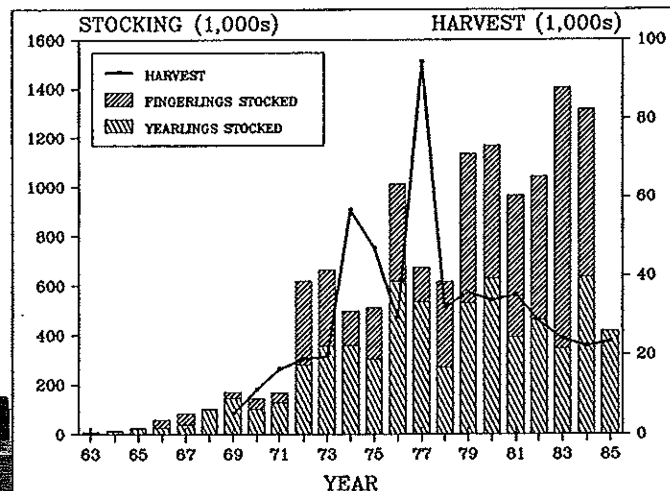
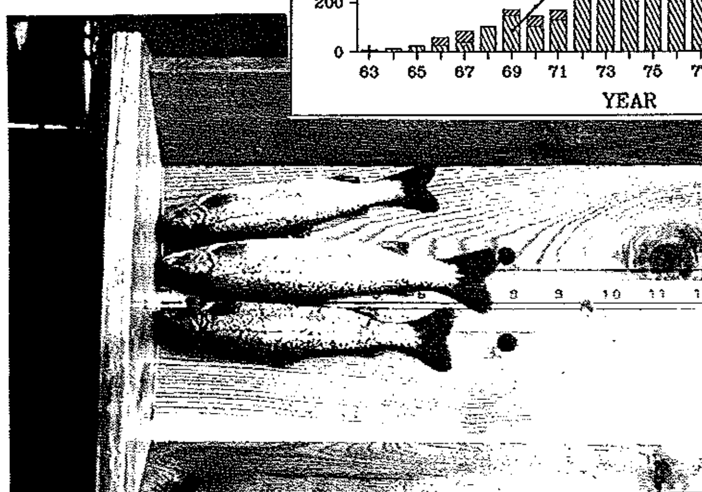
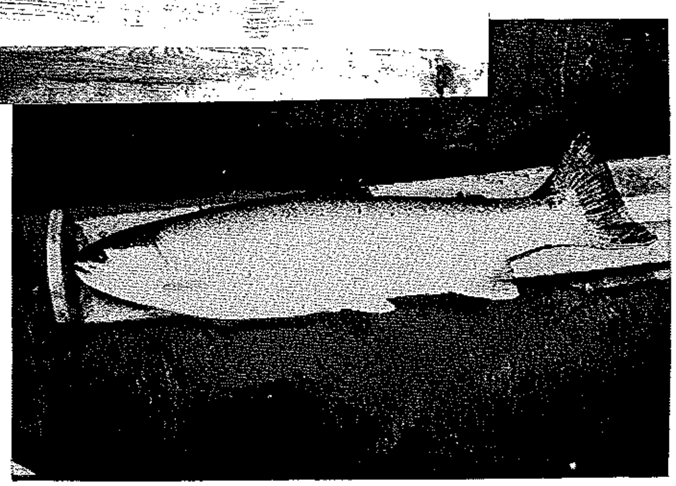
LAKE MICHIGAN STEELHEAD FISHERY MANAGEMENT PLAN

By Wisconsin Department of Natural Resources







Administrative Report No. 29

Bureau of Fisheries Management
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CONTENTS

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INTRODUCTION

Purpose

The modern era of Lake Michigan fisheries management in Wisconsin was initiated in 1963 when 9,200 rainbow trout were stocked in a Door County stream. Since that time more than 6.7 million yearling and 6.1 million fingerling rainbow trout have been stocked in Lake Michigan by the Wisconsin Department of Natural Resources (WDNR).

The resulting sport fishery for rainbow trout grew to a peak catch of more than 94,000 in 1977, then fell to an average catch of about 34,000 in 1978-81 and about 25,000 in 1982-85. The declining success of the rainbow trout fishery in Lake Michigan prompted the inclusion of a special catch objective for that species in the Lake Michigan Fisheries Management Plan: to increase the annual rainbow trout harvest from 25,000 to 50,000 (Wisconsin Department of Natural Resources, 1986).

This objective provided the impetus for development of a management plan for steelhead trout in Lake Michigan (the Plan). The Plan was developed by a committee composed of: Michael Baumgartner, Green Bay; Brian Belonger, Marinette; Ronald Bruch, Matthew Coffaro, and Michael Coshun, Milwaukee; Michael Hansen, Madison; Randall Link, Kettle Moraine State Fish Hatchery; Paul Peeters, Two Rivers; and Paul Schultz, Plymouth. Toward this end, obstacles to meeting the objective of the Plan were identified and tactics to overcome these obstacles were developed. These tactics will be used to implement specific management policies, hatchery improvements, and operational projects. Thus, the Plan will facilitate a rational and efficient management program for steelhead trout that will ultimately lead to an improved fishery in Lake Michigan.

