLOW fps	FLOW cfs	FLOW Method[d]	10) Sur. Temp.-°F
IN 1			IF	B		MI	B		10	2.0	0.5	10.0	F	63
IN 2			X	B		MI	B							65
IN 3			IF	B		MI	B		4	1.0	1.0	4.0	F	62
IN 4			IF	B		MI	B		15	1.0	0.5	7.5	F	64
IN 5			IF	B		MI	B		2	0.5	1.0	1.0	F	63
IN 6	Susan L. inlet		IF	L	69-741	MI	B		50	2	0.5	50.0	F	64

11) Inlet ID #	12a) Barrier to Fish Mvmt?[e]	12b) If Yes or Periodic, briefly describe	13) Known Spawning Runs[f] Spp. 1	Spp. 2	Spp. 3	Spp. 4	14) Inlet Comments (habitat, current water stage, etc.)
IN 1	P	Beaver dam 50 yds. upstream.					Muck bottom, heavily vegetated.
IN 2	X						Muck bottom, heavily vegetated. Couldn't find good flowage
IN 3	X						Muck bottom.
IN 4	X						Some rock/rubble substrates available.
IN 5	X						Sand substrates.
IN 6	P	Numerous beaver dams.	NOP	WAE			Good NOP spawning habitat. NOP fingerlings commonly seen. WAE reportedly migrate in spring, poor substrates.

15) Outl. ID #	16) Name	17) Tributary or DOW #	18) Tributary To (Trib. or DOW#)	19) Avg. Width	20) Avg. Depth	21) FLOW fps	FLOW cfs	FLOW Meth.[d]	22a) Barrier to Fish Mvmt?[e]	22b) If Yes or Periodic, briefly describe	23) WATER CONTROL STRUCTURE (DAM) Type[g]	Owner[h]	Head	> Sill	Gauge
OU 1			E-1-46-7-6	60	2	1	120	F	X		N				
OU															

24) Outlet Comments:

Type:

Owner:

(a) (ID) Intermittent - Dry (no flow at mouth, still may contain water), (IF) Intermittent - Flowing (currently has flow at mouth), (C)ontinuous Flow, (X) Unknown.

(b) (L)ake (give DOW#), (M)arsh, (B)og, (S)pring, (W)ell, (T)ile, (SS) Storm Sewer, (D)itch, (O)ther (describe), (X) Unknown. Consider only to next upstream waterbody.

(c) Give up to the two most common in order of abundance: (H)ardwoods, (CO)nifers, (MI)xed Forest, (G)rassland, (CR)ops, (P)asture, (MU)nicipal, (R)esidential, (MA)rshland, (B)ogs, (O)ther (describe), (X) Unknown.

(d) (F)loating object, (C)urrent meter, (D)irect time and volume measurement (gpm / 15.9 = cfs).

(e) (Y)es, (N)o (record only if entire stream is checked), (P)eriodic, (X) Unknown.

(f) List the species code for up to 4 species with known spawning runs in this inlet.

(g) (TC) Type "C" with stoplogs, (SP) Sheet piling, (DI) Drop inlet with stoplogs, (CF) Concrete with fixed sill, (BD) Beaver Dam, (N)one, (O)ther (describe after Type:)

(h) DNR, DOT, UFS, FWS, COE, NPS, (TOW)nship, (COU)nty, (CIT)y, (PRI)vate (list name after Owner:), (N)one (natural dam), (O)ther (list name after Owner:), (X) Unknown.

*Show Inlet (IN1, IN2, etc.), Outlet (OU1, etc.), DAM, Flow Measurement (FMI1, FMO1, etc.), and Average Width/Depth (WDI1, WDO1, etc.) locations on appropriate maps (IN,OU,DAM on habitat evaluation; FMI,FMO,WDI,WDO on sampling station) and record location description on Form 2.

Surrounding Watershed:

1) Type of Use/Coverage:

Watershed information should be recorded for each type of use listed that is present in the watershed. Add additional uses if needed.

2) Percent Use:

Record the percent availability for each type of use/coverage listed. Percents should total 100.

3) Relief:

Choose one of the following codes that best describes immediate watershed relief:

(S) Steep
(R) Rolling
(F) Flat

4) Location/Comments:

Note any additional comments concerning the surrounding watershed, especially the location of important characteristics.

5) Soil Types:

Choose up to two of the most common soil types within the watershed (in order of abundance) from the following codes:

(G) Glacial till
(R) Rock
(SA) Sand
(Si) Silt
(C) Clay
(L) Loam
(O) Other (describe in comments)
(X) Unknown

6) Comments (soils)

Describe any comments (if needed) related to soils.

Shoreline:

1) Type of Use/Coverage:

Shoreline information should be recorded for each type of use listed that is present along the shoreline. Add additional uses if needed.

2) Percent Use:

Record the percent availability for each type of use/coverage listed. Percents should total 100.

3) Slope:

Choose one of the following codes that best describes shoreline slope:

(S) Steep
(G) Gradual
(F) Flat

4) Location/Comments:

Note any additional comments concerning the shoreline for each type of use/coverage.

5) Number of Homes/Cabins:

Record the number of homes or cottages observed along the shoreline. Occasionally, houses or cabins will be close to the lake, but separated by a road or some other man-made structure. In these cases, use your judgement as to whether or not the construction has changed the shoreline. If it has, include the cabin in your count. If cabins away from the shoreline are counted, identify to what extent (for example, all cabins that could be seen from the lake) under comments (6).

6) Comments:

Describe substantial shoreline alterations (harbors, channels, breakwalls, jetties, etc.) or other factors having a major impact on the shoreline.

Resorts/Campgrounds:

1) ID Number:

Record the identification number of the resort from the habitat evaluation map.

2) Name:

List the name of the resort (list name on lake map if possible)

3) Number of Cabins:

List the number of cabins or cottages operated by the resort.

4) Number of Campsites:

List the number of campsites if known.

5) Comments:

List additional comments as needed.

DOW # _____ FORM 5 - WATERSHED/SHORELINE CHARACTERISTICS Page ____ of ____

Body of Water _____ Survey ID (Starting Date) _____

Dates of Fieldwork (mo/day/year) _____ through _____ Data Recorder(s) _____

SURROUNDING WATERSHED

1) TYPE OF USE/COVERAGE	2) % Use	3) Relief[a]	4) Location / Comments
Forest/Woodl.-Undeveloped			
Agricultural Crops			
Livestock / Pasture			
Marshland			
Bogs			
Grassland			
Municipal			

5) Soil Types[b]			6) Comments (soils):

SHORELINE

1) TYPE OF USE/COVERAGE	2) % Use	3) Slope[c]	4) Location / Comments
Forest/Woodl.-Undeveloped			
Agricultural Crops			
Livestock / Pasture			
Marshland			
Bogs			
Grassland			
Municipal			
Residential			

5) Number of Homes/Cabins	6) Comments[d]:

RESORTS / CAMPGROUNDS

1)ID#	2) Name	3)#Cabins	4)#Campsites	5) Comments	1)ID#	2) Name	3)#Cabins	4)#Campsites	5) Comments
RE					RE				
RE					RE				
RE					RE				

(a) Choose the one code that best describes the watershed relief: (S)teep, (R)olling, (F)lat.

(b) Choose the two most common: (G)lacial Till, (R)ock, (SA)nd, (SI)lt, (C)lay, (L)oam, (O)ther (describe in comments), (X) Unknown.

(c) Choose the one code that best describes the shoreline slope: (S)teep, (G)radual, (F)lat.

(d) Include area for Homes/Cabins count and substantial shoreline alterations (harbors, channels, breakwalls, etc.).

*Include resort/campground locations (RE1, etc.) on Habitat Evaluation map and record location description on Form 2. Also include adjacent wetland areas (bog, marshland) on Habitat Evaluation map (label as WE).

Body of Water Elbow Survey ID 6/1/1992 of 1

Dates of Fieldwork (mo/day/year) 8/17/1992 through 8/18/1992 Data Recorder(s) P. Hogan

SURROUNDING WATERSHED

1) TYPE OF USE/COVERAGE	2) % Use	3) Relief[a]	4) Location / Comments
Forest/Woodl.-Undeveloped	75	S	The majority of watershed is mixed forest (pin, fir, spruce, aspen, birch). Logging occurs.
Agricultural Crops			
Livestock / Pasture			
Marshland			
Bogs	25	F	Scattered throughout watershed with the NE, SE, and S areas from the lake with the majority.
Grassland			
Municipal			

5) Soil Types[b]	R	G	6) Comments (soils): Infertile, thin soils predominate.

SHORELINE

1) TYPE OF USE/COVERAGE	2) % Use	3) Slope[c]	4) Location / Comments
Forest/Woodl.-Undeveloped	70	S	The majority of shoreline is in mixed forest (pine, fir, spruce, aspen, birch). Logged in the past.
Agricultural Crops			
Livestock / Pasture			
Marshland			
Bogs	15	F	Primarily located at the NE, SE, and S areas of the lake associated with the inlets.
Grassland			
Municipal			
Residential	15	F	Scattered around the entire lake.

5) Number of Homes/Cabins	6) Comments[d]: Residential development has increased substantially in the last 10-15 years.
175	

RESORTS / CAMPGROUNDS

1) ID#	2) Name	3) #Cabins	4) #Campsites	5) Comments	1) ID#	2) Name	3) #Cabins	4) #Campsites	5) Comments
RE 1	Elbow Lake Lodge	10		Rooms available in Lodge.	RE				
RE					RE				
RE					RE				

(a) Choose the one code that best describes the watershed relief: (S)teep, (R)olling, (F)lat.

(b) Choose the two most common: (G)lacial Till, (R)ock, (SA)nd, (SI)lt, (C)lay, (L)oam, (O)ther (describe), (X) Unknown.

(c) Choose the one code that best describes the shoreline slope: (S)teep, (G)radual, (F)lat.

(d) Include area for Homes/Cabins count and substantial shoreline alterations (harbors, channels, breakwalls, etc.).

*Include resort/campground locations (RE1, etc.) on Habitat Evaluation map and record location description on Form 2. Also include adjacent wetland areas (bog, marshland) on Habitat Evaluation map (label as WE).

INSTRUCTIONS FOR FORM 6 - AQUATIC VEGETATION/SHOALWATER SUBSTRATE

1) Vegetation Common Name and Code:

List species or species group code and common name (if desired) - (see Appendix 5)

2) Transect Number:

Record transect number from map (for example, transect 1 would be VT1 (vegetation transect #1). Number all transects consecutively. Each form provides space for up to 20 transects. Number forms consecutively when using multiple pages. At each transect, identify each species or group present. If a species or species group is present, estimate it's abundance and record (R) rare, (C) common or (A) abundant in the appropriate box for that species and transect (see example forms). Use your best judgement when estimating abundance.

If transects have not been previously assigned, methods for determining the location of new transects are provided on page 3-5. The location of the transect should be identified on the map and on Form 2. Photographs of each transect may be helpful.

3) Maximum Vegetation Depth:

Record the maximum depth at which vegetation was located along each transect in feet.

4) Shoalwater Substrates:

At each transect, record substrate types present to a depth of 4 ft. If a substrate type is present, estimate it's extent and record (R) rare, (C) common or (A) abundant in the appropriate box for that substrate and transect (see example forms). Use your best judgement when estimating the extent of each substrate.

5) Additional Species Found:

List the species or species group code for vegetation observed that was not identified along a specific transect (for example, if you observe arrowhead, but did not locate arrowhead along any of the vegetation transects, record arrowhead in this section). Record the date (month/day) of the observation and any additional information concerning aquatic vegetation in the comments section.

FORM 3 - AQUATIC VEGETATION / SHOALWATER SUBSTRATE TRANSECTS

DOW # _____ Body of Water _____ Survey ID (Starting Date) _____

Dates of Fieldwork (mo/day/year) _____ through _____ Data Recorder _____ Page ____ of ____

AQUATIC VEGETATION TRANSECTS

		2) Transect Number[a]																			
1) Common Name	Code																				
3) Max. Veg. Depth																					

4) SHOALWATER SUBSTRATES

Ledge Rock	LR																				
Boulder (>10")	BO																				
Rubble (3-10")	RU																				
Gravel	GR																				
Sand	SA																				
Silt	SI																				
Clay	CL																				
Muck	MU																				
Detritus	DE																				
Marl	MA																				

5) ADDITIONAL SPECIES FOUND

Common Name	Code	Comments (date, locations, density)	Common Name	Code	Comments (date, locations, density)

a) Rate vegetation and substrate types within a transect as (R)are, (C)ommon, or (A)bundant.
*Show transect locations (VT1, VT2, etc.) on Sampling Station map and record locations on Form 2.

FORM 6 - AQUATIC VEGETATION / SHOALWATER SUBSTRATE TRANSECTS

DOW # 69-744 Body of Water Elbow Survey ID (Starting Date) 6/1/1992

Dates of Fieldwork (mo/day/year) 8/17/1992 through 8/18/1992 Data Recorder P. Hogan Page 1 of 2

AQUATIC VEGETATION TRANSECTS

1) Common Name	Code	2) Transect Number[a] 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Y. Waterlily	NUL							R		R	C								R	R	R
W. Waterlily	NT				R	A		R		C	R				R		A		R	R	
LW Waterlily	NYT								R												
W. Shield	BRS	C			C	C		C	R		C	R	R				C		R		
FL Burreed	SPA		R	R	C	A		C	C		C	R	C		R			C	R		
Sf. Wapato	SR										C										
Floatingleaf PW	PN																C				
Variable PW	PG								R		R										
Bladderwort	UI				R	R		R													
Sedges	CYP										R									R	
Grasses	G					A				C											
Sw. Horsetail	EF																	C	C	C	
Flatstem PW	PZ				R																
SS Bulrush	SV							R													
Wild Rice	ZIP																C				
3) Max. Veg. Depth		4	3	3	5	4	-	4	4	5	3	4	3	-	2	-	3	4	3	4	5

4) SHOALWATER SUBSTRATES

	Code																				
Ledge Rock	LR						A					C									C
Boulder (>10")	BO	C	R	C	C			C	R	C	R	R	R	C	C	R		R		R	C
Rubble (3-10")	RU		C	C	C			C	C	C				C	C	C				C	
Gravel	GR																				
Sand	SA		C						C				C			C		C	R	C	
Silt	SI	C																C	C		
Clay	CL										A								C		
Muck	MU					R											A				
Detritus	DE					A						C	C								
Marl	MA																				

5) ADDITIONAL SPECIES FOUND

Common Name	Code	Comments (date, locations, density)	Common Name	Code	Comments (date, locations, density)
C. Cattail	TL	8/17/1992. In back of bay west of VT1.	Wild Celery	VA	8/17/1992. Predominantly in NE bay.
Cane	PHAU	8/17/1992. West of VT20. West of VT7.	Leafy Pondweed	PF	8/17/1992. In NE bay.
Manna Grass	GB	8/17/1992. In vicinity of VT17 and VT18.	Spikerush	ELS	8/17/1992. Near Elbow Lake Lodge.
Giant Burreed	SE	8/17/1992. Patch growing south of VT12.	W. Watermilfoil	MS	8/17/1992. Near VT18.

a) Rate vegetation and substrate types within a transect as (R)are, (C)ommon, or (A)bundant.
*Show transect locations (VT1, VT2, etc.) on Sampling Station map and record locations on Form 2.

Fish Spawning Conditions

1) Species Code:

List species code.

2) Habitat Rating:

Choose from one of the following codes for evaluating fish habitat (see "Fish Spawning Habitat", page 3-8 for more information):

(E) Excellent
(G) Good
(F) Fair
(P) Poor
(N) None

3) Comments:

Describe the type and location of spawning habitat.

Erosion or Pollution (nature and extent):

1) Site Code and Number:

Record the site code and number for each (PO) pollution or (ER) erosion site from the Habitat Evaluation map. Assign code and number if not previously mapped.

2) GPS Coordinates:

Record latitude and longitude if available.

3) Location description:

Describe the location of each erosion or pollution site.

4) Nature and Extent:

To rate nature, use a combination of two codes from the following choices:

First Code:

(P) Point Source
(N) Non-point Source
(X) Unknown

Second Code:

(B) Bank Erosion
(G) Gully Erosion
(S) Sheet Erosion
(I) Industrial Pollution
(A) Agricultural Pollution
(M) Municipal Pollution
(D) Domestic Pollution
(O) Other
(X) Unknown

For example, direct outflow from a septic system into the lake would be coded PD, point source pollution from a domestic source.

To rate extent, choose from the following codes:

(L) Light
(M) Moderate
(S) Severe

5) Comments:

Describe additional comments concerning pollution or erosion by site as needed.

FORM 7 - FISH SPAWNING CONDITIONS, EROSION AND POLLUTION

DOW # _____ Page ___ of ___

Body of Water _____ Survey ID (Starting Date) _____

Dates of Fieldwork (mo/day/year) _____ through _____ FISH SPAWNING CONDITIONS Data Recorder(s) _____

1) Spp. Code	2) Habitat Rating[a]	3) Comments (Habitat description, locations, etc.)

Dates of Fieldwork (mo/day/year) _____ through _____ EROSION OR POLLUTION (Nature and Extent) Data Recorder(s) _____

1) Site Code[b] #	2) GPS Coordinates Latitude	Longitude	3) Location Description	4) Nature[c] and Extent[d] Nat.	Ext.	Nat.	Ext.	Nat.	Ext.	5) Comments

(a) Rate spawning habitat as: (E)xcellent, (G)ood, (F)air, (P)oor, (N)one.

(b) (ER)osion, (PO)llution.

(c) Use two letter code with first letter either (P)oint Source, (N)on-Point Source, or (X) Unknown and the second letter either (B) Bank erosion, (G) Gully erosion, (S)heet Erosion, (I)ndustrial Pollution, (A)gricultural Pollution, (M)unicipal Pollution, (D)omestic Pollution, (O)ther, (X) Unknown (e.g., PI, NA, etc.). Describe under comments.

(d) Rate extent of erosion and pollution as: (L)ight, (M)oderate, (S)evere.

*Include erosion and pollution locations (ER1, PO1, etc.) and known/favorable habitat spawning locations (label as SP-WAE, SP-NOP, etc.) on the Habitat Evaluation map.

DOW # 69-744

FORM 7 - FISH SPAWNING CONDITIONS, EROSION AND POLLUTION

Page 1 of 1

Body of Water Elbow Survey ID (Starting Date) 6/1/1992

Dates of Fieldwork (mo/day/year) 8/17/1992 through 8/18/1992 FISH SPAWNING CONDITIONS Data Recorder(s) P. Hogan

1) Spp. Code	2) Habitat Rating[a]	3) Comments (Habitat description, locations, etc.)
NOP	F	Marginal in-lake marsh habitat. Susan lake inlet best area (many beaver dams, however).
SMB	G	Suitable rock/rubble areas available. NW area of lake appears best.
WAE	P	Minimal gravel shoal areas. Shoreline drops off sharply in most areas. Most inlet substrates poor.

Dates of Fieldwork (mo/day/year) 8/17/1992 through 8/18/1992 EROSION OR POLLUTION (Nature and Extent) Data Recorder(s) P. Hogan

1) Site Code[b] #	2) GPS Coordinates Latitude	Longitude	3) Location Description	4) Nature[c] and Extent[d] Nat.	Ext.	Nat.	Ext.	Nat.	Ext.	5) Comments
ER 1	48°02'02"	92°37'26"	NE bay area between inlets 1 and 2.	PB	L					Clearcut area on moderate-steep slopes.

(a) Rate spawning habitat as: (E)xcellent, (G)ood, (F)air, (P)oor, (N)one.

(b) (ER)osion, (PO)llution.

(c) Use two letter code with first letter either (P)oint Source, (N)on-Point Source, or (X) Unknown and the second letter either (B) Bank erosion, (G) Gully erosion, (S)heet Erosion, (I)ndustrial Pollution, (A)gricultural Pollution, (M)unicipal Pollution, (D)omestic Pollution, (O)ther, (X) Unknown (e.g., PI, NA, etc.). Describe under comments.

(d) Rate extent of erosion and pollution as: (L)ight, (M)oderate, (S)evere.

*Include erosion and pollution locations (ER1, PO1, etc.) and known/favorable habitat spawning locations (label as SP-WAE, SP-NOP, etc.) on the Habitat Evaluation map.

INSTRUCTIONS FOR FORM 8 - ADDITIONAL FIELD NOTES

Describe additional information of interest. Winterkill dates, fishing reports, past angling history, algal blooms, access needs, etc. Also note wildlife or other species observed such as snapping turtles (list shell length), crayfish (number and size), loons (number observed, broods), etc.

FORM 8 - ADDITIONAL FIELD NOTES

Page ____
of ____

DOW # _____

Survey ID

Body of Water _____ (Starting Date) _____ Data Recorder(s) _____

*Indicate the date (mo/day/year) when documenting field observations and include a location description of field observations on this form if warranted.

DOW # 69-744 FORM 8 - ADDITIONAL FIELD NOTES Page 1 of 1

Body of Water Elbow Survey ID (Starting Date) 6/1/1992 Data Recorder(s) D. Hogan

(8/10/1992 - 8/14/1992) Looked at 8 walleye stomachs. All were empty. Lots of fat in cavity.

(8/10/1992 - 8/14/1992) 2 Bald Eagles and 1 Osprey observed.

(8/10/1992 - 8/14/1992) Interviewed 4 fishing parties. Fishing has been fair for walleye, good for smallmouth bass. A 9 lb. walleye was rumored to have been caught last week.

(8/12/1992) Owner of Elbow Lake Lodge was satisfied with the fishing.

*Indicate the date (mo/day/year) when documenting field observations and include a location description of field observations on this form if warranted.

WATER QUALITY

Water quality sampling requirements vary. Water samples for analysis by the Ecological Services Chemistry Lab are required for all full surveys. Dissolved oxygen, temperature, water color and water clarity measurements are required for all full surveys and population assessments. Total alkalinity and pH measurements are required for all full surveys and population assessments only if total alkalinity has historically been < 5ppm (as measured from previous surveys) or if either parameter has not been previously measured. Water quality data should be recorded on Form 9.

Water quality sampling provides physical and chemical data for measuring water quality at the time of the survey, evaluating long term changes or trends, and updating or establishing lake classification type. Lake productivity influences water quality and water clarity, which can affect fish growth, abundance, and habitat availability. A discussion concerning the interpretation and use of water quality data and it's application to fisheries management is provided in Appendix 9.

Sampling Stations:

In lakes less than 5,000 acres with relatively simple basins, one sampling station (a centrally located point with maximum or near maximum depth) should be selected. In lakes greater than 5,000 acres, or smaller lakes with complexly shaped or distinct basins, two sampling locations should be specified, the primary location (as described above) and a secondary location (a site well removed from the primary site but with similar physical characteristics). Additional sampling stations can be established at the discretion of the Area Supervisor. All sampling locations, once established must be permanently marked on the sampling station map and described on Form 2. All stations must remain consistent from year to year. Primary and secondary sampling stations should always be marked WQ1 and WQ2, respectively, with additional stations marked WQ3, WQ4, etc.

When to Sample:

Water quality should be measured during the initial stages of the survey. Dissolved oxygen and temperature monitoring must be completed prior to gill net sampling to ensure nets are not set in anoxic water. Ideally, all water quality field measurements will be completed the same day.

Water quality can change during the year. Areas have the option of sampling at different times if needed. For example, a two-story trout fishery historically surveyed in June may provide considerably less coolwater habitat during August. In situations where water quality directly affects management of the fishery, Areas should strongly consider additional sampling.

Dissolved Oxygen and Temperature:

Dissolved oxygen (DO) and temperature must be measured at each sampling station using a DO and temperature meter with sufficient cable to reach the lake bottom. Meters must be properly maintained and calibrated each day prior to use (see owners manual for instructions on maintenance and calibration). The boat should be anchored prior to sampling to ensure the water column is sampled vertically.

When sampling, record DO and temperature at 3 ft intervals from surface to the top of the thermocline, 1 ft intervals through the thermocline, and 3 ft intervals from the bottom of the thermocline to the lake bottom. The thermocline is defined as ">1 degree C drop in temperature per meter (approximately 3 ft). If the lake is not stratified, record DO and temperature at 3 ft intervals until reaching bottom. Measurements at 1 ft intervals through the thermocline are needed to determine availability of cool water habitat with adequate oxygen to support fish.

Secchi Disk Transparency:

Water transparency must be measured at each sampling station using a standard Secchi disk (circular plate, 20 cm in diameter, with opposing black and white quarters) that hangs horizontally from a calibrated line. Sampling should be conducted during mid-

day if possible. Avoid wearing polaroid or other glasses that reduce surface glare. When sampling, slowly lower the Secchi disk over the shady side of the boat until it disappears from view and record the depth in feet and tenths. Lower the disk several feet, then raise it until just visible and again record the depth. The average of the two readings should be recorded as the Secchi transparency. If needed, take several readings to obtain an "overall" average.

Measuring water clarity is strongly encouraged each time the lake is visited. Water clarity can change quickly, and several Secchi transparency measurements over the course of a year will provide a better understanding of water clarity for specific lakes. If possible, take all Secchi measurements at the primary or secondary sampling station.

Water Color and Cause:

Information concerning water color and associated cause is needed to measure the relationship between nutrient availability and primary productivity (see Appendix 9). Factors affecting water quality (such as algae blooms, suspended solids, bog stain, etc.) can be determined by estimating water color and cause. This information can also be used to monitor changes in water quality following watershed improvements.

Alkalinity and pH (for Area analysis):

Alkalinity, pH, and conductivity sampling is required during full surveys and population assessments for lakes with total alkalinity <5 ppm. Sampling is encouraged for lakes with total alkalinity >5 ppm if water quality problems are anticipated or for other reasons at the discretion of the Area Supervisor.

For measuring alkalinity, pH, and conductivity, one surface water sample must be collected from the primary sampling station using one of the following techniques:

1) Integrated - a 1 in diameter X 6.5 ft long PVC pipe is slowly lowered into the water (after rinsing three times) until fully immersed and the top end is corked. The pipe is retrieved and the water is emptied into the sample bottle.

2) Grab - the sample bottle is opened, rinsed three times, inverted, and slowly immersed to elbow depth while held by the bottom of the bottle. The bottle is then inverted slowly as it fills.

Grab samples minimize contamination, but can be less representative than integrated samples if algal biomass is concentrated near the surface. Total alkalinity and pH should be measured as soon as possible. Keep water samples refrigerated if left overnight.

Water Samples for Laboratory Analysis (Carlos Avery Lab):

For all full surveys, two surface water samples are required for laboratory analysis (one for total alkalinity and pH, total phosphorous, total dissolved solids, and conductivity, the other for chlorophyll a). If water quality changes are suspected or anticipated (such as major alterations to the watershed or addition or elimination of major point sources of pollution), Area Supervisors are encouraged to collect water samples during population assessments as well. Under this situation, the Lake and Stream Survey Coordinator should be contacted prior to collecting the samples. Water sample bottles and tags will be distributed to each Area prior to the sampling season.

Water samples should be collected from the primary sampling station using one of the methods described under the Alkalinity and pH section of this manual (page 4-3). For all samples, indicate collection method on the tag. The chlorophyll a sample bottle should be pre-wrapped in aluminum foil to ensure no light penetration, or dark bottles should be used. Secchi disk transparency should also be measured when water samples are collected.

Water samples should be appropriately labeled, immediately placed on ice or refrigerated, and transported to the Ecological Services Chemistry Lab at Carlos Avery as soon as possible. Results will be provided to each Area for entry into the data base.

Additional water samples may also be collected from the hypolimnion (near bottom) at the primary sampling station, from inlets, or from other locations of interest. Hypolimnetic sampling can provide information concerning internal nutrient loading (nutrients released from bottom sediments), while water samples from inlets can provide information on water quality problems related to the surrounding watershed.

Other chemical parameters (e.g. sulfate, chloride, total dissolved solids, total nitrogen, turbidity, fecal coliforms) are not required on a routine basis. However, they can be measured upon request of the Area Supervisor when specific problems are suspected. Area Supervisors must request these analyses through the Lake and Stream Survey Coordinator prior to collecting the samples.

INSTRUCTIONS FOR FORM 9 - WATER QUALITY SAMPLING

A separate form is needed for each sampling station and date.

1) Standard Sampling (Y/N):

List (Y) yes or (N) no whether or not you are using standard sampling for dissolved oxygen and temperature. If no, describe the method and type of sampling used. Use a separate form for each special sampling method.

2) Station Number:

List station number from Sampling Station map. Station WQ1 should always be the **primary** station (as described on page 4-1).

3) Date:

List the month, day and year sampling was conducted for each station.

4) Temperature - Dissolved Oxygen Profile:

List temperature (C) and dissolved oxygen (ppm) at each depth (feet) beginning at the surface. Depth is recorded as 0 for surface measurements. Follow procedures described on page 4-2 for taking measurements.

List the depth to the lake bottom in feet.

5) Standard Sampling:

List (Y) yes or (N) no whether or not you are using standard sampling for other water quality parameters. If no, describe the method and type of sampling used. Use a separate form for each special sampling method.

6) Station Location:

If sample taken from the lake, record (LA). If taken from an inlet, record inlet number from Habitat Evaluation map (e.g., IN1, IN2, etc.).

7) Time:

Record time of sampling from 0-2400 hours (military time).

8) Secchi:

Record secchi depth in feet and tenths at the sampling station. If the disk can be seen resting on the bottom in the deepest part of the lake, record a ">" (e.g., >13.5).

9) Wave Intensity:

Estimate wave intensity at the station from one of the following codes:

(C) Calm
(M) Moderate
(S) Strong

10) Wind Direction:

Select wind direction from one of the following codes:

(N) North
(S) South
(E) East
(W) West
(NE) Northeast
(NW) Northwest
(SE) Southeast
(SW) Southwest
(X) No Wind

11) Color:

Choose water color from the following codes:

(G) Green
(BR) Brown
(BL) Blue
(C) Clear
(O) Other (describe)

12) Cause:

Determine the cause of water color from the following codes:

(A) Algae
(S) Silt
(B) Bog Stain
(L) Low Fertility (blue, clear option)
(O) Other (describe)
(X) Unknown

13) Sample Depth:

Record the depth in feet at which the water sample was taken (0 if surface sample).

14) pH:

Record field pH from water samples taken from the sampling station.

15) Alkalinity:

Record alkalinity from water samples taken from the sampling station. List the method used to measure alkalinity based upon the following codes:

(SC) Single Titration, Colorimetric
(SP) Single Titration, Potentiometric
(DC) Double-endpoint Titration, Colorimetric
(DP) Double-endpoint Titration, Potentiometric

16) Other Field Measurements:

Record other field measurements (e.g. conductivity) from water samples taken from the sampling station.

17) Lab Samples Taken:

Record (Y) yes or (N) no whether or not water samples were collected and delivered to the Chemistry Lab (Ecological Services) for analysis.

18) Collection Method:

Choose from the following codes concerning how water samples were collected:

(G) Grab sample
(I) Integrated sampler
(O) Other (describe)

19) Comments:

Provide any additional comments as needed (weather conditions, light intensity, etc.).

FORM 9 - WATER QUALITY

DOW # _____ Survey ID _____ Page ____

Body of Water _____ (Starting Date) _____ Data Recorder _____ of ____

1) Standard Sampling (Y/N)? ____ If No, describe: _____

2) Station Number: WQ _____ 3) Date (month/day/year): _____

4) TEMPERATURE - DISSOLVED OXYGEN PROFILE

Depth (ft.)	Temp.-°C	D.O.- ppm	Depth (ft.)	Temp.-°C	D.O.- ppm	Depth (ft.)	Temp.-°C	D.O.- ppm
0								
						4) Bottom Depth: _____ feet		

5) Standard Sampling (Y/N)? ____ If No, describe: _____

6) Station Location - (LA)ke, (IN)let: _____ 7) Time (0-2400): _____ 8) Secchi[a] (ft.1): _____

9) Wave Intensity[b]: _____ 10) Wind Direction[c]: _____ 11) Color[d]: _____ describe: _____

12) Cause[e]: _____ describe: _____ 13) Sample Depth (feet, 0 if surface): _____ 14) pH: _____

15) Alkalinity: _____, method[f] _____ 16) Other Field Measurements: _____

17) Lab Samples Taken (Y/N): _____ 18) Collection Method[g]: _____ describe: _____

19) Comments (weather conditions, light intensity, etc.):

(a) If Secchi disk is visible on the bottom, include a ">" (e.g., >13.5).

(b) (C)alm, (M)oderate, (S)trong. Describe conditions at water quality station.

(c) N, S, E, W, NE, NW, SE, SW, X (No Wind).

(d) (G)reen, (BR)own, (BL)ue, (C)lear, (O)ther (describe).

(e) (A)lgae, (S)ilt, (B)og-stain, (L)ow fertility (blue, clear option), (O)ther (describe), (X) Unknown.

(f) Use 2-letter code: (S)ingle or (D)ouble-endpoint titration, (C)olorimetric or (P)otentiometric (e.g., DP, SC, etc.).

(g) (G)rab sample, (I)ntegrated sample, (O)ther (describe).

*Primary station is always WQ1.

**Show WQ station locations (label as WQ1, etc.) on Sampling Station map and record location description on Form 2.

DOW # 69-744 | FORM 9 - WATER QUALITY | Page 1 of 1

Body of Water: Elbow | Survey ID (Starting Date) 6/1/1992 | Data Recorder P. Hogan

1) Standard Sampling (Y/N)? Y If No, describe: _____

2) Station Number: WQ 1 3) Date (month/day/year): 8/10/1992

4) TEMPERATURE - DISSOLVED OXYGEN PROFILE

Depth (ft.)	Temp.-°C	D.O.- ppm	Depth (ft.)	Temp.-°C	D.O.- ppm	Depth (ft.)	Temp.-°C	D.O.- ppm
0	19.8	8.5	29	12.7	5.1			
3	19.8	7.9	32	12.0	5.2			
6	19.8	7.1	35	11.8	4.8			
9	19.5	6.6	38	11.5	4.7			
12	19.5	6.4	41	10.5	4.7			
15	19.0	6.3	44	10.3	4.3			
16	18.5	6.3	47	9.6	4.1			
17	18.1	5.9	50	9.1	3.4			
18	17.0	5.9	53	8.9	2.9			
19	17.0	5.5	56	8.4	2.6			
20	16.5	5.2						
23	15.5	5.2						
26	14.0	4.9				Bottom Depth: 60 feet		

5) Standard Sampling (Y/N)? Y If No, describe: _____

6) Station Location - (LA)ke, (IN)let: LA 7) Time (0-2400): 1100 8) Secchi[a] (ft.1): 7.5

9) Wave Intensity[b]: C 10) Wind Direction[c]: X 11) Color[d]: BR describe: _____

12) Cause[e]: B describe: _____ 13) Sample Depth (feet, 0 if surface): _____ 14) pH: _____

15) Alkalinity: _____, method[f] _____ 16) Other Field Measurements: _____

17) Lab Samples Taken (Y/N): Y 18) Collection Method[g]: G describe: _____

19) Comments (weather conditions, light intensity, etc.): Weather has been cloudy - partly cloudy with intermittent rain.

(a) If Secchi disk is visible on the bottom, include a ">" (e.g., >13.5).
(b) (C)alm, (M)oderate, (S)trong. Describe conditions at water quality station.
(c) N, S, E, W, NE, NW, SE, SW, X (No Wind).
(d) (G)reen, (BR)own, (BL)ue, (C)lear, (O)ther (describe).
(e) (A)lgae, (S)ilt, (B)og-stain, (L)ow fertility (blue, clear option), (O)ther (describe), (X) Unknown.
(f) Use 2-letter code: (S)ingle or (D)ouble-endpoint titration, (C)olorimetric or (P)otentiometric (e.g., DP, SC, etc.).
(g) (G)rab sample, (I)ntegrated sample, (O)ther (describe).
*Primary station is always WQ1.
**Show WQ station locations (label as WQ1, etc.) on Sampling Station map and record location description on Form 2.

ELECTROFISHING

Electrofishing was not previously part of Minnesota's long term monitoring program. Because of the need to better monitor bass populations, electrofishing has become a standard sampling technique and is required where possible during full surveys and population assessments on lakes where largemouth or smallmouth bass are the primary species in the lake management plan. Electrofishing is also encouraged on lakes where bass are listed as a secondary species. All other electrofishing (for example, walleye fingerlings during fall, spring muskie, etc.) is considered special sampling. Electrofishing requires completion of Form 10. Instructions are provided on page 5-6. Electrofishing catch should be recorded following instructions in "Recording the Catch," page 9-1. Additional information is provided in "Electrofishing Policy," Special Publication 144 (Section of Fisheries 1989).

Electrofishing is an active method that uses electricity to stun and capture fish. It is most effective in shallow water and is therefore selective towards species associated with shoreline or shallow water habitats. Largemouth and smallmouth bass are often effectively sampled by electrofishing. Target species are listed in Appendix 3.

Environmental factors directly influence the effectiveness of electrofishing. Daily weather patterns affect fish movement with electrofishing success often erratic or poor during cold front conditions. Conductivity influences electrofishing efficiency with extremely soft (low conductivity) or hard (high conductivity) water resulting in greater difficulty capturing fish as compared to water with moderate conductivity. Water temperature affects fish metabolism, influencing their ability to escape the electrical field. Water transparency influences electrofishing efficiency with turbid water limiting the visibility of dip-netters as they attempt to capture stunned fish, and clear water causing fish to move into deeper habitats not adequately sampled by electrofishing.

Season and time of day also affect electrofishing success. Spawning fish are more territorial and less likely to escape the electric field and night sampling is more likely to sample fish that move into shallow water after dark. Fish size also influences electrofishing success as large fish are generally more effectively stunned and are more visible to dip-netters than small fish.

Because of these and other biases, catch per unit-of-effort (CPUE) and population structure (especially for small fish) data should be evaluated carefully. If methods and environmental conditions at the time of the survey are similar to previous surveys, electrofishing can prove very useful in evaluating population trends. Electrofishing is also a valuable tool for collecting fish that are not vulnerable to other gears.

Safety:

Safety is the most important concern while electrofishing. Each member of the staff must complete a training seminar (conducted by the Section's electrofishing training committee) that describes gear and techniques that ensure safe operation. During boat electrofishing operations, each crew must have at least two individuals certified in CPR and first aid (see Electrofishing Policy, Special Publication No. 144 for additional information).

Gear Requirements:

There are many factors to consider when choosing electrofishing equipment. Current type (AC or DC), electrode size and shape (braided wire, metal ring with droppers, stainless steel sphere, etc.), pulse rate, voltage, amperage and other physical factors can influence the effectiveness of electrofishing equipment. As discussed earlier, conductivity, turbidity, season, water temperature, weather patterns and other environmental factors can affect fish activity and our ability to collect representative samples. Because these factors and conditions vary throughout the state, it would be difficult to

establish a "standard" electrofishing rig applicable to all Areas. For this reason, there is no "standard" rig for Minnesota waters. Each rig must be "customized" to meet Area needs.

References concerning electrofishing methods and equipment and their use under various environmental and physical conditions are located in Appendix 1. Additional assistance is available through the electrofishing training committee.

Sampling Season and Time of Day:

Electrofishing should be conducted during spring (preferred) or fall when water temperatures are approximately 50-70 F. Avoid sampling late in fall when water temperatures drop below 50 degrees. Sampling can occur during summer if catch rates exceed 15 bass (>8") per hour with a minimum sample size of 30. Spring or fall sampling, however, is recommended.

Catch rates for bass are often higher at night, especially in clear water (Gilliland 1985, Nielson and Johnson 1983). Sampling in clear water (>3' Secchi) should be at night, however daytime electrofishing is acceptable if catch rates exceed 15 bass (>8") per hour with a minimum sample size of 30. Areas may need to experiment to determine where daytime sampling is acceptable. If water clarity is poor (<3' Secchi), daytime sampling may be effective, however, if catch rates are low during the day Areas should try night sampling. Once a date and time (day or night) has been established on a given water body it should be duplicated for all subsequent surveys and assessments.

Sampling Stations:

Use sampling stations that have already been established. If sampling stations have not been established, choose a variety of areas that contain good habitat (vegetated bays, points, emergent stands, rocky shorelines, etc.) for largemouth bass or smallmouth bass during that time of year. Record all sampling stations on the Sampling Station map and describe them on Form 2.

For lakes <100 acres, the entire shoreline should be sampled. Consider conducting population estimates (mark-recapture) on small lakes. Population estimates will provide a

better estimate of abundance than catch per unit effort. References concerning population estimates are provided in Appendix 1. For lakes >100 acres a variety of sampling stations are needed to ensure an unbiased sample of fish is collected. For example, a particular bay may contain spawning bass with a larger average size than another bay where spawning does not occur. By sampling a variety of habitats, collection of a representative sample will be ensured. Sampling stations should be established depending upon lake size as follows:

Lake Size (acres)	Number of Electrofishing Stations
100-600	4
600-1500	6
>1500	8

These numbers should be considered a minimum. You have the option of increasing the number of stations if desired. The length of each station can vary depending upon the amount of habitat available, however each station should take <30 minutes to complete. For example, a bay with vegetation throughout that provides good bass habitat can be sampled entirely (as long as it takes 30 minutes or less), while a bay with vegetation covering 1/3 of it's surface should be sampled only in the area with good habitat.

