DEPARTMENT OF NATURAL RESOURCES

Fisheries Lake Management Planning Guide

Fish and Wildlife Division | Section of Fisheries | Special Publication 194

May 2025

Prepared by:

Lake Management Planning Guide Steering Committee:

Jon Hansen (co-chair; co-editor), Dave Weitzel (co-chair; co-editor), Nate Hodgins, Nathan Olson, Carl Pedersen, Steve Persons (retired), Joe Stewig, Shannon Fisher

Additional contributing authors:

Natalie Haberman (Policy and Planning Program), Bass Technical Team (co-led by Eric Altena and Tom Jones), Panfish Technical Team (co-led by Dave Weitzel and Jeff Reed), Muskellunge Technical Team (co-led by TJ DeBates and Brian Herwig), Walleye Technical Team (co-led by Doug Schultz, Rick Bruesewitz, and Dale Logsdon), Community Fishing Subcommittee (Tim Ohmann, Mario Travaline, and Nate Hodgins), Lake Survey Prioritization Subcommittee (Bethany Bethke, Jim Wolters, Dean Paron, Joe Stewig, Dave Coahran, Jacquelyn Bacigalupi, Liz Scherber, Jon Hansen), Fisheries Climate Action Subcommittee (Heidi Rantala, Kristan Maccaroni, Dean Paron, Tanner Stevens, Matt Weberg, Lauren Dagen, John Lindgren), Fish Habitat Subcommittee (John Hiebert, Heather Baird, Tara Latozke, Craig Soupir, Eric Altena, Mike Kelly)

This is an updated version of the 1982 Lake Management Planning Guide (Special Publication 132).

Development of this guide was supported by grants from the Sport Fish Restoration Program for Lake and Stream Fisheries Management.

HOW TO CITE THIS DOCUMENT Minnesota Department of Natural Resources (MNDNR). 2025. Fisheries Lake Management Planning Guide. Minnesota Department of Natural Resources, Special Publication 194, St. Paul, Minnesota (version 2.0), released May 2025.

Minnesota Department of Natural Resources
Division of Fish and Wildlife
Section of Fisheries
500 Lafayette Rd
St. Paul, MN 55155
mndnr.gov/fishing

A Note to Fisheries Staff

The Lake Management Planning Guide is a continuation of over forty years of excellence in preparing for and implementing fisheries management on lakes within the State of Minnesota. The guide will be used by the state's fisheries managers as they employ the art and science of fisheries management – practices that require consideration of a wide array of ecological, social, and fiscal variables. The guide provides a framework for staff to navigate the intersection of those variables in the development of individual lake management plans that represent the Agency's perspectives and offer a consistent structure while also providing local flexibility. The process of lake management planning, as laid out in this guide, calls for an intentional approach to evaluating actions through an iterative adaptive management process. This plan is intended to be a living document and periodic updates and revisions will be made as research in fisheries management reveals new insight, methods, and techniques.

As the Fisheries Section Manager, I would like to express my sincere appreciation to the statewide committee that made this updated and state of the art guide a reality. The committee members include regional representatives Nathan Olson (NW Region), Steve Persons and Dave Weitzel (NE Region), Joe Stewig (Central Region), and Nate Hodgins (Southern Region). Carl Pedersen represented the Large Lake program and provided additional insight from the Northwest Region. Shannon Fisher and Jon Hansen provided leadership and represented the Central Office.

I would also like to express appreciation to the many staff involved in developing species guidance through technical teams and work groups and Natalie Haberman (Policy and Planning Program) for providing critical guidance on the public input process. I would like to acknowledge the important technical review provided by the Assistant Regional Fisheries Managers; Ted Sledge (NW Region), Dave Weitzel (NE Region), Neil Vanderbosch (Central Region), and Brian Schulz (Southern Region).

Finally, I would like to acknowledge the staff that developed the original management planning guide in 1982. They could not have envisioned that the planning guide they developed would have been used unchanged for over forty years. The updated guide we now have would not have been possible without their pioneering contributions.

Brad Parsons

Division of Fish and Wildlife | Fisheries Section Manager

Table of Contents

Preface and History

The 1982 Lake Management Planning Guide (MNDNR 1982) established individual lake management as the standard for fisheries management in Minnesota. That guide provided a template and process for the development of individual lake management plans, and gave managers basic information, state-of-the-art for the times, needed to make sound management decisions. Since that guide was published, management plans have been prepared and maintained for over 2,500 lakes in Minnesota, with about 170 plans written or revised annually. Since 1982, management plans have evolved in different directions in different parts of the state, assuming many forms, but always retaining the same basic functions. Over this period, the intended audience of plans increased to include fisheries staff, agency managers, management partners, and often stakeholders and a diverse public. A tremendous amount of new information has been made available to managers, and managers themselves have learned much about the effectiveness of various management strategies. Over time, the need for an updated guide has become apparent, both to bring management plans back to a more consistent format, and to incorporate new systems, processes and knowledge gained over the past 40 years.

Introduction

The Lake Management Planning Guide (LMPG) provides the framework for Section of Fisheries staff to engage in the scientifically driven cycle of iterative lake management planning (Figure 1). Individual lake management plans (LMPs) are central to this cycle, and the primary purpose of the LMPG is to facilitate the writing of LMPs. The LMPG is intended to offer consistency in form and content yet flexibility in approach and application to reflect the diversity of Minnesota's lakes.

Responsible fisheries management requires social credibility – largely ensured through transparency, honesty, and consistency in process and form. As such, this guide lays out clear expectations for staff to follow throughout the entire plan development process, including public engagement. An LMP template is also provided, with some components being optional and others required. This template was designed to contribute to an end-product that meets the diverse needs of staff, managers, various partners, and the public.

The LMPG is a framework and not a detailed synthesis of technical fisheries knowledge. Specific literature references are relatively scant as many of the concepts offered are broad and established, making it challenging to identify the original source. However, the LMPG will refer to more detailed, up to date treatment of technical chapters (e.g. comprehensive species management, climate change considerations) where citations will be plentiful and updated more frequently. Recommendations made within LMPs should be based on current state of knowledge, some of which can be accessed in those living chapters; however, authors must also take this responsibility on themselves.

Figure 1. The cycle of individual lake management.

Individual Lake Management – the Cycle of Management

Individual lake management follows an iterative cycle (Figure 1). It starts with a survey or surveys to determine initial conditions. A management plan is written to describe those conditions including limiting factors that influence fisheries dynamics, determine the desired future state of the system based on these limiting factors and available management tools, set realistic objectives, and describe a strategy for achieving that state. That strategy is followed for a period, while additional surveys are done to determine the system's response. Once the response is understood, the management plan is revised as needed, and the cycle is repeated. The information provided by surveys is the most important driver in the planning cycle and plans should include a well thought out evaluation strategy with a defined cycle of assessments.

Generally, Minnesota's fisheries should be managed within an adaptive management framework (Walters 1986) that facilitates flexibility and informs management decisions through explicit and properly designed evaluation.

Simply stated, adaptive management is learning by deliberate doing, then making management changes based on what has been learned in a "monitor-compare-adjust" routine (Walters and Holling 1990). Hansen et al. (2015) concluded that an adaptive management approach was critical when managing fisheries for resilience to disturbances; that is, the capacity of a system to absorb or recover from a disturbance while retaining its core structure and function (Holling 1973). Given the wide range of potential stressors to fisheries sustainability, the need for system resilience is high and the demand for adaptive management approaches which facilitate informed decision-making is higher. While iterative learning and adaptive management concepts are central to this LMPG, there are real limitations to this approach within an individual lake management framework (Box 1).

Individual lake management is central to Minnesota's fisheries management philosophy and the LMPG, however fisheries managers should understand the limitations presented by individual lake management. Our survey data are imperfect. Error is introduced from various sources (e.g., measurement error, process error, observation error), temporal resolution is usually poor, and the ecological complexities of lakes make cause and effect interpretation difficult. Understanding and acknowledging these limitations is crucial for responsible fisheries management and maintaining stakeholder credibility (Fayram et al. 2009).

Interpreting survey data within a larger context such as lake classes (e.g., Schupp 1992) can help avoid misinterpreting imperfect data. In cases where critical uncertainties exist around a driver or management action, adaptive management (Walters 1986) is a framework that should be employed. True learning is best done through Active Adaptive Management (Williams 2011) which requires replication and reference systems to separate true drivers from error. Thus, lessons learned through the individual lake approach should be viewed and employed with caution when not considering replication and reference lakes.

Box 1. A cautionary note about individual lake management.

In the spirit of an adaptive management approach, well-written management plans will capture a record of past management intentions, strategies, and actions to ensure that the lessons learned over several evaluation cycles are not lost. These plans can provide a concise history of conditions in a lake, our management efforts, and the results of those efforts – all of which are valuable for new and future management staff and stakeholders who wish to know more about the lake. All that information should be carefully considered when developing or reviewing the core aspects of a Lake Management Plan: Goals, Objectives, and the Operational Plan (Box 2).

Goals: a broad vision for the type of fishery you are trying to provide.

Objectives: specific, quantified benchmarks (targets or ranges) that tell you if you are achieving your goals. Management objectives should generally be SMART (**S**pecific, **M**easurable, **A**chievable, **R**elated to the goal, and **T**emporally bound).

Operational Plan: the planned and necessary actions (sometimes called strategies) proposed to achieve established objectives and corresponding goals.

Box 2. Core components of a Lake Management Plan. More details provided under Elements of a Lake Management Plan.

Process for Drafting and Updating Lake Management Plans

The Section of Fisheries has processes in place for drafting an initial or modifying existing management plans (either through a revision or amendment). These processes facilitate a coordinated approach to managing fisheries across Minnesota, ensure a sufficient internal review process, and provide the public and management partners engagement opportunities.

Plain language that will retain the required technical information but be more understandable by non-technical readers should be used. For example, a technical expert may write "*The Walleye gill net catch exceeded the management objective of 10 per gill net. Catches exceeded the third quartile value for ecological lake class 22 in three of the past four surveys*" but this is difficult for many readers to understand. A better statement may be "*The Walleye catch was high compared to those from similar lakes in most surveys since 2010, suggesting that good numbers exist, and that the population is meeting management expectations*". Sometimes, technical jargon may be the best way to communicate to subject experts, but a plain language explanation should also be included. For example, "*The percentage of angler-preferred Northern Pike based on the number exceeding 28 inches suggested good size quality (PSD28= 20)*", communicates the concept to subject experts and non-technical readers so that both may understand the meaning.

Box 3. Examples of plain language used to explain technical concepts.

LMPs have a broad audience that often includes non-technical users. Although LMPs are often used as a guide for subject experts which may require technical language, plain language should be used to the maximum extent possible and technical terms should be explained so a non-technical reader can understand the concepts (Box 3). Executive Order 14-07 defines plain language implementation in the executive branch. The State of Minnesota serves a diverse clientele. All documents, including LMPs, have accessibility requirements to ensure they are viewable by all readers. More information about accessibility requirements can be found in Minn. Stats. 16E.03, 363A.43, and Operational Order 132. A template for Initial or Revised LMPs can be found in Appendix 1.

Preparing an initial plan

An initial plan may be written following an initial survey or series of surveys that are sufficient to determine the physical and biological attributes of the lake. At this point, relatively few initial plans will be developed but in those rare cases the preparation of an initial plan will largely consist of compiling information and identifying information gaps. Primary and secondary species may be unknown, let alone goals for the fishery. The main purpose of this type of initial plan would be to get required information-gathering activities into the Area's work plan, and to characterize the stakeholder interest in the lake. An initial plan would still have goals and objectives but will likely be somewhat generic and could be borrowed from other similar lakes in the same Lake Class.

Revising a plan

Traditionally, plans were typically revised whenever a new survey was completed, but a single survey is insufficient to determine if goals were met or if management actions were successful. A more efficient strategy

is to plan multiple surveys in an evaluation cycle and revise the LMP once the evaluation cycle is complete. There may be instances when a plan revision is desired after a single survey. Examples include lakes with established management that are not actively managed and occasional surveys are the only management tool being used, or where there is a strong public desire to include recent survey data in a revised plan. Plans that have not been updated after the last planned survey date are outdated and should be revised or amended to include future survey plans. Sometimes events or conditions are such that some aspect of the plan must be changed unexpectedly. In that case the entire plan may be reviewed or revised, or, if the change is minor, a plan amendment may be appropriate (see next section).

Although most plans have had multiple revisions and management direction may be well established, new information can be used to update a plan. Regardless of how well established the management is, the planner should take a critical look at existing goals, objectives, and the operational plan to ensure they remain scientifically relevant, ecologically appropriate, and align with angler values. The planner should evaluate whether the established objectives are being achieved. If objectives are not being achieved, consider whether management actions, objectives, or even goals must be adjusted. When objectives are being achieved, the planner should determine if the goals for the fishery and management species still align with known or expected systems change drivers. Just because something is working now does not mean it always will – consider opportunities for resilience strategies (see Climate Change Chapter). Ultimately, changes made in a revised plan may be minor or sweeping and affect one to many aspects of the lake's management.

Preparing a plan amendment

Changes to the plan may be necessary prior to the end of an evaluation cycle. If significant changes such as a change in management species, goals, or objectives refute the evaluation cycle or active management strategies, a full out-of-cycle revision should be conducted. If the changes to the plan (specifically the operational plans) are relatively minor and will not impact the overall management strategy or expected outcomes, then a plan amendment should be drafted. The purpose of plan amendments is to ensure that those changes make their way into the area's work plans, and to document the reasons for deviation. Amendments may be driven by changes in availability of fish for stocking, changes in crew availability, new information needs, or other factors that do not change the fundamental management of the lake. Some common examples of plan amendments include adding a survey to meet a new data need, changing a survey date, or extending the plan because a planned survey could not be completed due to workload issues, or to document a one-time stocking change that is not expected to impact the overall outcome of the management strategy. A template for plan amendments is provided in Appendix 2.

Process and timeline for preparing initial or revised LMPs

The timing of plan revisions has varied among Area Offices based on local needs. It is recommended that plans be revised immediately following the completion of the evaluation cycle, with revisions occurring during the winter immediately following the final survey outlined in the previous plan. This schedule allows plans to be reviewed while the data is still fresh, public interest is often high, and allows changes to be implemented quickly. In some cases, however, it may be necessary to delay plan revision until a year after the survey was

completed. This may be a result of a backlog of work or may be strategic. Sometimes, allowing more time to evaluate the data or collect social information is necessary. Other times, the delayed schedule is needed to work with external partners (e.g. Tribes, US Forest Service) to ensure that appropriate time is allowed for their review process.

Processes for preparing and approving initial and revised management plans are the same.

YEAR 1

- January: Identify the management plans scheduled for revision or development over the coming year (aka proposals). Provide a list for Federal Aid proposal based on revision dates established in current plans, plus known needs for initial plans. Amendments may be listed on the proposal or added later to the completion report submitted at the end of the year (mid-May, year 2).
- Spring through Fall: Contact or meet with lake associations, management partners, and other interested parties to discuss management of lakes with proposed plan reviews.
- November: Compile current information and begin work on drafts for plans listed on the Federal Aid proposal, and for any additional plans or amendments for which a need has been identified.