Scope

The Plan covers the period from the present through 1991, when it will be evaluated and revised. During this period, the Plan will be modified in response to the ever-changing conditions in Lake Michigan.

THE PLAN

Goal: To improve conventional angling opportunities for steelhead trout in Lake Michigan and its tributaries to sustain an annual harvest.

Stocking of rainbow trout in Lake Michigan by WDNR has been conducted since 1963, using both fall fingerlings and spring yearlings (Fig. 1). Stocking of yearlings grew from 9,200 in 1963 to more than 100,000 in 1968 and more than 200,000 in 1972. Thereafter, stocking of yearlings fell below 300,000 only in 1978 and exceeded 600,000 in 1976, 1980, and 1984.

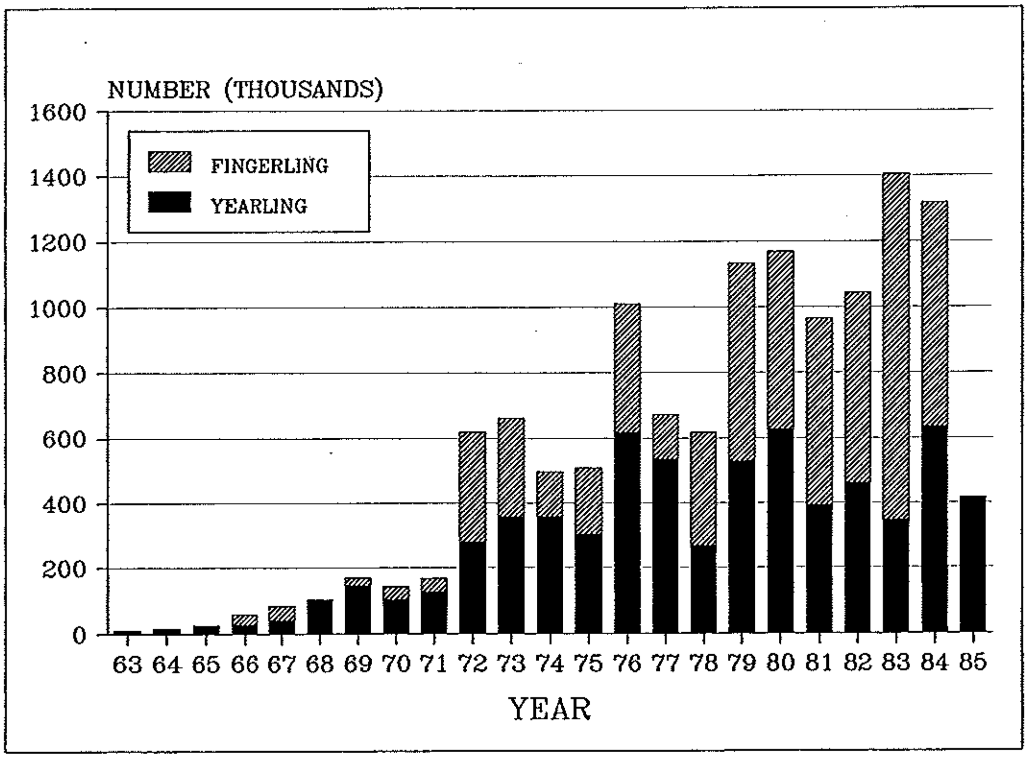

FIGURE 1. Annual stocking of rainbow (steelhead) trout into the Wisconsin waters of Lake Michigan, 1963-85.

Stocking of fingerling rainbow trout was conducted in only two years during 1963-68 and was below 50,000 until 1972 when plants increased sharply (Fig. 1). During 1972-77, fingerlings planted outnumbered yearlings in only one year and ranged between 130,000 and 400,000. Thereafter, fingerlings outnumbered yearlings in all but one year and ranged between 340,000 and 1,060,000. Stocking of fingerlings was discontinued in 1985 due to a lack of demonstrated performance.

The strain originally used for stocking was a spring spawning stock. This strain was used to develop two different brood stocks; one that spawned in the fall, primarily in September and another that spawned in the spring, primarily in January and February. The spring spawning stock was gradually shifted to a peak spawning date in December. The December spawning brood stock was maintained at Nevin State Fish Hatchery. Due to declining hatching success and an outbreak of bacterial kidney disease, the September spawning brood stock was stocked out in the fall of 1980. At that time, a spring spawning brood stock derived from the Mount Shasta strain was incorporated into the production plan as the primary strain for use in Lake Michigan.

Harvest of rainbow trout increased erratically from 5,300 in 1969 to more than 94,000 in 1977, then fell sharply to catches ranging from 22,000 to 36,000 during 1978-85 (Fig. 2). Because increased stocking during this period brought no commensurate increases in harvest, the percentage of stocked fish that were creeled fell drastically. This prompted concern with the steelhead management program, particularly the strain used and the size of fish stocked.