Stations should remain consistent from year to year, however, habitat changes (for example, aquatic vegetation removal) may necessitate changing the station size or adding new stations. Do not eliminate old stations, rather assign new stations a new station number. Also, stations in which large numbers of bass (>30 over 8") are collected can be shortened to decrease the amount of time needed to complete the survey. Be sure to modify the station description if changes occur.

For each station, the data base will calculate the total amount of time spent electrofishing (run-time) and, if properly equipped with a timer, the time in which the electrofishing unit was actually fishing (on-time). For example, it may take 30 minutes to complete a station from start to finish (run-time),

but the foot pedal may have been compressed for only 20 minutes (on-time). The data base will report the catch as number of fish/hour for both run-and on-time.

Additional Information:

Information concerning boat configuration, voltage, amperage, conductivity, water clarity, and water temperature should be recorded on Form 10.

Largemouth and smallmouth bass are the target species for collection, however, Areas are encouraged to collect additional species of interest, especially those that are less vulnerable to other sampling gear (for example, young of the year walleye).

How to Electrofish:

Electrofishing should be conducted along the shoreline in relatively shallow water (usually 6 ft. or less), if possible. The foot pedal should be depressed only when the boat is in appropriate depths. Operators have the option of continuous fishing or "pulsed" fishing where the foot pedal is depressed only when near "good" habitat. In many cases, continuous fishing works better in more conductive water while pulsed is better in soft water. In either case, consider experimenting to see what works best in specific situations.

In most cases, one dip-netter will be adequate, however Areas have the option of using two dip-netters if large numbers of fish are anticipated.

Most fish sampled by electrofishing will be alive. Crew members should take every precaution to insure that live fish are returned to the water in good condition.

INSTRUCTIONS FOR FORM 10 - ELECTROFISHING

The first section of the form allows you to list up to three different boat configurations (a,b, or c). This is useful if you change the configuration (for example, add additional anodes, change control box, etc.) between sampling stations. For each sampling station, you will be able to identify the configuration used.

The remainder of the form allows room for up to three sampling stations. Number each form consecutively if additional forms are needed.

1) Standard Sampling:

List (Y) yes or (N) no whether or not you are using standard sampling. If no, describe the method and type of sampling used (for example, fall electrofishing for YOY walleye). Use a separate form for each special sampling method used.

2) Boat Configuration:

a,b,c) Anode, Cathode, Current and Pulsator Types:

Choose the anode type used from the following codes:

(S) Sphere
(R) Ring
(C) Cable
(O) Other (describe under comments)

List the number of anodes used.

Choose the cathode type used from the following codes:

(B) Boat
(D) Droppers
(O) Other (describe under comments)

List the current type used from the following codes:

(A) AC
(3) 3 phase AC
(D) DC
(P) Pulsed DC
(O) Other (describe under comments)

List the variable voltage pulsator manufacturer and model used (for example, Coffelt VVP 15).

3) Station Code and Number:

List station code and number from map. For standard sampling (electrofishing to monitor bass), stations should be coded EF1, EF2, etc. All other sampling is considered "special sampling", with station numbers preceded by an S (for example, special sampling station number 1 would be SEF1). If different special sampling techniques are used at the same lake, do not repeat station numbers. For example, stations for fall electrofishing for walleye might be numbered SEF1, SEF2, ... SEF5. Stations for special sampling for musky during spring would then be numbered SEF6, SEF7, and so on. This will ensure stations for each special sampling method can be identified on the sampling station map and retrieved individually from the data base.

4) Time:

List the actual time electrofishing started and ended for each station using military time (0-2400 hours).

5) Date:

List the month, day and year of sampling.

6) Day/Night:

Record whether the station was sampled during daylight or night-time hours using the following codes:

(D) Daylight
(N) Night-time

7) On-Time:

Record the amount of time the electrofishing boat was actually sampling (in minutes) if a timer is available.

8) Number of Netters:

Record the number of netters used in the survey.

9) Target Species:

Record (A) if netting all species encountered, otherwise list codes for specific species sought (for example, if targeting and collecting only juvenile walleye, list WAE on form). If targeting young-of-the-year, place a Y in front of the species code. Record YOY if assessing natural reproduction for all species.

10) Boat Configuration:

List (a), (b) or (c) based upon the boat configuration used for that station (as described at the top of the form - section 2).

11) Clarity*:

Rate the effect of water clarity (based upon turbidity, waves, etc.) on fish catch from one of the following codes:

(P) Poor - significantly affected fish catch
(M) Moderate - some affect on fish catch
(G) Good - no perceived affect on fish catch

12) Conductivity*:

Record conductivity at each station.

13) Surface Temperature*:

Record surface temperature (F) at each station.

14) VVP Settings:

Record the settings used on the Variable Voltage Pulsator for amperage (A), voltage (V), % frequency (%F), pulses per second (PPS), and output power (watts) (W), if applicable.

15) GPS Coordinates:

Record latitude and longitude, if available, at the start and end of each electrofishing station.

16) Location Description:

Describe the location of each electrofishing station.

17) Comments:

Record additional comments including habitat (depth, amount and type of cover, etc.), sampling conditions (weather, visibility), sightings of non-target species, or other applicable information.

*note - if clarity, conductivity or surface temperature changes are not anticipated between stations, information can be duplicated from the previous station.

DOW # _____ FORM 10 - ELECTROFISHING Page _____ of _____

Body of Water _____ Survey ID (Starting Date) _____ Data Recorder(s) _____

1) Standard Sampling (Y/N)? _____ If No, describe method: _____

2) BOAT CONFIGURATION

a) Anode Type[a] _____ Cathode Type[b] _____ Number of Anodes _____ Current Type[c] _____ VVP Manufacturer and Model# _____

b) Anode Type[a] _____ Cathode Type[b] _____ Number of Anodes _____ Current Type[c] _____ VVP Manufacturer and Model# _____

c) Anode Type[a] _____ Cathode Type[b] _____ Number of Anodes _____ Current Type[c] _____ VVP Manufacturer and Model# _____

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/ (N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply)				
												A-	V-	XF-	PPS-	W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:

*For additional stations, need only to record the information that changes.

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/ (N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply)				
												A-	V-	XF-	PPS-	W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/ (N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply)				
												A-	V-	XF-	PPS-	W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:

(a) Anode Type Choices: (S)phere, (R)ing, (C)able, (O)ther (describe under comments).
(b) Cathode Type Choices: (B)oat, (D)roppers, (O)ther (describe under comments).
(c) Current Type Choices: (A)C, (3)-phase AC, (D)C, (P)ulsed DC, (O)ther (describe under comments).
(d) Standard sampling (EF); Special sampling, put an S before the gear type code (SEF).
(e) Record On-Time in seconds if VVP or generator has timer.
(f) Record species codes for netted species (LMB, SMB, etc.). Record (A)ll if netting all species. If targeting YOY, put Y before the species code (YWAE, etc.). If using boat electrofishing for assessment of natural reproduction for all species, record YOY.
(g) Record the letter of the correct boat configuration for that run (either a, b, or c from section 2).
(h) Rate water clarity (turbidity, waves, etc.) as (P)oor (significantly affected catch), (M)oderate (some affect on catch), (G)ood (no perceived affect on catch).
(i) Include general habitat description (depth zone sampled, amount and type of cover, substrate types, etc.), conditions (visibility, weather. etc.), sightings of non-target species.

DOW # 69-744 Body of Water Elbow Survey ID (Starting Date) FORM 10 - ELECTROFISHING 6/1/1992 Data Recorder(s) P. Hogan Page 1 of 2

1) Standard Sampling (Y/N)? Y If No, describe method:

2) BOAT CONFIGURATION

a)	b)	c)
Anode Type[a]: S	Anode Type[a]:	Anode Type[a]:
Cathode Type[b]: B	Cathode Type[b]:	Cathode Type[b]:
Number of Anodes: 1	Number of Anodes:	Number of Anodes:
Current Type[c]: P	Current Type[c]:	Current Type[c]:
VVP Manufacturer and Model#: Coffelt VVP-15	VVP Manufacturer and Model#:	VVP Manufacturer and Model#:

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/(N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply)
Ef 1	2105	2135	6/1/1992	N	1500	2	SMB, LMB, BLG, WAE	a	G		59	A- 4 V- 310 %F- 46 PPS- 60 W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:
48° 00' 10"	92° 40' 30"	48° 00' 10"	92° 40' 30"	Started at north tip of island. Went around 1 time clockwise.	Excellent boulder/rubble substrates (for SMB spawning) from 3-6 feet deep.

*For additional stations, need only to record the information that changes.

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/(N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply)
Ef 2	2210	2225			723							A- V- %F- PPS- W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:
48° 00' 12"	92° 40' 50"	48° 00' 07"	92° 41' 00"	Started in front of 2-story cabin and ended at point before narrows.	Good mix of rock/rubble substrates and firm bottom vegetated areas. Sampled 2-7 foot zone.

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/(N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply)
Ef 3	2300	2325			1317							A- V- %F- PPS- W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:
48° 00' 08"	92° 41' 35"	48° 00' 25"	92° 41' 50"	Started when narrows opens up to L. Elbow lake area. Shocked east shore to outlet.	Submerged vegetation and woody cover common. Good rock/rubble in many areas. Sampled 1-6 foot zone.

(a) Anode Type Choices: (S)phere, (R)ing, (C)able, (O)ther (describe under comments).
(b) Cathode Type Choices: (B)oat, (D)roppers, (O)ther (describe under comments).
(c) Current Type Choices: (A)C, (3)-phase AC, (D)C, (P)ulsed DC, (O)ther (describe under comments).
(d) Standard sampling (EF); Special sampling, put an S before the gear type code (SEF).
(e) Record On-Time in seconds if VVP or generator has timer.
(f) Record species codes for netted species (LMB, SMB, etc.). Record (A)ll if netting all species. If targeting YOY, put Y before the species code (YWAE, etc.). If using boat electrofishing for assessment of natural reproduction for all species, record YOY.
(g) Record the letter of the correct boat configuration for that run (either a, b, or c from section 2).
(h) Rate water clarity (turbidity, waves, etc.) as (P)oor (significantly affected catch), (M)oderate (some affect on catch), (G)ood (no perceived affect on catch).
(i) Include general habitat description (depth zone sampled, amount and type of cover, substrate types, etc.), conditions (visibility, weather. etc.), sightings of non-targeted species of interest, etc.
*Only use 1 special sampling method per page. Do not mix standard and special samples on the same page. **Show sampling locations (EF1, SEF1, etc.) on sampling station map.

GILL NETTING

Gill netting is required for all population assessments and full surveys, except on lakes <100 acres where it is optional (see page 6-5). Gill netting requires completion of Form 11. Instructions are provided on page 6-8. Gill net catch should be recorded following instructions in "Recording the Catch", page 9-1.

Gill net sampling is an important part of Minnesota's long-term monitoring program. Gill nets are one of our oldest sampling tools and have provided data on fish abundance, size distribution, growth, age structure, and mortality rates since the 1950's. Gill net data also help monitor year class strength and evaluate the effectiveness of stocking, harvest regulations or other management techniques.

Gill nets are a passive gear that capture fish by entanglement. They are selective for species and sizes of fish that exhibit substantial daily movements, and are often the best way to sample species that inhabit deep or open water away from shoreline areas. Fish that are tubular in shape and have well developed teeth, spines or other protrusions are generally more effectively captured by gill nets. Gill nets are especially important for sampling open water species like walleye, yellow perch, and trout. **Target species** for sampling with gill nets are provided in Appendix 3.

Several biases are associated with gill nets. Standard nets use different mesh sizes within the same net, with each mesh size highly selective for specific sizes of fish. In general, larger meshes are more efficient at capturing fish than smaller meshes. Mesh size can influence estimates of growth rate, mortality, and length-weight relationships (Nielson and Johnson 1983). In addition to size selectivity, net construction, season, time of day, length of time nets are fished, fish movement, and physical and chemical parameters associated with where nets are set can all influence the effectiveness of gill nets. In order to reduce

these biases, as many variables as possible have been standardized. References concerning gill net sampling can be found in Appendix 1.

Sampling Season:

Gill net sampling should be conducted in conjunction with trap netting during summer. Once a sampling date has been established it should be repeated (as closely as possible) with subsequent surveys and assessments.

Catch rates for various species can change during the sampling season. Appendix 6 shows net catches by season for species commonly caught in gill nets. If gill net catch rates for a specific lake are extremely poor, you have the option of changing the time period in which gill nets are set. Be aware, however, that historical comparisons will no longer be valid if the sampling date is changed. Changes should occur only if the species used to determine the new sampling date is listed as the primary species in the management plan. If changes are recommended, they should result in sampling during the time frame when catch rates are highest for that species. For any change to occur, it must first be approved by the Regional Manager.

For initial surveys, refer to the figures in Appendix 6 to help determine the best time for sampling (when catch rates are highest for important species). For special surveys, specific dates or occurrences (immediately after ice out, late fall when water temperatures are between 50-55 F, etc.) should be duplicated in future surveys.

Sampling Duration:

Gill nets should be set overnight and emptied each day. Duration of gill net sets for special surveys should be recorded on Form 11 if they differ from standard sets.

Sampling Stations:

Use sampling sites that have already been established (see Sampling Station map). If sampling sites have not been established, choose a variety of areas (shallow, deep, points,

bays, etc.) that represent available habitats. Identify all stations on the sampling station map and describe them on Form 2. Always conduct dissolved oxygen/temperature monitoring (see "Water Quality", page 4-2) immediately prior to setting nets to ensure they are not set in anoxic water.

Gear Requirements:

Standard experimental gill nets are required for full surveys and population assessments. Standard nets are 250 feet long, six feet deep and are constructed of #104 twisted nylon fibers, with nylon float lines and leadcore "lead" lines. Each net contains 50 feet of 3/4", 1", 1 1/4", 1 1/2 ", and 2" bar mesh. Standard gill net mesh should be left untreated and white in color unless treated nets were used historically. If treated nets were used historically, continue to use them in future surveys. If standard gill nets are not used (special surveys only), a description of the net (dimensions, mesh size and mesh color) must be recorded on Form 11.

Number of Gill Nets to Set:

Trends concerning fish population abundance are evaluated based upon catch-per-unit-effort (CPUE). The number of net sets will influence the reliability of the CPUE estimate. Moyle (1950) and Moyle and Lound (1959) suggested a minimum of 9 sets is needed to obtain a reliable estimate of CPUE. The average number of gill nets set historically by Region for most lakes falls well below that number. In order to improve our estimate of CPUE, all areas are encouraged to increase the number of net sets. The following table lists the number of sets needed based upon lake size:

Lake Size (acres)	Number of Gill Net Sets
<100	*see page 6-5
100-299	6
300-599	9
600-1499	12
>1500	15

These numbers should be considered a minimum. You have the option of increasing the number of sets if desired. While nine or more nets are recommended for most lakes, six nets are recommended in lakes 100-300 acres to prevent killing large numbers of game fish. CPUE from lakes with less than nine sets, however, should be interpreted cautiously.

Occasionally, large numbers of game fish are collected in a few gill nets. Setting the recommended number of nets could result in high mortality and unnecessary loss of fish, especially in small lakes. If this occurs, the Area Supervisor and Regional Manager have the option of reducing the number of net sets. Keep in mind, however, that any reduction in the number of net sets will reduce our ability to compare CPUE. Setting the minimum number of nets listed in the table above is strongly encouraged. If high catches of game fish are anticipated, crews should vary sets throughout the lake instead of sampling adjacent stations to ensure at least portions of the entire lake are sampled. Any reduction in the number of gill net sets below those recommended must be approved by the Regional Manager. In most cases, Area and Regional staff can agree prior to the sampling season on conditions where reducing the number of net sets is appropriate.

There will also be situations when the recommended number of sets is unrealistic. For example, high numbers of bullheads or yellow perch may dramatically increase the amount of time needed to tend the nets. If the recommended number of sets were required, it would take considerably longer to finish the survey and fewer surveys could be completed during the year. Under this scenario, decreasing the number of sets is practical and necessary. The number of fish needed to justify reducing the total number of net sets varies depending upon the number of target species collected. For example, if three nets catch >250 bullheads each, with over 10 walleye per set, it would be justifiable to stop setting nets as the total sample size (used to estimate length-frequency) for walleye is over 30. However, if the same number of bullheads in each net were combined with an average of five walleye per net, it would improve the walleye

length-frequency estimate if additional nets were set. Conversely, if a total of only 3 walleye were collected in all three nets and it did not appear adequate numbers would be collected to estimate length distribution, it would be justifiable to stop setting additional nets. Area Supervisors should use their judgement when determining whether or not they should reduce the number of net sets. Whatever the case, any reduction in the number of gill net sets below those recommended must be approved by the Regional Manager.

If nets are disturbed (cut, pulled up on shore, torn by outboard motor, etc.) or weather conditions prevent tending the net (high winds causing unsafe conditions), sets should be considered "bad" and fish data should not be collected. If 80% or more of the net sets are good, resetting the nets is not required. For example, if 10 nets are set, and 2 are tampered with, no additional sets are needed. If in this case, however, 3 nets were tampered with, an additional set is required to reach 80% of the original sets. Nets should not be set at the same location on consecutive days unless they replace a "bad" set.

Lakes <100 Acres:

Gill netting is optional for lakes less than 100 acres in order to reduce the potential for impacting the existing fish population by removing excessive numbers of fish. Area Supervisors have the option of setting a small number of nets (1-6) if desired to obtain length-frequency and growth data. This information should be used cautiously when estimating changes in CPUE. If gill nets are not used, or a small number are used, effort using alternative sampling methods (trap nets, electrofishing) should increase. Area Supervisors should use their judgement to determine what additional sampling is appropriate. For example, if gill nets are not set on a lake <100 acres for which northern pike are the primary species, then additional trap netting or electrofishing should be conducted. Appendix 3 provides information on target species for each sampling gear and can be used as a guide to determine appropriate sampling gears for lakes <100 acres.

Where to Set Nets:

Nets should be set perpendicular to shore. Where possible, do not set gill nets in water less than 9' deep to avoid being struck by boat motors. If the net location is along a steep drop-off, or if the net will lie in anoxic water (if set perpendicularly), set the net in a skewed fashion (at an angle <90 degrees to shore). In some cases (primarily where shallow water extends a long distance from shore) nets will be set in open water.

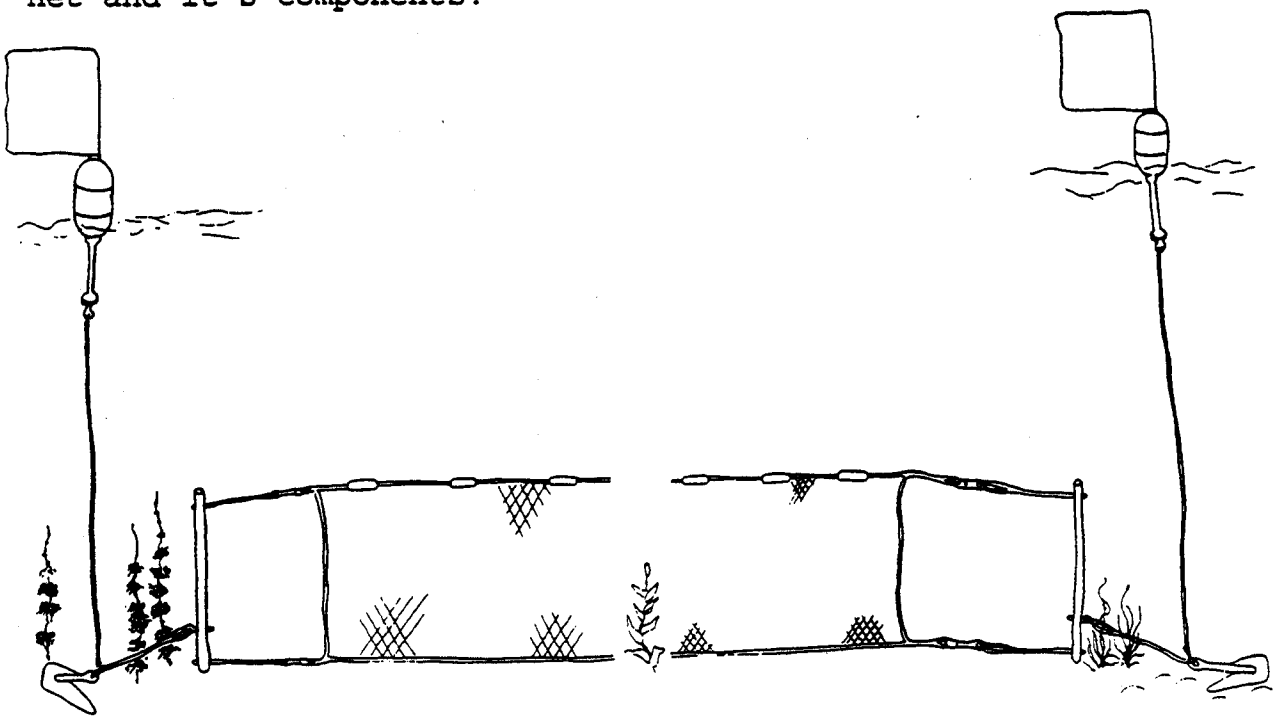
Mesh Size Orientation:

Mesh size orientation should vary between sampling stations. For initial surveys, alternate between big and small mesh towards shore. For open water sets or nets set parallel to shore it is unnecessary to vary orientation. For lakes that have been previously surveyed, repeat what was done originally. For example, if historical sets had big mesh to shore, continue this pattern. If mesh to shore was not recorded (unknown), alternate orientation as described above for initial surveys. Once orientation is established, it should remain the same for each station for subsequent surveys.

Separating the gill net catch by mesh size is optional. In many cases, it does not require significantly more time in the field to record gill net catch by mesh size. This information can help develop selectivity curves which are useful for correcting length frequency distributions and calculating mortality estimates. Areas anticipating needing selectivity curves for specific lakes should separate and record gill net catch by mesh size.

Properly Set Gill Net:

The following sketch is intended to show a properly set gill net and it's components:



Gill Net Storage and Replacement:

Gill nets should be dried completely following each survey to avoid transporting exotic species, especially Eurasian water milfoil. Drying time varies with the weather, however in general nets should be dried for a minimum of four days. Refer to Appendix 10 for additional information on preventing the spread of exotic species.

Torn nets should be repaired as soon as possible. Worn nets should be replaced as needed.

Disposing of Dead Fish:

If possible, dead fish should be buried. If large numbers of fish are collected, contact the Department of Health to determine an appropriate burial site. If burial is impractical (for example remote sites requiring portages) fish can be placed in a remote area (away from campsites or other high use locations). In all cases, do not bury or dispose of fish in areas with human activity.

INSTRUCTIONS FOR FORM 11 - TESTNETTING

1) Standard Sampling:

List (Y) yes or (N) no for standard sampling.

If listed (N) no for standard sampling, describe any variations from standard sampling gear. Different mesh sizes, net lengths, frame diameters, etc. should all be described in enough detail that the gear could be duplicated in subsequent surveys. If conducting specialized sampling using standard gear (for example, using standard gill nets during late fall to assess whitefish), write "standard gear" in this space.

2) Station Code and Number:

List gear type from one of the following codes:

(GN) Gill netting
(TN) Trap netting

Station numbers should correspond to those on the map and follow the code listed above. For example, trap net stations would be listed as TN1, TN2, etc. For special sampling, add an S to the beginning of the gear code (for example, specialized sampling using gill nets would be coded as SGN1, SGN2, etc. Use a different form for each special sampling gear used. If different special sampling techniques are used at the same lake, do not repeat station numbers. For example, special sampling stations for fall gill netting for trout might be numbered SGN1-SGN5. Stations for special sampling using non-standard gill nets (for example, 2 1/2 inch mesh only) for whitefish in the same lake would then be numbered SGN6, SGN7, and so on. This will ensure stations for each special sampling method can be identified on the sampling station map and retrieved individually from the data base.

3) Setting/Lifting:

List month, day, year and time (0-2400 hours) the net was set and lifted.

4) GPS Coordinates:

List latitude and longitude, if available, for each net set.

5) Location Description:

Describe the location of each net set.

6) Trap nets:

Record the bottom depth in feet where the frame is located, and the distance from the end of the lead to shore in feet.

7) Gill nets:

Record mesh size, depth to bottom, and direction of net (orientation, e.g. W for west) for each end of the net. For suspended sets, under the depth column record the depth to the lead line on the top space and the depth to the lake bottom on the bottom space for each end of the net.

8) Target Species:

For specialized sampling, list the target species code(s). If sampling young of the year, put a Y in front of the code (for example, young of the year walleye would be coded as YWAE, while adult walleye would be WAE. If using 1/4" mesh trapnets instead of seines to sample YOY of all species, record YOY as target species.

9) Comments:

Describe any additional comments pertaining to individual sets. Note heavy vegetation, algal blooms, etc.

DOW # 69-744

FORM 11 - TESTNETTING

Body of Water Elbow Survey ID (Starting Date) 6/1/1992 Data Recorder(s) P. Hogen

1) Standard Sampling (Y/N)? Y If No, describe method (include gear description):

2) Sta. Code[a]#	3) Setting/Lifting Date (mo/day/year)	Time (0000)	4) GPS Coordinates Latitude	Longitude	5) Location Description	6) TRAPNETS (feet) Frame Depth	Lead Dist. From Shore	7) GILLNETS[b] End 1 Mesh	Depth	Dir	End 2 Mesh	Depth	Dir	8) Target Species[c]	9) Comments (tampering, conditions, etc.)
GN1	8/10/1992	1300	48°01'25"	92°36'32"	approx. 150 feet up from Inlet 4.			0.75	10	SE	2	28	NW		
	8/11/1992	1045													
GN2	8/10/1992	1315	48°00'37"	92°37'46"	Just south of small point.			2	12	SE	0.75	40	NW		
	8/11/1992	1145													
GN4	8/10/1992	1330	48°00'31"	92°38'41"	Off of tip of point.			0.75	10	NE	2	36	SW		
	8/11/1992	1310													
TN12	8/10/1992	1345	48°00'02"	92°40'06"	In middle of shoreline in back of bay.	5	0								
	8/11/1992	1405													
TN7	8/10/1992	1400	48°00'04"	92°41'02"	In-between 2 biggest boulders.	4	0								
	8/11/1992	1455													
TN6	8/10/1992	1415	48°00'09"	92°41'32"	100 ft. west of tip of point.	4	0								
	8/11/1992	1530													
GN3	8/11/1992	1230	48°00'16"	92°37'39"	In-between 2 small points.			0.75	25	E	2	43	W		
	8/12/1992	1030													
GN5	8/11/1992	1340	48°00'10"	92°38'57"	approx. 25 feet out from island.			0.75	8	N	2	40	S		
	8/12/1992	1120													
GN9	8/11/1992	1350	48°00'09"	92°38'23"	In-between 2 small points.			2	15	SW	0.75	40	NE		
	8/12/1992	1155													
TN5	8/11/1992	1445	48°00'11"	92°40'15"	In back of small cut area.	5	0								
	8/12/1992	1345													
TN8	8/11/1992	1520	48°00'13"	92°39'53"	In between big white and Norway pines.	7	0								Did not catch any fish.
	8/12/1992	1420													
TN11	8/11/1992	1600	48°00'33"	92°38'43"	Just left of the big white pine.	8	0								
	8/12/1992	1455													
GN11	8/12/1992	1245	47°59'43"	92°39'03"	25 ft. south of island.			2	10	N	0.75	11	S		
	8/13/1992	1050													
GN10	8/12/1992	1310	48°00'02"	92°38'40"	In-between large boulder & big white pine.			2	10	E	0.75	35	W		
	8/13/1992	1145													
GN8	8/12/1992	1330	← THIS		SET NOT ENTERED →										Gillnet cut in half. Data thrown out.

(a) Standard Sampling (TN, GN); Special Sampling, put an S before the gear type code (SGN, STN).

(b) Mesh (inches.XX), Depth (bottom sets-depth in feet in bottom area; suspended sets-bottom mesh depth in top area, bottom depth in bottom area), Dir-N,S,E,W,NE,NW,SE,SW.

(c) If special sampling for particular species, record species code(s) for targeted species. If targeting YOY, put Y before the species code(s) (YWAE, etc.). If using 1/4-inch trapnets (or other spec. sampling gear) for natural reproduction success sampling, record YOY.

*Only use 1 spec. sampling method/gear descrip. per page. Do not mix stnd. and spec. samples on the same page.**Show sampling locations (GN1,STN1,etc.) on Sampling Station

DOW # _____ FORM 11 - TESTNETTING Page ____

Body of Water _____ Survey ID (Starting Date) _____ Data Recorder(s) _____ of ____

1) Standard Sampling (Y/N)? ____ If No, describe method (include gear description):_____

2) Sta. Code[a]#	3) Setting/Lifting Date (mo/day/year)	Time (0000)	4) GPS Coordinates Latitude	Longitude	5) Location Description	6) TRAPNETS (feet) Frame Depth	Lead Dist. From Shore	7) GILLNETS[b] End 1 Mesh	Depth	Dir	End 2 Mesh	Depth	Dir	8) Target Species[c]	9) Comments (tampering, conditions, etc.)

(a) Standard Sampling (TN, GN); Special Sampling, put an S before the gear type code (SGN, STN).

(b) Mesh (inches.XX), Depth (bottom sets-depth in feet in bottom area;suspended sets-bottom mesh depth in top area, bottom depth in bottom area), Dir-N,S,E,W,NE,NW,SE,SW.

(c) If special sampling for particular species, record species code(s) for targeted species. If targeting YOY, put Y before the species code(s) (YWAE, etc.). If using 1/4-inch trapnets (or other spec. sampling gear) for natural reproduction success sampling, record YOY.

*Only use 1 spec. sampling method/gear descrip. per page. Do not mix stnd. and spec. samples on the same page.**Show sampling locations (GN1,STN1,etc.) on Sampling Station

TRAP NETTING

Trap netting is required for all population assessments and full surveys (where feasible). Trap netting requires completion of Form 11. Instructions are provided on page 7-5. Trap net catch should be recorded following instructions in "Recording the Catch", page 9-1.

Trap net sampling is an important part of Minnesota's long-term monitoring program. Trap nets have been used since the 1950's to obtain information on fish population abundance and size distribution, growth, age structure, and mortality rates. Similar to gill nets, trap net data helps us monitor year class strength as well as evaluate management activities such as stocking and harvest regulations.

Trap nets are passive gear that capture fish by entrapment. They are normally used to sample shallow, shoreline-related habitats. Trap nets tend to be quite selective towards "cover" seeking, mobile species. Trap nets are especially important for species that are not well represented in gill net catches, such as crappie and bluegill. Target species for sampling fish with trap nets are provided in Appendix 3.

Several biases are associated with trap nets. Hamley and Howly (1985) and Latta (1959) reported trap nets are more efficient at collecting larger fish, causing potential bias when estimating fish size structure and abundance. Net construction (hoop diameter, mesh dimensions, color and mouth size), escapement, water temperature, turbidity, dissolved oxygen, depth and spawning activity can also influence the species and sizes of fish collected. In order to reduce these biases, as many variables as possible have been standardized.

Sampling Season:

Trap net sampling should be conducted in conjunction with gill netting during summer. Once a date has been established it should be repeated (as closely as possible) during subsequent surveys and assessments.

Catch rates for various species can change during the sampling season. Appendix 6 shows net catches by season for species commonly caught in trap nets. If trap net catch rates for a specific lake are extremely poor, you have the option of changing the time period in which trap nets are set. Be aware, however, that historical comparisons will no longer be valid if the sampling date is changed. Changes should occur only if the species used to determine the new sampling date is listed as the primary species in the management plan. If changes are recommended, they should result in sampling during the time frame when catch rates are highest for that species. For any change to occur, it must first be approved by the Regional Manager.

For initial surveys, refer to the figures in Appendix 6 to help determine the best time for sampling (when catch rates are highest). For special surveys, specific dates or occurrences (immediately after ice-out, late fall when water temperatures are between 50-55 F, etc.) should be recorded and then duplicated in future surveys.

Sampling Duration:

Trap nets should be set overnight and emptied each day. Duration of trap net sets for special surveys should be recorded on Form 11 if they differ from standard sets.

Sampling Stations:

Use sampling sites that have already been established (see Sampling Station map). If sampling sites have not been established, choose a variety of areas (points, bays, etc.) that represent available habitats. Record all stations on the sampling station map and on Form 2.

Gear Requirements:

Standard trap nets required for full surveys and population assessments are constructed of a 40 foot long lead approximately 3 1/2 ' deep with two 6' x 3' frames and six 30" hoops. Each net has an adjustable throat. The throat opening must be approximately 5" in diameter. All mesh is 3/4" nylon. If

treated nets were used historically, they should continue to be treated with 1 part black net set to 4 parts solvent. If standard trap nets are not used (for special surveys only), a description of the net (dimensions, mesh size and mesh color) must be recorded on Form 2.

Number of Trap Nets to Set:

Trends concerning fish abundance are evaluated based upon catch per unit effort (CPUE). The number of net sets will determine the reliability of the CPUE estimate. Moyle (1950) and Moyle and Lound (1959) suggested a minimum of 9 sets is needed to obtain a reliable estimate of CPUE. In general, the number of trap net sets by Region has exceeded the number recommended in the previous manual. For lakes <600 acres, however, too few nets have been set to obtain a reliable CPUE estimate. For this reason, the number of sets required has increased as follows:

Lake Size (acres)	Number of Trap Net Sets
<600	9
600-1500	12
>1500	15

These numbers should be considered a minimum. In several Regions, larger lakes are already being sampled with the recommended effort. You have the option of increasing the number of sets if desired.

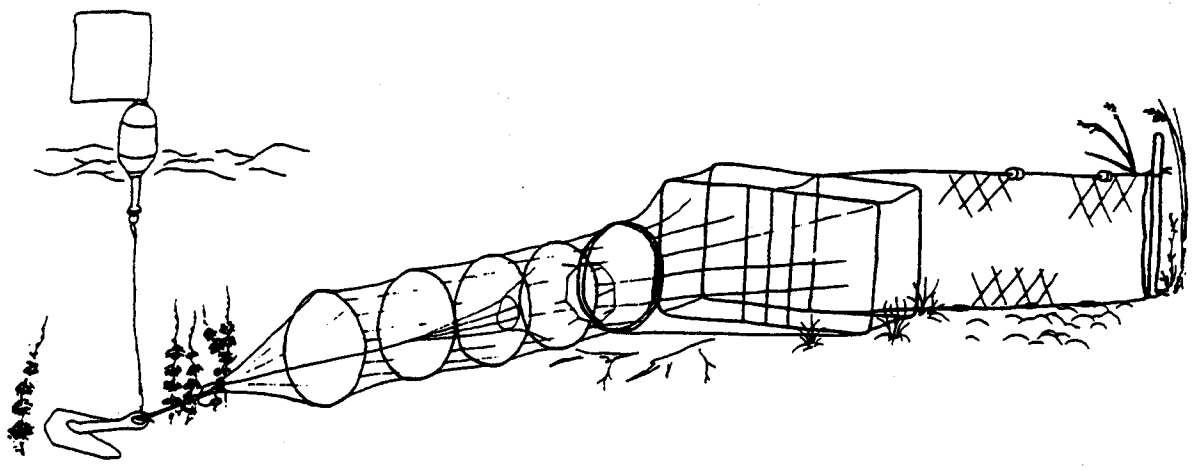
If nets are disturbed (cut, pulled up on shore, torn by outboard motor, pot end is open, etc.) or weather conditions prevent tending the net (high winds causing unsafe conditions), sets should be considered "bad" and fish data should not be collected. If 80% or more of the net sets are good, resetting the nets is not required. For example, if 10 nets are set, and 2 are tampered with no additional sets are needed. If in this case, however, 3 nets were tampered with, an additional set is required to reach 80% of the original sets. Nets should not be set at the same location on consecutive days unless they replace a "bad" set.

Where to Set Nets:

Trap nets should be set perpendicular to shore, in 8' of water or less (if possible). If the bottom drops rapidly, the net can be set at an angle to shore. Deep sets (on steep drop-offs) can cause the lead to collapse resulting in poor sets. In all cases, the throat should be covered with water. Occasionally, if vegetation or very shallow water extend outward from shore, trap nets can be staked away from the bank.

Properly Set Trap Net:

The following sketch is intended to show a properly set trap net and it's components:



Trap Net Storage and Replacement:

Trap nets should be dried completely following each survey to avoid transporting exotic species, especially Eurasian water milfoil. Drying time varies with the weather, however in general nets should be dried for a minimum of four days. Refer to Appendix 10 for additional information on preventing the spread of exotic species.

Torn nets should not be used until repaired. Worn nets should be replaced as needed.

INSTRUCTIONS FOR FORM 11 - TESTNETTING

1) Standard Sampling:

List (Y) yes or (N) no for standard sampling.

If listed (N) no for standard sampling, describe any variations from standard sampling gear. Different mesh sizes, net lengths, frame diameters, etc. should all be described in enough detail that the gear could be duplicated in subsequent surveys. If conducting specialized sampling using standard gear (for example, using standard gill nets during late fall to assess whitefish), write "standard gear" in this space.

2) Station Code and Number:

List gear type from one of the following codes:

(GN) Gill netting
(TN) Trap netting

Station numbers should correspond to those on the map and follow the code listed above. For example, trap net stations would be listed as TN1, TN2, etc. For special sampling, add an S to the beginning of the gear code (for example, specialized sampling using gill nets would be coded as SGN1, SGN2, etc. Use a different form for each special sampling gear used. If different special sampling techniques are used at the same lake, do not repeat station numbers. For example, special sampling stations for fall gill netting for trout might be numbered SGN1-SGN5. Stations for special sampling using non-standard gill nets (for example, 2 1/2 inch mesh only) for whitefish in the same lake would then be numbered SGN6, SGN7, and so on. This will ensure stations for each special sampling method can be identified on the sampling station map and retrieved individually from the data base.

3) Setting/Lifting:

List month, day, year and time (0-2400 hours) the net was set and lifted.

4) GPS Coordinates:

List latitude and longitude, if available, for each net set.

5) Location Description:

Describe the location of each net set.

6) Trap nets:

Record the bottom depth in feet where the frame is located, and the distance from the end of the lead to shore in feet.

7) Gill nets:

Record mesh size, depth to bottom, and direction of net (orientation, e.g. W for west) for each end of the net. For suspended sets, under the depth column record the depth to the lead line on the top space and the depth to the lake bottom on the bottom space for each end of the net.

8) Target Species:

For specialized sampling, list the target species code(s). If sampling young of the year, put a Y in front of the code (for example, young of the year walleye would be coded as YWAE, while adult walleye would be WAE. If using 1/4" mesh trapnets instead of seines to sample YOY of all species, record YOY as target species.

9) Comments:

Describe any additional comments pertaining to individual sets. Note heavy vegetation, algal blooms, etc.

DOW # _____ FORM 11 - TESTNETTING Page _____

Body of Water _____ Survey ID (Starting Date) _____ Data Recorder(s) _____ of _____

1) Standard Sampling (Y/N)? ____ If No, describe method (include gear description):_____

2) Sta. Code[a]#	3) Setting/Lifting Date (mo/day/year)	Time (0000)	4) GPS Coordinates Latitude	Longitude	5) Location Description	6) TRAPNETS (feet) Frame Depth	Lead Dist. From Shore	7) GILLNETS[b] End 1 Mesh	Depth	Dir	End 2 Mesh	Depth	Dir	8) Target Species[c]	9) Comments (tampering, conditions, etc.)

(a) Standard Sampling (TN, GN); Special Sampling, put an S before the gear type code (SGN, STN).

(b) Mesh (inches.XX), Depth (bottom sets-depth in feet in bottom area;suspended sets-bottom mesh depth in top area, bottom depth in bottom area), Dir-N,S,E,W,NE,NW,SE,SW.

(c) If special sampling for particular species, record species code(s) for targeted species. If targeting YOY, put Y before the species code(s) (YWAE, etc.). If using 1/4-inch trapnets (or other spec. sampling gear) for natural reproduction success sampling, record YOY.

