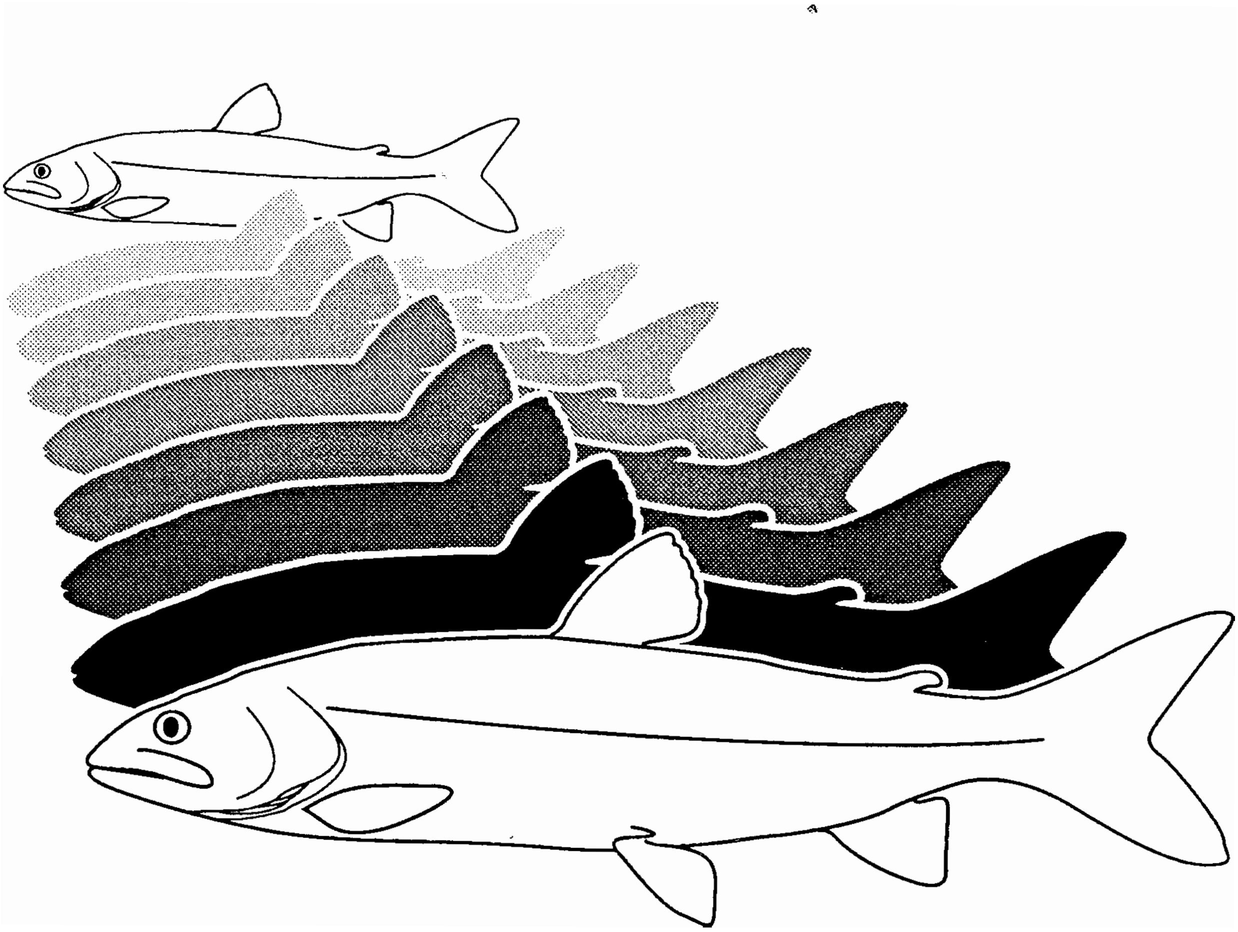
# MICHIGAN

# FISH STOCKING GUIDELINES

revised 1987



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July 15, 1987

PREFACE TO FISHERIES WORKERS

These Fish Stocking Guidelines supersede those issued to Michigan fisheries managers in 1977.

Changes reflect developments in policy and techniques that have come to pass since the last revision.

The Guidelines can be expected to continue changing as our information and experience accumulate. You are invited to freely question and criticize the Guidelines and to offer improvements at any time.

John A. Scott
Chief
FISHERIES DIVISION

Fisheries Management Report No. 11 September 1987

# FISH STOCKING GUIDELINES
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## GENERAL POLICIES

The creation and maintenance of a high quality and productive fishery for both sport and food fish in the public waters of this state is the primary fisheries management objective of the Department of Natural Resources. Toward achieving this objective, the Department shall produce and plant hatchery fish; construct, maintain, and operate artificial spawning areas and rearing ponds; transfer and plant wild fish; and authorize certain private plants. The following fish planting activities are authorized.

### Introducing a New Species

Game and food fish may be introduced in any public water to establish new species or reestablish native species, provided:

1. Biological assurance exists that the quality of the total sport fishery will be improved.
2. The species can be expected to maintain itself through natural reproduction or is so desirable (grayling, for example) that it will be maintained via hatcheries.
3. No species, exotic or non-indigenous to Michigan waters, will be so introduced without specific authorization of the Chief of Fisheries, the Director of Natural Resources, and the Natural Resources Commission.

### Production Planting in Public Waters

Game fish may be stocked in any public water to maintain a high quality sport fishery whether or not such fish can be expected to reproduce in the natural environment, provided:

1. Natural reproduction and survival are inadequate for maximum production of the species.
2. A growth potential is assured in the natural environment whereby more pounds of fish will be taken in the fishery than were originally stocked.
3. The fishery produced justifies the cost of the program.

All fish stocked in public waters must be justified under one or the other of the above sets of conditions. No fish shall be stocked or furnished by the Department for other purposes, except in the following situations.

## Department Planting in Private Waters

1. Either introductory or production plants may be made in private waters which, by written agreement with the Department of Natural Resources, are provided with public access and posted as open to public fishing for a sufficiently long period of time to assure utilization of the stocked fish in the public interest.
2. Introductory plants may be made to reintroduce fish populations in private waters where existing fish populations have been removed as an essential segment of a chemical reclamation project.

## Authorization for Non-Departmental Planting in Public Waters

The Department of Natural Resources may authorize the stocking of fish from licensed Michigan fish breeders or authorized out-of-state sources by permit issued to individuals or public or private groups when it can be determined that no damage will be done in any way to the public interest in the existing fishery in:

1. Waters which are privately owned, but which have a connection whereby fish can migrate to public or private waters at some time of the year.
2. Public waters where private persons or interests wish to enhance recreational fishing beyond the scope of our departmental fish management program.

Many proposals to plant public waters conflict with what is in the long-term best public interest. In other cases, the plants will predictably fail. In these situations, we owe the applicant our strong recommendation against planting along with a tactful explanation and a possible constructive suggestion for the use of their conservation monies and energies (also see Procedures and Guidelines).

## Private Plants in Private Waters

No permit is required from this department for the stocking of fish in private waters which have no connection at any time of year to other public or private waters, provided: that such fish are acquired by legal angling methods, by transfer from other private waters, or by purchase from licensed Michigan fish breeders. No exotic fish may be introduced, however. Under a Memorandum of Understanding with the U. S. Fish and Wildlife Service (USFWS), no federally produced fish shall be stocked in any Michigan waters, public or private, without prior approval by the Michigan Department of Natural Resources. Such approval is made through regular administrative channels and no planting permit is required.

### Fish for Research Purposes

Fish may be provided to either public or private institutions for research purposes. Formal requests for research fish should be submitted to the Hatcheries Section of the Fisheries Division staff, who will screen them for reasonableness, determine availability of stocks, and oversee arrangements for pickup.

## PROCEDURES AND GUIDELINES

### Fish Planting Requests and Review Process: Approval

Fish planting requests are normally prepared by the districts and are submitted on appropriate forms to the region for review and approval. Long-range requests (up to 6 years) are encouraged (when appropriate) in order to facilitate establishment of production targets. Requests are to include transfer of fish from wild sources, rearing pond needs, and transfer from outlying rearing ponds. Region should screen the requests for reasonableness, adherence to policy, and for program balance (districts should not go their separate ways in the management of similar resources). The region should not request substantial increases unless the increases have previously been fed into long-range planning and the fish are to be available. Major program changes require early planning and division approval.