YEAR 2

- January: Outreach (e.g., press release) promoting upcoming public input opportunity. Reach out to known tribal partners or connect with DNR tribal liaisons for guidance.
- February: The list of plans and proposed fishery goals will be posted on a dedicated web page with an associated press release soliciting input on management goals (not objectives). Expectations and more details for public input are outlined in the Social Considerations section of this guide.
- March: Complete work on draft plans, complete area reviews, and sign off at the area level. Submit area-signed plans to the region for review and approval. Add any previously unlisted plan revisions or amendments, or unlisted initial plans, to the Federal Aid proposal done in Year 1. Record dates plans or amendments were signed (at the area), mark the proposal as a completion report, and submit it to the regional office for review and final signature.
- April: Work with the Regional Fisheries Office (region) to finalize and approve LMPs. Supply final list of completed LMPs to the region for Federal Aid completion reporting.
- May: Upload the region-signed LMPs to final storage destination (currently I Drive). Update FishPad with all LMP and stocking plan changes.

A tabular version of the Timeline can be found in Appendix 3.

Process for preparing plan amendments

Plan amendments tend to be reactive, rather than proactive. They would typically be done prior to a scheduled plan revision, but not in place of that revision. The timeframe for review and approval may be condensed, and in some cases the need for public input may be waived. Timing depends on circumstances and urgency. Steps required to prepare a plan amendment are:

1. Review the current management plan, current information available on the lake, and changes in circumstances that suggest an immediate change in operational plans may be needed.
2. In consultation with the regional office, determine whether the proposed operational change requires an amended plan, a revised plan (accelerate the date for plan revision), or no plan prior to implementation.
3. If a plan amendment is required, consult with the regional office to determine whether public input on the change is required.
4. Prepare a draft amendment.
5. If public input is desired, issue a news release describing the proposed change and allowing a minimum of 30 days (from date of publication) for comment on the draft. Other outreach may be done at the area's discretion.
6. Once input has been received, incorporate that review as needed, sign at the area, and forward to the region for review and approval.
7. Attach the amendment to the original plan and post the resulting document to the I drive.
8. Update the plan (and stocking plan) in FishPad.

Notes on timing

Warm- and cool-water stocking proposals are usually due in mid-winter and are supposed to be based on approved plans. Therefore, plans covering those proposals should have been completed the previous winter. Work with regional staff if a plan revision must be finalized in the year of the proposed stocking, prior to the proposal deadline.

Cold-water stocking proposals are usually due in mid-summer, two years prior to the proposed stocking date (e.g., proposals for cold-water stocking in 2023 were due in summer 2021). Plans requesting new cold-water stocking must therefore be completed and approved two years prior to the commencement of that stocking. That time is required to get the proposed stocking into the hatchery production pipeline. Exceptions are sometimes possible.

Periodically (every few years), all plans in an area should be given a quick review to make sure none have fallen completely out of date, and that all are still relevant. Plans that have not been reviewed or revised for many years should be added to the Federal Aid proposal and revised.

Priority-Based Planning

Minnesota's rich lake resources provide exceptionally diverse and quality fishing opportunities but with that gift comes a significant challenge for staff tasked with managing these fisheries – insufficient survey capacity. Data collected during fish surveys is the backbone of fisheries management and central to lake management planning. With approximately 4,500 lakes currently managed by only 29 Area Fisheries offices, it is impossible to

survey most lakes with sufficient frequency to closely track changes in fish populations. Thus, Fisheries staff must prioritize some lakes over others when deciding how to allocate survey resources.

The Section of Fisheries has developed guidance for determining how frequently to survey a lake known as the Lake Survey Prioritization Framework (LSPF). The LSPF employs a two-pronged system – the first prong is called the "Information Tier" and the second a "Lake Priority Rank". The Information Tier reflects whether a lake has a survey frequency/need that is determined by an explicit evaluation plan (e.g., experimental regulation evaluation) or participation in some additional monitoring program or need outside the Area. The Lake Priority Rank is a criteria-based approach to placing a lake into a management (and thereby survey) priority category, which is intended to operate independent of the Information Tier and serve as a general index of importance. Every lake will be assigned to an Information Tier (A, B, C) and given a Lake Priority Rank (1 – 5), both of which are independent of each other.

Information Tier (A, B, C)

A) Long-term monitoring lakes.
   - Large Lakes and lakes in the Sentinel Lakes Program.
     - Survey frequency defined in program protocols.
   - Lakes scheduled for Fish Index of Biotic Integrity surveys are considered long-term monitoring lakes, but each lake will not necessarily have an information Tier A designation as the watershed rotation and lake selection does not typically align with the Lake Management Planning cycle.

B) Management evaluation lakes.
   - Lakes where Area level management evaluations are underway (e.g., experimental regulation or stocking evaluations).
   - Lakes involved in a statewide initiative (e.g., Quality Sunfish Initiative) or research project.
   - Survey frequency determined by information needs and/or project protocols and will often rely on Targeted Surveys.

C) Established management lakes.
   - Any lake not in Tier A or B.
   - Survey frequency determined by Lake Priority Rank.

Lake Priority Rank (1 – 5)

The Lake Priority Rank is a score generated from various attributes of a lake that determine that lake's relative management importance and subsequent survey attention. A higher score results in a higher rank (on a scale from 1 to 5, with 1 being highest importance), which is intended to guide survey frequency (Table 1). The survey frequency guidelines set forth in Table 1 are not entirely prescriptive as Areas have different resource bases, survey capacity, and priorities often shift over time. Moreover, the survey frequency guidelines are not specific to Standard Surveys – if Targeted Surveys are called for in a Lake Management Plan but no survey frequency is set per a Management Evaluation, then the survey frequency guidelines should be used.

Table 1. Relationship between Lake Priority Rank, number of points generated from attribute scoring, and suggested survey frequency. *Frequency ranges are guidelines and subject to adjustment and change.

Rank	Importance	Points	Survey Frequency Guidelines*
1	High	33-40	1-2 years
2	Moderately High	24-32	3-5 years
3	Moderate	15-23	6-10 years
4	Moderately low	6-14	11-20 years
5	Low	<6	Rarely, if ever

The Lake Priority Rank is determined based on eight fishery and lake attributes organized into three broad categories: Ecological, Social, and Economic. Each attribute is worth a varying number of points that all contribute to the total score (maximum = 40) and Lake Priority Rank (Table 2). A Lake Priority Rank calculation tool is available within FishPad (Management Plans > Actions > Lake Prioritization Wizard) or as an Excel workbook (Appendix 4). The Lake Priority Rank attributes are intended to offer standard criteria for Area staff to consider yet significant subjective decision making is still necessary when assigning points. A brief narrative explaining some of the scoring decision making should be included in the LMP (example in Box 4). Every time a LMP is revised, the Lake Priority Rank should be reviewed and adjusted if necessary. The Information Tier will need to be adjusted as the Tier changes, which may or may not align with LMP revisions.

Table 2. Lake and fishery attributes and potential point contribution to the Lake Priority Rank score. A tool to help calculate a Lake Priority Rank is available in FishPad (Management Plans > Actions > Lake Prioritization Wizard).

Attribute	Influence on Priority Ranking	Points
Ecological		
Fishery Quality and Stability	Destination fisheries and those with shifting populations score higher	8
Ecological Importance	Ecologically unique and/or entirely native populations score higher	4
Systems Change Susceptibility	Lakes more susceptible to climate change, AIS, land use impacts get more points	6
Social		
Fishing Pressure	High fishing pressure at concerning levels score higher	8

Attribute	Influence on Priority Ranking	Points
Stakeholder Interest	Highly developed lake with strong interest in fishery score higher	3
Political Importance	Direct tribal interest or multiple management partners score higher	3
Economic		
Importance to Local Economy	Presence of resorts or businesses score higher	3
Management Investment	Fiscal investments (e.g., stocking) score higher	5
TOTAL SCORE		40

Round Lake is in Information Tier B because of ongoing management evaluations to determine the effectiveness of a special regulation and natural Walleye recruitment. Fisheries managers must consider ecological, social, and fiscal responsibilities when determining management priorities within an information Tier. Round Lake is considered a moderately-high management priority (2). The lake has outstanding biological significance, largely because it supports Cisco. Impacts of climate change are possible and may impact the fish community. Most of the components of the fishery are of average quality for the area and gamefish populations are relatively stable so active management is not required for most species (except Walleye). The lake has high social importance relative to other local fisheries. The shoreline is heavily developed, but fishing pressure is considered moderate. The fishery directly supports several resorts and is economically important to nearby communities. The fishery is important to several partners including the local tribal government, forest service, and lake association.

Box 4. Example narrative in LMP to describe considerations when scoring Lake Priority Rank.

Social Considerations in Lake Management Planning

Fisheries themselves are an interaction between fish, fish habitat, and human communities. Biologists have often been guilty of ignoring the human component or at least separating it out as a standalone, somewhat obligatory effort. However, an approach that treats fisheries as a coupled social-ecological system where the human component is acknowledged as a major (direct and indirect) driver is paramount (Hunt et al. 2013). Major social drivers that can shape a fishery include fishing pressure, fish harvest, motivations (e.g., competitive angling), and the various scales of human induced fish habitat decline. Not only are human preferences,

motivations, and values an important driver of our lake systems, but we also have a duty to ensure that the opportunities provided by the lakes we manage are available and accessible to all of society. Ultimately, managers are faced with the admittedly challenging task of aligning the ecological realities of our fisheries with these human values.

Despite this massive challenge, planners can effectively integrate and try to interact with these social drivers. Managing for angler preferences given a lake's ecological realities is the most straightforward pathway. When reviewing an LMP, planners should consider what species anglers prefer, desirable sizes, interest in, or use, of shore fishing or access sites, tolerance for crowding, and proximity to population centers. Creel surveys can provide lake-specific information on some of these topics but are often cost prohibitive. Statistically valid human dimension surveys are hugely informative but also cost-prohibitive and typically done at a much broader scale than the individual lake. There are many other valid, small-scale social science techniques that Areas can use depending on their information needs. Consult with FAW Policy and Planning or others with social science expertise to develop an effective approach given the lake and social context.

Direct contact with users is an important input collection method and is often lake specific and inexpensive. Additionally, direct contact can involve two-way interaction and thus provide the opportunity to influence behavior. To that end, every plan written or in revision is continually open for public input and comments should be taken at any time during the plan's cycle. We must also work closely with other management partners to ensure all interests are represented. To the extent that we have this information, particularly lake-specific information, it should be documented in the LMP, and taken into consideration when crafting goals and objectives for managed species.

Structured Public Input

In addition to a "we're always listening" approach, it is important that we offer a structured public input opportunity. Providing a consistent structured public input approach across the state enhances credibility and promotes inclusive input. Generally, listening to angler concerns or observations can corroborate existing patterns or reveal new issues, identifying our own data weaknesses. Finally, public input helps identify education needs and opens the doors to directly address common misconceptions.

Ultimately, we have a responsibility to seek public input on LMPs. Public input should be solicited whenever plans are revised but this may prove difficult depending on workload. Planners should consider a stepped approach to a public input process, with higher profile lakes (e.g., higher Lake Priority Rank) having more involved input opportunities (Figure 2). Although a formal public input process is encouraged for all plans, it will not be required for established management lakes with no proposed changes to management strategies or goals. These plans are often a simple data update based on new survey information**.**

Any plans with a proposed change in goals or management strategies (or high-profile lakes), must be included in a statewide annual public input process. A list of these lakes will be posted online with an accompanying press release soliciting public input. Brief information for each lake should highlight any topics of specific interest (e.g., change in managed species, shift in fishery quality goal) otherwise "general fish management" should be listed.

Comments received during the input process (and in general since the last plan revision) should be documented in summary form in the Social Aspects section of the LMP. When input strongly suggests management that is likely to be detrimental or ineffective, that input, and the reason it was not followed, should be briefly addressed in the plan. The privacy of those providing input must always be protected, so do not list names or sources for comments. The timeline for collecting formal public input is described in the Process for Drafting and Updating Lake Management Plans section of this guide. For "high profile" lakes (e.g., Lake Priority Rank 1 or 2) additional input opportunities such as a public meeting, open house, or explicit user group is strongly encouraged (Figure 2). This structured public input opportunity will often be supplemented by summer meetings or scheduled outreach events. For lakes with active associations, resorts, or other groups, additional effort through directed contacts should be made. When available, draft plans should be provided to stakeholders upon request. If draft plans are not available, the latest revision and most recent survey report should be sufficient.

Figure 2. Stepped approach guide to soliciting public input on lake management plans.

Tribal Coordination and Other Agency Input

We often manage lakes in cooperation with another agency be it tribal, State, Provincial, or Federal. Partners should be engaged in lake management planning through direct consultation and/or coordination. Input from those agencies must be given strong consideration as we write our plans and should be summarized. In cases where we are engaged in true co-management of the resource, plans will likely be reviewed and approved by our partners before they are considered final.

Per Operational Order 129, the Division of Fish and Wildlife has developed a Tribal Communication and Coordination Plan, which staff are expected to follow. All lakes in Minnesota are within a ceded territory and therefore are of interest to at least one, if not multiple, Indian Tribes. Each Fisheries Area is responsible for knowing what lakes fall within historic tribal lands. Tribal engagement should be an ongoing process. In some

cases, tribal coordination is formalized through consent judgements, formal agreements, or memorandums of understandings (MOUs). In other cases, it may occur on an "as needed" basis. Regardless, tribal engagement on management plans should happen prior to the public comment period to honor government to government relationships. Planners are encouraged to work with DNR tribal liaisons to develop strategies to meet each tribes' individual needs and expectations.

Fish Community Considerations

Fisheries management planning has historically focused on the individual species level. Managers should think more broadly, and community interactions should be considered when writing LMPs, especially when assigning primary and secondary management species, describing limiting factors and developing management goals and objectives. The fish species we manage are often part of a complex fish community with complex interactions. That community is part of a broader aquatic ecosystem, that is itself tied to events and conditions within a watershed. Many studies of fish populations, and their reactions to management efforts, fail to account for the interactions between these levels that may result in unexpected outcomes or contribute to unachievable goals and expectations.

Fisheries managers have long understood that lakes should be managed for species that are well suited to ecological conditions in those lakes. In the ecological classification system developed by Schupp (1992), Minnesota lakes were assigned a classification based on water chemistry and limnological factors. After classes had been assigned, Schupp looked at fish communities in those lakes to see which species were most strongly associated with each lake class (Figure 8 in Schupp 1992). Schupp's lake classes provide a good first cut at determining whether management for a particular species is likely to be feasible in each lake.