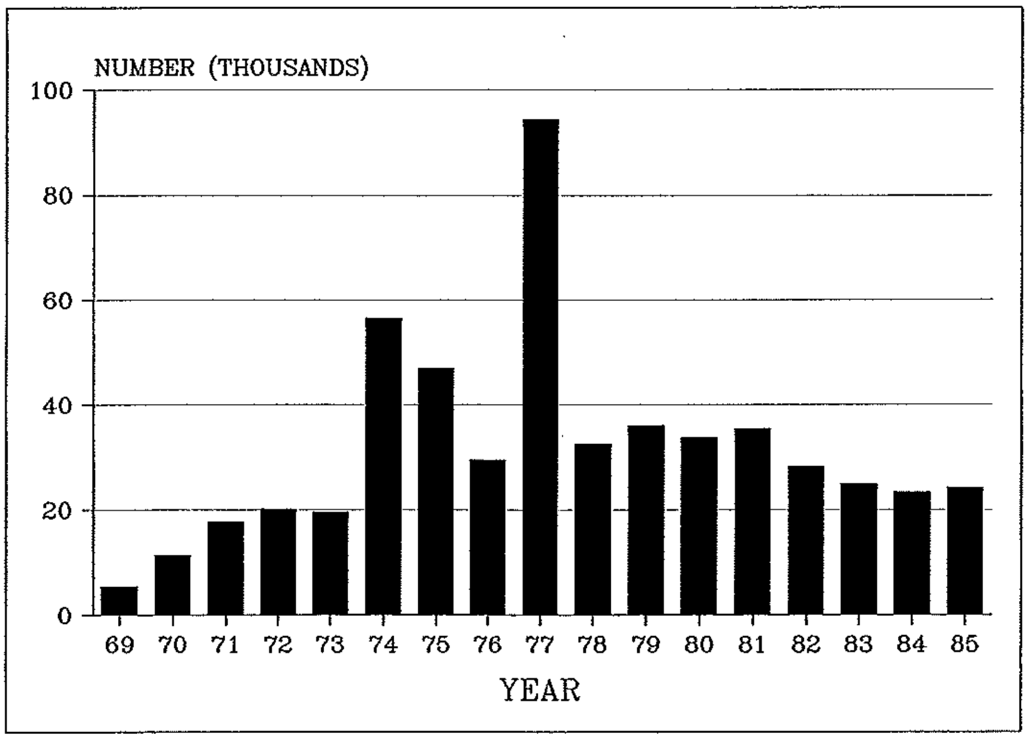

FIGURE 2. Annual harvest of rainbow (steelhead) trout by anglers fishing in the Wisconsin waters of Lake Michigan, 1969-85.

The harvest rate of rainbow trout, as estimated by catch per 1,000 angler hours, was relatively stable during 1969-81 (Fig. 3). Three years during that interval, 1970, 1974, and 1977, were notably higher than the rest, averaging 23.7 rainbow trout per 1,000 angler hours (s = 3.7). The remaining ten years in the interval averaged 13.4 rainbow trout per 1,000 angler hours (s = 1.8). During 1982-85, however, the average fell to 6.5 rainbow trout per 1,000 angler hours (s = 1.0), indicating an abrupt change in fishing efficiency and/or fish vulnerability. Poor strain performance is the suspected cause for this reduction in the harvest rate, because the latter period coincided with the introduction of the Shasta strain.

