A STREAM IMPROVEMENT PROGRAM FOR THE HIGH SCHOOL CONSERVATION TEACHER

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY
Edward C. Mueller
1962

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ABSTRACT

A STREAM IMPROVEMENT PROGRAM FOR THE HIGH SCHOOL CONSERVATION TEACHER

by Edward C. Mueller

Stream improvement programs, in existence in the United States since the early 1930's, have not gained the prominence once expected of them. Lack of funds, poorly constructed devices, and an absence of total watershed management have hampered the program.

The stream improvement efforts of Wisconsin and Michigan, however, merit consideration because of the results they have shown. Past history of these programs and their present objectives and policies are included.

Physical characteristics such as size, velocity, gradient, geographic location, ground water, surface water, streambottom materials, streambank vegetation, water quality, and flora and fauna should be surveyed before actual improvement begins.

Included in the in-stream improvement are deflectors, dams, covers, and spawning areas, whereas the upland phase includes bank stablization, gully control, improved cropping procedures, and reforestation. Streams which show the effects

of improper land use are considered for improvement. Factors which have caused the deterioration of habitat are modified to gain optimum trout production, improve water quality and improve the aesthetic beauty of the stream.

The influence of agriculture, forestry, industry, and land and water use for recreation must be considered among other cultural characteristics which may limit the possible modification of streams.

It is the purpose of this paper to provide background information for high school conservation teachers, youth group leaders and sportsmen's clubs who are able to furnish valuable assistance to improvement programs which are lacking funds and are sorely in need of aid and encouragement to provide the maximum amount of highly desirable fishing areas for an ever-increasing population of fishermen.

Deterioration of streams need not continue if enlightened groups of citizens are willing to support an active stream habitat restoration program and prevent further destruction of our streams by providing funds for such improvement efforts.

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By

Edward C. Mueller

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Resource Development

1962

ACKNOWLEDGEMENTS

The writer wishes to thank Dr. C. R. Humphrys, Department of Resource Development for his guidance and assistance. He also expresses gratitude to Dr. Raleigh Barlowe, Dr. Gilbert W. Mouser, and Dr. Milton H. Steinmueller for general advice and criticisms in the manuscript.

He also wishes to acknowledge Mr. Roger B. Wicklund of the Michigan Department of Conservation for helpful suggestions and reference material, and Mr. Willard M. Spaulding of the Michigan Department of Conservation for various suggestions.

He also acknowledges the cooperation of the Michigan Department of Conversation and the Wisconsin Conservation Department in providing information about their stream improvement programs.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF MAPS

CHAPTER I

INTRODUCTION

What is Stream Improvement?

Stream improvement involves the modifications of land use practices, riparian and upland vegetation and water quality in order to satisfy the needs of the fish species desired. Measures are used to control erosion, provide vegetative cover, limit the access of livestock to well-sloped and graveled crossings, reduce beaver populations wherever they cause damage to the stream and improve the stream channel by installation of deflectors, log jams, covers to provide pools, riffles, and improved spawning facilities.

Up to the present time only cold water streams suitable for trout (below 75^{o} for brook trout), have received consideration for improvement. The objectives of a good stream improvement program are: (1) To provide an abundance of cool, clear water. (2) To increase the food supply of trout by improving conditions for the invertebrates. (3) To increase cover for trout. (4) To provide more gravel-spawning for trout. (5) To promote and encourage good land and water conservation measures. (6) To improve the aesthetic value of the stream. (7) To increase land values by providing trout angling of a higher quality.

Deterioration of trout streams is continuing at an alarming rate. Dumping of refuse into streams has caused many of these "eye sores." Much of the debris which man has cast into the stream can be removed without a major effort. This does not mean that we should remove the logs and other materials which serve as cover for fish--only the rubbish and other unsightly materials.

Evaluation of stream improvement programs in the past had only considered the fishery resource. It may be difficult to show an increase in the number of trout caught in the improved areas of streams for the gain may be in the size of fish, not in numbers. Evaluations of early programs have stressed the lack of good land use planning and improvement of land use and water quality. At present, good land use is one of the primary objectives of stream improvement.

Some of the existing programs include good land and water use practices for the entire watershed area--not just the stream. The upland phase is directed by a land use planner, forester or soil scientist. The stream phase is guided by the stream planner who is a biologist in the fisheries division of the conservation department.

