Status of Southeast Minnesota Brown Trout Fisheries in Relation to Possible Fishing Regulation Changes

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Minnesota Department of Natural Resources
Division of Fish and Wildlife
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Box 12, 500 Lafayette Road, St. Paul, Minnesota 55155-4012

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EXECUTIVE SUMMARY

DNR Recommendations:

- DNR Fisheries continues to support individual waters management based on a sound biological approach. The biological potential of southeast Minnesota trout streams is not realized by applying a single regulation to all streams.
- Pending a positive response from trout anglers, DNR Fisheries will implement special regulations on a limited number of streams where there is a potential for increasing the abundance of brown trout greater than 12 inches. DNR Fisheries has developed a list of candidate streams for future consideration.
- Develop a plan to evaluate special regulations on these streams with the use of controls (reference streams). The plan will include clear, measurable objectives.
- Additional special regulations may be added to other streams as their biological potential becomes known.
- Focus future sampling efforts to address information needs in the areas of trout population data, trout habitat requirements, trends in angler pressure, catch and harvest, and angler characteristics.

Status and Characteristics of Brown Trout Populations

- Trout reproduction during the past 30 years has improved dramatically due to improved land management, resulting in increased stream flows, less frequent flooding and improved trout habitat.
- The miles of streams in southeast Minnesota supporting trout populations have increased from 281 in the 1970s to more than 700 in the 1990s, of which 569 are currently managed for brown trout.
- Brown trout abundance and biomass typically fluctuate year to year but have been increasing over the past 26 years to near record highs in the 1990s.
- The number of brown trout greater than 12 inches has increased two to threefold in the past 26 years and is still increasing.
- The number of brown trout greater than 15 inches has not changed during this period.
- Brown trout in southeast Minnesota take an average of 3 years to reach 11 inches and more than 5 years to reach 15 inches in length, although growth rates vary among streams.
- Over one-half of the spring biomass (weight) of a typical brown trout population is composed of age 1 (5.3-inch) and age 2 (8.5-inch) fish.
- Total annual mortality for age 3 and older trout (greater than 11 inches) is more than 70% (i.e., more than 70% are lost in a given year due to natural causes, fishing and out- migration).

- Instream habitat (the amount and quality of pools, overhead bank cover, rock and woody cover, and deep water) has been identified as the major factor limiting southeast Minnesota trout populations.
- Habitat requirements of trout greater than 15 inches are more specific than those of smaller trout.

Trends in Angler Pressure and Harvest

- Angler creel surveys from the 1940s to the 1990s indicate fishing pressure has not changed on a per mile of stream basis.
- Creel survey data indicate that trout harvest per angler-hour and per stream mile decreased from the 1940s to the 1950s and has remained stable even though the number of stream miles has increased.
- Average annual angling pressure has increased from 330,000 hours in the 1940s to 1,130,000 hours in the 1990s (based on an increase of 288 miles of managed trout water over the period).
- Average annual brown trout harvest has decreased from 240,000 trout in the 1940s to 115,000 trout in the 1990s (based on an increase of 288 miles of managed trout water over the period).
- Anglers in a 1995 survey released 66% of all caught brown trout and 53% of those greater than 12 inches.
- Angler attitudes regarding the quality of trout fishing experiences are important in designing and evaluating special regulations. The quality of fishing trips is influenced by a combination of tangible factors (including number, size, kind, and diversity of fish caught) and intangible factors (including stream setting, companionship, personal values, and the importance of fishing in a special regulation area).

Seasonal Variation in Trout Populations and Angling

- Creel surveys show angling pressure is high in the spring with about 44% of the total pressure occurring in the first month of the fishing season.
- About 35% of the total harvest of brown trout greater than 12 inches occurs in the first month of the season.
- A creel survey conducted in 1995 showed no significant difference in brown trout harvest rates (number of trout harvested per angler-hour) between the first month and the rest of the season. This was also true for trout greater than 12 inches.
- Recent trout population estimates showed an average 36% decrease in abundance for all sizes and a 22% decrease for brown trout greater than 12 inches six weeks after the trout opener.
- Numbers of brown trout greater than 12 inches are similar or slightly higher in the fall than in the preceding spring, indicating early season harvest is offset by the growth of smaller fish.

Success of Past Experimental Fishing Regulations

- Evaluation of more restrictive regulations on seven stream reaches in southeast Minnesota found that one was successful based on regulation objectives (Hay Creek), while five were unsuccessful and one inconclusive (Middle Branch Whitewater River).
- Catch-and-release only on Hay Creek increased the abundance of brown trout greater than 12 inches but failed to increase the number of trout greater than 15 inches.
- Past experimental regulations in southeast Minnesota failed to increase the abundance of trout greater than 15 inches, and often failed to increase the abundance of any size trout.

- Factors which may limit success of regulations based on possession and size limits are low fishing mortality, lack of adult habitat, slow growth rate, migration and high overwinter mortality.

Computer Modeling of Fishing Regulations

- Computer modeling of eight kinds of regulations show that the more restrictive regulations produce the greatest increases in trout abundance and greatest reductions in harvest.
- Modeling results indicate that there is a higher potential for increasing brown trout greater than 12 inches in streams with fast trout growth rates.
- Increasing numbers of brown trout greater than 15 inches is unlikely on most streams and will only occur in streams with fast trout growth rates and where adult habitat is not limiting.
- Early season catch-and-release, a 10-15 inch protected slot, and catch-and-release the entire season showed the highest increases in trout abundance regardless of growth rates.
- Because the model assumes that adult habitat is not limiting trout populations, increases in trout abundance projected by the model may be overestimated and in some cases unrealistic.

Regulation Proposals:

- The Minnesota Trout Association and Trout Unlimited are proposing a change in trout angling regulations to increase the size of larger brown trout in eight southeastern counties based on their perception that trout greater than 12 inches are rapidly depleted during the first 4 to 6 weeks of the season.
- The proposal would add an additional two weeks of catch-and-release only fishing prior to the current trout opener, implement a protected slot limit between 12 inches and 16 inches (all fish caught between 12-16 inches would be immediately released) and change the last two weeks of the current trout season to catch-and-release only.
- The implementation of the proposed MTA-TU regulation would reduce trout harvest on all streams. It will have little if any effect at increasing abundance of trout greater than 12 inches on slow growing populations, limited if any success in average growth streams, and may be successful on some fast growing trout populations. Streams that may benefit from more restrictive regulations have moderate to high angler harvest, high trout growth rates, and abundant adult trout habitat.
- No criteria for evaluating the success of the regulations have been stated in the MTA-TU proposal.

INTRODUCTION

Southeast Minnesota has 711 miles of coldwater streams of which 569 miles are managed for brown trout by the Minnesota Department of Natural Resources Section of Fisheries (DNR Fisheries). Management has evolved from primarily stocking in the 1950s and 1960s to include acquisition of public fishing easements, population monitoring, habitat management, and recently experimental fishing regulations. DNR Fisheries current management approach is individual waters management (fit a regulation that has a chance to be biologically successful) based on the stream habitat and biological characteristics of a fishery. This management approach has been endorsed by various angling groups through the annual Fishing Roundtable process.

In the past few years, the Minnesota Trout Association (MTA) and local chapters of Trout Unlimited (TU) have been discussing potential regulation changes with the goal of increasing the numbers of large trout (greater than 12 inches). This is based on their perception of a reduction in the numbers of trout greater than 12 inches, especially in late spring and early summer. In the spring of 1996, MTA proposed a regulation change of reducing the daily bag limit from 5 to 3, of which only 1 trout could be greater than 12 inches. The Section of Fisheries agreed to evaluate this proposal by summarizing existing fish population data and conduct computer simulations based on the proposal.

The 1996 MTA proposal was modified in early 1997 after MTA received feedback from members and had discussions with local TU chapters. The revised proposal suggested keeping the current daily bag limit (5), instituting a protected harvest slot of 12 to 16 inches, and allow the harvest of 1 trout over 16 inches. It also proposed to extend the trout fishing season by an additional two weeks in the spring (April 1 to current opener), and allow catch-and-release only fishing from April 1 to the walleye opener (mid-May).

In the spring of 1997, southeast (Region 5) fisheries personnel met with MTA and TU to discuss the most recent proposal. MTA and TU articulated 3 objectives for any potential regulation changes: (1) increase the numbers of trout greater than 12 inches; (2) distribute the harvest more evenly throughout the season; and (3) promote a catch-and-release ethic.

During the summer of 1997, MTA and TU again modified their proposal by removing the catch-and-release only provision from the trout opener to the walleye opener, while retaining a two week catch-and-release extension to the early season (April 1 to current trout opener). They also proposed to change the last two weeks of the trout season (September 15-30) to catch-and-release only.

The objectives of DNR Fisheries during this process has been to: (1) facilitate discussions regarding proposed regulation changes; (2) collate and summarize existing fisheries data and provide an overview of brown trout population and angler trends over the past 26 years; (3) evaluate whether there has been a change in abundance of trout greater than 12 inches; (4) examine the potential for success of the MTA-TU proposals and similar regulations based on computer simulation models; (4) determine the level of public support for proposed regulation changes; (5) make management recommendations to increase large brown trout abundance based on a biological approach; and (6) identify fishery information needs to better evaluate regulation proposals and other trout management activities.

METHODS

To develop current status and trend data on brown trout populations, DNR Fisheries compiled results from stream electrofishing samples on 2,423 stations on 114 streams collected in southeast Minnesota from 1970-1996 (Table 1). These data include all electrofishing surveys where brown trout were sampled. Stream samples included both wild populations and stocked populations. About 60% of the estimates used were from south of Interstate-90 (Lanesboro Area) while the remaining 40% were from north of I-90 (Lake City Area). Trout populations were sampled using standard electrofishing equipment and population estimates calculated using either depletion or mark and recapture techniques. Population estimates were sorted by sample year and annual averages calculated for brown trout biomass (weight) as well as numbers of brown trout equal to or greater than 12 inches, 14 inches, 15 inches, and 16 inches. For ease of reporting, these size groups are referred to as "greater than 12 inches," etc. To eliminate the sampling bias due to stream size, trout abundance for adults is reported as numbers or pounds per acre. Line graphs representing trends over time were developed for brown trout biomass, numbers, size structure, and reproductive success. DNR creel surveys were reviewed and tabulated to assess trends in angling pressure, harvest and fishing success. Angler catch rate and catch (fish harvested plus fish caught and released) were not tabulated for trend evaluation because this information was not recorded in angler surveys prior to the 1980s.

