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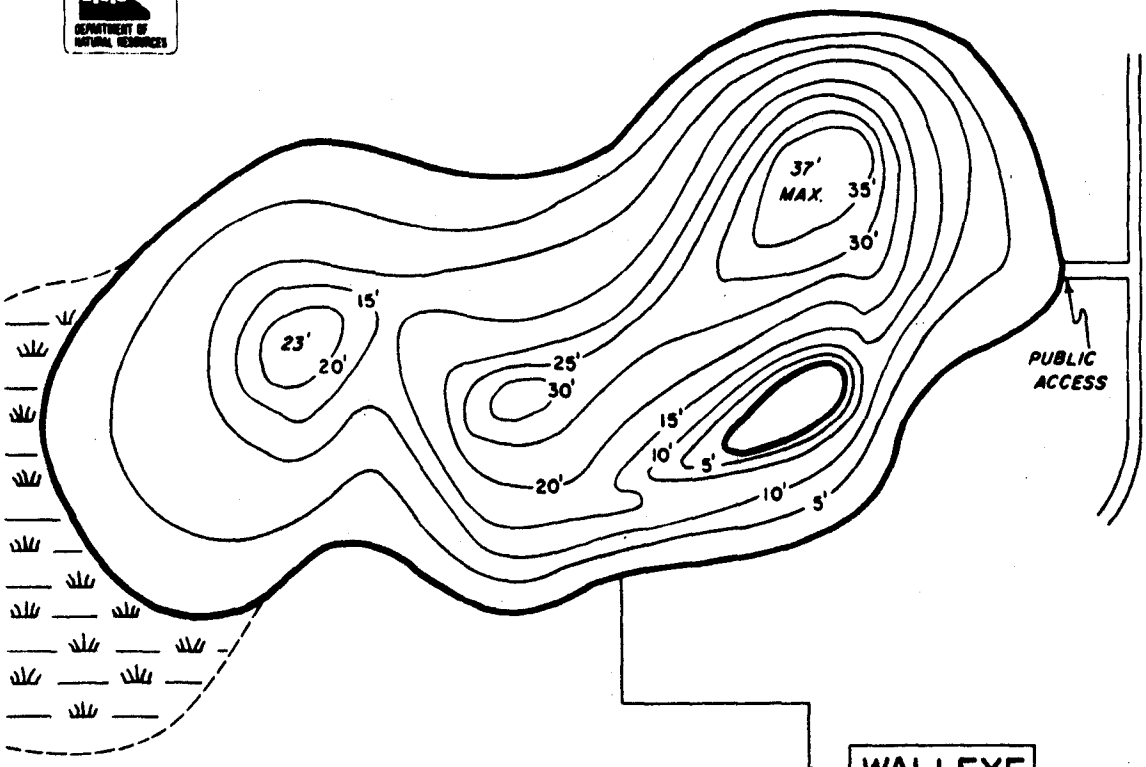

LAKE MANAGEMENT PLANNING GUIDE

- WALLEYE
- NORTHERN PIKE
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- LAKE TROUT
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PREFACE

This guide is to be used by the state's fisheries managers in the art and science of fisheries management. To those who have devoted much time and effort in diligent study of modern fisheries methods, it may appear overly simplistic. However, the majority of reviews received during its development were enthusiastic and positive to the concept.

The user should not expect more than is offered. It is a simple and direct guide to aid professional fisheries managers in reaching decisions regarding the best management of the waters in their charge, prepare and implement plans, and evaluate results. The Guide is designed to allow management flexibility, and very few outright restrictions appear. Although evaluation is always important, it is especially stressed when applying unusual or untried techniques.

Periodic updates and revisions will be made in area, regional and staff working guides as research in fisheries management reveals new methods and techniques.

I would like to express my sincere appreciation to the statewide task force who made this guide a reality. Fisheries managers Paul Diedrich, Edward Feiler, William G. Johnson, Howard Latvala, Donald Reedstrom, James Storland, Richard Trombley, and Chairman James A. Schneider all deserve special thanks for staying with it through many intense and long meetings spaced over a year's time.

Special appreciation is also due Dick Sternberg who steered the guide through the important first stages before resigning from State service to enter the publication world.

Finally, thanks to Bruce Hawkinson and Roy Johannes for the miles of footwork involved with organizing, typing, copying and rewrites; and to Jane Hicks and Berneice Grimm for dedicated secretarial assistance.

Jerome H. Kuehn
Chief of Fisheries
April, 1982

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A GUIDE FOR MANAGEMENT OF MINNESOTA LAKES

During the past half-century, fish management in Minnesota has evolved from intensive fish propagation with indiscriminate stocking methods to a more sophisticated procedure of collecting data, analyzing problems, and applying best management techniques.

Because of the diversity in Minnesota, different management techniques have evolved throughout the state. Although training sessions have been held to keep managers apprised of new developments, no written guide is available as a reference.

This guide has been prepared by managers for use by managers for the following purposes:

-to provide guidelines for managing Minnesota's major game fish species so that the most cost effective management techniques are used.

-to provide program continuity.

-to provide guidelines for preparing fish management plans for individual lakes within fish management areas.

-to promote modern fish management practices to all who are involved in Minnesota's fishery.

-to allow integration of fisheries management information into a centralized electronic information network.

This guide will attempt to define when and where specific management practices should be used; but will not detail techniques. The manager is referred instead to existing fisheries publications (investigational reports, management reports, special publications, and past surveys and population assessments), many of which should be present in area files and libraries. A list of references is appended to the guide.

Special regulations are sometimes used to help management control over-use or abuse of fisheries resources. However, with a few exceptions, special regulations will not appear in the guide as an important management tool. On specific occasions where special regulations seem necessary, it should be handled through channels.

During the development of the guide, flow charts were used to identify and organize limiting factors and management tools to combat them. Individual managers may find the flow chart method useful for their own lake planning. As an example, one flow chart was left in the guide and is found in the walleye section.

This guide cannot cover every situation the manager may encounter; rather, it will provide general guidelines and some alternatives for lake management which can be revised accordingly by region and area through trial and evaluation.

The management plan for each lake may and should, if necessary, be revised as new fisheries information becomes available. One of the manager's most important duties is to evaluate the success of management techniques. Goals must be established for future lake management. When the goals are not being achieved, the manager must re-examine the problem and adjust the management plan accordingly.

This guide is to be used closely with the lake survey manual and existing file information such as lake surveys, population assessments, stocking plans, fish removal, creel or recreational census, and general public input to arrive at individual lake management plans. The individual lake management form will be discussed in the final chapter of this guide.

ESTABLISHING PLANNING PRIORITIES

Many fish management areas have more lakes than can be effectively managed with available budget and staff. To assure that the most important lakes receive proper management attention, it is necessary to establish a management planning priority system.

The primary criteria in determining a lake's importance are 1) size in acres, and 2) angling use. In assigning a numerical (priority) rating, large lakes are given a higher number than small lakes and heavily used lakes are given a higher number than lightly used lakes. The use rating (pressure) is determined subjectively by fisheries area. Important factors to be considered when determining angling use are: location of lake, public access, and species present. The formula to be used in establishing the planning priority number is: P = size value + use value (or use potential* if appropriate).

The following table is to be used in determining values:

Lake Size in Acres	Value	Fishing Use	Value
10-150	1	None	0
151-500	2	Sparse	1
501-2,000	3	Light	2
2,001-10,000	4	Moderate	4
Over 10,000	5	Heavy	5

To assign a priority number to a lake, add the ratings for size and use. For example, a 900 acre lake that has moderate potential with management is assigned a priority rating of 7. In case of ties, size of lake usually prevails.

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*If additional management is definitely planned that will have the effect of significantly increasing use, use that higher number as your indicated Fishing Use value.

These ratings can be adjusted for special problems at the manager's discretion. For example, a stream trout lake located in a zone of warm water lakes or a small, highly productive lake with excellent access may be assigned a higher rating than is warranted by size if the manager feels it is especially important. If a high priority lake is doing well without fish population manipulation, the manager must still prepare a plan - but should not feel obligated to effect unnecessary management simply because it is "important water".

Finally, if a management plan cannot be prepared without additional survey work, the highest priority lakes should be surveyed first.

GENERAL FISH MANAGEMENT GUIDELINES

Defining Problems and Finding Solutions

To ensure that area lakes are managed wisely, the fisheries manager must become familiar enough with the lakes to determine what, if any, problems are affecting game fish populations. Only then can it be determined which management measures will be effectively and economically feasible to correct the problems.

Problems affecting game fish populations generally fall into one or more of the following categories:

1. Habitat degradation
2. Inadequate natural reproduction
3. High fishing pressure
4. Inadequate forage (and/or fertility)
5. High predator population
6. Inadequate or improper management

Management techniques that can be used to resolve these problems for each major species will be discussed in the species management chapters.

Management of a Satisfactory Fish Population

In some instances, a good fish population may develop, but does not provide a satisfactory fishery. This can result from several causes, such as a high forage fish population, excessive growth of aquatic vegetation, turbid water or a bowl shaped lake basin. While it is usually impractical to correct any of these problems, there may be an occasional instance where it is possible to control forage fish abundance.