Requests are reviewed by Lansing staff to make sure they adhere to policy and represent a balanced statewide program. After questions of policy are resolved with each region, division approval is granted.

### Allocation, Surpluses, and Shortages

The fish stocking schedule for each year balances approved requests with the inventory. This results in an allocation being made to each region. Any questions of programming and fish availability are resolved with each region at this time. A preliminary allocation for each stocking site is provided to regions and districts for their review. Regions and districts may request reallocations between sites within their jurisdictions. The annual fish stocking schedule is then implemented by program directive.

Inevitably, minor surpluses and shortages will crop up during the plantout. Minor adjustments of the plant size will be made automatically by computer within the bounds of the priorities set by the district.

Major surpluses and shortages (over or under 10% of request) should be identified by the hatchery system as early as possible and prior to development of the fish stocking schedule. These differences will be handled by field-staff consultation. Major surpluses or shortages will require an amendment to the fish stocking program directive, but minor surpluses or shortages will not. Small odd lots of surplus fish may be stocked out at field's prerogative (broodstock, for example).

Requests are reviewed by Lansing staff to make sure they adhere to policy and represent a balanced statewide program. Any questions of policy are resolved with each region, after which approval is granted.

## Fish Transfers

Under certain circumstances, it is advantageous to transfer wild fish (usually for broodstock) for introductions or following chemical reclamations or severe winterkill. Under special circumstances, transfers may be used for maintenance stocking.

Most species can be transferred successfully when water temperatures are cool and the fish are not under spawning stresses. If reproduction from the species to be transferred is desired, plan to complete transfer operations a minimum of 2 months prior to the spawning period. Not only will most species be incapable of successful reproduction if transferred during their spawning periods, but immediate or delayed mortalities may negate transfer benefits.

There are a number of desirable forage and game species without complementary hatchery programs (white bass, black crappie, yellow perch, smelt, etc.). These species have demonstrated suitability in certain management situations and should not be ignored. Excess steelhead and salmon broodstock can sometimes be used to advantage by transferring them to unused spawning areas (above barriers). Approval for transfers should be obtained via the same procedures as routine fish plants.

## Private Plants – Permits and Inspection

Private plants in private waters need no permit from the Director unless exotic fish are involved. Rarely will permits for exotic fish be given favorable consideration. Individuals requesting assistance in stocking private ponds should be advised of the legality of planting by transfer of live fish legally taken from other waters in the state. This is often the easiest way to introduce bass and bluegills. The list of game fish breeders is a source to purchase fish. The state does not supply fish for private waters but we do provide consultation services on a low priority basis. Nearly all farm pond problems can and should be handled over the phone or by letter. The Soil Conservation Service and Michigan State University Extension provide good service on farm ponds and they coordinate their programs with ours.

Private plants in public waters (includes all waters which connect with public waters) require a permit from the Director. Districts issue these permits for the Director. As a provision of the permit, a planting report should be filed and the right of inspection (for diseased fish) be stated.

Care should be taken not to approve species that may be a threat to other species in the system. For example, northern muskellunge should not be approved for certain trout drainages nor should brown trout be approved for key brook trout streams. Plants that are a waste of money should not be routinely approved. Sponsors should be counseled so they fully understand why we recommend they not plant fish under adverse or unneeded circumstances. For example, proposed plants of brown trout for top quality brown trout streams (Boardman, Au Sable, Little Manistee, Pere Marquette) should not be approved. These are important public waters and we need to assure our fishermen that if more trout were needed in these streams, we would stock them. It is also important that we not expose fish populations to unnecessary disease or genetic contamination. Counsel to would-be sponsors of private plants requires diplomacy, not an iron hand. Done correctly a sponsor will usually be grateful for our advice and recommendations. Seek withdrawal of requests for private plants that are ill-advised and try to avoid the confrontation of denials.

## Reporting

Reports shall be the responsibility of the unit making the fish plant and should be completed and distributed within 2 weeks of the release. Refer to "Instruction for Completing the Fish Stocking Record." In addition to reporting state plants, districts are also responsible for reporting private plants in public waters which have been authorized by permit.

## Fish Available for Stocking – Fish Sizes

Biologists and hatchery managers should target plants to hit good food and temperature conditions in the receiving water. This timing may vary considerably between large lakes and small ones or between streams and may influence the choice between fall fingerlings and spring yearlings.

The following varieties and sizes of fish will be available to management biologists for stocking at approximately the dates shown below.

### Coldwater species

Fingerlings.—Fish beyond the egg-sac state, but less than 1 year old, depending on the species, time of year, and hatchery, will range from 1 to 6 inches in length. Brook, brown and rainbow trout, and splake will be available for stocking at approximately the following sizes:

| | | | | | |
|---|---|---|---|---|---|
| Apr | 2.5" | 235/lb | Jul | 4.0" | 50/lb |
| May | 3.0" | 125/lb | Aug | 4.5" | 33/lb |
| Jun | 3.5" | 75/lb | Sep | 5.0" | 25/lb |

Fingerlings should ordinarily be stocked while there are still good temperature and food conditions for a period of good growth before winter. Expect poor results from plants made too late in the fall.

Yearlings.—Trout become yearlings on January 1 following their first summer of life. With our present hatchery facilities, yearling trout (except lake trout) should be available for planting in spring at a size of 5 to 10 per pound. Yearling spring spawning trout (steelhead, wild rainbow strains) will normally be somewhat smaller but Wolf Lake Hatchery can now produce steelhead at a target size of 5 to 7 per pound by May 1.

Coho salmon will be stocked as yearlings (15 per pound) in the spring (late March through April). Chinook salmon will be stocked as fingerlings (100 per pound) in April or May.

## Warmwater species

Warmwater fish species are produced in the hatcheries or outlying ponds from eggs taken in the spring and early summer months. For purposes of production stocking, warmwater fish are not reared or held beyond one summer season. The descriptive terminology, eyed eggs, fry, or fingerlings, should be used for the desired type of plant. Brood fish used to introduce a warmwater species in new water or for stocking artificial spawning areas shall be termed simply adults. Adults are not available from the Hatchery Section and should be secured by transferring wild fish.

The following species are available at the approximate times and sizes indicated:

| Species | Apr-May | May-Jun | Jul-Oct |
|---|---|---|---|
| Northern pike | fry | 2–4" | — |
| Muskellunge | fry | 2–4" | 5–10" |
| Hybrid muskellunge | fry | 2–4" | 5–10" |
| Walleye | eggs, fry | — | 2–4"[1] |
| Largemouth bass | — | 1" | 4" |
| Smallmouth bass | — | 1" | 4" |
| Bluegills or hybrid sunfish | — | — | 1" |
| Channel catfish | — | — | 1" |

[1]From rearing ponds.

## Determining the Size of Fish and Time of Year to Stock

### Trout

**Trout size.**—Unless a water is nearly barren of competing or predatory fish (as in trout-only lakes or after chemical treatment), fingerlings smaller than 2 inches or 300 per pound should not be requested. Where rainbow or brook trout are the most serious fish predators and "forage" fish competition is not severe, 3- to 5-inch trout (25 to 125 per pound) should give good results. Where brown trout, lake trout, or other predator fish are abundant, or where "forage" fish competition is severe, larger trout (6 to 8 inches, 5 to 10 per pound) will normally be needed.

**Planting date.**—In general, the best time to plant trout is between April 1 and September 1. Growth and survival are usually maximized by planting during this period. In making plants later in the year, try to take advantage of as much of the good fall growing conditions as possible. Good trout growth occurs through November on the large oligotrophic lakes.

With fingerlings, the choice of planting date within the above range is largely a function of fish sizes and numbers. The earlier the date, the smaller the trout will be and a larger number may be needed to produce the same results as fewer larger fingerlings planted later. If the planted fish have easy access to deep, cooler waters, brook, brown, and rainbow trout can be stocked in 78 °F without significant mortality. However, it should not be necessary to stock in water over 70 °F if sensible precautions are taken (proper scheduling of lakes, planting relatively warm lakes during cool spells, making morning plants). Region III, for example, should complete most of its trout planting by June 1.

Splake and lake trout should not be planted when the receiving waters are over 68 °F.