The landowner is the key to the stream improvement program in areas where public land ownership is non-existent. To obtain his cooperation and support is of paramount importance when initiating an improvement program in any given area. To achieve success, all agencies and organizations interested in resource conservation should provide some form of assistance.

Why Do Stream Improvement?

Justification of management practices in terms of expenditures and benefits accrued presents a formidable challenge. To determine what benefits may be accrued from stream improvement, it is expedient that we define the characteristics of a good stream. A good trout stream drains an area which has adequate vegetative cover and insures maximum absorption of precipitation. A large supply of cool ground water is thus provided with a relatively small amount of surface water entering the stream. Streamflow is stable because it is derived from ground water sources. An abundance of riparian vegetation provides adequate shade for the stream. There are no obstacles which prevent fish migration and the stream itself has a variety of bottom types such as boulders, rubbles, sand and silt. Pollution by sewage or soil erosion should be negligible.

To find this type of stream in Wisconsin or Michigan today is not an impossible task, but these streams are exceptions. The effects of poor land use, forest fires, poor logging practices, removal of streamside vegetation and improper road construction have reduced the original number of good trout streams considerably. The Wisconsin Conservation Department, in a recent survey, reports that about one-third of the trout streams in the state produce trout naturally. The designation was made by field personnel on the basis that over half of the fish caught were native to the stream. Habitat improvement was suggested as a replacement for stocking in these streams.[1]

Is there a need for more fishing areas today with our population expanding and our leisure time increasing? A recent survey (1961) by the U. S. Bureau of Census, U. S. Department of Commerce, seems to support the need for more fishing areas.

Number of anglers------------------------------30,000,000

Money spent------------------------------------$3,000,000,000.

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[1]Wisconsin Fishing Waters. Sport Fishing Institute Bulletin, Washing D. C.; No. 119, October, 1961, p. 4.

Money spent per angler---------------------------------$106.00

Average Number of fishing trips per angler-----------16-17

Distance Traveled------------------------------------18.8 billion
an average of 743 miles per angler

Total number of angler, increase since 1955--21.7 per cent

Expenditures of Fisherman----------------------------11 per cent for tackle, 28 per cent for motors and boats, 9 per cent for auxilliary equipment (tents, sleeping bags, and camping equipment), 51 per cent for food, lodging, transportation and privilege fees, 2 per cent licenses and tags, 1.5 per cent for miscellaneous.

Increase in inland anglers---------------------------3.3 per cent

Increase in number of women anglers------------------up 1.8 per cent

Nearby Fishing areas are vital----------------------Most fishing trips within 50 miles of home, 4 in 5 fishermen fish in fresh water. Usually fish with only one companion or none. Chances are 1 in 32 that the angler belongs to some sportsman's group.[1]

If fishermen continue to increase at a rate of over 4 per cent per year, all waters should receive consideration for possible improvement. The discouraging part of the above report is that only two per cent of every dollar expended for licenses is for improvement of the sport (excludes 10 per cent tax on fishing equipment which is spent on research and improvement). The privilege to fish is still very

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[1] U. S. Anglers, Three Billion Dollars. Sport Fishing Institute Bulletin, Washington D. C., No. 119, October, 1961, pp. 1-4.

economical. The sportsman should not be proud of the fact that he pays so little for this privilege and hopes to obtain so much.

In another survey by Dr. Lewis C. Copeland,[1] the value of tourists to Tennessee was found to be $230,000,000. According to a formula worked out by Dr. Copeland, each day spent in Tennessee by the tourist angler would generate $1.72 of new income for some citizen of Tennessee. The amount in Michigan or Wisconsin may, of course, be higher depending on the type of fishing, type of accomodation, source of tourists and length of fish trips.

The importance of trout fishing, as an angling pursuit, is emphasized by Edward Schneeberger, Superintendent of Fish Management, Wisconsin Conservation Department.

> Trout fishing has long been looked upon as one of the most sporting and challenging of all types of fresh water angling. Furthermore, in all of the states having trout streams, trout have received the major attention even though trout fishermen are in the minority.[2]

What tangible results has stream improvement shown? The following are examples of evaluation made of trout stream improvement since 1932.

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[1] Tennessee Angling Economics. Sport Fishing Institute Bulletin, Washington D. C., No. 119, October, 1961, p. 4.