Stocking of northern pike, walleye or largemouth bass may help to reduce populations of yellow perch but are not likely to have much impact on centrarchid populations. Stocking of any predators should be approached cautiously

taking into consideration fish population balance. For example, if northern pike levels are adequate but a high yellow perch population is buffering successful fishing of a good walleye population, attempts to increase fishing success by stocking additional northern pike to reduce perch could be detrimental since both species rely on the yellow perch for food and, in addition, it could make the walleye population vulnerable to fishing.

Unnecessary Management

Although game fish populations may be satisfactory and adequately used by fishermen, the manager should evaluate the management plan periodically to determine if changes are warranted. In some cases, stocking rates or frequency could be reduced without appreciably affecting fish populations or smaller fish could be stocked to reduce production costs. Over-management is wasteful and every effort should be made to determine the lowest economical level of management capable of establishing and/or maintaining a satisfactory fishery.

Evaluation

All management should be evaluated at regular intervals to assure that progress is being made toward reaching the management goal. For example, it is poor management to stock a lake year after year without some indication that it is contributing to the adult fish population or the sport fishery.

Management should be planned and implemented in such a way that evaluation is possible. If a lake is stocked every year, it is difficult to determine the contribution of natural reproduction. Perhaps natural reproduction would sustain the population without stocking, but unless the manager leaves periodic blanks and then compares year-class strength in stocking versus nonstocking years, the question will never be resolved.

I. WALLEYE MANAGEMENT PLANNING

Habitat Requirements and Distribution

Walleye adapt to a wide range of environmental conditions. They occur naturally in medium to large-sized lakes and rivers with zones of rubble which provide spawning substrate. Ecologically they are suited to large, shallow basins with relatively hard water. Walleye are stocked in Minnesota lakes of every ecological type.

Sampling

To gather information as a basis for preparing management plans and to monitor the management plans, every lake intensively managed for walleye should have a complete or partial survey conducted every four or five years (see Manual of Instruction for Lake Survey).

Management to Improve a Poor Walleye Population

Although there is no absolute definition of a satisfactory walleye population (satisfactory in one situation is not necessarily satisfactory in another), the following conditions are generally indicative of an inadequate walleye population, except in winterkill lakes.

- -walleye net catches are substantially below median by geographical area and lake type.
- -successive year-class gaps of walleye under eight years of age.

If a walleye population is inadequate, the manager must identify limiting factors before any further management is attempted. The common limiting factors and the management measures used to overcome them are as follows:

A. Inadequate forage - If condition (use K factor analysis if necessary) of young walleye (1-2 years old) is poor during late summer or early fall, forage may be inadequate. If proper sized forage is scarce or absent in seine hauls and if adult forage species are substantially below regional or area medians, it is likely that forage is not adequate to support the walleye populations present. If it is determined that food is the limiting factor, the following management tools may improve forage abundance or make the existing forage more available to walleye:

1. Reduction of competitor abundance - Other top predators (northern pike and largemouth bass) and rough fish may compete with walleye for food. Northern pike populations in small lakes may be reduced by trapnetting immediately after ice-out and/or by blocking spawning areas. Trapnetting for northern pike is not recommended on lakes much over 500 acres. Even on smaller lakes a minimum of five years intensive netting is usually necessary. If there is little reduction after this period, it should be discontinued.

   Removal of spawning suckers by shoreline trapnetting has been effective in northeastern Minnesota (Johnson 1975), and may have potential elsewhere. It should be done only if all of the following conditions prevail: Immigration of (new) suckers is highly unlikely, the population consists of adult suckers with little recruitment, and there is a relatively simple species relationship. Adequate removal usually requires 2-3 years. If trapnet catches show little reduction after this time, the removal project should be discontinued.

   These methods for reducing competitor abundance are likely to be effective only if spawning is, or can

be, limited to a very low level. Commercial removal is recommended to utilize commercial fish species, but has not been demonstrated to be effective in actually reducing competition.

2. Reduction or elimination of competitor stocking - Northern pike compete with walleye for forage, especially for yellow perch. If northern pike are abundant, perch and other prey species are scarce, and walleye numbers or condition factors are poor or declining, stocking of northern pike should be substantially reduced or discontinued. If walleye are assigned management priority, northern pike spawning areas should be operated only when prey abundance is sufficient to support both species. Stocking of other competitors should also be regulated by the prey abundance.
3. Forage introduction - Although this has limited application, it may be warranted under the following circumstances: It is done for introductory purposes only and not for maintenance feeding, the forage species exist in the watershed ecosystem of the lake being stocked (all introductory stocking must be approved by the Fisheries Chief), and the forage shipments to be introduced should be carefully screened for presence of undesirable species and diseases.

4. Reduction of walleye stocking quota - If the lake's productivity is not adequate to sustain the number of walleye present, then reduction of the stocking quota or stocking frequency is probably the best management strategy. The reduction should be followed by an evaluation to determine if the condition factor of young fish has improved.

B. High predator population - Almost any fish eating species can become a walleye predator, especially in the early stages of walleye life. If physical conditions in the lake are satisfactory and forage is adequate, yet walleye fail to survive, predation is likely to be a leading problem.

The following management alternatives may improve the situation:

1. Reduction or elimination of predator stocking - Stocking of northern pike or any other species which prey upon walleye is probably counter-productive to maintaining a satisfactory walleye population. Predator stocking should be discontinued and resumed only if test netting shows their presence is not a threat to the walleye population.
2. Reduction of predator populations - Northern pike are one of the most significant predators on small walleye. Reduction of a northern pike population can be accomplished by trapnetting after ice-out. See page 8 for recommendations.
3. Chemical rehabilitation - If none of the above measures for controlling predators are effective or appropriate, rehabilitation is probably the only other option if management is to be continued. The manager should refer to the Developmental Procedural Manual* for a check on feasibility. If rehabilitation is not feasible, walleye management should be discontinued until the predator population falls naturally to a level where a satisfactory walleye population can be maintained.

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*Hereafter referred to by its common title "reclamation manual".

C. High fishing pressure - Symptoms of high fishing pressure are reductions in catch rate, average size of walleye taken and number of year-classes represented in the fishery. Fishing pressure is likely to be a leading cause if physical stress or inadequate natural reproduction is not a problem.
The following management alternatives may overcome this problem:

1. Special regulations - Any requested change in regulations should be preceded by documentation of the problem and good evidence that the proposed measure is feasible. For instance, the closing of areas to fishing to prevent overharvest or to provide protection to brood stock is an accepted "special regulation" for walleye management.

2. Adjust walleye stocking - If few walleye of any size are present because of high fishing pressure and the lake is capable of supporting more, a modest increase in stocking rate or stocking frequency may be warranted.

3. Adjusting population levels of other species - In some situations, allowing the forage base, i.e. yellow perch, to increase significantly will provide an ample food source for walleye and result in decreased fishability. This may also promote walleye recruitment and thereby improve the population structure. This can be done by adjusting the stocking of (or removal of) competing predators, especially northern pike.

D. Habitat degradation - Domestic, municipal, industrial or agricultural pollution can result in high rough fish populations, decreased water clarity, reduced forage, reduced fishability, increased biological oxygen demand

and more frequent winterkills.

If dissolved oxygen (O_2) levels fall to 2-3 ppm or lower and remain low for a long period of time (several weeks) or if oxygen levels fluctuate or drop rapidly, walleye may be lost. If this happens frequently, one or more of the following intensive management measures will be required to sustain a satisfactory walleye populations. If none of the following are practical or likely to maintain a walleye fishery, walleye management should be discontinued.

1. Aeration - Currently, the state does not finance the installation or operation of aeration systems. Technical assistance is provided, however, to anyone who wishes to install and operate an aeration system. Small, portable systems are being researched for potential management use. Aeration is most beneficial in areas where fishing opportunities are limited.
2. Rough fish - Rough fish control with seines, hoopnets or large mesh gillnets is usually feasible only on small or shallow lakes. Rough fish removal must be intensive to be an effective control. Commercial fishermen should be encouraged to do the netting wherever possible. Large mesh gillnet operations should be closely monitored if a population of large game fish is present (gillnetting has had some success in lakes and rivers with large populations of buffalo and carp where under-ice seining was not feasible). Traps or barriers for restricting access to spawning areas or preventing entry from other lakes may be effective where there is a suitable site.
3. Pollution control - If there are sources of domestic, municipal, industrial or agricultural pollution causing increased fertility and more

frequent winterkills, the appropriate government agency should be notified. If, after a reasonable period of time, no action is taken to alleviate the problem, the Regional Supervisor should be notified for follow-up action.

4. Stock fry after winterkill - If test netting after ice-out confirms a winterkill, or if the manager knows through experience and O_2 testing that a severe kill has occurred, fry stocking at a rate of 250-500/acre may be warranted if surviving predators and frequent winterkills do not preclude development of a population of catchable size walleye. Since fry survival after a severe winterkill is usually excellent, the initial stocking rate should be low (unless the lake is being used for fingerling production and harvest). If small mesh trapnetting indicates low survival, the lake should be stocked again the following spring. Additional fry stocking should be avoided until the next winterkill. Fingerling stocking is never justified in winterkilled lakes.