### Warmwater species

The size of warmwater species to stock is also dependent upon the competition present in the receiving water as well as food conditions, but flexibility with warmwater species is more limited than with trout. Where walleye fry are to be planted directly into a lake, consider splitting the plant to hedge against adverse food and weather conditions (make the plants a week or so apart). Consider boat plants to distribute fry or plant where lake currents will carry the fry into open water. This is normally the windswept northeast shore (while surface waters are piled onshore by warm southwest winds, reverse bottom currents carry fry to open water). Dye tests may aid in picking a site. Plant fry before they have completely absorbed their yolk sac (true for other species as well).

Release walleye and northern pike fingerlings from rearing ponds (marshes) before food runs out and cannibalism becomes severe. Two or more "crops" may be available from walleye ponds—the fish from successive "crops" being increasingly larger.

For further guidance refer to Policies and Procedures for Selection and Operation of Walleye Rearing Ponds.

Muskellunge fingerlings anywhere between 3 to 10 inches may produce good results depending on the availability of forage fish; but, most situations will demand the larger sizes.

### Determining Numbers of Fish to Stock

Although management situations vary greatly from water to water, a general four-step approach to determine the planting rate is suggested.

1. Estimate the expected annual yield (Y) in pounds of fish to be taken as a result of stocking. The following guidance may be of some help in estimating (Y).

   In estimating (Y), consider the lake's producing potential (fertility), competing fish populations, and the available niche for planted fish. Fertile waters with no competing species (as after chemical treatment) can be expected to yield more per surface acre than large, sterile waters containing competing populations.

   To provide an attractive trout fishery on all but very large lakes, at least 2 pounds per acre should be available for harvest. Five pounds is a reasonable goal when beginning a trout lake stocking program where competing or predatory species are present. On most trout-only lakes, a harvest of more than 10 pounds per acre can be expected; and on small, fertile lakes, 30 pounds or more is not unusual. Trout growth is a good indicator to watch if you are uncertain about the potential yield from a given water. If trout grow unusually well when the harvest is 5 pounds per acre, perhaps the lake will produce 10. However, to assure good trout growth and survival, and good cost/benefits from planting, stocking should be on the light rather than the heavy side.

   Trout streams, on a surface acre basis, are typically as productive as the best trout lakes. Thus, a harvest of 10 to 30 pounds per surface acre can normally be expected. Of course, fertility and the degree of rough fish competition must be taken into account in streams as well as in lakes. Severe predation and competition dictates large fish (if stocking is justified at all) but even small fingerlings will show excellent survival, growth, and production on recently treated streams. The maintenance and improvement of trout fishing on streams with inadequate reproduction and excessive competition of non-trout species is a category of fish management for which many management practices are still being pioneered. Therefore, some variation in the use of fingerlings and yearlings shall be in order, provided that adequate plans for evaluation are made in conjunction with each experimental planting project.

2. Estimate the fraction harvested (H) of stocked fish. Use whatever data are available from comparable waters and from the literature to make this estimate.

3. Estimate the average weight (W) of the planted fish in the catch. Since growth can be greatly influenced by planting density, this estimate, as well as the estimate of survival, should be optimistic.

4. Using the above estimates, the number of fish to be stocked (N) can be computed by substituting in the following formula:

$$N = Y/WH$$

As an example, let us say a yield of 10 pounds per acre of trout, that weigh an average 1.0 pound, is expected on a particular lake and that 20% of the stocked fish will be harvested. The number of trout to plant then would be:

$$N = 10/(1.0)(0.20) = 50 \text{ per acre}$$

Although trout were used for illustrative purposes throughout the above example, the general approach is applicable to warmwater species as well.

## Stocking Guidelines for each Fish Species

### Brown trout

Trout streams with inadequate reproduction may be stocked with brown trout on a production basis if a growth potential exists. The normal stocking procedure shall be with yearling fish in the spring to take advantage of the period of rapid trout growth. Trout planted as yearlings should produce some return to the angler late in the year planted, and the remainder will be in much better condition than fall planted trout to overwinter and produce angling the following year.

Some cool streams have few trout because of poor reproduction, but also lack significant populations of competing species. Fingerling plants may be used in this type of stream.

Where the competition of non-trout species clearly limits natural trout populations, chemical reclamation projects may be undertaken. Treatments should be scheduled early enough to allow for good summer and fall trout growth but late enough to kill young-of-the-year of major rough fish species. Chemically reclaimed streams shall be planted with

Simplified Trout Stocking Table

| Lake or stream classification | Expected yield (lb/acre) | Percent survival trout to angler | Average size of trout in catch (lb) | Number and size of trout to stock per acre | Cost per pound of trout in creel[1] |
|---|---|---|---|---|---|
| Large, oligotrophic multispecies lakes | 1–5 | 20 | 1–2 | 2–25 (5–7"yrlg) 10/lb + | 0.75 1.50 |
| Multispecies, two-story (mesotrophic) lakes | 5 | 20 | 1 | 25 (5–7" yrlg) 10/lb + | 1.50 |
| Single-species trout lakes | 10–30 | 20 | 0–5 1.0 | 50–150 (3–4" fing) 100/lb | 3.00 |
| Large (50'–200' wide) fertile trout streams, maintenance stocking | 10–30 | 20 | 0.5 | 50–150 (5–7"yrlg) 10/lb + | 3.00 |
| Small- to moderate-sized trout streams of average fertility[2] with light competition, maintenance stocking | 10–20 | 20 | 0.5 | 50–100 (5–7"yrlg) 10/lb | 3.00 |
| | 10–20 | 10 | 0.5 | 100–200 (3–4"fing) 100/lb | 0.90 |
| Large (50'–200' wide) fertile trout streams, chemical treatment | 75–150 | 50 | 0.5 | 150–300 (300 fing or 150 yrlg 1st, 2nd, & 3rd year, treat again during 4th year) | 0.40 plus treat-ment costs |
| Small- to moderate-sized trout streams of average fertility[2] chemical treatment | 50–100 | 50 | 0.5 | 100–200 (200 fing or 100 yrlg 1st, 2nd, & 3rd year, treat again during 4th year) | 0.40 plus treat-ment costs |

[1] Based on $3.00 per pound for 10/lb yearlings, $4.00 per pound for 100/lb fingerlings.

[2] Reduce expected yield for infertile streams.

Simplified Warmwater Fish Stocking Table
(no competing fish stocks present)

| Species composition[1] | Percent by weight | Number to stock per acre to produce 100 lb/acre | Percent survival | Average size produced (lb) |
|---|---|---|---|---|
| Bluegill | 80 | 640 fing | 50 | 0.25 |
| Largemouth bass | 20 | 40 fing | 50 | 1.00 |
| | | | | |
| Bluegill | 80 | 640 fing | 50 | 0.25 |
| Largemouth bass | 15 | 30 fing | 50 | 1.00 |
| Northern pike | 5 | 200 fry | 1 | 2.50 |
| | | | | |
| Bluegill | 50 | 400 fing | 50 | 0.25 |
| Largemouth bass | 15 | 30 fing | 50 | 1.00 |
| Northern pike | 5 | 200 fry | 1 | 2.50 |
| Channel catfish | 10 | 60 fing | 50 | 0.33 |
| Crappie | 20 | 0.2 adult | 1 (fry produced) | 0.33 |
| | | | | |
| Bluegill | 20 | 160 fing | 50 | 0.25 |
| Smallmouth bass | 15 | 30 fing | 50 | 1.00 |
| Walleye | 15 | 800 fry (or 50 fing) | 1 (30) | 2.00 |
| | | | | |
| Perch | 50 | 0.2 adult | 1 (fry produced) | 0.25 |

[1] Other species and percentages may be substituted to fit the situation.

fingerlings (or yearlings when available) immediately after treatment. Yearlings or good-sized fall fingerlings should be stocked thereafter.

In heavily fished lakes, or in lakes with severe competition from non-trout species (particularly forage species), brown trout may be utilized. In such two-story lakes, brown trout should be stocked as 7-inch (5 per pound) yearlings.

Yearling brown trout stocked at 5 to 10 per pound have produced excellent nearshore and bay fishing in lakes Michigan and Huron.