The MTA-TU regulation proposal was analyzed using a computer simulation model. Individual streams and pooled (combined) data sets from a number of streams were tested under various regulation scenarios. Potential for success of the proposal was evaluated along with possible trade-offs such as loss of harvest opportunities and out-migration of larger brown trout. Using available information, DNR Fisheries recommendations were developed to increase abundance of larger brown trout based on a biological approach.

To assess public support for regulation changes, a mail survey was sent to 114 anglers who were contacted by fisheries personnel during a spring 1997 angling survey, and a subset of anglers (609) who purchased a fishing license in Fillmore or Houston County in 1997. This information will be analyzed by the University of Minnesota Center for Survey Research, Minneapolis, and presented in a separate report.

RESULTS

Brown Trout Population Trends from 1970 to 1996

Brown trout populations have increased significantly during the period 1970-1996 as indicated by increases in average annual biomass (Figure 1). Biomass ranged from 30 pounds per acre in 1972 to 141 pounds per acre in 1988. The average biomass for streams in southeast Minnesota during the 1970s, 1980s, and 1990s were 40, 94 and 100 pounds per acre, respectively.

Brown trout greater than 12 inches have shown two to three-fold increases since the 1970s (Figure 2). Average abundance has increased from 12 per acre in the 1970s to 24 per acre in the 1990s, with individual years as high as 35 per acre. Brown trout greater than 14 inches also have increased (Figure 3). While trout populations have been increasing the past 26 years, abundance of trout greater than 15 inches (Figure 4) and 16 inches (Figure 5) have not increased. Average annual abundance for trout greater than 15 inches was 2.7 per acre (range 1-5 per acre) between 1970 and 1996. For trout greater than 16 inches, average abundance was 1.6 per acre (range 0-4 per acre). Anecdotal reports indicate trout greater than 15 inches may have increased in the lower reaches of large trout streams and in transition areas of warmwater streams, however, these areas were not adequately sampled by standard survey methods.

Brown trout reproductive success in southeast Minnesota is variable, but has increased in the past 26 years (Figure 6). Fall abundance of young of the year (YOY) ranged from 75 per mile in 1976 to 3,655 in 1991. During the 1970s, average YOY abundance was 196 mile, increasing to 874 per mile in the 1980s and 1,181 in the 1990s. These increases have followed improved land use practices resulting in increased stream flow, less frequent flooding, and improvements in trout habitat.

While trout populations were increasing during the 1970s to 1990s, DNR Fisheries also documented an increase in the total miles of coldwater streams in southeast Minnesota from 281 miles in 1970 to over 700 miles in 1996. While part of this increase is likely due to increased sampling efforts in recent years, much of the increase is attributable to improved land use practices. For whatever reasons, it is evident that trout populations have been increasing over the last 26 years and are currently at or near all time highs.

Brown Trout Age, Growth and Mortality

Possession and size restrictions work by reducing fishing mortality and allowing more trout to survive and reach larger sizes. Information on trout age, growth rates, and mortality is critical in order to make decisions regarding regulation changes.

Age and growth data were available for 72 electrofishing samples on 30 streams in southeast Minnesota from 1988 to 1996. Seventeen streams were from the Lanesboro Area and 13 from the Lake City Area. Average growth rates, as represented by length at age, were calculated from the entire sample, while age distributions and total mortality rates were only calculated from the Lanesboro Area samples which had estimates of population age distribution.

Brown trout in southeast Minnesota average 8.5 inches at age 2 and 11.0 inches at age 3 (Figure 7). The average brown trout reaches 12 inches in length between ages 3 and 4. Size at age varies considerably among streams (Table 2). Age 3 brown trout ranged from 8 to 15 inches in length. Age 5 and older fish averaging 14.5 inches and greater were present in one-third of the samples.

The abundance of brown trout at each age decreases annually due to a combination of fishing mortality and natural mortality. Mortality rates on five Lanesboro Area streams in the 1990s increased with age (Figure 8). From age 1 to age 2, total mortality averaged about 50%, and increased to 71% to 86% for remaining year classes. Because brown trout in southeast Minnesota are vulnerable to harvest between ages 2 and 3 (8-11 inches), the higher total mortality rates reflect increases in angling mortality.

Over 50% of the spring biomass is composed of age 1 (5.3 inch) and age 2 (8.5 inch) fish (Figure 9). While younger trout are on average more numerous than older trout in a population, biomass (population weight) by age of an average brown trout population is highest at age 2 (8.5 inches to 11 inches).

Table 3 illustrates the effect of estimated annual mortality rates on a hypothetical year class of 1,000 brown trout. In this example, it takes about 7 five-inch trout (age 1) to produce one 11 inch (age 3) trout. To produce a 16+ inch trout (age 6), it would take about 1,000 age 1 trout.

Assessment data indicates that "something" happens to brown trout in southeast Minnesota after age 3. Age distributions indicate that age 3 and older trout experience high mortality, which is probably a combination of natural mortality, fishing mortality, and out-migration.

Brown Trout Habitat Requirements

Instream habitat is a major limiting factor for larger trout in southeast Minnesota. Large brown trout (greater than 15 inches) are associated with the quantity and kinds of instream cover. In the summer, they require large pools, overhead bank cover, instream rocks, riprap, woody debris, and water deeper than 2 feet. Therefore, streams with excellent habitat quality show greater potential for increases in large trout than those lacking adult habitat. Experimental management during the last 20 years has shown that adult habitat, not reproduction, now limits brown trout abundance and fisheries in most streams. Instream habitat improvements can reduce this limiting factor, and increase trout populations. DNR Fisheries instream habitat projects have been very successful in increasing the biomass and abundance of brown trout. Most of these increases have occurred in trout 10-14 inches in length, but with few increases in trout over 14 inches.

Although winter habitat requirements of these large brown trout have not been documented in southeast Minnesota, studies elsewhere have concluded that these trout also require abundant cover and low water velocities in the winter. Determining the habitat requirements of large brown trout and developing habitat based approaches to increasing large trout are areas of ongoing research and evaluation in southeast Minnesota.

Trends in angler pressure and harvest, 1940s to the 1990s

Creel survey data summarized by decade from the 1940s through the 1990s indicate that on a per mile basis, angling pressure has remained relatively stable while angler harvest rates and angler harvest has declined (Table 4). It is important to note that historical creel data is highly variable due to both the low number of angler surveys and non-random selection of stream reaches sampled. Angling pressure has not varied much from 1,167 hours/mile and 2,764 hours/mile in the 1940s and 1950s respectively to 2,021 hours/mile and 1,191 hours/mile in the 1980s and 1990s. The exception is the 1970s where pressure was only 578 angler-hours per mile. No creel data was available for the 1960s. Total annual fishing pressure has increased from an estimated 330,000 hours in the 1940s to 1,130,000 hours in the 1990s. This estimated increase in total hours is based on the increase in stream miles from 281 to 569.

Brown trout harvest rate was the highest in the 1940s at 0.83 trout per hour, declined to 0.28 trout per hour in the 1950s, and remained relatively stable from the 1970s to 1990s, ranging from 0.18-0.23 trout per hour. Harvest per mile also decreased during the same period averaging 800 trout per mile in the 1940-50s to 344 trout per mile in the 1980-90s. The low harvest figure for the 1970s reflects low fishing pressure and not poor angler success. While harvest per mile has been relatively stable the past 26 years, total harvest decreased from an estimated 240,000 in the 1940s to 116,000 in the 1990s, again based on the increase in miles of managed trout waters over the period.

Reductions in harvest per mile from the 1940s to the 1990s is most likely related to both the reduced emphasis on catchable stockings and the increased practice of voluntary catch-and-release. Because brown trout abundance has been increasing the past three decades, the reduction in harvest per mile over the same period indicates higher rates of voluntary catch-and-release. Angler surveys on standard regulation stream reaches in the 1980s and 1990s had an average voluntary release rate of 64% (range 32%-87%). Voluntary release rates also tended to increase over time during the same period, but may also be associated with higher trout populations. The percent of the brown trout population harvested (rate of exploitation) was negatively correlated with biomass. Anglers may be releasing larger numbers of smaller fish (less than 10 inches) when populations are high.

Angler Attitudes

Angler attitudes are important in assessing the success of management efforts. They are also an important consideration when designing and implementing special regulations. The quality of a trout fishing experience is a combination of tangible and intangible factors. Tangible factors include size, number, kind, and diversity (number of different kinds) of fish caught. Intangible factors include stream setting, companionship, personal values, and the importance of fishing in a special regulation area. Angler attitudes can vary from stream to stream, indicating a need for tailoring management (including regulations) to angler expectations.

Seasonal Variation in Brown Trout Populations and Angling

The MTA-TU proposal is based in part on the belief that early season harvest has reduced the abundance of brown trout greater than 12 inches. In order to examine this issue and more fully understand seasonal variations in both trout populations and angler success, numerous seasonal comparisons of data were made. This information included seasonal angling pressure, abundance of brown trout prior to the trout season compared to the abundance after seven weeks of angling, and abundance of larger brown trout in the spring compared to the fall.

Most angling pressure occurs in the spring. In 1995, a creel survey was conducted on five trout streams in southeast Minnesota (Table 5). Fishing pressure during the first month of the season (trout opener to the walleye opener) was compared to the remainder of the season (walleye opener to the end of the trout season). The first month (April 13 - May 12) was 30 angling days (18%) while the remainder of the season was 141 angling days (82%). Total angling pressure was 4,921 hours during the first month (44% of the total pressure) with 6,227 hours (56% of the total pressure) for the remainder of the season. All surveyed streams showed substantially higher pressure per day during the first month of the season as compared to the remainder of the season. Pressure per day averaged 164 hours in the first month of the season and 44 hours during the remainder of the season.