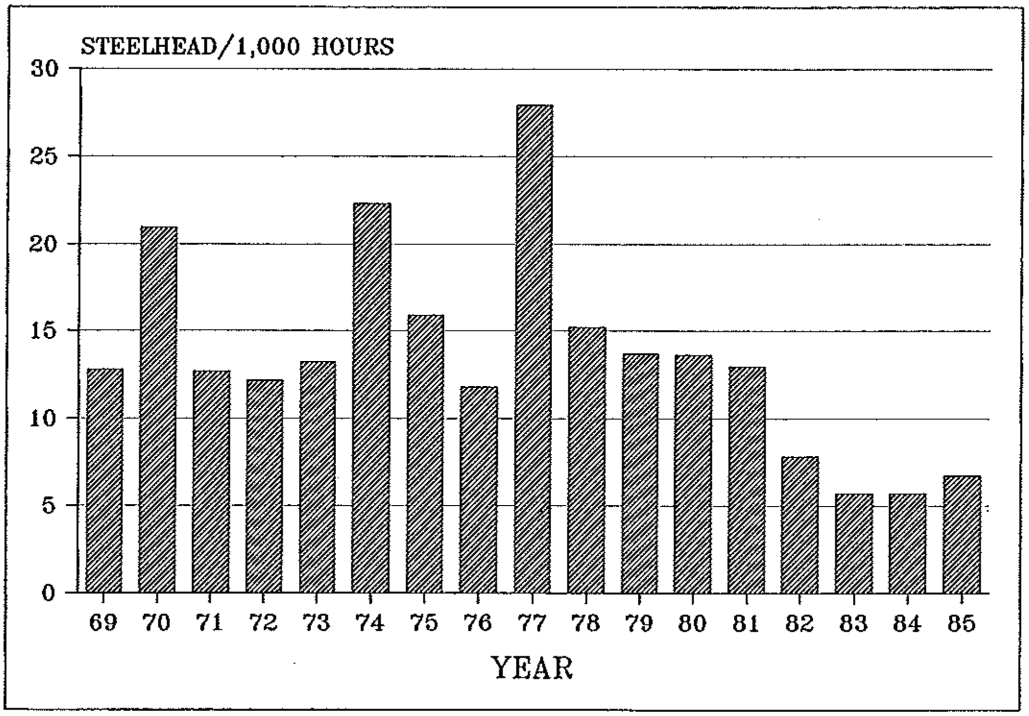

FIGURE 3. Catch rate of rainbow (steelhead) trout by anglers fishing in the Wisconsin waters of Lake Michigan, 1969-85.

Objective: To increase the annual harvest of steelhead trout from 25,000 to 50,000.

Problem 1: <u>Return to creel is inadequate</u>.

<u>TACTIC 1</u>: Stock strains that improve return to creel.

A strain is defined as a fish population that exhibits reproducible physiological, morphological, or cultural performance characteristics that are significantly different from other fish populations or a brood stock derived from such a population and maintained thereafter as a pure breeding population (Claggett and Dehring 1984). A minimum performance characteristic of at least 10 percent survival to harvest is proposed to measure strains of steelhead for use in the Lake Michigan steelhead program. Declining return rates associated with the use of Shasta strain rainbow trout in the Lake Michigan steelhead program spurred the attempt to find a better performing strain of steelhead. This search was somewhat limited due to disease restrictions that prevented the importation of any fish stock from outside of the Great Lakes drainage system.

Research of each strain was conducted on the basis of the strain's performance in the fishery and the availability of a reliable egg source. The Shasta, Skamania, and Pike's Creek strains were initially compared to each other to determine their performance characteristics. The Shasta strain was used as a control. The Pike's Creek strain was replaced in 1985 due to unavailability with a mixed strain from Michigan. The Michigan strain was only a temporary replacement which in 1986 was replaced by the Chamber's Creek strain steelhead. Shasta rainbow trout were stocked for the last time in the spring of 1987 due to poor performance and were replaced by the Ganaraska River strain in 1988. Thus, the three strains that will be evaluated in the future are the Skamania, Chamber's Creek, and Ganaraska River steelhead strains.

Skamania summer-run steelhead: This steelhead strain originated at the Skamania Hatchery on the Washougal River in Washington. Wisconsin's source of eggs from this strain has been the Indiana Department of Natural Resources. However, eggs were taken from adults returning to Wisconsin streams in 1987 and will be the future egg source for the program. The spawning migration begins in June and runs through late fall with the peak months being July and August (Robert Koch, Ind. Dep. Nat. Resour., pers. comm. 1985). Spawning occurs from mid December through mid March. The peak spawning period is in January and February. The average spawner of this strain is four to five years old. Four year old fish average 28 inches and 8 pounds while five year old fish average 32 inches and 12 pounds. The average female produces between 4000 and 4800 eggs. Survival to creel of the 1980 year class in Indiana was 12.8 percent through 1986 (Braun 1987). Catches of 5 fish limits of 15-20 pound fish are not uncommon in Indiana.

Chambers Creek winter-run steelhead: Steelhead from this strain originated on the west coast at Washington's South Tacoma Hatchery. Eggs for Wisconsin's program were obtained from the New York Department of Environmental Conversation's (DEC) Lake Ontario steelhead program on the Salmon River. The spawning migration for this strain begins in late October and continues through mid March with the peak spawning period in March (Leslie R. Wedge, N. Y. Dep. Environ. Conserv., pers. comm. 1985). The major portion of the run in New York consists of three and four year old fish with four year old fish averaging 26.5 inches and 6.1 pounds while five year old fish average 30 inches and 9.6 pounds (Wedge 1986). Average female spawners produced 4000 to 4800 eggs per fish. Combined survival to creel and weir of Chamber's Creek strain steelhead in New York ranges from 19 to 23 percent.

Ganaraska River spring-run steelhead: This steelhead strain originated on the west coast but has since become a naturalized population in Lake Ontario, where it uses the Ganaraska River on the north shore of Lake Ontario as a spawning and brood stream. The exact origin of this strain is unclear. The spawning migration begins in late March and peaks near the second week in April. Peak spawning occurs in late April and the fish move out of the river by May (David A. Bell, Ont. Minist. Nat. Resour., pers. comm. 1987). The spawning run is composed mainly of five and six year old fish but ages ranging from four to ten make up the entire spawning population. The fork length of age five fish that migrated to the lake after one year in the brood stream was 21.25 inches (Biette et al. 1981). Mean weight of age five fish was approximately 3.3 pounds (R. W. Beecher, Ont. Minist. Nat. Resour., unpubl. data). Fecundity data are not available. The size of the steelhead run in the Ganaraska River increased from 527 fish in 1974 to 14,197 in 1985 (R. G. Karges and D. R. Barton, Ont. Minist. Nat. Resour., unpubl. data). Information on the survival of this strain is not available.