Plants of 10,000 to 40,000 brown trout along the Lake Michigan shoreline and at the Tip of the Thumb in Lake Huron have, in many cases, produced substantial returns. Only a few fish are caught incidentally by salmon and lake trout fishermen, as might be expected from such relatively small plants. Instead, most are caught by fishermen actually seeking brown trout. Whenever the onshore waters are cool enough (in the spring through June and again in the fall) the browns are caught in very shallow water along the beach by lone-line trollers and off breakwalls by sport fishermen.

They are highly regarded as a sport fish and inject an important element of variety to Great Lakes sportfishing. Plantings totaling at least 500,000 per year are planned to continue to support Great Lakes brown trout fishing. Some planting locations do not seem to be favorable, however, and plants must be adjusted accordingly.

## Rainbow trout

There are few stream situations in Michigan where populations of sizable resident (non-migratory) rainbows exist. The young of migrant rainbows (steelhead) rarely reside in streams long enough to produce fish of attractive size to the angler. Therefore, the stocking of rainbow trout in streams has limited application in management for a growth potential. There are a few large, rich streams where good growth and angler harvest can be realized with rainbows, but generally brown and brook should be used to enhance resident stream fisheries. On the other hand, steelhead management offers great possibilities and there are situations (i.e., Muskegon River) where a portion of stocked domesticated rainbows provide a resident fishery while those "lost" downstream during high water can be expected to enhance the steelhead fishery.

Rainbows are a major trout species for inland lake plantings. Newly treated trout-only lakes should be stocked with rainbow fry as soon as detoxification is assured. These lakes should be replanted with fingerlings (100 per pound) annually thereafter in May or June. Two-story lakes shall generally be maintained by production stocking of 7-inch (5 per pound) yearlings in April, May, or June. In large oligotrophic lakes, larger (10 per pound) fingerlings stocked in August may be substituted for yearlings.

The Great Lakes rainbow trout program is similar to the brown trout program in that it is designed to provide increased inshore, harbor, and pier fishing opportunities during periods when more migratory anadromous salmonids are offshore in open water. Rainbow trout reared from eggs of domesticated broodstocks seem to remain closer to the release site than steelhead, but results with domesticated rainbow plants in the Great Lakes have been highly variable. This program is still considered to be in a developmental stage and results should be carefully scrutinized.

## Brook trout

Brook trout fingerlings may be utilized in a manner similar to brown trout for production stocking to maintain resident stream trout populations where a demonstrated lack of natural recruitment exists. Stream planting of yearling brook trout is approvable only for experimental projects. Yearling brook trout are at or near the legal size of 7 inches when planted in the Upper Peninsula, and planting yearling brook trout, which are particularly vulnerable to angling, invites return to put-and-take fishing, which is against policy. Generally, the use of brook trout should be restricted to plants in newly rehabilitated streams (soft-water streams) or to coldwater streams where summer temperatures rarely exceed 70 °F.

Wild brook trout originating from the Assinica and Temescamie strains (Quebec) have shown considerable promise in research studies in New York, in the Pigeon River research lakes, and in our management application. Growth of the wild fish and of crosses between Assinica strain and domestic broodstock has been markedly faster than brook trout heretofore used as planting stock. The Quebec trout are slow to mature (age III-IV for females), long-lived, and are more vulnerable to angling than our usual brook trout. To realize their growth potential, they should be stocked sparsely (around 50 per acre).

Expanded use of Quebec strains and its hybrids has already occurred and is expected to continue. These new strains have had a dramatic impact on our brook trout lake program but Great Lakes plants of these strains (in bays and island areas) also offer possibilities.

## Splake

Splake are well suited to planting in the coldwater lakes of the Upper Peninsula and in large, deep oligotrophic lakes throughout the state, including the Great Lakes where they inhabit shallower water than lake trout and exhibit stay-at-home tendencies.

Their role in management lies between that of the brook and lake trout. Compared with other species, splake are costly to produce so their use should be limited to those situations in which they are clearly superior. They may be planted as fingerlings or yearlings.

## Lake trout

Lake trout should be stocked in large oligotrophic lakes. Many of these lakes traditionally have been managed for lake trout and some have self-sustaining lake trout populations. Where feasible, natural reproduction is to be sought in these waters.

Lake trout are a mainstay of Great Lakes fishing. Nearly all of this fishing now is a result of planting yearlings or fall fingerlings, except in Lake Superior where substantial natural reproduction is occurring. Lake trout are reared in Michigan at the Marquette State Fish Hatchery and at the federal Jordan River, Pendills Creek, and Hiawatha Fish hatcheries.

Annual lake trout plantings represent a major segment of a continuing management commitment to rehabilitate fisheries of the Great Lakes. Rehabilitation efforts, which include lamprey control, are coordinated among the United States and Canada through the Great Lakes Fishery Commission. Through Commission coordination, available lake trout are allotted to the various states by lake and planting site. Staff and the fisheries stations have worked together toward formulating lake trout stocking schedules in Michigan.

The goal of reestablishing self-sustaining lake trout populations in the Great Lakes is being pursued through research with innovative stocking techniques, including seeding of known spawning reefs with eggs, fry, and fingerlings. Altered lake trout strains, developed in Ontario hatcheries by splake backcrossing, hopefully to better withstand lamprey predation and to spawn at an earlier age, have not met expectations. Lake trout reproduction in recent years has increased in Lake Superior but not in the other lakes.

Planting of lake trout will continue at high levels in lakes Superior, Michigan, and Huron until natural reproduction begins to complement it. As natural reproduction becomes substantial, plantings will be cut back to accommodate it.

Yearlings should be stocked in May and June and care must be taken to avoid warmwater temperatures and gull predation. Experimentation with planting sites and refuges will continue with the goal of increasing natural reproduction in Great Lakes waters.

## Steelhead

Steelhead are caught chiefly in streams and estuaries, but the open-water catch is increasing and bears watching.

Until recently, most steelhead landed while trolling in the open water were taken while fishing for other species. Now they are being targeted at the "scum line" (the surface temperature break that occurs with offshore winds).

Some mature steelhead ascend streams in the fall and furnish an excellent fall and winter fishery. Spawning does occur sporadically during the winter but the main spawning period for fall-run fish is March. Spring-run fish enter the stream and spawn in March, April, and May.

Spawning of spring-run steelhead usually occurs 1 to 3 weeks later than spawning of fall-run fish on the same stream.

Naturally produced juvenile steelhead migrate downstream to the Great Lakes as silvery smolts in spring and early summer and to a lesser extent in the fall, usually as age group-II fish. If natural runs of steelhead are to be supplemented, or new runs of steelhead are to be established in streams lacking areas for natural reproduction, best results will be had through the utilization of yearling or 2-year-old fish of a size sufficient to encourage smolting within a few days or, at most, a few weeks after planting (7-inch or 5 to 7 fish per pound).

Michigan's top-quality wild steelhead streams, particularly the ones most accessible to southern Michigan fishermen, are neither numerous nor large. Maintenance of moderate runs of steelhead in these streams, runs that can normally be sustained by natural reproduction, is our management goal. Excessively large spawning runs of steelhead attract large numbers of anglers which cause crowded fishing conditions and streambank damage. Angling quality suffers under such circumstances. Dam removal and fish ladder construction programs have opened additional spawning and fishing areas on top-quality streams, but steelhead are not normally planted in them.

The opportunity to provide more steelhead angling lies on the large streams that have less than optimum wild steelhead runs. Most, if not all, of these streams are blocked by dams and natural reproduction is limited. In order to build up steelhead runs in these large, second-quality streams, it is necessary to plant large numbers of fish (20,000 or more).

Based on weir records at the Little Manistee and a subjective assessment of the resultant fishing intensity there, an annual steelhead run of 5,000 is adequate, 10,000 is good, and 15,000 is heavy for a stream that size.

Therefore, assuming (under the best of conditions) that 25% of planted steelhead return as adults to their parent stream, a plant of 20,000 would be required to produce 5,000 adults. This would be adequate on rivers the size of the White and Rifle (assuming no natural reproduction) but plants of twice that number would not be excessive. Rivers the size of the Muskegon or Lower Au Sable should receive 40,000 to 80,000 steelhead smolts.

Fingerling steelhead, surplus to yearling production needs, can be put into streams having adequate food, space, and water temperatures, where they will contribute to the anadromous runs. There may be an opportunity to chemically reclaim these streams to reduce competition prior to stocking.