Based on the 1995 creel survey, there was no significant difference in fishing success (trout harvested per angler-hour) between the first month and the remainder of the trout season (all streams combined), however, seasonal success varied among streams (Table 6). Similar patterns were seen for trout greater than 12 inches. Although harvest of brown trout greater than 12 inches in the first month (16%) of the season was 35% of the season total, this was due to higher fishing pressure in the first month and not to higher harvest per angler-hour.

The 1995 creel survey indicated that on standard regulation streams, anglers released 66% of all caught brown trout and 53% of brown trout over 12 inches (Table 7). Early season anglers tended to release about the same percent of brown trout, but a somewhat lower percent of brown trout greater than 12 inches. Again, there was considerable variability among streams. The high percent of trout released voluntarily is significant when considering regulation changes.

To measure the relative abundance of brown trout prior to the trout opener and after seven weeks of angling, 11 stations on 10 streams in the Lanesboro Area were electrofished prior to the April 12, 1997 trout opener and again in late May (Table 8). There was an average decrease of 36% in the total trout populations and a 22% reduction in the numbers of trout greater than 12 inches. There was considerable variation among streams with total trout populations increasing 10% on Camp Creek and decreasing 55% on Trout Run Creek. Similar variability existed for trout greater than 12 inches with an increase of 31% on Pine Creek and a decrease of 50% on Trout Run Creek. These changes are attributable to fishing mortality, natural mortality and trout movement. Because fishing mortality is likely a major portion of reductions, it is evident that early season anglers can harvest a substantial portion of the trout population. However, the majority of the impact appears to be on trout less than 12 inches.

Analysis of spring and fall electrofishing samples of 324 sampling stations on 26 streams between 1975 and 1996 indicate that the abundance of larger brown trout is at least as high in the fall as in the previous spring (Table 9). Only data from stations that were sampled in the spring and fall of the same year were used. The average number of brown trout greater than 12 inches was 20 fish per acre in the spring and 25 fish per acre in the fall. Similar results were seen for 14 inch, 15 inch, and 16 inch fish. This indicates that growth of smaller brown trout during the summer is sufficient to offset the mortality on trout greater than 12 inches from both angling and natural causes.

Historical Success of Past Experimental Regulations

Angler regulations including possession and size limits have the potential to change trout abundance and size structure when angler harvest is the primary factor limiting the population. Successful regulations reduce fishing mortality, allowing populations to increase. If factors other than fishing mortality are limiting abundance, such as poor habitat or slow growth, regulations have a poor chance of succeeding.

Experimental regulations with the goal to increase the numbers of large trout have been evaluated on portions of seven stream in southeast Minnesota (Table 10). Regulations included catch-and-release only, maximum size limits, and protected slot limits. Only one (Hay Creek) was determined to be successful based on objectives.

Catch-and-release only has been evaluated on three streams, Hay Creek, Middle Branch Whitewater River, and South Branch Whitewater River. The Hay Creek regulation was successful at increasing the abundance of trout greater than 12 inches, but did not increase trout greater than 15 inches. The South Branch Root River regulation failed to meet the goal of increasing abundance of trout greater than 14 inches, however, numbers between 8 inches and 14 inches increased dramatically. The regulation on the Middle Branch Whitewater River is still being evaluated.

Ten inch maximum size regulations were evaluated on East Beaver Creek and the South Branch Whitewater River, with the goal of increasing trout greater than 12 inches. Neither regulation increased large trout abundance relative to experimental control reaches. An 11 inch maximum size limit was implemented on Trout Run Creek with the goal of increasing abundance of trout greater than 14 inches. Again, no increases attributable to the regulation were found.

A 10 inch to 18 inch protected slot regulation was evaluated on the Main Branch Whitewater River. The goal was to double the number of trout greater than 15 inches. No increase occurred in this size range.

Experimental regulations to date in southeast Minnesota have failed to increase the abundance of trout greater than 15 inches, and often failed to increase the abundance of any size trout. Trout populations with fishing mortality less than 40-50% are unlikely to respond to possession and size limit regulations. Additional factors which can limit success include lack of adult trout habitat, slow growth, high natural mortality, movement and angler noncompliance with regulations. Regulations can reduce summer mortality of brown trout from 50-60% to 30%, and still be unsuccessful because of winter mortality or movement.

Computer Modeling of Proposed Regulations

The use of mathematical simulation models of fish populations is a valuable tool in developing angling regulations and estimating how populations might change based on various regulation scenarios and fish population parameters. It is important to note that models are one of many tools in evaluating regulation changes and have limitations based on their assumptions.

The fish population model MANSIM was modified for southeast Minnesota brown trout populations and used to evaluate various possession and size restrictions. Assumptions of this model include no net migration (fish movement out equals fish movement in) and that fish habitat is not a limiting factor to trout abundance. While these assumptions are probably violated in many southeast streams, the model does allow relative comparisons of regulations and evaluation of the effect of trout growth rate and growth potential (maximum attainable length) on regulation success.

Computer modeling simulations were completed for the following eight regulation types:

1) current regulation of five trout with only one over 16 inches;
2) bag limit of three trout with only one over 12 inches;
3) bag limit of five trout with catch-and-release during April;
4) bag limit of five trout with a protected slot of 12 to 16 inches;
5) bag limit of five trout with a maximum size limit of 12 inches;
6) bag limit of five trout with catch-and-release during the months of April and May;
7) bag limit of five trout with a protected slot of 10 to 15 inches; and
8) catch-and-release for the entire season.

The model output indicates that to varying degrees, all regulation scenarios reduced trout harvest and increased the numbers of trout greater than 12 inches (Table 11). In general, more restrictive regulations produce the greatest increases. Because adult habitat is often a limiting factor in southeast Minnesota streams, increases in abundance may be overestimates and in some cases unrealistic.

Data analysis indicates that growth rate is one of the major factors in determining the success of any regulation change. Simulations indicate that populations in which trout are at least 12 inches long at the beginning of their third growing season have a greater potential to reach 15-16 inches. Restrictive regulations may help to improve the size structure in these cases if habitat is not a limiting factor.

Brown trout greater than 12 inches in slow growing populations (Table 12) showed substantial increases only under the most restrictive regulations. Although increases occur in average and fast growing populations under the less restrictive scenarios, the actual increases are still low. Early season catch-and-release, catch-and-release the entire season and a 10-15 inch protected slot show the largest increases of larger trout regardless of growth rate.

Substantial increases in trout greater than 15 inches (Table 13) were seen only in fast growth streams under the most restrictive regulations. On slow growth streams with low growth potential (such as Diamond Creek and Upper Hay Creek), trout may never reach 15 inches before dying or migrating. On these streams, the 12-16 inch slot limit functions as a 12 inch maximum size limit, since trout are unlikely to ever reach 16 inches.

Substantial changes in trout abundance are needed to be detected, both by fisheries managers and anglers. Because trout population estimates (mark and recapture) used in the model have confidence limits of at least 25% more or less than the estimate, a 25% or greater change in trout numbers would have to occur in order to be detectable in evaluations. Anglers would also have difficulty detecting changes below this range. Confidence limits for individual size classes would be even larger, making evaluation even more difficult. Increases in abundance of large trout may not be biologically meaningful, even if detectable. For example, under the 12-16 inch slot scenario, trout greater than 12 inches increased from 43 per acre to 56 per acre (a 28% increase). This represents an increase from 143 to 183 trout on a one mile long stream averaging 25 feet in width. This may not be detectable by either the DNR or the angler.

Model results and assessment data indicate that regulation changes would be potentially more successful on streams in southeast Minnesota that have fast growth rates and high growth potential. Assessment data indicates that 'something' happens to trout in southeast Minnesota trout streams after age 3. Age distributions indicate that age 3 and older trout experience either high natural mortality or migrate out of the sampling reach, perhaps into lower reaches or a larger stream. Consequently, assuming that habitat is not limiting, those streams in which trout reach the largest sizes in the fewest years will have the greatest numbers of large trout. Age and growth data on 15 southeast brown trout streams indicate that populations which reach 12 inches in length by age 3 have maximum attainable sizes greater than 15 inches, whereas few slower growing populations have maximum attainable sizes exceeding 14 inches (Figure 10).

It is doubtful that noticeable benefits in brown trout populations would occur under the less restrictive regulations. Catch-and-release (early season or entire season) and a 10-15 inch slot show the greatest potential for success on streams with high growth potential, suitable adult habitat, and high angler harvest.

Restrictive regulations require anglers to sacrifice something (in this case harvest of trout) to achieve the desired gain (more large trout, higher catch rate rates for large trout). To illustrate these "trade-offs," the computer simulation model was used to provide estimates of changes in harvest for different regulation scenarios. Table 14 gives the reduction in trout harvest of greater than 10 inches, 12 inches, and 15 inches relative to the harvest that could take place under current regulations. Reductions in harvest increase with more restrictive regulations as the cost for increasing numbers of trout greater than 12 inches. No reductions in angler harvest are projected for trout greater than 15 inches under any of the regulations due to their low abundance in both current regulation and special regulation scenarios.

Future Information Needs

Southeast Minnesota trout streams have extensive population estimates since the early 1970s. While this is one of the best fisheries data sets in the state, it is important to continue to collect this information along with additional data which are key to improving our understanding and management of this resource. Information needs fall into three major categories: (1) trout population data; (2) trout habitat requirements; and (3) angler surveys.

1) **Trout population data**
   a. Continue to conduct periodic population estimates to maintain the current data base.
   b. Continue annual population estimates on long term monitoring streams to improve our understanding of trout population cycles and trends.
   c. Calculate and report confidence limits on population estimates to improve interpretation of data and for use in modeling.
   d. Collect age and growth information on additional streams to document growth rates and mortality.
   e. Maintain population estimates and age and growth information in an electronic form for future analyses.

f. Standardize the collection and reporting of trout population data.