Managers are encouraged to review potential interactions in primary literature, special investigations, and internal guidance documents developed by subject experts and technical teams. Although a complete and detailed knowledge of all the possible connections within different levels and communities in a lake is beyond our abilities, even in the simplest settings, decades of fish management and research in Minnesota and across North America have identified some common species interactions that managers should consider when writing management plans. For example, Yellow Perch are often positively associated with Walleye while Northern Pike may be negatively associated with Walleye. While some of these interactions are likely causative, others should not be interpreted further than correlative. Other perceived relationships have been investigated but found little evidence of a positive or negative relationship (e.g., Muskellunge negatively impacting Walleye). Furthermore, shifting fish communities may strongly influence fisheries management. For example, declining Cisco populations may limit production of large pike but may also occur concurrently with increased opportunities for warmwater fish such as bass. Adaptive managers will recognize the potential impacts of these interactions and adjust management expectations and strategies accordingly.

Fish Population Parameters and Considerations

Understanding the population dynamics of a fishery is vital to management planning, especially when describing the status and trends of important management species, identifying limiting factors, setting goals and objectives, and applying strategies such as regulation or stocking in operational plans. This chapter provides a cursory coverage of basic fish population parameters that should be considered during the planning process, with emphasis on Minnesota's perspective. A more thorough treatment can be found in Guy and Brown (2007) which offers helpful tutorials on analyzing population data, albeit using the programming language SAS. For an equivalent approach in R, see Ogle (2016).

Recruitment

Recruitment is the survival of young fish into some later stage and is typically used as an indicator of fish that will be entering (or already have entered) the fishery. While the concept is intuitive the practice of characterizing recruitment varies widely and can be context dependent. For example, recruitment can describe fish reaching reproductive age, reaching a certain size for harvest, or when fish reach a size when they are vulnerable to specific sampling gear. Recruitment is subject to biotic and abiotic factors that need to be considered to fully understand potential of managed species. The potential for reproductive success (e.g., fecundity, mean age of brood stock, available habitat, etc.), climatic factors (e.g., ice-out date, growing degree days, water temperature, etc.), and mortality are just a few. The drivers of recruitment vary by species and systems and continue to be at the center of fisheries research across the world. When writing management plans, managers should refer to technical guidance (e.g., species chapter) and the literature.

Important considerations for planners include the frequency of recruitment events (consistency), the magnitude of events (year class strength), and the source of events (natural or stocked). Within the context of management planning, knowing a fishery's recruitment scenario (e.g., inadequate recruitment, inconsistent recruitment, excessive recruitment) and recruitment source (e.g., natural reproduction, stocked, or a mixture of the two) can be critical in developing goals and effective management strategies.

The frequency of recruitment events is an important consideration, and some species are known to have more consistent recruitment (e.g., Bluegill, Largemouth Bass, Northern Pike) than others (e.g., Walleye, Muskellunge). Populations with consistent recruitment may be well suited to provide harvest opportunities but size quality may be limited by density dependent factors. Alternately, fisheries with inconsistent recruitment may be subject to shifting age and size distributions that result in cyclical angling patterns or require additional regulation or stocking. Determination of recruitment frequency typically involves collecting age structures during fish surveys. Otoliths are recommended because accurate year class assignment is needed to evaluate recruitment patterns. Managers must also be aware of sampling bias such as size selectivity when determining recruitment frequency.

Characterizing the magnitude of recruitment can be done in numerous ways, depending on how the manager is defining recruitment for that population. The use of a year class strength index (YCSI) is common and most often

the relative abundance of a certain age of fish when they're fully recruited to the gear but not fully selected for by anglers. For example, if Yellow Perch in a specific lake reach 7 inches by age 4, the gill net catch rate of 4-year-old Yellow Perch can be used as in indication of recruitment since the majority are recruited to the sampling gear yet are smaller than the size most anglers elect to harvest. Alternatively, the relative number of a certain species at a point they are no longer considered immature may be adequate to describe recruitment.

Understanding the recruitment source can directly influence management decisions. Ample literature exists on the implications and pitfalls of stocking fish on top of strong natural reproduction and specific guidelines are available for some species, including Walleye. Furthermore, regulation needs may differ between a naturally sustained population and a put-grow-and take scenario. Methods to determine the recruitment source can vary but typically involves surveying for juvenile fish – either prior to when stocking would occur or following the marking of stocked fish with something like OTC.

Mortality

Mortality describes how fish are lost from a population and is extremely important but often inadequately described. Total mortality is the combination of natural and fishing related sources. Natural sources of mortality can be attributed to disease, starvation, predation, inadequate environmental conditions (e.g., winterkill), and old age. Fishing related sources of mortality include harvest by angling or fish dying after being caught and released. The separation of natural and fishing mortality is typically overlooked in many fish populations, yet management of species is uniquely related to their survival within a population. Additionally, natural and fishing mortality is not always additive. Compounding sources of mortality may exponentially increase the total mortality experienced within a population due to unknown factors. Length (non-lethal) and age (lethal) based methods exist to quantify different sources of mortality and should be used, especially when considering special regulations (Miranda and Bettoli 2007). Size limits, slot limits, creel limits, closed seasons, and gear restrictions are all examples of regulations typically used to modify fishing mortality (Noble and Jones 1999). Mark recapture studies can also be utilized to determine mortality within populations, especially in long-lived and critically important species (endangered or threatened, low abundance).

It is common to adjust fishing regulations and wait for a response in the fish community without quantifying sources of potential mortality. When the regulation implemented does not result in the desired change in the population the regulation is altered, essentially taking a "wait-and-see" approach to fisheries management. This may be adequate for short-lived or under-utilized species. However, fisheries managers should focus on quantifying sources of mortality to accurately describe the population and utilize an evidence-based approach to determining the proper regulation to effect the desired change (mean length increase, maximum length increase, abundance shift, etc.). In many systems total mortality is unknown, and determination would require effort beyond what is available to provide an explanation for the managed species in question. In these instances, determination of mortality could be borrowed from what is known for similar populations, or values near 50% could be utilized (Steve Persons, personal comm.).

Potentially the largest obstacle to fisheries managers is accurately describing the true partitioning of sources of total mortality, all while aquatic systems are undergoing changes due to climate, fishing pressure, urbanization, eutrophication, and many other factors. The need for accurate estimates of natural and fishing mortality will increase as more fisheries managers take advantage of advancements in population models (Miranda and Bettoli 2007). When a fish population is managed intensively, every effort should be taken to consider and quantify mortality, particularly where special regulations are used.

Abundance

Abundance data is often considered when describing species status and trends or setting goals and objectives. Unfortunately, we seldom know the absolute abundance of fish within a lake, even among a single species. Instead, we rely on sampling techniques that give indices of relative abundance, like catch per unit effort (CPUE). For most species in most sampling gears, we do not know whether CPUE relates well to absolute abundance, and we should be cautious about assuming it does. Comparisons of CPUE probably have the most value when made between years on the same lake, for sampling done at a consistent time of year. Schupp (1992) found that significant reductions in variation for gill and trap net CPUEs and fish mean weights were achieved when grouping similar lakes within his lake classification system; however, more than 80% of variation was still unaccounted for in most cases. He recommended that CPUEs be compared to lake class quartiles (first [25%] and third [75%]), rather than class or statewide medians, with CPUEs within the 25-75% inter-quartile range considered normal for the class, and those above or below it flagged as potential problems. He considered this approach to be an aid in the rapid identification of gross departures from normal, but not a substitute for statistical testing. As such, management planners should use CPUE data in relative terms, especially when establishing goals and objectives (e.g., high, low, or moderate catches compared to lakes with similar habitats or compared to the lake's history). Some management strategies may require more precise abundance data, especially when applying triggers to management strategies. Alternate methods of determining abundance such as mark-recapture studies can produce more precise estimates, but these are often costly in terms of funds and staff time so they will only be considered when strong justification is clearly given.

Size Structure

Size structure is an increasingly important management parameter as most anglers prefer specific sized fish. These preferences vary by the species and the angler. Most management planning objectives will include some index of the size of fish in the population and the specific metrics will vary. Size structure objectives can be simple (e.g., "some walleye over 20 inches present") or detailed; detailed size objectives should be expressed using standardized length criteria (Neumann et al. 2012) where, for example, Walleye stock size = 10 inches (PSD10), quality size = 15 inches (PSD15), preferred size = 20 inches (PSD20), and memorable size = 25 inches (PSD25). Because angler values are often tied to size quality, simple statistics such as the range of sizes captured and average length, may be important metrics. Each species has different considerations and standards and managers should refer to the assessment framework developed by technical experts (species chapters) for guidance.

Age and Growth

Age and growth of fish are often key metrics to assess a fish population and are directly used to estimate previously covered parameters of mortality and recruitment, but also growth rate. Growth rate can be a very useful diagnostic tool as it is less subject to observation and process error (compared to abundance and size structure). Additionally, knowing growth rate can directly inform management recommendations, especially special regulations. Slow growth often contributes to poor size structures, thus reducing angler satisfaction. However, descriptions of growth as 'slow' or 'fast' should be based on data derived within lake classes, since lake conditions that determined lake classes likely also affect growth potential.

Options for influencing growth are often limited which then limits management potential. Caution should be taken about claims that growth has changed from survey to survey, or over time; data is often lacking adequate sample sizes to support those conclusions, and past growth data, often based on unreliable methods, can be suspect (under-estimating age, thus over-estimating growth). If growth considerations are part of the reason for sampling a lake in question, then careful consideration should be given toward obtaining adequate samples.

In addition to adequate sampling, using the appropriate structures and aging techniques is paramount in properly characterizing age and growth. Things to consider when collecting age and growth information are; what is the question that is trying to be answered, what species should be collected (focus on primary target species), what time of year should samples be collected (usually spring or fall), what is the adequate sample sizes (number of fish), should sex and maturity of target species be recorded, and is the staff time needed to collect these data worth the investment? Collecting and aging structures and estimating growth should follow the guidelines of the Lake Survey Manual (MNDNR 2017) and the Age and Growth Manual (MNDNR 2018).

Climate Change and Lake Management Planning

Minnesota's fisheries have been undoubtably impacted by climate change and will continue to be into the future. These climate related changes are driven by an interactive and cascading set of drivers that are impacting fish habitat. The temporal and spatial scale and sheer complexity of changes are daunting and easy to dismiss as out of our control, however we have a professional responsibility and requirement (Operational Order 131) to explicitly incorporate climate change into our LMPs. This condensed chapter provides a broad summary of expected changes to our managed fisheries and offers a framework for proactive management in the face of climate change. A richer treatment of the subject, including numerous climate relevant citations can be found in the Climate Change and Fisheries Lake Management Planning chapter.

Expected changes to lakes and selected fish populations

Climate change is altering fish population dynamics through changes to abundance, growth, and recruitment which can lead to demographic changes in inland fisheries. Some of the most dramatic fish population responses

documented with climate change are shifts in species composition, spatial distributions, and the timing of key behaviors, all of which can be exacerbated by subsequent changes in species interactions. There is little evidence that direct interactions between cool- and warm-water species are responsible for community shifts. Climate change acts on aquatic systems in concert with anthropogenic stressors (fishing mortality, land use, invasive species introductions) and together these stressors can have complex, compounded effects on fish populations and assemblages.

The following changes to fish and their habitats in lakes have been observed and are expected to continue. These changes have been linked to shifts in fish populations and fish communities. Managers should consider this bulleted list as an overly simplified characterization of a highly complex response, especially when identifying limiting factors and developing goals and objectives for primary and secondary species:

- Water temperature and the length of the growing season are increasing
- Duration and timing of ice cover will change and become more unpredictable
- Water clarity is changing. Some lakes are becoming clearer, while others are becoming less clear
- Nutrient delivery and algal productivity are increasing in many lakes
- Oxygen concentrations and oxy-thermal habitat are declining in many lakes
- Water levels and water connectivity will increasingly fluctuate, as flooding and droughts become more common
- Coldwater fish populations (e.g., Burbot, Cisco, Lake Trout, and Whitefish) will become increasingly stressed and extirpated in some lakes as suitable habitat is lost
- Natural reproduction and recruitment of coolwater species (e.g., Walleye) will be negatively affected in many lakes, particularly as habitat becomes more suitable for warmwater species. Historically coldwater lakes may become more suitable for coolwater species
- Warmwater species (e.g., Largemouth Bass and Bluegill) are expanding to new lakes and becoming increasingly abundant in many lakes

The Resist-Accept-Direct Framework for Climate Action

Effectively responding to and planning for climate related fisheries changes is a tall order at the individual lake scale. However, a relatively new and increasingly popular approach provides an effective framework for action. The Resist-Accept-Direct (RAD) Framework (Schuurman et al. 2020) gives us a common language that fits into the iterative process of adaptive management (Lynch et al. 2022). The RAD framework uses three strategies - Resist, Accept, and Direct - to categorize pathways to different management goals (desired or achievable future condition). All management goals fit in one or more of these strategies and by nature are action oriented. Resist is a strategy that seeks to maintain or restore historical conditions of a system (community structure, function, processes). The Accept strategy allows for changing of ecosystem characteristics, by following the trajectory, as determined by changing conditions. The Direct strategy actively moves to shape new ecosystem characteristics towards a new desired state.

Staff should include information in the LMP (Climate Change subsection within the Limiting Factors section) that provides expected climate related impacts to the fishery, the desired future condition of the impacted portions of the fishery and selected RAD strategy for managed species. Any specific actions associated with the RAD strategy should be identified as such within the appropriate subsection of the Operational Plan Detail section. Climate change is an important consideration in many parts of a LMP and may be especially important in describing the management history, limiting factors, goals and objectives, and operational plan. Box 5 provides an example of how climate may be addressed.

Managed Species and Trends- *Although Round Lake remains well suited for coolwater fish such as Walleye, warmwater species such as Largemouth Bass and sunfish have increased overtime, while Cisco have declined. These changes are likely climate driven.*

Climate Change (in Limiting Factors)- *Climate change has likely impacted and will continue to impact the fishery. Cisco have declined resulting in an increased reliance on Yellow Perch as forage for pike and Walleye. Despite these changes, the current state of the lake and fish community suggests the coolwater fishery is sustainable in the near to mid-term, and a strategy to resist climate change (Resist RAD strategy) is appropriate, but this may change in the future warranting a management shift that favors the warmwater fishery.*

Operational Plan

Stocking- *This plan optimizes conditions for natural reproduction by protecting spawning-aged fish and critical habitats. Climate change has the potential to impact Walleye recruitment, but current conditions support natural reproduction. As such, stocking is not currently planned or needed but could be considered in the future.*

Habitat- *Minnesota lakes are undergoing a period of rapid change driven by climate change, AIS, and increased human disturbances to lakeshores and watersheds. Maintaining healthy riparian zones and in-lake habitat is critical to support system resilience in the face of changing environmental conditions. The protection of spawning habitat is critical to maintain natural Walleye recruitment. Landowners, the lake association, and local units of government will be partnered with to protect a minimum of 50% of the near-shore spawning habitat for Walleye.*

Surveys- *Water temperature and the length of the growing season will increase further, which may negatively impact recruitment of Walleye and other coolwater species, especially as habitats become more suitable for Largemouth Bass and sunfish. Walleye recruitment, Bluegill, and Yellow Perch abundance should be closely monitored through frequent standard surveys. Bass electrofishing should be conducted to monitor trends in bass abundance.*

Box 5. Example narrative in LMP to describe and address climate considerations.