5. Chemical rehabilitation - If carp, bullheads or other species have degraded the habitat to the point where walleye survival is poor but the habitat is otherwise suitable, rehabilitation may be justified if none of the other management procedures are successful (refer to "reclamation manual").

E. Inadequate natural reproduction - If natural walleye spawning areas are absent and test netting indicates two or more missing year-classes out of six, it is likely that natural reproduction is insufficient to maintain an adequate walleye fishery. The following management tools may improve the fishery.

1. Walleye stocking - Walleye stocking is generally

unnecessary and not practical in natural walleye lakes over 15,000 acres. Traditionally, a percentage of the fry produced from a spawn taking site is returned to the parent lake. This practice should be continued where there is public demand or where there is evidence the fry have made a contribution to the population, but may not be necessary in cases where there is an abundance of juvenile walleye and little public interest in stocking.

Whenever possible, fry rather than fingerling stocking should be employed because it is less expensive and the supply of fry is generally more dependable.

Walleye fry should be stocked off shore in open water, but toward the lee side to prevent them from being washed ashore. It may be necessary to distribute fry in several locations on a large lake. Lakes that are slow warming or low fertility should be placed late in the fry stocking schedule to increase fry survival. Fingerlings should be stocked in an area with abundant vegetative cover. Fry and fingerling shortages sometimes occur. The manager should establish a priority system whereby the most important lakes receive at least 75 percent of their quota before lower priority lakes are stocked. This approach is better than stocking limited numbers in many lakes with minimal results. Stocking feasibility should always be closely examined. In lakes where there is a possibility of natural reproduction, stocking schedules should include periodic blanks to allow evaluation of natural reproduction. If the evaluation shows that reproduction is not adequate (as in most southern Minnesota lakes) to maintain a satisfactory walleye population, annual stocking may be

required. For practical reasons, large lakes are usually stocked at a lesser rate than small lakes. If evaluation shows that there is some natural reproduction, but not enough to completely support the fishery, stocking rates should also be reduced. Stocking guidelines for each of the following lake types may require modification to suit the needs of individual lakes. The following stocking plans (by ecological lake type) are recommended:

a) Hardwater or soft water walleye lakes - Although many of these lakes have walleye reproduction, it may be variable. Fry stocking may supplement poor year-classes, but more research is needed to determine optimal stocking rates.

   A stocking schedule should be designed to allow evaluation of the contribution of stocked fry and adjusted until the optimal rate is established. If evaluation shows no consistent patterns of improving year-class strength, stocking should be discontinued.

b) Centrarchid-walleye lakes - Most of the walleye stocked in Minnesota are in lakes of this type. Stocking guidelines are recommended in Table 1. (Following page).

c) Centrarchid lakes - While it is possible to establish a walleye population in centrarchid lakes, the population is often underutilized because the lake is difficult to fish (shape of basin, over-abundant vegetation and/or forage, lack of structure, etc.). If a lake of this type has been stocked for a period of years but has failed to produce a fishery, stocking should be reduced or discontinued. These lakes should have a low priority for walleye stocking. Stocking rates should

follow the guidelines established for centrarchid-walleye lakes.

Table 1 - Stocking guidelines for centrarchid-walleye lakes.

%Littoral Area	Size to be stocked	Stocking frequency	Stocking rate
50 or over	fry 1/	Annual	500-1,000 fry per littoral acre
25-49	fingerling	Every 2nd or 3rd year	1/2-1 lb. of 40 per lb. fgl. per littoral acre 2/
0-25	fingerling	Annual	"

1/ If fry stocking fails, stock fingerlings at rate recommended for lakes with 25-49% littoral area.

2/ May be adjusted depending upon size of fingerlings.

d) Rough fish-game fish lakes - As is the case with many centrarchid lakes, walleye populations can usually be established, but may produce a limited fishery because the lake is difficult to fish. All walleye stocking in these lakes should be carefully evaluated in order to match the level of management effort to the amount of fishing generated. If the public is aware of the population and management cannot improve fishing conditions, stocking should be reduced or discontinued.

More evaluation of walleye stocking techniques in these lakes is needed before definite

guidelines can be recommended. Until such time, use the same plan as recommended for centrarchid-walleye lakes, but cut the annual stocking rate to 50 percent every other year to allow evaluation. The following evaluation procedure is recommended:
Determine with shoreline seine or small mesh trapnets if there was survival through the first summer. Determine if there was survival to age 2 or 3 with 1 inch mesh gillnets. If there was survival through the first summer, but no evidence of the year-class was found in subsequent gillnetting, the cause of fingerling mortality should be investigated. If the reason cannot be determined or if corrective management is not possible, stocking should be discontinued. If surviving fingerlings are emaciated, the stocking rate should be reduced. Based on gillnetting results, the stocking rate should be adjusted to determine the lowest rate capable of producing an acceptable walleye fishery. Evaluation should continue for several years to assess natural variations.

e) Bullhead lakes - Refer to page 13, for guidelines for stocking.

f) Lake trout lakes - These relatively infertile lakes often lack walleye spawning habitat, therefore stocking is necessary to maintain a walleye fishery. This should be considered only in lakes that are no longer managed for lake trout. Walleye may prey upon young lake trout and compete for food, therefore walleye stocking is generally not recommended in lakes

managed for lake trout.

Walleye fry stocking is recommmended every other year at approximately 1,000/surface acre and fingerling stocking in opposite years at 1 lb. (40 per lb) per littoral acre. A blank should be left every 4 or 5 years to help management evaluate natural reproduction and stocking plans (fry vs. fingerling).

g) Northern pike-sucker lakes - Walleye management in such lakes is questionable. Although some success has been realized where adequate forage, especially perch, exist. In an area where there are nearby lakes with adequate walleye populations, it should not be considered without an evaluation plan. Stocking recommendations are similar to those for centrarchid-walleye lakes.

2. Water level management - If water level can be controlled, walleye spawning success may be improved by maintaining a stable or rising water level through the incubation period.

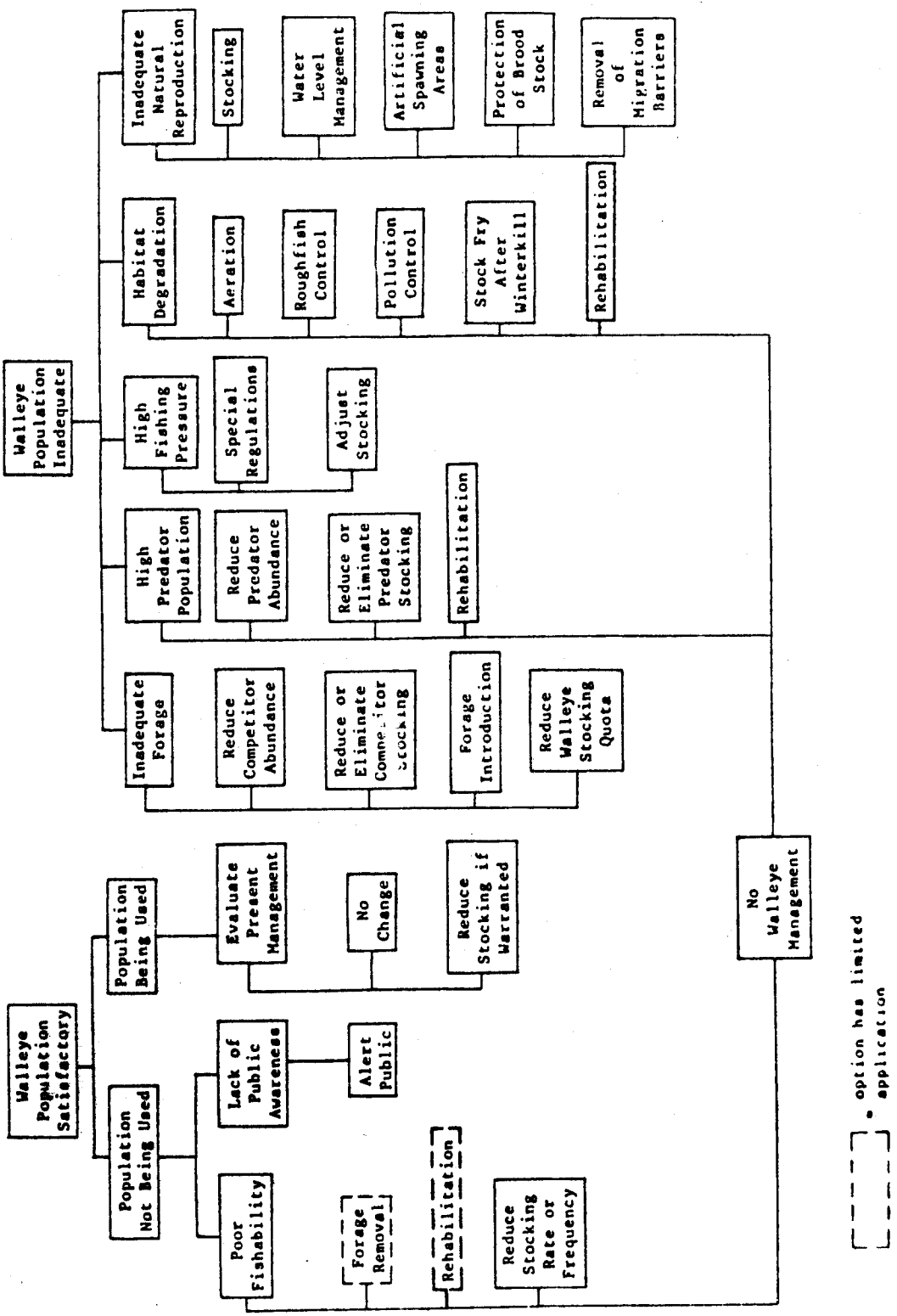
3. Artificial walleye spawning areas - Installation or enlargement of a spawning area may be justified under the following conditions:
a) lake large enough to allow adequate wave action or lake currents to prevent detritus build-up, b) undeveloped shoreline is available for placement of rubble, c) walleye have historically used the area but with poor or no results; or a low success spawning run can be intercepted and, d) cost analysis shows installation of spawning area to be cheaper than fry stocking (Newburg, 1975).