(2) Trout habitat requirements

a. Continue research and evaluation of habitat requirements and limiting factors of brown trout with an emphasis on increasing numbers of large trout.
b. Develop a standard method to inventory instream trout habitat and conduct habitat inventory as part of standard stream surveys and assessments.
c. Use habitat inventory information to assist in planning and evaluating instream habitat improvement projects, interpret trout population estimates, and evaluate other management.

(3) Angler surveys

a. Develop a plan to conduct periodic creel surveys on a representative sample of streams to assess long term trends in angler pressure, catch and harvest, angler demographics, angler attitudes and economic impacts.
b. Continue to conduct creel surveys targeted at evaluating specific management techniques including regulations and habitat management.
c. Conduct an expanded mail survey of trout anglers after the DNR electronic licensing system is implemented.

DNR RECOMMENDATIONS

1) DNR Fisheries continues to support individual waters management based on a sound biological approach. The biological potential of southeast Minnesota trout streams is not realized by applying a single regulation to all streams.

2) Pending a positive response from trout anglers, DNR Fisheries will implement special regulations on a limited number of streams where there is a potential for increasing the abundance of brown trout greater than 12 inches. DNR Fisheries has developed a list of candidate streams for future consideration.

3) Develop a plan to evaluate special regulations on these streams with the use of controls (reference streams). The plan will include clear, measurable objectives.

4) Additional special regulations may be added to other streams as their biological potential becomes unknown.

5) Focus future sampling efforts to address information needs in the areas of trout population data, trout habitat requirements, trends in angler pressure, catch and harvest, and angler characteristics.

Table 1. Number of streams and stations sampled by season for southeast Minnesota from 1970 to 1996. Numbers in parentheses represent percent of total.

Management Area	Streams	Stations	Spring Stations	Summer Stations	Fall Stations
Lake City	45 (39)	1,167	448	107	612
Lanesboro	69 (61)	1,256	613	87	556
Totals	114	2,423	1,061 (44)	194 (8)	1,168 (48)

Table 2. Brown trout growth in southeast Minnesota streams as measured by average length at age. Numbers in columns represent the percent (%) of streams sampled with a specific average length at age.

Length (in.)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
3.0 - 3.4	1					
3.5 - 3.9	3					
4.0 - 4.4	14					
4.5 - 4.9	18					
5.0 - 5.4	22					
5.5 - 5.9	24					
6.0 - 6.4	11	1				
6.5 - 6.9	1	4				
7.0 - 7.4	3	17				
7.5 - 7.9	3	15				
8.0 - 8.4		13	1			
8.5 - 8.9		11	1			
9.0 - 9.4		21	7	3		
9.5 - 9.9		10	13			
10. - 10.4		4	16			
10. - 10.9			16	3		
11. - 11.4		1	13	14		
11. - 11.9		1	7	17	6	7
12. - 12.4		1	13	16	8	
12. - 12.9			3	3	8	
13. - 13.4			3	9	17	13
13. - 13.9			1	10	3	
14. - 14.4			3	9	6	
14. - 14.9				7	17	
15. - 15.4			1		3	
15. - 15.9				3		7
16. - 16.4					19	
16. - 16.9						13
17. - 17.4					11	
17. - 17.9						7
18. - 18.4				3		7
18. - 18.9				2		13
19. - 19.4						7
19. - 19.9						
20. +					3	27
Age	1	2	3	4	5	6
Mean Length	5.3	8.5	11.0	12.9	14.6	17.4
No. Samples (%)	72 (100)	72 (100)	69 (96)	58 (81)	36 (50)	15 (21)

Table 3. Reduction in abundance of a hypothetical brown trout year class by annual total mortality. Mortality rates are from Figure 8. Average lengths at age were taken from Table 8. Mortality rates represent total annual death rate (e.g., 50% of age 1 trout die from all causes between age 1 and age 2).

Age	1	2	3	4	5	6
Mortality rate	50%	73%	71%	82%	86%	-
Numbers	1,000	500	135	39	7	1
Average Length (in)	5.3	8.5	11.1	12.9	14.6	17.4

Table 4. Angler hours per mile, trout harvest per mile, and trout harvest per hour from creel survey data between the 1940s and 1990s.[a]

Decade	Angler-hours/mile	Trout harvest/mile	Trout harvest/hour
1940	1,167	859	0.83
1950	2,764	741	0.28
1970	578	115	0.21
1980	2,021	483	0.23
1990	1,991	204	0.18
Average	1,704	480	0.35

[a] Although angler pressure and harvest per hour have been relatively stable since the 1950s, total harvest decreased from the 1940s to the 1970s and has been stable to increasing since (based on an increase from 281 to 569 miles of managed trout water).

Table 5. Comparison of angling pressure during the first month (April 13 - May 12) and the remainder (rest) of the trout season (May 13 - September 30, 1995) on five trout streams in southeast Minnesota. The first month had 30 angling days (18%) while the rest of the season had 141 days (82%).

	Angler-Hours		Angler-hours/day	
Stream	First Month	Rest	First Month	Rest
Spring Creek	279	131	9.3	0.9
Hay Creek	1,037	715	34.6	5.1
Middle Branch Whitewater River	1,840	2,806	61.3	19.9
South Branch Whitewater River	700	1,282	23.3	9.1
Main Branch Whitewater River	1,065	1,932	35.5	9.2
Total	4,921	6,227	164.0	44.2

Table 6. Comparison of brown trout harvest rates during the first month (April 13 - May 12) and the remainder (rest) of the angling season (May 13 - September 30, 1995) on five trout streams in southeast Minnesota. "≥" denotes greater than or equal to.

Stream	Number / hour Harvested		Number ≥ 12 inches per hour harvest	
	First Month	Rest	First Month	Rest
Spring Creek	0.32	0.30	0.04	0.30
Hay Creek	0.21	0.12	0.06	0.03
Middle Branch Whitewater River	0.11	0.25	0.00	0.04
South Branch Whitewater River	0.38	0.27	0.17	0.11
Main Branch Whitewater River	0.06	0.34	0.03	0.07
Average (weighted)	0.18	0.23	0.05	0.06
Average (unweighted)	0.22	0.26	0.06	0.11

Table 7. Percent of all brown trout and brown trout greater than or equal to 12 inches released during the first month (April 13 - May 12 1995) and the remainder (rest) of the season (May 13 - September 30, 1995) on five trout streams in southeast Minnesota. "≥" denotes greater than or equal to.

Stream	All Trout			Trout ≥ 12 Inches		
	First Month	Rest	Total	First Month	Rest	Total
Spring Creek	0	40	20	0	40	20
Hay Creek	67	69	68	21	57	39
Middle Branch Whitewater	53	73	63	100	76	88
South Branch Whitewater	71	73	72	54	63	59
Main Branch Whitewater	77	33	55	0	0	0
Average (uweighted)	54	58	56	35	47	41

Table 8. Changes in brown trout abundance between the trout opener (April 12) and the end of May, 1997. A negative sign (-) indicates a decrease while a positive sign (+) indicates an increase. Column 3 represents the percent of the total population (in numbers) of trout greater than or equal to 12 inches, and the relative change of this proportion over the seven week period. "≥" denotes greater than or equal to. "%" denotes percent. Winnebago Creek had samples at two stations (6 and 7).

Stream	Total April	Total May	% + or -	≥12" April	≥12" May	% + or -	%≥12 April	%≥12 May	% of Total + or -
Bee	378	216	-43	51	35	-31	13	16	+3
Winnebago-6	290	174	-40	29	16	-45	10	9	-1
Winnebago-7	312	164	-47	9	8	-11	3	5	+2
East Beaver	157	122	-22	27	28	4	17	23	+6
West Beaver	271	182	-33	6	5	-17	2	3	+1
Gribben	308	212	-31	10	8	-20	3	4	+1
Trout Run	304	137	-55	14	7	-50	5	5	0
Willow	74	48	-35	2	2	0	3	4	+1
Camp	119	131	10	6	4	-33	5	3	-2
Pine	139	126	-9	13	17	31	9	13	+4
Total	2352	1386	-41	166	125	-25	7	9	+2

Table 9. Average population estimates of brown trout per acre from spring and fall samples on 26 streams in southeastern Minnesota from 1975 to 1996. Size groups are defined as greater than or equal to (≥) a given length.

	≥ 12.0" / acre	≥ 14.0" / acre	≥ 15.0" / acre	≥ 16.0" / acre
Spring	20	5	2	2
Fall	25	7	3	3

Table 10. Historical listing of streams with experimental regulations in southeast Minnesota.

Stream	Miles	Years	Regulation	Success
East Beaver Creek	0.5	1986-1988	10 inch maximum size limit, AO [a]	No
Hay Creek	0.7	1985-1990	Catch-and-release only, AO or BH[b]	Yes
Main Branch Whitewater	3.1	1991-1995	10-18 inch protected slot limit, AO or BH	No
South Branch Whitewater	1.0	1985-1995	10 inch maximum size limit, AO or BH	No
Middle Branch Whitewater	3.3	1991 to	Catch-and-release only, AO or BH	evaluate
South Branch Root River	1.6	1984-1986	Catch-and-release only, AO	No
Trout Run Creek	1.2	1984-1986	11 inch maximum size limit, AO	No

[a] AO - artificial lures only.
[b] AO or BH - artificial lures only until 1991, after 1992 only barbless hooks required.

Table 11. Computer modeling results showing the numbers and sizes of brown trout in the pre-season spring population for an average southeast Minnesota trout stream. "≥" denotes greater than or equal to. "C&R" equals catch-and-release.