Even though individual lakes will respond differently to climate change, classifying lakes into groups and offering associated guidance can help make adaptation more approachable. The lake grouping schema developed for the Fish Index of Biotic Integrity program (Table 2 in Bacigalupi et al. 2021) provides a helpful organizational framework for what to expect, some potential strategies, and associated specific actions. Appendix 5 offers that guidance for each lake group (aka “IBI tool”).

Climate Action in Lake Management Plans

Management of fisheries in the context of climate change is a rapidly expanding, multi-dimensional field of study. Hansen et al. (2015), Paukert et al. (2016), Myers et al. (2017), Tingley et al. (2019), Lynch et al. (2016), and Paukert et al. (2021) are excellent sources of information. Much of what is currently known is summarized in Table 3, which should be considered, especially when developing operational plans. For specific RAD application guidance by lake group see Appendix 5 in the Climate Change and Fisheries Lake Management Planning chapter.

Table 3. Summary of potential management actions in response to climate change.

Action	Knowns, unknowns, and more
Stocking	• Common practice used to maintain or bolster existing populations where reproduction is a limiting factor. • May be used to establish new population, reintroduce species, or provide put-and-take opportunities. • May not be viable and success may decrease with some species and/or life stages. • Translocation or climate resilient strains possible but genetic risk justifies caution.
Regulations	• Protective regulations can be used for climate vulnerable species (e.g., Lake Trout) • Can promote diversity for the sake of resilience including diversity in age classes and harvest/quality opportunities. • Seasonal regulations in response to life history timing is uncertain and needs more research, regardless of changing phenology. • Liberalizing regulations to reduce climate resilient species may not help climate sensitive species; evaluation is important.
Monitoring	• Central to planning for climate change. • Adjustments to monitoring schedule and/or procedures can be made to shed light on fish responses to climate change. • Standardized monitoring critical for characterizing and understanding broad spatial and temporal trends. • New survey techniques and methods may need to be developed. • Characterizing patterns in angler preference, motivation, and behavior will be increasingly important for resource prioritization and informing outreach.
Education and outreach	• Staff should devote time to professional maintenance and stay climate informed. • Formal training for climate wise management should be provided and encouraged to all Fisheries staff. • Informal social conversations and information sharing with anglers critical for facilitating expectations and relaying the nuanced complexities of climate change. • Successful and unsuccessful adaptation strategies should be documented and shared with the public.

Action	Knowns, unknowns, and more
Collaboration and Habitat	• Broad-scale climate challenges necessitate a collaborative, partner focused approach. • Landscape-scale habitat work (e.g. forested landscape preservation, increased lake connectivity) provides the most resilient solutions to many interacting factors (e.g. nutrient reductions) but requires broad collaboration with multiple governing bodies. • In-lake habitat conservation (e.g. protecting native aquatic plant communities) and nearshore habitat conservation (e.g., critical shoreline preservation) provide climate resilience but should focus on promoting ecological function over enhanced structure.

Aquatic Invasive Species and Lake Management Planning

The Division of Ecological and Water Resources (EWR) Invasive Species Program has staff that are dedicated to the management and prevention of aquatic invasive species (AIS). Their staff should be the first point of contact for Area Supervisors who are faced with new occurrences of AIS or need guidance on their prevention and management. Nonetheless, some knowledge about the primary AIS that are present in Minnesota and how they can impact fisheries management can be beneficial while writing Lake Management Plans. AIS are often a major limiting factor, both biologically and socially, that must be considered when developing goals and objectives and designing operational plans.

Invasive aquatic plants have the longest management history in Minnesota, are widespread, and consume a significant amount of EWR staff resources. Accordingly, their direct and indirect impact on fisheries and management planning can be highly consequential. The two most common species are Eurasian watermilfoil (*Myriophyllum spicatum)* and Curly-leaf pondweed (*Potamogeton crispus*). Curly-leaf pondweed has a unique lifecycle—growing while the lake is ice covered and exhibiting a die-off in midsummer. This life history has been suggested as contributing to algae blooms at the height of summer on lakes where the plant is abundant. Eurasian watermilfoil's impact on lake ecology and fish habitat is highly variable and depends on coverage.

Numerous attempts at eradication of both plants have been unsuccessful and management has focused on preventing further spread, controlling abundance, and minimizing recreational impacts. Some of the primary methods used for control consists of mechanical removal (e.g., harvesting or hand pulling) or chemical treatments. Both methods may have impacts on nontarget native plants and chemical activities can have lake-wide effects, potentially doing more harm to native plants than what the invasives would have otherwise (Mikulyuk et al. 2020). Invasive aquatic plant management is complex and wrought with social (e.g., recreational boaters vs anglers) and ecological tradeoffs (e.g., native plant communities vs fish habitat provided by invasive plants). Permits are needed for this work, so fisheries managers should work closely with their local invasive species specialist (ISS) and aquatic plant management (APM) specialist to review any proposals and provide recommendations to minimize impacts to non-target species and maximize benefits to fish ecology. On lakes where significant aquatic plant management (invasive or native) activities occur, Areas should consider working

with the APM specialist and ISS staff to develop a Lake Vegetation Management Plan. LVMPs lay out management goals, objectives, monitoring expectations, and management thresholds that attempt to strike an ecological and recreational balance – similar to the LMP an LVMP is a useful tool for staying the course on a management approach even when social opposition emerges.

Since 2009, zebra mussels have debatably received the most attention of all aquatic invasive species in Minnesota. Although zebra mussels were first discovered in Minnesota in Lake Superior in 1989, their discovery in the Alexandria Chain of Lakes in 2009 was the first time they had been found in western Minnesota. The result of this find was an increased concern of the potential impact the mussel may have on aquatic resources. Besides the zebra mussel's ability to reproduce rapidly and attach to objects in large numbers, the zebra mussel is a filter feeder, usually resulting in clearer water and changes to the zooplankton community. Recent research has shown that the presence of zebra mussels can reduce the growth rate of young Walleye by 14%, presumably due to the impact of zebra mussels on the zooplankton population (Hansen et al. 2020). Research has also shown that Walleye and Yellow Perch rely more heavily on resources from the littoral zone in zebra mussel infested lakes, resulting in higher mercury concentrations (Blinick 2022). There is additional research occurring in Minnesota to continue to evaluate the impact of zebra mussels on Walleye and what steps (if any) a manager can take to mitigate those impacts. Until those results are compiled, fisheries managers can only be aware of the potential impacts zebra mussels may have on fish populations in lakes where they occur or become found.

Like zebra mussels, spiny waterflea have been found to impact Walleye. Research showed that Walleye in their first year of life were 12% smaller in lakes that were infested with spiny waterflea compared to uninfested lakes (Hansen et al. 2020). Spiny waterflea prey directly on zooplankton, causing competition with young Walleye for food. The same study also evaluated the growth rate of Yellow Perch, but the impacts were not as evident.

Common Carp have been present in the Midwest since the 1880s and are widely distributed across Minnesota. The feeding behavior of these benthivores can impair water quality as they uproot aquatic plants, reducing clarity and releasing phosphorus. For many years, DNR removed carp to attempt population control, but this was discontinued in the 1980s as the effectiveness and ecological benefit was increasingly questioned. Commercial harvest was then the only control effort employed, until approximately 2011 when research from the University of Minnesota implemented a type of integrated pest management approach to control Common Carp. Private consultants are now engaged heavily in this work, leveraging water quality improvement funding and lake association partnerships, to remove and control Common Carp. Some of this work has led to management conflicts when other fishery goals (e.g., increased connectivity) do not align with Common Carp control. Fisheries managers should engage in the permitting and discussion surrounding Common Carp control to ensure all tradeoffs are properly considered.

Other aquatic invasive plant species that a fishery manager may encounter include flowering rush and starry stonewort. Flowering rush has been present in Minnesota since 1968 and starry stonewort was first confirmed in Minnesota in 2015. Impacts from these plants resemble curly-leaf pondweed and Eurasian watermilfoil, such as displacing native plants and inhibiting water recreation. Control efforts may consist of mechanical removal or the use of chemicals, so fisheries managers may be asked to provide input on permits issued by ISS and APM specialists.

There are many other species of AIS that have limited distribution in Minnesota or have been found to have minimal impact on fisheries management so they will not be discussed here. Fisheries managers need to be aware that the list will likely continue to grow, and it would be wise to stay abreast of any emerging issues. Working to preserve native and undeveloped aquatic habitat at the broadest scale possible is important, as effective options for control of AIS once they are established are limited.

Incorporating Fish Habitat into Lake Management Planning

Maintaining and enhancing high quality aquatic habitat and healthy ecosystems are essential for sustaining populations of fish that are safe to eat, support a multi-billion-dollar angling economy, and contribute to the quality of life we enjoy. Changing land use and climate change threaten fish habitat in Minnesota lakes in unprecedented ways. Historic fish habitat management activities have focused on nearshore physical habitat (aquatic plant removal permitting) and riparian stewardship (acquiring land and restoring shoreline). In addition to these successful traditional practices, approaches such as improved watershed management and strategic interactions with internal and external partners to advocate for fish and their habitats are increasingly critical given the scale of current threats. The goal of this chapter is to guide Area Staff in the development of meaningful habitat management strategies for incorporation into individual lake management plans.

This chapter uses the concepts and framework put forward in the Fish Habitat Plan (MNDNR 2013) to help define and prioritize the focus of aquatic habitat protection and restoration. Our understanding of the drivers of and main approach to fish habitat management in Minnesota is covered well by Jacobson et al. 2016. The framework identifies a general strategy for habitat management based on a lake's condition. The lake's condition is determined by the level of shoreline disturbance and watershed disturbance as surrogate measures of physical habitat and water quality, respectively (Figure 3). Lakes in the lower left quadrant have relatively undisturbed watersheds with good water quality and good physical habitats (Vigilance). Lakes in the upper left quadrant still have good physical habitats but may be suffering from lowered water quality due to watershed disturbances (Watershed Protection). Lakes in the lower right quadrant have disturbed physical habitats but good water quality (Shoreline Protection). Finally, lakes in the upper right quadrant have impacted physical habitats and water quality (Enhance/Restore).

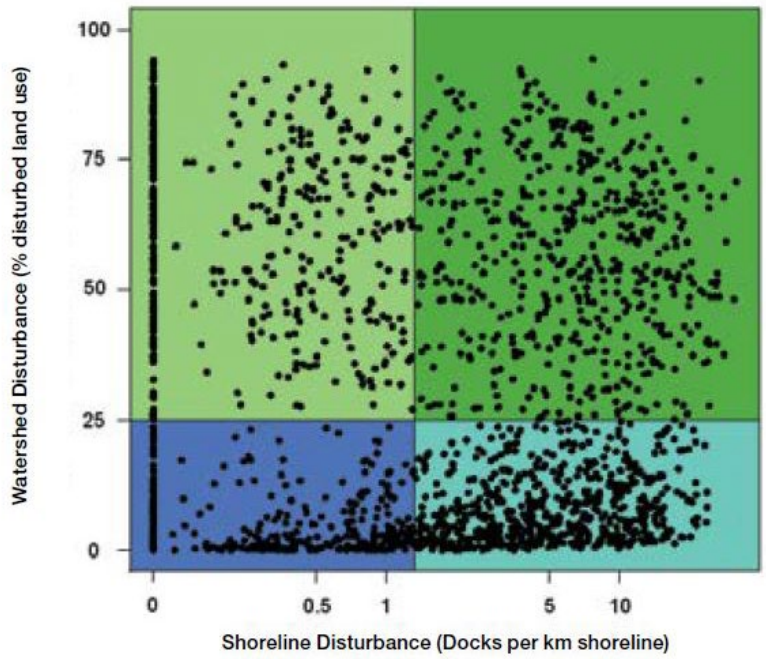

Figure 3. The lake habitat condition plot categorizes lakes by the relationship of how much of a lake's watershed and shoreline are disturbed (MNDNR 2013). The quadrat a lake falls into should guide the lake's habitat management strategy and subsequent actions.

Balancing Protection and Restoration

The most cost-effective way to achieve healthy aquatic habitats is to protect areas that are still functionally intact. Therefore, the Section of Fisheries has chosen to direct approximately 60% of habitat management resources towards protection and 40% towards restoration (MNDNR 2013). Protection can also be the first step in a restoration project by the protection of the remaining functional components before restoration begins in the degraded portions of the watershed.

Recognizing that restoration of disturbed or degraded shoreline and watershed habitats are also critical, options for restoration are also provided. Projects that can simultaneously reduce shoreline and watershed disturbances could yield the greatest conservation return for these highly altered systems. The Watershed Restoration and Protection Strategy (WRAPS) process brings together partners to summarize monitoring and modeling data and prioritize local projects to protect and restore waters. The resulting WRAPS report informs local water planning and feeds into a One Watershed One Plan (1W1P) to target local implementation activities at the watershed scale. The restoration component will largely be driven by Total Maximum Daily Load (TMDL) implementation plans and local water management plans while the protection component will be driven by interests of stakeholders and identification of critical habitats. Clean Water implementation funds will be available to local government units through the MN Board of Water and Soil Resources for activities identified in the local water management plans that can be used for shoreline restoration projects as well as installing landscape wide BMPs.

All of these watershed based planning and implementation activities plug into a structured multi-disciplinary, high-level approach known as the Minnesota Water Management Framework. Fisheries managers can and should engage in the planning process to assist other state agencies and local governments with prioritizing watershed activities that benefit water quality and aquatic habitat.

Applying the Fish Habitat Plan Framework in Lake Management Planning

Providing prescriptive guidance on what habitat management techniques to employ is not the intent of this chapter. However, a lake's habitat strategy should drive where DNR's limited habitat resources are allocated. The Habitat Focus Matrix (table 4) offers actions/topics for staff to consider as they write lake management plans that varies by a lake's habitat strategy. These actions/topics are organized into the following categories: In-lake habitat; shoreline habitat; watershed influence; and water quality, quantity, and connectivity. Additionally, the actions/topics are ranked based on a lake's habitat condition status.

When considering planning for fish habitat management in LMPs, Areas should generally:

1. Review the Lake's general habitat health in the Watershed Health Assessment Framework (WHAF-L). Decide which habitat strategy (Figure 3) is most appropriate and refer to the corresponding column in Habitat Focus Matrix (Table 4).
2. Identify habitat and water quality related factors that limit your ability to meet your management goals or objectives.
    - Review recent TMDL, WRAPS, and 1W1P reports – these in-depth studies will offer suggested strategies to improve or restore habitat. Consult with IBI or other Fish Habitat Staff for assistance.
    - Include summary in Habitat subsection of the Limiting Factors section.
3. Review the NHIS GIS layer (accessible through the Conservation Explorer) to look for the presence of any Rare, Endangered or SGCN, especially aquatic ones, in the lake. Many of these species have very specific habitat needs that should be identified in the plan.
    - Include any relevant findings in the Description of Fish Community section.
4. Identify and implement habitat actions listed as Primary or Secondary. Explore Tertiary activities after primary issues have been addressed and avoid NA activities.
    - Include description and discussion of habitat actions in the Habitat Development and Protection subsection of the Operational Plan Detail section.