Fingerling steelhead may also be stocked in natural rearing ponds directly tributary to streams capable of supporting a steelhead fishery. The possibility of stocking fingerling steelhead in streams treated for other purposes should be considered. Transfer of surplus adult steelhead above barriers on good spawning water is also a valuable tool when it can be done at reasonable cost (from Little Manistee weir to Pine River, for example) and where the public is receptive.

Early evaluation of the steelhead stocking program indicates that stream mouth plantings of yearlings give higher survival than upstream plants. This is expected to change as larger yearlings replace the smaller ones of the past.

## Atlantic salmon

In 1972 Michigan renewed efforts to establish Atlantic salmon in its waters. First releases were small and directed toward broodstock development and research. Early hatchery success was encouraging but releases of salmon smolts from Quebec-Grand Cascapedia strain, have given way to the landlocked Sebago Lake strain and emphasis has shifted from stream fisheries to large oligotrophic lakes.

Gull Lake, Kalamazoo County, is being developed as a landlocked salmon broodstock lake.

As with all experimental programs, results of early plants will set the course for future releases. Atlantic salmon are reared to a size of 5 per pound (7 to 8 inches) and released into rivers during early spring runoff (April).

## Coho salmon

The major objective of the coho program is to provide open-water fishing in the Great Lakes. The offshore coho fishery is of high quality but it now is overshadowed by our tremendous chinook fishery. The fish are in prime condition when caught from the Great Lakes. Stream fisheries are of secondary importance. Congested stream fishing conditions can be a problem, although more in the past than present. Salmon rapidly lose condition during their spawning migration and they are often reluctant to strike but vulnerable to snagging.

Coho salmon now support an important early season topline troll fishery in March, April, and May in southern Lake Michigan and in Marquette Bay in Lake Superior.

During the fall, spring, and early summer—Indiana, Illinois, and southern Wisconsin waters yield large numbers of Michigan coho. As the lake warms in June and July, Lake Michigan's coho work north along Wisconsin's shore and in mid-lake. By late July or early August, coho begin to appear off Ludington and Manistee. By Labor Day the concentrations center around the mouths of parent streams and Platte Bay begins to yield its annual harvest of salmon. By October the coho are in the spawning streams. Spawning activity peaks in mid-October. Coho performance in Lake Huron has not been reliable.

Coho smolts are planted in March or April at a target size of 15 fish per pound. Survival rates of smolts vary in different stream systems. The number of coho removed from the weirs at Platte and Little Manistee rivers during egg-taking operations has varied from a low of 2.3% to a high of 22.3% of the number planted. Angler harvest varies similarly.

Natural reproduction of coho is of a low magnitude compared to what is planted in lakes Michigan and Huron (about 5%). Many streams support wild populations. Evidence strongly indicates that most of the coho produced in Lake Superior are wild fish (perhaps 90%).

If a good open-water fishery is to be maintained, large schools of adult salmon must be present. In the past, a good fishery was produced between Ludington and Frankfort by planting a total of about 1.5 million smolts in several closely related stream systems. Minimal plant rate in a stream system to produce an offshore troll fishery should be 200,000 smolts, optimal may be 500,000 or more. It must be kept in mind that even with a significant open-water fishery that up to 20% of the fish planted may enter the stream during the fall spawning run, although 10% is closer to the norm. This number can cause problems unless proper plans are made.

In developing an open-water coho fishery several elements are desirable: good fishing grounds having deep water and dropoffs nearshore, preferably with some protection from the wind; a safe harbor nearby, having boat launching and mooring facilities, generous parking areas, good hotels, motels, eating places, camping areas, and reasonable accessibility by car and air from population centers.

## Chinook salmon

When chinook salmon were introduced in 1967, it was expected that the majority would be captured in the open-water troll fishery. It took over a decade to come about but such is now the case.

The open-water chinook fishery starts in early spring with fish fairly evenly distributed along the coast. In mid-summer, the fish remain dispersed but in deeper water. The August-September fishery is concentrated along inshore dropoffs and river mouths with a few fish entering the larger river-mouth lakes. A few will ascend some large stream systems as early as August, although the main runs usually start in September and peak in early October.

Chinook salmon weighing 100 per pound are planted in May as 6-month-old smolts. Chinook planting levels have stabilized at 6 million smolts statewide annually. In large streams that warm rapidly, smolts should be planted no later than mid-May and before stream temperatures reach 70°F.

Chinook salmon have spawned successfully in many Michigan streams. The fish make little demand on a stream system because of the short period of time (2 to 4 months) they spend feeding in it. They can and do successfully spawn in large river systems, especially the Muskegon, that are unsuitable for natural reproduction of other salmonids.

Survival rates of hatchery smolts will vary depending upon size of fish at release, planting location, water temperature at time of planting, predator population of the stream system in which they are released, and food conditions in the Great Lakes. In 1985, and again in 1986, just over 500,000 chinook were caught in the Lake Michigan (Michigan waters) open-water fishery.

With planting rates at around 2,500,000, this would represent an open-water harvest of about 20%. However, Leon Carl (1980) found that seven Lake Michigan tributaries contributed over 630,000 chinook smolts via natural reproduction. Considering production from streams he did not study, 1 million smolts is probably a more reasonable lakewide total. Weir harvest at the Little Manistee (Hay 1986) shows stream returns to be about 6 to 8% of the number planted or 180,000 to 240,000 out of 3,500,000 smolts (planted plus wild). The Lake Michigan stream catch in 1985–86 was about 75,000 to 100,000 (G. Rakoczy, Charlevoix Great Lakes Research Station, personal communication) and weir harvest accounts for about 30,000 more annually.

Thus, about 15% of chinook smolts live to be caught in open water, another 3% are caught in spawning streams by anglers, 1% are harvested at weirs, and about 3% spawn and die. Not all chinook mature at the same age. About 3% mature after two summers in the lake as age-II jacks (males), 18% at age III (mostly males), 60% at age IV (mostly females), 18% at age V (mostly males), and 1% at age VI (mostly males).

Because large numbers of chinook are caught in streams or estuaries as mature adults, large, fishable streams with adequate public frontage and facilities receive most of our chinook plants. Liberalized fishing has been permitted on many of these streams to allow a quick harvest of these rapidly maturing salmon. Plant sizes average 200,000 to 300,000 smolts but ranges between 50,000 and 500,000. In a few cases (Harrisville Harbor) chinook have worked well in providing stream mouth-harbor fishing where no fishable stream exists.

Items of importance in making stocking recommendations are the goals for the open-water and stream fisheries that are to develop. The expected magnitude of runs of coho and steelhead, and the type of regulations necessary to harvest the salmon are also important considerations. Planting rates and locations must be influenced by the amount and kind of public land available along either the lakeshore or along the stream; the impact of both anglers and observers on the environment; and availability of parking, boat launching, and toilet facilities.

Barriers concentrate fish and will attract anglers and spectators. They can often serve as a focal point for a localized intensive chinook fishery. Adequate public facilities are an absolute necessity where intensive fishing is planned.

## Muskellunge

The muskellunge stocking program involves the stocking of strategically located sizable lakes on the premise that these large spectacular fish will add excitement, variety, and quality to the state's overall fisheries picture. Before a lake is designated to receive muskellunge, it should be thoroughly screened not only for its own qualifications but for the way it will fit into the statewide muskie program. A winter spearing ban is generally desirable, but not mandatory. The muskie program must be watched, as it expands, so that expansion can be curbed when a reasonable balance between quality and quantity is reached. Some public reaction against muskellunge is already being voiced. Program levels for tiger and northern muskellunge combined have leveled off at around 200,000.

Planting of muskellunge shall be restricted to lakes which are not scheduled for any type of trout or salmon management or lakes which are not scheduled for routine bluegill thinning operations. Muskie fingerlings (8- to 12-inch) should be stocked annually or biannually at the rate of 2 to 4 per acre. (Purebred muskie at 2 to 4 per acre and hybrids at 4 per acre.) Smaller muskies, 3 to 6 inches, may be stocked at slightly higher rates.

Northern muskellunge fingerlings will be stocked in broodstock lakes to maintain assured sources of eggs for future production. After this priority is met, northern muskellunge may be planted in other suitable lakes, particularly in the Upper Peninsula and northern Lower where their performance has often been better than that of hybrids.