*Only use 1 spec. sampling method/gear descrip. per page. Do not mix stnd. and spec. samples on the same page.**Show sampling locations (GN1,STN1,etc.) on Sampling Station m

DOW # 69-744 FORM 11 - TESTNETTING Page 1 of 2

Body of Water Elbow Survey ID (Starting Date) 6/1/1992 Data Recorder(s) P. Hogan

1) Standard Sampling (Y/N)? Y If No, describe method (include gear description):

2) Sta. Code[a]#	3) Setting/Lifting Date (mo/day/year)	Time (0000)	4) GPS Coordinates Latitude	Longitude	5) Location Description	6) TRAPNETS (feet) Frame Depth	Lead Dist. From Shore	7) GILLNETS[b] End 1 Mesh	Depth	Dir	End 2 Mesh	Depth	Dir	8) Target Species[c]	9) Comments (tampering, conditions, etc.)
GN1	8/10/1992	1300	48°01'25"	92°36'32"	approx. 150 feet up from Inlet 4.			0.75	10	SE	2	28	NW		
	8/11/1992	1045													
GN2	8/10/1992	1315	48°00'37"	92°37'46"	Just south of small point.			2	12	SE	0.75	40	NW		
	8/11/1992	1145													
GN4	8/10/1992	1330	48°00'31"	92°38'41"	Off of tip of point.			0.75	10	NE	2	36	SW		
	8/11/1992	1310													
TN12	8/10/1992	1345	48°00'02"	92°40'06"	In middle of shoreline in back of bay.	5	0								
	8/11/1992	1405													
TN7	8/10/1992	1400	48°00'04"	92°41'02"	In-between 2 biggest boulders.	4	0								
	8/11/1992	1455													
TN6	8/10/1992	1415	48°00'09"	92°41'32"	100 ft. west of tip of point.	4	0								
	8/11/1992	1530													
GN3	8/11/1992	1230	48°00'16"	92°37'39"	In-between 2 small points.			0.75	25	E	2	43	W		
	8/12/1992	1030													
GN5	8/11/1992	1340	48°00'10"	92°38'57"	approx. 25 feet out from island.			0.75	8	N	2	40	S		
	8/12/1992	1120													
GN9	8/11/1992	1350	48°00'09"	92°38'23"	In-between 2 small points.			2	15	SW	0.75	40	NE		
	8/12/1992	1155													
TN5	8/11/1992	1445	48°00'11"	92°40'15"	In back of small cut area.	5	0								
	8/12/1992	1345													
TN8	8/11/1992	1520	48°00'13"	92°39'53"	In between big white and Norway pines.	7	0								Did not catch any fish.
	8/12/1992	1420													
TN11	8/11/1992	1600	48°00'33"	92°38'43"	Just left of the big white pine.	8	0								
	8/12/1992	1455													
GN11	8/12/1992	1245	47°59'43"	92°39'03"	25 ft. south of island.			2	10	N	0.75	11	S		
	8/13/1992	1050													
GN10	8/12/1992	1310	48°00'02"	92°38'40"	In-between large boulder & big white pine.			2	10	E	0.75	35	W		
	8/13/1992	1145													
GN8	8/12/1992	1330	← THIS		SET NOT ENTERED →										Gillnet cut in half. Data thrown out.

(a) Standard Sampling (TN, GN); Special Sampling, put an S before the gear type code (SGN, STN).

(b) Mesh (inches.XX), Depth (bottom sets-depth in feet in bottom area; suspended sets-bottom mesh depth in top area, bottom depth in bottom area), Dir-N,S,E,W,NE,NW,SE,SW.

(c) If special sampling for particular species, record species code(s) for targeted species. If targeting YOY, put Y before the species code(s) (YWAE, etc.). If using 1/4-inch trapnets (or other spec. sampling gear) for natural reproduction success sampling, record YOY.

*Only use 1 spec. sampling method/gear descrip. per page. Do not mix stnd. and spec. samples on the same page.**Show sampling locations (GN1,STN1,etc.) on Sampling Statio

SEINING

Seining is required for full surveys and is optional for population assessments. Seining requires completion of Form 12. Instructions are provided on page 8-5. Seining catch should be recorded following instructions in "Recording the Catch", page 9-1.

Seining is an important sampling method used to determine species diversity (collect species not commonly caught by other gears), evaluate non-game species, document natural reproduction, and determine number and lengths of young-of-the-year (for estimating year class strength). Lakes that are unsuitable for seining (steep drop-offs, rocky shorelines, etc.) should be sampled using 1/4" trap nets as described in Special Sampling, page 11-2 to collect similar information.

Seines are active gear that capture fish by entrapment. They are selective for species that are typically small, slow moving and associated with smooth bottom, shoreline habitats. Target species for sampling with seines are provided in Appendix 3. In general, age 1 and older gamefish are not representatively sampled using standard seining methods. Larger fish are better able to escape the seine, therefore, data from age 1 and older fish should be used with caution. The same holds true for extremely small fish (particularly fry) which can swim through the mesh. The skill of the operator, habitat being sampled, and time of seining (season and day) can all influence seine catches. As with other sampling methods, however, these biases can be reduced by standardization of equipment and methods. References concerning sampling fish with seines are provided in Appendix 1.

Sampling Season:

Seining should be conducted during August or September after most species have spawned and young-of-the-year are present. Once a sampling date is selected, it should be repeated (as close as possible) in subsequent surveys. Other sampling (e.g., targeting walleye young of the year during July) is considered special sampling.

Sampling Stations:

Use sampling sites that have already been established (see Sampling Station map). If sampling sites have not been established, choose a variety of areas that are representative of the shoreline and are relatively undisturbed. Record all stations on the Sampling Station map and describe them on Form 2. Once sampling stations have been established, they should be repeated in subsequent surveys.

Occasionally, physical conditions at a station will change (for example, complete coverage by aquatic vegetation in a station with previously sparse coverage). In this situation, if the station becomes physically unseinable a new station can be established with habitat similar to the original station. If this occurs, assign a new station number. In subsequent surveys, determine if the original station can be seined. If it can, use it instead of the replacement station.

Gear Requirements:

Standard seining gear is a 5' deep X 50' long, 1/4" nylon mesh bag seine. If standard seines are not used (for special sampling only), a description of the seine (type, dimensions, mesh size) must be recorded on Form 12.

Number and Length of Seining Stations:

Each station represents one seine haul. A minimum of three stations are recommended, however, the number selected should be based upon the lake being surveyed. For example, large windswept lakes with similar shoreline throughout can be adequately sampled with fewer stations than large lakes with a diversity of habitats (bays, points, vegetation beds, etc.). Use your judgement when determining the number of stations.

Each seine haul should have a maximum length of 100 linear feet. Historical stations that exceeded 100 feet, however, should be repeated as in previous surveys. In most cases, increasing the number of sampling stations will result in a more representative sample. By limiting station length to 100 feet, Areas are encouraged to sample more stations.

If the seine does not sample properly (for example; dense vegetation fouling the bag, twisted lead and float lines, etc.), do not repeat the haul at that station. Either eliminate the station for that particular year (acceptable if there are a large number of stations for that particular lake) or select an alternate sampling site.

Seining Methods:

Three methods can be used depending upon the sampling station or size of the sampling crew. Once a method has been determined it should be used for all subsequent surveys for that sampling station. For each seine haul, the data base will calculate the total area seined in square feet. Avoid disturbing the area to be seined prior to sampling. Seining methods are as follows:

Parallel Seining:

One end of the seine is pulled into the lake perpendicular to shore, taking care to avoid disturbing the area being sampled. When in position, the seine is pulled parallel to the shoreline with the shallow end of the net slightly behind. Once the sampling area is covered, the deep end of the net is swung in an arc towards shore until even with the other end of the net, which is then pulled up to shore.

Perpendicular to Shore:

This method should be used when vegetation, rocks, etc. limit the use of the parallel method. Both ends of the seine are carried into the lake an equal distance (up to 100' from the bank if practical) and stretched parallel to shore facing the area to be sampled. Once in position, both ends of the net are pulled simultaneously towards shore.

Fixed Pole Seining:

This method should be used when only a small area can be seined. One end of the seine is pulled into the lake perpendicular to the shoreline (the other remains stationary along the bank) until the seine is fully extended. The deepwater end of the seine is pulled in a 90 degree arc to shore.

Seine Storage and Replacement:

Seines should be dried completely following each survey to avoid transporting exotic species, especially Eurasian water milfoil. Drying time varies with the weather, however in general nets should be dried for a minimum of four days. Refer to Appendix 10 for additional information on preventing the spread of exotic species.

Worn seines should be replaced as needed.

INSTRUCTIONS FOR FORM 12 - SEINING

1) Standard Sampling:

List (Y) yes or (N) no for standard sampling.

If listed (N) no for standard sampling, describe any variations from standard sampling gear. Different mesh sizes, net lengths, etc. should be described in enough detail that the gear could be duplicated in subsequent surveys. If conducting specialized sampling using standard gear (for example, using standard seines during late fall to assess walleye), write "standard gear" in this space.

2) Station Code and Number:

List station code and number from map. For standard sampling, stations should be coded SE1, SE2, etc. For special sampling, add an S to the beginning of the gear code (for example, specialized sampling using seines would be coded SSE1, SSE2, etc.). Use a different form for each special sampling gear used. If different special sampling techniques are used at the same lake, do not repeat station numbers. For example, special sampling stations for fall seining for young of the year musky might be numbered SSE1-SSE5. Stations for special sampling using non-standard seines (for example, 200' purse seine) for adult largemouth bass in the same lake would then be numbered SSE6, SSE7, and so on. This will ensure stations for each special sampling method can be identified on the sampling station map and retrieved individually from the data base.

3) Date:

List the month, day and year of the survey.

4) Time:

List the time (0-2400 hours) of seining at each station.

5) GPS Coordinates:

List latitude and longitude, if available, for each seining station. The location of each station can also be described under comments (15).

6 Location Description:

Describe the location of the seining station.

7) Method:

List the seining method used from one of the following codes:

(PA) Parallel
(PE) Perpendicular
(F) Fixed Pole

If using fixed pole method, disregard column 9 (haul length) and estimate average haul width (column 10)

8) Maximum Depth:

Record the maximum depth seined (in feet).

9) Haul Length:

Record the distance seined (for parallel and perpendicular seining only) in feet.

10) Average Haul Width:

Record the average width of the seine haul in feet for all seining methods.

11) Substrates:

Record (R) rare, (C) common, or (A) abundant for each substrate present at the seining station (see example form). Substrate abbreviations are as follows:

(LR) Ledge Rock
(BO) Boulder (>10")
(RU) Rubble (3-10")
(GR) Gravel (1/8-3")
(SA) Sand
(SI) Silt
(CL) Clay
(MU) Muck
(DE) Detritus
(MA) Marl

12) Vegetation:

Estimate the amount of vegetation at the seining station from the following codes:

(N) None
(L) Light
(M) Moderate
(D) Dense

13) Wave Intensity:

Record wave intensity at the seining station from the following codes:

(C) Calm
(M) Moderate
(S) Strong

14) Surface Temperature:

Record surface temperature (F) at the seining station.

15) Target Species:

If standard sampling, leave blank. If special sampling, record target species code (if targeting YOY of a particular species, list Y in front of the species code). If targeting all YOY, list YOY.

16) Comments:

Describe any additional comments or observations at the seining station (for example, observed small muskie that escaped seine).

FORM 12 - SEINING

DOW # _____ Page ___ of ___

Body of Water _____ Survey ID (Starting Date) _____ Data Recorder(s) _____

1) Standard Sampling (Y/N)? ____ If No, describe method (include gear description):_____

2) Sta. Code[a]#	3) Date (mo/day/year)	4) Time (0000)	5) GPS Coordinates Latitude	Longitude	6) Location Description	7) Met.[b]	8) Max. Depth (feet.5)	9) Haul Length (feet)	10)Avg. H.Width (feet)	11) SUBSTRATES[c] LR	BO	RU	GR	SA	SI	CL	MU	DE	MA	12) Veg.[d]	13) Wave Int.[e]	14) Surf. °F	15) Target Species[f]	16) Commen

(a) Standard Sampling (SE); Special Sampling, put an S before the gear type code (SSE).

(b) (PA)rallel, (PE)rpendicular, (F)ixed Pole. For fixed pole method, disregard column 9 (Haul Length) and estimate Avg. Haul Width (column 10).

(c) Ledge Rock (LR), (BO)ulder (>10"), (RU)bble (3-10"), (GR)avel, (SA)nd, (SI)lt, (CL)ay, (MU)ck, (DE)tritus, (MA)rl. Rate substrates as (R)are, (C)ommon, or (A)bundant.

(d) (N)one, (L)ight, (M)oderate, (D)ense.

(e) (C)alm, (M)oderate, (S)trong. Describe conditions at seining station.

(f) For standard natural reproduction monitoring, leave blank. If special sampling for a particular species, record species code(s) for the targeted species (if targeting YOY, put Y before the species code, for example, YWAE, etc.).

*Only use 1 special sampling method per page. Do not mix standard and special samples on the same page.

**Show sampling locations (SE1, SSE1, etc.) on Sampling Station map (for parallel seine hauls, show starting location and direction).

FORM 12 - SEINING

DOW # 69-744

Body of Water Elbow

Survey ID (Starting Date) 6/1/1992

Data Recorder(s) P. Hogan

1) Standard Sampling (Y/N)? Y If No, describe method (include gear description):

2) Sta. Code[a]#	3) Date (mo/day/year)	4) Time (0000)	5) GPS Coordinates Latitude	Longitude	6) Location Description	7) Met.[b]	8) Max. Depth (feet.5)	9) Haul Length (feet)	10) Avg. H.Width (feet)	11) SUBSTRATES[c] LR	BO	RU	GR	SA	SI	CL	MU	DE	MA	12) Veg.[d]	13) Wave Int.[e]	14) Surf. °F	15) Target Species[f]	16) Comments
SE1	8/19/1992	1030	48°00'47"	92°37'40"	Started when shoreline starts into bay and ended in back of bay.	PA	6.0	120	65				R	A						L	C	64		
SE2	8/19/1992	1100	47°59'40"	92°39'23"	Started at 2 large boulders on shore, went to back of bay.	PA	4.0	100	75			R		A						N	C	65		
SE3	8/19/1992	1130	48°00'00"	92°38'35"	Started at tip of point and went to back of bay.	PA	4.0	100	75			R		C	R					L	C	65		Seine roll a little
SE4	8/19/1992	1200	48°00'29"	92°37'35"	Started at tip of point, went around point, ended halfway up shoreline of bay.	PA	3.5	125	85					A	R					N	C	64		

(a) Standard Sampling (SE); Special Sampling, put an S before the gear type code (SSE).

(b) (PA)rallel, (PE)rpendicular, (F)ixed Pole. For fixed pole method, disregard column 9 (Haul Length) and estimate Avg. Haul Width (column 10).

(c) Ledge Rock (LR), (BO)ulder (>10"), (RU)bble (3-10"), (GR)avel, (SA)nd, (SI)lt, (CL)ay, (MU)ck, (DE)tritus, (MA)rl. Rate substrates as (R)are, (C)ommon, or (A)bundant.

(d) (N)one, (L)ight, (M)oderate, (D)ense.

(e) (C)alm, (M)oderate, (S)trong. Describe conditions at seining station.

(f) For standard natural reproduction monitoring, leave blank. If special sampling for a particular species, record species code(s) for the targeted species (if targeting YOY, put Y before the species code, for example, YWAE, etc.).

*Only use 1 special sampling method per page. Do not mix standard and special samples on the same page.

**Show sampling locations (SE1, SSE1, etc.) on Sampling Station map (for parallel seine hauls, show starting location and direction).

RECORDING THE CATCH

Information concerning the length, weight, condition, and health of fish is critical to evaluating fish population characteristics. Individual lengths and weights provide data concerning length distribution, age structure, fish condition, fish health, growth and mortality. Individual weights can also be used to develop length-weight relationships for estimating weights of fish measured during other sampling (i.e. creel surveys).

There are two data forms for recording this information, Form 13 (for length, weight, sex, disease and other information), and Form 14 for tallying the number of fish sampled (to keep track of the number weighed and sampled for age and growth analysis). Instructions for completing Forms 13 (page 9-5) and 14 (page 9-9), as well as techniques for subsampling are provided in this chapter.

Most sampling methods require measuring and/or weighing fish. To provide consistency, all measuring boards and weighing scales are standardized. All fish lengths should be recorded in millimeters. If possible, all weights should be taken in grams or kilograms using a Homs 1000 gram platform spring scale for fish less than 1000 grams (approximately 2 pounds) and a Homs 12 kilogram platform spring scale for fish over 1000 grams. Other scales can be useful under varying circumstances (i.e. small tube scales for portage lakes). For each survey, however, investigators should have scales able to accurately measure small and large fish (two scales are necessary in most cases).

Wind and boat movement or other factors can affect the accuracy of weighing fish. Several options are available to improve accuracy, especially for small fish. Most obviously, fish can be weighed on shore out of the wind, or if needed, small fish can be bagged (separated by net) and transported to an enclosed facility (such as the Area office) prior to weighing.

Information concerning disease and parasites should be recorded for individual fish. Fish that have been dissected to determine sex (primarily from gill nets) for age and growth

analysis should be examined for internal parasites and disease. Instructions for recording parasite and disease information are found on page 9-6. Symptoms and characteristics of diseases and parasites are described in Appendix 8.

Fish Collected by Seining:

All game fish and panfish (bluegill and crappie only) should be counted by species with up to 20 young of the year individuals of each species measured from each seine haul, with a goal of 50 young of the year measured for the entire survey. Weights are not required but can be taken if desired. If more than 20 game fish or panfish are collected per haul, the catch can be subsampled (see page 9-3). **All non-game fish** should be identified and counted, with measuring optional. See Appendix 11 for a listing of game, panfish and non-game species. For lakes managed for walleye (primary or secondary species in the management plan), yellow perch should also be measured. Species that cannot be identified in the field should be transported to the field station for later identification. References pertaining to fish identification are provided in Appendix 1.

Fish Collected by Electrofishing, Gill Nets or Trap Nets:

Individual lengths (millimeters) are required for **all game fish**, and for **25-50 panfish and non-game fish** of each species from each net (gill and trap nets) or sampling station (electrofishing). Do not include fish that have been partially eaten or destroyed (by turtles, crayfish, etc.). Measuring all fish is encouraged for all surveys. If more than 25-50 panfish or non-game fish are collected, however, the catch can be subsampled (see page 9-3). The data base will expand the length-frequency to include non-measured fish.

It is preferable to measure some fish from each net, rather than a large number of fish from a few nets. Occasionally, a specific size range of fish may be caught in only one or two nets. If fish were not measured individually from those nets, the length-frequency distribution would be biased. When determining whether to measure 25 or 50 panfish or non-game fish

from each station, consider measuring 50 during the initial stages of the survey (first few nets or electrofishing stations) to ensure a large enough sample size is collected for developing length-frequency distributions. If it becomes apparent that a particular species is caught in large numbers at most stations, it would be appropriate to reduce the number individually measured to 25.

Individual weights (grams) are required for 5 measured fish from each 10 mm length group up to 300 mm for **all game fish and panfish (non-game fish optional)**, and 10 fish from each 25 mm length group for all fish over 300 mm. Collecting individual weights on a portion of the catch will eliminate the need for bulk weights. The data base will compute total weight of the sample based upon the length-weight relationship. If individual weights are not collected from non-game fish (at the discretion of the Area Supervisor or Regional Manager), each species from the entire catch for each net or electrofishing station should be bulk weighed and the number not measured should be counted.

Fish Collected for Age and Growth Analysis:

Refer to the age and growth section (page 10-1) for information on species, number of samples, and type of structures to collect for age and growth analysis. In most cases, fish that are individually measured and weighed can also be used for age and growth analysis.

Subsampling:

Subsampling is needed to reduce the amount of time needed to record the catch when large numbers of fish are collected. Subsampling can only be used for panfish and non-game fish in excess of 25-50 individuals per net or electrofishing station, or in excess of 20 game fish per seine haul.

Use your discretion as to when subsampling is needed. If there are 65 black bullheads in a net, it may be just as easy to measure all of them than subsample 50 (lengths are required on 25-50 from each sampling station). Keep in mind that subsampling introduces bias and should be conducted only when necessary. It

is very important that the subsample accurately represent the entire sample to avoid biasing length frequency distributions.

There are several methods for subsampling. Fish can be sorted by species, placed in a tub and mixed, then scooped alternately into two buckets or tubs. One bucket can then be used as the subsample. This method should not be used for live fish that will be released (primarily from trap net sampling and electrofishing).

Another method involves selecting every 3rd, 4th, 5th, etc. fish, depending on the number of fish in the sample. This method requires knowing approximately how many fish are in the sample to ensure all fish have an equal chance of being selected. This method can be used for all sampling gears.

After subsampling is complete, count and record the number of additional fish of that species in the sample that were not individually measured. The data base will expand the length-frequency distribution to include those fish.

INSTRUCTIONS FOR FORM 13 - RECORDING THE CATCH

This form should be used to record information from fish collected by all sampling methods. A summary of information to collect is provided on the back of the form.

1) Station Code and Number:

List gear type from the following codes (if special sampling, place a S in front of each code), and station number:

(GN) Gill Net
(TN) Trap Net
(EF) Electrofishing
(SE) Seining

2) Mesh Size (optional):

If recording fish by mesh size from gill nets, list mesh size in decimals. For example, 3/4" mesh would be recorded as 0.75, 1 1/2" mesh as 1.5, etc.

3) Species Code:

List species code. When recording natural reproduction monitoring data (seining, 1/4" trapnets, electrofishing, etc.), precede the species code with a Y (for example, YWAE, YNOP, etc.). For age 1+ or older fish, or for non-game fish use the standard 3-letter code.

4) Length:

List length in millimeters.

5) Weight:

List weight in grams or kilograms. If weight is recorded in kilograms place an X in the KG column.

6) Serial Number:

For age and growth analysis. Record numbers consecutively, beginning with 1, for each fish in which scales or other structures were collected for age and growth analysis. Number should correspond with the number on the scale envelope. Number consecutively until the entire survey is completed. Do not begin numbering at 1 for new nets or species.

7) Sex:

Record the sex of the fish as (M) male, (F) female or (U) unknown, followed by it's condition from one of the following codes (do not sacrifice live fish unless a specific need exists):

(I) immature
(M) mature
(U) unknown
(G) gravid (unripe female with eggs prior to spawning)
(R) ripe
(S) spent

For example, a gravid female would be coded FG.

8) Disease:

There are two columns for recording parasite or disease information. The first column (one with an X) is used to record whether or not the fish was examined based upon the following codes:

(E) Examined for external parasites or diseases
(I) Examined for internal and external parasites or diseases

<u>If the fish was not examined, leave this column blank.</u>

The second column is used to record parasites or diseases observed based upon the following codes:

(N) None Observed
(AW) Anchor Worm
(AR) Argulus
(BT) Bass Tapeworm
(BW) Bladderworm
(F) Fungus
(GP) Gill Parasites
(I) Ich
(L) Leeches
(LC) Lymphocystis
(LS) Lymphosarcoma
(M) Myofibrogranuloma
(N) Neascus
(OH) Open Sores/Hemorrhage
(SK) Skeletal Deformities
(SL) Slime Discoloration
(T) Tumors
(TR) Triaenophorus
(YG) Yellow Grub
(O) Other (describe in comments section)

9) Comments:

Describe other diseases, deformities, tag numbers, fin clips or information of interest concerning individual fish.

10) Tagging Study:

Indicate whether the fish was marked or recaptured. For marked fish, record the tag number or fin clip code in the marked column. Clip codes are as follows:

(LP) Left Pectoral
(RP) Right Pectoral
(LV) Left Pelvic
(RV) Right Pelvic
(A) Anal
(LC) Lower Caudal
(UC) Upper Caudal
(AD) Adipose
(O) Other

If the fish is a recapture, record the tag number or fin clip code in the recapture column.

11) Additional Catch Information:

11a) Station Code and Number:

List gear type from the following codes (if special sampling, place a S in front of each code) and station number:

(GN) Gill Net
(TN) Trap Net
(EF) Electrofishing
(SE) Seining

11b) Mesh Size (optional):

If recording fish by mesh size from gill nets, list mesh size in decimals. For example, 3/4" mesh would be recorded as 0.75, 1 1/2" mesh as 1.5, etc.

11c) Species Code:

List species code.

11d) Number not Measured:

Record the total number of fish that were not measured for each species for each net or sampling station.

11e) Bulk Weight (entire sample of non-game fish or panfish that were not measured)

For each net or sampling station, record the bulk weight in grams or kilograms (place an X in the KG column if fish were measured in kilograms) for each species in which fish were not individually weighed (it may be easier to bulk weigh the entire sample before collecting individual lengths). For panfish, if subsampling for lengths bulk weigh the individuals that were not individually measured. For non-game fish bulk weigh the entire sample if individual weights were not taken.

DOW # _____ FORM 13 - RECORDING THE CATCH Data Page ____
Body of Water _____ Survey ID (Starting Date) _____ Recorder _____ of ____

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1													
2													
3													
4													
5													
6													
7													
8													
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30													

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

DOW # 64-147 | FORM 13 - RECORDING THE CATCH | Data Recorder P. Hogan | Page 1 of 14

Body of Water Elbow | Survey ID (Starting Date) 6/1/1992

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	8) Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1	Ef 1		SMB	318	476		1	FG	E	X			
2				226	144		2	MU	E	X			
3				292	350		3	MM	E	X			
4				368	724		4	FG	E	X			
5				354	600		5	MM	E	X			
6				393	860		6	FG	E	X			
7				432	1134		7	FR	E	X			
8				267	254		8	MM	E	X			
9	Ef 2		LMB	317	388		9	MM	E	X			
10				260	246		10	MM	E	X			
11				325	480		11	FG	E	X			
12				405	976		12	FG	E	X			
13				264	246		13	MM	E	X			
14				258	242		14	MM	E	X			
15			SMB	262	250		15	MM	E	X			
16				350	580		16	MM	E	X			
17				325	564		17	FG	E	X			
18				272	250		18	MM	E	X			
19			WAE	356	450		19		E	X			
20				424	790		20		E	X			
21				584	1700		21		E	LC			
22	Ef 3		SMB	262	250		22	MM	E	X			
23				295	312		23	MM	E	X			
24				315	404		24	FG	E	X			
25			BLC	216	136		25		E	X			
26				198	112		26		E	X			
27				204	120		27		E	X			
28			WAE	324	340		28		E	X			
29			LMB	305	392		29	MM	E	X			
30				292	320		30	MM	E	X			

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

DOW # 61 111 | FORM 13 - RECORDING THE CATCH | Data Recorder P. Hogan | Page 4 of 14

Body of Water Elbow | Survey ID (Starting Date) 6/1/1992

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1	GN 1	0.75	WTS	188	58								
2			YEP	183	56		82		E	N, YG			
3				170	52		83		E	N, YG			
4				152	36		84		E	N, YG			
5		1.25	WAE	297	196		85		E	X			
6		1.50	WTS	445	880								
7		2.00	WTS	475									
8				472									
9				457									
10				429									
11				437									
12	GN 2	0.75	WAE	511	1248		86		E	X			
13			TLC	188									
14				183									
15				196									
16				183									
17				173									
18				193									
19		1.00	TLC	213	88								
20		1.50	LKW	559	2040								
21				587	2296								
22		2.00	WTS	476									
23				442									
24				462									
25	GN 4	1.00	WAE	292	228		87		E	X			
26				391	596		88		E	X			
27		1.50	WAE	373	454		89		E	X			
28			WTS	284	216								
29		2.00	WTS	406	824								
30	TN 12		WAE	584	1700								

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG
GN 1	2.00	WTS		5360	
GN 2	0.75	TLC		312	
		WTS		3260	

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

DOW # 67-177 Body of Water Elbow

FORM 13 - RECORDING THE CATCH Survey ID (Starting Date) 6/1/1992 Data Recorder P. Hogan

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1	TN12		WAE	338	312		90		E	X			
2			YEP	170	56		91		E	N, YG			
3				203	88		92		E	N			
4			BLC	160	52		93		E	X			
5			RKB	178									
6				137									
7				150									
8				152									
9				91									
10	TN7		RKB	155	84								
11			YEP	152	36		94		E	N			
12				190	64		95		E	X			
13				182	58		96		E	X			
14				148	32		97		E	N, YG			
15				144	32		98		E	YG			
16				162	48		99		E	N, YG			
17				156	38		100		E	N, YG			
18				176	64		101		E	N, YG			
19				192	84		102		E	X			
20				148	36		103		E	YG			
21				160	52		104		E	YG			
22				182	56		105		E	X			
23				192	68		106		E	X			
24				142	32		107		E	N, YG			
25				138	30		108		E	N			
26				142	34		109		E	N, YG			
27				138	30		110		E	N, YG			
28				136	32		111		E	YG			
29				150	36		112		E	N			
30				146									

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG
TN12		RKB		368	

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

DOW # 67-144 | FORM 13 - RECORDING THE CATCH | Data Recorder P. Hogan | Page 6 of 14

Body of Water Elbow | Survey ID (Starting Date) 6/1/1992

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	8) Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1	TN7		YEP	162	44		113		E	N, Y6			
2				146									
3				138	32		114		E	N, Y6			
4				154	36		115		E	N, Y6			
5				148									
6				172	60		116		E	X			
7				186	68		117		E	Y6			
8				148									
9				152	36		118		E	Y6			
10				136	30		119		E	N			
11				142									
12				172	60		120		E	N, Y6			
13				166	54		121		E	N			
14				154									
15				150									
16				136									
17				132									
18				128	24		122		E	Y6			
19				154									
20				176	60		123		E	N, Y6			
21				154									
22				136									
23				174									
24				162	52		124		E	N			
25				182	64		125		E	N			
26				212	100		126		E	X			
27				208	96		127		E	X			
28				184	64		128		E	X			
29				156									
30				144									

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG
TN7		YEP	76	3800	

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

DOW # 67-147 FORM 13 - RECORDING THE CATCH Data Page 1 of 14

Body of Water Elbow Survey ID (Starting Date) 6/1/1992 Recorder

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1	TN6		WTS	454									
2				480									
3				492									
4				444									
5				462									
6				424									
7				498									
8				464									
9				444									
10				452									
11				460									
12													
13													
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28													
29													
30													

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG
TN6		WTS		11.80	✓

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

DOW # 69-744 Body of Water Elbow

FORM 13 - RECORDING THE CATCH Survey ID (Starting Date) 6/1/1992 Data Recorder P. Hogan

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1	SE 1		YYEP	61									
2				60									
3				64									
4				58									
5				55									
6				63									
7				64									
8				57									
9				54									
10				55									
11				61									
12				64									
13				63									
14				61									
15				65									
16				57									
17				61									
18				58									
19				53									
20				60									
21	SE 3		YYEP	55									
22				51									
23				49									
24				55									
25				59									
26				50									
27				47									
28				61									
29				63									
30				55									

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG
SE 1		YYEP	73		
		YEP	25		
		PKS	3		
SE 2		YEP	4		
		PKS	4		

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG

DOW # 67-144 | FORM 13 - RECORDING THE CATCH | Data Recorder P. Hogan | Page 14 of 14

Body of Water Elbow | Survey ID (Starting Date) 6/1/1992

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight	KG	6) Serial Number[c]	7) Sex Code[d]	8) X	Disease[e]	9) Comments	10) Tagging Study[f] Mark	Recap.
1	SE3		YYEP	54									
2				49									
3				60									
4				49									
5				53									
6				55									
7				61									
8				58									
9				56									
10				48									
11			YLMB	69									
12				71									
13			YWAE	66									
14				65									
15				67									
16			YSMB	71									
17				69									
18				81			281						
19				64									
20				59									
21	SE4		YYEP	53									
22				55									
23				48									
24				60									
25				57									
26				55									
27				51									
28				47									
29				45									
30				46									

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG
SE3		YYEP	27		
		YEP	19		
		LMB	1		
		PKS	7		
SE4		YYEP	19		

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight	KG
SE4		PKS	3		
		SMB	2		

INSTRUCTIONS FOR FORM 14 - BONY PART COLLECTION/INDIVIDUAL WEIGHT TALLY SHEET

This form should be used to tally the number of fish weighed and sampled for age and growth analysis. This form will not be entered into the data base.

FORM 14 - BONY PART (Fraser-Lee) / INDIVIDUAL WEIGHT TALLY

DOW # _____ Survey ID Page _____

Body of Water _____ (Starting Date) _____ Data Recorder _____ of _____

Species										
Gear										
<50										
50-59										
60-69										
70-79										
80-89										
90-99										
100-109										
110-119										
120-129										
130-139										
140-149										
150-159										
160-169										
170-179										
180-189										
190-199										
200-209										
210-219										
220-229										
230-239										
240-249										
250-259										
260-269										
270-279										
280-289										
290-299										
300-324										
325-349										
350-374										
375-399										
400-424										
425-449										
450-474										
475-499										
500-524										
525-549										
550-574										
575-599										
600-624										
625-649										
650-674										
675-699										
700-724										
725-749										
750-774										
775-799										

*Weigh and age (Fraser-Lee) 5 per length group <300 and 10 per length group >300 for each gear type considered.

DOW # 69-744 FORM 14 - BONY PART (Fraser-Lee) / INDIVIDUAL WEIGHT TALLY

Body of Water Elbow Survey ID (Starting Date) 6/1/1992 Data Recorder P. Hogan Page 1 of 2

Species	SMB	LMB	WAE	BLC	YEP		WAE		BLC	
Gear	Ef	Ef	Ef	Ef	GN	TN	GN	TN	TN	
<50										
50-59										
60-69										
70-79										
80-89										
90-99										
100-109										
110-119										
120-129						1				
130-139						5				
140-149						5				
150-159					1	5				
160-169						5			1	
170-179					1	5				
180-189					1	5				
190-199				1		3				
200-209				1		2				
210-219				1		1				
220-229	1									
230-239										
240-249										
250-259		1								
260-269	3	2								
270-279	1									
280-289										
290-299	2	1					2			
300-324	2	2	1							
325-349	1	1						1		
350-374	3		1				1			
375-399	1						1			
400-424		1	1							
425-449	1									
450-474										
475-499										
500-524							1			
525-549										
550-574										
575-599			1					1		
600-624										
625-649										
650-674										
675-699										
700-724										
725-749										
750-774										
775-799										

*Weigh and age (Fraser-Lee) 5 per length group <300 and 10 per length group >300 for each gear type considered.

AGE AND GROWTH

Age and growth information is required for all full surveys and population assessments.

Age and growth information is needed to monitor changes in fish growth and age structure, determine age frequency, age at maturity, and mortality rates, and estimate year class strength. Many decisions affecting fisheries management (regulations, stocking, habitat improvement, etc.) depend upon accurate age and growth information.

Several methods have historically been used to determine age and growth characteristics. These include sampling known-aged fish (mark-recapture), analyzing length-frequency distributions (peaks representing age groups), and measuring bony structures. Measuring bony structures is the most common and is standard for full surveys and population assessments.

Several biases are associated with ageing fish. Annulus formation generally occurs during periods of slow growth. Bony structures, particularly scales occasionally form "false" annuli (due to environmental changes, spawning or other factors) which can result in an inaccurate estimate of fish age. Additionally, as fish get older it becomes more difficult to discern each annulus and true age is often poorly estimated. This can be compounded by occasional loss of peripheral annuli due to scale resorption or erosion. These problems can be reduced by having trained and experienced scale readers that are familiar with the species and lake from which the samples were collected read the sample, or by having several individuals read the same scales as a cross reference. In addition, other bony structures (such as otoliths, spines) can be used to help determine age.

Species to Age:

Ageing of game fish and panfish (bluegill, crappie and yellow perch only) is required for all full surveys. Ageing of all other species is optional. For population assessments, only

primary species listed in the management plan are required to be aged. Ageing additional species (especially game fish or secondary species in the management plan) is strongly encouraged.

Structures to Age:

Scales should be collected from all species being aged except catfish which require collecting pectoral spines.

Additional bones, spines or rays may also be collected to compare to fish age estimated from scales or to analyze growth. These structures are often used to verify scale annuli to improve the accuracy of age estimates for older fish. This is especially important in lakes with slow growing populations or where natural reproduction or stocking is being evaluated based upon fish age. The Area Supervisor should decide whether or not additional structures are needed. Alternate ageing structures vary by species and should be considered as follows:

Structure	Species
otoliths	walleye, crappie, bluegill, largemouth and smallmouth bass, lake trout
dorsal spines	walleye, catfish
cliethra	northern pike, muskellunge
fin rays	trout, salmon
opercle	yellow perch, walleye, largemouth bass, smallmouth bass

References concerning **collecting, preparing and ageing** these structures are provided in Appendix 1.

Number of Samples to Collect:

Collection of scale samples depends upon the method of analysis. See page 10-3 for a discussion of analysis methods. Two options are provided, Frasier-Lee equation (using Disbcal) or Weisberg's linear growth model. When using the Frasier-Lee equation, collect scales (spines for catfish) from at least 5 fish from each 10 mm group whenever possible (10 is better) for fish <300 mm. For fish 300 mm or longer, collect scales from 10 or more fish from each 25 mm group, if possible. Subsampling is not necessary, however, within each length group be sure to

sample a range of lengths. This is especially important for smaller species such as bluegill, where a few mm in length can influence age-frequency estimates.

For Weisberg's linear growth model, collect scales from all fish individually measured (especially for gamefish), or a random subsample of all fish (when large numbers of panfish are collected) from each net or electrofishing station. If scale samples are collected from all fish, they can be proportionately subsampled to get a representative distribution of age classes. If subsampling, a minimum of 50 samples should be collected.

Sampling Gear:

If possible, obtain scale samples from fish captured by the gear type most effective at sampling a wide range of sizes of that species (Appendix 3 describes target species for each sampling gear). If sufficient numbers of fish by length group are not collected from the target gear include individuals from other gears to supplement the sample. Be sure to keep samples separated by gear type (Form 14 allows this separation) to aid in analysis.

Sex Differences in Growth and Maturity:

Growth rates vary by sex for most fish species, especially after maturity. Fortunately, general information on length and age at maturity is available for most common Minnesota species. Therefore, collecting additional samples to obtain adequate sample size by sex is optional. If possible, determine the sex of the fish being sampled, however, do not sacrifice the fish unless a specific need exists.

Analysis:

The first question to consider is whether the ages determined are valid (the Area Supervisor can determine the effort devoted to this question). The strongest validation involves known-age fish, but more often use of similar ages read from different structures, similar ages assigned by different

curve analysis for ages fully recruited to that gear. Age distributions should be calculated using FISHCALC or AGEDIST 123 to expand the age distribution to fit the length-frequency.

References pertaining to analysis and interpretation of age and growth information are provided in Appendix 1.

Archiving Ageing Structures:

All ageing structures collected should be archived for later use. As methods for ageing fish and calculating growth change, there is occasional need to reevaluate historical growth data. In these cases, archived samples often prove invaluable. Be sure each structure archived is identified by lake name, year and serial number (see page 9-5). The serial number will identify the species, length, weight, gear, date collected, and sex (from information stored in the data base).

SPECIAL SAMPLING

This section is intended to provide general direction for non-standard sampling, and to encourage experimentation with new sampling methods. Methods are not described in detail, but are intended to provide general information concerning equipment, season, effort, etc. for common types of special sampling. This section should save time and provide guidelines for individuals considering new sampling methods, yet maintain consistency statewide. Any variation in the methods described in this section should be considered a new sampling method. This section can be expanded as new special sampling methods are implemented.

In most cases, the Forms developed for standard sampling can also be used for special sampling. Be sure to describe, <u>in detail</u>, the specific methods and gear used for each type of special sampling on the appropriate form. Provide enough detail that others can repeat your methods.

1/4" TRAP NETS FOR YOUNG OF THE YEAR SAMPLING

This method is used to obtain young of the year or species diversity information when seining is not possible due to steep or rocky shorelines, or other factors. Record net set information on Form 11, and fish data on Form 13. Follow the procedures in the **Trap Netting section**, page 7-1 with the following modifications:

Sampling Season:

The sampling season varies depending upon the species sought. Walleye and yellow perch young of the year should be sampled during June and early July, while minnow species can be sampled at any time. If your goal is to develop a species list, sampling should occur during late summer (August/September). Once a sampling season is chosen for this specific method, it should be repeated as closely as possible with subsequent surveys.

Gear Requirements:

For sampling YOY or developing a species list, trap nets should consist of a single 6X3 ft. frame with a 50 ft. lead, all covered by 1/4" nylon mesh.

FALL ELECTROFISHING FOR WAE

This method is used to sample walleye, primarily age 0 and 1+, during fall. Record electrofishing data on Form 10, and fish data on Form 13. Follow the procedures described in the **Electrofishing section**, page 5-1 with the following modifications:

Sampling Season and Time of Day:

Electrofishing should be conducted at night during October or November when water temperature are <55 F.

Sampling Stations:

Sample along sandy or rocky shorelines. If estimating CPUE, several sampling stations should be selected (as opposed to one long station, unless the entire shoreline can be sampled). Follow procedures in "Electrofishing", page 5-3, for selecting sampling stations.

APPENDIX 1 - REFERENCES

This appendix lists specific references cited in the text, as well as other references pertaining to topics addressed in this manual. It is not intended to be a complete bibliography, but rather a guide to books and other general sources of information.

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APPENDIX 2 - FIELD DATA FORMS

There are 14 forms for recording data from lake surveys. Full surveys require completion of Forms 1-13 (Form 10 is optional), while population assessments require completion of Forms 9-13, with Forms 10 and 12 optional. Instructions for each form are provided in the appropriate section of this manual.

These forms will be used for data entry into the lake and stream data base, which will complete data analysis and print desired reports as specified by the data entry operator. A complete set of blank forms is provided in this appendix. Completed forms (as examples) are provided in the individual chapters.