Table 4. Habitat focus matrix. A combination of a lake's watershed and shoreline disturbance determines the habitat condition and subsequent Lake Habitat Strategy. A selected array of potential habitat related management actions or topics are offered and, depending on the Lake Habitat Strategy, ranked in effectiveness (P= Primary Focus; S = Secondary Focus; T=Tertiary Focus; and NA = Not Applicable).

		Lake Habitat Strategy			
Category	**Action or Topic**	**Vigilance**	**Shoreline Protection**	**Watershed Protection**	**Restoration/ Enhancement**
In Lake Habitat	Conduct Vegetation Survey, emergent mapping, sonar submersed veg mapping	P	P	P	P
	Conduct Fish Survey - IBI	P	P	P	P
	Conduct Score the Shore Survey	P	P	P	P
	Cisco/Whitefish/Lake Trout Assessment	P	T	S	T
	Coarse Woody Survey*	P	P	S	T
	Work with Invasive Species to develop LVMP	T	S	S	P
	Increased APM Permit Review with SGCN present	S	S	P	T
	Increased Water Permit Review with SGCN present	S	S	P	T
	Monitor Invasives species	S	S	P	T
	Integrated Carp management	NA	T	T	S
	Assess need for reclamation	NA	T	T	S
	Assess need for dredging	NA	T	NA	S
	Wildlife Lake Designation	NA	S	T	S
	Determine Aeration Need/DO profiles	NA	S	S	P
	In-lake Habitat Projects*	T	T	S	P
	Improve Spawning Habitat	T	T	S	P
Shoreline Habitat	Identify/protect Sensitive Shorelines	P	P	S	T
	Shoreline Restoration	T	T	P	P

		Lake Habitat Strategy			
Category	**Action or Topic**	**Vigilance**	**Shoreline Protection**	**Watershed Protection**	**Restoration/ Enhancement**
	Restrictive County Shoreline Ordinances	P	P	S	T
	Improved Septic System	S	S	P	S
	Reduce Impervious Surfaces	T	S	P	S
Watershed Influence	Knowing Lake Placement within Watershed	P	P	P	P
	Restrictive County Ordinances	P	S	P	S
	Manage/Protect Private Land	P	S	P	T
	Manage/Protect Public Land	P	S	P	T
	Reduce Disturbances	S	S	S	P
Water Quality, Quantity and Connectivity	Protect Groundwater	P	P	P	S
	Assess Inflow/Outflow	P	P	P	P
	Improve connectivity	S	P	S	S
	Wetland Restoration	T	P	T	P
	Identify Lakes with Phosphorus Sensitivity	S	P	S	S
	Reduce In Lake Nutrient Loading	T	S	S	P
	Watershed Nutrient Management	T	P	S	P

Incorporating Statewide, Special, and Experimental Regulations

Angler harvest is an important component of most fisheries and is an often-cited limiting factor in LMPs. Harvest regulations are valuable tools used on all waters in one form or another. The historical, current, and future use of regulations should be outlined in lake management plans and may be discussed in various sections. The historical use of regulations, featuring timelines of regulation proposals or changes should be discussed in the

Management History section but may also be detailed in Research and Relevant Findings if formal evaluations or research projects have been completed. Fishing mortality is a common concern and may be described in the Limiting Factors section. Social concerns about harvest or regulations should be discussed in the Social Aspect section. Current and future use of regulations and evaluation plans should be detailed in the Operational Plan.

Statewide Regulations

Statewide (or zone-based) regulations that specify a bag limit (see glossary for explanation of often conflated terms bag limit, creel limit, daily limit, and possession limit) and/or size restriction for inland waters are sufficient in most situations and will be the default regulation used in most management plans. Minnesota has a long history of using bag and size limits with regulations dating back to the 1910s. These regulations have often been based on a socially defined concept of fair harvest and were revised as the public's concept of a fair limit has changed. Changes in statewide regulations will rarely be part of a lake management plan, although evaluation of a regulation change could be included if the lake is part of a broader assessment. These evaluations would have a high statewide priority and should be clearly detailed in the Surveys and Evaluation segment of the Operational Plan.

Special and Experimental Regulations

Statewide bag limits may be insufficient when harvest is an identified limiting factor. Alternatively, lake-specific regulations can address harvest-oriented problems such as reduced size quality or spawning stock abundance, or to better distribute angler catch throughout the season or across anglers.

Harvest regulations will only succeed if harvest is limiting the potential to attain management goals and sufficient harvest reduction can be accomplished to facilitate a meaningful change. The rate of recruitment, growth, natural mortality, fishing pressure, and harvest are important biological considerations. Individual regulations should only be applied where pre-regulation data are sufficient to determine the biological potential for success. If pre-regulation data are insufficient, managers should develop a clear survey and evaluation plan within the Operational Plan and collect the needed data before formalizing a regulation proposal.

Public acceptance of a potential regulation is also critical, because even a low non-compliance rate may undermine effectiveness. Special or experimental regulations are generally more restrictive than statewide regulations so most stakeholders must accept that reduced harvest opportunity is the cost of achieving management goals. Additionally, regulations often take time to work so stakeholders and managers must be willing to commit to a long evaluation period, especially for experimental regulations. Managers should develop outreach strategies in the Operational Plan to address social data needs before proposing regulations and only develop proposals when public acceptance is expected. Regulation options should be reviewed by regional managers and species technical teams prior to discussing specific regulation details with the public to avoid unrealistic expectations or demand for a regulation with a low biological probability of success.

Lake-specific regulations are set using a statutory process (s 97C.001 or s 97C.005) that "designates" a water for some unique management opportunity for a specified species (Table 5). There are two designation options, "experimental" or "special", however, anglers typically do not differentiate between these regulations and often refer to both collectively as "special regulations". Both options are simply a way to apply a different regulation to a specific water – the most practical difference between the two options is that experimental designation requires an end date, typically 10-15 years after implementation. Special regulations will be selected from a finite list of proven options, found in each species regulations toolbox (see Special Regulations below). If there is no suitable toolbox option, the experimental designation is required.

Table 5. Process for designating waters as special or experimental using lake-specific regulations. All approved designations done through exempt permanent rulemaking process are codified in Minnesota rule 6264.0300 (experimental) or 6264.0400 (special).

Timing	Step
November – December	Proposals developed and reviewed. Experimental designations must be reviewed by Species Tech Teams.
January - February	Fisheries Management Team, Division, and Commissioner's Office review and approve to solicit input
May	Signs posted at boat launches by June 1st notifying public of proposed changes and opportunities to comment.
July – August	Two press releases are required. First is a statewide release done by July 1, coordinated by Central Office. Second is a local press release done by August 20, coordinated by Area Office.
September - October	Area holds public meeting (virtual or in person) and accepts comments for at least 10 days following meeting, reviews input and makes final recommendation.
November – February	Internal rule making process (Exempt Permanent) coordinated by Central Office
March 1	Rule changes become effective

Special Regulations

Since 1982 the Section of Fisheries has gained considerable experience with special regulations for several species. That knowledge base is driven by a relatively recent expansion in the use of special regulations and

subsequent evaluations. Very few lakes had any type of lake-specific regulations in place as recently as the late 1980s, however that changed quickly through the 1990s and by 2001, 130 lakes were under some type of special regulation. As of 2023, over 400 lakes in Minnesota have some type of special or experimental regulation. Special regulations typically apply only to a single lake, or perhaps a chain of lakes (and connecting waters). While special regulations do not require an evaluation period (as opposed to experimental regulations), managers should include and follow through with an evaluation plan in the lake management plan.

Based on over 30 years of use and evaluation, combined with an ever-growing body of literature, each species technical team has developed a toolbox of regulations. These toolboxes attempt to offer a suite of regulation options without unnecessarily increasing regulation complexity. They are criteria-based and take into consideration angler preferences, management goals, and fish population parameters. For a more thorough discussion on species-specific special regulations, refer to the appropriate species chapter.

Experimental Regulations

Unlike special regulations from the species toolboxes, experimental regulations usually lack a history of successful use and evaluation, at least in Minnesota waters. As a result, more supporting data must be provided in the proposal (e.g., population modeling), the regulation must include an end date, and the proposal must include a strong evaluation plan. The process and timeline for proposing an experimental regulation are the same as those for a special regulation with the exception that experimental regulations must be reviewed by the appropriate Species Technical Team.

A thorough evaluation plan and defined end date are required. A recommendation to extend or modify, make permanent (convert to a special regulation), or revert to the statewide regulation must be submitted for internal review following a public input process completed prior to the end date. The timing of data collection and analysis, public input, and internal review must be carefully planned and should be outlined in the LMP. Time must be allowed for regulation effects to fully occur and become measurable so evaluation periods of a decade or more are commonly used. Experimental regulations require intensive population and harvest assessments, both before and after implementation, to adequately evaluate regulation effects. Fisheries managers and research staff must carefully consider workload logistics before committing. Species technical teams have developed evaluation protocols for several species and should be consulted while developing evaluation plans. Modeling assistance for potential regulations is available from the Fisheries Research Unit. Creel surveys are useful in the evaluation because the goals of the regulation are often to improve angling metrics and should be considered. Evaluations that include control waters may require revision of the LMPs for those waters to ensure that all elements of the evaluation find their way into the area's work plans.

Closures

Temporary or permanent closures of certain parts of waters (e.g., fish refuges) have historically been widely implemented. However, the cost-benefit between effort required to properly post these fish refuges relative to their efficacy is unclear. Despite this, the approach can be popular with anglers, lakeshore residents, lake associations, and enforcement staff. Moreover, there are certain stream segments or mouths that do see heavy

congregations of spawning sportfish, often overlapping with an open harvest season. Accordingly, each spring the Section publishes a list of waters that are permanently closed to taking fish (MR 6262.0500 Subp. 1), waters that are closed during a set time period every spring (MR 6262.0500 Subp. 2), or waters that can be closed for a time-period specified by the Area (MR 6264.0125). While many of these closures are intended to protect lake fish populations, managers should first look elsewhere when considering tools during management planning.

Planning Surveys and Evaluations

The use of previously collected information and knowledge of social aspects, biological potential, and limiting factors to develop realistic and attainable goals and objectives are core outcomes of the management planning process. A sound evaluation plan is needed to determine if goals are being met and if the application of management tools was successful. A robust assessment program is necessary to inform the adaptive management process and provide feedback to the public on the status and response of fish populations to various management activities. When the manager determines that changes are warranted, there needs to be a specific set of goals and a sampling strategy intended to measure the response of the fishery to the management changes over a specific period.

A single data point is typically insufficient so good evaluation plans include multiple assessments over enough time to yield meaningful results. Typically, a 10-year period or three survey cycles are recommended to capture sustaining changes to a population. This timeframe is usually necessary to allow for a full generation of turnover in a fish population following management changes. However, populations of fast-growing, early maturing, short-lived fish that are common to southern Minnesota can require more frequent assessments because they recruit to the fishery sooner and have faster turnover of the population. Failure to follow through with the assessment of management actions (and change when appropriate) can lock managers into unintended management commitments which can be expensive (e.g., continuing to stock high densities of walleye fingerlings with no measured return to the angler), detrimental to the population (e.g., reduced forage abundance and growth), detrimental to the fishery (e.g., regulations that restrict harvest with no measurable benefit to the population), and/or create unrealistic expectations and loss of credibility with stakeholders.

Managers must consider the specific information needs including the parameters needed meet those needs (Fish Population Parameters and Considerations Chapter), potential bias and limitations of each survey option including seasonality, and cost (both fiscal and staff time) when developing a good evaluation plan. Several evaluation approaches exist, and the more common survey types are described in the following subsections.

Standard and Targeted Lake Surveys

Lake surveys are the cornerstone of fisheries lake management, both for the data they provide on individual waters, but also for the historical context they provide for survey results. Lake survey protocols are provided by the Lake Survey Manual (MNDNR 2017). The Lake Survey Manual describes two main types of surveys: standard surveys and targeted surveys. Standard surveys can include many different components but at their minimum,

they provide the broadest look at a lake's fish community, whereas targeted surveys are used primarily to address specific questions. Targeted surveys can take many forms, use many types of sampling gears, and address many types of questions. Specifically, Standard Surveys must include summer trap netting, summer gill netting, and spring electrofishing (only if bass are a management species) but additional surveys (e.g. ice-out trap netting, fall electrofishing) can be added to a Standard Survey that would otherwise be considered a Targeted Survey on its own. The Lake Survey Manual recommends sampling gears and methods to provide answers to most management questions and should be a manager's first reference when it comes to designing an evaluation.

The validity of survey results will depend on biases associated with the sampling gear, the amount of sampling effort, and often, the number of fish sampled. In general, when preparing a Lake Management Plan, we are comparing results within a single sampling gear in a single lake, so the results being compared will have the same biases. Except in rare cases where population estimates can be made, we are obtaining relative abundance estimates based on index sampling. The precision and accuracy of those estimates (how well they reflect true abundance) depends heavily on the sampling effort and biases associated with the sampling gear. For some types of sampling, accuracy rests on following a well-defined representative sampling protocol (e.g., bass electrofishing). When we have metrics derived from individual fish, accuracy depends on the extent to which our sampling and measurements have been unbiased, and precision depends on the number of fish sampled and the variability of the sample (e.g., sample comes from one year class, or is a mix of several). The Lake Survey Manual provides some information on recommended minimum sampling effort (number of sets) for gill nets and trap nets in standard surveys, based only on the amount of effort needed to produce a useful index of abundance. If those standards cannot be met (as in smaller lakes), or if different metrics are being assessed, more sets or multiple surveys may be needed before a manager can confidently identify a change in a fish population.

Time of year also effects the validity and value of the sampling effort. Some timing issues are explored in the Lake Survey Manual. Most lakes already have an established time of year for completing standard surveys often defined in the management plan; comparisons should be limited to surveys done within that defined time frame. Effects of time-of year on standard gill net and trap net catches were illustrated for many species in the Lake Survey Manual (Appendix 15 in MNDNR 2017). Some survey metrics may only be measurable at certain times of the year. For example, attempts to determine mean length and age at maturity for walleye and yellow perch are best made in the fall when gonads are well-developed.

Habitat Surveys

Habitat sampling is also covered in the Lake Survey Manual (MNDNR 2017); however, habitat survey techniques continue to evolve especially as new technologies emerge (e.g. sidescan sonar mapping of bottom substrate). If a specific habitat issue arises on a lake and warrants investigation, a manager may want to enquire within the Section of Fisheries habitat group or EWR's Lake Ecology Unit for current best practices. Standard vegetation survey techniques used by MNDNR Fisheries are described in the Minnesota Lake Plant Survey Manual (Perleberg et al. 2016). Methods used will depend on the type of information sought (e.g., frequency of occurrence by species versus a complete species list), and the way that information will be used (e.g., descriptive

versus comparative). Habitat surveys may be done as part of a standard lake survey, or as a separate targeted survey.