4. Protection of brood stock - If the spawning run is

late and walleye are concentrated and vulnerable to fishermen, posting may be advisable.

5. Removal of migration barriers - Barrier removal should be considered if: a) a barrier prevents walleye from reaching spawning grounds of high potential and b) removal is feasible.

WALLEYE MANAGEMENT FLOW CHART



II. NORTHERN PIKE MANAGEMENT PLANNING

Habitat Requirements and Distribution

The northern pike is the most adaptable game fish species in Minnesota. Pike are found in all types of Minnesota lakes and spawn in shallow, weedy bays or in adjacent marshes connected by small tributary streams.

Sampling

Every lake managed for northern pike should have complete or partial surveys conducted periodically (once every 4-5 years) according to the Manual of Lake Survey to determine if the pike population is satisfactory or if further management is necessary.

Management to Improve an Unsatisfactory Northern Pike Population

A northern pike population is unsatisfactory if netting indices are substantially below area or regional medians by ecological lake type or inordinately high numbers of small pike predominate.

If the northern pike population is inadequate, the manager must determine which limiting factor(s) are involved. Common limiting factors and suggested strategies follow:

A. Inadequate forage- If adult yellow perch are substantially below regional or area medians, if minnows are scarce or absent in seine hauls, if no alternate forage species is available, and if condition (use K factor analysis if necessary) of young northern pike (1-3 yrs.) is poor, forage is probably inadequate. This situation may exist because of low lake productivity,

competition, or because of excessive northern pike reproduction or excessive stocking. Treatments to overcome this problem are as follows:

1. Reduce or eliminate northern pike stocking.
2. Reduce spawning or immigration - Hardware screen or rough fish panels can be used to block an inlet and prevent northern pike from entering a spawning marsh. In some instances, it may be possible to install temporary or permanent barriers to prevent northern pike immigration from other lakes. However, frequent maintenance is usually required. Screens may also concentrate pike, causing law enforcement problems. If there is a structure such as a beaver dam or a dam with removable boards holding water in an area utilized by spawning northern pike, it may be possible to remove the structure and isolate or dry up the spawning area.
3. Northern pike removal by trapnetting - This procedure is discussed on page 8.
4. Forage introduction - Discussed on page 9. In some infertile lakes, forage density may be too low to support a fishable population of northern pike. Under these circumstances, northern pike management is not advisable.

B. Habitat degradation - High rough fish populations can result in decreased water clarity, reduced forage, reduced fishability, increased B.O.D. and increased winterkill frequency. Northern pike can survive lower oxygen levels than most other game fish species. However, if a lake is subject to intermittent winterkills, the following measures will help establish a satisfactory pike population:

1. Aeration - Discussed on page 12.

2. Rough fish control - Discussed on page 12.

3. Pollution control - Discussed on page 12.

4. Chemical rehabilitation - Discussed on page 13.

5. Stock after winterkill - If a winterkill lake is also being managed for walleye and forage is scarce, pike should not be stocked until the second year. If brood stock are used, they are generally stocked at a lower rate than normal.

C. Inadequate natural reproduction - When sampling indicates a scarcity of young northern pike, when assessment netting shows many year-class gaps in the adult population and when suitable spawning habitat is lacking, it is likely that northern pike natural reproduction is not adequate to support a satisfactory pike fishery.

Pike are aggressive predators and can have a dramatic effect on populations of other fishes. Therefore, before any management is begun to improve the pike population, consideration must be given to the effect added predation will have on other species present, particularly walleye. In lakes where perch are the primary forage species, a moderate to high perch population (gillnet index of 15 or more perch/lift) should be present before additional northern pike are stocked. Where perch are present at less than 5/lift, increasing pike populations by stocking or any other means may be detrimental (Maloney and Schupp 1977).

The following management tools can improve the northern pike population:

1. Stock winter rescued northern pike - Stocking of winter rescued northern pike is an effective tool for improving pike populations in lakes with inadequate natural reproduction. However, this procedure should be used with caution and only when the forage base (usually perch) is capable of supporting more pike. In cases where there is sufficient natural recruitment, winter rescued pike should not be stocked simply because they are available. Rescue should not be conducted unless there is a definite management need for the fish (Maloney and Schupp 1977).

2. Controlled northern pike spawning area - Operation of controlled northern pike spawning areas is an effective method of augmenting or providing natural reproduction. Refer to the Section of Fisheries Manual "Procedures for Acquiring Northern Pike Spawning Areas" for specific instructions when it is desirable to acquire a spawning area.

3. Remove migration barriers - Removal of beaver dams, fish traps, log jams or silted channels which block spawning movements can be beneficial.

4. Restore or improve spawning habitat - Removal of brush, trees, silt, etc. can improve the productivity of northern pike spawning areas by encouraging desirable vegetation.

III. MUSKELLUNGE MANAGEMENT PLANNING

At this time, "muskies" are the only fish in Minnesota actively managed for trophy fishery purposes. A trophy musky is generally regarded as being over 40 inches long and exceeding 20 pounds.

Habitat Requirements and Distribution

Lakes chosen for muskellunge management should have the following characteristics:

- low northern pike population (below 3/gillnet lift)
- adequate forage base
- moderate to high water clarity (muskies are sight feeders and are difficult to catch in turbid water).
- no potential for winterkill
- minimum size of 500 acres
- public acceptance

Minnesota muskellunge lakes fall into two general categories, those in which natural, primarily unstocked populations exist (examples - Mississippi headwater's lakes such as Leech Lake, or Woman Lake in the Boy River chain) and those in which the population consists primarily of stocked fish (examples - Rush Lake in Chisago County and Mantrap Lake in Hubbard County).

Sampling

Large, natural muskellunge lakes (over 5,000 acres) cannot be assessed with nets because of difficulty in taking enough fish to establish a reliable catch index. However, these lakes usually require little manipulative management and general observation of the creel and resurvey will provide an indication of the status of the muskellunge and

forage populations.

Stocked muskellunge populations should be monitored regularly by intensive trapnetting in sheltered bays or other prime spawning areas immediately after ice-out. Captured fish should be marked and measured and scale samples taken for age and growth determinations. Since immature muskies are very difficult to sample, assessment should be delayed until the fourth year after introduction and should be conducted at least once every 4-7 years.

If netting shows a high population of small muskellunge, the stocking rate or frequency should be reduced.

Management to Improve a Poor Muskellunge Population

The following parameters indicate an adequate muskellunge population:

- a catch rate of 0.5/trapnet lift immediately after ice-out. In some cases lower population densities may be satisfactory, especially if trophy sized individuals are present.
- some individuals attain a size of at least 40 inches.

When population assessment indicates an unsatisfactory population, the fisheries manager must determine why. Common limiting factors and management options are as follows:

A. Inadequate forage - If test netting shows adult yellow perch substantially below regional or area medians, minnows scarce or absent in seine hauls, alternate forage species (primarily Coregonids) are not available and growth is slow, forage is probably not adequate to support a satisfactory muskellunge population. The following management options may improve forage abundance:

   1. Reduction of northern pike abundance - This may be accomplished by trapnetting and/or constructing barriers to block spawning runs. These options are discussed on page 8.

2. Forage Introduction - Discussed on page 9.
3. Reduction of stocking rate or frequency - Where forage is inadequate because of low water fertility, reduction in muskellunge stocking rate or frequency may be the only practical solution.

B. High predator population - Lakes chosen for muskellunge management should have low northern pike populations (below 3/gillnet lift). If pike become overabundant, the control measures recommended under A-1 in the previous section should be considered.

C. High fishing pressure - Muskies, like most other predator species, can be affected by high fishing pressure. The typical result, scarcity of large individuals. If the manager suspects high fishing pressure to be a problem, a regulation change be in order. The following regulation changes would reduce fishing pressure:
   1) Increase the minimum size limit.
   2) Closure of muskellunge fishing (this is a drastic measure and will seldom be considered).