FORM 1 - GENERAL INFORMATION

Data Recorder(s) _____

1) Lake Name: _____ 2) Alternative Name: _____

3) DOW #: _____ 4) Survey ID (Starting Date) _____ 5) Area Code: _____ 6) Map ID#: _____

7) Type of Survey: Initial ☐ Resurvey ☐ Population Assessment ☐

Special Sampling ☐ (describe special sampling): _____

_____

8) County(ies): _____ 9) Nearest Town[a]: _____

10) Legal Description

Township	Range	Section(s)

Township	Range	Section(s)

Township	Range	Section(s)

Access

11) ID #	12) Ownership[b]	13) Type[c]	14) Location Description / Comments
AC			
AC			
AC			
AC			
AC			
AC			

15) Previous Surveys and Investigations: Initial Survey: _____ Resurvey(s): _____

Population Assessment(s): _____ Creel(s): _____

Other (describe): _____

16) Total Lake Area: _____ acres, Area in MN: _____ acres 17) DOW Acres: _____ 18) Watershed Size: _____ acres

19) Max. Depth: _____ ft. 20) Mean Depth: _____ ft. 21) Littoral Acres: _____ 22) Shoreline Length[d]: _____ mi.

23) Max. Fetch[e]: _____ mi., Orientation: _____ 24) Lake Class #: _____ 25) Alt. Lake Class #: _____

26) Major Watershed #: _____ 27) Minor Watershed #:_____ 28) Primary USGS Quad Map (7.5) Code: _____

(a) Include angular distance and direction to lake in parenthesis (e.g., 3 miles North and 1 mile East).

(b) (DNR), (UFS), (COU)nty, (COE), (FWS), (CIT)y, (TOW)nship, (NPS), (O)ther (describe in comments), (X) Unknown.

(c) (CA)rry-in, (E)arthen, (CO)ncrete, (G)ravel, (O)ther (describe in comments).

(d) Do not include Islands.

(e) Longest straight line without intersecting any land mass. Orientation from 16-point compass (e.g., NNW-SSE).

*Include access locations (AC1, AC2, etc.) on Habitat Evaluation map and record location description on Form 2.

FORM 2 - SAMPLING STATION AND HABITAT EVALUATION LOCATIONS

DOW # _____ Data Page _____

Body of Water _____ Survey ID (Starting Date) _____ Recorder(s) _____ of _____

1) Sta. Code[a] #	2) GPS COORDINATES Start Latitude	Start Longitude	End-if applicable Latitude	End-if applicable Longitude	3) GILLNETS[b] Mesh	Depth	Dir	Mesh	Depth	Dir	4) Location Description/Comments (include Twp.,R.,S. for inlets, outlets)

(a) VT, WQ, FMI, FMO, WDI, WDO, IN, OU, AC, GA, BM, RE, DAM, ER, PO, TN, GN, EF, SE, STN, SGN, SEF, SSE.

(b) Record mesh size in inches.hundredths for both ends. Record bottom depth (feet) for standard sets in bottom area (leave top area blank); for suspended sets, record lead line depth in top area and bottom depth in bottom area. Record direction that each gillnet end is facing (N,S,E,W,NE,NW,SE,SW).

*After station locations have been established, only describe new or alternate station locations.

**All locations should be identified (Code and Station Number) on Sampling Station (VT,WQ,FMI,FMO,WDI,WDO,GA,BM,TN,GN,EF,SE, STN,SGN,SEF,SSE) or Habitat Evaluation (IN,OU,AC,RE,DAM,ER,PO) maps.

Survey ID Page ____

DOW # _____ Body of Water _____ (Starting Date) _____ of ____

1) Station Code[a] #	2) Reading[b]	3) Current Water Level[c]	4) Date (mo/day/year)	5) Comments (Include new or lost/removed BM or GA)	Data Recorder

WATER LEVEL DESCRIPTION (Completed by:_____)

6) Normal Water Level (obtain data from D.O.W. Area Hydrologist) = _____ feet[b] at _____

7) Average Annual Fluctuation (mean of yearly differences between high and low readings) = _____ feet

Data Source: _____ # of years of data = _____

_____ Total # of readings = _____

_____

8) Long-Term Fluctuation (highest and lowest recorded water levels):

High[b] = _____ ft. at _____ on _____ Low[b] = _____ ft. at _____ on _____
(Location) (Date) (Location) (Date)

Data Source: _____

_____

_____

9) Water Level History (include sources): _____

_____

_____

_____

_____

_____

_____

_____

(a) (BM) Benchmark, (GA)uge.

(b) If measuring at a benchmark, include a (+) if water level is higher than BM and a (-) if lower.

(c) (L)ow, (N)ormal, (H)igh.

*Show gauge (GA1, etc.) and benchmark (BM1, BM2, etc.) locations on Sampling Station map and record location description on Form 2.

DOW # _____ FORM 4 - INLETS / OUTLET Page ___

Body of Water _____ Survey ID (Starting Date) _____

Dates of Fieldwork (mo/day/year) _____ through _____ Data Recorder(s) _____ of ___

1)Inlet ID #	2) Name	3) Tributary Number	4) Type[a]	5) Origin[b]		6) Cover Type / Land Use[c]			7) Avg. Width	8) Avg. Depth	9) FLOW fps	FLOW cfs	FLOW Method[d]	10) Sur. Temp.-[o]
IN														
IN														
IN														
IN														
IN														
IN														

11)Inlet ID #	12a)Barrier to Fish Mvmt?[e]	12b) If Yes or Periodic, briefly describe	13) Known Spawning Runs[f] Spp. 1	Spp. 2	Spp. 3	Spp. 4	14) Inlet Comments (habitat, current water stage, etc.)
IN							
IN							
IN							
IN							
IN							
IN							

15)Outl. ID #	16) Name	17)Tributary or DOW #	18) Tributary To (Trib. or DOW#)	19)Avg. Width	20)Avg. Depth	21) FLOW fps	FLOW cfs	FLOW Meth.[d]	22a)Barrier to Fish Mvmt?[e]	22b) If Yes or Periodic, briefly describe	23) WATER CONTROL STRUCTURE (DAM) Type[g]	Owner[h]	Head	> Sill	Gauge
OU															
OU															

24) Outlet Comments:

Type: _____

Owner:

(a) (ID) Intermittent - Dry (no flow at mouth, still may contain water), (IF) Intermittent - Flowing (currently has flow at mouth), (C)ontinuous Flow, (X) Unknown.

(b) (L)ake (give DOW#), (M)arsh, (B)og, (S)pring, (W)ell, (T)ile, (SS) Storm Sewer, (D)itch, (O)ther (describe), (X) Unknown. Consider only to next upstream waterbody.

(c) Give up to the two most common in order of abundance: (H)ardwoods, (CO)nifers, (MI)xed Forest, (G)rassland, (CR)ops, (P)asture, (MU)nicipal, (R)esidential, (MA)rshland, (B)ogs, (O)ther (describe), (X) Unknown.

(d) (F)loating object, (C)urrent meter, (D)irect time and volume measurement (gpm / 15.9 = cfs).

(e) (Y)es, (N)o (record only if entire stream is checked), (P)eriodic, (X) Unknown.

(f) List the species code for up to 4 species with known spawning runs in this inlet.

(g) (TC) Type "C" with stoplogs, (SP) Sheet piling, (DI) Drop inlet with stoplogs, (CF) Concrete with fixed sill, (BD) Beaver Dam, (N)one, (O)ther (describe after Type:

(h) DNR, DOT, UFS, FWS, COE, NPS, (TOW)nship, (COU)nty, (CIT)y, (PRI)vate (list name after Owner:), (N)one (natural dam), (O)ther (list name after Owner:), (X) Unknown.

*Show Inlet (IN1, IN2, etc.), Outlet (OU1, etc.), DAM, Flow Measurement (FMI1, FMO1, etc.), and Average Width/Depth (WDI1, WDO1, etc.) locations on appropriate maps (IN,OU,DAM on habitat evaluation; FMI,FMO,WDI,WDO on sampling station) and record location description on Form 2.

DOW # _____ Form 3 - WATERSHED/SHORELINE CHARACTERISTICS _____ of _____

Body of Water _____ Survey ID (Starting Date) _____

Dates of Fieldwork (mo/day/year) _____ through _____ Data Recorder(s) _____

SURROUNDING WATERSHED

1) TYPE OF USE/COVERAGE	2) % Use	3) Relief[a]	4) Location / Comments
Forest/Woodl.-Undeveloped			
Agricultural Crops			
Livestock / Pasture			
Marshland			
Bogs			
Grassland			
Municipal			

5) Soil Types[b]			6) Comments (soils):

SHORELINE

1) TYPE OF USE/COVERAGE	2) % Use	3) Slope[c]	4) Location / Comments
Forest/Woodl.-Undeveloped			
Agricultural Crops			
Livestock / Pasture			
Marshland			
Bogs			
Grassland			
Municipal			
Residential			

5) Number of Homes/Cabins	6) Comments[d]:

RESORTS / CAMPGROUNDS

1)ID#	2) Name	3)#Cabins	4)#Campsites	5) Comments	1)ID#	2) Name	3)#Cabins	4)#Campsites	5) Comments
RE					RE				
RE					RE				
RE					RE				

(a) Choose the one code that best describes the watershed relief: (S)teep, (R)olling, (F)lat.

(b) Choose the two most common: (G)lacial Till, (R)ock, (SA)nd, (SI)lt, (C)lay, (L)oam, (O)ther (describe in comments), (X) Unknown.

(c) Choose the one code that best describes the shoreline slope: (S)teep, (G)radual, (F)lat.

(d) Include area for Homes/Cabins count and substantial shoreline alterations (harbors, channels, breakwalls, etc.).

*Include resort/campground locations (RE1, etc.) on Habitat Evaluation map and record location description on Form 2. Also include adjacent wetland areas (bog, marshland) on Habitat Evaluation map (label as WE).

FORM 6 - AQUATIC VEGETATION / SHOALWATER SUBSTRATE TRANSECTS

DOW # _____ Body of Water _____ Survey ID (Starting Date) _____

Dates of Fieldwork (mo/day/year) _____ through _____ Data Recorder _____ Page ____ of ____

AQUATIC VEGETATION TRANSECTS

	2) Transect Number[a]																				
1) Common Name	Code																				
3) Max. Veg. Depth																					

4) SHOALWATER SUBSTRATES

Ledge Rock	LR																				
Boulder (>10")	BO																				
Rubble (3-10")	RU																				
Gravel	GR																				
Sand	SA																				
Silt	SI																				
Clay	CL																				
Muck	MU																				
Detritus	DE																				
Marl	MA																				

5) ADDITIONAL SPECIES FOUND

Common Name	Code	Comments (date, locations, density)	Common Name	Code	Comments (date, locations, density)

a) Rate vegetation and substrate types within a transect as (R)are, (C)ommon, or (A)bundant.
*Show transect locations (VT1, VT2, etc.) on Sampling Station map and record locations on Form 2.

CODE	COMMON NAME
SAC	Arrowhead (S.cristata)
SC	Arrowhead (S.cuneata)
SAL	Arrowhead (S.latifolia)
SP	Bayonet Grass
BC	Beggartick
PB	Berchtold's Pondweed
UI	Bladderwort (U.intermedia)
UM	Bladderwort (U.minor)
IV	Blueflag
CC	Bluejoint
PO	Bluntleaf Pondweed
AG	Bog Rosemary
MT	Buckbean
CB	Bulb-Bearing Water Hemlock
NF	Bushy Pondweed (N.flexilis)
NAG	Bushy Pondweed (N.gracillima)
EC	Canada Waterweed
PHAU	Cane
CE	Chufa Nut Grass
POR	Claspingleaf Pondweed
TL	Common Cattail
CD	Coontail
SPPE	Cord Grass
PC	Curled Pondweed
RS	Cursed Crowfoot
EM	Duck Millet
MYS	Eurasian Water Milfoil
PZ	Flatstem Pondweed
SPA	Floatingleaf Burreed
PN	Floatingleaf Pondweed
AA	Foxtail
NO	Fragrant Waterlily
POFR	Fries' Pondweed
SE	Giant Burreed
CM	Giant Water Hemlock
RM	Golden Dock
UV	Greater Bladderwort
SPP	Greater Duckweed
RUO	Great Water Dock
SPC	Greenfruited Burreed
SA	Hardstem Bulrush
ZP	Horned Pondweed
PI	Illinois Pondweed
LG	Laborador Tea
VM	Large Cranberry
PA	Largeleaf Pondweed
PV	Largesheath Pondweed
SCA	Leafy Bulrush
PF	Leafy Pondweed
CHC	Leatherleaf
LM	Lesser Duckweed
NYT	Little White Waterlily
NUM	Little Yellow Waterlily
GB	Manna Grass
HV	Marestail
CAP	Marsh Marigold
TA	Narrowleaf Cattail
PS	Narrowleaf Pondweed (P.strictifolius)
CAN	Narrow-Leaf Sedge
EA	Needlerush
MS	Northern Water Milfoil
PE	Nuttall's Pondweed
H	Mud Plantain
POC	Pickerelweed
ES	Pipewort
POF	Pondweed (P.filiformis)
POPU	Pondweed (P.pusillus)
LS	Purple Loosestrife
AS	Redtop Grass
PHA	Reed Canary Grass
GG	Reed-meadow Grass
LO	Rice Cutgrass
SCF	River Bulrush
PON	River Pondweed
PR	Robbins' Pondweed
JB	Rush (J.balticus)
JN	Rush (J.nodosus)
PP	Sago Pondweed

CODE	COMMON NAME
CA	Sedge (C.aquatilis)
CAC	Sedge (C.comosa)
SL	Skullcap
BS	American Slough Grass
PL	Smartweed (P.lapathifolium)
VO	Small Cranberry
MA	Small-leaf Milfoil
POS	Snailseed Pondweed
SV	Softstem Bulrush
NG	Southern Pondweed
ELS	Spikerush
NM	Spiny Naiad
HJ	Squirrel-tail Grass
LT	Star Duckweed
SR	Stiff Wapato
BA	Swamp Aster
POPA	Swamp Fivefinger
EF	Swamp Horsetail
AC	Sweet Flag
SCP	Threesquare
DA	Three-Way Sedge
PG	Variable Pondweed
CP	Water Arum
SS	Water Bulrush
LA	Water Horehound
MB	Water Marigold
WC	Water Meal
MYT	Water Milfoil (M.tenellum)
SIS	Water Parsnip
AT	Water Plantain
BRS	Water Shield
POA	Water Smartweed
HD	Water Star-Grass
CV	Water Starwort
POP	Whitestem Pondweed
SF	Whitetop
NT	White Waterlily
CAW	Wide-Leaf Sedge
RO	Widgeon Grass
VA	Wild Celery
ZIP	Wild Rice
EV	Wild Rye
SCC	Wool Grass
NL	Yellow Lotus
RF	Yellow Water Buttercup
NUL	Yellow Waterlily

CODE	PLANT GROUP NAME
SAS	Arrowhead/Duck Potato Group (Sagittaria spp.)
POSB	Broadleaf Pondweed Group
FA	Filamentous Algae
G	Grasses (Gramineae)
E	Love Grass - Eragrostis spp.
C	Muskgrass (Chara spp.)
POSN	Narrowleaf Pondweed Group
J	Rushes (Juncus spp.)
CYP	Sedges (Cyperaceae)
CS	Carex spp.
CY	Cyperus spp.
ELSP	Eleocharis spp. (Spikerush)
SCS	Scirpus spp. (Bulrush)
P	Smartweeds (Polygonum spp.)
N	Stonewort (Nitella spp.)
D	Water Moss (Drepanocladus spp.)
R	White Water Buttercups (Ranunculus spp.)

FORM 7 - FISH SPAWNING CONDITIONS, EROSION AND POLLUTION

DOW # _____ Page ____ of ____

Body of Water _____ Survey ID (Starting Date) _____

Dates of Fieldwork (mo/day/year) _____ through _____ FISH SPAWNING CONDITIONS Data Recorder(s) _____

1) Spp. Code	2) Habitat Rating[a]	3) Comments (Habitat description, locations, etc.)

Dates of Fieldwork (mo/day/year) _____ through _____ EROSION OR POLLUTION (Nature and Extent) Data Recorder(s) _____

1) Site Code[b] #	2) GPS Coordinates Latitude	Longitude	3) Location Description	4) Nature[c] and Extent[d] Nat.	Ext.	Nat.	Ext.	Nat.	Ext.	5) Comments

(a) Rate spawning habitat as: (E)xcellent, (G)ood, (F)air, (P)oor, (N)one.

(b) (ER)osion, (PO)llution.

(c) Use two letter code with first letter either (P)oint Source, (N)on-Point Source, or (X) Unknown and the second letter either (B) Bank erosion, (G) Gully erosion, (S)heet Erosion, (I)ndustrial Pollution, (A)gricultural Pollution, (M)unicipal Pollution, (D)omestic Pollution, (O)ther, (X) Unknown (e.g., PI, NA, etc.). Describe under comments.

(d) Rate extent of erosion and pollution as: (L)ight, (M)oderate, (S)evere.

*Include erosion and pollution locations (ER1, PO1, etc.) and known/favorable habitat spawning locations (label as SP-WAE, SP-NOP, etc.) on the Habitat Evaluation map.

FORM 8 - ADDITIONAL FIELD NOTES

Page _____ of _____

DOW # _____

Survey ID

Body of Water _____ (Starting Date) _____ Data Recorder(s) _____

*Indicate the date (mo/day/year) when documenting field observations and include a location description of field observations on this form if warranted.

FORM 9 - WATER QUALITY

DOW # _____ Survey ID Page ____

Body of Water _____ (Starting Date) _____ Data Recorder _____ of ____

1) Standard Sampling (Y/N)? ___ If No, describe: _____

2) Station Number: WQ _____ 3) Date (month/day/year): _____

4) TEMPERATURE - DISSOLVED OXYGEN PROFILE

Depth (ft.)	Temp.-°C	D.O.- ppm	Depth (ft.)	Temp.-°C	D.O.- ppm	Depth (ft.)	Temp.-°C	D.O.- ppm
0								
						4) Bottom Depth: _____ feet		

5) Standard Sampling (Y/N)? ___ If No, describe: _____

6) Station Location - (LA)ke, (IN)let: _____ 7) Time (0-2400): _____ 8) Secchi[a] (ft.1): _____

9) Wave Intensity[b]: _____ 10) Wind Direction[c]: _____ 11) Color[d]: _____ describe: _____

12) Cause[e]: _____ describe: _____ 13) Sample Depth (feet, 0 if surface): _____ 14) pH: _____

15) Alkalinity: _____, method[f] _____ 16) Other Field Measurements: _____

17) Lab Samples Taken (Y/N): _____ 18) Collection Method[g]: _____ describe: _____

19) Comments (weather conditions, light intensity, etc.):

(a) If Secchi disk is visible on the bottom, include a ">" (e.g., >13.5).

(b) (C)alm, (M)oderate, (S)trong. Describe conditions at water quality station.

(c) N, S, E, W, NE, NW, SE, SW, X (No Wind).

(d) (G)reen, (BR)own, (BL)ue, (C)lear, (O)ther (describe).

(e) (A)lgae, (S)ilt, (B)og-stain, (L)ow fertility (blue, clear option), (O)ther (describe), (X) Unknown.

(f) Use 2-letter code: (S)ingle or (D)ouble-endpoint titration, (C)olorimetric or (P)otentiometric (e.g., DP, SC, etc.).

(g) (G)rab sample, (I)ntegrated sample, (O)ther (describe).

*Primary station is always WQ1.

**Show WQ station locations (label as WQ1, etc.) on Sampling Station map and record location description on Form 2.

DOW # _____ FORM 10 - ELECTROFISHING Page ___ of ___

Body of Water _____ Survey ID (Starting Date) _____ Data Recorder(s) _____

1) Standard Sampling (Y/N)? _____ If No, describe method: _____

2) BOAT CONFIGURATION

a) Anode Type[a] _____ Cathode Type[b] _____
Number of Anodes _____ Current Type[c] _____
VVP Manufacturer and Model# _____

b) Anode Type[a] _____ Cathode Type[b] _____
Number of Anodes _____ Current Type[c] _____
VVP Manufacturer and Model# _____

c) Anode Type[a] _____ Cathode Type[b] _____
Number of Anodes _____ Current Type[c] _____
VVP Manufacturer and Model# _____

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/ (N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply) A-	V-	XF-	PPS-	W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:

*For additional stations, need only to record the information that changes.

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/ (N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply) A-	V-	XF-	PPS-	W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:

3) Station Code[d] #	4) TIME (0000) Start	End	5) DATE (mo/day/year)	6) (D)ay/ (N)ight	7) On-Time[e]	8) #Netters	9) Target Species[f]	10) Boat Config[g]	11) Clarity[h]	12) Conduct.	13) Sur. Temp.-°F	14) VVP Settings (record all that apply) A-	V-	XF-	PPS-	W-

15) GPS COORDINATES Start Latitude	Start Longitude	End (if applicable) Latitude	End (if applicable) Longitude	16) Location Description:	17) Comments[i]:

(a) Anode Type Choices: (S)phere, (R)ing, (C)able, (O)ther (describe under comments).
(b) Cathode Type Choices: (B)oat, (D)roppers, (O)ther (describe under comments).
(c) Current Type Choices: (A)C, (3)-phase AC, (D)C, (P)ulsed DC, (O)ther (describe under comments).
(d) Standard sampling (EF); Special sampling, put an S before the gear type code (SEF).
(e) Record On-Time in seconds if VVP or generator has timer.
(f) Record species codes for netted species (LMB, SMB, etc.). Record (A)ll if netting all species. If targeting YOY, put Y before the species code (YWAE, etc.). If using boat electrofishing for assessment of natural reproduction for all species, record YOY.
(g) Record the letter of the correct boat configuration for that run (either a, b, or c from section 2).
(h) Rate water clarity (turbidity, waves, etc.) as (P)oor (significantly affected catch), (M)oderate (some affect on catch), (G)ood (no perceived affect on catch).
(i) Include general habitat description (depth zone sampled, amount and type of cover, substrate types, etc.), conditions (visibility, weather. etc.), sightings of

DOW # _____ FORM 11 - TESTNETTING Page ____

Body of Water _____ Survey ID (Starting Date) _____ Data Recorder(s) _____ of ____

1) Standard Sampling (Y/N)? ____ If No, describe method (include gear description):_____

2) Sta. Code[a]#	3) Setting/Lifting Date (mo/day/year)	Time (0000)	4) GPS Coordinates Latitude	Longitude	5) Location Description	6) TRAPNETS (feet) Frame Depth	Lead Dist. From Shore	7) GILLNETS[b] End 1 Mesh	Depth	Dir	End 2 Mesh	Depth	Dir	8) Target Species[c]	9) Comments (tampering, conditions, etc.)

(a) Standard Sampling (TN, GN); Special Sampling, put an S before the gear type code (SGN, STN).

(b) Mesh (inches.XX), Depth (bottom sets-depth in feet in bottom area;suspended sets-bottom mesh depth in top area, bottom depth in bottom area), Dir-N,S,E,W,NE,NW,SE,SW.

(c) If special sampling for particular species, record species code(s) for targeted species. If targeting YOY, put Y before the species code(s) (YWAE, etc.). If using 1/4-inch trapnets (or other spec. sampling gear) for natural reproduction success sampling, record YOY.

*Only use 1 spec. sampling method/gear descrip. per page. Do not mix stnd. and spec. samples on the same page.**Show sampling locations (GN1,STN1,etc.) on Sampling Station

FORM 12 - SEINING

DOW # _____ Page ___

Body of Water _____ Survey ID (Starting Date) _____ Data Recorder(s) _____ of ___

1) Standard Sampling (Y/N)? ____ If No, describe method (include gear description):_____

2) Sta. Code[a]#	3) Date (mo/day/year)	4) Time (0000)	5) GPS Coordinates Latitude	Longitude	6) Location Description	7) Met.[b]	8) Max. Depth (feet.5)	9) Haul Length (feet)	10)Avg. H.Width (feet)	11) SUBSTRATES[c] L R	B O	R U	G R	S A	S I	C L	M U	D E	M A	12) Veg.[d]	13) Wave Int.[e]	14) Surf. °F	15) Target Species[f]	16) Comment

(a) Standard Sampling (SE); Special Sampling, put an S before the gear type code (SSE).

(b) (PA)rallel, (PE)rpendicular, (F)ixed Pole. For fixed pole method, disregard column 9 (Haul Length) and estimate Avg. Haul Width (column 10).

(c) Ledge Rock (LR), (BO)ulder (>10"), (RU)bble (3-10"), (GR)avel, (SA)nd, (SI)lt, (CL)ay, (MU)ck, (DE)tritus, (MA)rl. Rate substrates as (R)are, (C)ommon, or (A)bundant.

(d) (N)one, (L)ight, (M)oderate, (D)ense.

(e) (C)alm, (M)oderate, (S)trong. Describe conditions at seining station.

(f) For standard natural reproduction monitoring, leave blank. If special sampling for a particular species, record species code(s) for the targeted species (if targeting YOY, put Y before the species code, for example, YWAE, etc.).

*Only use 1 special sampling method per page. Do not mix standard and special samples on the same page.

**Show sampling locations (SE1, SSE1, etc.) on Sampling Station map (for parallel seine hauls, show starting location and direction).

DOW # _____ FORM 13 - RECORDING THE CATCH Data Page ____

Body of Water _____ Survey ID (Starting Date) _____ Recorder _____ of ____

	1) Station Code[a] #	2) Mesh Size	3) Species Code[b]	4) Length (mm)	5) Weight KG	6) Serial Number[c]	7) Sex Code[d]	8) X	8) Disease[e]	9) Comments	10) Tagging Study[f] Mark	10) Tagging Study[f] Recap.
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
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21												
22												
23												
24												
25												
26												
27												
28												
29												
30												

11) Additional Catch Information

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight KG

a) Station Code[a] #	b) Mesh Size	c) Species Code[b]	d) Number not Measured	e) Bulk Weight KG

(a) Standard Sampling (EF,GN,TN,SE); Special Sampling, put an S before the gear type code (SEF,SGN,STN,SSE).
(b) When recording natural reproduction monitoring data (seining, 1/4" trapnets, electrofishing, etc.), include a Y for YOY (YLMB, YWAE, etc.). For fish age 1+ or > and for species under LIST C below (if not concerned with differentiating between YOY and age 1+>) , use standard 3-letter code.
(c) Record serial number (number consecutively) on scale envelope in the field.
(d) If column utilized, use 2-letter code: 1st letter - (M)ale, (F)emale, (U)nknown; 2nd letter - (I)mmature, (M)ature, (U)nknown, (G)ravid (unripe females prior to spawning that have eggs), (R)ipe, (S)pent (e.g., FM - female mature).
(e) Under the X column, record (E) if the fish was examined externally and record (I) if the fish was examined both externally and internally. Leave blank if the fish was NOT EXAMINED externally or internally.

**********DISEASE CODES**********

(X) None observed, Anchor Worm (AW), (AR)gulus, Bass Tapeworm (BT), Bladderworm (BW), (F)ungus, Gill Parasites (GP), (I)ch, (L)eeches, Lymphocystis (LC), Lymphosarcoma (LS), (M)yofibrogranuloma, (N)eascus, Open Sores/Hemorrhages (OH), Skeletal Deformities (SK), Slime Discoloration (SL), (T)umors, (TR)iaenophorus, (YG) Yellow Grub, (O)ther (describe).

****

(f) Clip Codes: (LP) Left Pectoral, (RP) Right Pectoral, (LV) Left Pelvic, (RV) Right Pelvic, (A)nal fin, (LC) Lower Caudal, (UC) Upper Caudal, (AD)ipose fin. Other mark type codes can be defined and used as well as tag numbers.

Recording the Catch - Summary

LIST A	LIST B	LIST C
Northern Pike	Bluegill	ALL OTHER SPECIES
Walleye	Black Crappie	
Sauger	White Crappie	
Largemouth Bass	Yellow Perch	
Smallmouth Bass		
Muskellunge		
Trout (all species)		
Salmon (all species)		
Catfish-Channel,Flathead,Blue		
Lake Sturgeon		

I. Lengths - Minimum Requirements:

A. Measure all individuals under LIST A.
B. Subsampling for lengths is an option for LISTS B and C.
   1. Conduct only when necessary (time constraints).
   2. Should not be conducted when there is high variability in sizes.
   3. Minimize selection bias as much as possible.
   4. Procedure - Measure 25-50 per station or per mesh size (if keeping separate). Measure 25 if low variation in size, measure 50 if moderate variation in size. Record the number not measured on the bottom of Form 13.

II. YOY Lengths (Seining, 1/4-trapnets, etc.) - Minimum Requirements:

A. Measure up to 20 per station and up to 50 for the entire survey for all fish species under LISTS A and B. Record the number not measured on the bottom of Form 13.

III. Individual Weights and the collection of ageing structures - Minimum Requirements:

A. Collect individual weights and structures for all fish species under LISTS A and B.
B. Ageing Structures - Collect 5 per length group <300 mm and 10 per length group >300 mm for each gear type considered.
C. Individual weights - Collect 5 per length group <300 mm and 10 per length group >300 mm. Get an individual weight from every fish that an ageing structure was taken from.
D. Use Form 14 to keep track of numbers per length group.

IV. Bulk Weights

A. For fish species under LIST B:

If NOT Subsampling for Lengths - DO NOT COLLECT BULK WEIGHTS, the length-weight equation will estimate the weight of the individual fish not measured.

If Subsampling for Lengths - The remainder of the individuals not measured should be bulk weighed (counted also) and recorded on the bottom of Form 13.

B. For fish species under LIST C:

The ENTIRE SAMPLE of fish (measured and not measured) must be bulk weighed (assuming no individual weights taken).

General Rule: Bulk Weights are not necessary for a species that is not being subsampled for lengths and where individual weights are taken on a portion of the sample.

Note: When recording bulk weights on the bottom of Form 13, check ( ) whether the number is in grams or kilograms.

DOW # _____ Survey ID Page _____

Body of Water _____ (Starting Date) _____ Data Recorder _____ of _____

Species										
Gear										
<50										
50-59										
60-69										
70-79										
80-89										
90-99										
100-109										
110-119										
120-129										
130-139										
140-149										
150-159										
160-169										
170-179										
180-189										
190-199										
200-209										
210-219										
220-229										
230-239										
240-249										
250-259										
260-269										
270-279										
280-289										
290-299										
300-324										
325-349										
350-374										
375-399										
400-424										
425-449										
450-474										
475-499										
500-524										
525-549										
550-574										
575-599										
600-624										
625-649										
650-674										
675-699										
700-724										
725-749										
750-774										
775-799										

*Weigh and age (Fraser-Lee) 5 per length group <300 and 10 per length group >300 for each gear type considered.

APPENDIX 3 - TARGET SPECIES BY SAMPLING GEAR

Each sampling method is selective for the species and sizes of fish most susceptible to capture. For this reason, a variety of gears are required during most lake surveys. Occasionally, however, special sampling is needed to evaluate a specific species or lifestage. In these situations, choosing the appropriate sampling method becomes extremely important in order to maximize the amount of information collected.

The table below lists each gear type described in this manual, with both **primary** and **secondary** species (and lifestage if applicable) identified for each gear. Primary species are those most susceptible to a specific gear, while secondary species are commonly caught by that gear. For most special sampling, choose the gear type based upon the primary species of interest, unless alternative or additional information is desired or that gear cannot be used for some reason (for example, steep shoreline that is unseinable).

Gear Type	Primary Species	Secondary Species
Gill nets	Walleye Yellow perch Northern pike Catfish Bullhead Carp Trout Salmon Whitefish Cisco White sucker	Crappie Bluegill Muskie
Trap nets	Bluegill Crappie Bullhead Muskie	Northern pike Walleye Carp Catfish
Electrofishing	Largemouth bass Smallmouth bass Walleye (fing)	Walleye (adults) Northern pike Bluegill Crappie Muskie

Seines	Young-of-the-year (all species)
	Minnows
	Other non-game species

APPENDIX 4 - FISH SPECIES NAMES AND CODES

This appendix lists fish species common name, scientific name, and code. Use these codes when referencing fish species on all data Forms.

Phylogenetic Listing of Minnesota Fishes
Common and Scientific Names, Species Abbreviations
3/93

PETROMYZONTIDAE/LAMPREYS		
*Lamprey		LAM
Chestnut Lamprey	Ichthyomyzon castaneus	CHL
Silver Lamprey	Ichthyomyzon unicuspis	SIL
American Brook Lamprey	Lampetra appendix	ABL
Sea Lamprey	Petromyzon marinus	SEL
ACIPENSERIDAE/STURGEONS		
*Sturgeon		STG
Lake Sturgeon	Acipenser fulvescens	LKS
Shovelnose Sturgeon	Scaphirhynchus platorynchus	SLS
POLYODONTIDAE/PADDLEFISHES		
Paddlefish	Polyodon spathula	PAH
LEPISOSTEIDAE/GARS		
*Gar		GAR
Longnose Gar	Lepisosteus osseus	LNG
Shortnose Gar	Lepisosteus platostomus	SNG
AMIIDAE/BOWFINS		
Bowfin	Amia calva	BOF
ANGUILLIDAE/FRESHWATER EELS		
American Eel	Anguilla rostrata	AME
CLUPEIDAE/HERRINGS		
Skipjack Herring	Alosa chrysochloris	SKJ
Alewife	Alosa pseudoharengus	ALW
Gizzard Shad	Dorosoma cepedianum	GIS
HIODONTIDAE/MOONEYE		
Goldeye	Hiodon alosoides	GOE
Mooneye	Hiodon tergisus	MOE

SALMONIDAE/TROUTS

*Salmon		SAL
*Trout		TRT
Tullibee (Cisco)	Coregonus artedii	TLC
Lake Whitefish	Coregonus clupeaformis	LKW
Bloater	Coregonus hoyi	BLT
Kiyi	Coregonus kiyi	KIC
Blackfin Cisco	Coregonus nigripinnis	BFC
Shortnose Cisco	Coregonus reighardi	SNC
Shortjaw Cisco	Coregonus zenithicus	SJC
Pink Salmon	Oncorhynchus gorbuscha	PKS
Coho Salmon	Oncorhynchus kisutch	COS
Rainbow Trout	Oncorhynchus mykiss	RBT
	Fish Lake (FIL)	
	Kamloop (KAM)	
	Madison (MAD)	
	Shasta (SHA)	
	Steelhead (STT)	
	Wytheville (WYV)	
Chinook Salmon	Oncorhynchus tshawytscha	CHS
	Michigan (MIC)	
	Minnesota (MIN)	
Pygmy Whitefish	Prosopium coulteri	PGW
Round Whitefish	Prosopium cylindraceum	RDW
Atlantic Salmon	Salmo salar	ATS
	Maine (MNE)	
	Minnesota (MIN)	
Brown Trout	Salmo trutta	BNT
	Crawford (CRF)	
Brook Trout	Salvelinus fontinalis	BKT
	Owhi (OHI)	
	Temescami (TEM)	
Lake Trout	Salvelinus namaycush	LAT
	Gillis (GIL)	
	Isle Royal (IRY)	
	Michigan (MIC)	
Siscowet	Salvelinus siscowet	SCT
Splake	S. fontinalis X S. namaycush	SPT

OSMERIDAE/SMELTS

Rainbow Smelt	Osmerus mordax	RBS

UMBRIDAE/MUDMINNOWS

Central Mudminnow	Umbra limi	CNM

ESOCIDAE/PIKES

Northern Pike	Esox lucius	NOP
Muskellunge	Esox masquinongy	MUE
	Leech (LLP)	
	Leech Brood (LLB)	
	Wisconsin (WIS)	
Tiger Muskellunge	Esox lucius X E. masquinongy	TME
	Hybrid-Leech (NPL)	
	Hybrid-Wisconsin (NPW)	
	Hybrid-Iowa (NPI)	

CYPRINIDAE/CARPS and MINNOWS

*Minnows		OTM
Central Stoneroller	Campostoma anomalum	CSR
Largescale Stoneroller	Campostoma oligolepis	LSR
Goldfish	Carassius auratus	GOF
Redside Dace	Clinostomus elongatus	RSD
Lake Chub	Couesius plumbeus	LKC
Common Carp	Cyprinus carpio	CAP
Ozark Minnow	Notropis nubila	OZM
Brassy Minnow	Hybognathus hankinsoni	BRM
Silvery Minnow	Hybognathus nuchalis	SLM
Speckled Chub	Macrhybopsis aestivalis	SPC
Silver Chub	Macrhybopsis storeriana	SLC
Gravel Chub	Erimystax x-punctatus	GRC
Hornyhead Chub	Nocomis biguttatus	HHC
Golden Shiner	Notemigonus crysoleucas	GOS
*Shiners		SHI
Pallid Shiner	Notropis amnis	PLS
Pugnose Shiner	Notropis anogenus	PGS
Emerald Shiner	Notropis atherinoides	EMS
River Shiner	Notropis blennius	RVS
Common Shiner	Luxilus cornutus	CSH
Bigmouth Shiner	Notropis dorsalis	BMS
Pugnose Minnow	Notropis emiliae	PGM
Blackchin Shiner	Notropis heterodon	BCS
Blacknose Shiner	Notropis heterolepis	BNS
Spottail Shiner	Notropis hudsonius	SPO
Red Shiner	Cyprinella lutrensis	RDS
Rosyface Shiner	Notropis rubellus	RFS
Spotfin Shiner	Notropis spilopterus	SFS
Sand Shiner	Notropis stramineus	SDS
Weed Shiner	Notropis texanus	WDS
Topeka Shiner	Notropis topeka	TKS
Redfin Shiner	Lythrurus umbratilis	RES
Mimic Shiner	Notropis volucellus	MMS
Suckermouth Minnow	Phenacobius mirabilis	SKM
Northern Redbelly Dace	Phoxinus eos	NRD
Southern Redbelly Dace	Phoxinus erythrogaster	SRD
Finescale Dace	Phoxinus neogaeus	FND
Bluntnose Minnow	Pimephales notatus	BNM

Fathead Minnow	Pimephales promelas	FHM
Bullhead Minnow	Pimephales vigilax	BHM
Blacknose Dace	Rhinichthys atratulus	BND
Longnose Dace	Rhinichthys cataractae	LND
Creek Chub	Semotilus atromaculatus	CRC
Pearl Dace	Margariscus margarita	PRD
*Chub		CHU
*Dace		DAC

CATOSTOMIDAE/SUCKERS

*Carpsucker	Carpiodes sp.	CPS
River Carpsucker	Carpiodes carpio	RCS
Quillback	Carpiodes cyprinus	QBS
Highfin Carpsucker	Carpiodes velifer	HFS
*Suckers		OTS
Longnose Sucker	Catostomus catostomus	LNS
White Sucker	Catostomus commersoni	WTS
Blue Sucker	Cycleptus elongatus	BLS
Northern Hog Sucker	Hypentelium nigricans	NHS
*Buffalo	Ictiobus sp.	BUF
Smallmouth Buffalo	Ictiobus bubalus	SAB
Bigmouth Buffalo	Ictiobus cyprinellus	BIB
Spotted Sucker	Minytrema melanops	SPS
*Redhorse	Moxostoma sp.	RHS
Silver Redhorse	Moxostoma anisurum	SLR
River Redhorse	Moxostoma carinatum	RRH
Black Redhorse	Moxostoma duquesnei	BRH
Golden Redhorse	Moxostoma erythrurum	GLR
Shorthead Redhorse	Moxostoma macrolepidotum	SHR
Greater Redhorse	Moxostoma valenciennesi	GRR

ICTALURIDAE/CATFISHES

*Catfish		CAT
*Bullhead		BLH
Blue Catfish	Ictalurus furcatus	BCF
Black Bullhead	Ameiurus melas	BLB
Yellow Bullhead	Ameiurus natalis	YEB
Brown Bullhead	Ameiurus nebulosus	BRB
Channel Catfish	Ictalurus punctatus	CCF
	Lake Pepin (PEP)	
	Iowa (IOW)	
	Ohio (OHO)	
	St. Louis (STL)	
Slender Madtom	Noturus exilis	SDM
Stonecat	Noturus flavus	STC
Tadpole Madtom	Noturus gyrinus	TPM
Flathead Catfish	Pylodictis olivaris	FCF
	Illinois (ILL)	
	Lake Pepin (PEP)	

APHREDODERIDAE/PIRATE PERCHES		
Pirate Perch	Aphredoderus sayanus	PRP
PERCOPSIDAE/TROUT-PERCHES		
Trout-Perch	Percopsis omiscomaycus	TRP
GADIDAE/CODFISHES		
Burbot	Lota lota	BUB
CYPRINODONTIDAE/KILLIFISHES		
Banded Killifish	Fundulus diaphanus	BKF
Plains Topminnow	Fundulus sciadicus	PTM
ATHERINIDAE/SILVERSIDES		
Brook Silverside	Labidesthes sicculus	BKS
GASTEROSTEIDAE/STICKLEBACKS		
*Stickleback		STK
Brook Stickleback	Culaea inconstans	BST
Ninespine Stickleback	Pungitius pungitius	NST
PERCICHTHYIDAE/TEMPERATE BASSES		
White Perch	Morone americana	WHP
White Bass	Morone chyrsops	WHB
Yellow Bass	Morone mississippiensis	YLB
CENTRARCHIDAE/SUNFISHES		
Rock Bass	Ambloplites rupestris	RKB
*Sunfish	Lepomis sp.	SUN
Hybrid Sunfish	Lepomis sp.	HSF
Green Sunfish	Lepomis cyanellus	GSF
Pumpkinseed Sunfish	Lepomis gibbosus	PMK
Warmouth	Lepomis gulosus	WAM
Orangespotted Sunfish	Lepomis humilis	OSS
Bluegill	Lepomis macrochirus	BLG
Longear Sunfish	Lepomis megalotis	LES
*Bass		BAS
Smallmouth Bass	Micropterus dolomieu	SMB
Largemouth Bass	Micropterus salmoides	LMB

*Crappie		CRP
White Crappie	Pomoxis annularis	WHC
Black Crappie	Pomoxis nigromaculatus	BLC

PERCIDAE/PERCHES

*Darter		DAR
Crystal Darter	Ammocrypta asprella	CRD
Western Sand Darter	Ammocrypta clara	WSD
Mud Darter	Etheostoma asprigene	MDD
Rainbow Darter	Etheostoma caeruleum	RBD
Bluntnose Darter	Etheostoma chlorosomum	BLD
Iowa Darter	Etheostoma exile	IOD
Fantail Darter	Etheostoma flabellare	FTD
Least Darter	Etheostoma microperca	LED
Johnny Darter	Etheostoma nigrum	JND
Banded Darter	Etheostoma zonale	BDD
Yellow Perch	Perca flavescens	YEP
River Ruffe	Gymnocephalus cernuus	RIR
Logperch	Percina caprodes	LGP
Gilt Darter	Percina evides	GLD
Blackside Darter	Percina maculata	BSD
Slenderhead Darter	Percina phoxocephala	SHD
River Darter	Percina shumardi	RVD
Sauger	Stizostedion canadense	SAR
Walleye	Stizostedion vitreum	WAE

SCIAENIDAE/DRUMS

Freshwater Drum	Aplodinotus grunniens	FRD

COTTIDAE/SCULPINS

*Sculpin		SCU
Mottled Sculpin	Cottus bairdi	MTS
Slimy Sculpin	Cottus cognatus	SMS
Spoonhead Sculpin	Cottus ricei	SHS
Deepwater Sculpin	Myoxocephalus thompsoni	DWS

MISCELLANEOUS DESIGNATIONS

*Panfish	PAN
*Salmon/Trout	SAT
*Walleye/Sauger	WAS
*Walleye/Northern Pike	WNP
*Other	OTH
*No Particular Species	NPS

TURTLES

*Turtles		OTT
Snapping Turtle	Chelydra serpentina	SNT
Softshell Turtle	Amyda sp.	SST
Painted Turtle	Chrysemys bellii	PNT

SPECIAL NOTES

The following species and/or strain have been discontinued in state hatcheries:

Rainbow Trout - Donaldson (DON)
Eagle Lake (EAL)
Ennis (ENN)
Erwin (ERN)
Redband (REB)
Valley Creek (VLC)

Sockeye Salmon (Kokanee) - Oncorhynchus nerka (KOE)

Brown Trout - Plymouth Rock (PLR)

Ohrid Trout - Salmo letnica (OHR)

Brook Trout - New York (NWY)
Ontario (ONT)
Wisconsin (WIS)

Lake Trout - Jenny L. (JEL)

Brookinaw - S. fontinalis X S. namaycush (BKN)

Artic Grayling - Thymallus arcticus (ARG)

Muskellunge - Shoepac (SHP)

Tiger Muskellunge - Hybrid Shoepac (NPS)

Striped Bass - Morone saxatilis (STB)

APPENDIX 5 - AQUATIC VEGETATION SPECIES AND GROUP CODES

This appendix lists aquatic vegetation common name, scientific name, group name, and code. Use these codes when referencing aquatic vegetation on all data Forms.