Creel Surveys

Creel surveys are essential to fully evaluate experimental regulations and are also highly desirable on any managed lake supporting a significant fishery. Creel surveys are most valuable when historic creel survey data for the lake are available to provide some context to current estimates. Currently, the best source of information on designing angler surveys, including creel surveys, is provided by the American Fisheries Society's Special Publication 25 (Angler Survey Methods and Their Applications in Fisheries Management; Pollack et al. 1994). Creel surveys should be employed when information on fishing pressure, catch rates, harvest, species preferences, sizes of fish taken by anglers, compliance with regulations, and angler attitudes towards a fishery is needed in an evaluation. Cost ranges from low (a camera monitoring a trail access) to high (a traditional survey requiring one or more full-time clerks to cover a season (open water vs winter), yielding a full suite of estimates). Current funding allows for one to two traditional creel surveys to be conducted within each region annually. Generally, creel surveys done on lakes that already have a history of creel surveys will have more value than surveys of waters with no such history.

Creel surveys provide important data on catch (harvest, release, hooking mortality, age and size structure, sex, preferred sizes, and seasonality), angling pressure, and angler demographics. A variety of methods have been used to conduct creel surveys (roving, access based, mail/social media), and a standardized program is currently available for use statewide.

Drafting an Individual Management Plan

Information Needed to Develop or Revise a Lake Management Plan

As you begin to write or revise an LMP, some basic information should be readily available. That includes copies of previous LMPs (if any), a lake map, an area map, lake survey reports, creel survey reports, comments obtained during the public input process, information gleaned from informal angler contacts, and from other stakeholder contacts, and relevant investigation reports. Have your GIS platform up and running open the WHAF-L application. You will want to have this guide handy and have prepared a blank management plan template in the format outlined in this guide. If you will be referring to tables and figures, it is often helpful to have them ready, in at least draft form, before you begin writing. Talk to your co-workers about the lake and speak with your local conservation officers about any insights they may have. You may want to consult with resource professionals from other agencies, like the U.S. Forest Service, the U.S. Fish and Wildlife Service, local water planners, tribal natural resource staff, and MPCA or SWCD staff working in your area.

A goal of this new guide is to move the Section to a more consistent format and approach for LMPs, so do not assume that all you need to do is pull up the last plan, tweak it a bit, and send it in. Look at the old plan with fresh eyes, put it in the new format, and rethink how the lake can best be managed now and into the future given ongoing large-scale climatic and landscape changes.

Elements of a Lake Management Plan

A blank LMP template can be found in Appendix 1. Although the Lake Management Plan process and template provide a consistent approach for plan development, the elements of a plan allow for flexibility to meet various needs. This may result in some sections with redundancy but that is expected because some aspects of the fishery may apply to multiple sections of a plan.

Cover Page

The cover page is critical as this will be the extent of what most audiences read. A row for Revisions is included and is helpful for Assistant Regional Managers to understand what specifically changed in this round of revisions. Check all boxes that apply. The options should be interpreted as follows:

- Initial Plan – check if this is the Lake Management Plan for the lake
- Species – check if the management species (primary or secondary) changed or were re-assigned
- Goals/objectives – check if the goals or objectives changed
- Stocking – check if stocking plans changed
- Survey – check if new survey information was collected and added to the LMP
- Other – check and add short one or two word descriptor for other significant changes such as special or experimental regulations (e.g. “exp. reg.”) or a large habitat project is happening (e.g. “habitat”)

Concisely summarize the Goals, Objectives, and Operational Plan. Carefully read the guidance below on how to write Goals and Objectives – neither are actions, that is what the Operational Plan is for. Include major partners such as tribal cooperators, state agencies (e.g. border waters), or federal agencies (e.g. US Forest Service for Boundary Water Canoe Area lakes).

The LMP Body

Known previously as the narrative section, the body of the LMP should provide detail that supports the bare structure of the cover page, and helps a reader understand the basis for current management. The following topics can be addressed in the body of the LMP. Those that are not relevant to the lake, or its management need not be included in the plan. Other topics may be added if important to the lake in question. A reference list, and supporting tables, figures, and appendices may be added at the end of the body of the text.

Description of the Lake

Describe the relevant physical, chemical, and biological parameters that structure the fish community and are most relevant for management purposes. Include descriptions of the water quality, critical in-lake habitat, watershed drivers, connectivity, trophic state, AIS infestations, etc.

Description of the Fish Community

Provide a narrative on both native and non-native species in the lake, including the current composition and a brief history of any major changes. This section may be used to describe warmwater, coolwater, and coldwater communities and include a list of all species sampled over time. This section may include a summary of past fish Index of Biological Integrity (IBI) scores and relevant narrative.

Management History

Provide a concise description of the lake's management history. The following elements should be covered in the management history.

- Plan revision history- Note the last plan revision date, if any, including previous goals and whether they were achieved.
- Surveys and evaluations completed: Note the date of initial survey with a summary of findings. Date and types of other important surveys completed. Be sure to include all the various types of surveys conducted (e.g., sportfish survey, FIBI, creel, habitat, stocking evaluations, etc.) but a detailed listing of every survey is not necessary. For example, "Six standard surveys or population assessments have been completed since 1973; the last was done in August 2018. Three vegetation surveys have been conducted including 1 point intercept (2015) and 2 Floating Leaf and Emergent Mapping (FLEM; 2015 and 2019)".
- Major fish species – status and trends: Describe the key results of previous survey work, including population trends and recent status of managed species, relying heavily on figures and tables more than text.
- Other species: A brief note on other species of interest (e.g., "Common carp were taken in surveys done in 1973 and 1977 but have not been captured since.")
- Research projects and relevant findings: Document previous formal evaluations (e.g., Study 4 projects), creel studies, research projects, or informal investigations and provide key findings from the projects. Focus mainly on surveys and evaluations relevant to the listed management species – other supporting information should be included as Appendices. Include any relevant work from watershed evaluation and/or identified Stressor IDs (e.g., established TMDLs).
- Stocking: Note dates on new introductions, periods of stocking in summary form. No need to list all past stocking in detail (e.g., "Walleye fry have been regularly stocked since 1982; since 1996 stocking has been done only in even-numbered years."). Notable stocking failures or successes may be described in more detail.
- Regulations: Describe any special or experimental regulations employed, with a brief description of outcomes, and a reference to any evaluations reported.

- Habitat Management: Describe any significant habitat projects in the lake or on a large scale in the watershed (if targeting water quality in the lake). Describe outcomes, if known, with a reference to full evaluations, if any.
- Other past management: Describe what was done and learned? Examples may include aeration, fish removal, barrier installation or modification, rehabilitations, etc.

Social Aspects

Describe the social aspects, including people as drivers of change on the fishery and as social influencers of management. Things to include could be:

- General Information: Include the location in respect to population centers, amount (and location) of lakeshore and watershed development, type and location of public access, availability of resort accommodations (consider vacation rentals too).
- Fishing Pressure and Other Uses: Describe fishing pressure (even if just a subjective evaluation), species preferences, other unique considerations (e.g., “Hosts an annual Dogfish Days tournament.”), and other types of recreational use that may impact anglers or fish management. If known, describe the source of angler use (subjective information or “angler-sheds” from creel surveys).
- Public Input: Document efforts made to obtain public input on this plan, and the input received. Describe other important outreach efforts and active partners.
- Any relevant social or community history related to the resource should be described.

Limiting Factors

To the extent they are known (or suspected), limiting factors that directly or indirectly affect primary or secondary management species should be documented. Address relevant systems change drivers such as climate change, even if out of your control. Limiting factors that could be addressed could include (but are not limited to) climate (and climate change), habitat, water quality, Invasive species, fish community dynamics or composition (including forage availability), and exploitation (fishing mortality).

For management species, refer to relevant technical guidance (i.e., species chapters) to identify limiting factors that may be associated with or preventing you from achieving objectives. Explicitly identify which limiting factors are within and outside of your control. If factors outside of your control are preventing you from achieving management objectives, you may need to change your goals and associated objectives, citing those factors when you do so. Critical uncertainties can also be limiting factors. Consider questions that, if answered, would help you achieve or refine your management goals.

Rationale for Management Species Selection, Goals, and Objectives

Summarize information covered in the LMP and relevant history that led to rationale for management priorities for the lake, selection of primary and secondary management species, and crafting management goals and objectives. Keep the justification for goals concise. Indicate where benchmarks used for objectives came from (e.g., interquartile range for lake class, historic targets).

Management Priorities

Determining the lake's Information Tier (A, B, C) and Lake Priority Rank (1-5) per the Lake Survey Prioritization Framework is covered in detail in the Priority-Based Planning chapter. A plain language description of the lake's tier and priority with clear justifications for the rankings should be included in the rationale section.

Determining Primary and Secondary Management Species

A critical part of any lake management plan is the selection of primary and secondary management species. We are often asked questions like "how many lakes do we manage for X", or "what trends are we seeing in the catch of Y in lakes managed for Y?" These questions come from many sources, including the public, oversight committees, legislators, researchers, and other resource professionals. Designation of species as primary or secondary allows us to categorize lakes to answer queries. More importantly, it determines how much effort will be expended to manage that species, our level of expectation for the species, and the types of management tools we may employ. Important considerations for listing species include fish community considerations, management history, and social aspects.

Selection of primary and secondary management species should be limited to no more than two primary and four secondary species. It is unrealistic to expect to effectively manage more than this at one time. In many, if not most cases, fewer species will be listed; there are some lakes where we may not list a primary or secondary species at all, because the lake simply won't support a fishery of any kind. If a lake has historically had more than six species listed as primary or secondary, the species least likely to respond to management efforts, or the least important species, should no longer be listed. The line between primary and secondary is not absolute, and the divide between the two levels is not necessarily great.

Any species subject to some management effort beyond routine monitoring should be listed as a primary or secondary species but species with minimal management efforts may still be listed in either category. A species should be flagged as actively managed if any management actions designed to manipulate the population or the fishery are in progress or planned. Active management could include any type of stocking, special or experimental regulations, increased survey effort or frequency needed to propose or evaluate a management action, or other actions directly or mostly targeting a species or fishery. Routine monitoring alone is not active management. Neither are routine enforcement nor permitting activities. Surplus stocking that does not require evaluation is also not considered active management.

To be listed as a primary species, a species should provide one of the most important or high-value fisheries in the lake. It should be a species for which the lake is ecologically well suited or one being intensively managed (e.g., by stocking, or by special/experimental regulation). A primary species should be a species that anglers can reasonably expect to target and catch in that lake, and one that is targeted by a significant number of anglers on the lake (a "destination" fishery for the species). Primary management species should have associated goals and objectives regardless of whether active management is ongoing or planned.

Secondary species are those that provide some targeted or incidental fishing opportunity, that are important to a smaller group of anglers, or that are important for other ecological or fish management reasons (e.g., a critical

forage species, or a rare species requiring protection). If a secondary fishery in a lake is based on a species complex (e.g., panfish, or bullheads), that complex or group (based on species groups in the Fisheries Lake Survey Module) may be listed as one of the secondary species. For secondary species subject to some management effort, goals and objectives for the species should be listed. Goals and objectives are not required for secondary species (or complexes) that are self-sustained, requiring no management intervention, or not amenable to management intervention although describing goals may be useful to convey expectations for those fisheries.

Species that are not listed as primary or secondary do not require goals or objectives. They may be monitored at a minimal level, through scheduled standard surveys. They do not require intensive or detailed treatment in the body of the lake management plan. A brief description of the opportunities they provide, or their value in the fish community, will suffice.

As the lake management planning cycle progresses, species may be moved into or out of primary and secondary positions. Whenever such a change is made, the reasons for the change should be clearly stated in the body of the lake management plan. Justification for species designation should always be clearly defined. A species designation example is provided below.

Walleye is the primary management species. They are well suited for the lake and frequently targeted by anglers. Walleyes are actively managed with a special regulation which require frequent evaluation. Northern Pike and Largemouth Bass are secondary species. They are well suited for the lake and provide a quality size structure but occur in low to moderate numbers. They require no active management. Bluegill is another secondary species. They naturally occur in high numbers which provides opportunities for high angler catches, but poor size quality may limit angler popularity.

Identifying Goals and Setting SMART Objectives

Management goals were previously thought of as ideal scenarios, with lofty goals that were often beyond the fisheries' biological potential. This often contributed to unrealistic expectations for anglers and managers. A better approach is to develop goals and objectives that acknowledge the known limitations of the fishery and limited tools that may be applied.

Management goals are a broad vision for the type of fishery you are trying to provide. Goals should include references to species per the primary and/or secondary management species designation and include what aspect(s) of the fishery is being managed for. Goals should be socially and ecologically realistic and are best developed in consultation with key stakeholders. Goals should be written in plain language, digestible by the public, and not quantified with specific benchmarks. Recommended goals have been established for some species by technical teams (species chapters). Example goals for a popular Walleye fishery with secondary opportunities for pike, bass, and sunfish are provided below.

This plan is expected to provide a Walleye fishery that offers consistently good fishing opportunities of angler-preferred sized fish supported primarily with natural reproduction. Secondary fisheries for Northern Pike and Largemouth Bass will be maintained with low to moderate numbers but anglers will have opportunities to catch quality-sized fish. Bluegill will be maintained in plentiful numbers to support high angler catches, but relatively few large fish are expected, so angler popularity may be limited.

Management objectives are the specific, quantified benchmarks (targets or ranges) that tell you if you are achieving your goals. Management objectives should generally be SMART (**S**pecific, **M**easurable, **A**chievable, **R**elated [to the goal], and **T**emporally bound). The temporal aspect of the objective will depend on whether a fishery is currently achieving established objectives. If a population is not achieving the goal, the objective should be directional and have a temporal component (see Northern Pike example below). Specific numbers in objectives should be based off population metrics developed from lake class quartiles as specified in the species chapters or, where sufficient time series data exist, from previous surveys. Example objectives associated with above goals are provided below.

The primary objective is to maintain an average Walleye catch rate above the lake class third quartile of 10 per gill net in surveys from 2027-2033, with a moderate proportion of fish over 20 inches (PSD20 of 20 to 60). Multiple Walleye year-classes and fish younger than age-4 should be observed in each survey. Secondary objectives include reducing the Northern Pike catch rate to under the lake average of 5 per gill net while increasing the proportion of angler preferred pike (PSD28 ≥ 40) by 2030; maintaining a nighttime Largemouth Bass electrofishing catch rate between 10 and 30 fish per hour (typical range for area lakes), with quality fish present (PSD15 ≥ 30); and maintaining a Bluegill catch rate near the lake class third quartile of 30 per trap net.

Operational Plan

The operational plan describes the strategies and tools that may be used to help reach the goals and objectives and an evaluation plan to determine if their application was successful. Unfortunately, not every useful strategy or evaluation is possible given limited resources. With fluctuating staffing and funding, operational plans will be contingent on various resource scenarios. Include any operational plans and indicate which will be continued under two resource scenarios: base or base-plus. Base includes the work expected to be done on the lake assuming base staffing and funding from your area alone. Base-plus includes work that would be done with additional project funds or that would require assistance from other Area offices. Components that might be possible with additional resources (base-plus), should be included in the body of the LMP. Details on the following aspects of operational planning are provided as follows.

Stocking

Stocking may be a useful tool to overcome poor natural recruitment but is not effective at managing other limiting factors. Several important questions should be asked when considering stocking as a management option.