D. Habitat degradation - High rough fish populations result in decreased water clarity, reduced forage abundance, poor fishability, increased biological oxygen demand and more frequent winterkills.
Domestic, municipal, industrial or agricultural pollution can also increase winterkill frequency. Muskellunge should never be stocked in lakes with these habitat problems. However, if these problems develop in a good muskie lake, the following measures be used:
   1. Rough fish control - Discussed on page 12.
   2. Pollution control - Discussed on page 13.

E. Inadequate natural reproduction - If spring trapnetting shows missing year-classes or low populations, one or both of the following options should be employed.

1. Stocking - Young-of-the-year muskellunge (3-7 per pound) should be stocked at a rate of up to 1 fish per littoral acre. Stocking is usually on an annual or biennial basis, but less frequent stocking may be sufficient to develop a trophy muskellunge fishery. There should be periodic blanks established to allow assessment of natural reproduction.
2. Removal of migration barriers - If feasible, barrier removal should be considered if a barrier prevents muskellunge from reaching high quality spawning areas.

IV. STREAM TROUT LAKE MANAGEMENT

Stream trout for lake management in Minnesota consist of brook, rainbow and splake trout. Brown trout are not generally used because of their wariness and predatory habits, except under special conditions which can be easily evaluated. Since trout transport well, grow fast, bite willingly and are an excellent production fish, the cost/benefit ratio in a properly managed stream trout lake is usually very good.

Habitat Requirements

Lakes managed intensively for stream trout should be small (under 100 acres), at or near the top of the watershed and have an outlet which allows control over ingress of undesirable fish species. Water quality should be good and there should always be an adequate volume of oxygenated water under 70 degrees F. to support the trout population desired.

The following section on stream trout management is largely excerpted from Johnson's "Management of Lakes for Stream Trout and Salmon" (Minnesota Special Publication No. 125) and managers are urged to refer to that publication for a thorough treatment of the subject, including species management and stocking rates.

Sampling

Sampling of trout present by assessment netting alone for the purpose of making management decisions is usually not effective. Legitimate assessment sampling must include creel census information. For a discussion of creel census techniques, the manager is referred to Johnson (1978) as well

as earlier works by Micklus and Johnson (1962). By utilizing "random" and/or "stratified" creel census techniques, useful information can be gathered at relatively low cost. Managers not trained in statistical methods should always have creel census plans checked by a qualified individual before proceeding with implementation. Even the most efficient creel census represents a substantial investment in time and expense. Valid results should be guaranteed.

Management to Improve Poor Trout Populations

The following conditions are usually indicative of inadequate trout populations:

- few fish being caught.
- small fish predominating the creel (under 6").
- trout emaciated or unsightly.

Poor Angling Success

Causes of low populations of trout in Minnesota stream trout lakes include oxygen (O_2) depletion during the winter O_2 depletion and/or high temperatures during the summer, predation by or competition with other fish, loss to predators other than fish, incomplete detoxification following chemical rehabilitation, and loss of sub-catchable trout from hooking and release by anglers. An additional reason for poor fishing can be related to heavy fishing pressure during periods when trout are particularly vulnerable which removes a significant portion of the population in a few days or weeks.

Remedies for oxygen and/or temperature problems are few and expensive. Aeration of water turnover devices will work under ideal conditions but should be considered case-by-case and include a thorough cost-benefit study.

Competition with, or predation by other fish species is a common cause of trout mortality. Generally, fingerling

trout stocked in waters containing northern pike, walleye, perch and various centrarchid suffer severe losses in the sub-catchable stage. Stream trout stocked as "yearling" (about eight inches) have produced a fishery in spite of incompatible fish populations. However, this is an expensive procedure and is generally not recommended. A thorough cost/benefit study is required before such a stocking plan would be approved and follow-up evaluation including some creel census would also be in order.

In most cases, the only solution is removal of undesirable populations by chemical rehabilitation. If only minnows are present, management is sometimes possible but close evaluation should be made of the fishery.

Losses of sub-catchable trout to hook-and-release mortality is a definite but not a major part of the total mortality of stream trout lakes. These losses are usually greater for ice fishing because of the large number of small (fall stocked) fish available and the damage caused by exposure to winter temperatures.

Small Fish

A lake managed for stream trout that does not produce fish of a size acceptable to the angler may have one or more of the following problems: 1) productivity so low that growth is poor even with minimal stocking, 2) excessive stocking followed by high survival, 3) vulnerability to angling when the fish are small, or 4) excessive stress during the growing season from high temperatures or low O_2.

Stream trout stocked in Minnesota study lakes have usually shown good growth. Indications are that where trout seldom reach highly acceptable sizes it is simply because the population is removed by angling before the growth potential is realized. In these lakes, except some marginal lakes, stream trout stocked at 100 to 300 per acre have not experienced slow growth.

Remedies for over-cropping include stocking (expensive) catchable sized fish and regulations (experimental) to restrict the harvest of small fish. Some success was realized in northeastern Minnesota by posting informational signs at the lake indicating that only small fish were present and giving a date when satisfactory fishing might be expected. This probably won't work where people pressure and competition for fish is high.

In some cases, stocking another strain or species will produce a larger fish to the angler. For example, rainbow trout will do well in water a little too warm for brook trout or splake. In addition, some strains such as Kamloop rainbows are not as vulnerable to angling and will enter the creel later in the season or carry over into the following season.

Poor Quality Trout

Trout of poor quality are usually the result of parasites, poor flavor or poor appearance. These problems are not as common as poor fishing or small fish, but can be detrimental to a sport fishery. Neascus ssp. and yellow grub (Clinostomumm spp.) are the most common, but control of the problem is not feasible. An informational leaflet entitled "Black Spots In Fish" (Informational Leaflet No. 2) is available for dissemination when answering inquiries.

Poor flavor is not often encountered in Minnesota trout lakes. It most often occurs in marginal waters which warm excessively or in fish that are in close contact with lush or dying vegetation. As with parasites, control is not feasible.

Poor appearance can also include white instead of pinkish flesh. The abundance of crustaceans in the diet usually determines the level of color in the flesh. An introduction of crustaceans such as native crayfish, Hyalella spp. or Gammarus spp. help if they are not already present

in the lake.

Socio-Economics

Stream trout lake management is usually intensive and depends on heavy fishing to provide an acceptable cost/benefit ratio.

When judging the suitability of a small lake for trout management, the manager must address the problems of excessive pressure. Roads, public access, parking and even the lake itself should be studied. Construction and maintenance must be addressed in any intensive lake management plan. Lakes with public campgrounds are usually ideal for intensive stream trout mangement.

V. LAKE TROUT MANAGEMENT PLANNING

Habitat Requirements and Distribution

Lake trout require cold, well-oxygenated water to survive. They thrive only in deep, oligotrophic lakes in northeastern Minnesota and a few other deep lakes in the northern half of the state. To determine if a lake can support lake trout, water samples should be taken in mid-August and the following conditions must be met in a zone of at least 5 vertical feet of water:

- temperature does not exceed 55 degrees F.
- dissolved oxygen is at least 5.0 ppm
- pH between 6.0 and 8.0

Minnesota has two basic types of lake trout lakes, those with fish as the primary forage base and those in which insects and other invertebrates provide the main food source. The lakes that contain smelt and/or cisco generally produce most of the trophy lake trout, but provide a harvest of only around 0.5 lbs./acre/year. The lakes in which perch are an important forage species generally provide annual harvests higher than smelt/cisco lakes, but rarely produce lake trout larger than 10 pounds (mostly 1.5-3 pounds). Lakes with invertebrate forage provide an annual harvest of up to 5.0 lbs./acre/year but generally produce much smaller lake trout (0.75-1.5 pounds) with few fish exceeding 5 pounds.

Special Problems

Lake trout management is generally not feasible in lakes with heavily developed shoreline areas. Even though difficult to catch in summer, lake trout can be vulnerable to

over harvest during the winter and spring. This is especially detrimental in lakes with poor natural reproduction. Survival of stocked lake trout fingerlings has been successful primarily in reclaimed lakes. Yearling lake trout survival is higher than fingerling in lakes with predators and/or competitors.

With a few exceptions, lake trout management is confined to lakes which receive relatively light fishing pressure. Stocking of remote, lightly fished waters such as interior Boundary Waters Canoe Area Wilderness (BWCAW) lakes should be reduced, intermittent or discontinued especially if there are nearby trout lakes with adequate, natural populations.

Sampling

Lakes intensively managed for lake trout should be test netted periodically (once every 3-5 years) according to the guidelines of the Manual of Lake Survey. This information, along with periodic creel census information, determines necessary changes in the management plan.