CODE	COMMON NAME
SAC	Arrowhead (S.cristata)
SC	Arrowhead (S.cuneata)
SAL	Arrowhead (S.latifolia)
SP	Bayonet Grass
BC	Beggartick
PB	Berchtold's Pondweed
UI	Bladderwort (U.intermedia)
UM	Bladderwort (U.minor)
IV	Blueflag
CC	Bluejoint
PO	Bluntleaf Pondweed
AG	Bog Rosemary
MT	Buckbean
CB	Bulb-Bearing Water Hemlock
NF	Bushy Pondweed (N.flexilis)
NAG	Bushy Pondweed (N.gracillima)
EC	Canada Waterweed
PHAU	Cane
CE	Chufa Nut Grass
POR	Claspingleaf Pondweed
TL	Common Cattail
CD	Coontail
SPPE	Cord Grass
PC	Curled Pondweed
RS	Cursed Crowfoot
EM	Duck Millet
MYS	Eurasian Water Milfoil
PZ	Flatstem Pondweed
SPA	Floatingleaf Burreed
PN	Floatingleaf Pondweed
AA	Foxtail
NO	Fragrant Waterlily
POFR	Fries' Pondweed
SE	Giant Burreed
CM	Giant Water Hemlock
RM	Golden Dock
UV	Greater Bladderwort
SPP	Greater Duckweed
RUO	Great Water Dock
SPC	Greenfruited Burreed
SA	Hardstem Bulrush
ZP	Horned Pondweed
PI	Illinois Pondweed
LG	Laborador Tea
VM	Large Cranberry
PA	Largeleaf Pondweed
PV	Largesheath Pondweed
SCA	Leafy Bulrush
PF	Leafy Pondweed
CHC	Leatherleaf
LM	Lesser Duckweed
NYT	Little White Waterlily
NUM	Little Yellow Waterlily
GB	Manna Grass
HV	Marestail
CAP	Marsh Marigold
TA	Narrowleaf Cattail
PS	Narrowleaf Pondweed (P.strictifolius)
CAN	Narrow-Leaf Sedge
EA	Needlerush
MS	Northern Water Milfoil
PE	Nuttall's Pondweed
H	Mud Plantain
POC	Pickerelweed
ES	Pipewort
POF	Pondweed (P.filiformis)
POPU	Pondweed (P.pusillus)
LS	Purple Loosestrife
AS	Redtop Grass
PHA	Reed Canary Grass
GG	Reed-meadow Grass
LO	Rice Cutgrass
SCF	River Bulrush
PON	River Pondweed
PR	Robbins' Pondweed
JB	Rush (J.balticus)
JN	Rush (J.nodosus)
PP	Sago Pondweed
CA	Sedge (C.aquatilis)
CAC	Sedge (C.comosa)
SL	Skullcap
BS	American Slough Grass
PL	Smartweed (P.lapathifolium)
VO	Small Cranberry
MA	Small-leaf Milfoil
POS	Snailseed Pondweed
SV	Softstem Bulrush
NG	Southern Pondweed
ELS	Spikerush
NM	Spiny Naiad
HJ	Squirrel-tail Grass
LT	Star Duckweed
SR	Stiff Wapato
BA	Swamp Aster
POPA	Swamp Fivefinger
EF	Swamp Horsetail
AC	Sweet Flag
SCP	Threesquare
DA	Three-Way Sedge
PG	Variable Pondweed
CP	Water Arum
SS	Water Bulrush
LA	Water Horehound
MB	Water Marigold
WC	Water Meal
MYT	Water Milfoil (M.tenellum)
SIS	Water Parsnip
AT	Water Plantain
BRS	Water Shield
POA	Water Smartweed
HD	Water Star-Grass
CV	Water Starwort
POP	Whitestem Pondweed
SF	Whitetop
NT	White Waterlily
CAW	Wide-Leaf Sedge
RO	Widgeon Grass
VA	Wild Celery
ZIP	Wild Rice
EV	Wild Rye
SCC	Wool Grass
NL	Yellow Lotus
RF	Yellow Water Buttercup
NUL	Yellow Waterlily

CODE	PLANT GROUP NAME
SAS	Arrowhead/Duck Potato Group (Sagittaria spp.)
POSB	Broadleaf Pondweed Group
FA	Filamentous Algae
G	Grasses (Gramineae)
E	Love Grass - Eragrostis spp.
C	Muskgrass (Chara spp.)
POSN	Narrowleaf Pondweed Group
J	Rushes (Juncus spp.)
CYP	Sedges (Cyperaceae)
CS	Carex spp.
CY	Cyperus spp.
ELSP	Eleocharis spp. (Spikerush)
SCS	Scirpus spp. (Bulrush)
P	Smartweeds (Polygonum spp.)
N	Stonewort (Nitella spp.)
D	Water Moss (Drepanocladus spp.)
R	White Water Buttercups (Ranunculus spp.)

AQUATIC VEGETATION - CODES, SCIENTIFIC AND COMMON NAMES
(codes in alphabetic order)

CODE	SCIENTIFIC NAME	COMMON NAME
AA	Alopecurus aequalis	Foxtail
AC	Acorus Calamus	Sweet Flag
AG	Andromeda glaucophylla	Bog Rosemary
AS	Agrostis stolonifera (alba)	Redtop Grass
AT	Alisma trivale	Water Plantain
BA	Boltonia asteroides	Swamp Aster
BC	Bidens cernua	Beggartick
BS	Beckmannia syzigachne	American Slough Grass
BRS	Brasenia Schreberi	Water Shield
C	Chara spp.	Muskgrass
CA	Carex aquatilis	Sedge
CB	Cicuta bulbifera	Bulb-Bearing Water Hemlock
CC	Calamagrostis canadensis	Bluejoint
CD	Ceratophyllum demersum	Coontail
CE	Cyperus esculentus	Chufa Nut Grass
CM	Cicuta maculata	Giant Water Hemlock
CP	Calla palustris	Water Arum
CS	Carex spp.	Carex (Sedge)
CV	Callitriche verna (palustris)	Water Starwort
CY	Cyperus spp.	Cyperus (Sedge)
CAC	Carex comosa	Sedge
CAN	Carex spp.	Narrow-Leaf Sedge
CAP	Caltha palustris	Marsh Marigold
CAW	Carex spp.	Wide-Leaf Sedge
CHC	Chamaedaphne calyculata	Leatherleaf
CYP		Sedges (Cyperaceae)
D	Drepanocladus spp.	Water Moss
DA	Dulichium arundinaceum	Three-Way Sedge
E	Eragrostis spp.	Love Grass
EA	Eleocharis acicularis	Needlerush
EC	Elodea canadensis	Canada Waterweed
EF	Equisetum fluviatile	Swamp Horsetail
EM	Echinochloa muricata (pungens)	Duck Millet
ES	Eriocaulon septangulare	Pipewort
EV	Elymus virginicus	Wild Rye
ELS	Eleocharis smallii (palustris)	Spikerush
ELSP	Eleocharis spp.	Spikerush
FA		Filamentous Algae
G		Grasses (Graminae)
GB	Glyceria borealis	Manna Grass
GG	Glyceria grandis	Reed-meadow Grass
H	Heteranthera spp.	Mud Plantain
HD	Heteranthera dubia	Water Star-Grass
HJ	Hordeum jubatum	Squirrel-tail Grass
HV	Hippuris vulgaris	Marestail
IV	Iris versicolor	Blue Flag
J	Juncus spp.	Rushes
JB	Juncus balticus	Rush
JN	Juncus nodosus	Rush
LA	Lycopus americanus	Water Horehound
LG	Ledum groenlandicum	Laborador Tea
LM	Lemna minor	Lesser Duckweed
LO	Leersia oryzoides	Rice Cutgrass
LS	Lythrum salicaria	Purple Loosestrife
LT	Lemna trisulca	Star Duckweed
MA	Myriophyllum alterniflorum	Small-leaf Milfoil
MB	Megalondonta beckii	Water Marigold
MS	Myriophyllum sibiricum	Northern Water Milfoil
MT	Menyanthes trifoliata	Buckbean
MYS	Myriophyllum spicatum	Eurasian Water Milfoil
MYT	Myriophyllum tenellum	Water Milfoil
N	Nitella spp.	Stonewort
NF	Najas flexilis	Bushy Pondweed
NG	Najas guadalupensis	Southern Pondweed
NL	Nelumbo lutea	Yellow Lotus
NM	Najas marina	Spiny Naiad
NO	Nymphaea odorata	Fragrant Waterlily
NT	Nymphaea tuberosa	White Waterlily
NAG	Najas gracillima	Bushy Pondweed
NUL	Nuphar luteum (variegatum)	Yellow Waterlily
NUM	Nuphar microphyllum	Little Yellow Waterlily
NYT	Nymphaea tetragona	Little White Waterlily
P	Polygonum spp.	Smartweed
PA	Potamogeton amplifolius	Largeleaf Pondweed
PB	Potamogeton Berchtoldi	Berchtold's Pondweed
PC	Potamogeton crispus	Curled Pondweed
PE	Potamogeton epihydrus	Nuttall's Pondweed
PF	Potamogeton foliosus	Leafy Pondweed

AQUATIC VEGETATION - CODES, SCIENTIFIC AND COMMON NAME (page 2)
(codes in alphabetic order)

CODE	SCIENTIFIC NAME	COMMON NAME
PG	Potamogeton gramineus	Variable Pondweed
PI	Potamogeton Illinoensis	Illinois Pondweed
PL	Polygonum lapathifolium	Smartweed
PN	Potamogeton natans	Floatingleaf Pondweed
PO	Potamogeton obtusifolius	Bluntleaf Pondweed
PP	Potamogeton pectinatus	Sago Pondweed
PR	Potamogeton Robbinsii	Robbins' Pondweed
PS	Potamogeton strictifolius	Narrowleaf Pondweed
PV	Potamogeton vaginatus	Largesheath Pondweed
PZ	Potamogeton zosteriformis	Flatstem Pondweed
PHA	Phalaris arundinacea	Reed Canary Grass
POA	Polygonum amphibium	Water Smartweed
POC	Pontederia cordata	Pickerelweed
POF	Potamogeton filiformis	Pondweed
PON	Potamogeton nodosus	River Pondweed
POP	Potamogeton praelongus	Whitestem Pondweed
POR	Potamogeton Richardsonii	Claspingleaf Pondweed
POS	Potamogeton spirillus	Snailseed Pondweed
PHAU	Phragmites australis (communis)	Cane
POFR	Potamogeton Friesii	Fries' Pondweed
POPA	Potentilla palustris	Swamp Fivefinger
POPU	Potamogeton pusillus	Pondweed
POSB	Potamogeton spp.	Broadleaf Pondweed Group
POSN	Potamogeton spp.	Narrowleaf Pondweed Group
R	Ranunculus spp.	White Water Buttercup
RF	Ranunculus flabellaris	Yellow Water Buttercup
RM	Rumex maritimus	Golden Dock
RO	Ruppia occidentalis	Widgeon Grass
RS	Ranunculus sceleratus	Cursed Crowfoot
RUO	Rumex orbiculatus	Great Water Dock
SA	Scirpus acutus	Hardstem Bulrush
SC	Sagittaria cuneata	Arrowhead
SE	Sparganium eurycarpum	Giant Burreed
SF	Scolochloa festucacoa	Whitetop
SL	Scutellaris lateriflora	Skullcap
SP	Scirpus paludosus	Bayonet Grass
SR	Sagittaria rigida	Stiff Wapato
SS	Scirpus subterminalis	Water Bulrush
SV	Scirpus validus	Softstem Bulrush
SAL	Sagittaria latifolia	Arrowhead
SAC	Sagittaria cristata	Arrowhead
SAS	Sagittaria spp.	Arrowhead/Duck Potato Group
SCA	Scirpus atrovirens	Leafy Bulrush
SCC	Scirpus cyperinus	Wool Grass
SCF	Scirpus fluviatilis	River Bulrush
SCP	Scirpus pungens (americanus)	Threesquare
SCS	Scirpus spp.	Bulrush
SIS	Sium suave	Water Parsnip
SPA	Sparganium angustifolium (fluctuans)	Floatingleaf Burreed
SPC	Sparganium chlorocarpum	Greenfruited Burreed
SPP	Spirodela polyrhiza	Greater Duckweed
SPPE	Spartina pectinata	Cord Grass
TA	Typha angustifolia	Narrowleaf Cattail
TL	Typha latifolia	Common Cattail
UI	Utricularia intermedia	Bladderwort
UM	Utricularia minor	Bladderwort
UV	Utricularia vulgaris	Greater Bladderwort
VA	Vallisneria americana	Wild Celery
VM	Vaccinium macrocarpon	Large Cranberry
VO	Vaccinium oxycoccos	Small Cranberry
WC	Wolffia columbiana	Water Meal
ZP	Zannichellia palustris	Horned Pondweed
ZIP	Zizania palustris (aquatica)	Wild Rice

*Species names in parentheses ( ) were used in Special Pub. No. 53.

**Many of the codes used in Special Pub. No. 53 have been changed.

***Code Rules:
1. 1st letter - genus, 2nd letter - species
2. if already used, 1st and 2nd letter - genus, 3rd letter - species
3. if already used, 1st and 2nd letter - genus, 3rd and 4th letter - species
4. if already used, use any combination of 4 letters from the genus and species (2 from each) so the code is unique.

FOR PLANTS NOT LISTED, GET CODES APPROVED BY DATABASE SYSOPS.

APPENDIX 6 - SEASONAL CATCH RATE BY SPECIES, GILL AND TRAP NETS

The following figures show catch rate by season and species for gill nets and trap nets. These figures were generated from lake survey data collected since the early 1980's, and represent the average catch (statewide) for each species at specific times during the summer. This information can be used to determine the "best" sampling time for these survey methods, depending upon the target species.

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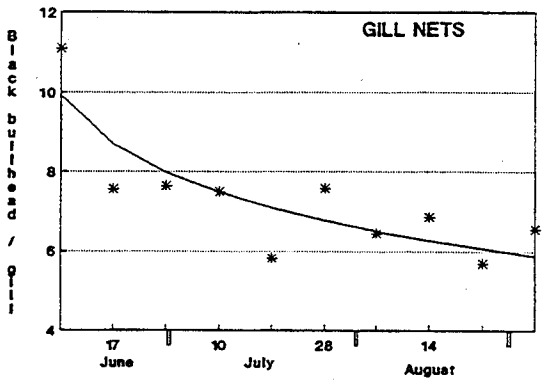

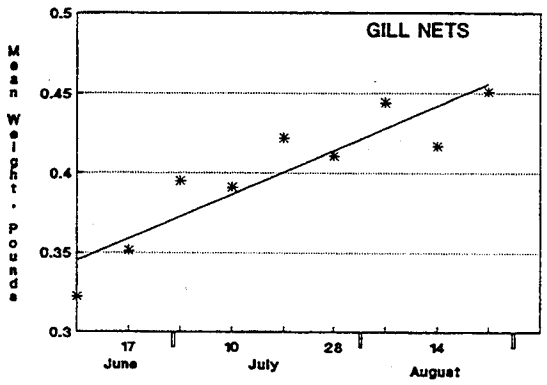

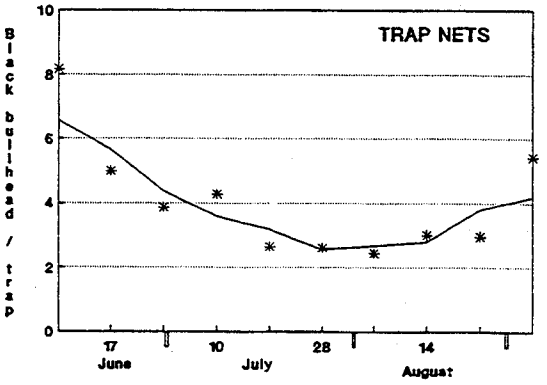

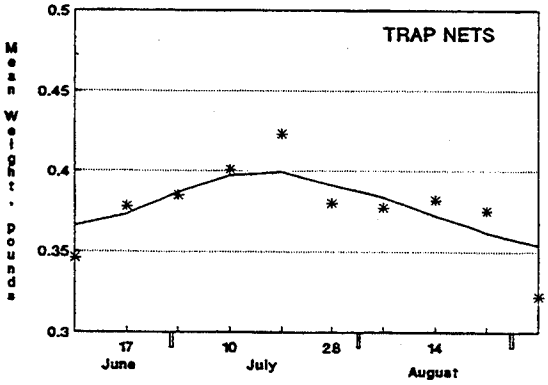

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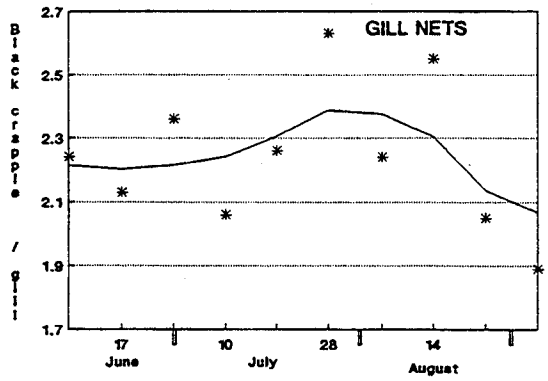
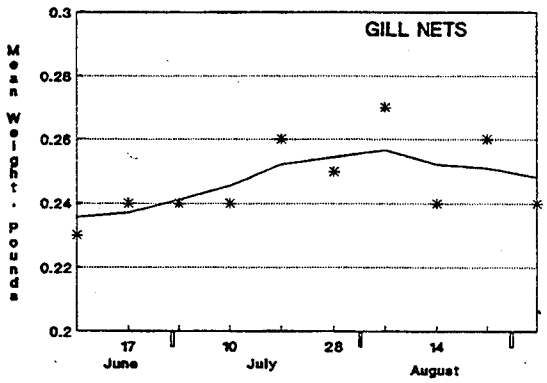
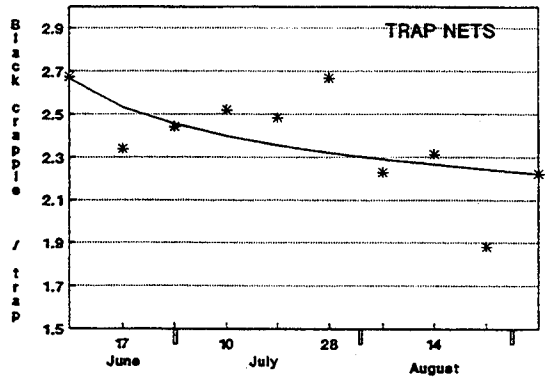
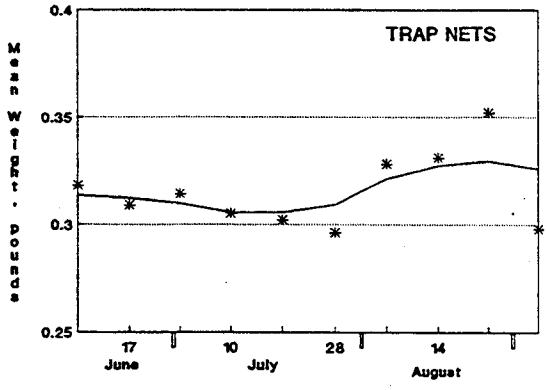
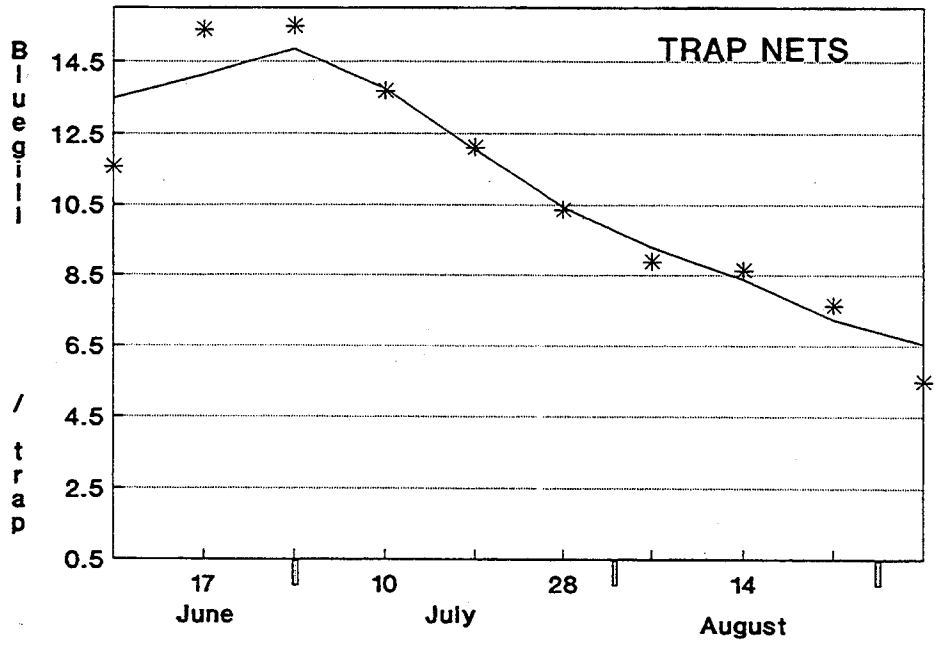


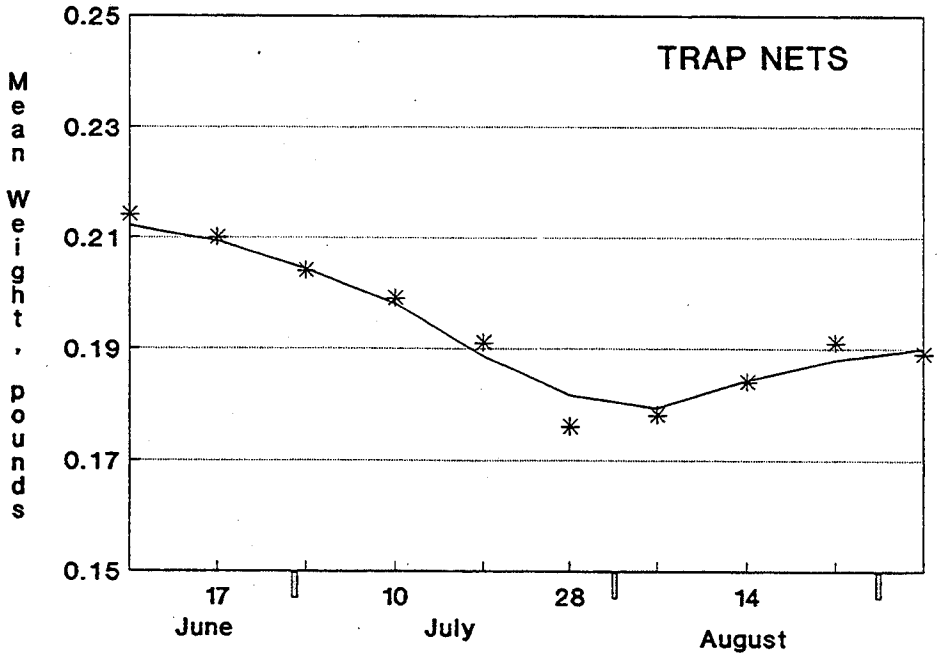




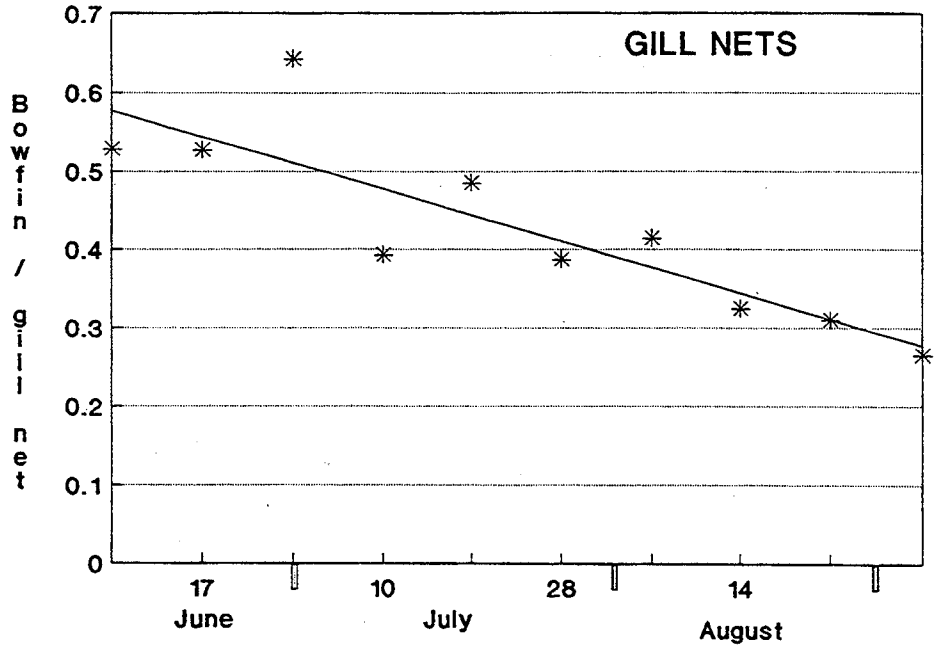


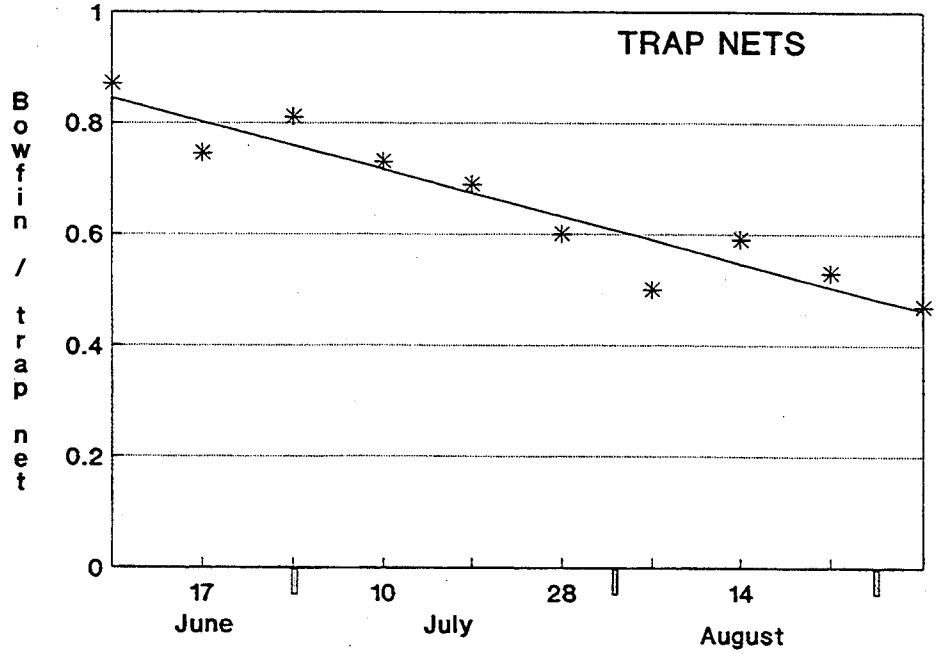
BLUEGILL


TRAP NETS
Bluegill / trap
14.5
12.5
10.5
8.5
6.5
4.5
2.5
0.5
17
June
10
July
28
14
August

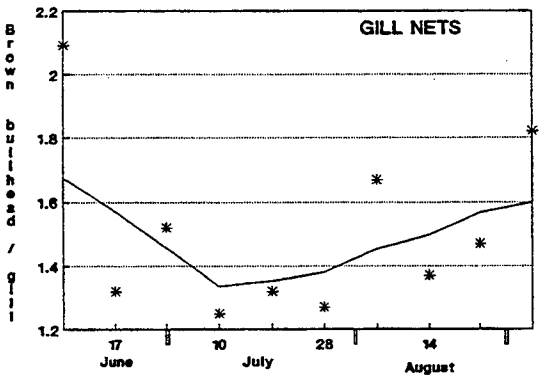

TRAP NETS
Mean Weight, pounds
0.25
0.23
0.21
0.19
0.17
0.15
17
June
10
July
28
14
August

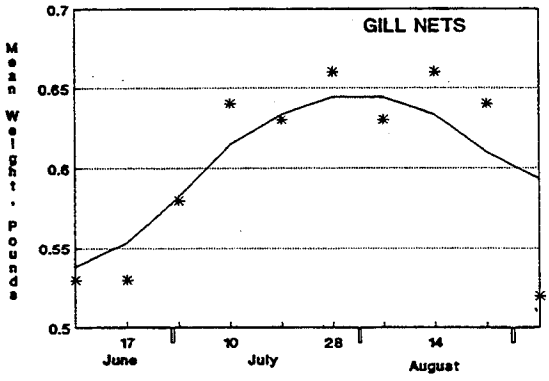
BOWFIN

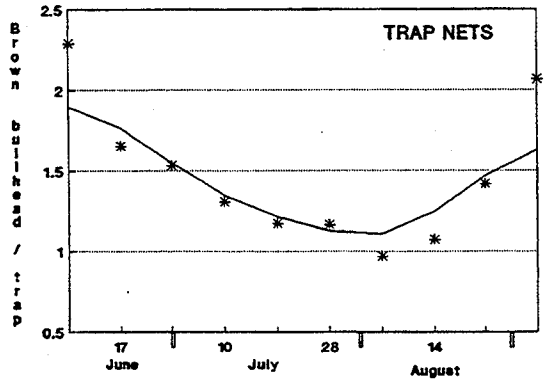

GILL NETS
Bowfin / gill net
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
17
June
10
July
28
14
August