- Is the species and strain appropriate for the waterbody and consistent with the management plan? For example, stocking crappie may be counter to Walleye management in a lake with Walleye as a primary management species.
- Genetics should be considered. Walleye should always be assigned a strain based on genetic management units as defined in the Walleye Stocking Operational Plan. Most species do not have established genetic management units but that does not mean that local genetics are not important and non-local strains should only be stocked in land locked systems with low risk of escapement, or when there is a clear need for stocking, but local strains are not available or appropriate (e.g., widespread use of Leech Lake strain Muskellunge).
- Connectivity to other water bodies should be reviewed. Lakes with connectivity are unlikely to benefit from stocking due to colonization of species that are well suited to those environments and escapement could impact management of other connected waters.
- Are there social considerations that support or oppose the stocking? Areas know their waters and stakeholders best. Stocking certain species may cause social concerns (for example, Smallmouth Bass in a lake managed for Walleye may be controversial) or stocking may send the wrong message to stakeholders (e.g., supporting a belief that stocking is needed and likely to be successful in the lake when in fact, it is most likely to fail).

List all stocking proposed over the life of the plan. Include species, strain, size, target rate (fish per pound), target number or pounds, time of year, stocking frequency (or list specific years), and whether the stocking is considered base, contingency, or surplus. If non-local strains are being stocked, why? Do stocking plans change with different resource scenarios? If no stocking is being done, why not?

The plan should also note if there is a history of private stockings or if requests are anticipated. Per MN Statute 17.4987, a person may not release private aquatic life into public waters that are not licensed as part of an aquatic farm without first obtaining a transportation permit from the commissioner. The commissioner may deny issuance of a permit if stocking is not consistent with the public waters management plan. Each management plan should define when private stocking requests would be approved or denied, and under what constraints or considerations? In addition to the general stocking considerations previously discussed (appropriate species, genetics, connectivity, social considerations), private stockings should consider their impact on our evaluation plans of the stocked water and connected waters. Private stocking permits that impact our ability to evaluate active management should be denied. For example, private fingerling stocking in a lake where DNR fry stocking is being evaluated may be inappropriate.

An example stocking plan associated with previously described goals and objectives is provided below.

Although the lake has a history of Walleye stocking, evaluations have consistently found that natural reproduction is sufficient, and stocking has not been additive. This plan optimizes conditions for natural reproduction by protecting spawning-aged fish and critical habitats. As such, stocking is not currently planned or needed. The evaluation of regulation effects and natural reproduction is critical to this plan. Private Walleye stocking would interfere with on-going evaluation efforts and permit requests should be denied. Given the lakes connectivity to other waters, stocking other fish species is not needed and stocking from non-local sources may compromise genetic integrity and is not allowable.

Regulations

Describe current regulations and what will be used between plan revisions. Indicate whether other special or experimental regulations are used or being considered in the future. List any proposed regulation changes (special or experimental), with a proposed implementation year. An example regulation plan associated with previously described goals and objectives is provided below.

Walleye harvest has been regulated with a special 17-to-26-inch protected slot limit since 2023. Although more time is needed to evaluate this regulation, it is expected to help reach the management goals by maintaining sufficient spawner stock to contribute to frequent natural recruitment. The regulation should be maintained as long as it remains acceptable to anglers and is contributing to management goals. The regulation should be relaxed to the 20-to-24-inch toolbox option or dropped if it does not contribute to management goals by 2033, or if fish over 20 inches are disproportionately high (PSD-20 > 60) in two consecutive surveys thereafter. All other species are managed with statewide or zone regulations. The lake is in the northcentral pike zone. This regulation includes a 10 fish bag limit with a 22-to-26-inch protected slot for anglers (there is a spearing exception). This regulation is hoped to contribute to improved pike size quality but if the objectives are not met by 2030, a special 24-to-36-inch toolbox slot regulation should be considered.

Habitat development, protection, and acquisition

Describe watershed planning opportunities within the plan life cycle, habitat improvement plans, aeration plans and note protection or improvement needs including potential acquisitions. For existing fisheries managed properties include a summary of maintenance plans (or reference another document). What in-lake habitat or watershed-based habitat work is needed and what is planned under the two resource scenarios? Refer to the Habitat chapter for prioritizing efforts -- include what lake habitat strategy you consider the lake in, what actions should be prioritized, and list key partnerships for accomplishing the actions. If significant habitat work is planned, include goals of work and any subsequent objectives. Permitting considerations for projects or aquatic plant control should be discussed (e.g., what conditions would support approvals or denials for anticipated applications?). For intensively management aquatic plant communities, consider whether an LVMP is appropriate. An example habitat plan associated with previously described goals and objectives is provided below.

The in-lake habitat strategy includes a primary focus for vigilance and shoreline protection, with a secondary focus on watershed protection and restoration. The protection of spawning habitat is critical to maintain natural Walleye recruitment. Sensitive areas will be evaluated during a habitat mapping project (base plan). Landowners, the lake association, and local units of government will be partnered with to protect a minimum of 50% of the near-shore spawning habitat for Walleye. This effort will largely consist of public education to encourage lakeshore owners to employ best use practices. Degraded habitats will be identified, and potential improvement projects will be designed, and funding sought, as time allows. The distribution of cattail has increased with time, degrading some near shore plant communities. Cattails are a protected plant and removal is regulated via Aquatic Plant Management (APM) permitting. Protection is warranted where cattail removal would destabilize shorelines or is simply for aesthetic or recreational purposes beyond reasonable access. Alternatively, APM permits that allow expanded cattail control or removal should be supported when they are associated with a habitat improvement project that would provide clear benefits to fish and wildlife. The Old-Times Resort on the north end of the lake has not operated in over a decade. The resort property includes 500 feet of shoreline with wind-swept gravel shoal areas that may support Walleye spawning. Acquisition of this property should be considered if it is offered for sale and funding and staff resources are available (base-plus).

Fish removal (commercial, State, or bait harvest)

Describe commercial fishing or fish removal planned between plan revisions. Include desired plans for fish removal and whether it is contingent on a resource scenario. Note if fish removal is not desirable or no commercial species exist. What permitting conditions would be approved versus denied? An example acquisition plan associated with previously described goals and objectives is provided below.

The current fish community is composed of a variety of native fish species. Although Bigmouth Buffalo are present, the lake does not support commercial species in sufficient numbers to warrant removal and is not a listed Core Water for inland commercial fishing. Commercial fishers may apply for a B-permit, but these applications should be denied.

Outreach

Describe your communication plan including key stakeholders and list special outreach and engagement efforts. Outreach is an important but often overlooked management tool. Include key messaging points for anglers and stakeholders to consider. An example outreach plan associated with previously described goals and objectives is provided below.

Outreach will occur through annual attendance of the lake association meeting, county fair attendance, and general correspondence with anglers (phone calls, emails, etc.). Important messaging includes reminding anglers that the lake is in the north-central zone and angler caught pike from 22-26 inches must be released. Anglers can further help improve Northern Pike size quality by focusing harvest on pike under 22 inches, while releasing all pike over 26 inches. Additionally, lakeshore owners are encouraged to employ best use practices for lakeshore development. The Walleye fishery is maintained by natural reproduction, so protection of spawning habitat is critical.

Surveys and evaluations

Detail the information needs and investigations that will be completed before the next plan revision. This plan should be sufficient to fulfill data needs and evaluate whether goals for the fishery are met and tools are applied appropriately. A good evaluation plan details the primary information needs. Indicate the lake's Information Tier (A, B, C) and Lake Priority Rank (1-5) per the Lake Survey Prioritization Framework (see Priority Based Planning Chapter). Important parameters should be defined (see Fish Population Parameters and Considerations Chapter) and multiple surveys or investigations should be described (see Planning Surveys and Evaluations Chapter). List any planned or desired surveys or investigation projects, including Study 4s (creels or management evaluations), staff reports, and research projects (internal or external). List the specific survey components including timing and gear. Include what surveys or survey components are contingent on resource scenarios (e.g., workload considerations, funding, etc.). Include the year and time of year for each planned survey. If survey frequency disagrees with LSPF guidelines, indicate why. Consider the IBI watershed rotation so opportunities to conduct IBI surveys are not missed. The following would provide a good evaluation plan for the goals and objectives previously described:

The primary information needs are to evaluate the Walleye fishery to determine if natural recruitment is maintaining a desirable fishery and if the special 17-to-26-inch slot limit is effective; and to identify key Walleye spawning habitat to ensure sufficient protection. Secondary needs are to determine the status of the Northern Pike, Largemouth Bass, and Bluegill fisheries and provide information to anglers.

Lake habitat mapping is on-going and should be completed by 2025. As a Tier B (management evaluation) lake with a moderately high priority (Rank 2), fisheries surveys will be conducted on a three-year rotation beginning in 2027 (base plan). The evaluation plan will include gill net only targeted surveys in 2027 and 2030 with an emphasis on collecting length, age, and growth data for Walleye and Northern Pike. These surveys will consist of 12 gill net sets in late-August at standardized net locations. A follow-up standard survey and Index of Biological Integrity (IBI) survey will be conducted in 2033 during the watershed IBI rotation. This survey should include spring night-time electrofishing for Largemouth Bass with aging structures collected. Near-shore seining and backpack electrofishing will be conducted in the summer as time allows. In mid-August 12 trap nets and 12 gill nets will be set at standardized locations. Aging structures will be collected for Walleye and Northern Pike. The LMP will be revised following the 2033 evaluation.

August trap netting is not likely sufficient to fully characterize the Bluegill fishery but may provide enough insight given the modest goals of this plan. More specific Bluegill data could be collected using a spring targeted trap net survey if staff time allows (base-plus). Annual night-time electrofishing for young-of-the-year Walleye and fall targeted surveys to determine Walleye spawner stock biomass would be useful but are currently not feasible due to workload and staffing considerations. These should be considered if staffing and time allow (base-plus).

References

A reference list is optional but is recommended when discussing the results of past investigations affecting management of the lake. A reader may want to learn more from the source. References can lend some credibility to statements that might not otherwise be supported by information available in a lake file.

Supporting Tables, Figures, and Appendices

Do not try to include every piece of information found in a lake file in tables or figures attached to an LMP. Include only the information needed to directly support text in the body of the plan, and that helps reduce the amount of text in the plan. Include additional supporting information (e.g., survey catch rate history tables, trend figures) that is referenced in the body of the LMP but can be relatively standalone. These could include additional survey work (e.g., Score the Shore report), selected WAESTOCK figures helpful to justify a stocking decision, maps, photos, diagrams, etc.).

Cover Page

The cover page of the LMP is intended to provide an executive summary of management goals, objectives, and proposed actions on a lake. Details and supporting information are provided in the body of the plan as previously described in the guide. This information needs to be considered to provide a good summary, so the cover page should be the last part of a plan to be completed. Try hard to keep entries on the cover page brief, and to keep the cover page to a single page.

At the top of the cover page is basic information on the lake, including its name, DOW number, ecological class, surface area (acres), littoral area (acres), maximum depth (feet), and management area (office name and number, e.g., Grand Marais – F218). The Information Tier and Lake Priority Ranks should be noted in the appropriate boxes. The plan revision date notes the year in which the next full revision of the plan is scheduled. This will often coincide with the temporal parameter in one or more of your SMART objectives. You do not have to revise the plan after every survey; typically, two or more surveys will be part of the adaptive management cycle and will provide a better base for a plan revision. Checkboxes are provided to note what aspects of the plan have changed since the last revision. Next, primary and secondary management species are listed, flagging those considered to be actively managed with an asterisk (*). The next section lists management goals and objectives followed by space to outline the operational plan.

The operation plan on the cover page is a summary or simple list of the planned and necessary actions proposed to achieve established objectives and corresponding goals. Even though good objectives should be achievable, our management actions are limited in scope and effectiveness, particularly under inevitable budget and staffing constraints. Management actions listed on the cover page will not be comprehensive but should be the highest priority actions that are planned and feasible under base staffing and funding. Justification and operational details for actions included in the operation plan should be described in the body of the LMP, not on the cover page.

Jurisdictions

Many lakes lie within multiple jurisdictions and every lake lies within a Ceded Tribal Territory. In this section list those that may have an explicit interest in management of the lake – the list would be considered primary partners in management. That list may include counties, other States or Provinces, tribal partners, Minnesota Pollution Control Agency monitoring units, National or State Parks and Forests, municipalities, and other locally important jurisdictions or areas (e.g., the Boundary Water Canoe Wilderness Area. These jurisdictions should be noted on the cover page and in the Social Aspects section of the LMP.

Approvals

A plan is a draft until it has been approved at the area and regional levels. Document those approvals on the cover page.

Citations

Citations within the main body of the LMPG are static however work cited in the accompanying species chapters are subject to change.

Bacigalupi, J., D. F. Staples, M. T. Treml, and D. L. Bahr. 2021. Development of fish-based indices of biological integrity for Minnesota lakes. Ecological Indicators, 125:1—15

Blinick, N.S. 2022. Zebra mussel invasion associated with higher reliance on littoral energy sources and higher mercury levels in walleye and yellow perch. Master's Thesis, University of Minnesota. Available from https://conservancy.umn.edu/server/api/core/bitstreams/930fb03e-224d-4e2b-a73c-e8b6c6a05a59/content.

Bonar, S. A., W. A. Hubert, and D. W. Willis, editors. 2009. Standard methods for sampling North American fishes. American Fisheries Society, Bethesda, Maryland.

Fayram, A. H., D. A. Schenborn, J. M. Hennessy, N. A. Nate, and P. J. Schmalz. 2009. Exploring the conflict between broad scale and local inland fisheries management: The risks to agency credibility. Fisheries 34(5):232-236 DOI: 10.1577/1548-8446-34.5.232

Guy, C. S. and M. L. Brown, editors. 2007. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, Maryland.

Hansen, G. J. A, Gaeta, J. W., Hansen, J. F., and Carpenter, S. R. 2015. Learning to manage and managing to learn: sustaining freshwater recreational fisheries in a changing environment. Fisheries, 40, 56–64.

Hansen, G. J. A., T. D. Ahrenstorff, B. J. Bethke, J. D. Dumke, J. Hirsch, K. E. Kovalenko, J. F. LeDuc, R. P. Maki, H. R. Rantala, and T. Wagner. 2020. Walleye growth declines following zebra mussel and Bythotephes invasion. Biological Invasions, volume 22:1481—1495.

Holling, C. S. 1973. Resilience and stability of ecological systems. A. Rev. Ecol. System, 4: 1-24.

Hunt, L. M., S. G. Sutton, and R. Arlinghaus. 2013. Illustrating the critical role of human dimensions research for understanding and managing recreational fisheries within a social-ecologicl system framework. Fisheries Management and Ecology 20:111-124.

Jacobson, P. C., T. K. Cross, D. L. Dustin, and M. Duval. 2016. A fish habitat conservation framework for Minnesota Lakes. Fisheries 41:302-317.

Lynch, A. J., B. J. E. Myers, C. Chu, L. A. Eby, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, T. J. Kwak, J. Lyons, C. P. Paukert, and J. E. Whitney. 2016. Climate change effects on North American inland fish populations and assemblages. Fisheries, volume 41:346—361.