[2] Wisconsin Conservation Department, Wisconsin Trout Management. 1954, p. 1.

Saunders and Smith Found an increase of brook trout from a five year mean of 137 to a total of 286 yearlings following stream improvement in Hayes Creek, Prince Edward Island.[1]

Webster, in providing artificial spawning facilities for trout observed that, although some areas were completely utilized, others were ignored.[2]

Tarzwell concluded,

> . . . that improvement devices introduced into Michigan streams studied have been found to be relatively stable and efficient in producing physical and biological changes, and since these changes have been found in test areas to increase the production of fish food organisms and probably fish, the improvement work of Michigan streams has been successful.[3]

Heding, Peters and Wilson, citing 10 years experimental stream improvement work in Wisconsin, state the improvement has shown the way to more native trout.[4]

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[1]J. W. Saunders and M. W. Smith, Physical Alteration of Stream Habitat to Improve Brook Trout Production. Trans. Am. Fish Soc., Vol. 91, (2), 1961, p. 187.

[2]Dwight A. Webster, Artifical Spawning Facilities for Brook Trout, Salvelinus fontinalis. Trans. Am. Fish. Soc., Vol. 91 (2), 1961, p. 172.

[3]C. M. Tarzwell, Experimental Evidence on the Value of Trout Stream Improvement in Michigan. Trans. Am. Fish. Soc., Vol. 66, 1936, p. 187.

[4]Robert B. Heding, Lester A. Peters, and George M. Wilson, Fish Housing. Wisconsin Conservation Bulletin, Vol. 27, No. 2., March-April, 1962, p. 7.

L. Price Wilkins, in an evaluation of Tennessee stream improvement, concludes that findings show an increase of 6-8 inch trout in improved areas despite increased angling pressure.[1]

Warner and Porter, in experimental work in Maine, report that results were encouraging despite some limitations. Rock dams were severely damaged by high water, thus creating few permanent pools.[2]

Shetter, Clark and Hazzard, show an increase of 35 per cent more fish caught per hour, and a 141.5 per cent increase in pounds of legal fish removed. In an analysis of cost per fish caught during the five year period each additional trout cost $2.82.[3] If deflectors last approximately 20 years with some maintenance, the cost would probably be somewhat below half of the above amount. These figures, however, are not applicable now due to increased costs. Cost of unskilled labor used for stream improvement

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[1]L. Price Wilkins, Construction and Evaluation of Stream Alteration Structures. Tennessee Fish and Game Comm., 1958, p. 9.

[2]Warner, Kendall, and Ivan R. Porter, Experimental Improvement of a Bulldozed Trout Stream in Northern Maine. Trans. Am. Fish. Soc., Vol. 89 (1), 1959, p. 62.

[3]David S. Shetter, O. H. Clark, and Albert Hazzard, The Effects of Deflectors in a Section of a Michigan Trout Stream. Trans. Am. Fish. Soc., Vol. 76, 1946, pp. 248-278.

has not gone up excessively, but the cost of administration and survey has increased.

Gee concludes that many mistakes were made in earlier efforts, but that much was learned. He also stated that stream improvement fell far short if other destructive forces were still at work within the watershed.[1]

In a report on stream improvement in the Intermountain Region, M. J. Madsen reports that stream improvement has not been practical or economically sound. He further reported that all possibilities would be analyzed before it would be condemned in the Intermountain Region.[2]

In a recent report, Wicklund and Spaulding report an increase in trout in an improved section over a reserve section in a three year survey. A reversal of reserve and improved sections and another evaluation at the end of three years is to follow.[3]

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[1]U. S. D. A. Forest Service. Fish Stream Improvement Handbook. 1952, p. 1.

[2]M. J. Madsen, A Preliminary Investigation into the Results of Stream Improvement in the Intermountain Forest Region. Trans. Third N. Am. Wildl. Conf., 1938, p. 503.

[3]Roger G. Wicklund and Willard M. Spaulding, Progress Report on the Effects of Stream Improvement Devices on the Standing Crop of Trout in One Stretch of the Platte River, Benzie County, Michigan. Michigan Department of Conservation, Mimeo., April, 1962.

Many states which have made evaluations have not published them making it difficult to obtain and appraise all of the work completed. An effort to make such an evaluation would be valuable to further stream improvement efforts.