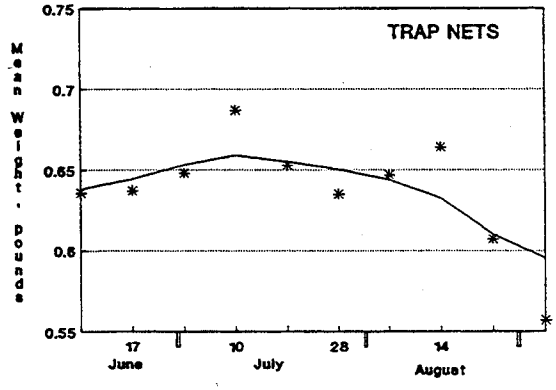

TRAP NETS
Bowfin / trap net
1
0.8
0.6
0.4
0.2
0
17
June
10
July
28
14
August

BROWN BULLHEAD

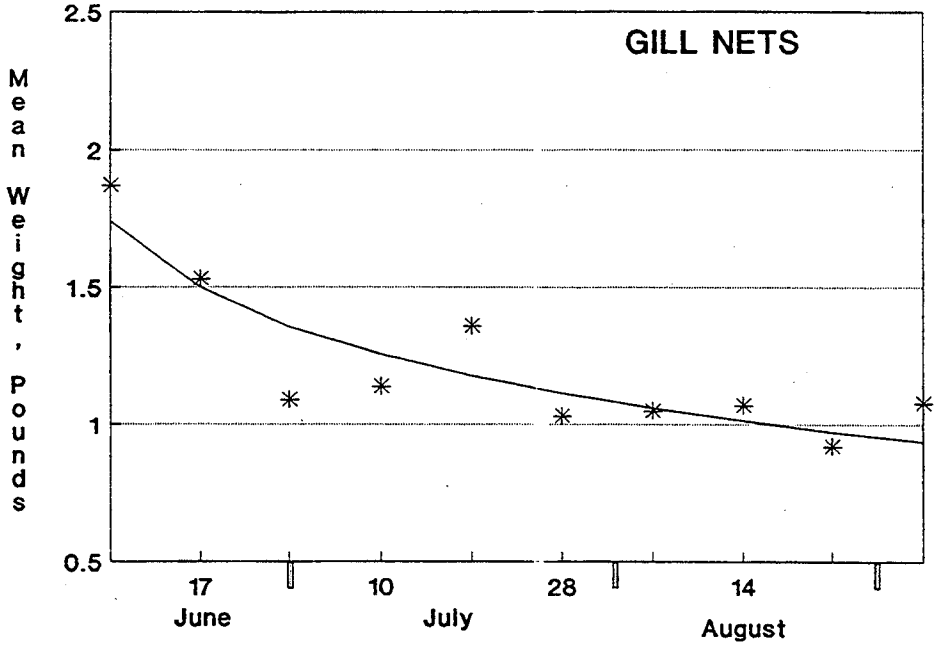


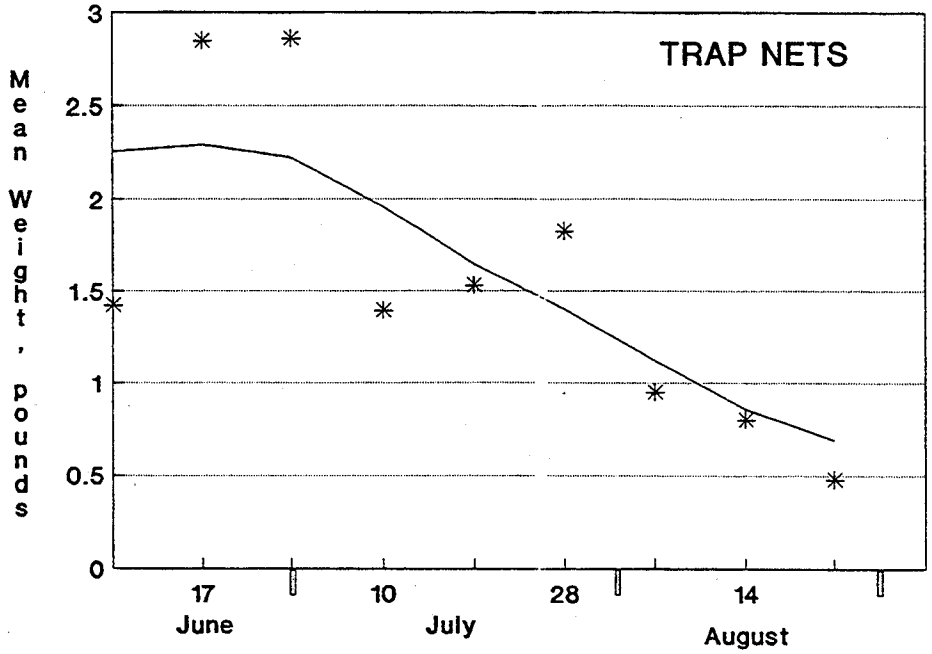




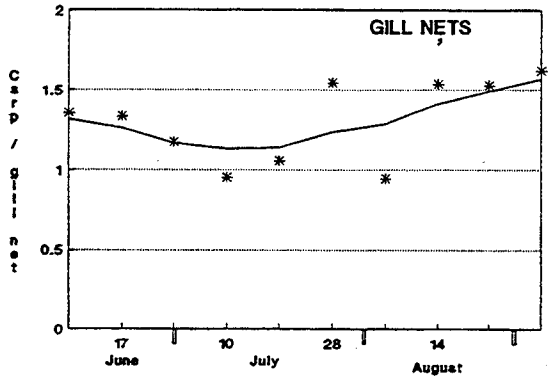


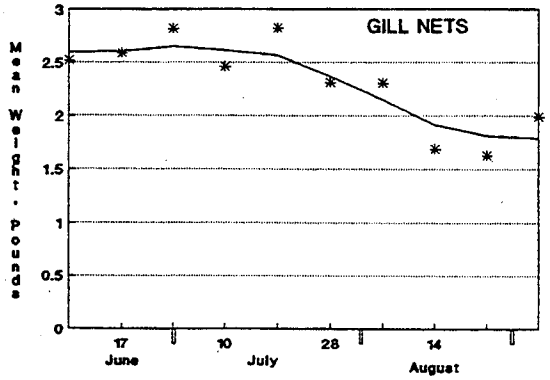
BURBOT
MEAN WEIGHT

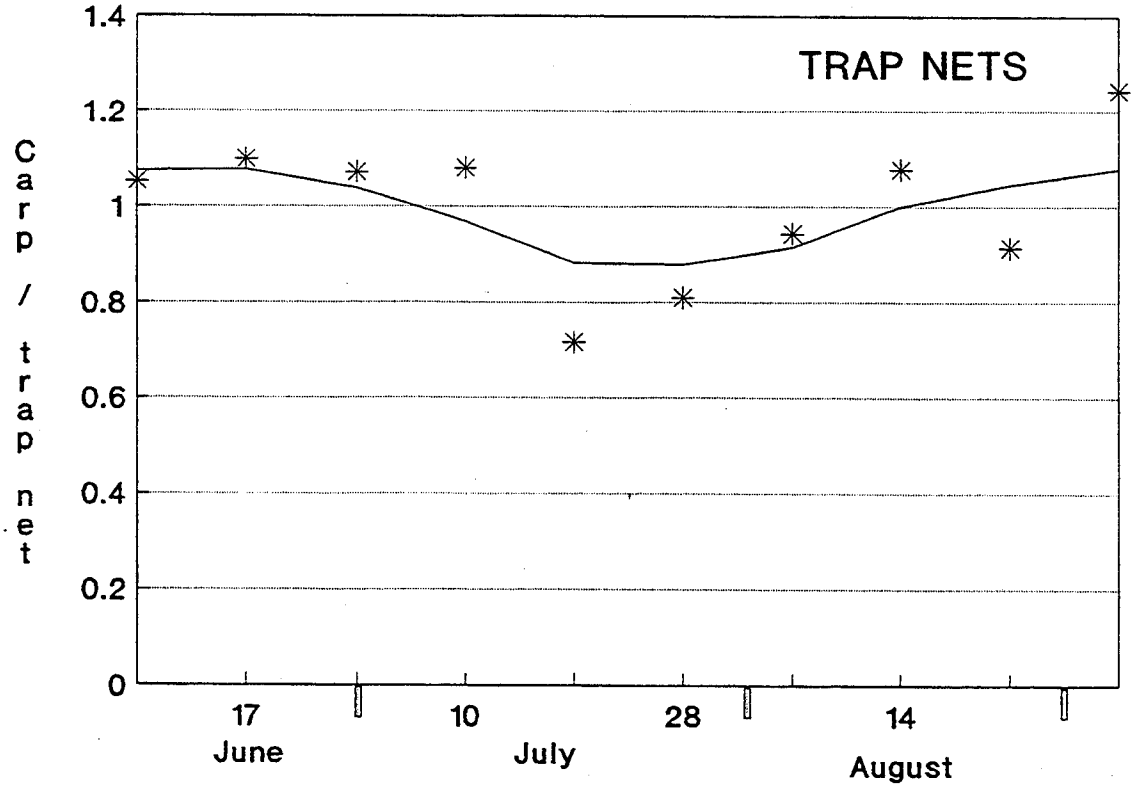




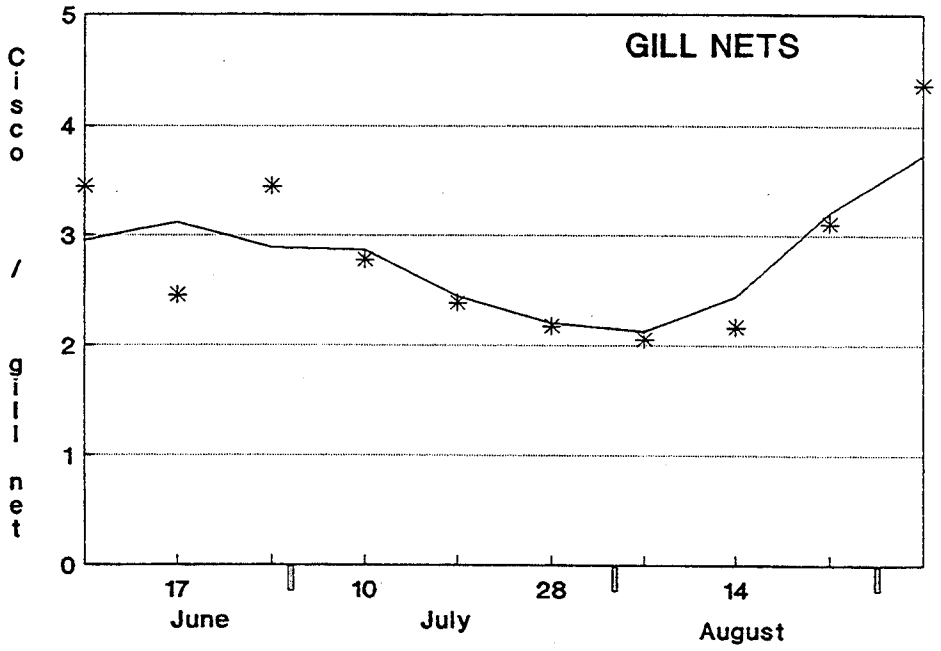
CARP

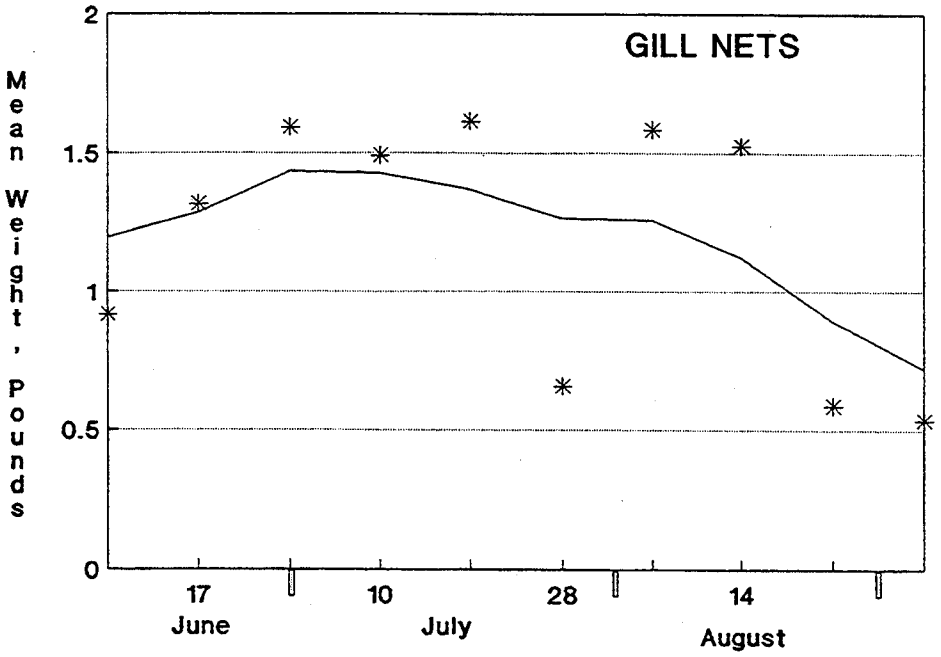

GILL NETS
Carp / gill net
2
1.5
1
0.5
0
17
June
10
July
28
14
August


GILL NETS
Mean Weight - Pounds
3
2.5
2
1.5
1
0.5
0
17
June
10
July
28
14
August

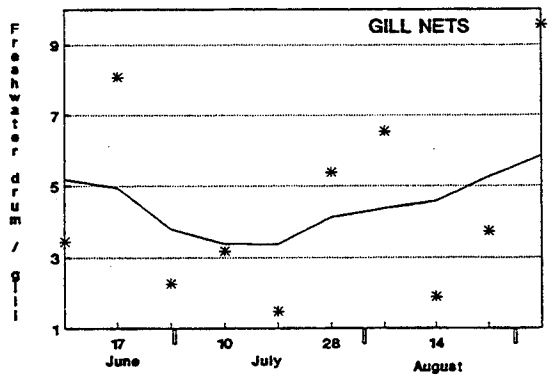

TRAP NETS
Carp / trap net
1.4
1.2
1
0.8
0.6
0.4
0.2
0
17
June
10
July
28
14
August

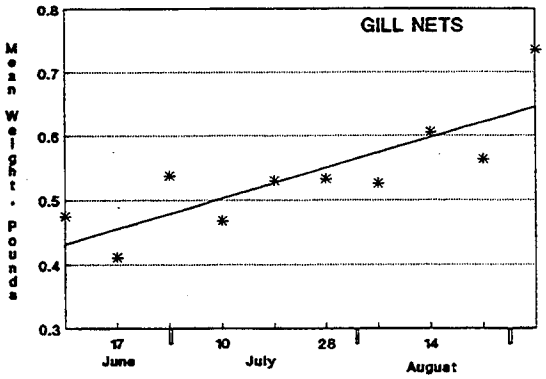
CISCO (TULLIBEE)

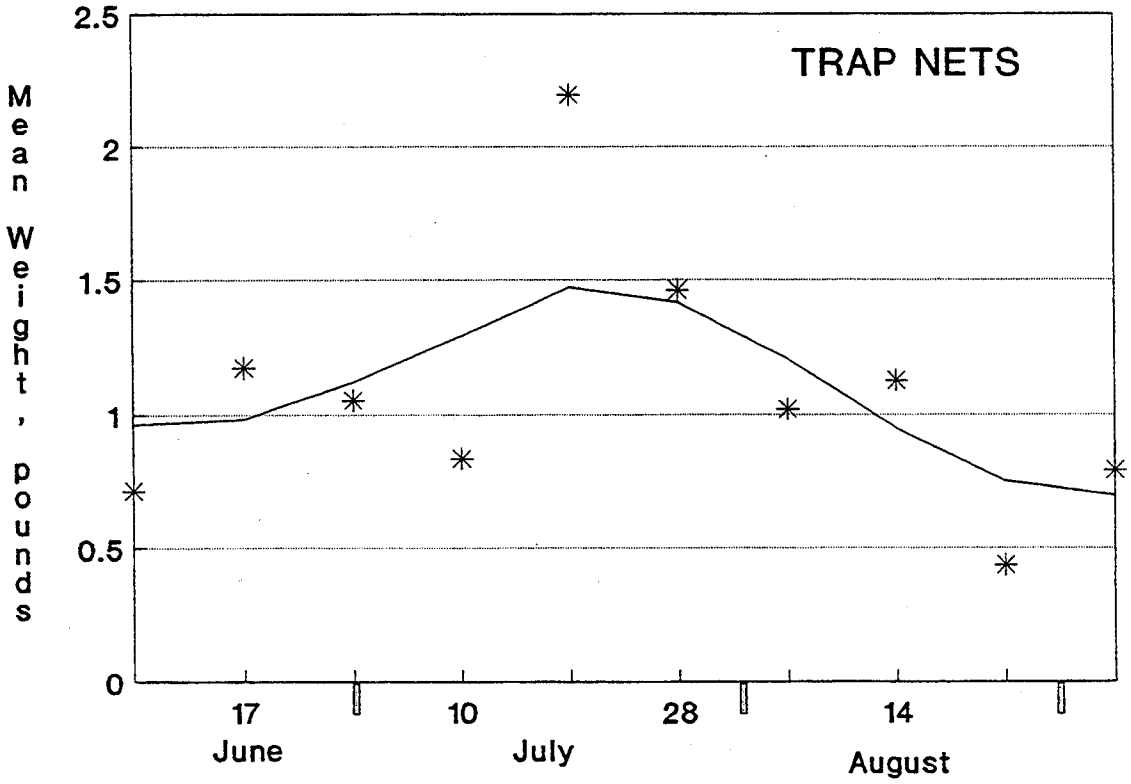




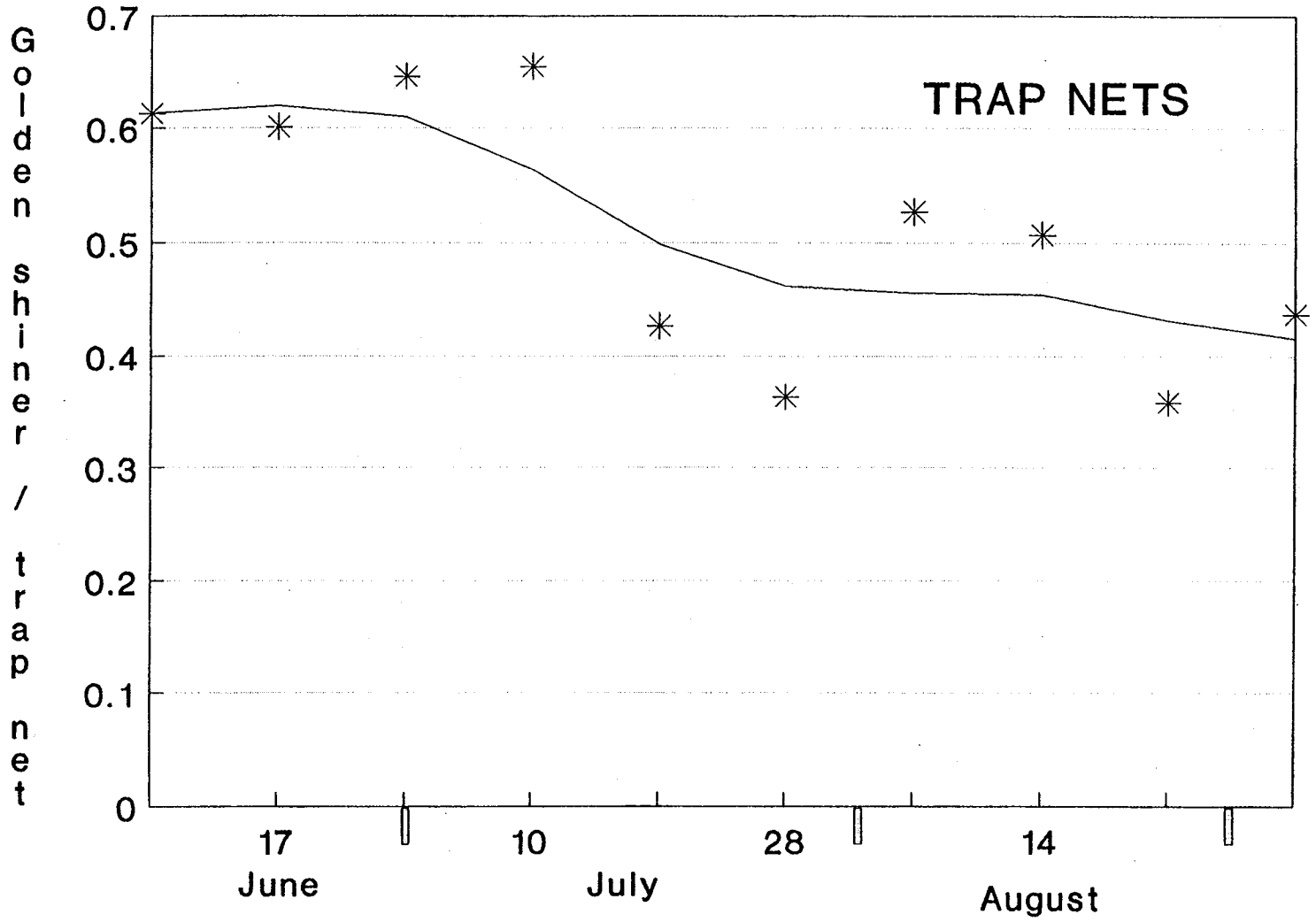
FRESHWATER DRUM



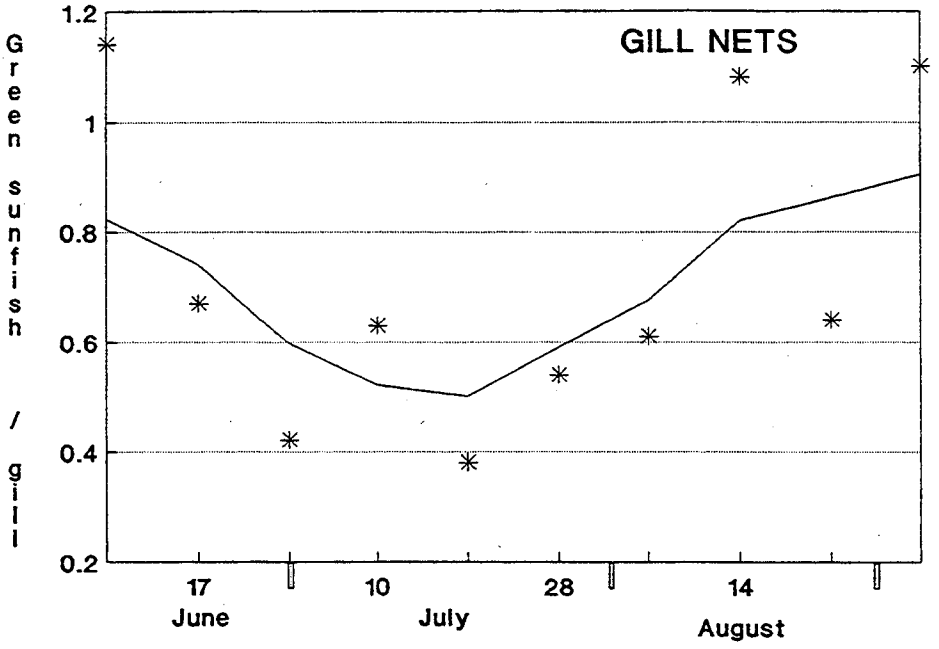


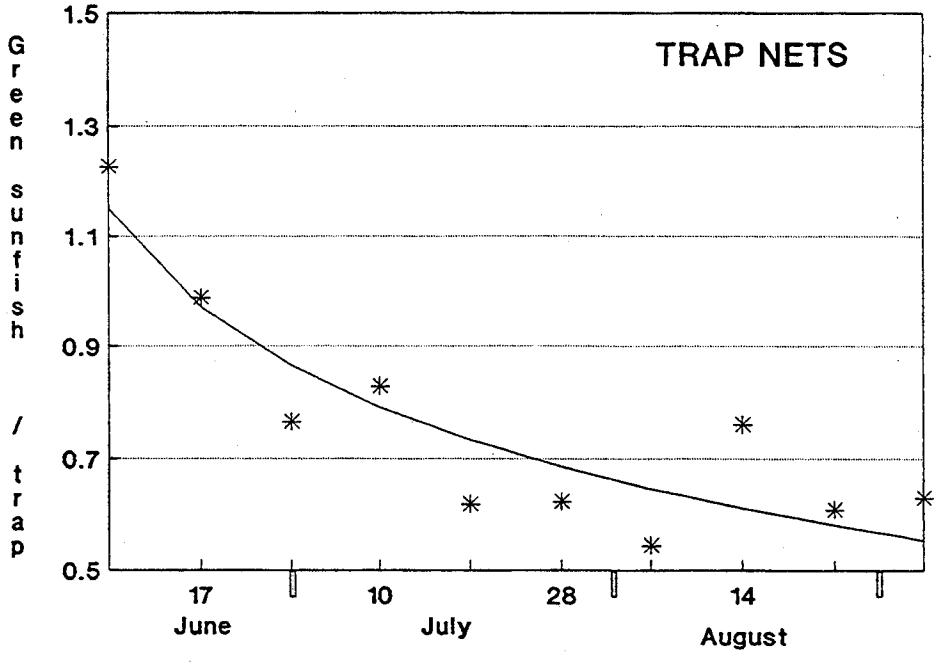


GOLDEN SHINER

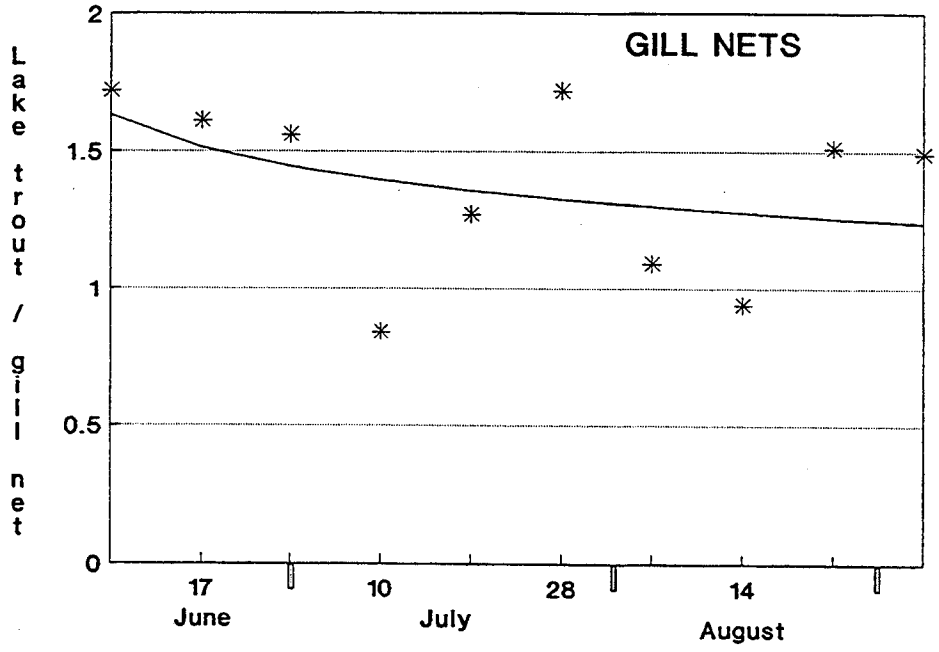


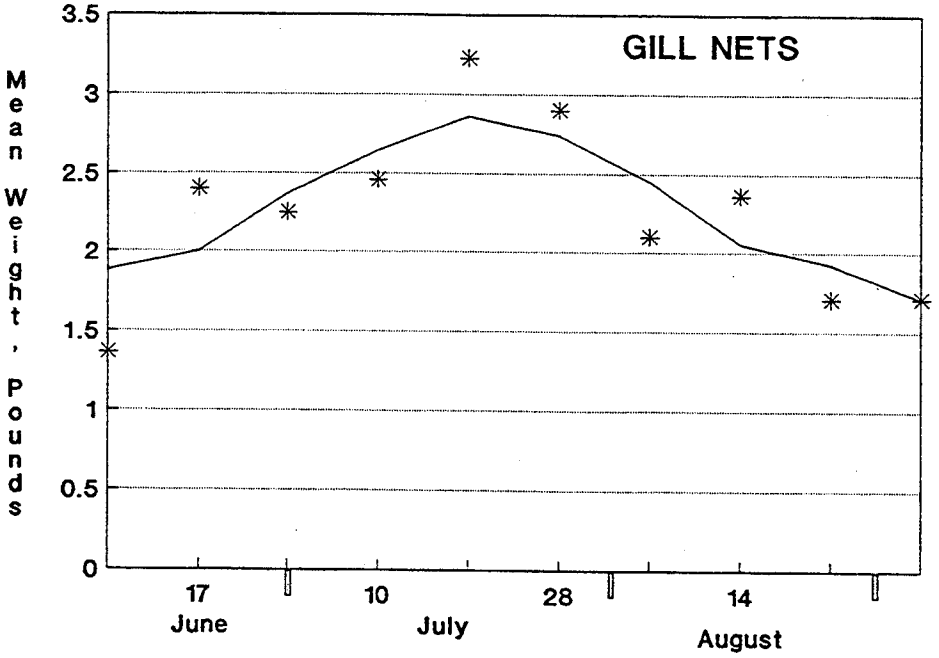
GREEN SUNFISH



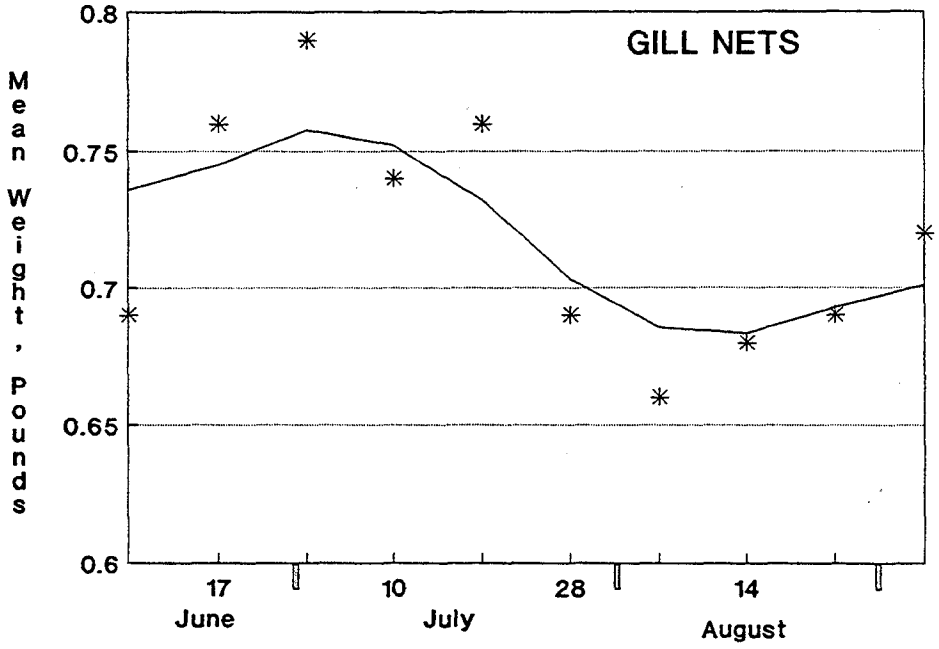


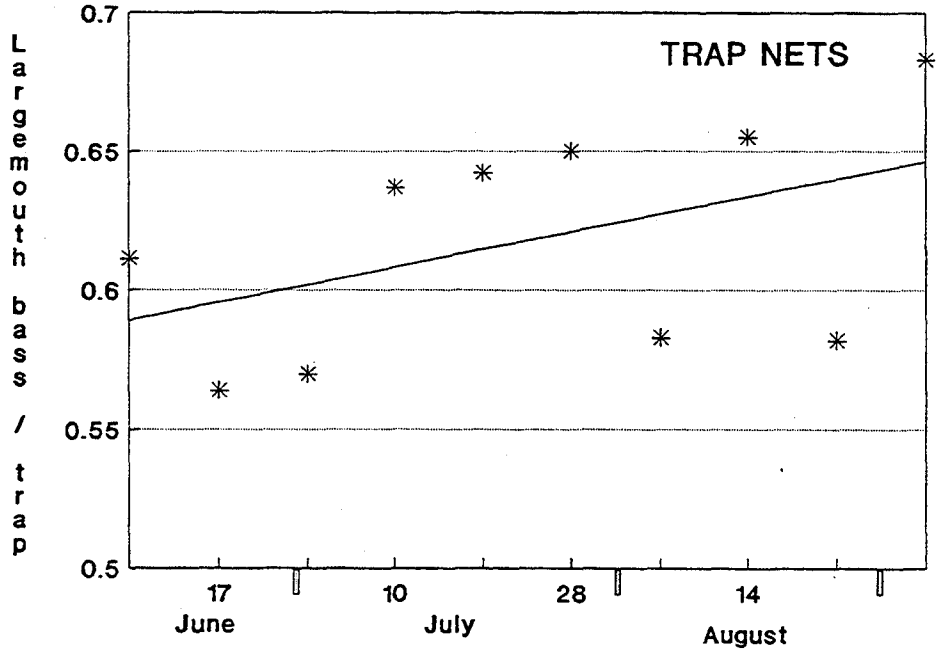
LAKE TROUT


GILL NETS
Lake trout / gill net
2
1.5
1
0.5
0
17
June
10
July
28
14
August

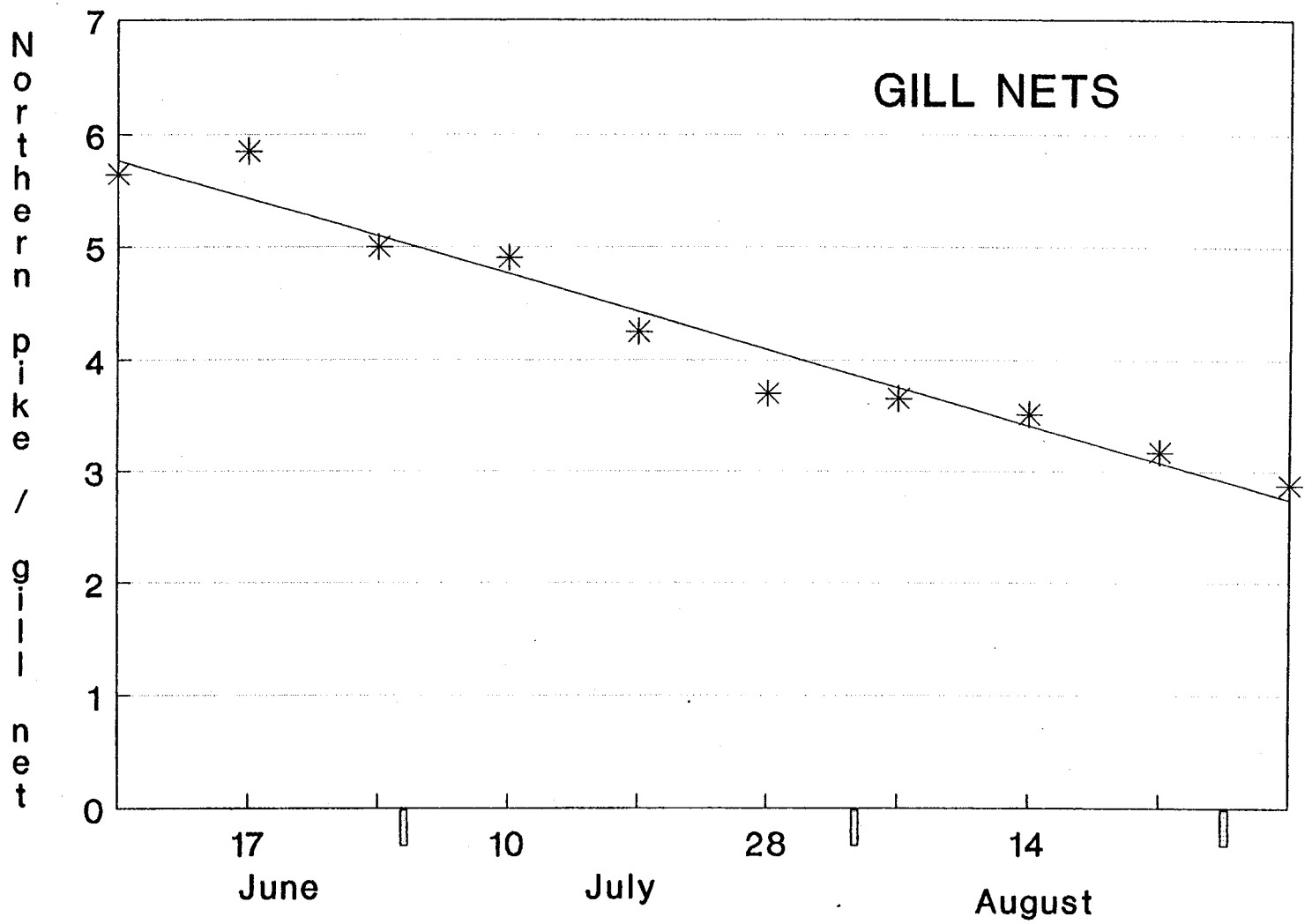

GILL NETS
Mean Weight, Pounds
3.5
3
2.5
2
1.5
1
0.5
0
17
June
10
July
28
14
August

LARGEMOUTH BASS

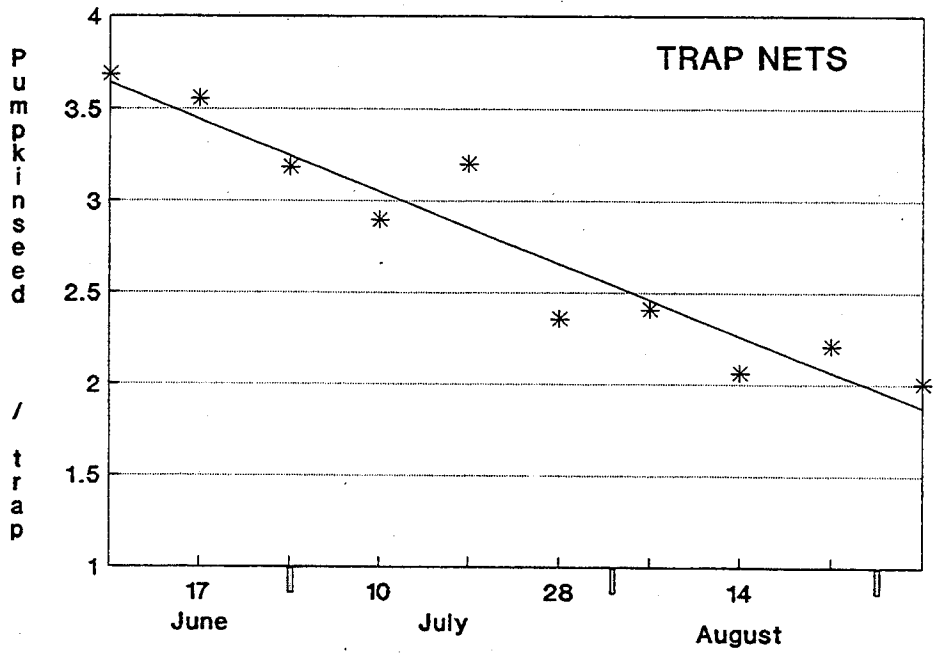


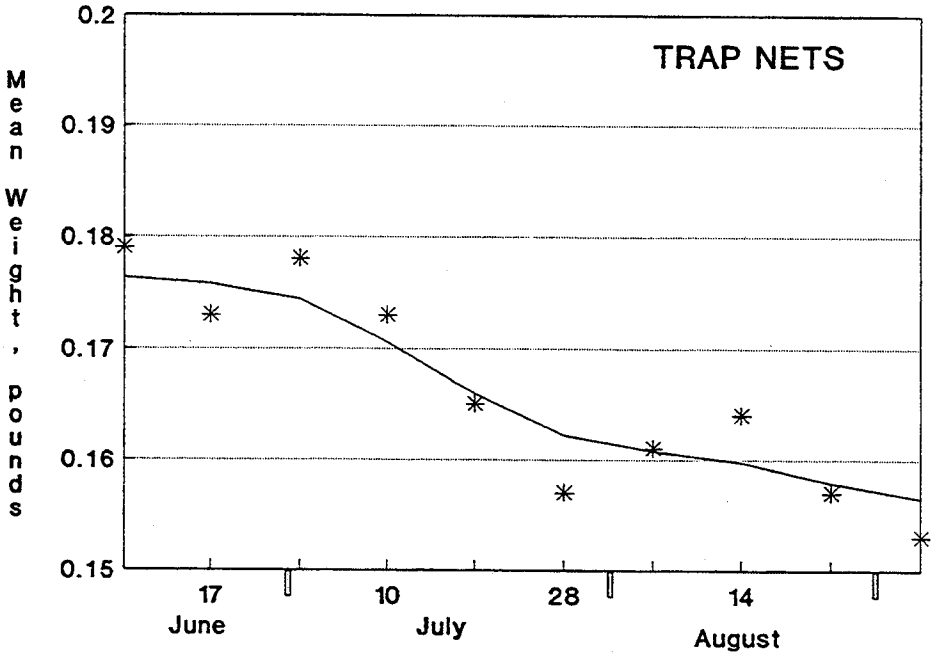


NORTHERN PIKE

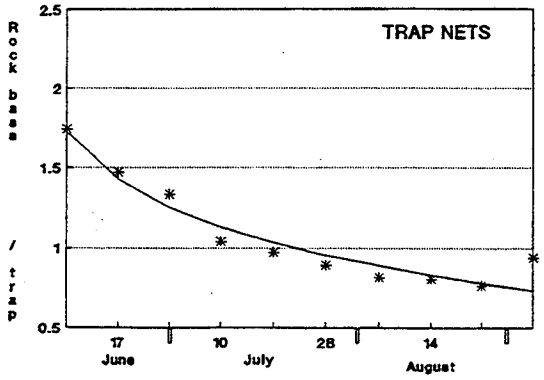


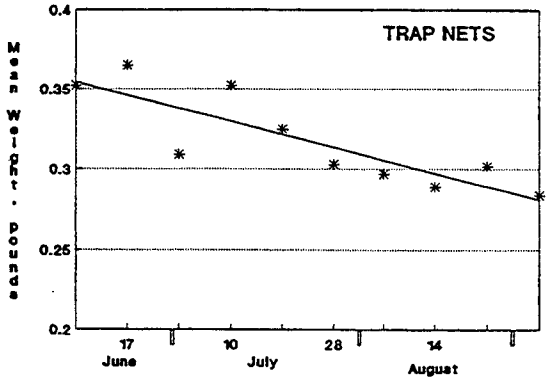
PUMPKINSEED

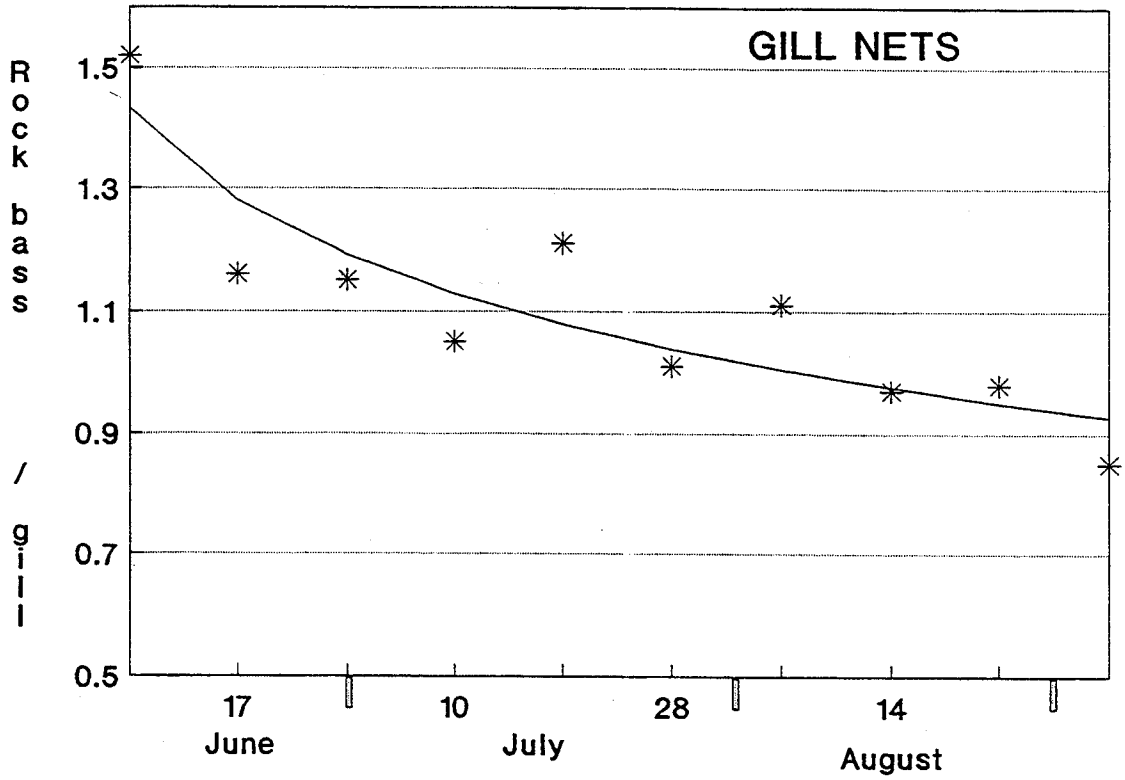




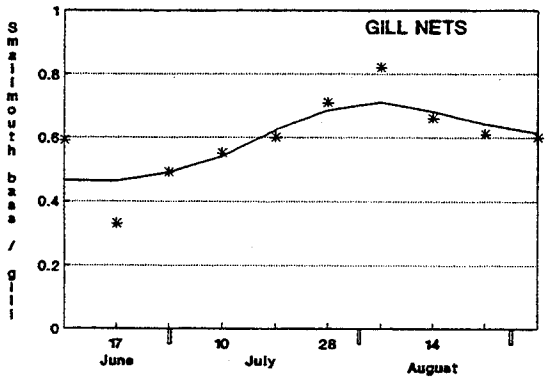
ROCK BASS

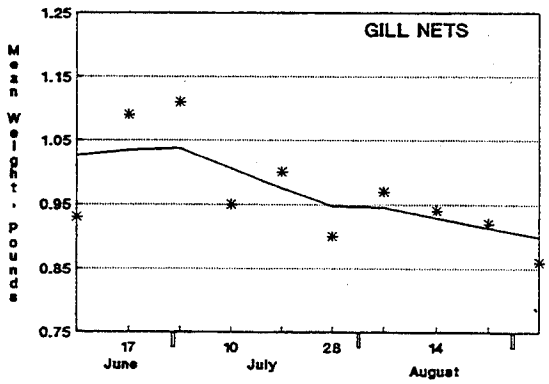

TRAP NETS
Rock bass / trap
2.5
2
1.5
1
0.5
17
June
10
July
28
14
August

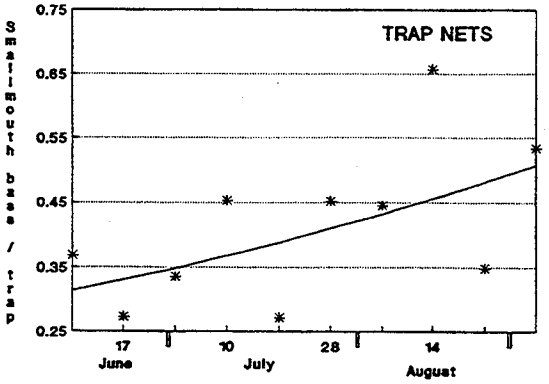

TRAP NETS
Mean Weight - pounds
0.4
0.35
0.3
0.25
0.2
17
June
10
July
28
14
August