Mikulyuk, A., E. Kujawa, M. E. Nault, S. Van Egeren, K. I. Wagner, M. Barton, J. Hauxwell, and M. J. Vander Zanden. 2020. Is the cure worse than the disease? Comparing the ecological effects of an invasive aquatic plant and the herbicide treatments used to control it. Facets, 5:353—366.

Minnesota Department of Natural Resources (MNDNR). 1982. Lake management planning guide. Minnesota Department of Natural Resources, Special Publication No. 132, St. Paul, Minnesota.

Minnesota Department of Natural Resources (MNDNR). 1993. Manual of instructions for lake survey. Minnesota Department of Natural Resources, Special Publication No. 147, St. Paul, Minnesota. .

Minnesota Department of Natural Resources (MNDNR). 2013. Fish Habitat Plan: a strategic guidance document. Minnesota Department of Natural Resources, Section of Fisheries, St. Paul, Minnesota.

Minnesota Department of Natural Resources (MNDNR). 2017. Manual of instructions for lake survey. Minnesota Department of Natural Resources, Special Publication No. 180, St. Paul, Minnesota.

Minnesota Department of Natural Resources (MNDNR). 2018. Guidelines for Age and Growth Estimation of Minnesota Fishes. Minnesota Department of Natural Resources, Special Publication No. 189, St. Paul, Minnesota.

Miranda, L. E., and P. W. Bettoli. 2007. Mortality. Pages 229–277 in C. S. Guy and M. L. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, Maryland.

Myers, B. J. E., A. J. Lynch, D. B. Bunnell, C. Chu, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, T. J. Kwak, and C. P. Paukert. 2017. Global synthesis of the documented and projected effects of climate change on inland fishes. Reviews in Fish Biology and Fisheries, volume 27:339—361.

Neumann RM, Guy CS, Willis DW. 2012. Length, Weight, and associated Indices. In: Zale AV, Parrish DL, Sutton TM, editors. Fisheries techniques. 3rd ed. Bethesda (MD): American Fisheries Society. p. 637–76.

Noble, R. L., and T. W. Jones. 1999. Managing fisheries with regulations. Pages 455-480 in C. C. Kohler and W. A Hubert, eds. Inland fisheries management in North America, second edition. American Fisheries Society, Bethesda, Maryland.

Ogle, D. H. 2016. Introductory fisheries analyses with R (Vol. 32). Boca Raton, FL: CRC Press.

Paukert, C., B. A. Glazer, G. J. A. Hansen, B. J. Irwin, P. C. Jacobson, J. L. Kershner, B. J. Shuter, J. E. Whitney, and A. J. Lynch. 2016. Adapting inland fisheries management to a changing climate. Fisheries, volume 41:374—384.

Paukert, C., J. D. Olden, A. J. Lynch, D. D. Breshears, R. C. Chambers, C. Chu, M. Daly, K. L. Dibble, J. Falke, D. Issak, P. Jacobson, O. P. Jensen, and D. Munroe. 2021. Climate change effects on north American fish and fisheries to inform adaptation strategies. Fisheries, volume 46:449—464.

Perleberg, D,. P. Radomski, S. Simon, K. Carlson, and J. Knopik. 2016. Minnesota lake plant survey manual. Minnesota Department of Natural Resources, Ecological and Water Resources Division, Brainerd, Minnesota.

Pollock, K. H., C. M. Jones, and T. L. Brown. 1994. Angler survey methods and their application in fisheries management. American Fisheries Society Special Publication 25.

Schuurman, G.W., D.N. Cole, A.E. Cravens, S. Covington, S.D. Crausbay, C.H. Hoffman, D.J. Lawrence, D.J. Lawrence, D.R. Magness, J.M. Morton, E.A. Nelson, and R. O'Malley. 2020. Navigating Ecological Transformation: Resist-Accept-Direct as a Path to a New Resource Management Paradigm. BioScience 72:16-29

Tingley, R.W. III, C.P. Paukert, G.G. Sass, P.C. Jacobson, G.J.A. Hansen, A.J. Lynch, and P.D. Shannon. 2019. Adapting to climate change: guidance for the management of inland glacial lake fisheries. Lake Reservoir Management, 35:435-452.

Schupp, D. H. 1992. An ecological classification system of Minnesota lakes with associated fish communities. Investigational Report Number 417, Minnesota Department of Natural Resources, Division of Fish and Wildlife, Investigational Report 417, St. Paul.

Tingley III, R. W., C. Paukert, G. G. Sass, P. C. Jacobson, G. J. A. Hansen, A. J. Lynch, and P. D. Shannon. 2019. Adapting to climate change: guidance for the management of inland glacial lake fisheries. Lake and Reservoir Management, 35:435—452.

Walters, C. 1986. Adaptive management of renewable resources. Macmillan, New York. 374pp.

Walters, C. J. and C. S. Holling. 1990. Large-scale management experiments and learning by doing. Ecology, volume 71, number 26: 2060—2068.

Williams, B. K. 2011. Passive and active adaptive management: Approaches and an example. Journal of Environmental Management, volume 92:1371—1378.

Appendices

Appendix 1- Lake Management Plan Template

Appendix 2- Lake Management Plan Amendment Template

Appendix 3- Lake Management Timeline

Appendix 4- Lake Management Priority Consideration Tool (Excel workbook)

Appendix 5- Climate RAD Tables (Excel workbook)

Species Chapters

Species chapters will be more technical reference pieces including things like limiting factors, management options, assessment framework/metrics. Chapters will rely on references to provide the details and background associated with general statements and management directions listed in the chapter. For popular fish species, the amount of technical and historical information is rich and thus the species chapters can be rather lengthy. Presenting such rich content in a digestible and somewhat consistent manner is challenging so 2-3 page condensed versions of species chapters are also offered. Because we are always learning, the content in the species chapters is subject to change. The most up-to-date versions are available upon request.

Glossary

Accuracy. A measure of the closeness of a statistic obtained by sampling to the true value of the population parameter (Zale et al. 2012).

Active Management. Management actions that are taken to manipulate a system or community to reach specific objectives. Active management may include stocking, special regulations, special evaluations (beyond routine monitoring), or habitat projects designed to contribute to meeting a defined objective.

Aquatic Invasive Species (AIS). Aquatic species that are not native to Minnesota *and* cause economic or environmental harm or harm to human health.

Bag limit. Commonly used and general term to specify how many fish an angler can keep. Can be further specified as a daily limit or a possession limit and can be associated with a size restriction. Synonymous with creel limit.

Catch per unit effort (CPUE). The number or weight of organisms captured with a defined unit of sampling or fishing effort (Zale et al. 2012).

Coldwater fish (coldwater communities). Fish species that survive, grow, and reproduce best in cold water. They generally spawn at water temperatures below 13° C (55° F) and do not survive at water temperatures exceeding approximately 21° C (70° F; Bonar et al. 2009).

Coolwater fish (coolwater community). Fish species that survive, grow, and reproduce best in cool water. They generally spawn at water temperatures between 4° C and 16° C (40° F and 60° F) and do not survive well in waters exceeding approximately 32° C (90° F; Bonar et al. 2009).

Creel limit. Synonymous with bag limit.

Daily limit. The number of a particular species an angler is allowed to keep in a calendar day. Note, a lake specific daily limit applies just to that lake. Thus, an angler could fish another lake to get another daily limit until they reach their possession limit.

Fishery. A general term comprised of the social and ecological factors surrounding an angling opportunity. The term can mean the enterprise of raising or harvesting fish or, more commonly, the site where such enterprise takes place. For the purpose of management planning, a fishery usually refers to a species or multiple species of fish in a lake and the anglers that target them.

Fisheries. A description for more than one fishery in a waterbody or geographic region, or the Minnesota Department of Natural Resources Section of Fisheries Management.

Fish Community. The species present and their relative proportions in an assemblage of organisms (Bonar et al. 2009).

FishPad. A DNR Fisheries application and statewide database used to house management plans and stocking information.

Gamefish. For the purposes of this guide, these fish are considered gamefish: Walleye, Northern Pike, Largemouth Bass, Smallmouth Bass, Muskellunge, trout (all species), salmon (all species), catfish (all species other than bullheads), Lake Sturgeon, Shovelnose Sturgeon, Paddlefish, and Sauger (MNDNR 1993). A statutory definition can be found in Minn. Stats. 97A.015.

Harvest. The removal of fish from a fishery for personal (typically consumptive) uses.

I drive. A DNR network location used to store digital information including survey reports, management evaluations, and management plans.

Index. A number (such as a ratio) derived from a series of observations and used as an indicator or measure.

Lake Class (ecological lake class). A grouping of lakes determined by methods to classify Minnesota lakes based on physical and chemical attribute. Multiple lake classification schemes exist but the most commonly used one in Minnesota is described in Schupp 1992.

Managed Species. Fish species that are managed or manipulated to produce a desirable outcome.

Mark-Recapture (study). A population estimate methodology derived from a fish marking and recapture study phase.

Native Rough Fish. Buffalo, suckers (including redhorses), sheepshead, bowfin, gar, goldeye, and bullhead. Carp were formally considered rough fish but are no longer and are an unprotected species. A statutory definition can be found in Minn. Stats 97A.015.

Nongame fish. Fish species that are not harvested for recreational purposes; fish that are legally described as nongame species (Bonar et al. 2009). For the purposes of this manual, fish not identified as gamefish or panfish are considered nongame fish (MNDNR 1993).

Panfish. For the purposes of this manual, these fish are considered panfish: Bluegill, Black Crappie, White Crappie, Yellow Perch, Pumpkinseed, other sunfishes, White Bass, and Rock Bass (MNDNR 1993).

Parameters. A numerical or other measurable factor forming one of a set that defines a system or sets the conditions of its operation.

Possession limit. The number of a particular species an angler is allowed in possession, including any and all locations such as a livewell or freezer at home.

Precision. The amount of variation in the data used to compute an estimate. It is most often expressed as a standard deviation or standard error (Bonar et al. 2009).

Relative abundance. Information obtained from samples or observations and used as an index to population abundance; often based on catch per unit of sampling effort in fisheries (Bonar et al. 2009).

Selectivity (Gear). The bias of a gear leading to misrepresentation of taxa, sizes, or life stages in samples relative to actual occurrence. Gear selectivity is undesirable if an unbiased sample is wanted. It can be useful if only certain sizes or kinds of fish are sought (Zale et al. 2012).

Size Structure. The distribution of lengths within a fish population. An even distribution of lengths, or a distribution that favors angler preferred-length individuals is often desirable while a distribution comprised mostly of small fish is often considered undesirable.

Target species. Fish or other aquatic species intentionally sought for capture (Zale et al. 2012).

WAESTOCK. Walleye stocking evaluation workbook. A Microsoft excel based method developed by the Section of Fisheries to evaluate Walleye stocking and recruitment using age data from gill net surveys.

Warmwater fish (warmwater community). Fish species that survive, grow, and reproduce best in warm water. They generally spawn at water temperatures above 16^{o} C (60^{o} F; Bonar et al. 2009).

Year Class. A group of one kind of fish produced in one year.

Appendix 1. Lake Management Plan Template

DEPARTMENT OF NATURAL RESOURCES

FISHERIES LAKE MANAGEMENT PLAN

LAKE NAME (DOW):	REGION:	AREA:	COUNTY:	ACRES (surface | littoral):	CLASS:

Information Tier (A,B, or C):	**Lake Priority Rank** (1 [hi] -5 [lo]):	**Next Plan Revision:**

Revisions: ☐ Initial Plan | ☐ Species | ☐ Goals/Objectives | ☐ Stocking | ☐ Survey | ☐ Other:

Primary Species (2 maximum; *active management):	**Secondary Species (4 maximum; *active management):**
•	•

Management Goals:

-

Management Objectives:

-

Operational Plan Summary:

-

Additional Jurisdictions and Tribal Partners:

-

APPROVALS

Area Fisheries Supervisor (e-signature):

Regional Fisheries Manager (e-signature):

The plan was revised by AUTHOR and replaces the DATE plan (OPTIONAL).

Description of lake

Text here

Description of fish community

Text here

Management history

Stocking

Optional use of table, include supporting text.

Year	Species	Life Stage	Number	Pounds	Stocked By

Special and Experimental Regulations

Optional use of table, include supporting text.

Species	Regulation	Start Year	End Year

Surveys and Evaluations Completed

Optional use of table, include supporting text.

Year	Survey Type	Components Used	Species Targeted

Managed Fish Species – Status and Trends

Text with references to supporting figures, tables and appendices.

Research Projects and Relevant Findings

Insert text or delete section if N/A.

Other Projects

Insert text or delete section if N/A.

Social Aspects

General Information

Insert text.

Fishing Pressure and Other Recreational Use

Insert text.

Public Input

Insert text.

Limiting Factors

Habitat

Insert text.

Water Quality

Insert text.

Fish Community

Insert text.

Invasive Species

Insert text.

Climate Change

Insert text.

Fishing Mortality

Insert text.

Other

Insert text or delete if N/A.

Rationale for Management Species Selection, Goals, and Objectives

Information Tier and Lake Priority Rank Comments

Insert text.

Primary and Secondary Management Species

Insert text.

Goals and Objectives

Insert text.

Operational Plan Detail

Stocking

Insert text or delete section if N/A.

Regulations

Insert text or delete section if N/A.

Habitat Development, Protection and Acquisition

Insert text or delete section if N/A.

Fish Removal (commercial, state, or bait harvest)

Insert text or delete section if N/A.

Outreach

Insert text or delete section if N/A.

Surveys and Evaluation

Insert text.

References

Insert references using AFS citation standards.

Supporting Tables, Figures, and Appendices

Include supporting material and reference in body of LMP.

Tables accessibility – avoid unnecessary merged cells, check for reader compatibility using by tabbing through table.

Figures accessibility – use informative figure captions, insert figure as image and include alt text.

Appendix 2. Lake Management Plan Amendment Template

DEPARTMENT OF NATURAL RESOURCES

FISHERIES LAKE MANAGEMENT PLAN AMENDMENT

LAKE NAME (DOW):	REGION:	AREA:	COUNTY:	ACRES (surface | littoral):	CLASS:

Reason for amendment (check all that apply):

☐ Goals/Objectives | ☐ Survey | ☐ Schedule | ☐ Stocking Plan | ☐ Species Priority | ☐ Other:

Primary Species (2 maximum; * denotes active management):	Secondary Species (4 maximum; * denotes active management):

Management Goals:

Management Objectives:

Operational Plan Summary:

APPROVALS	
Area Fisheries Supervisor (e-signature):	**Regional Manager (e-signature):**

<Insert approval date>

Background and Justification for Amendment(s):

Insert text that could/should include what initiated the change and what public input was done. Insert figures and text as necessary but include alt text on each.

Appendix 3. Lake Management Plan Timeline

	Year 1												Year 2				
	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May
Proposal																	
Outreach																	
Survey																	
Information Compilation																	
Formal Input																	
Revision																	
Review/Approval																	
Completion																	
Post/Upload																	