Regulation	Trout/acre ≥12 inches	Trout/acre ≥15 inches	Increase in Trout/acre ≥12 inches	Increase in Trout/acre ≥15 inches
Bag of 5, 1 ≥ 16 inches[a]	43	5	0	0
Bag of 3, 1 ≥ 12 inches	51	7	8	2
Bag of 5, April C&R	53	7	10	2
Bag of 5, 12-16 inch slot	56	10	13	4
Bag of 5, max. 12 inches	56	10	13	4
Bag of 5, April/May C&R	73	11	30	6
Bag of 5, 10-15 inch slot	84	13	41	8
C&R entire season	100	16	57	11

[a] Current regulation

Table 12. Computer modeling results showing the number of brown trout in the spring population greater than 12 inches for slow, average, and fast growing populations in southeast Minnesota. Actual numeric increase over current regulations in shown in parentheses. "≥" denotes greater than or equal to. "C&R" equals catch-and-release.

	Trout/acre ≥ 12 inches		
Regulation	Slow growth	Average growth	Fast growth
Bag of 5, 1 ≥ 16 inches[a]	24 (0)	43 (0)	55 (0)
Bag of 3, 1 ≥ 12 inches	30 (6)	51 (8)	65 (10)
Bag of 5, C&R April	32 (7)	53 (10)	67 (12)
Bag of 5, 12-16 inch slot	32 (8)	56 (13)	71 (16)
Bag of 5, max. 12 inches	32 (8)	56 (13)	72 (17)
Bag of 5, C&R April/May	46 (21)	73 (30)	89 (34)
Bag of 5, 10-15 inch slot	55 (31)	84 (41)	100 (45)
C&R entire season	66 (42)	100 (57)	117 (62)

[a] Current regulation

Table 13. Computer modeling results showing the number of brown trout in the spring population greater than 15 inches for slow, average, and fast growing populations in southeast Minnesota. Actual numeric increases over current regulations are in parenthesis. "≥" denotes greater than or equal to. "C&R" equals catch-and-release.

Trout/acre ≥ 15 in	Slow growth	Average growth	Fast growth
Bag of 5, 1 ≥ 16 inches[a]	1 (0)	5 (0)	11 (0)
Bag of 3, 1 ≥ 12 inches	1 (0)	7 (2)	15 (3)
Bag of 5, C&R April	1 (0)	7 (2)	15 (4)
Bag of 5, 12-16 inch slot	2 (1)	10 (4)	19 (8)
Bag of 5, max. 12 inches	2 (1)	10 (4)	20 (8)
Bag of 5, C&R April/May	2 (1)	11 (6)	23 (12)
Bag of 5, 10-15 inch slot	2 (1)	13 (8)	26 (15)
C&R entire season	2 (1)	16 (11)	33 (21)

[a] Current regulation

Table 14. Computer modeling output indicating changes in numbers of trout in a pre-season spring trout population, and changes in numbers harvested relative to numbers present or harvested under the current regulation. Values represent trout per acre in an average southeast Minnesota stream. ("B" indicates bag limit; PS equals protected slot limit; max. equals maximum size limit; C&R equals catch-and-release; "≥" denotes greater than or equal to; and "-" equals a decline in harvest.)

	Number per Acre in Spring		Increase in Numbers		Change in Harvest (Numbers)		
	≥12 in	≥15 in	≥12 in	≥15 in	≥10 in	≥12 in	≥15
B5; 1 over 16 in.[a]	43	5	0	0	0	0	0
B3; 1 over 12 in	51	7	8	2	-2	0	0
B5; Apr C&R	53	7	10	2	-10	-1	0
B5; PS 12 to 16 in	56	10	13	4	-15	-15	0
B5; max. 12 in	56	10	13	4	-15	-15	-1
B5; Apr/May C&R	73	11	30	6	-27	-5	0
B5; PS 10 to 15 in	84	13	41	8	-51	-13	1
C&R entire season	100	16	57	11	-53	-15	-1

[a] Current regulation

Figure 1. Average annual biomass (pounds per acre) of brown trout in southeast Minnesota streams, 1970-1996. Annual biomass estimates represent the mean biomass in all electrofishing population estimates for a given year (N=2,423).

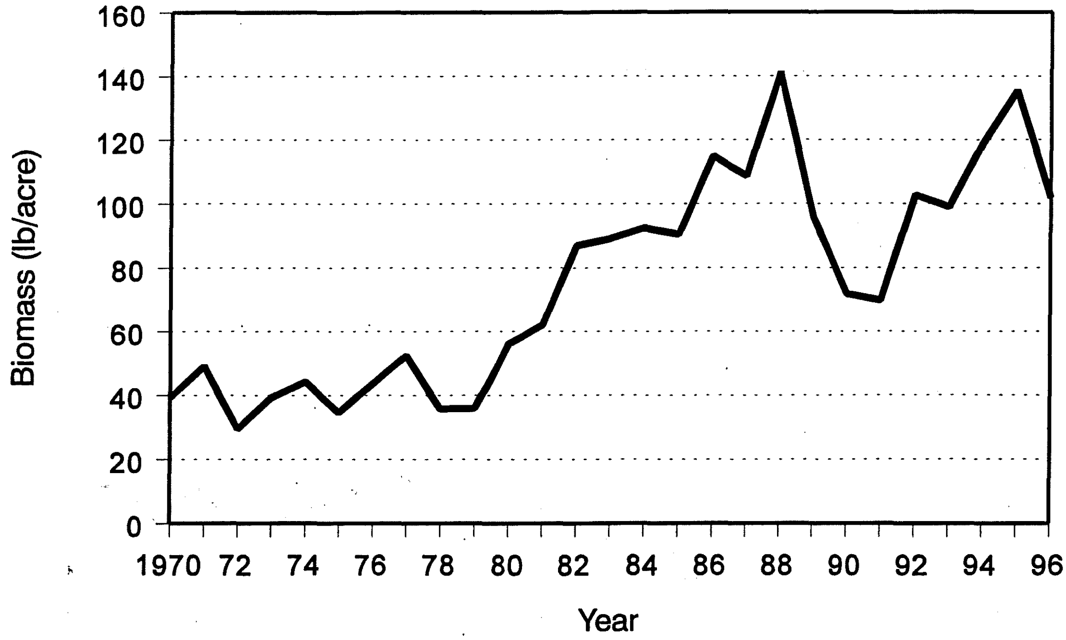


Figure 2. Average annual abundance (number per acre) of brown trout greater than or equal to 12 inches in southeast Minnesota streams, 1970-1996. Annual abundance estimates represent the mean abundance in all electrofishing population estimates for a given year (N=2,423).

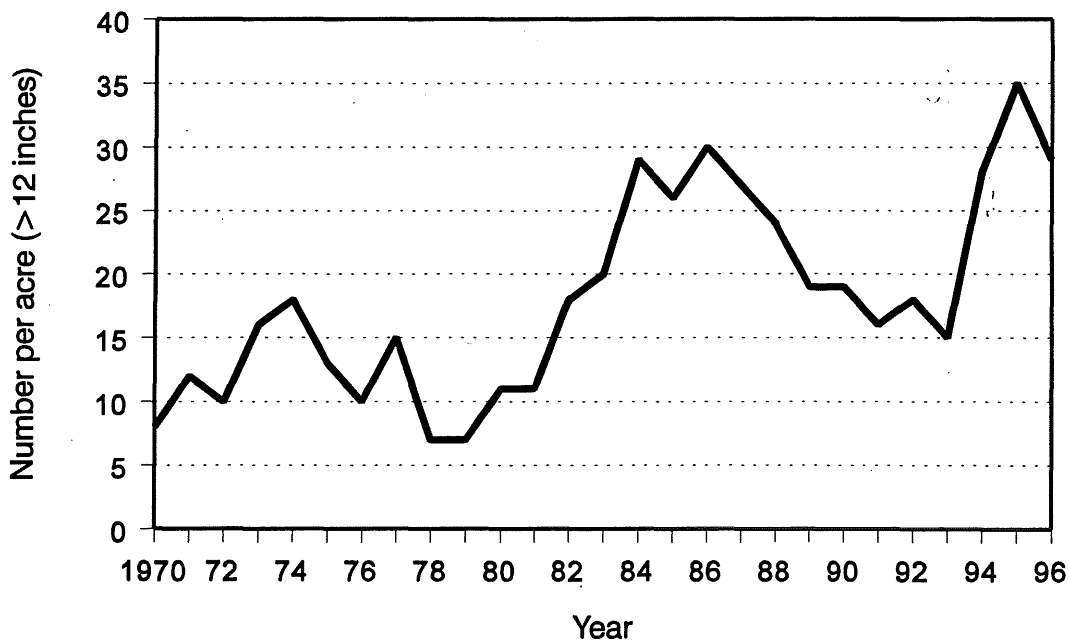


Figure 3. Average annual abundance (number per acre) of brown trout greater than or equal to 14 inches in southeast Minnesota streams, 1970-1996. Annual abundance estimates represent the mean abundance in all electrofishing population estimates for a given year (N=2,423).