TACTIC 2: Stock proper size of smolts, at the proper time of year, in the proper streams and proper numbers.

Stock Proper Size at the Proper Time of Year: Based on research conducted on West Coast and Great Lakes steelhead, the critical size for stocking steelhead smolts is 4 to 6 fish per pound, 7.5 inches minimum total length, and 3.5 condition factor. The critical time for stocking these fish is early to mid-April. On the west coast, where steelhead management has been most highly developed because steelhead occur naturally, many researchers have found that survival of stocked juvenile steelhead through adult return is directly proportional to their size at stocking, within certain limits (Larson and Ward 1954, Hallock et al. 1961, Houston 1969, Wagner et al. 1963, Hoar 1976). Another important factor in survival of stocked fish appears to be the time of release (Wagner 1968). Similar findings have been obtained by researchers working with steelhead on Lake Michigan and its tributaries (Hansen and Stauffer 1971, Seelbach 1985), indicating that transporting steelhead to Lake Michigan from the west coast has not altered their survival characteristics.

Hatchery reared steelhead should be stocked at migrant size during a period of time that coincides with the downstream migration of wild smolts. A smolt is a steelhead which has lost its parr marks and has turned silvery as it goes through physiological changes for ocean life. Juvenile steelhead imprint to their home stream just prior to smolting (Scholz et al. 1978). If stocked too small, most steelhead remain in the stream past the normal smolt time which occurs from late April through June and few survive to smolt size the following year (Larson and Ward 1954, Seelbach 1985). Stocked steelhead which leave the stream before reaching the critical size of smolting probably do not imprint to the stream. Subsequent homing and return of these fish is likely to be poor.

Stock Proper Number: To attain a harvest goal of 50,000 steelhead as outlined in the Lake Michigan plan, 500,000 must be stocked annually. This assumes a 10% minimum survival to the creel. This assumption appears reasonable based on experience in other Great Lakes steelhead fisheries. Survival to the creel and weir of Chambers Creek steelhead in New York has exceeded 19%. Harvest of Skamania steelhead in Indiana has approached 13% of those stocked. Average return to creel of steelhead in the Wisconsin sport fishery prior to the introduction of the Shasta strain (1969-81; yearling stocking only) was 12%. Lake survival of stocked steelhead from smolt to weir return in the Little Manistee River was 31% (Paul W. Seelbach, Mich. Dep. Nat. Resour., pers. comm. 1987).

Stock Proper Streams: The summer-run Skamania and winter-run Chambers Creek strain adults return to their stocking streams and overwinter in them before spawning and returning to the lake. As a result, streams stocked with these strains must have sufficient depth and flow to provide overwinter living space and must remain open at the mouth to allow these fish to enter the stream. The Wisconsin streams which have these overwintering characteristics are ranked below in order of priority for stocking based on their selection as brood stock streams, their habitat characteristics, and their geographic locations (class I streams). They are the Kewaunee, Root, Oconto, Manitowoc, Menominee, Milwaukee, East Twin, Peshtigo, Ahnapee and West Twin Rivers. The Sheboygan River will be added to this list after PCB levels have been reduced. Minimum stocking rates for these streams should be 10,000 per strain, with brood fish collection streams being stocked at higher rates and a higher priority.

The spring-run Ganaraska River strain is better suited for small streams which do not have sufficient overwintering habitat and may often become blocked with sand at their mouths during some times of year. The streams which are suitable for this strain are ranked below in the order of priority for stocking according to geographic and biological characteristics (class II streams). They are the Pigeon River, Stony Creek, Oak Creek, Heins Creek, Sauk Creek, Little River, Whitefish Bay Creek, Pike River, Fischer Creek, Hibbards Creek, Silver Creek, Reibolts Creek, Menominee River, and Kinnickinnic River. Minimum stocking rates for Ganaraska River steelhead in these streams should be 5,000.

Problem 2: Existing production facilities may limit our ability to meet production needs.

TACTIC 1: Improve production practices of all species to optimize total rearing efficiency.

At present, the total annual production of cold water species is about 7.2 million fish weighing 530,000 pounds. Fall fingerlings comprise about 25% while spring fingerlings and yearlings make up the remaining 75% of production during a rearing cycle. Approximately 75% of all fish stocked in a production schedule go to the Great Lakes, the majority into Lake Michigan.

Production of steelhead to a minimum length of 7.5 inches, a weight of from 4 to 6 fish per pound, and a condition factor of 3.5 will require modified propagation procedures minimizing human contact (see Problem 2, Tactic 2). The main areas of concern in propagation will be the increased space requirements necessary to house larger fish at reduced densities for longer periods of time and the maintenance of water temperatures necessary to insure continued growth through the winter. Most hatcheries will also be rearing the upcoming year class while attempting to hold larger steelhead smolts longer into the spring season, resulting in fish densities that are heaviest through late winter and early spring. Since most domestic fish are fall spawners, their progeny can be cultured for 14 to 16 months before stocking. Wild steelhead are spring spawners, requiring their progeny to be cultured for 10 to 13 months before stocking. Warmer water temperatures will be necessary to achieve needed growth.