Hybrid (tiger) muskies (northern pike x northern muskellunge) have been accepted as muskellunge by Michigan fishermen. They are easier to produce and catch than pure northern muskies. They are the muskie now most widely used for non-broodstock lakes, particularly in southern Michigan.

## Northern pike

Northern pike may be reared to 2 to 4 inches in hatcheries or spawning marshes for release into adjacent lakes. Northern pike fry should be stocked in spawning marsh areas at rates of approximately 10,000 per acre or, if fry are not available, 5 pounds of females may be stocked per acre with sufficient accompanying males for fertilization. If adults are used, care should be taken to assure that they are in excellent spawning condition. To discourage the spread of red sore or lymphosarcoma, northerns should not be transferred from waters suspected of harboring these diseases.

## Walleye

Public interest in walleye stocking in the lakes and rivers throughout the state remains at a high level. Except for experimental plants, and plants for walleye lakes where fry stocking has been proven effective, walleye fry shall be stocked in lakes only where populations of competing species have been reduced by chemical treatment. In these lakes, all plants of walleyes shall be made with swim-up fry prior to complete absorption of the egg sac at a rate of approximately 2,000 per acre.

Five-year experimental planting programs, using walleye fry, are being approved on lakes where there is good reason to believe walleyes can be sustained by fry plants. These programs are to be evaluated by netting surveys. Where these fry plants work, walleye management will be inexpensive.

Results from stocking 2- to 3-inch walleye fingerlings from walleye rearing ponds have been extremely effective. Although good figures on survival are not yet available, in parts of the Great Lakes, notably Green Bay, Saginaw Bay, Muskegon River, and Clinton River, survival of these walleye fingerlings rivals that of chinook salmon (see Policies, Procedures, and Guidelines for Selection and Operation of Walleye Rearing Ponds).

## Bass

Stocking of large and smallmouth bass should be limited to those waters which have been chemically reclaimed or new waters void (or nearly so) of fish. (They should not be requested for waters where panfish have been thinned. The thinning process itself will stimulate bass reproduction.) The goal of these stocking efforts will be to establish self-supporting bass fisheries. Because of the special spawning requirements of smallmouth and the difficulties in rearing time, their use will necessarily be limited to waters which possess suitable habitat or which previously supported smallmouth.

Stocking rates should be geared to the productivity of the receiving water. The general approach detailed in the "Determining Numbers of Fish to Stock" section should be used. In reclamation projects involving lakes of moderate productivity (100 pounds per acre), two plants of bass fingerlings at 40 per acre, one immediately following detoxification and one the next year, will suffice to reestablish the fishery. When production stocks are lacking, adults may be introduced at a rate of no more than one pair per 10 acres.[1] Because of the uncertainties associated with year-class strength, however, adult stocking should be avoided when fingerlings are available.

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[1]Female bass produce about 4,000 eggs per pound of which about 50% hatch, perhaps more. In treated situations, a high proportion of these fry reach fingerling size. Therefore, a single 2-pound female could produce 4,000 fingerlings in a treated situation, enough to seed 100 acres of lake.

## Purebred and hybrid sunfish

Recent experience indicates that hybrid sunfish excel only in treated waters where purebreds do not reenter (small landlocked waters). They show no growth advantage in combination with other sunfish. Therefore, the potential role of hybrid sunfish in our overall management program is minor. In most cases, purebred sunfish should be used where sunfish stocking is desirable. Where hybrids are needed, the bluegill-green cross should be requested.

Bluegills or hybrids should only be stocked following chemical treatment or in new waters void of fish. They should be stocked during the first year only. Also, as in bass management, the sunfish stocking rate should be geared to the productivity of the water to be stocked. For example, when bass and bluegills are introduced after a typical reclamation, a reasonable goal would be to establish a standing crop of 100 pounds per acre, 80 of which would be panfish. If these fish are to be harvested at 0.25 pound each and 50% of the stocked fingerlings survive, then 640 need to be stocked per acre.

It should be remembered as more species are added to the above combination, it will be necessary to adjust the poundage of all species and hence the stocking rates.

Since the best fishing following chemical reclamation or impoundment occurs within the first 3 years, and since this fishing draws heavily from the initial sunfish year class, it is important to stock adequate numbers of sunfish. A strong initial sunfish year class may also serve to repress its own succeeding year classes.

Hybrids, being more resistant, should be considered for winterkill lakes which, in general, call for innovative management strategies.

For further guidance refer to: "Managing Michigan ponds for sport fishing" by Schrouder et al.

## Channel catfish

Because of the high water temperatures this species requires for reasonable growth, catfish stocking will normally be limited to southern Michigan waters. Also, since catfish planting stock is now only available in limited quantities from the USFWS, they should only be stocked as a new introduction or experimentally following reclamation. This species may be restocked with bass and bluegills in suitable lakes or with bass, pike, and walleye in treated warmwater streams.

<u>**Perch and crappie**</u>

Black crappie, other sunfish adults, and yellow perch may be introduced following reclamation in suitable waters. The reintroduction of black crappie in southern Michigan impoundments will predictably be very popular in those areas. It must be remembered, however, that adjustments in the bluegill stocking rate may be necessary when other panfish are stocked in combination.

## Stocking Guidelines for each Major Type of Water

For purposes of cross reference and further clarification, fish stocking guidelines for all major classifications of water are discussed below.

<u>**Trout streams**</u>

<u>**Top-quality trout streams.**—There</u> shall be no general stocking of fish in trout steams classified as top quality. Natural trout reproduction in these streams is generally adequate to support an acceptable fishery and to produce enough young trout, or more than enough, to stock the stream to the limit of food and space available. These streams are our premier waters. We should go the limit in protection and development of the natural habitat and in establishing proper fishing regulations. In the case of some exceptional streams, there may be room for stocking trout in addition to wild trout, even though the wild trout alone produce excellent fishing. The Au Sable below Mio is an example. Requests for planting stocks will be approved for such exceptions.

<u>**Second-quality trout streams.**—Streams</u> in this category by definition lack adequate natural reproduction or contain sufficiently high populations of competing non-trout species to limit trout production. Some may be fine trout producers, however, and not need immediate attention. If the problem is judged to be primarily one of a lack of suitable spawning habitat and inadequate reproduction, the streams may be stocked with brown trout or brook trout (especially in the Upper Peninsula) or rainbow in exceptionally large, fertile streams.

If the problem is primarily one of high populations of competing non-trout species, and this competition is severe enough to seriously limit trout growth and production, chemical treatment followed by restocking should be considered. Chemical treatment should be conducted early enough in the summer so stocked trout will be able to take advantage of much of the growing season but not so early that rough fish young-of-the-year are missed. Reclaimed streams should be planted with fingerling trout as soon as possible after detoxification. Stocking should be repeated with fingerlings or yearlings in May or June of the next year and subsequent plants should generally be with yearling trout planted in May or June.

These streams should be rescheduled for chemical treatment if competing non-trout species again build up so that survival and growth of stocked trout becomes seriously limited. A common mistake is to wait too long before retreatment.

**Salmon-steelhead streams.**—Streams in this category support anadromous runs of trout and salmon from the Great Lakes. Runs of adult fish may occur as a result of natural reproduction or of stocking the stream with young salmonids. Since the number of returning adults is dependent primarily upon the number of downstream juvenile migrants, the abundance of adult fish in the runs can theoretically be adjusted to almost any magnitude desirable through stocking and other management techniques (we have the vast areas of the Great Lakes to draw upon in rearing the adult fish). The number of smolts can be increased by: (1) extending the natural spawning range; (2) increasing its productivity; (3) operating rearing ponds; (4) direct planting of hatchery fish; and (5) controlling competition.

Because of the great interest in salmon and steelhead fishing on the one hand, and the controversy that surrounds intensive stream fishing on the other, the various types of salmon-steelhead streams and the many options for managing them will be discussed in detail.

Our salmon-steelhead streams are basically of two types: Top-quality wild streams are those that support healthy "wild" runs of salmon or steelhead through natural reproduction, and Second-quality streams are those with runs of little or no significance without stocking.

An important consideration from the standpoint of fisheries management of salmon-steelhead streams is whether the streams are free-flowing or obstructed in their lower reaches by some natural or artificial barrier.