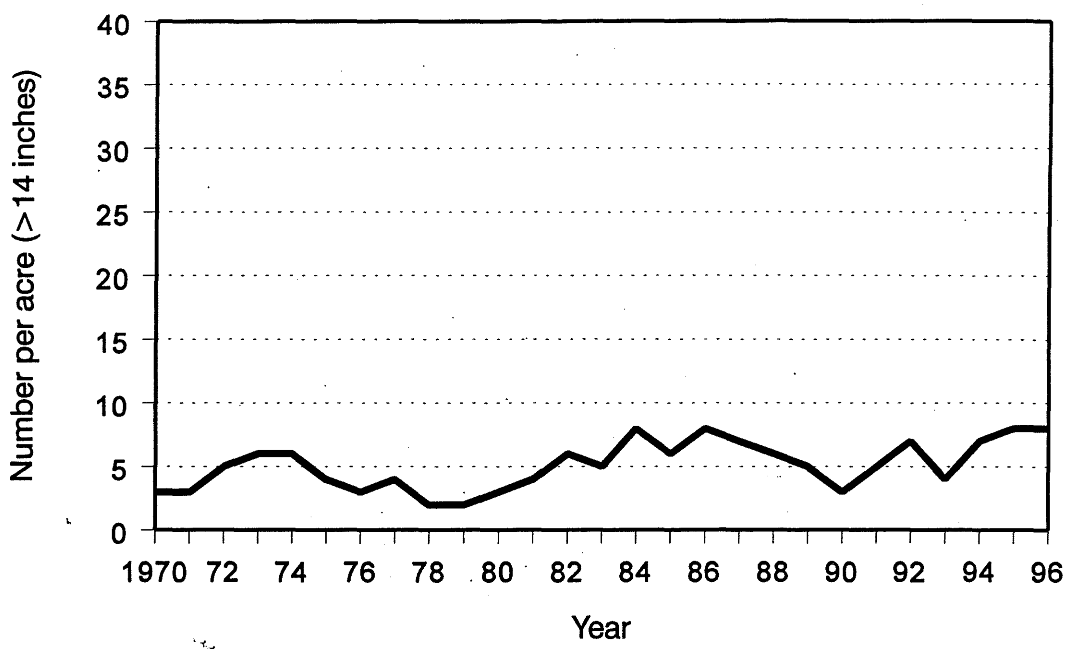


Figure 4. Average annual abundance (number per acre) of brown trout greater than or equal to 15 inches in southeast Minnesota streams, 1970-1996. Annual abundance estimates represent the mean abundance in all electrofishing population estimates for a given year (N=2,423).

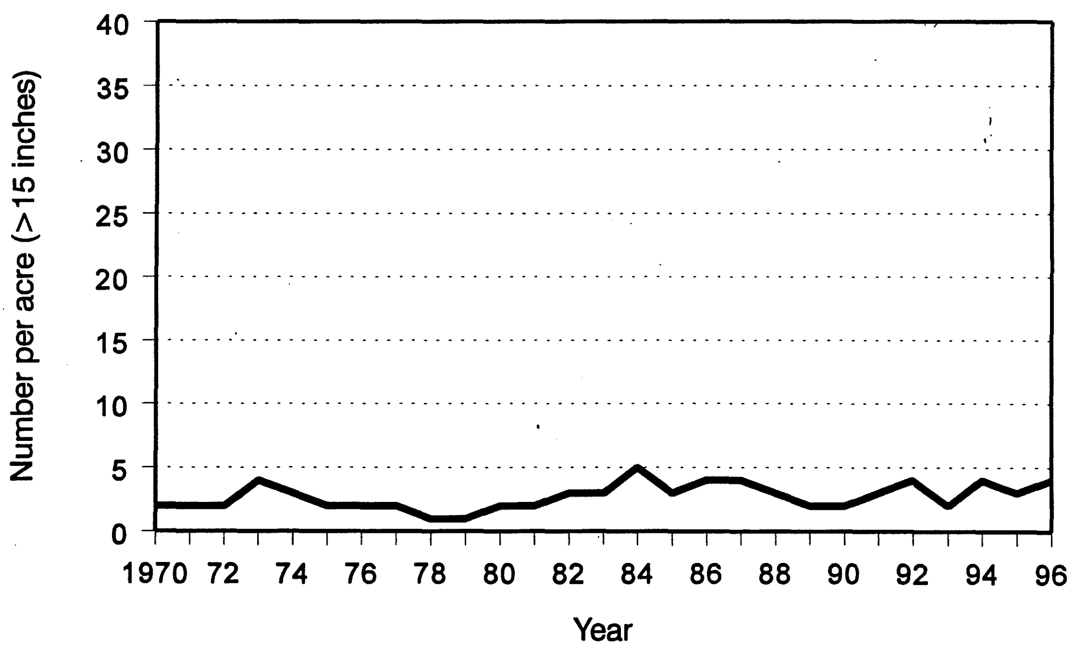


Figure 5. Average annual abundance (number per acre) of brown trout greater than or equal to 16 inches in southeast Minnesota streams, 1970-1996. Annual abundance estimates represent the mean abundance in all electrofishing population estimates for a given year (N=2,423).

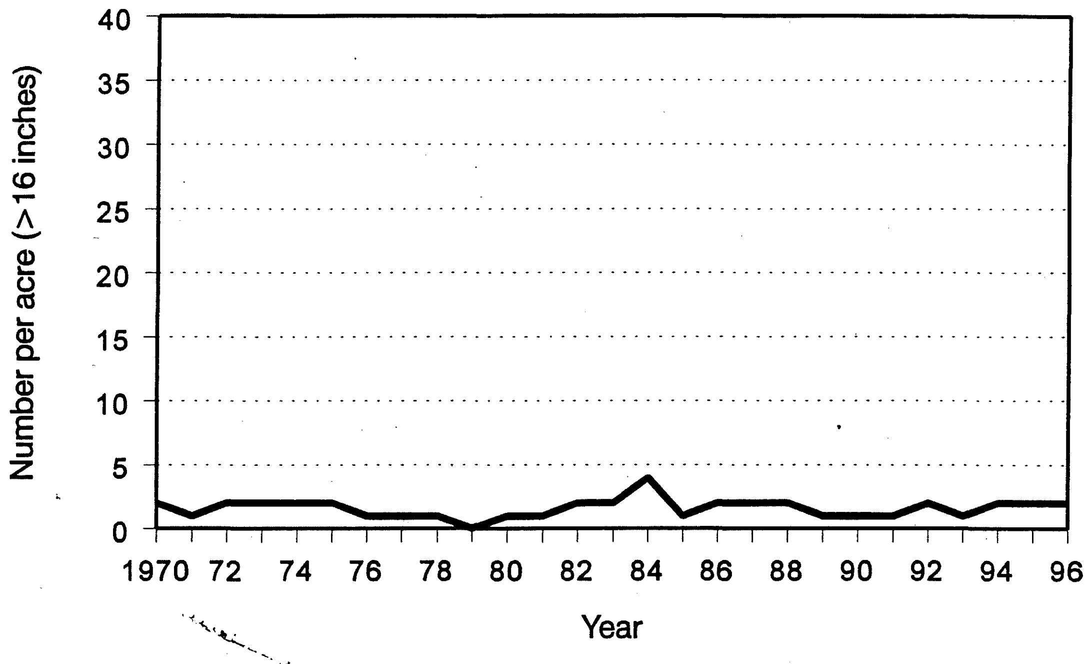


Figure 6. Brown trout reproductive success in southeast Minnesota streams, 1970-1996, as measured by the average annual abundance of young-of-the-year (YOY) brown trout in fall electrofishing samples (N=1,168).

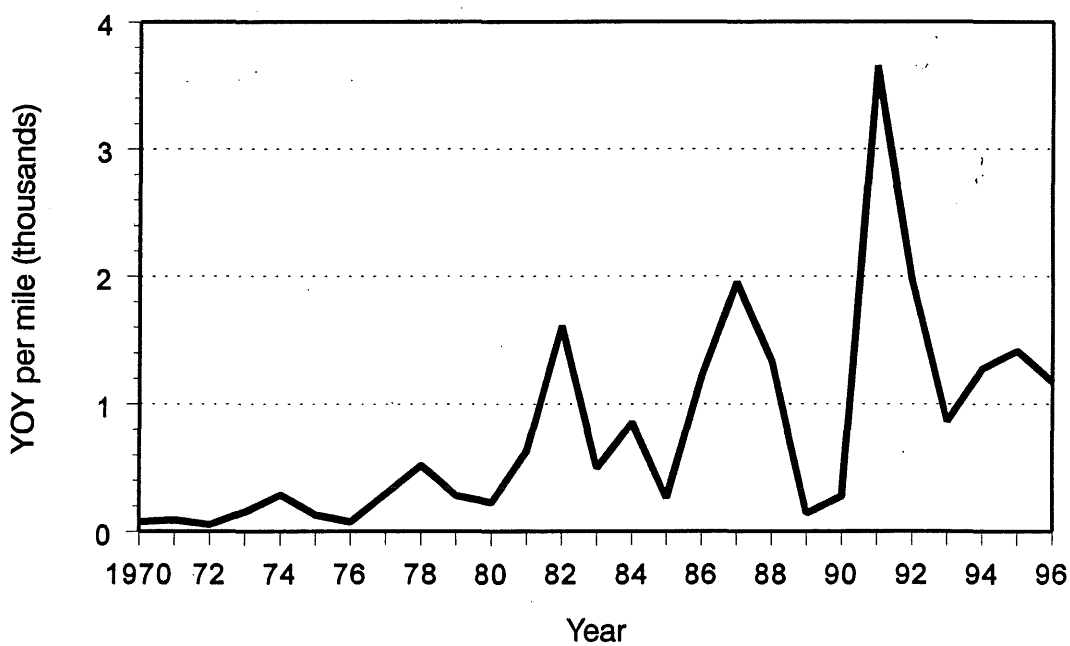


Figure 7. Growth of brown trout in Southeast Minnesota streams as measured by the mean length at age. Mean length at age represents the average length at which an annular mark is formed on trout scales after a growing season. Lengths are in inches (N=72 samples on 30 streams, 1988-1996).