What are the tangible results of stream improvement? In his capacity as a land use planner, Brown[1] concluded the following to be of value in the Michigan program of stream improvement:

> (1) Increase in land values due to the establishment of good conservation practices. (2) Gain in the intrinsic value through increased membership, activity and interest acrued from involvement in a successful program. (3) Increased use of the watersheds for recreational purposes due to clear streams, land cover and favorable attitude of the landowners. (4) Most important, an improvement sentiment toward streams. "There is now a community fund of good will developed toward the maintenance of a clear stream."[2]

Both tangible and intangible results are evident in this program which has gained public acceptance despite the lack of funds and support of fish management. Although emphasis is on improvement of trout fishing in the present program, numerous other benefits may appear.

Some of the benefits of the stream improvement program are becoming more evident. The sportsman is requiring

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[1]Norman J. Brown, op. cit., pp. 58-59.

[2]Ibid.

stream improvement, the landowner is usually in favor and the trout fisherman, who prefers native trout, is willing to expend money on a trout stamp to be used for improvement. It would seem then, that the only stumbling block to the program is the lack of foresight to allocate funds for stream improvement purposes.

Who Does Stream Improvement Work?

Stream improvement programs gained their greatest impetus during the early 1930's. Although the program evolved in Europe in advance of this time and some experimental work was completed in Michigan in the later 1920's, major efforts began in the early 1930's. The advent of the Civilian Conservation Corps (CCC) and pioneering efforts of the Michigan Conservation Department helped to spread the program to all areas of the United States.[1] Fifteen states were engaged in some form of stream improvement in 1953. Some of the early improvement work was not well planned and was often described as "habitat alteration"[2] instead of improvement. Stream improvement, however, was

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[1] George A. Rounsefell, and W. Harry Everhart, Fishery Science, Its Methods and Applications. New York: John Wiley and Sons, Inc., 1960, p. 229.

[2] Ibid.

one of the first concentrated attempts in fisheries management which recognized that some extenuating circumstance within the habitat was the limiting factor in trout production.

Many of the early efforts were unsuccessful because they attempted to duplicate much of the work done in Michigan. States in the western region, having high mountain streams with steep gradient, found that the methods used in the Lake states would not succeed where water velocity was high. Many of the programs lacked the foresight to provide money for purposes of evaluation after the work was completed. This resulted in abandonment of many programs. Programs which are once discarded by fisheries administrators are seldom reinstated. It is difficult to persuade the sportsman that an abandoned program may have had intrinsic values and again ask his renewed acceptance.

Stream improvement programs, stressing total watershed improvement, which exist in Michigan and Wisconsin today had their inception in the early 1950's. Although both have similar objectives, the programs are planned and administered somewhat differently.

In the Michigan stream improvement program, a number of streams are selected by district fisheries personnel for possible stream improvement surveys. These selections are routed through the regional office, where they are given a priority rating, to the Lake and Stream Improvement Section office in Lansing. Preliminary surveys are conducted on these watersheds to determine whether factors limiting trout production can be regulated or controlled. Reports of the survey are then scrutinized to set up a priority for development. Streams with high priority are then mapped for device construction by a trained fisheries biologist while upland areas are planned by a land use planner or forester.

After completion of the planning by the conservation department, local landowners and other agencies involved in land and water conservation are brought into the program. Soil Conservation Districts may make major changes in land use and practices as a part of these projects.

Crew foremen follow the recommendations of the stream planner as to the type of device and where to locate it. Records of labor and materials used are made on some watersheds for later cost analysis.

During the early 1950's, three watersheds were worked simulatenously in the state of Michigan. The number was later limited to only two, and presently (1962) two crews are active; the one in the lower peninsula working toward the completion of the Tobacco River Watershed and the other in the upper peninsula working on several small projects. Improvement in the upper peninsula favors development of sections of streams in contrast to the entire watershed because of existing stream conditions. Further development will depend upon the availability of adequate funds.

Many of the improved streams have been within the boundaries of national and state forests, but improvement has also progressed without difficulty on private lands. Of the practices planned for private lands,[1] 98 per cent have been approved by the landowners. This is, indeed, a fine example of cooperation between governmental agencies and private landowners. It could well be one of the finest examples of public relations efforts in resource management. The stream improvement program has been accepted by both the landowner and the fisherman, which is an unparalleled accomplishment.