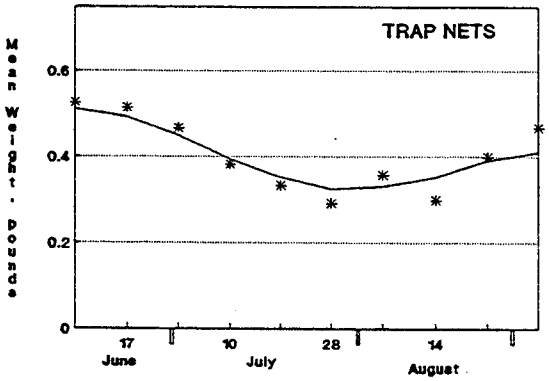

GILL NETS
Rock bass / gill
1.5
1.3
1.1
0.9
0.7
0.5
17
June
10
July
28
14
August

SMALLMOUTH BASS

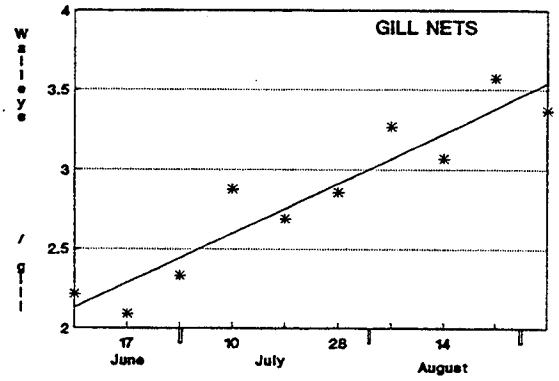


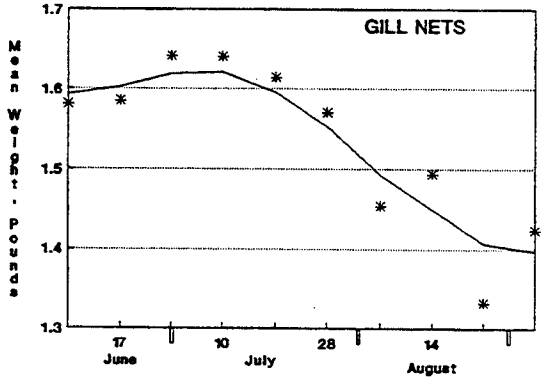


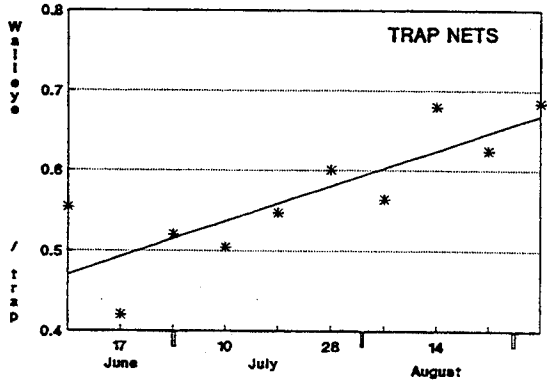


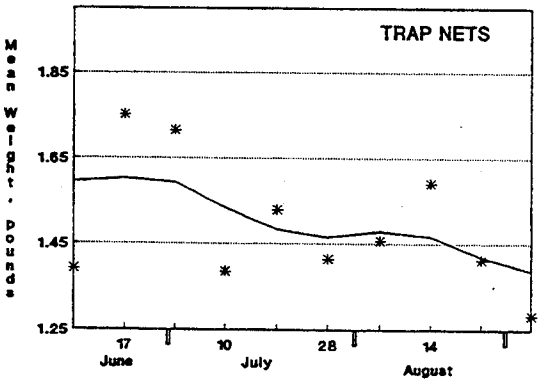


WALLEYE

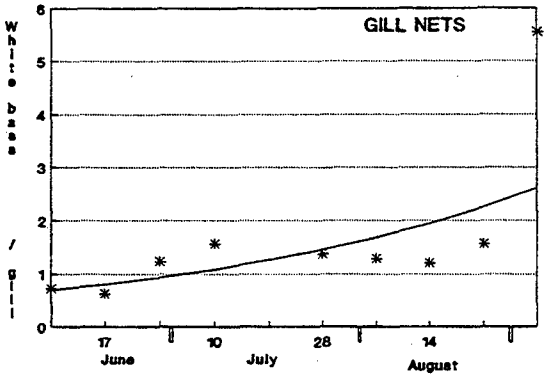

GILL NETS
Walleye / gill
4
3.5
3
2.5
2
17 June
10 July
28
14 August

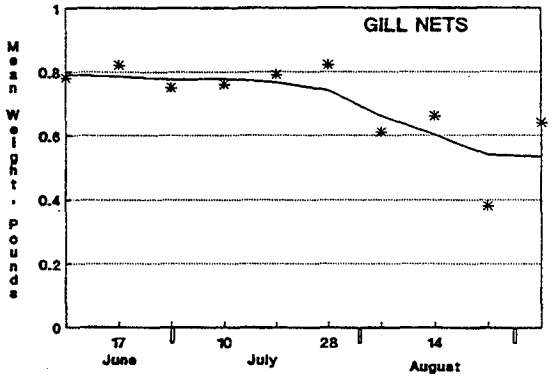

GILL NETS
Mean Weight - Pounds
1.7
1.6
1.5
1.4
1.3
17 June
10 July
28
14 August

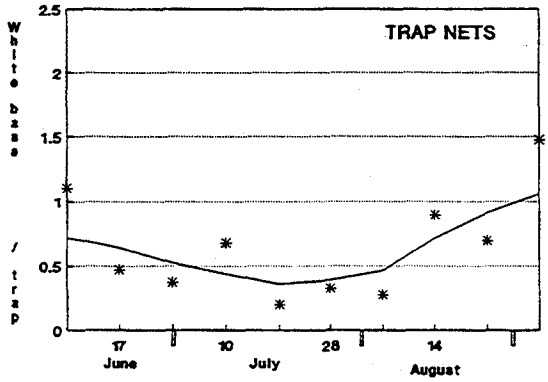

TRAP NETS
Walleye / trap
0.8
0.7
0.6
0.5
0.4
17 June
10 July
28
14 August

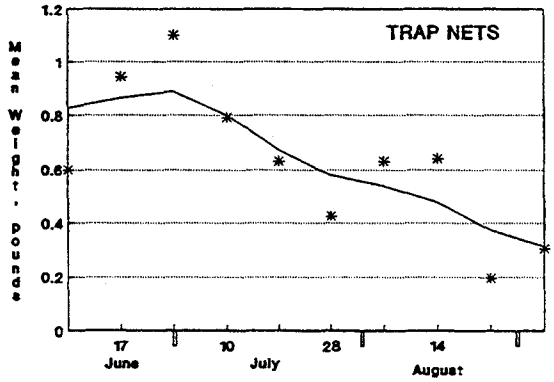

TRAP NETS
Mean Weight - Pounds
1.85
1.65
1.45
1.25
17 June
10 July
28
14 August

WHITE BASS

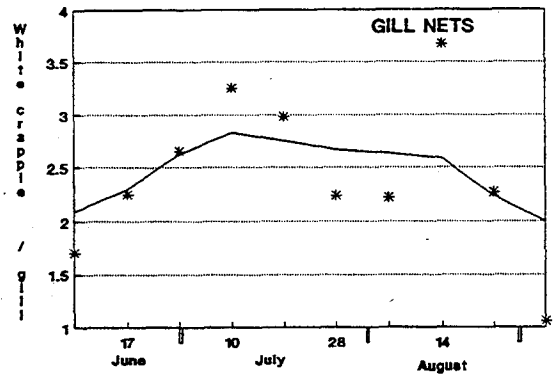

GILL NETS
White bass / gill
0
1
2
3
4
5
6
17
June
10
July
28
14
August

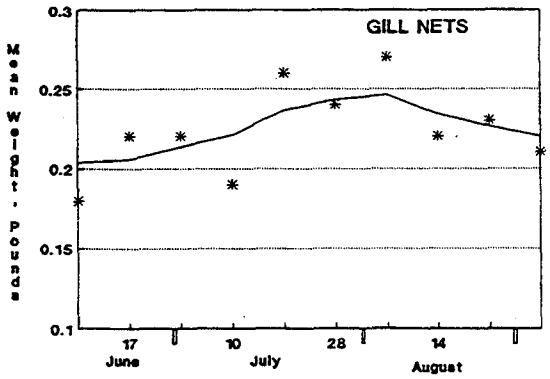

GILL NETS
Mean Weight - pounds
0
0.2
0.4
0.6
0.8
1
17
June
10
July
28
14
August

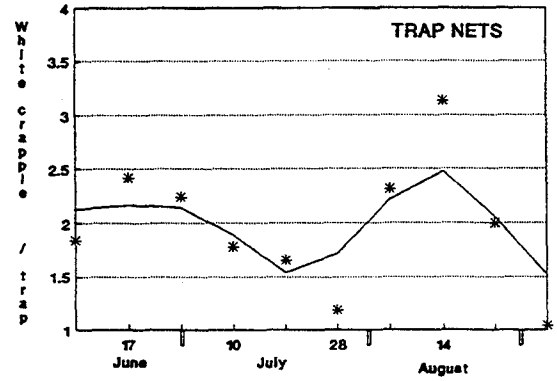

TRAP NETS
White bass / trap
0
0.5
1
1.5
2
2.5
17
June
10
July
28
14
August

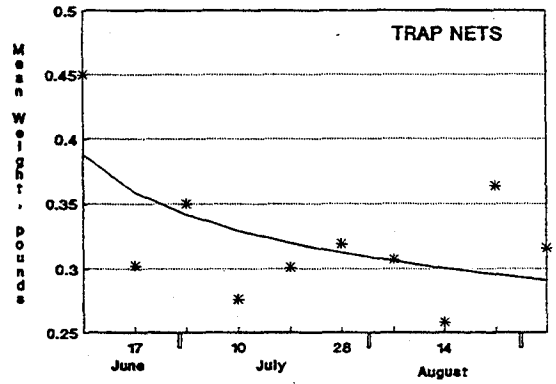

TRAP NETS
Mean Weight - pounds
0
0.2
0.4
0.6
0.8
1
1.2
17
June
10
July
28
14
August

WHITE CRAPPIE

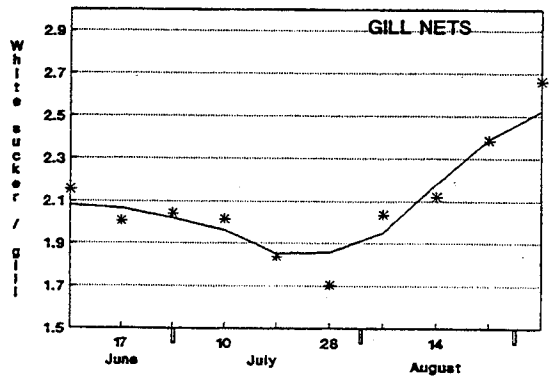


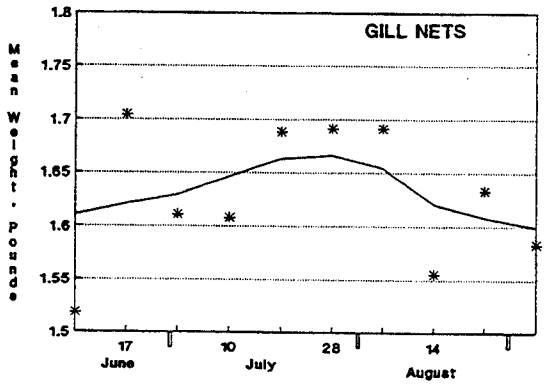


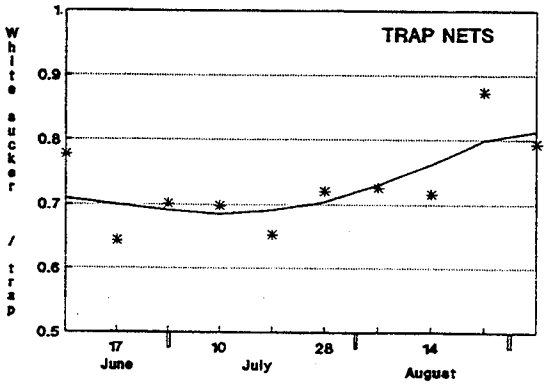


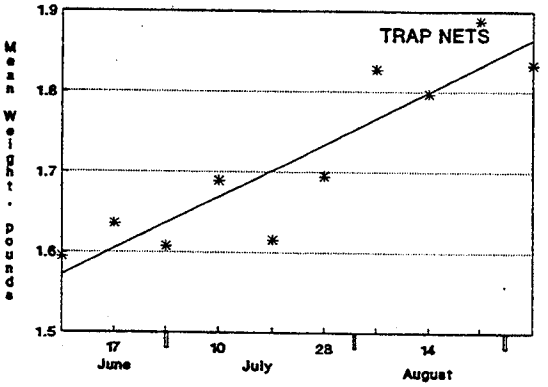


WHITE SUCKER

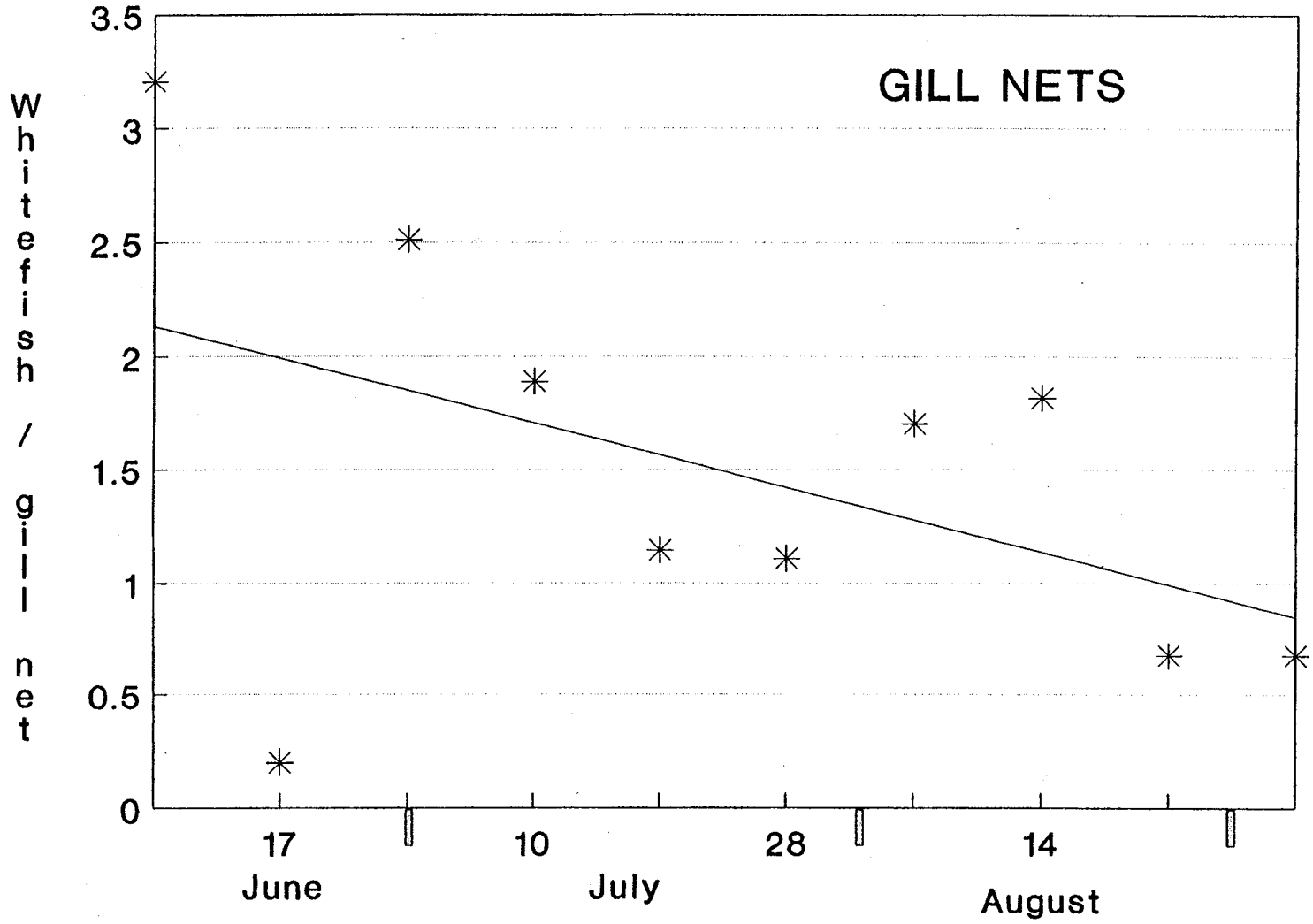




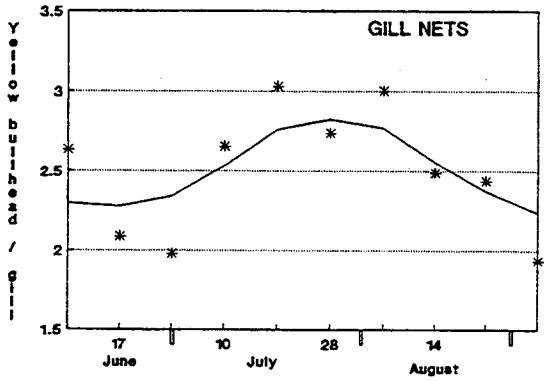


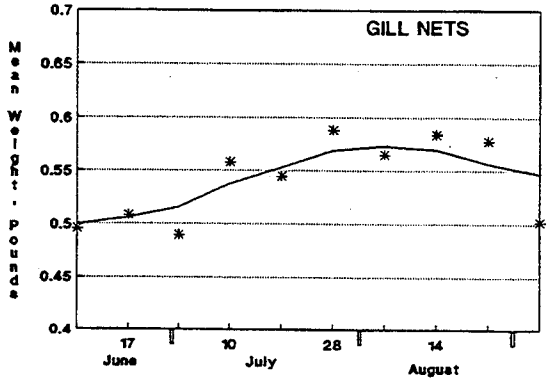


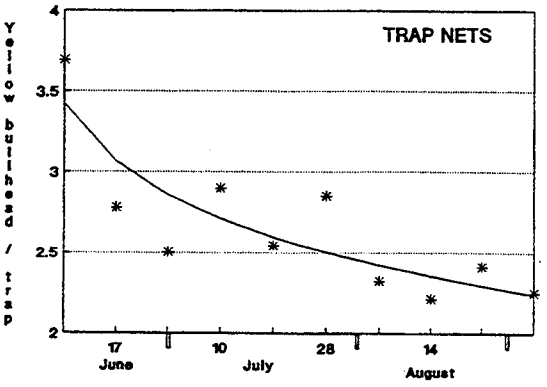
WHITEFISH

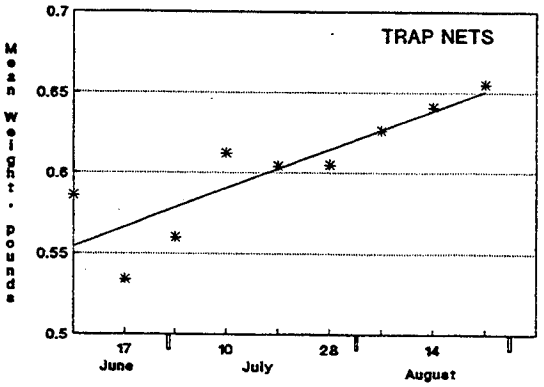

GILL NETS
Whitefish / gill net
3.5
3
2.5
2
1.5
1
0.5
0
17
June
10
July
28
14
August

YELLOW BULLHEAD

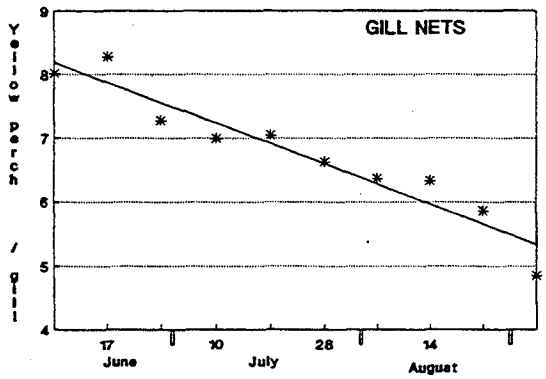


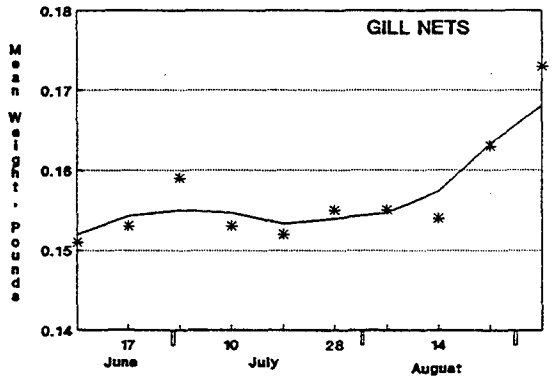


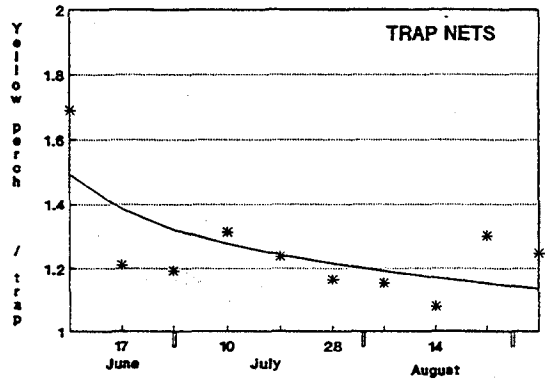


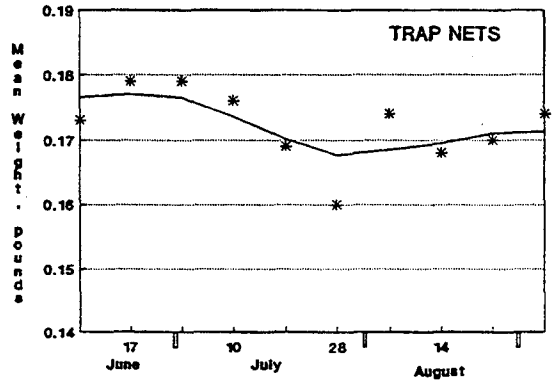


YELLOW PERCH





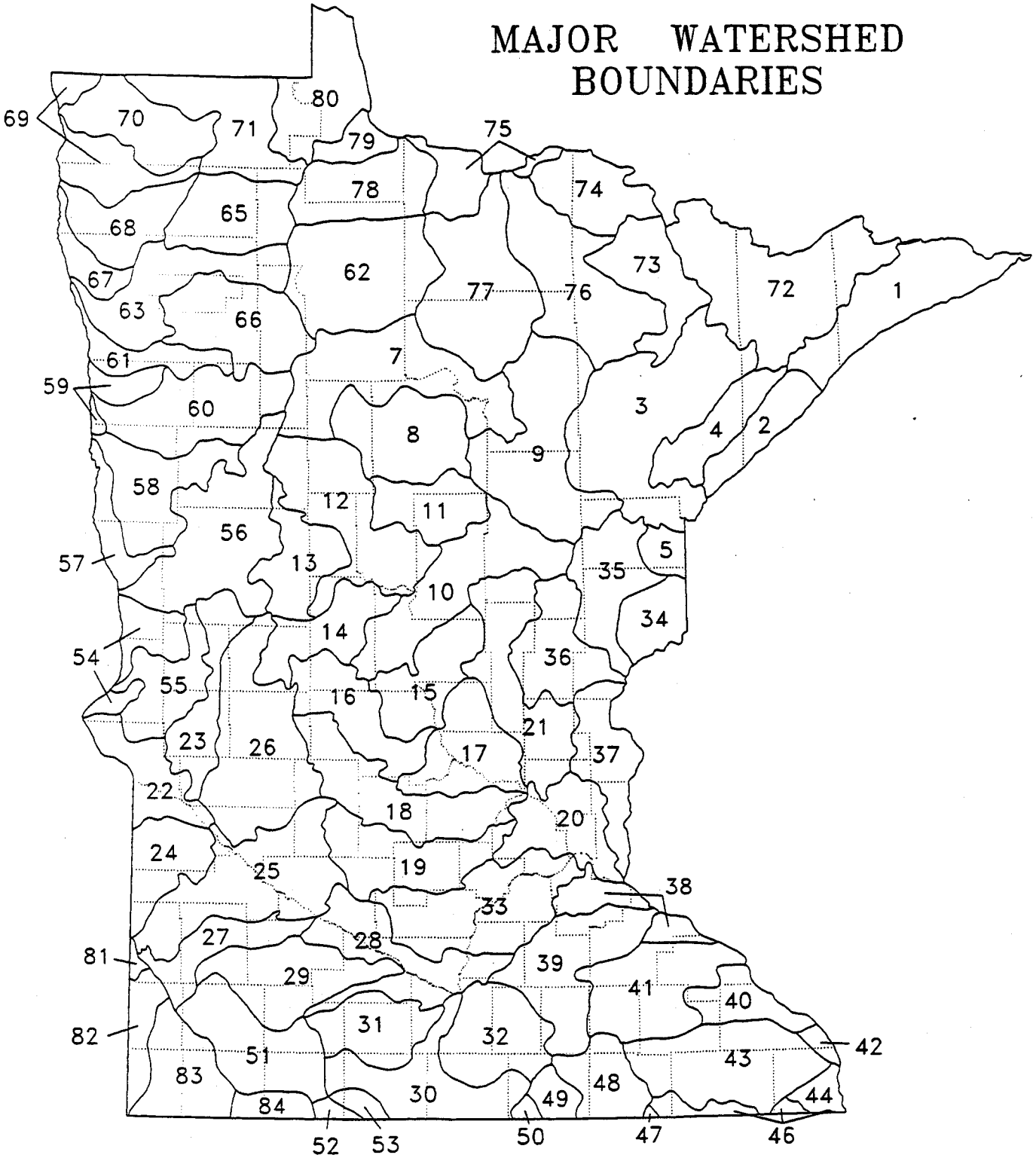




APPENDIX 7 - MAJOR WATERSHED BOUNDARIES

The following map identifies major watershed boundaries as determined by the DNR Division of Waters. More detailed information can be obtained through the Division of Waters.

MAJOR WATERSHED BOUNDARIES



MAJOR WATERSHED UNITS AND AREAS

Unit Number	Major Watershed Name
	St. Lawrence River Basin
1	Lake Superior (North)
2	Lake Superior (South)
3	St. Louis River
4	Cloquet River
5	Nemadji River
	Mississippi Basin
7	Mississippi River (Headwaters)
8	Leech Lake River (Leech Lake)
9	Mississippi River (Grand Rapids)
10	Mississippi River (Brainerd)
11	Pine River
12	Crow Wing River
13	Redeye River (Leaf River)
14	Long Prairie River
15	Mississippi River (Sartell)
16	Sauk River
17	Mississippi River (St. Cloud)
18	North Fork Crow River
19	South Fork Crow River
20	Mississippi River (Metro)
21	Rum River
22	Minnesota River (Headwaters)
23	Pomme de Terre River
24	Lac Qui Parle River
25	Minnesota River (Granite Falls)
26	Chippewa River
27	Redwood River
28	Minnesota River (Mankato)
29	Cottonwood River
30	Blue Earth River
31	Watonwan River
32	Le Sueur River
33	Minnesota River (Shakopee)
34	St. Croix River (Upper)
35	Kettle River
36	Snake River
37	St. Croix River (Stillwater)
38	Mississippi River (Red Wing and Lake Pepin)
39	Cannon River
40	Mississippi River (Winona)
41	Zumbro River
42	Mississippi River (La Crescent)
43	Root River
44	Mississippi River (Nevo)
46	Upper Iowa River
47	Wapsipinican River (Headwaters)
48	Cedar River
49	Shell Rock River
50	Winnebago River (Lime Creek)
51	West Fork Des Moines River (Headwaters)
52	West Fork Des Moines River (Lower)
53	East Fork Des Moines River
81	Big Sioux River (Medary Creek)
82	Big Sioux River (Pipestone)
83	Rock River
84	Little Sioux River
	Hudson Bay Drainage
54	Bois de Sioux River
55	Mustinka River
56	Otter Tail River
57	Red River of the North (Headwaters)
58	Buffalo River
59	Marsh River
60	Wild Rice River
61	Sandhill River
62	Upper and Lower Red Lake
63	Red Lake River
65	Thief River
66	Clearwater River
67	Grand Marais Creek (Red River of the North)
68	Snake River
69	Tamarack River (Red River of the North)
70	Two River
71	Roseau River
72	Rainy River (Headwaters)
73	Vermillion River
74	Rainy River (Rainy Lake)
75	Rainy River (Manitou)
76	Little Fork River
77	Big Fork River
78	Rapid River
79	Rainy River (Baudette)
80	Lake of the Woods

INTRODUCTION TO COMMON FISH DISEASES

Fishing is a very popular outdoor activity in Minnesota and many fishermen are interested in the welfare of the fish. Consequently, the fish they catch are often scrutinized for anything unusual, and fishery biologists and fish pathologists are questioned for identification of these conditions. Because fish, like humans are attacked by a wide variety of parasites, bacteria, viruses and anomalies , many inquiries are received every year.

The specific identity of many parasites, bacterial and viral diseases, and tumors can only be accomplished through complex laboratory techniques. Any unusual specimens not described should be forwarded to the pathology laboratory. Live specimens are most desirable, but fresh refrigerated, or iced material is good, although material preserved in 10% neutral buffered formalin is also suitable. If there is any question about the method of preservation , the pathology lab should be contacted.

Fish are no different than other animals where disease is concerned. A healthy animal is more resistant to disease than a weak animal, or an animal under stress. Fish respond physiologically to environmental change. A fishes body temperature changes with water temperature. Metabolism also changes with water temperature. If the temperature changes very rapidly, physiological processes are drastically altered, sometimes causing death. Such things as low oxygen, excess silting, lightning, excessive current, supersaturation of water by gases and all kinds of pollutants exert stresses on fish. If fish are not damaged directly by these things, they may be weakened, their resistance lowered, and their vulnerability to disease caused by parasites, bacteria and viruses increase.

Common terminology used to describe various stages in the life cycle of parasites and pathological conditions are defined below:

1. Parasite: An organism which lives in or on another organism (host) and which depends on the host for its food, has a higher reproductive potential than the host, and is suspected of harming the host when present in large numbers.

2. Host: An animal or plant which harbors or nourishes another organism.

3. Accidental host: The host in which a parasite of another animal will live for a variable length of time.

4. Definitive host: The host in which a parasite passes its adult or sexual existence.

5. Intermediate host: A host in which a parasite passes a larval or non-sexual existence.

6. Cercaria: Larval trematode form which produces rediae or sporocysts in infected snails.

7. Metacercaria: Larval stage of trematodes between cercarial and adult stage, a more or less quiescent stage. The larval stage of flukes which follows the cercarial stage.

8. Pleurocercoid: Larval stage of cestodes.

9. Cestode: Girdle-form. Tapeworms.

10. Trematode: The flukes. Monogenea: ectoparasitic in general, one host; Digenea: endoparasitic in general,two hosts or more.

11. Nematode: A diverse phylum of round worms, many of which are plant or animal parasites.

12. Lesion: Any visible alteration in the normal structure of organs, tissues or cells.

13. Stress: A state manifested by a syndrome or bodily change caused by some force, condition, or circumstance in or on an organism or on one of its physiological or anatomical systems. Any condition which forces an organism to expend more energy to maintain homeostasis.

14. Infection: The introduction or reentry of a pathogen or parasite into a host, resulting in the presence of the pathogen or parasite within the body, tissues, or cells of the host, whether or not this results in overt disease.

15. Disease: A morbid process or condition of the body or its parts, having a characteristic train of signs that distinguishes it from other morbid processor conditions and from the normal state. Any state which results in a gradual degeneration of homeostasis.

Anchor Worm

The genus Lernea contains species of copepods parasitic on fish. Identification of Lernea is based on the morphology of the adult female which is seen protruding from the skin of the host. Lernea is a long slender copepod which , when attached , gives the appearance of a soft stock with two egg sacs attached. Actually, the head-end is buried in the flesh. This end has large, leathery horns which aid in the identification of the parasite.

Lernea eggs hatch in 1 to 3 days, releasing larvae which are free swimming. The larvae pass through five successive stages before the female attaches to a fish, where they penetrate the skin and attain a permanently fixed position. Then they increase in length up to 3/4 of an inch, and develop the embedding anchors. After reaching adulthood, egg sacs and eggs are formed completing the life cycle.

Argulus (Fish Lice)

Argulus sp. have been given the common name fish lice as they have the ability to creep about over the surface of the fish. These are large copepods and consequently, they are conspicuous objects on the fish they inhabit. At first glance they look like a scale but on closer examination are seen to be saucer-shaped and flattened against the side of the fish. They have jointed legs and two large sucking discs for attachment which may give them the appearance of having large eyes. Argulids penetrate the skin of the host fish, inject a cytolytic substance, and feed on blood. Lice prefer those parts of the skin best supplied with blood vessels like the mouth region, the operculum and the base of fins.

Ergasilus

Ergasilus is a small, cyclops -like gill parasite which is found attached to the gills of a wide variety of fish species by means of clasper-like claws. These copepods appear as small, elongated white spots on the gills of fish. Impregnated females are the only Ergasilids found on fish and they produce eggs at intervals of 3-12 days depending upon the temperature and species of parasite. Up to 1 million eggs may be produced during the 1 year life span of the female. Eggs hatch in 2-4 days and another 10-70 days

is required for the copepod to reach sexual maturity.

Proteocephalus (Bass Tapeworm)

Several species of Proteocephalus may be found in a wide variety of fresh water fish species. This tapeworm has been given the common name of the bass tapeworm as Proteocephalus ambloplitis is commonly found in the adult stage in the intestine of both largemouth and smallmouth black bass. The pleurocercoid larvae, however, are found in the body cavity and internal organs of many species of fish, especially rock, large and smallmouth bass in many lakes and streams. It is the larval plerocercoid stage which is most often seen, and which causes damage to fish. The pleurocercoids develop in the body cavity and internal organs, especially the liver and ovaries. Because they do not encyst, but continue to move around, they destroy tissue and cause multiple tiny hemorrhages. This may produce adhesions and a brown color in the body cavity. Heavy ovarian infestation may cause sterility.

The life cycle of this tapeworm involves a larger bass eating a smaller fish (intermediate host) infested with pleurocercoids. Research has shown that the pleurocercoid may also migrate from the body cavity directly into the gut, thus omitting the intermediate host stage. These larval tapeworms attach to the intestinal wall of the larger fish and grow to maturity. Eggs produced by the adult worm pass into the water where they are fed upon by copepods and amphipods. Inside these invertebrate hosts a larval form emerges from the egg, penetrates into the crustacean's body cavity, and develops into a pleurocercoid. When an infested crustacean is ingested by a small fish, the pleurocercoid emerges, burrows through the intestinal wall of the fish, and migrates into visceral organs where it may cause extensive damage as a pleurocercoid. The pleurocercoid may live several months in the internal organs of a fish.

The bass tapeworm will not infest humans.

Bladder Worm

This roundworm is a common parasite of trout, salmon, smelt, and whitefish. As an adult the worm is found in the swim bladder of the above fishes. These worms belong to the genus Cystidicola.

The adult worms found in the swim bladder of fish are from 1 to 2 inches in length, and usually a translucent white in color. They produce eggs which eventually reach water and are ingested by crustacea. Here the juvenile worms develop to a stage infective to fish. When infested crustacea are eaten by a suitable fish, the larval nematodes are freed and migrate to the swim bladder. Here, they grow, mature, and produce eggs thus completing the life cycle. It seems probable that larger fish, such as lake trout which do not feed on crustacea, develop heavy infestations by consuming smaller fish which have eaten infested crustacea and still have invasive juvenile worms in their guts.

The worms cause little harm to the fish hosts even when large numbers are present in the swim bladder. Infested fish appear healthy, but no studies have yet been reported dealing with the effects of this parasite upon its host.

This parasite is not harmful to man. Since the swim bladder is discarded in dressing the fish, the parasites are not objectionable in fish prepared for human consumption.

Fungal Infections

Fungal diseases are encountered by all freshwater fishes at one time or another. Under fish culture conditions certain fungi are especially troublesome. fungi which infect fish or fish eggs are generally considered to be secondary invaders after tissue injuries or tissue death. However, once the fungus begins growing, lesions continue to enlarge and potentially cause death.

Good sanitation and cleanliness are absolutely essential to effectively control fungal infection under intensive culture conditions. There are two general methods for the control of fungal infections on eggs: mechanical and chemical. The mechanical method used for salmonid eggs involves the removal of dead and/or infected eggs at frequent intervals during incubation. This method is time consuming and there is a risk of injuring healthy eggs in the process.

There are three prominent chemical controls for fungal infections: formalin, salt and malachite green. Malachite green has never been cleared for fishery use.

Saprolegnia

Fungus, or water mold, is frequently found on fish in the natural environment and in fish hatcheries nationwide. The appearance of grayish-white, furry or cottony like patches is an indication of a fungal infection, most likely caused

by **Saprolegnia parasitica.** Several other species can also be found but Saprolegnia is the most common. Water with a high silt or dirt particle content will mask the white fungal color to a brownish color as the particles collect on the fungus.

The fungal growth consists of a mass (mycelium) of nonseptate filaments(hyphae) each of which is about 20 microns in diameter. This fungus reproduces sexually and asexually. The lesions are circular and grow by radial extension around the body until lesions merge. At this point, the lesions may appear dark gray or brown because the mycelium traps mud and silt.

Fungus attacks on fish are considered to be secondary invaders. Any physical injury, such as produced during spawning, or migrating activities or by infection by external parasites or bacteria may enable fungus to gain a foothold on the fish. Once the protective mucus covering of the fish is broken, an opportunity is offered for the zoospores to germinate and penetrate the epithelium at the point of injury. Fungal infections rarely develop on strong fish, even in injuries. It develops rapidly on fish which have been weakened by stresses such as spawning activity, disease, overcrowding and rapid environmental change.

Branchiomycosis

Branchiomycosis is a fungal disease affecting the gills of freshwater fish. The fungus grows within the blood vessels and reduces the blood supply to the gills causing loss of oxygenation of the blood. The gill tissue becomes necrotic and sloughs away, which is why the condition has been referred to as "gill rot."

Fish having acute to subacute infections may be weak and lethargic and have labored opercular movements. Gills may appear bright red from impaired circulation. Some areas of the gill may be white to brown depending on the stage of necrosis. Subacute cases develop more slowly and a definite marbling appears on different sections of the gills as necrosis advances. The gills may eventually develop a very ragged or corroded appearance.

GILL DISEASES

Nearly all gill disease are going to require the use of a microscope and some fish pathology training in order to be able to determine the actual pathogen responsible.

Bacterial Gill Disease

Bacterial gill disease is a common external infection of hatchery reared salmonids and occasionally warmwater species reared under intensive conditions. Flavobacteria sp. and Cytophaga sp. have been isolated from bacterial gill disease cases. BGD is a superficial infection of gill epithelium by large numbers of filamentous bacteria resulting in fusion and clubbing of gill lamellae. BGD usually occurs as a result of overcrowding and poor environmental conditions. Fish infected with BGD are usually lethargic, refuse food ride high in the current, orient themselves into the current ,space themselves equidistant from each other and the tips of the gills may appear slimy with whitened tips. The most important fact is that bacteria causing bacterial gill disease do not cause necrosis.

Columnaris

Columnaris disease is an acute to chronic bacterial infection that infects anadramous salmonids and virtually all species of warmwater fish. It occurs both as external or systemic infections and under certain conditions, can result in significant losses of hatchery reared fish. Epizootics of columnaris disease frequently cause substantial mortalities in natural fish populations primarily in the spring as water temperatures in the shallows warm and primarily in crappies, other sunfish and catfish. The disease was named columnaris because of the haystack pattern which the bacteria tend to form on the gill lamellae.

Columnaris disease is caused by the bacteria Flexibacter columnaris. The disease begins externally on the body surfaces and gills but lesions vary. Lesions of scaleless fish, begin on the body as small circular erosions of the skin which have grey-blue necrotic centers and red margins surrounded by a ring of inflamed skin. As the disease progresses, these lesions spread over the rest of the body. In scaled fish, necrotic lesions begin at the outer margins of the fins and spread inward towards the body. Columnaris also causes extensive gill necrosis. In well advanced cases e bacteria may also be isolated using special growth media.

Chilodonella

These ciliated protozoans are most frequently found on warmwater fish such as pike and carp, although infestation of trout fry in hatcheries is not uncommon.

The parasites are tiny, 50 to 70 microns long, and cannot be seen without magnification, although heavily parasitized fish may show blotchy gray areas on the surface of the skin. Under magnification the parasites may be seen as tiny, motile, oval bodies covered with fine cilia.

When Chilodonella occurs in very great numbers on a fish, particularly on the gills, it causes the fish to produce great quantities of mucus which impair respiration. Affected fish may become lazy, lie on their sides, rise to the surface, and eventually die. The parasite shows a preference for debilitated and undernourished fish. It is frequently observed on northern pike in the spring of the year as they enter a marsh for spawning.

The parasites are not harmful to man.

Gyros

Fish culturists frequently observe the symptoms of "Gyro" infestation. "Gyros," Gyrodactylus elegans and Dactylogyrus sp. seldom become a serious menace to fish in nature. However, they may become a problem in hatcheries where fish are closely crowded and the worms may be easily spread from one fish to another. Infested fish can be seen 'flashing" as they rub themselves against the sides and bottom of the trough or stream in an effort to rid themselves of the parasites.