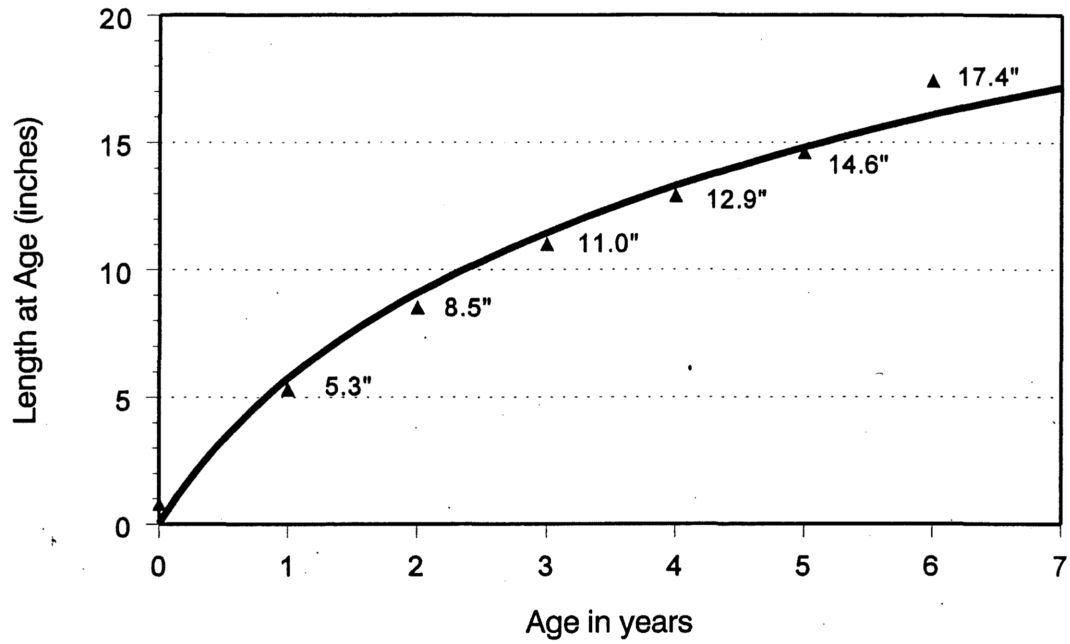


Figure 8. Estimated annual total mortality rates by age for southeast Minnesota brown trout. Mortality rates are shown as percent loss (%) between age groups (i.e. age 1 to age 2). Annual total mortality rates represent the death rate from all causes including natural mortality, fishing mortality, and out-migration. Mortality rates were calculated from five streams with population estimates by age group.

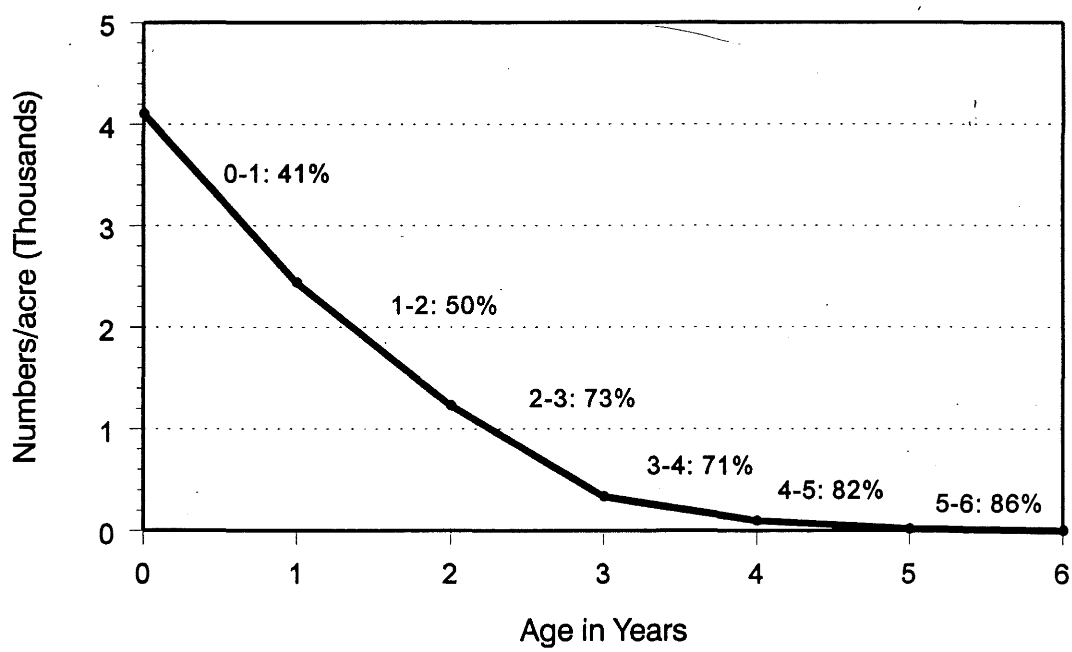


Figure 9. Average annual biomass (pounds per acre) by age group for southeast Minnesota brown trout populations. Estimates were calculated from five streams with population estimates by age group (spring and fall samples combined). Numbers above bars represent the average length in inches for a given age group. No estimate is presented for age 0 trout, since they were not fully vulnerable to electrofishing in all samples.

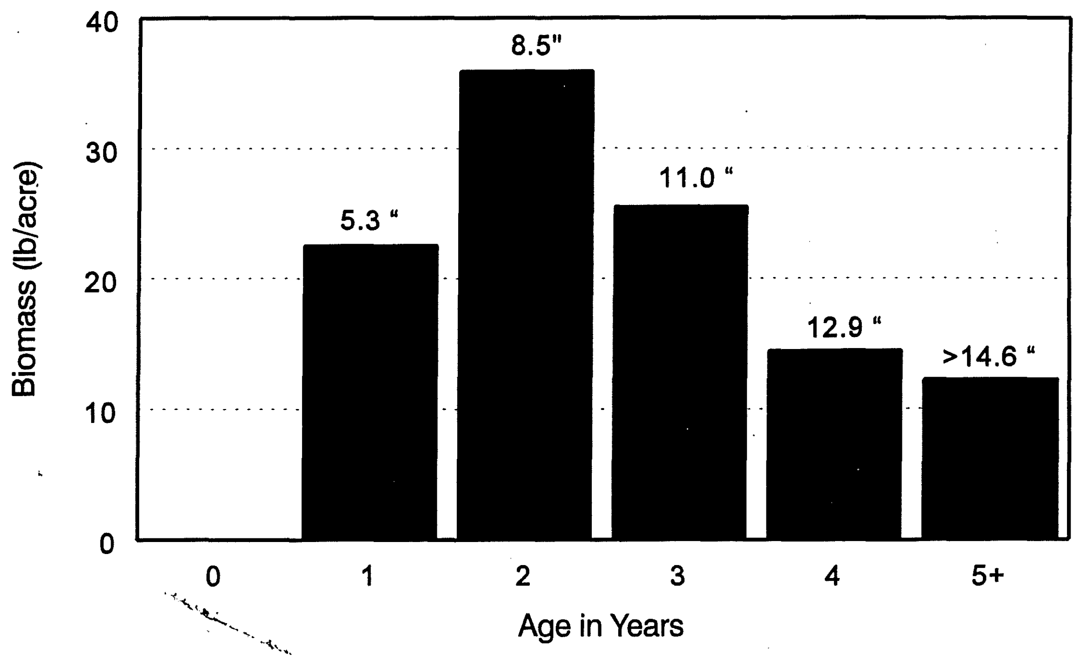
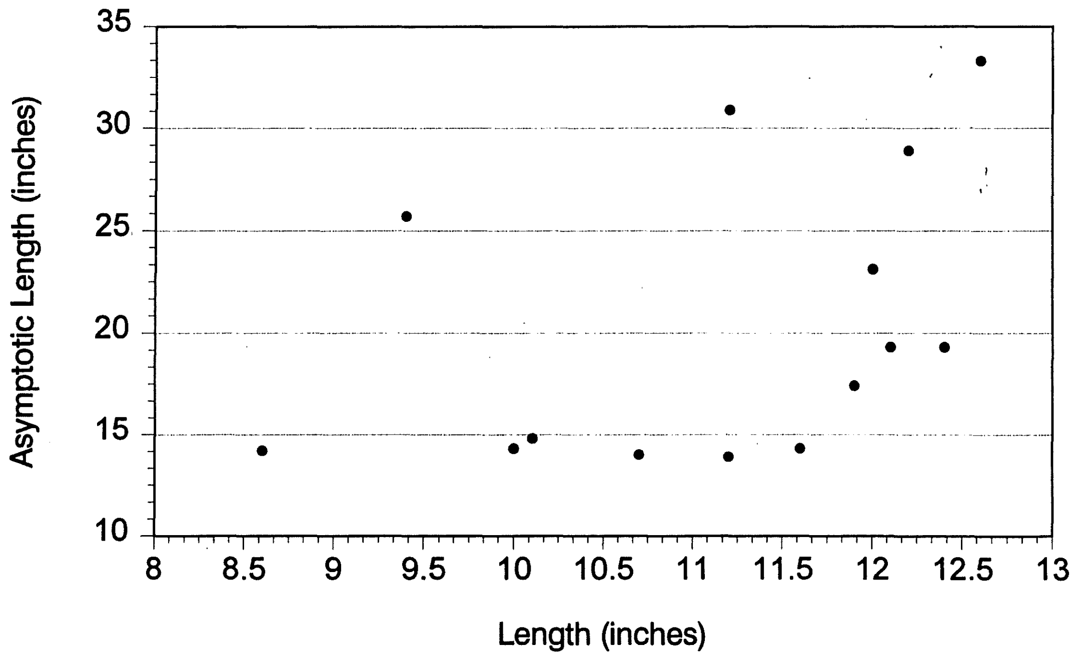


Figure 10. Maximum attainable size (asymptotic length) as a function of length at age 3 for southeast Minnesota brown trout populations (N=19 samples on 14 streams).



Southeast Minnesota Trout Streams Where Special Regulations May Have The Potential to Increase Abundance of Large Brown Trout

Minnesota Department of Natural Resources
Division of Fish and Wildlife
Section of Fisheries

November 24, 1997

BACKGROUND

During 1996 and 1997, the Minnesota Trout Association (MTA) and Trout Unlimited (TU) proposed angler harvest regulations for all southeast Minnesota streams with the goal of increasing the abundance of trout greater than or equal to (≥) 12 inches. Regulation proposals included catch-and-release only fishing the first two weeks in April, a possession limit of five with a protected slot limit where all trout from 12-16 inches must be released, only one over 16 inches could be kept from mid-April to September 15, and catch-and-release only from September 15-30.

The Minnesota Department of Natural Resources (DNR) has evaluated existing fish population and angler harvest data to determine whether the MTA-TU proposal has the potential to increase the abundance of trout ≥12 inches. The results of this evaluation are presented in the DNR Fisheries Staff Report (November 1997) "*Status of Southeast Minnesota Brown Trout Fisheries in Relation to Possible Fishing Regulation Changes*." The evaluation concluded that the proposed regulation will have little if any effect on increasing the abundance of trout ≥12 inches in the majority of southeast Minnesota streams, and that special regulations on a smaller group of selected streams would have more potential for success.