Management to Improve a Poor Lake Trout Population

The following conditions may indicate unsatisfactory lake trout populations:

- lake trout net catches from several assessment periods substantially below regional or area median.
- all or most lake trout less than 14 inches in length.
- size and age gaps demonstrating spotty reproduction or recruitment

The common management measures to overcome these problems are as follows:

A. Inadequate forage - If condition of young lake trout (1-4 yrs. old) is poor, forage is probably inadequate. Nets used during standard lake surveys may not provide quantitative information on forage

abundance. However, if proper sized forage is scarce or absent in 1/4" trapnets or small mesh gillnets and if brood fish of the forage species are substantially below region or area medians, it is likely that forage abundance is not adequate to support a satisfactory lake trout population. Inadequate forage also seems to be a problem in larger lakes that have high abundance (over 10/lift) of large herring or whitefish (over 12"). In this situation, there appears to be substantial competition between the Coregonid species and young lake trout for pelagic and benthic organisms (food energy transfer), causing slow trout growth and poor condition of trout until they reach a size large enough to feed on the Coregonids. This situation may be conducive to trophy sized lake trout but results in low catch rates of satisfactory sized fish. It may be possible to improve the situation by using one of the following tools:

1. Reduce competitor abundance - Sucker removal by established methods may create a void that can be utilized by lake trout. See page 8 for a discussion on this technique.
2. Forage introduction - Although this has limited application, it may be warranted under the following circumstances: a) The forage species is not already present and it is for introductory purposes only (forage should not be stocked for maintenance feeding), b) the forage species already exists in the watershed (if not, its introduction must be cleared through proper channels with the Fisheries Chief) and c), the forage to be introduced should be screened for undesirable species.

Forage introductions should be limited to a

suitable species of minnow (under study) or the crustaceans Mysis relicta or Pontoporeia affinis.

3. Chemical rehabilitation - This should be considered only if the above measures are not effective, the lake is of suitable size (100-500 acres), and there is a favorable cost/benefit ratio (refer to "reclamation manual").

B. High predator population - Many fish eating species can become lake trout predators, especially in the early stages of lake trout life. Northern pike are the major predator and are sometimes possible to control.

1. Trapnetting northern pike after ice-out - Discussed on page 22. The goal should be to reduce northern pike to a level of less than 2 per lift with a buffer forage species present, or less than 0.5 per lift with no buffer species present.

2. Chemical rehabilitation - If the above measure to control predators prove ineffective, the lake is of suitable size (100-500 acres) and there is a favorable cost/benefit ratio, rehabilitation may be justified (refer to "reclamation manual").
If none of the above are feasible to reduce predator abundance, management should be discontinued.

C. High fishing pressure - The primary symptom is reduction of the catch rate, but there also may be a reduction in the number of year-classes represented in the fishery. Where natural reproduction and survival is good this problem tends to be self-regulating (under present regulations). The population may be fished to a low level, but as the catch rate declines so does fishing pressure, thus allowing the population to recover. However, in lakes with poor natural reproduction, heavy fishing pressure can cause a swift decline of the population with little chance for natural recovery. If natural reproduction is poor and fishing pressure has

reduced the lake trout population to a low level, increased stocking may be warranted.

D. Habitat degradation - Domestic or municipal pollution may reduce the lake trout carrying capacity by decreasing oxygen levels in the hypolimnion. Natural aging also causes this problem. If sources of domestic or municipal pollution can be identified, the appropriate government agency should be notified. If habitat deterioration is limiting lake trout survival, and nothing can be done to correct the problem, lake trout management should be discontinued.

E. Inadequate natural reproduction - Lack of lake trout spawning habitat is generally not a problem in native lake trout lakes. However, spawning habitat may be lacking in lakes where lake trout have been introduced. Where spawning habitat is adequate, the most common cause of poor reproduction is an abundance of competitors and/or predators which reduce hatch success or survival of young lake trout. The following tools may improve abundance of young lake trout:

1. Predator and competitor control - Discussed on page 10 and page 8, respectively.
2. Chemical rehabilitation - Consider only if predator and/or competitor control is not feasible.
3. Stocking - Fingerlings (50-75/lb. at 10-20/surface acre) should be stocked for 2-3 consecutive years followed by an evaluation.
   a) Stocking in established lake trout lakes with substantial populations of predators and/or competitors - Yearling lake trout (10-15/lb.) should be stocked at a rate of about 5-10 per surface acre every other year. This enables evaluation of stocking versus nonstocking years. Stocking rates can be adjusted after adequate evaluation.
   b) Stocking new lake trout lakes with populations

of predators and/or competitors - Yearling lake trout should be stocked annually at the rate recommended above until survival can be assessed and mature females are found. Stocking should then be cut back to every other year to assess natural reproduction. Before stocking, lakes of this type should meet the following criteria:

i) Lakes over 70 feet deep with at least 5.0 ppm dissolved oxygen throughout the hypolimnion and with smelt or Coregonids less than 10 inches long as a buffer - Stock only if northern pike can be controlled below 2.0/gillnet lift and walleye can be controlled below 5.0/gillnet lift.

ii) Lakes less than 70 feet deep with walleye and/or northern pike with oxygen levels above 5.0 ppm throughout the hypolimnion and no buffer species - Stock only if northern pike can be controlled below 0.5/gillnet lift and walleye can be controlled below 2.0/gillnet lift.

c) Rehabilitated lakes or those with very few predators or competitors - Stock fingerling lake trout (50-75/lb.) at a rate of 40/surface acre every other year. In newly rehabilitated lakes, stocking should be annual for the first 3-4 years or until mature females are found.

d) Evaluation of stocked lake trout - It is most important to set assessment nets in the preferred temperature zone of lake trout (50-55 degrees F.). Lake trout are often suspended in the water column during the summer months and are difficult to capture with standard bottom-set gillnets. By

locating suspended lake trout with a graph recorder and then setting suspended gillnets, it may be possible to improve the catch rate. In cases where summer netting is not effective, netting should be done in May-June and/or September-October when lake trout are more vulnerable. Netting should be done every 3-5 years on each lake and resurveys should be conducted every 10-20 years depending upon the rate of change of other environmental factors. Creel censuses should be conducted on lakes with heavy angler use to determine if stocked fish are being taken by anglers.

VI. LARGEMOUTH BASS MANAGEMENT PLANNING

Habitat Requirements and Distribution

Largemouth bass are present throughout Minnesota with the exception of Lake Superior and some of the deep, cold lakes of northeastern Minnesota.

Sampling

Largemouth bass are "net shy" and difficult to sample quantitatively with standard lake survey nets. Some of the tools that have been used to give managers better information on bass populations include:

- night electrofishing.
- seining - Adult bass can be sampled with large seines in the spring and young-of-the-year bass are vulnerable to standard shoreline seines.
- angler reports - The manager can learn a great deal about a bass population simply by talking to fishermen, resorters, etc. Cooperative angler surveys may have some value if closely monitored. Information collected from bass tournaments may also be useful.
- visual observation - The manager can obtain information on bass populations by observing shallows during the spawning period.
- creel census - A creel census can provide a great deal of information on bass population structure.

Management to Improve a Poor Bass Population

The usual problems resulting in a poor largemouth bass

population and the management tools used to overcome them are as follows:

A. Inadequate forage - Other predators such as walleye and northern pike often compete with largemouth bass for food. If forage is scarce and largemouth bass are of greatest importance, stocking of other predators should be reduced or discontinued. Other control measures of northern pike may also be considered. If it appears that bluegill are competing with largemouth bass for food or space, a partial chemical treatment as described by Davis (1979) may be beneficial. This technique should be considered experimental and its effectiveness should always be evaluated.

   Stocking of perch or other forage species is not likely to solve the problem and may create new problems.

B. High predator population - If northern pike are abundant and forage species scarce, it is possible that a largemouth bass population could be significantly reduced by northern pike dominance of feeding edges. Under these circumstances, the manager might consider reducing the northern pike population as described on page 10.

C. Habitat degradation - If rough fish action, pollution or natural eutrophication are causing frequent winterkills, the following tools may alleviate the problem:

   1. Aeration - Discussed on page 12.
   2. Rough fish control - Discussed on page 12.
   3. Pollution control - Discussed on page 12.
   4. Chemical rehabilitation - If rough fish populations are extremely high, this may be the only feasible solution. (See "reclamation manual").
   5. Stocking after winterkill - The method of bass stocking after winterkill is somewhat dependent on the bluegill stocking style and timing since the bass will require a fish forage base as they reach large fingerling size. However, there are very few

lakes which winterkill so severely that there is no carry over of a few forage fish of some sort. Good assessment and recording (already available for most managed winterkill lakes) will help dictate the stocking style best suited to the individual lake.

Stocking of brood stock is probably the easiest way to establish a new population. Stock 1 pair per 10 acres soon after ice-out. A problem with this method is locating and trapping mature (brood stock) bass in the numbers required. In some areas, bass brood stock can be collected by electro-fishing in the spring or taken from rough fish traps. Brood stock can also be obtained from commercial seiners and over-wintered in easily harvested ponds. Fry stocking also works well. Fry are readily collected at time of "swim-up" and can be safely transported in large numbers. The manager should experiment in area bass lakes with this collection method and prepare a bass fry contingency plan before the need actually arises. Since each lake differs in how many bass it will raise and support, evaluation is important in order to adjust future stocking rates.

Finally, if bass fingerlings are used for restocking, the stocking rate is 50-100/acre.

6. Protection of vegetation - Aquatic vegetation provides essential cover for young largemouth bass. Every attempt should be made to ensure that vegetation in areas used by spawning bass is not removed.