"Gyro" infestation can be identified only with the use of a microscope as the worms are quite small, 0.5 to 0.8 mm long. The posterior end of these worms is disc shaped and equipped with hooks which are used to hold the parasite to the host. These hooks penetrate the skin or gill tissues, creating open sores which frequently become infected with fungus, and may serve as portals of entry for pathogenic bacteria and viruses.

Gyrodactylus may be distinguished from worms belonging to the genus Dactylogyrus by its absence of eye spots in the anterior end. Gyrodactylus may live almost anywhere on the host but it is usually most abundant on the fins, especially the dorsal and caudal. "Gyros" give birth to live young which are already well developed and immediately become attached to a fish host.

Dactylogyrus is easily identified by the presence of two pairs of eyes which appear as small black dots near the anterior end. This genus differs from Gyrodactylus by laying eggs, which become attached to the gills of the host. After the young hatch they require some time to grow to maturity. The eggs of Dactylogyrus may resist treatment and hatch later, so treatment must therefore be repeated to kill the newly hatched young before they mature and lay eggs.

Ichthyopthirias- " ICH "

A common disease of hatchery and aquaria fish is white spot, a condition caused by large ciliated protozoans. The adults od this parasite are up to 1 mm in diameter, and may be seen with the unaided eye as tiny white spots on affected fish. The parasites live under the epithelial layers of the skin, fins, and gills of many species of fish, especially young fish. They are found more frequently on warmwater fishes than on fish from coldwater because low temperatures inhibit their activity.

When the parasite has grown to maturity it leaves the host and becomes enclosed in a cyst. Within this cyst multiplication occurs resulting in the production of from 400 to 2,000 young parasites. These are also ciliated, and when they leave the cyst, swim actively until contacting a fish. If a fish is not found within a few days , the parasites die. If they find a fish, they burrow into the skin, migrate for a time, then grow to maturity. The entire life cycle takes from 4 days to 3 weeks, depending on the water temperature.

White spot can be very serious, causing high mortality, especially when fish are under crowded conditions and heavy infestation occurs.

Leeches

Certain leeches attack fishes, but do little damage unless present in large numbers. The damage done to the fish is proportional to the number of leeches present and the amount of blood they remove. Leeches attach periodically to fish, take a large blood meal, and leave for varying periods of time.

The true fish leeches belong to the family Piscicolidae and are related to the common earthworm. Leeches usually have a greenish brown color, are from 1/4 to 1 inch long, and may be found in the mouth, on the gills, fins, or body of bluegills, perch, and many other fishes. All leeches are composed of only 34 true segments with each segment subdivided into a definite and constant number of superficial annuli. Leeches have two suckers, one at each end. The anterior one surrounds the mouth and may be large or small, and lip-like. The caudal sucker faces ventrally and is much larger, disclike, powerful and expanded over central attachment pedestal. Leeches are flattened dorsoventrally and are highly muscular and contractile.

Lymphocystis

Lymphocystis is a viral caused disease of the higher order of fish (Percidae and Centrarchidae). The incidence of the disease in walleye may be high in some locations and affected fish are discarded by fishermen.

The lesions of lymphocystis disease are raised nodular masses of the generally light-colored tissue which resemble warts. The wart like growths are usually located on the skin or on fins but often may be restricted to a small area of a single fin. The growths are due to viral infected cells enlarging. Color of the lesion is usually light and may be white, gray or cream colored. There is a tendency toward opalescence, and larger lesions may show pink due to the vascular network. Lymphocystis cells may occur internally, but the infection is characteristically a disease which involves the skin.

Transmission of the virus is by the bursting and/or sloughing of host cells and release of the viral particles. This can occur intermittently through the duration of the infection, or it can be massive as upon death and decomposition of the host fish. In temperate freshwater fishes, lymphocystis disease usually appears in the spring, peaks in summer and disappears through fall and winter.

Neascus- "Black Spot"

These parasites are easily discerned as obvious pigmented cysts (the size of a pinhead) slightly raised from the skin or fins, or sometimes in the mouth or flesh. The parasites commonly infest rock bass and other sunfish, bass, pike, minnows, and other fish species. Various species of black spot are found in practically all parts of the world. The black spots are actually pigmented cysts of larval trematodes which mature in fish-eating birds. The life cycle is snail to fish to bird.

Fish may be heavily infested, yet the parasites do relatively little damage in most cases and do not obviously affect growth or longevity of the fish. There is some evidence, however, that a massive infestation on a young fish may cause excessive blood loss, physiological stress, and sometimes though not frequently death.

These trematodes are incapable of infesting man, and even a heavily infested fish is safe to eat. It may be more aesthetically pleasing to skin a very heavily infested fish before eating. Cooking kills the parasite.

Yellow Grub

This is the common "grub" found in our freshwater fish as a yellow worm up to 1/4 inch long just under the skin, or in the flesh. Yellow grub has been reported from so many kinds of freshwater fish in North America that apparently no fish is immune to it. The grub is the larval stage which must be eaten by fish-eating birds, such as herons and bitterns, to develop. The grub matures in the throat of the bird, and eggs wash into the water from the bird's mouth when feeding. The eggs hatch and the first larval stage (miricidia) swim by means of fine hair like cilia until they find a snail of the genus Helisoma. Unless they find this snail they die within several hours. In the snail they go through several developmental stages during which they multiply a thousand fold, finally leaving the snail as a free-swimming cercariae. Unless the cercariae find a fish within a few hours, they die. When they find a fish, they burrow through the skin and encyst, where they develop into metacercariae, which are the yellow grubs. There they remain until eaten by the bird host, thus completing the life cycle.

The grubs may live for several years in the fish, thus in many lakes rather heavy infestations accumulate and the fish are classed by fishermen as unfit for food.

Normal cooking of the fish destroys the grub.

Diplostomum spathaceum

Diplostomum spathaceum utilizes many species of fishes as a second intermediate host, the metacercariae localizing in eye tissue. Several fish-eating aquatic bird species, especially gulls, are the primary hosts of this fluke.

The life cycle of D. spathaceum begins as an adult trematode in the intestine of gulls or other pisciverous birds. The body is 0.3 to 0.5 mm in length and distinctly divided into a flattened anterior forebody and a more cylindrical and narrower hindbody. Eggs are shed and passed in feces to the water. They hatch in about 21 days at summer water temperatures into free-swimming ciliated miracidia.

Miracidia seek aquatic snails for a first intermediate host; only lymnaeid snails are acceptable. The miracidia penetrate the hepatopancreas of the snail and metamorphose to a mother sporocyst, then to one or more daughter sporocysts. Each produces many cercariae which are released into the water. The free-swimming cercariae seek second intermediate hosts.

The usual route of transmission from the snail to the second intermediate host is through water and active penetration of the cercariae. However, much evidence points to the fact that transmission is possible by fishes feeding on snails containing cercariae. Some cercariae which enter the skin, fins, and gills enter the blood stream and are carried to the eyes within 30 minutes of the time of penetration.

The snails cause a parasitic blindness diagnosed by cataract and isolation of the parasite.

Lymphosarcoma

A red sore disease of the pike, Esox lucius, has frequently been observed by Minnesota anglers. The disease is specific to northern pike and muskellunge.

The disease is circumpolar in distribution in the northern hemisphere and widely distributed in the USA and Canada. This condition is known to be fatal to muskellunge, but its effect on pike is not totally understood.

Lymphosarcoma is a tumorous condition which appears as weltlike sores on the flank, fins, or head. The tumor may appear as a cluster of pink blisters which may rupture, resulting in a sore resembling a lamprey scar. The tumor may also appear as a series of bluish blisters surrounding a "cream-like core." Or the tumor may most typically appear as what we have traditionally called "red sore."

Studies to date indicate that the disease is a contact-transmitted virus spread from fish to fish during the spawning act. The disease begins as a skin lesion which invades the underlying tissues and muscle. Two sequels are then possible: the tumor may progress to involve internal organs and subsequent death of the animal or the tumor may regress and heal. The highest incidence of the disease is seen in spring, suggesting that the syndrome may cause death of most tumor bearing fish during the summer months.

There is no evidence at this time that this disease affects humans or other animals. However, heavily infected fish are not considered very palatable and are being discarded by most fishermen.

In general, warmwater fish are most susceptible in the spring although cases have been reported during the winter months. The infection frequently occurs during the winter months, and the disease not showing itself until spring.

The best method of control is to avoid the transfer of fish from infected waters to those where the disease has not been known to occur.

Myofibrogranuloma

Myofibrogranuloma (MFG) is a muscular dystrophy-like anomaly of walleye in which the skeletal muscle has undergone profound structural changes. The myopathy is recognized by its swollen, coarsely fibrous, granular, and fatty characteristics. The lesion has an opaque yellow-brown color. Included in this pattern of striated muscle deformation is a consolidation and fusion of contiguous muscle fibers to form prominent aggregates of rough, cordlike strands, which eventually undergo a coagulation necrosis and calcification. A simple description is that it looks like the flesh has been freezer burned. The lesions are typically found along the vertebral column while filleting.

Myofibrogranuloma has been found exclusively in adult walleyes whose ages range from 3 to 10 years. The sex frequency ratio of the disease is about equal. A higher frequency of this anomaly has been observed to occur in walleyes from comparatively small, fertile lakes and ponds in which the species is maintained exclusively by periodic stocking of hatchery-reared walleyes.

Open sores/ Hemorrhage

Any time one sees open sores, furuncles, fluid filled cysts the first and most likely cause is bacteria. Primary damage to the epithelial layers may have been due to parasites but now the intrusion is due to bacteria. Bacterial species responsible for such damage may be Aeromonas, Pseudomonas, Citrobacter, or other opportunistic species. Diagnosis can not be accomplished by the naked eye. Tissues need to be cultured and tissue sections need to be studied to determine the actual identity.

Tumors and Anomalys

Tumors and malformations of many kinds,some due to injuries, are found among fishes and the cause of many of them is seldom diagnosed. Certain tumors of the liver of hatchery rainbow trout, called hepatomas, are caused by various ingredients in the diet and can be avoided by altering the diet. Viruses are implicated in some tumors. Tumors occur on nearly all organs or tissues. Those on the skin are very obvious and some are spectacular. Most tumors do not appear

to be fatal to the fish, and the fishermen can remove them along with the entrails,before the fish is cooked.

The cause of tumors is for the most part poorly known. Of course, certain chemicals are known to be carcinogenic and may cause tumors. There is also suspicion that viruses may cause certain tumors, and that is the case with lymphocystis and lymphosarcoma.

But more and more data are accumulating to implicate environmental agents as important for carcinogenesis in humans and other animals including fish. Many of these agents enter the natural waters and come in contact with fish and invertebrates. These agents, of natural, industrial and agricultural origin, are numerous and include such natural agents as UV light. Other agents include crude oil, various soluble metals and their salts, petroleum wastes, DDT, other pesticides, benzyl, arsenic, domestic wastes, herbicides, aromatic amines, and various components of effluent from mines, industry, and dyestuffs.

The mechanisms by which these environmental agents act to generate neoplasia are presently unknown. That these probably do act additively and even synergistically in conjunction with multiple host factors is well known in mammalian systems and certainly should be similar in fish.

Spinal Deformities

Spinal deformities are not unusual among fish of various species. Drastic temperature changes during early developmental stages are thought to be responsible in some cases. Diet and contaminants may also be responsible in some instances.

Slime Discoloration

Most slime discoloration is due to either chemicals in the water environment or parasites present on the fish. Trichodina and Ichthyoboda are two ciliated protozoans which cause excess mucus to build causing the skin coloration to change. Skin discoloration is a clinical sign of a problem which can be very valuable to a diagnostician in determining the cause of a problem.

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APPENDIX 9 - INTERPRETING WATER QUALITY DATA

BACKGROUND. The collection and interpretation of water quality data has broad implications for fisheries management. In many lakes it explains underlying lake productivity and sets limits on potential fish production. Water quality data is essential in defining the types of fish habitat available and how that habitat changes with time. Also, water quality parameters are important in determining lake classification type.

The underlying relationship between water quality (the degree of enrichment/ eutrophication) and fish production is well established (e.g. Moyle 1956, Ryder 1965). Use of the Morphoedaphic Index (MEI) to estimate fish production (Ryder 1965) is an established fisheries technique, though a direct cause and effect relationship between MEI and fish production certainly does not exist. The chemical parameters on which MEI is based (total alkalinity (Alk), conductivity (Cond), and/or total dissolved solids (TDS)), are not controlling the amount of primary production in typical Minnesota lakes. Instead, most Minnesota lakes are limited by the amount of phosphorus available. Recent papers have emphasized that primary production represents a far better predictor of fish production than does MEI (Downing et al. 1990; Oglesby 1977). MEI is useful because its chemical constituents often are correlated with total phosphorus and because mean depth is often correlated with lake retention time. Cultural eutrophication, a common problem in Minnesota lakes, predominantly increases phosphorus concentration (not Alk, Cond, or TDS), so that fish production changes due to eutrophication will not be well represented by MEI.

Water quality data is also essential in evaluating habitat availability. Phosphorus availability not only determines the amount of primary production but, by extension, the amount of organic material available for decomposition. Rates of oxygen depletion are important in situations where a two-story fisheries exists or where winterkill is a possibility. Water quality and the quantity of algae also influence the light environment of lakes. The depth to which light penetrates influences the depth

available for rooted aquatic plant growth, heat absorption/strength of stratification, and the light environment in which fish feed.

The classification of Minnesota's fish lakes by Moyle (1956) and Schupp (in press) both incorporate water quality information as important components. These classification approaches reflect the fact that the biota in a lake are a reflection of the chemical and physical conditions in the water body.

WORDS OF CAUTION. Interpretation of water quality data, particularly when only a few samples are available, needs to be done cautiously. This point is particularly relevant for our sampling program which typically collects single point estimates with multi-year intervals. The water quality parameters we measure (total phosphorus (TP), chlorophyll (Chl *a*), and Secchi Disk depth (SD)) show large seasonal variability, reflective of the dynamic nature of the physical, chemical, and biological processes that influence them. To adequately characterize water quality and reduce the uncertainty associated with individual estimates, multiple samples are needed. Our data can be used to describe in-lake conditions but it will be difficult to determine if the variability observed represents trends or just normal seasonal variation.

INTERPRETATION. WATER QUALITY VARIABLES TO EXAMINE.

Fisheries water quality assessment in Minnesota is currently focused on the same four parameters used by MPCA: TP, Chl *a*, SD, and hypolimnetic oxygen depletion rate. These parameters were chosen because they reflect the primary nutrient limiting plant growth (TP), measure the quantity of algae in a lake (Chl *a*), describe water transparency (SD), and characterize the extent of anoxia. Other parameters are important (Heiskary and Wilson 1989, 1990), but these four are viewed as primary.

CONTEXT FOR INTERPRETATION. Any interpretation of lake water quality results must be done within the ecoregion context (Heiskary and Wilson 1989, 1990). Ecoregions, as characterized by EPA, represent areas with similar land use, soils, land and surface form, and potential natural vegetation. Similar concepts were incorporated into Moyle's (1956) lake classification system. Seven ecoregions are recognized in MN and most (98%) of the state's lakes are situated in four (A-D in Fig. 1). The MPCA has established general water quality characteristics for each ecoregion by examining sets of minimally impacted lakes. Those water quality characteristics (Table 1) approximate baseline conditions for ecoregion lakes and serve as a yardstick for current comparisons.

TROPHIC STATE. The underlying fertility of a lake, its trophic state, has important implications for all aspects of lake management. The water quality parameters we measure identify a lake's trophic state, which may range from oligotrophic (low nutrients/low fertility) to hyper-eutrophic (very high nutrients/high fertility). Carlson's (1977) Trophic State Index (TSI) represents a convenient and commonly used method to compare lakes on a continuous scale. The index is defined by three separate equations which rank trophic state on a scale from 0 - 100 (very oligotrophic - hyper-eutrophic). Index values can be calculated or estimated graphically (Fig. 2).

SD--TSI = 60 - (14.41*ln SD(meters))
TP--TSI = 4.15 + (14.42*ln TP(µg/l))
Chl a--TSI = 30.6 + (9.81*ln Chl a(µg/l)

The three index values can be averaged if a difference of ≤ 5 TSI units exist. Larger differences may provide valuable information about in-lake processes (e.g. in highly colored lakes differences in TSI values are expected, TP-TSI>Chla-TSI). Osgood (1982) outlines approaches for dealing with variable TSI values. Precise methodology for interpreting or comparing the derived

index values does not exist but the data was scaled so that each 10 unit increase in TSI represents a doubling in algal biomass. This information can be used to monitor change in trophic state over time.

RELATIONSHIPS BETWEEN WATER QUALITY PARAMETERS. In most lakes, a strong correlation exists between the primary water quality variables (SD, TP, and Chl a). The relationships, based on summer mean results, are summarized for Minnesota lakes in Fig. 3. Individual values, such as those obtained during a lake survey, may agree as well. Points that fall on or near the normal relationships suggest that phosphorus is limiting phytoplankton growth and that phytoplankton are the primary source of turbidity in the water. In contrast, if monitoring data fell well below the general relationships (e.g. "A" in Fig. 3), then light availability not phosphorus may be limiting (typical of a lake with high color or inorganic turbidity).

HAS FISH HABITAT BEEN ALTERED? This issue should be viewed from two different perspectives. The first, the community perspective, was clearly stated by Moyle (1956), "a natural balance tends to be achieved between the size and structure of the fish population and the chemistry of the water and the factors that influence that chemistry." In other words, the fish community appropriate for a particular body of water may change over time as water quality changes. Replacement of yellow bullheads by black bullheads as a lake becomes more eutrophic is an example of this type of community alteration. The second

perspective emphasizes how the habitat requirements of individual species are impacted by water chemistry changes. The availability of two-story fish habitat, the distribution of aquatic plants, or the suitability of spawning beds are all dependent on water quality conditions that can improve or degrade over time.

WHAT ARE THE PUBLIC'S PERCEPTIONS AND EXPECTATIONS? The public does not perceive water quality uniformly and regional trends in perception are evident (Heiskary and Wilson 1990). What is "good" vs "bad" water quality is dependent on the individual's frame of reference. This is particularly true for water clarity (i.e. SD and Chl a) where users of northern Minnesota lakes expect clearer water than users of lakes in southern part of the state. It is important that expectations are developed that are consistent with the ecoregion context within which each lake is located.

Table 1. Summer average water quality characteristics for lakes by ecoregion. Based on interquartile range (25th-75th) for ecoregion reference lakes.

Parameter	Ecoregion: Northern Plains and Forests	North Central Hardwood Forests	Western Corn Belt Plains	Northern Glaciated Plains
TP µg/L	14 - 27	23 - 50	65 - 150	130-250
Chl a µg/L	<10	5 - 22	30 - 80	30 - 55
SD ft	8 - 15	4.9 - 10.5	1.6 - 3.3	1.0 - 3.3
m	2.4 - 4.6	1.5 - 3.2	0.5 - 1.0	0.3 - 1.0

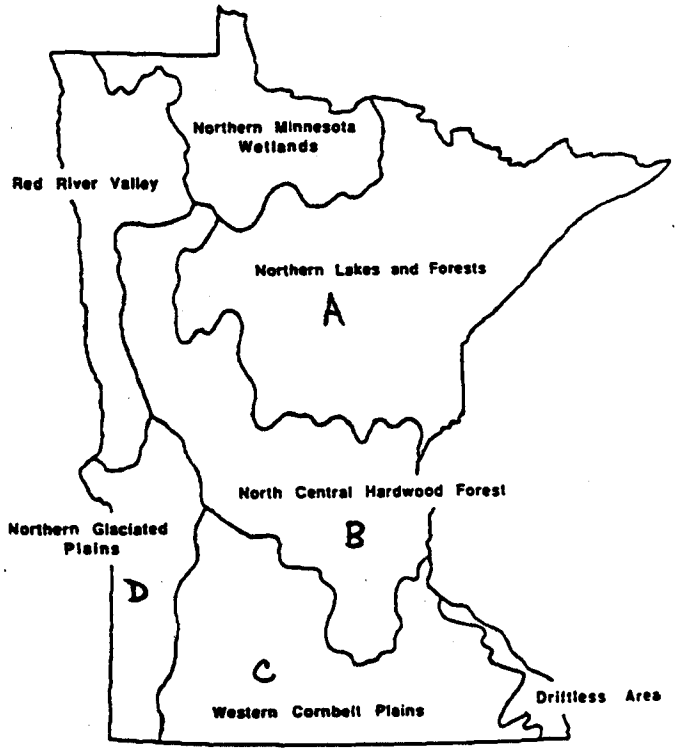

Figure 1. Minnesota's seven ecoregions.

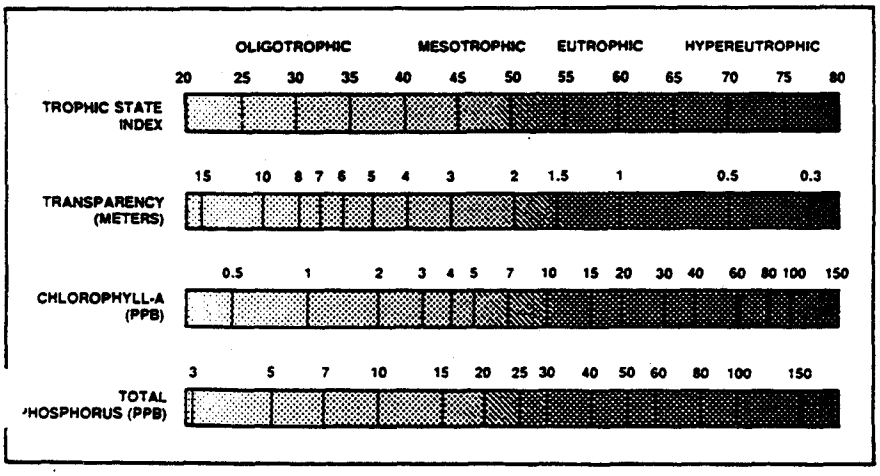

Figure 2. Carlson's Trophic State Index (EPA 1988).

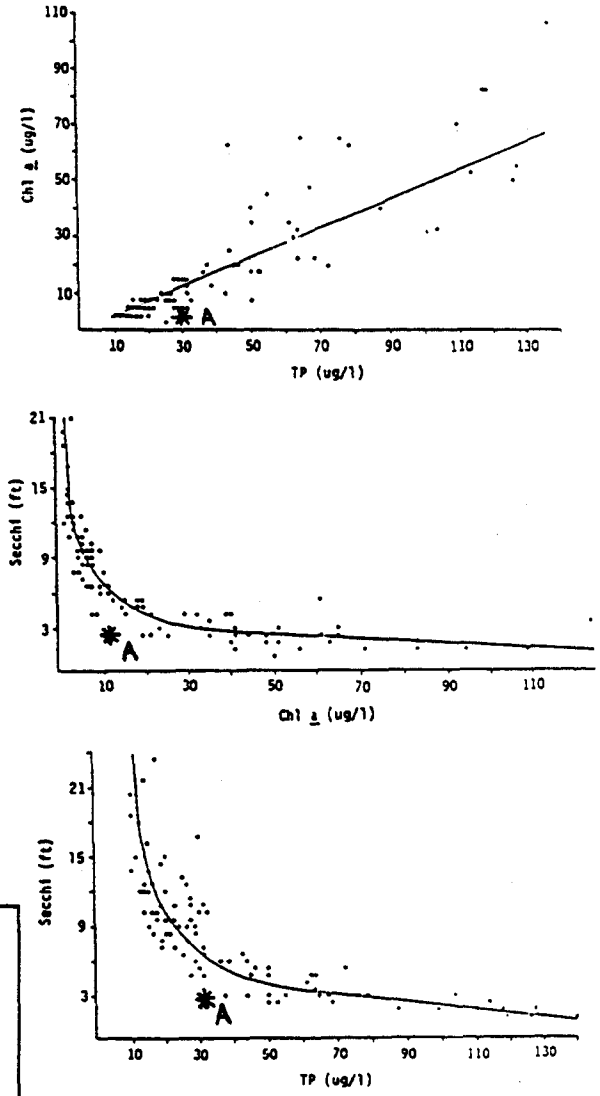

Figure 3. Scatterplots of Chl a, SD, and TP based on summer mean concentrations for representative ecoregion lakes.

DEPARTMENT : NATURAL RESOURCES
Section of Fisheries
DATE : October 12, 1992

STATE OF MINNESOTA
Office Memorandum

TO : Regions, Areas, Research

FROM : Jack Skrypek
Chief of Fisheries

PHONE : (612) 296-0792

SUBJECT : Updated Procedures for Preventing the Spread of Exotic Species

Please follow the attached updated recommendations for preventing the spread of exotic species during field operations. These recommendations contain a couple of changes from the original guidelines based on comments received from the field. The changes are in procedures when leaving an access and treatment of equipment used in water bodies containing exotic species.

We plan to continue evaluating other methods for preventing the spread of exotic species. Please follow the attached guidelines until additional information is available.

JS/RJ/kbs

c: Ron Payer
Steve Hirsch
Jack Wingate
Darryl Bathel
Program Staff
Jay Rendall
John Lindgren

Updated Procedures for Preventing the Spread of Exotic Species

10/15/92

The following procedures should be followed during field operations:

1) All water must be drained from the boat and equipment (bilge pump, tubs, live wells, etc.) prior to leaving the access.

2) All vegetation must be removed from boats, motors, trailers, nets (as much as possible) or other equipment while on shore prior to leaving the access.

3) St. Louis Bay, Lake Superior, and the Mississippi River below St. Paul contain known populations of zebra mussel, and Island Lake in St. Louis County contains B.C. Equipment used in any of these water bodies must be treated or dried sufficiently (See No.s 4, 5, and 6) before being used again.

4) Water from St. Louis Bay, Island Lake in St. Louis County, and the Mississippi River cannot be used for fish transport. Lake Superior water can be used for fish transport as long as it is filtered and water temperature is 50 F or less (filters prevent transport of B.C. and zebra mussel adults, but not zebra mussel veligers, however, veligers are not produced until water temperatures reach 52 F). Salt (1/4%) should also be added to fish transport water from Lake Superior as an additional measure for preventing the spread of zebra mussels. We are currently reviewing information on the use of potassium chloride to kill zebra mussels. In the future, there may be options for treating transport water from infested lakes and streams to eliminate the risk of accidental transfer of zebra mussels.

5) All nets should be dried a minimum of four days prior to subsequent use. Lakes with known concentrations of Eurasian watermilfoil are considered "contaminated". Areas should consider using a separate set of nets for contaminated waters if Eurasian watermilfoil is common to water bodies in their area. In addition, nets should be thoroughly inspected and hand cleaned to ensure <u>all</u> species of vegetation are removed. Areas which do not have sufficient nets to dry for four days should take steps to obtain the necessary number of nets as soon as possible. In addition, water from contaminated lakes cannot be used for fish transport to uncontaminated water.

6) The spread of exotics will likely become more of a problem in the future. As such, areas should get used to operating in such a way as to minimize the risk of accidental transfer of exotics. We should make every effort to ensure vegetation or aquatic organisms of any species are not transported between water bodies. Be sure to use your judgement when drying nets. If nets are dried under cloudy, wet conditions then four days may not be enough to kill milfoil or other exotics. In these situations, additional drying time may be needed.

7) The following state statutes clarify the responsibility of all individuals in preventing the transportation of zebra mussels and Eurasian watermilfoil:

M.S. 18.317 EURASIAN OR NORTHERN WATERMILFOIL

Subd. 1. Transportation prohibited. Except as provided in subdivision 2, a person may not transport Eurasian or Northern watermilfoil, myriophyllum spicatum or exalbescens, zebra mussels, or other water-transmitted harmful exotic species identified by the commissioner of natural resources on a road or highway, as defined in section 160.02, subdivision 7, or on forest roads.

Subd. 3. Launching of watercraft with Eurasian or Northern watermilfoil or other Harmful Species is prohibited. (a) A person may not place a trailer or launch a watercraft with Eurasian or Northern watermilfoil, zebra mussels, or other water-transmitted harmful exotic species identified by the commissioner of natural resources attached into waters of the state.

APPENDIX 11 - GAME, PANFISH AND NON-GAME SPECIES

The "Age and Growth" and "Recording the Catch" sections of this manual require collecting information from game fish, panfish, and non-game fish. For purposes of this manual, the following species have been grouped into these categories:

Gamefish:

Walleye
Northern Pike
Largemouth Bass
Smallmouth Bass
Muskellunge
Trout (all species)
Salmon (all species)
Catfish (all species - not bullheads)
Lake Sturgeon
Shovelnose Sturgeon
Paddlefish
Sauger

Panfish:

Bluegill
Crappie (black and white)
Yellow Perch
Pumpkinseed
White Bass
Rock Bass

Non-game:

All other species

APPENDIX 12 - STANDARD INTERCEPTS

The following intercepts should be used for age and growth analysis:

Species	Intercept
Black crappie	0.8
Bluegill	0.8
Carp	0.9
Cisco	1.4
Drum	0.8
Green sunfish	0.4
Lake trout	1.2
Largemouth bass	0.8
Northern pike	2.1
Pumpkinseed	1.0
Rock bass	1.0
Sauger	1.0
Smallmouth bass	1.4
Walleye	1.1
White crappie	0.8
Whitefish	1.4
White sucker	1.2
Yellow perch	1.2

APPENDIX 13 - EQUIPMENT LISTS

The following equipment may be needed to complete surveys as described in this manual. These lists are not complete for all situations, but are intended to provide a quick reference for most of the equipment needed to complete each survey.

Vegetation and Substrate Transects/Mapping:

- Forms 2 and 6 (waterproof paper)
- Clipboard
- Habitat Evaluation map(s) with pre-determined transects
- Taxonomic keys
- Standard grapple
- Depth finder
- Magnifying lens
- GPS Unit
- Map wheel (to establish transects)
- Blank contour maps (for mapping vegetation and substrate)
- Vegetation codes
- Boat anchor
- Probing device (e.g. oar) to sample substrate to 4'
- Polaroid sunglasses
- Camera or camcorder

Water Levels:

- Forms 2 and 3 (waterproof paper)
- Clipboard
- Habitat Evaluation map
- GPS unit
- Hand or string level
- Stadia rod
- Tools/hardware to establish new benchmarks

Inlets and Outlets:

- Forms 2 and 4 (waterproof paper)
- Clipboard
- Habitat Evaluation map
- Thermometer (F)
- Flow meter
- Orange or vial
- GPS unit
- Stopwatch
- Measuring tape
- Stadia rod (depth)

Water Quality Sampling:

- Forms 2 and 9 (waterproof paper)
- Clipboard
- Sampling station map
- Properly calibrated and maintained D.O./Temp. meter
- Depth finder
- Anchor
- pH meter and alkalinity equipment (if <5 ppm alkalinity)
- Watch
- Secchi disk
- Water bottles/tags
- Cooler w/ice
- Aluminum foil (or dark water sample bottles)
- Water column sampler (if testing hypolimnetic water)
- Integrated tube sampler (optional to grab samples)
- GPS unit

Electrofishing:

- Forms 2, 10, 13, 14 (waterproof paper)
- Clipboard
- Sampling station map
- Conductivity meter (optional)
- Thermometer (F)
- Fish species code list
- Measuring board (in millimeters)
- Platform scales (1000 g, 12 kg)
- Scale envelopes
- Knife
- Appropriate electrofishing sampling and safety gear
- Watch
- GPS unit

Seining:

- Forms 2, 12, 13 (waterproof paper)
- Clipboard
- Sampling station map
- Appropriate seines
- Watch
- Thermometer (F)
- Measuring board (in millimeters)
- Platform scale (1000 gram) - optional
- Knife
- Scale envelopes
- Fish species code list
- Fish species identification key
- Jars or bags and preservative or cooler with ice (to transport fish for later identification, if needed)
- GPS unit
- Secchi disk

Testnetting:

- Forms 2, 11, 13, 14 (waterproof paper)
- Clipboard
- Sampling station map
- Appropriate nets and sampling gear (tubs, etc.)
- Measuring board (in millimeters)
- Platform scales (1000 g, 12 kg)
- Fish species code list
- GPS unit
- Scale envelopes
- Knife
- D.O./Temp. meter
- Secchi disk
- Watch
- Front cutters (if removing otoliths)
- Tweezers
- Fingernail clippers (dorsal spines)

Appendix 14 - Average Total Length at Age of Minnesota Fishes

This appendix will be used as a depository for length at age tables generated from the most recent lake survey records. Information should be used to supplement growth data as reported in the *Fisheries Managers Handbook*. The first tables to be added contain the average rate of growth for bluegill by lake class, and for northern pike as determined from 238 Minnesota lakes. More detailed information on bluegill growth rates in Minnesota is available in: Tomcko, C. 1997. Bluegill Growth Rates in Minnesota. Minnesota Department of Natural Resources, Section of Fisheries Investigational Report 458. St. Paul. More detailed information on northern pike growth rates is available in: Jacobson, P.C. 1993. Analysis of factors affecting growth of northern pike in Minnesota. Minnesota Department of Natural Resources, Section of Fisheries Investigational Report 424, St. Paul.

Table 1. Median backcalculated total lengths (mm) at age by lake class for bluegill. Samples were taken from Minnesota lakes during 1982-1994. Also listed for purpose of comparison, is an unweighted grand mean based on mean bluegill length per survey (1,947 surveys) and a weighted mean calculated from individual bluegill lengths (77,485 bluegill); a mean for Minnesota lakes from Dobie (1970); and a means of means for Minnesota lakes from Carlander (1977; pages 88-93).

Lake Class	Number of surveys	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	3	42	72	100	129	142	158								
2	10	38	63	94	125	152	177	196	197						
3	7	37	65	96	122	143	163	188	190						
4	1	43	79	115	122	148	162	193							
5	55	37	58	88	121	146	157	173	172	179	173	170	166	170	174
6	2	38	68	97	121	139	186	204							
7	22	38	72	108	145	160	181	199	191	199	206	214	221		
8	2	46	70	103											
10	17	39	66	94	119	143	163	174	176	196	186	181			
11	34	37	66	100	132	154	168	177	188	202	202	228	228		
12	15	38	64	88	119	143	160	182	185	220	196				
13	14	41	70	108	154	160	151	161	174	186	211	228			
14	6	40	66	98	130	154	140								
15	5	40	79	130	178	210	225	243	250	257					
16	14	39	82	122	146	171	176	183	196	208					
17	5	36	77	89	122	126	142	173	185						
19	18	39	75	114	149	172	187	206	209	222	217				
20	37	39	62	89	116	137	162	172	171	179	188	197			
21	29	41	66	92	117	138	158	171	185	197	199	191			
22	133	40	64	89	118	148	162	176	185	194	199	185			
23	106	38	58	80	103	130	151	164	173	181	196	206	236	234	
24	153	42	70	98	124	144	156	165	168	189	190				
25	134	41	68	96	125	146	163	170	180	179	185	189	186		
26	2	49	89	130	154	188	235								
27	137	40	64	90	120	147	161	176	189	198	204	199	211		
28	61	41	64	90	121	144	159	171	183	190	177	181	180		
29	92	39	61	84	106	128	148	162	170	177	182	196	223	235	240
30	77	44	79	112	137	147	157	158	162	170	184				
31	144	41	65	91	117	144	162	173	187	189	185	216			
32	69	38	56	76	95	114	133	148	157	166	167	154	155		
33	27	42	68	100	129	157	175	192	211						
34	108	45	80	112	139	157	175	184	185	175	176	200			
35	29	42	67	94	116	139	155	169	177	193	186	205			
36	34	44	71	99	125	148	163	168	178	184	186	188	197		
37	22	49	81	111	136	155	166	172	179	191	192	221			
38	62	45	76	102	125	144	153	155	155	164	192				
39	62	44	75	108	136	160	177	185	197	208	191	223	208	223	228
40	36	46	83	114	126	146	149	161	178	182					
41	71	48	100	144	162	179	189	197	214	240	247	256			
42	37	49	87	124	150	162	181	192	208	202					
43	54	48	94	132	157	174	182	194	174	188					
unweighted		43	72	102	128	148	163	174	181	187	191	197	198	207	214
weighted		42	68	93	115	135	151	163	172	182	189	194	195	201	214
Dobie (1970)		48	86	124	155	180	198	211	218	231	244				
Carlander (1977)		83	118	133	160	184	200	204	210						

Table 2. Median backcalculated total lengths (in) at age by lake class for bluegill. Samples were taken from Minnesota lakes during 1982-1994.

Lake class	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.6	2.8	3.9	5.0	5.5	6.2								
2	1.5	2.4	3.7	4.9	5.9	6.9	7.7	7.7						
3	1.4	2.5	3.7	4.8	5.6	6.4	7.4	7.4						
4	1.6	3.1	4.5	4.8	5.8	6.3	7.6							
5	1.4	2.2	3.4	4.7	5.7	6.1	6.8	6.7	7.0	6.8	6.6	6.5	6.6	6.8
6	1.5	2.6	3.8	4.7	5.4	7.3	8.0							
7	1.5	2.8	4.2	5.7	6.3	7.1	7.8	7.5	7.8	8.1	8.4	8.7		
8	1.8	2.7	4.0											
10	1.5	2.6	3.7	4.6	5.6	6.4	6.8	6.9	7.7	7.3	7.1			
11	1.4	2.6	3.9	5.2	6.0	6.6	6.9	7.4	7.9	7.9	8.9	8.9		
12	1.5	2.5	3.4	4.6	5.6	6.3	7.1	7.2	8.6	7.7				
13	1.6	2.7	4.2	6.0	6.3	5.9	6.3	6.8	7.3	8.3	8.9			
14	1.5	2.6	3.8	5.1	6.0	5.5								
15	1.5	3.1	5.1	7.0	8.2	8.8	9.5	9.8	10.1					
16	1.5	3.2	4.8	5.7	6.7	6.9	7.2	7.7	8.1					
17	1.4	3.0	3.5	4.8	4.9	5.5	6.8	7.2						
19	1.5	2.9	4.4	5.8	6.7	7.3	8.1	8.2	8.7	8.5				
20	1.5	2.4	3.5	4.5	5.3	6.3	6.7	6.7	7.0	7.4	7.7			
21	1.6	2.6	3.6	4.6	5.4	6.2	6.7	7.2	7.7	7.8	7.5			
22	1.5	2.5	3.5	4.6	5.8	6.3	6.9	7.2	7.6	7.8	7.2			
23	1.5	2.2	3.1	4.0	5.1	5.9	6.4	6.8	7.1	7.7	8.1	9.2	9.2	
24	1.6	2.7	3.8	4.8	5.6	6.1	6.5	6.6	7.4	7.4				
25	1.6	2.6	3.7	4.9	5.7	6.4	6.6	7.0	7.0	7.2	7.4	7.3		
26	1.9	3.5	5.1	6.0	7.4	9.2								
27	1.5	2.5	3.5	4.7	5.7	6.3	6.9	7.4	7.8	8.0	7.8	8.3		
28	1.6	2.5	3.5	4.7	5.6	6.2	6.7	7.2	7.4	6.9	7.1	7.0		
29	1.5	2.4	3.3	4.1	5.0	5.8	6.3	6.6	6.9	7.1	7.7	8.7	9.2	9.4
30	1.7	3.1	4.4	5.3	5.7	6.1	6.2	6.3	6.6	7.2				
31	1.6	2.5	3.5	4.6	5.6	6.3	6.8	7.3	7.4	7.2	8.5			
32	1.5	2.2	2.9	3.7	4.4	5.2	5.8	6.1	6.5	6.5	6.0	6.1		
33	1.6	2.6	3.9	5.0	6.1	6.8	7.5	8.3						
34	1.7	3.1	4.4	5.4	6.1	6.8	7.2	7.2	6.8	6.9	7.8			
35	1.6	2.6	3.7	4.5	5.4	6.1	6.6	6.9	7.6	7.3	8.0			
36	1.7	2.8	3.9	4.9	5.8	6.4	6.6	7.0	7.2	7.3	7.4	7.7		
37	1.9	3.1	4.3	5.3	6.1	6.5	6.7	7.0	7.5	7.5	8.7			
38	1.7	2.9	4.0	4.9	5.6	6.0	6.1	6.1	6.4	7.5				
39	1.7	2.9	4.2	5.3	6.3	6.9	7.2	7.7	8.1	7.5	8.7	8.1	8.7	8.9
40	1.8	3.2	4.4	4.9	5.7	5.8	6.3	7.0	7.1					
41	1.8	3.9	5.6	6.3	7.0	7.4	7.7	8.4	9.4	9.7	10.0			
42	1.9	3.4	4.8	5.9	6.3	7.1	7.5	8.1	7.9					
43	1.8	3.7	5.2	6.1	6.8	7.1	7.6	6.8	7.4					

Table 3. Median backcalculated total lengths (mm) at age for northern pike from 298 Minnesota lakes.

Age									
1	2	3	4	5	6	7	8	9	10
228.5	374.9	461.0	520.7	577.8	642.1	716.5	775.7	836.9	891.0

Table 4. Median backcalculated total lengths (in) at age for northern pike from 298 Minnesota lakes.

Age									
1	2	3	4	5	6	7	8	9	10
8.99	14.76	18.15	20.50	22.75	25.28	28.21	30.54	32.95	35.08