The full impact upon the hatchery system of following these recommendations for steelhead is difficult to assess. For example, to rear 500,000 steelhead to the recommended size for stocking in April may require that some fish be eliminated from the present hatchery production cycle. Modifications in rearing one or more of these species could mitigate some of this impact. Coho salmon for example, could be reared at an accelerated rate for earlier stocking. Additional rearing space and water supplies could also be developed as needed to maintain existing production of all species. It may also be possible to stock reduced quotas of one or more species into Lake Michigan. However, increases in production requests of trout species for inland quotas could nullify any reductions in Great Lakes stocking, necessitating close coordination of inland and Great Lakes stocking programs.

The survival and return of accelerated growth coho salmon smolts is currently being assessed. These smolts are stocked in late summer and early autumn at 7 to 8 months of age and 15 fish per pound (6.0 inches long). This stock will be compared to coho salmon reared by normal practices which result in smolts 15 to 16 months of age. If accelerated growth coho salmon smolts perform well, rearing space for about 600,000 fish at 15 fish per pound would become available for conversion to other uses. An added benefit is that early stocking may reduce problems with bacterial kidney disease.

__TACTIC 2__: **Expand and/or improve existing facilities to meet production needs.**

None of the streams selected to receive stocks of wild steelhead currently have permanent wild brood collection facilities, though a permanent facility has been designed for the Kewaunee River and a pipe weir has been constructed for the Root River. Streamside facilities could also be designed and constructed to function as parr rearing and smolt release raceways. This would alleviate spring hatchery densities and imprint smolts to the facility.

The Kewaunee River is being considered as a location for a facility to trap and hold brood fish of all three recommended steelhead strains and of coho salmon. A portable pipe weir has been developed for the Root River and has been used as a facility to collect brood fish prior to the construction of a permanent facility. In the future, it will continue to be used as a back-up facility and can be moved to other streams when problems in collection occur on the Kewaunee River.

Disease control must be considered in collection and holding of wild brood fish. Facilities should be designed and constructed to hold a minimum of 10,000 pounds of brood fish and to incubate their eggs to the eyed stage. Such facilities should be operated with a remote water source so that disease control techniques could be administered through spawning time. At spawning time, diagnostics work could be completed and analyzed before eggs were transferred to the hatchery. Summer-run steelhead require the longest holding period since their migration begins earliest and all collected brood fish must be held until spawning the next spring.

Production of steelhead to a minimum length of 7.5 inches, a weight of 4 to 6 fish per pound, and a condition factor of 3.5, without manipulating present fish production, will require some hatchery development. Hatchery loading of domestic strains normally does not exceed 1.5 pounds of fish per cubic foot of rearing space. Experience with wild steelhead strains indicates that rearing densities should not exceed 1.0 pounds per cubic foot in a single-use, multiple-pass system. These relaxed densities become increasingly important as the fish near smoltification. Thus, hatcheries would need to develop 50% more rearing space (with water supplies) in order to convert from domestic production to the same amount of steelhead production. Conversely, 33% fewer steelhead could be reared in hatcheries if funding limitations prevent such development. Reductions would be even greater for hatcheries that typically do not produce 7.5 inch long salmonids.

Steelhead progeny will be derived from adult fish captured during spawning migrations that occur from August through the following April, depending on the strain. Peak spawning of all strains occurs from mid-February through early April, resulting in a culture period of 10 to 13 months. This compares to a 14 to 16 month rearing cycle for progeny of fall spawning species. Thus, rearing steelhead smolts that are 7.5 inches long at time of stocking will require that growth rates in the hatchery are accelerated. This will require that hatchery water temperatures be managed to optimize growth and that hatchery rearing practices be adapted to minimize human contact during rearing. Experience to date indicates that rearing should make use of programmable automatic feeders, round start tanks, high protein diets, covered outdoor raceways, and predator-proof rearing units. Water supplies with higher oxygen content and low suspended solids are also known to improve production.

Problem 3: Angling opportunities may be limited by inadequate access to available habitat.

TACTIC 1: Improve access to available habitat.

Adult holding areas should be determined through a combination of: 1) increasing creel survey effort either by longer seasonal coverage or added emphasis on rivers; 2) continuing floy-tagging and electroshocking surveys in key index stations so that consistency and standardization can be maintained and valid seasonal or annual comparisons can be made; and 3) checking past creel surveys and electroshocking surveys to see if patterns have developed that may indicate where adult holding areas exist. Radiotelemetry could also be used to define adult holding areas. Expenses for radio telemetry studies would include one or two receivers, antenna, headphones, flying time, surgical supplies, and transmitters. Manpower will be required to learn the technique and to follow up with monitoring.

Land should be purchased or easements obtained proximate to adult holding areas wherever appropriate. Since limited access is not a problem on all Lake Michigan tributary streams, specific areas where problems exist need to be defined. Maps should be used to identify public and private lands. Since recent legislation permits fisheries management easements for access only and not for habitat improvement or other land development, land should be purchased where such manipulation is required.