Stream size, location, and ownership also have great bearing on the type and intensity of management that can be employed.

**Top-quality wild salmon-steelhead streams.**—Management intensity will normally be kept to a minimum on these high-quality, free-flowing streams. They will be managed to protect their wild runs of salmon and steelhead but stocking will not normally be needed. Low stocking levels may be approved in special circumstances (to increase steelhead runs to encourage summer steelhead, coaster brook trout, or Atlantic salmon runs).

Until better acceptance of Pacific salmon is realized on these streams, Pacific salmon fisheries will not be encouraged. Pacific salmon will not be stocked unless weirs offer control and the fish are needed for broodstock or important Great Lakes open-water fisheries (example, Platte River, Little Manistee River). In some cases wild Pacific salmon runs may be discouraged by weirs or netting in order to retain the integrity of existing trout fisheries (example: Jordan River).

Mainstream waters will normally be open to extended or year-round fishing and quality fishing regulations may be employed. The lower reaches of most small coastal streams (such as those tributary to Lake Superior and Lake Huron) are also opened to extended fishing.

Anadromous fish often constitute the dominant fishing interest in these streams and the season steelhead and salmon fishing pressure on their lower reaches pose no threat to resident trout populations.

Second-quality salmon-steelhead streams.—With few exceptions, southern Michigan streams (south of Muskegon and Bay counties) and streams having dams or barriers in their lower reaches fall in this category because they do not naturally produce good runs of salmon or steelhead (the Manistee River is one notable exception). These streams typically need stocking (or fish ladders or transfers of adult spawners) to induce good salmon and steelhead runs. Because the lower reaches of our sizeable streams are not often productive of resident trout, major rivers below barriers offer opportunities to develop salmon and steelhead fishing that do not conflict with established trout fisheries. Runs can be created (or increased) by stocking smolts or by passing a limited number of adults above the barrier strictly for reproduction. (Fish ladders, of course, are another matter. Unless they are operated selectively, they simply eliminate the barrier to salmon and steelhead migrations, and problems associated with salmon and steelhead fisheries can develop in headwaters as if barriers had not existed.)

Large streams in this category offer great flexibility for salmon and steelhead management. Heavy plants of chinook and steelhead in the Grand and Au Sable rivers, for example, serve three purposes:

1. They support the important open-water troll fishery for salmon.
2. They support an intensive fishery in the rivers for salmon in the fall and for steelhead in the late fall, winter, and spring.
3. They stimulate visitor and spectator interest and activity.

Small, second-quality streams, whether or not they have barriers, are not stocked unless they are strategically located to produce stream-mouth, harbor, or open-water fisheries. The creek at Harrisville Harbor, for example, is stocked to attract salmon to the fishable and well-located harbor area. The streams in this case serve only to imprint the planted fish so they will return to provide a stream-mouth or harbor fishery at the desired location.

Harvest weirs on key streams offer great flexibility for salmon-steelhead management but weir installation and operation are costly. At the Platte River, for example, a half million or more coho can be planted to support the Lake Michigan troll fishery, yet all surplus salmon can be removed from the lower river at the weir to prevent excessive fishing use on the fragile upstream sections of the river. Further, steelhead and brown trout can be selectively passed upstream (or transferred as broodstock) and eggs can be stripped from any species for hatchery culture.

## Trout lakes

**Trout-only lakes**.—Lakes in this category shall be managed with trout as the only fish species present. They should be included in the list of Designated Trout Lakes and use of live minnows should be prohibited. When necessary, these lakes should be chemically treated to eliminate predatory and competing non-trout species of fish. These lakes are normally open only during the regular trout season.

The first plantings following chemical treatment in trout-only lakes should always be made with fingerlings. Fishing should be discouraged via posting and the media, until the trout reach legal size. Thereafter, trout-only lakes should be stocked annually with fingerlings or yearlings, although yearlings should not normally be needed on these lakes. When trout success becomes severely limited by competition or predation of non-trout species, the lakes should be rescheduled for chemical treatment.

**Two-story trout lakes**—Lakes in this category shall be managed in combination with the non-trout species existing in the lakes by the stocking of yearling or large fingerling trout. Depending on the characteristics of the lake, rainbow trout, brown trout, brook trout, landlocked salmon, or splake may be used for the stocking of two-story lakes. These lakes are normally open year-round.

## Great Lakes

Fisheries management in the Great Lakes is complicated by the need to coordinate efforts with other states, Canada, and the federal government. But the principles of management are no different for these than for smaller lakes and, in many respects, these lakes represent rather simple ecological systems. But the economic importance of our fisheries management decisions on the Great Lakes is staggering. Department of Natural Resources costs of fish planting, access development, fish ladders, and weirs are high, but they are of little significance when compared to the indirect impact that Great Lakes fisheries management has had on property values, travel, communications, business, and living patterns.

Trout and salmon are the key to Great Lakes fisheries management. Perch and walleye in southern Lake Michigan, northern Green Bay, Saginaw Bay, Lake St. Clair, and Lake Erie are also very important, and locally their importance is often greater than salmon and trout. However, these species must be considered peripheral in terms of the upper lakes as a whole.

Even if perch, walleye, muskellunge, and smallmouth bass were increased to their logical limit, most of the upper Great Lakes available forage base of alewives, smelt, cottids, and chubs would remain unutilized. Knowing the sustainable surplus forage production available for trout and salmon each year from lakes Michigan, Huron, and Superior is extremely important to management because only through such knowledge can the potential for salmonid production be estimated.

Lake Michigan.—In Lake Michigan, studies of stocks of alewives, chubs, smelt, and sculpins by the USFWS estimate biomasses at approximately 400 million pounds. It is safe to say that the annual production of alewives is at least half as great as the standing crop. Thus, the forage fish available for salmonid consumption is about 200 million pounds per year.

Salmonid harvest has reached (1985-86) roughly 20,000,000 pounds per year for Lake Michigan (lakewide).

It appears that salmonid abundance has now neared its maximum expansion in Lake Michigan. Growth rates, which show signs of decline, and observed shifts in forage abundance support this position.

Jointly with the other states, the tribes, and the USFWS, we have a long-range (year 2000) goal of rehabilitating a self-sustaining stock of lake trout in Lake Michigan capable of producing 2.5 million pounds of harvest annually. Protection of lake trout stocks by appropriate regulation, combined with stocking of the best lake trout strains in the best locations (including refuges), is the strategy being employed.

Planting rates and locations for Lake Michigan plants have been worked out jointly with field, staff, local community leaders, and tourist interests. Major juggling of planting rates is neither desirable nor contemplated. Minor adjustments to improve catch will continue as will adjustments to reduce stream salmon problems. You are encouraged to make recommendations toward this end.

Lake Superior.—Lake trout now dominate the salmonid catch from Lake Superior and this situation is expected to continue. The long-term goal (year 2000) calls for a lakewide annual production from self-sustaining lake trout stocks of 4 million pounds. In fact, it is likely that lake trout dominance will become even more marked as lake rehabilitation progresses and excessive local commercial harvests are regulated. Pelagic prey fishes are not nearly as abundant in Lake Superior as they are in lakes Huron and Michigan. This fact, plus the shorter growing season, makes this lake less favorable to Pacific salmon and anadromous trout and better suited to lake trout, splake, and perhaps brook trout. Assinica strain brook trout may be used to advantage to bolster the high-quality inshore coaster fishery, but total numbers of fish involved will be small.

Pacific salmon plants will be concentrated at the few major ports on the lake to create an interesting mix of game fish for the angler. Natural reproduction should allow a future phaseout of most salmon plants.

Lake Huron.—Lake Huron shows promise for lake trout production and natural reproduction. It is expected that lake trout will continue to increase in Lake Huron to the point where their relative importance in the sport catch is intermediate between Lake Michigan and

Lake Superior. Long-range goals for lake trout call for a harvestable surplus of 2.5 million pounds annually (lakewide) from self-sustaining stocks by the year 2000.

The open-water chinook catch has already reached 100,000 (1986) and should continue upward. Increased use of the Saginaw system for walleye management is planned in the future. The 1986 walleye catch in Saginaw Bay exceeded 70,000. It is possible that the offshore salmon fishery will become more successful as the fish-finding capabilities of the fishery improves.

Concerns for salmon management include loss of fish to the Canadian gill-net fishery and loss through the St. Clair River to Lake Erie.