D. Inadequate natural reproduction - Largemouth bass have a high reproductive potential and insufficient natural reproduction is seldom a problem. If maintenance stocking is necessary to provide a bass fishery, bass management is probably not feasible.

E. Fishing pressure - While fishing pressure in Minnesota's prime bass waters has not been shown to curtail necessary natural reproduction, there is concern that in some instances the quality of the sport fishery is affected by excessive harvest. It is also theorized that cropping bass off at around 12 inches can affect the predator/prey relationship in a lake and increase the possibility of a stunted panfish population.

Research is presently underway in Minnesota lakes to study the "slot length limit" as a means of combatting high harvest where it appears to be a problem.

VII. CRAPPIE MANAGEMENT PLANNING

Black crappies generally favor the clear lakes of central and northern Minnesota, while white crappies are found mainly in the more turbid lakes of southern Minnesota. However, there is substantial overlap. Black crappies are usually associated with abundant aquatic vegetation while white crappies often exist in lakes where aquatic vegetation is lacking.

Special Problems

Often a good crappie population exists in a lake, yet few are caught by fishermen. If the lake lacks fish concentrating structure, crappies may suspend in midwater and be difficult for fishermen to locate.

Some Minnesota fisheries managers are currently experimenting with "fish shelters" to concentrate crappies in lakes of this type. Evaluation is still underway. Fish shelters, however, do not improve the productive capacity of the lake; they concentrate the fish that are already present.

Sampling

Crappies are difficult to sample, but an idea of their abundance can be acquired by trapnetting during the spawning period, observing spawning sites, and conducting creel censuses in early or late winter or early spring.

Management to Improve a Poor Crappie Population

Any of the following problems can result in a crappie

population that is unsatisfactory in terms of numbers or size of fish:

A. Stunting - If few crappies over 8 inches are present in a population and age analysis indicates slow growth rates, it is likely that population is overcrowded or "stunted". The only proven remedy is chemical rehabilitation. Because of cost, this technique is feasible only on small lakes and considered only if the lakes does not provide satisifactory fishing for other gamefish species.

   Stocking predators for controlling stunting should be considered experimental and any such stocking must include plans for intensive evaluation before and after.

B. Habitat degradation - Crappies are among the most winterkill resistant species. However, if eutrophication or rough fish have degraded the habitat to the point where winterkills are too frequent to allow development of a satisfactory crappie population, the following tools may correct the problem:

   1. Aeration - Discussed on page 12.
   2. Rough fish control - Discussed on page 12.
   3. Pollution control - Discussed on page 12.
   4. Chemical rehabilitation - If rough fish have degraded the habitat to the point where survival is low, rehabilitation may be the only feasible solution.
   5. Stock after winterkill - If the crappie kill was complete, stock fingerling or larger crappie at a rate of 50-100 per acre if available. If not available, brood fish should be stocked at a rate of 1 pair/10 acres soon after ice-out. If habitat problems persist and the above techniques are not feasible, crappie management should be discontinued.

C. Inadequate natural reproduction - Crappie have a high reproductive potential. Poor reproduction is rarely

limiting to crappie populations. However, if habitat favorable to survival of young crappie is lacking, a logical tool is stocking. A rate of about 50/acre/year is required to maintain a satisfactory population. Care should be exercised when using this method since crappie are often difficult to obtain in the numbers required for stocking purposes, especially without including undesirable species. White crappie should not be introduced into watersheds where not already present since they are judged to be inferior to black crappie in terms of population stability, body structure and edibility.

VIII. BLUEGILL MANAGEMENT PLANNING

Habitat Requirements and Distribution

Vegetative cover appears to be the key habitat requirement of successful bluegill populations. Bluegill exist throughout their native range and in many northern waters due to introductions.

Management to Improve a Poor Bluegill Population

If assessment netting indicates that a bluegill population is unsatisfactory in terms of number or size of fish, it is probably the result of one of the following problems:

A. Stunting* - Stunting is the most common problem in managing bluegill populations. To improve growth, the population must be substantially reduced. The proven tools to accomplish this are as follows:

   1. Partial rehabilitation - This involves applying Fintrol to the shallows in fall when a high percentage of the small bluegill are concentrated near shore. This technique is limited mainly to small lakes because of the cost and limited availability of the chemical. Refer to Davis (1979) for details on this procedure.
   2. Chemical (total) rehabilitation - This should be considered a last resort and be applied only when the lake does not provide satisfactory fishing for

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*Stunting should not be assumed because of the presence of many small fish and/or a lack of large fish. Growth should be checked by scale analysis and compared to area or regional medians.

other game fish species.

B. Habitat degradation - Habitat degradation in the main bluegill range includes domestic, agricultural and industrial pollution and rough fish action. The results are turbid water, lack of food and dissolved oxygen problems.

Some management options to control these problems are aeration, rough fish control, pollution control, and chemical rehabilitation. You are referred to the walleye chapter for discussions of these options.

When stocking after rehabilitation or even winterkill, extreme care should be exercised in stocking only pure strain bluegill since hybridization occurs readily.

Stocking rates of bluegill into winterkilled or rehabilitated waters vary with size and maturity of fish available as well as time of year being stocked. Some suggested guidelines follow:

1. Gravid brood stock (mature fish early spring) - For the purpose of establishing a population they may be stocked at a low rate of 10 pair per hundred acres. Be certain to evaluate this procedure as some lakes do not have adequate spawning areas and the stocking plan may require revision.
2. Adult stocking - If an adequate supply of large (stunted or otherwise) bluegill are available at a reasonable cost (time and expense), they should be stocked in early spring at a rate of 50-100 per acre. This stocking method should not be used where the receiving lake is expected to provide long term fishing (without winterkill) as stunting will probably occur sooner and pure strain bluegill are difficult to obtain in these high numbers. The advantage of this method is a sport fishery one year earlier than when using fingerlings or brood stock.
3. Fingerling stocking - Sometimes it is difficult to

obtain brood stock at the proper time but larger supplies of young-of-year bluegill become available later. These should be stocked at a rate of 50-200 per acre depending on size, condition, cover and numbers of predators.

C. Inadequate natural reproduction - Inadequate natural reproduction is seldom a problem. However, rough fish action or lack of protective vegetation can cause problems in certain instances. Where one or both of these problems are considered to be a limiting factor, the following tools may be effective:

1. Rough fish activity - Carp and bullheads (especially) destroy vegetation by physically uprooting plants and roiling the water thus preventing light penetration necessary for plant growth. They also recycle nutrients which may intensify algal blooms, decrease light penetration and have a significant negative affect on macrophytes. Where these conditions exist, total chemical rehabilitation is probably the only solution.
2. Vegetation protection - Both emergent and submerged vegetation provide cover and feeding grounds for young bluegill. Every attempt should be made to preserve vegetation if lack of it is a potential limiting factor. Applications for aquatic nuisance control permits should be scrutinized carefully and rigid enforcement of existing regulations may be necessary.
3. Stocking - Stock if surplus bluegills are available at a reasonable cost.

IX. OTHER SPECIES OCCASIONALLY MANAGED IN MINNESOTA LAKES

The species discussed in this chapter are occasionally managed and techniques are not well defined for Minnesota waters. Management of these species should be carefully planned, evaluated and documented to serve as information for future management.

A. Smallmouth bass - Smallmouth bass require cooler waters and firmer substrate than do largemouth bass. As a result they are rarely found in eutrophic lakes. They thrive in the clear, rocky lakes of northeastern Minnesota.

Sampling smallmouth bass populations presents the same problem as with largemouth bass. Refer to the techniques discussed on page 41 of the largemouth bass section.

Introductory stocking in centrarchid-walleye lakes has occasionally been successful, but it should be considered only where smallmouth bass spawning habitat is limited. Smallmouth sometimes compete with walleye for food and if they become abundant, could have a negative effect on the walleye population. Smallmouth bass management may be an attractive option in lakes with suitable smallmouth bass habitat where walleye management is not working well.

B. Yellow perch - Yellow perch, a common species in Minnesota lakes, may be the most important link between lake productivity and the well-being of predatory fish species. Perch are prolific, adaptable to a wide range of lake habitats and are generally of sizes suitable as prey.

The highly valued predator fishes - walleye, northern pike and largemouth bass - depend on perch as prey in many lakes. Maloney and Johnson (1957) have found in walleye lakes (over 1,000 acres) that walleye

populations are usually associated with fairly large populations of perch. They suggest that the similar habitat preference of young-of-the-year perch and walleye together with their comparative growth rates and feeding habitats may be an important and a causative factor in their relationship. They also pointed out the necessity of understanding and managing whole fish populations rather than placing emphasis on a single desirable species.

In typical bass-panfish-pike lake associations, containing no whitefish or cisco (tullibee), perch populations are generally low. Northern pike apparently have the capability of reducing recruitment of perch breeding stock until the perch population collapses. The ability to affect perch abundance by adjusting northern pike abundance may be a potent tool. But, one or two stockings of northern pike into a lake has been shown to affect the fish community for 10-15 years. However, in large, natural walleye lakes perch populations maintain adequate resiliency to predation. Yellow perch enjoy an excellent reputation as a sport fish in many regions of North America. If management can provide quality perch to the creel, it certainly should be considered.