Parking facilities should be developed in areas where angler effort warrants. Creel surveys or public meetings should be used to determine where parking is inadequate. However, some reaches of stream with limited access should be maintained as quality areas for anglers who desire to get away from the crowds. Given the limited river resources available, this approach may be better than having specialized regulations such as fly fishing only sections.

A fishing map of each steelhead river should be developed to include some easily identifiable landmarks such as bridges and roads, the location of parking facilities, state owned land, land on which the state has acquired easements for access, and prime fishing areas.

A brief description of the steelhead program should also be provided, including the various strains used, rivers stocked, number and year stocked, fin clips and expected time of return. Some general fishing tips should be provided for novice anglers and those who were accustomed to snagging.

TACTIC 2: Improve habitat accessible to existing access.

Trout stream habitat improvement is a well documented technique of improving trout populations in small inland trout streams (White and Brynildson 1967, Hunt 1971, and Hunt 1979). Although the specific techniques outlined in these studies may not apply to anadromous salmonids, the major principles of providing cover do apply. Studies on small west coast streams also indicate that in-stream cover is important to adult and juvenile salmonids (Lisle 1986, Dolloff 1986, House and Boehne 1986, Brusven et al. 1986, Leider et al. 1986).

Habitat manipulation in Lake Michigan tributaries for anadromous salmonids should be studied and should focus on two major areas: 1) providing cover for stocked juveniles prior to smolting, and 2) providing cover or holding areas for returning adults. First, stocking of hatchery pre-smolts should be focused in reaches of rivers being managed for anadromous salmonids that have good juvenile cover. Next, habitat improvements should be applied in river reaches where adequate juvenile cover is lacking in the desirable upriver areas. Techniques used in Wisconsin inland trout streams should also be effective in providing cover for juvenile anadromous salmonids. Some of these techniques include brush bundles, half-logs, and artificial bank covers.

To provide cover for returning adult steelhead, larger scale habitat management may be more appropriate. For example, half-logs properly placed with two to four inches of clearance would be of little use to returning adult steelhead, but would provide excellent pre-smolt habitat. Large woody debris was primarily responsible for the development of meanders, pools, and undercut banks in west coast salmonid streams (Lisle, 1986; House and Boehne 1986). Small streams which did not contain the large woody debris had significantly lower salmonid biomass associated with them. Thus, the use of log or tree drops anchored to the bank may be appropriate in larger Wisconsin trout streams where large woody debris is not naturally present. Log or tree drops should be installed in large trout streams by cabling the butt ends to a stump or other solid fixture above the high water mark so as to not catch debris (White and Brynildson, 1967). The tree or log should trail downstream nearly parallel to the flow to prevent debris accumulation and damming and so as not to interfere with navigation.

The use of boulders could also be a valuable technique, provided they do not cause a hazard to navigation and do not cause debris accumulation and damming. Such problems could be largely avoided by using boulders only in larger streams and by spacing them adequately. Other such habitat enhancement techniques should be investigated, particularly those which create pockets of deepened water or cause surface turbulence without interfering with navigation. In using new or different techniques, the natural character of the river should be preserved and each river should be treated according to its own characteristics.

<u>TACTIC 3</u>: **Develop fish passage facilities to currently unavailable upstream river reaches.**

Each Lake Michigan and Green Bay tributary stream presents a unique situation for upstream fish passage. Only the Oconto and Peshtigo Rivers offer the potential for natural reproduction upstream of existing dams, so the primary benefit of passing anadromous steelhead past barriers or dams on remaining rivers is to provide additional angling opportunities for steelhead. This could also reduce some of the congestion in areas immediately downstream from dams. Natural reproduction in the upper Oconto and Peshtigo Rivers would help augment production of juvenile steelhead.

There are several potential problems associated with passing anadromous steelhead past dams. First, sea lamprey and other undesirable species could also be passed upstream to suitable spawning areas. While a fish passage facility could be designed to prevent the passage of undesirable species, the initial cost to construct such facilities and the continuing cost to operate them can be quite high. Conversely, trap-and-transfer facilities may be more desirable for accomplishing upstream fish passage because they do not permit indiscriminate fish passage and are cheaper to build and operate. Second, passage of anadromous steelhead above existing dams could create law enforcement problems, since current Lake Michigan regulations apply upstream to the first dam on most rivers. Such rules would have to be changed prior to conducting any fish passage. Third, natural reproduction of anadromous steelhead could reduce production of resident wild trout populations in the Oconto and Peshtigo rivers. The potential for such negative interactions between resident and anadromous salmonids should be thoroughly evaluated prior to conducting fish passage on these rivers. Last, angler access to areas newly populated by steelhead could be very limited due to private streamside ownership on some rivers. Fish passage should only be pursued, therefore, where adequate public access exists. A discussion of fish passage feasibility on individual streams follows.