Lake Erie.—Returns from plants of anadromous salmonids in tributaries to Lake Erie have not been good, but they have shown that some salmon and trout fishing can be made available in southeast Michigan. This program will require considerable attention to increase benefits and reduce current high costs.

## Warmwater lakes

Maintenance planting.—Warmwater species are prolific and strong competitors. Once established in suitable habitat, they maintain themselves without hatchery help. Maintaining population balance and good growth, and controlling angler harvest, are our major concerns.

Therefore, with the exception of muskellunge, walleye, northern pike, and channel catfish, hatchery-produced warmwater fishes are to be stocked only to introduce the species in new lakes or treated waters.

Available data point to 9 inches and larger as the best planting size for muskellunge fingerlings. ("Best size" means most economical size to produce fish to the angler.)

Restocking reclaimed carp lakes.—Lakes dominated by carp rate among our toughest fisheries management problems. The lakes are not only of little value for fishing but they are aesthetically degraded by the severe turbidity caused by carp. Carp typically become dominant in enriched situations—reservoirs and streams in farm country and shallow, rich natural lakes.

Carp may be present in less rich waters without becoming a nuisance. In fact, moderately fertile waters having modest carp populations are often very good fishing lakes in spite of the carp population. The fundamental solution to carp problems lies in controlling the enrichment that favors them and stresses game fish. Unless fertility can be reduced in concert with chemical treatment, reclamation of carp waters is a tenuous proposition to be approached with temporary benefits (3 to 5 years) as a goal and longer term benefits as a hope. In such treatments, early reestablishment of strong game fish populations is crucial, for without competitive population pressures a strong carp year class can be expected the year following treatment. Thereafter, continued attention and priority need to be given these problem waters if benefits are to persist.

In the past we have often overemphasized stocking predators in treated carp waters and understocked with panfish. In carp waters the early establishment of a solid panfish year class may be as important as the establishment of predators.

In a healthy warmwater fish population panfish dominate the biomass by a factor of at least 4 to 1, usually more. The first panfish year class established by stocking should be large enough to lock up this 80% of potential fish biomass, leaving stocked predators to tie up the remaining 20%. Predators cannot be expected to fill the same role as panfish in these carp lakes. Thus, if predators are overstocked and panfish understocked, it is likely that a void will remain to be filled by young-of-the-year carp. Increased panfish stocking has other ascribable benefits that make it appealing for carp waters. For one thing, the risk of eventual panfish stunting in these waters is minimal and preferable to the alternative of carp dominance. Secondly, good panfish growth is the rule immediately following chemical treatments and a strong year class of fast-growing panfish will support a fine sport fishery as well as inhibit subsequent panfish year classes.

Considering the above, panfish should be stocked in reclaimed carp waters at a 16 to 1 rate over bass. This ratio assumes the average weight of bass harvested will be four times that of panfish (about 1.0 pound each vs 0.25 pound) and that survival is equal so that the resulting standing crop will favor panfish by 4 to 1. If other predators are stocked (pike, walleye fry), somewhat fewer bass will be needed. Actual numbers to stock can be computed by working back from expected standing crop of game fish. Persistent stocking of walleye, channel catfish, and muskellunge can extend the benefits of carp control indefinitely.

**Restocking reclaimed stunted panfish lakes.**—Lakes in this category are typically fertile, shallow, and weedy. ("Stunted" perch lakes are not included here.) They contain a few healthy big bass that are rarely caught. The preponderance of panfish biomass is locked up in fish of less than "keeper" size.

If such lakes are partially treated or thinned to kill half or more of the panfish biomass, no restocking is in order. Growth of the remaining fish will quickly fill the void created by the partial kill and bass reproduction will improve. Although it may be tempting, from the standpoint of local public relations, to ask for walleye fry or muskellunge fingerlings for these situations, such plants are not ordinarily justified. Walleye are not suited to these lakes and, before muskellunge can be stocked, the lake should be ranked on a priority basis with other muskie lakes. "One shot" muskie plants are, at best, a questionable practice and will rarely receive approval.

After complete chemical reclamation, stunted panfish lakes should be restocked with a combination of fish that will delay retrogression and maintain good fishing as long as possible. Several means of approaching this goal are available. Where a bass-panfish population is desired, bluegill fingerlings should be stocked as soon after detoxification as possible, along with bass fingerlings at a 16 to 1 ratio. Adult bass (1 per acre, but at least 30 total) may be stocked also to establish two year classes of this species (the fingerlings in year one and the offspring of the adults in year two) or a second plant of fingerlings in year two should be scheduled.

Adult bluegills (1 per acre, but at least 30) and crappie may be restocked in late summer or fall of year 2). Bass should be well established by the time these fish spawn. Continuation of hybrid sunfish plants in year two, where invasion of bluegills and crappie has not occurred, is a permissible option. Hybrid sunfish (see page 22) are of questionable value on all but small, landlocked lakes, however.

**Restocking walleye following perch or sucker thinning.**—Walleye fry or fingerlings may be introduced following thinning or partial treatment in lakes which have a remnant walleye population or possess the characteristics (medium productivity, yellow perch-sucker forage) for sustaining a good walleye fishery.

**Winterkill lakes.**—Winterkill lakes may be small lakes that frequently winterkill or they may be sizable and experience only occasional kills. Where severe winterkill is believed to have occurred on a lake which normally provides good fishing, restocking may be in order. An inspection of the lake's shoreline during the following spawning season should reveal if enough bass and bluegill broodstock survived the kill. If there is no evidence of bass or bluegill spawning activity, the lake should be restocked either by transfer of adult broodstock or with fingerlings. Winterkills are usually only partial kills, in which case no restocking is in order.

Some winterkill lakes may lend themselves well to single-species management or to be used as rearing ponds for walleye or northern pike. Bluegill-green sunfish hybrids are more winterkill tolerant than bluegills.

## Warmwater streams

Warmwater streams are usually treated as part of a broader lake or reservoir reclamation project, often to remove carp. Such streams may be restocked with smallmouth bass, pike, muskellunge, walleye, or channel catfish. If the water quality is good, particularly in more northerly streams, trout may be used as in interim species. Warmwater streams do not lend themselves well to intensive management. They are subject to very seasonal use at bridges (usually during sucker runs) with use being very light at other times (by occasional wading bass or pike fishermen or car top boaters).

Maintenance stocking of walleye, muskellunge, or channel catfish may hold some promise for these streams but right now any such plants must be considered experimental. Chemical treatments of these streams have been successful only where trout are reintroduced. The growth of warmwater fish is so slow that by the time a warmwater fishery is reestablished following chemical treatment, rough fish are back too. The potential benefits of intensive management are fairly low on small- to moderate-sized streams because the acreage of fishable water is low (a few acres per mile), and accessibility to the good holes is often difficult. Major warmwater rivers offer better opportunities for management.

### Survey and Evaluation

An effective fish stocking program requires detailed biological and fishing intensity information on all of the waters involved. This report furnishes stocking policy and guidelines. It is the responsibility of field biologists to periodically assess the status of fish stocks on individual waters, investigate management problems, and evaluate the results of the stocking.

Basically, the field biologists will investigate the success of each plant which varies from routine production plants. Many routine plants should also be evaluated to verify expected results.

### Check Points in Fish Stocking

The following basic points of fish stocking are known to all management biologists, but sometimes we tend to forget or work around them.

1. Fish stocking is an important and expensive management tool. Directly and indirectly it involves about half of the annual fish management budget.

2. Fish hatchery production space is pitifully small compared to the natural environments. Use hatchery stock only in the sense of artificial reproduction. Never make production plants except where growth potential (a void) exists.

3. Fish stocking, except for new introductions, is short-term management. Without continued management, natural populations will quickly reestablish their original equilibrium.

4. Fish stocking is employed to improve the quality of fishing through more complete utilization of the productivity of natural waters in making available fish of desirable size and species.

5. Plant only for a specific and feasible management objective. Be sure the objective is completely defensible.

6. There is no gain in planting fish that die shortly after swimming out of sight. Do not plant fish physiologically incapable of survival. Mortality induced by careless handling is unforgivable.

7. There is always a best time in the season to plant fish for a given purpose and a best size to plant. Determine what this combination is and try to hit it. Calculate the loss when you miss it.

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