C. Channel catfish - Channel catfish are native to southern Minnesota's major rivers and are also found in the Red, Red Lake, Otter Tail and St. Louis rivers. They also occur in riverine lakes such as Tetonka and Big Stone. Channel catfish are usually stocked in rough fish-game fish, centrarchid, or centrarchid-walleye lakes for the following purposes:

1. To augment an existing fishery. This usually requires stocking yearling sized fish since largemouth bass, bullhead and many other warmwater fish prey heavily on young catfish.

   Stocking rates are usually 500-1,000 fry, 1-2

pounds of fingerlings or 25-50 yearlings per littoral acre. It should be noted that:

a) Little if any natural reproduction takes place in other than riverine lakes.

b) Survival of stocked fry and fingerlings (under 8") in lakes with well established piscivorous fish populations is poor.

2. To establish a short term sport fishery after lake reclamation while the long term fish become established.

3. To provide trophy fish in addition to the natural existing sport fishery.

D. Bullheads - Bullheads are classified as rough fish and are commercially harvested in many waters of the state. They are accepted by a minority of resident anglers and eagerly pursued by many non-resident fishermen.

Three species of bullhead occur in Minnesota: the black, which predominates in the warm, murky lakes of the south; the yellow, found in warm, clear lakes; and the brown, which prefers the cooler northern waters.

Due to inherent problems, management of lakes for bullheads is practiced only in southern Minnesota.

Black bullhead introductions are sometimes made after winterkills to provide a fast recovery fishery.

Harvesting has been carried on to reduce competition with game fish, to improve the quality of the bullhead fishery by reducing their numbers (intraspecific competition), and to harvest an otherwise under-utilized protein resource.

The problem of over-population and resultant stunting is extremely difficult to combat. Annual average removal of 52 lb/acre at Lake Sallie, Becker County, did not control or adequately harvest black bullheads (Olson and Koopman 1976).

Observations suggest that largemouth bass may suppress burgeoning black bullhead populations in reclaimed and

winterkill type lakes. There is also concern over the role that bullheads play in the recycling of nutrients in these types of lakes. More research and close management evaluation is needed to develop cost effective techniques for black bullhead management. Yellow bullheads require relatively clear, warm waters with some vegetation. They are unobtrusive in the fish community and usually add to the sport fishery where present. Management consists of introductory stocking after rehabilitation or winterkill. It appears that the yellow and brown bullheads, the most desirable species to the angler, may be vulnerable to over exploitation by commercial hoopnetting (Olson and Koopman 1976). Brown bullheads are currently not managed for sport fishery purposes since the demand is not high in the prime range. However, they do have some value in the commercial fishery.

E. Sauger - Presently the sauger is found in Lake of the Woods, Rainy Lake, and Lake Kabetogama. It is common in Lake St. Croix, the Minnesota River and the Mississippi River south of St. Anthony Falls. Sauger populations are being monitored with no intensive management planned. They appear to be a "boom and bust" species, making management difficult. It appears that sauger are accepted at a smaller size than walleye, enter the creel earlier and may allow a larger harvest.

F. White bass - A species which is present in lake chains and riverine habitats. They are vigorous predators, and at this time no management which would enlarge their presence in Minnesota waters is considered. They may have some management potential.

X. INDIVIDUAL LAKE MANAGEMENT PLAN FORMAT

Introduction

As fisheries personnel who have addressed sportsmen clubs or lake associations will attest, an individual lake management plan is a very important document. It should be well thought out with decisions capable of being defended. It should be current. It should have some new ideas waiting in case present management is not effective or fails due to unforeseen natural changes.

Form number NA-01570-01 (Lake Management Plan) has been prepared for the purpose of documenting a plan for individual lake management. This form will replace the management recommendation section in the lake survey form. It is compatible with computerized information retrieval systems, yet meets the needs of area level management planning.

Lake management plans are necessary as aids to many throughout the Fisheries Division. Regional offices need them for integration in the regional planning and budgeting process as well as to provide advice and input. St. Paul staff will use it for supply and demand evaluations, operational management, strategic planning, staffing, budgeting and legislative work.

A statewide system of organized lake management planning is necessary to provide continuity. New managers should have the benefit of understanding previous decisions and how they were determined as well as what stage of management a given lake is in.

The individual lake management plan is the most important document in a lake file. The time necessary to make it an accurate, professional plan is time well spent.

Developing the Plan

Only lakes that are receiving some sort of management attention are to be addressed during this planning effort. In other words, completely private lakes or lakes so remote that management is considered infeasible need not be addressed at this time.

Using the lake priority planning system outlined on page 3 of this guide, the manager should prepare a prioritized list of lakes to begin preparing the lake management plans. Where information is so lacking that a plan cannot be written, a separate list should be compiled of those lakes for the purpose of prioritizing area lake survey needs.

The lake management plan contains four major planning items. The long-range goal is a brief statement about where the manager would like to be with the lake in about 10 or 15 years. This should be an ideal, and should be consistent with the "potential plan" which is also an ideal in the sense that the manager is being asked" what could you do if money and manpower were removed as limiting factors in your area management program?"

The mid-range objectives and the operational plan are also closely related; both are realistic in the sense of money and manpower. In other words, what do you actually intend to do with your normal budget (operational plan) and where do you intend to be with important sub-goals about 5 to 8 years in the future (mid range objective).

The primary and secondary species management boxes are self-explanatory. These are important decisions, since the species that a lake is to be managed for completely dictates the tools that will be used and thus the money and manpower to be expended. These decisions must be consistent with the goal and with the narrative. Species not listed as primary or secondary will not be managed for and may be managed against. The "narrative" is necessary for the manager to explain how he arrived at the species management decisions as well as

other management decisions. A list of key parameters in managing lakes for fisheries has been included in the following paragraph. They are in the same order that they should be included in the narrative. They are provided as a composition aid, as reminders so that important elements are not forgotten, and for continuity so that information can be recorded in the most efficient manner. If a parameter is superfluous, simply skip over it and proceed to the next in line.

Following are the parameters to be included, if appropriate, in the narrative: Historical perspectives - various surveys, past management and social considerations, i.e., angler satisfaction, etc; present limiting factors (refer to Guide) survey needs; land acquisition (public access, northern pike spawning area, etc.); habitat development and protection; commercial fishery; stocking plans; other management tools (refer to Guide); evaluation plans.

As you proceed with the narrative, underline these key parameters. This will greatly facilitate recording and comprehension by users. Additional narrative regarding the general conclusions can then follow. Use the back and add additional sheets as needed.

Conclusion

The "lake management plan" should be an orderly dissertation beginning with the long range goal - an ideal attainable in a ten to fifteen year period. The mid range objective should be a point five to eight years down the the road with your operational plan toward the long range goal. The operational plan is what you intend to do in the next few years with the budget and manpower you have reason to believe will be available.

One of the most important uses of the potential plan will be to enable the St. Paul planning staff to answer the

common legislative query "what would you do with this money and manpower if we made it available?" For that reason a dollar figure must be included by the area manager in the potential plan. This dollar figure must be above and beyond what the manager intends to spend in his operational plan. In other words, if your potential plan calls for a public access and acquisition of a northern pike spawning marsh, but your operational plan does not include those items because of budget limitations, the dollar figure shown for your potential plan would be for the public access and the spawning marsh acquisition. One further caution, the potential plans must be realistic and feasible. Dollar amounts should be based on present values, i.e., value at the time the plan is dated. Do not spend agonizing hours determining values. Use your judgment as to value and round off to the nearest hundred dollars.

Finally, the potential plan is also important for developing strategic plans for long range program changes and for directing management evaluations and research.

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APPENDIX

NA-01570-01

DEPARTMENT OF NATURAL RESOURCES

LAKE MANAGEMENT PLAN

(Use reverse side and add additional sheets as needed)

Region	Area	D.O.W. Number	County	D.O.W. Lake Name	Acreage
		–			

Long Range Goal:

Operational Plan:

Mid Range Objective:

Potential Plan:

TOTAL $ _____

Primary Species Management	Secondary Species Management

Area Supervisor's Signature	Date
	__ __ / __ __ / __ __

Regional Supervisor's Signature	Date
	__ __ / __ __ / __ __ Month Day Year

NARRATIVE:

'Historical perspectives - various surveys; past management; social considerations; present limiting factors; survey needs; land acquisition; habitat development and protection; commercial fishery; stocking plans; other management tools; and evaluation plans'

FOR CENTRAL OFFICE USE ONLY

Entry Date	Year Resurvey
__ __ / __ __ / __ __	__ __

Stock Species - Size - Number per Acre

Pr./Sec.

Schedule	Year Beginning
	__ __

Population Manipulation
☐ YES ☐ NO Year __ __

Development
☐ YES ☐ NO Year __ __

Creel or Use Survey
☐ YES ☐ NO Year __ __

Other

cc: Area, Regional and St. Paul Fisheries Offices