<u>Class I Streams (North to South)</u>:

a) Menominee River - The Hattie Street dam two miles upriver in the City of Marinette/Menominee is the first restriction to upstream movement of anadromous steelhead. The river upstream of this dam is a series of more dams, with warm and/or cool water habitat for many miles.

b) Peshtigo River - The dam eight miles upriver in the Village of Peshtigo is the first restriction to upstream movement of anadromous steelhead. Passage of steelhead past this dam and the Potato Rapids Dam upstream (there are about 5 dams before reaching headwaters) would allow some significant natural reproduction of steelhead. However, any passage facility would have to contain a sea lamprey barrier. In 1972 a large hatch of sea lamprey produced in the Peshtigo River decimated the Green Bay population of lake trout in 1976 and 1977. The river has been subsequently treated for lamprey. Removal of the dam is unlikely, barring safety concerns, since it is used as a water supply system for Badger Paper Company and a power generator for Wisconsin Public Service.

c) Oconto River - The Stiles Dam 13 miles upriver is the first restriction to upstream movement of anadromous steelhead. The Stiles Dam is currently operated as a hydroelectric facility by the Oconto Electric Cooperative and its removal is considered unlikely. The trap and transfer of steelhead above the farthest upstream dam at Oconto Falls could be conducted to utilize natural reproduction areas of the upper river.

d) Ahnapee River - The dam eight miles upstream in the Village of Forestville is the first impediment to upstream fish movement. Areas upstream from the dam are typically warm water fisheries, of limited area, and privately owned, so upstream passage would provide little additional fishing opportunities.

e) Kewaunee River - The Kewaunee River is unique among the Class I steelhead streams in that it does not have a dam stopping upstream migration by anadromous salmonids. The Kewaunee River and its major tributaries, Scarboro, Little Scarboro and Casco Creeks, contain approximately 22 river miles suitable for steelhead runs. Natural reproduction of chinook salmon, coho salmon, and steelhead trout has been documented in this system. The Kewaunee River has been selected for the development of a coho salmon and steelhead trout brood stock collection facility.

f) East Twin River - The dam 11 miles upstream in the Village of Mishicot is the first barrier to fish movement. This dam was modified in 1983 to serve as a sea lamprey barrier since the river had been one of the major Wisconsin sea lamprey producers on Lake Michigan up to that time. Upstream from Mishicot there are several high quality cool water tributaries that are largely in private ownership.

Thus, trap and transfer of steelhead above the dam at Mishicot would provide little additional steelhead angling opportunities. The dam at Mishicot is not in good repair at this time and may become an important issue in the near future since the risk of sea lamprey reproduction upstream is high.

g) West Twin River - The dam six miles upstream at Shoto is the first barrier to steelhead movement. The area upstream from Shoto has several good quality cool water streams but the watershed is predominately a warm water area in private ownership. Thus, few additional steelhead angling opportunities can be provided by passing fish above the Shoto dam.

h) Manitowoc River - The dam 21.2 miles upstream at Clarks Mills is the first barrier to steelhead movement on the main stem of the Manitowoc River. There are no barriers to fish movements on the Branch River, the major tributary to the Manitowoc River. There are over 41 total river miles accessible to anadromous salmonids in the Branch-Manitowoc basin. The main stem of the Manitowoc River drops 200 feet from the dam at Clarks Mills to Lake Michigan. The Branch River drops 120 feet in the lower 11.2 miles before its confluence with the Manitowoc River 13 miles from Lake Michigan. As a result of this high gradient, these river areas are largely gravel and rubble riffles, interspersed with pools and runs. Upstream from Clarks Mills, the gradient of the Manitowoc River levels out and the river is soft bottomed and marsh like. Since there is little steelhead habitat upstream from Clarks Mills, there is little to be gained by fish passage above this point.

i) Sheboygan River - The lower dam at Kohler eight miles upriver is the first barrier to steelhead movement. The river upstream from there is a series of dams and impoundments, all of which are dominated by carp. Thus, there is little reason to bypass steelhead upstream from the present Kohler Dam fish barrier.

j) Milwaukee River - The North Avenue Dam two miles upriver in the City of Milwaukee is the first barrier to steelhead migration. The area upstream from North Avenue is a series of low-head dams, spillways, and warm-water flowages. The Estabrook Park dam and the Kletzsch Park spillway allow fish passage during spring and fall. Therefore, passing steelhead past the North Avenue Dam would result in numerous additional fishing opportunities, particularly in the several miles of park land adjacent to the upper river.

k) Root River - The Horlick Dam six miles upriver in the City of Racine is the first barrier to steelhead movement. The

Root River is the primary backup to the Kewaunee river for steelhead brood stock collection. The habitat above the Horlick Dam is currently not suitable for holding adult steelhead. Bank stabilization and habitat improvement of the upstream reaches of the river should precede any plans for fish passage above the Horlick Dam.

Class II Streams: The primary barrier on most Class II streams is "sand blocking" at their mouths during periods of low stream flow. Under these low flow conditions it is best not to pass any steelhead into the upstream areas of these streams, since conditions would be poor for their survival and for angling. Technology can be developed to maintain an open access for fish past these blocked river mouths. Thus, these streams should be allowed to flow as they now do, pending a specific and special need on individual streams.

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