The purpose of this report is to provide a list of streams with the best potential to increase the abundance of trout ≥12 inches using special regulations. It also provides a brief description of the main criteria used in selecting these streams.

CRITERIA USED TO SELECT CANDIDATE STREAMS

Three criteria are necessary for a regulation to successfully increase the number of trout ≥12 inches. **Habitat** must be suitable to support and retain target sized fish; **exploitation** (the percent of the population harvested) must be high; and **growth potential** must be fast enough for fish to reach 12 inches by age 3. If one of the criteria is not met, the regulation has a minimal chance to succeed. If two of the three criteria are not met, the regulation has virtually no chance for succeed.

Table 1 lists trout streams in southeast Minnesota with the most potential to increase the number of brown trout ≥12 inches using special regulations. This list includes streams where habitat is most suitable for large trout. It identifies whether growth potential and exploitation meet the criteria for a successful regulation. This list does not imply that special regulations will necessarily work on all of these streams.

Habitat

Special regulations succeed when habitat is available for those fish that the regulation "saved" from harvest. If habitat is unavailable, fish die from natural causes or move from the area, and the regulation fails. Regulations to increase the number of larger trout have been successful where good habitat is available (Hunt 1981, 1987; Kerr 1982).

Research has shown that during summer, large brown trout (≥15 inches) are associated with large pools, overhead bank cover, instream rocks, riprap, woody debris, and water deeper than 2 feet (Thorn 1993). Although winter habitat requirements of large trout have not been documented in Minnesota, studies elsewhere have concluded that they also require abundant cover and low current velocities during winter. Therefore, streams with excellent summer and winter habitat quality have the greatest potential to produce more brown trout ≥12 inches with special regulations.

Exploitation

High exploitation (harvest) or angling mortality is needed for a regulation to be successful. Research indicates exploitation must exceed a minimum of 40% for a regulation to have a chance to succeed (Behnke 1978; Hunt 1975). Exploitation data is not available for most streams because it is costly and time-consuming to collect. Estimates of angler exploitation requires trout population estimates prior to and after the fishing season, and creel surveys during the season to measure angler harvest.

Exploitation has been estimated for four of six streams where experimental regulations were used in an effort to increase the abundance of larger trout in southeast Minnesota. Exploitation estimates on standard regulation segments of these four streams were variable, averaging 40%, and ranging from 3% to 84% (Table 2). If data from East Beaver Creek are removed, exploitation averaged 51%.

The only stream where experimental regulations were successful (Hay Creek) had exploitation rates averaging 47%, ranging from 15% to 72% Exploitation on the South Branch Whitewater River and East Beaver Creek, where the regulations did not work, averaged 52% (ranging from 26% to 84%) and 14% (ranging from 35% to 43%), respectively. In the Middle Branch Whitewater River, where experimental regulations are still under evaluation, exploitation averaged 51%.

Exploitation was negatively correlated with brown trout biomass and voluntary angler release rate (Table 2). Hunt et al. (1962) found the same pattern for brook trout density. Therefore, in years with higher trout abundance, anglers tend to harvest a lower percent of the trout population and release a higher portion of their catch. For southeast Minnesota streams where exploitation has been measured, voluntary release rates averaged 63% and have been increasing over time, with release rates as high as 80% in 1995.

Better exploitation data, specifically for larger fish, and its relationship to trout density and voluntary angler release are needed to better determine a "minimum" exploitation rate for regulations to be successful in southeast Minnesota.

Growth potential

For size based fishing regulations to succeed, trout must grow fast enough to reach target size or they will be subjected to additional harvest and natural mortality. For special regulations to increase the numbers of trout ≥ 15 inches to succeed, streams need the growth potential for trout to reach 12 inches by age 3, with a maximum attainable size of at least 15 inches. However, based on age and growth data from 29 streams, trout in most southeast Minnesota streams do not reach 12 inches by age 3. Under a 12-16 inch protected slot limit, age 3 trout in these populations would be subject to fishing and natural mortality through an additional spring season with losses of 25% or higher. Modeling results indicate other restrictive harvest regulations may have more potential for increasing the abundance of trout ≥12 inches in southeast Minnesota streams.

Other Considerations

Other factors must be considered when selecting streams for special regulations including stocking of catchable size trout, land ownership, and long term trout population monitoring. Stocking catchable size brown trout and rainbow trout for put-and-take fisheries would have minimal success, as high annual mortality of stocked fish would result in a limited harvest. Land ownership and fishing access is an increasingly sensitive issue, and landowners along individual streams would need to be contacted regarding proposed regulations. Lastly, long term trout population data sets have provided excellent information on trout population trends and could be affected by changing fishing regulations.

SUMMARY AND RECOMMENDATIONS

While considerable information is available regarding trout abundance in many streams, exploitation rate and growth potential data are less available. For all but three streams in Table 1, at least one of these variables, and in some cases both, are unknown.

To accurately choose streams where regulations would most likely be successful would require collecting additional growth potential and/or exploitation data. Without additional work, implementing special regulations on these streams would require using our "best professional judgement" rather than data.

If there is support from trout anglers for individual waters management, our recommendation is to implement special regulations on streams where it is biologically feasible to increase the number of brown trout ≥12 inches. Statewide procedures for implementing special regulations would be followed. Through that process, we would collect biological data and implement special regulations on streams with the best chance of success. An evaluation of the success or failure of these regulations would be completed.

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Table 1. Southeast Minnesota trout streams with the best potential to increase the abundance of trout ≥12" using special regulations. "Yes" means the criteria would be met; "No" means the criteria would not be met; and "Unknown" means no data is available. For management area, "510" is Lake City and "520" is Lanesboro.

Stream	Management Area	Habitat Quality	Exploitation > 50%	Growth Potential
Badger Creek	Lanesboro	Yes	Unknown	Unknown
Beaver Creek	Lake City	Unknown	Unknown	No
Bee Creek	Lanesboro	Yes	Unknown	Unknown
Big Springs Creek	Lanesboro	Yes	Unknown	Unknown
Camp Creek	Lanesboro	Yes	Unknown	No
Canfield Creek	Lanesboro	Yes	Unknown	Unknown
Cold Spring Brook	Lake City	Yes	Unknown	Unknown
Crooked Creek, North Fork	Lanesboro	Yes	Unknown	Unknown
Crooked Creek (mi.5.5-9.5)	Lanesboro	Yes	Unknown	Unknown
Daley Creek	Lanesboro	Yes	Unknown	Unknown
Duschee Creek	Lanesboro	Yes	Unknown	Unknown
East Beaver Creek	Lanesboro	Yes	Unknown	Yes
East Indian Creek[1]	Lake City	?	Unknown	Unknown
Etna Creek	Lanesboro	Yes	Unknown	Unknown
Ferguson Creek	Lanesboro	Yes	Unknown	No
Forestville Creek	Lanesboro	Yes	Unknown	No
Garvin Brook[1]	Lake City	?	Unknown	Yes
Gilmore Creek	Lake City	Unknown	Unknown	Unknown
Gribben Creek	Lanesboro	Yes	Unknown	No
Hay Creek	Lake City	Yes	Yes	Yes
Hemmingway Creek	Lanesboro	Yes	Unknown	Unknown
Kedron Creek	Lanesboro	Yes	Unknown	Unknown
Middle Creek	Lake City	Unknown	Unknown	Unknown
Mill Creek	Lanesboro	Yes	Unknown	No
Pine Creek (M-9-17-5)	Lanesboro	Yes	Unknown	No
Pine Creek (M-11)	Lanesboro	Yes	Unknown	Unknown
Rice Creek	Lanesboro	Yes	Unknown	No
Root River, South Fork	Lanesboro	Yes	Unknown	No
Root River, South Branch	Lanesboro	Yes	Unknown	No
Rush Creek	Lanesboro	Yes	Unknown	Unknown
Trout Run Creek	Lanesboro	Yes	Unknown	No
West Indian Creek	Lake City	Yes	Unknown	Yes
West Beaver Creek	Lanesboro	Yes	Unknown	Unknown
Whitewater R., North Branch	Lake City	Yes	Unknown	Yes
Whitewater R., South Branch[1]	Lake City	?	Yes	Yes
Whitewater R., Middle Branch	Lake City	Yes	Yes	Yes
Whitewater R., Main Branch	Lake City	?	Unknown	Yes
Winebago Creek	Lanesboro	Yes	Unknown	Yes
Wisel Creek	Lanesboro	Yes	Unknown	Unknown

[1] Long term data base streams

Table 2. Brown trout exploitation and voluntary angler release rates for southeast Minnesota trout streams under standard regulations.

Stream	Year	Station or Reach	Spring Biomass (lb/acre)	Angler Release Rate %	Exploitation Rate %
Hay Creek	1983	A	94	55	37
	1984	A	94	44	72
	1984	B	123	66	72
	1985	B	488	62	15
	1986	B	186	57	55
	1987	B	255	70	30
				Hay Creek Mean =	**47**
South Branch Whitewater	1983	A	43	50	42
	1983	B	43	50	42
	1984	A	55	67	53
	1984	B	50	32	84
	1985	B	34	63	76
	1986	B	61	54	74
	1987	B	71	53	26
	1988	1 and 2	127	79	51
	1995	B	142	80	17
				South Branch Whitewater Mean =	**52**
Middle Branch Whitewater	1988*	2 and 3	151 / 297	74	54
	1990*	Upper	26 / 37	63	48
				Middle Branch Whitewater Mean =	**51**
East Beaver Creek	1984	A	314	53	43
	1984	B	338	43	28
	1985	A	199	57	24
	1985	B	225	81	4
	1986	B	256	87	7
	1987	B	292	84	5
	1988	B	274	76	3
				East Beaver Mean =	**16**

* Stations were combined for exploitation and release estimates.