Wisconsin's program, although not based on total completion of work within a watershed, has also been very active

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[1]Norma J. Brown, Organizational Techniques Used With Michigan's Conservation Watershed Management Projects. Michigan State University, Department of Resource Development, Agricultural Experiment Station, Water Bulletin No. 10, 1961, p. 44.

since 1946.[1] Fish management personnel have created a number of demonstration projects throughout the state. The demonstration projects have frequently involved the headwaters areas or sections which still have native trout populations. After initial surveys are conducted to determine if the stream is in need of improvement or can benefit from it, strips or parcels of land bordering the stream are leased or purchased. Although stream surveys are made, the stream crew foreman may modify the location and type of stream devices. The types of devices planned are restricted, to a certain degree by the materials available. After completion of the in-stream work, location of the devices is recorded for later evaluations. At first, Wisconsin's stream improvement program covered only the stream phase, but now, it is approaching the scope of Michigan's total watershed management concepts.

Another phase of Wisconsin's program has been carried out by cooperating groups. Interested groups, such as Boy Scouts, high school classes and sportsmen's clubs have cooperated on many stream improvement projects throughout the

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[1]John D. O'Donnell and C. W. Threinen, Fish Habitat Development. Wisconsin Conservation Department, Publication No. 231, 1960, p. 3.

state. Cooperative groups have generally received assistance in planning and supervision from their states fish management division in establishing a project on a trout stream, which was in need of improvement out and located within the immediate area of the interested group.

The cooperative projects have not completed as great a volume of work as the demonstration projects, but they have been helpful in securing the approval of the conservation department's stream improvement program. It is interesting to note how an individual's opinion will change once he becomes active in a project. Involvement appears to stimulate acceptance of the program.

Cooperating groups are also active in Michigan today, although they are not as numerous as in Wisconsin. A good example of a Michigan group is a Lake Leelanau Boy Scout troop which has included fish conservation projects among its many activities. In 1961, rocks and boulders totaling 105 tons were picked up, hauled and placed in Solon Creek for bank rip-rap, deflectors and V-dams, under the direction of area fishery supervisor, Stanley Livense. The stream improvement project included maintenance and has continued for eight years.[1]

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[1]Troop 29 Conservation. Sport Fishing Institute,

With an increase in resource education in our high schools, there are more groups who are interested in learning about and engaging in, some of the good land and water use practices so necessary to our total conservation program. These school groups, cooperative sportsmen's clubs and trout fishermen's associations are actively supporting stream improvement programs today. Although many conservation administrators include stream improvement in their objectives, they fail to include money for adequate development in their budgets.

Generally, fishery biologists favor some type of habitat improvement over put and take stocking procedures and regulations as management practices if the stream improvement is well planned and work is well coordinated.

The removal of undesired species, which is looked upon by the biologist with great anticipation, is in reality a method of habitat improvement for it modifies stream conditions so that trout are able to utilize the entire food supply. The trout population, however, is still limited by the carrying capacity of the habitat.

Bulletin, No. 124, March, 1962, p. 3.

It is important that some stream improvement work be completed in the future. Who is to do it? This question can only be answered by the fisheries administrator, encouraged by public requests that an active stream improvement program be a significant part of the total fish management plan.

What Type of Streams Are Improved?

Although most streams are in need of some improvement, major efforts are concentrated on small trout streams. Some of the visible signs of a trout stream which is in need of improvement are listed below.

1. Lack of vegetative cover on the streamband and on upland areas.

2. Warm water temperatures, exceeding upper limits of 75° F. (Brook), 81° F. (Brown), 83° F. (Rainbow).[1]

3. A flat stream gradient, with few pools or gravel riffles.

4. A lack of gravel areas in the proximity of ground water sources which are necessary for spawning.

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[1]Lloyd L. Smith and John B. Moyle, A Biological Survey and Fishery Management Plan for the Streams of the Lake Superior North Shore Watershed. Minnesota Department of Fish and Game, 1944, p. 26.

5. Heavy siltation and loss of stream-side vegetation caused by high beaver populations.

6. Improper road building practices which accelerate erosion.

7. Turbid water after moderate to heavy rainfall.

8. An abundance of minnows and other warm water water species such as suckers, bass, and panfish. (Many of our best trout streams, however, have minnow and sucker populations in slower water areas of the stream.)

9. Poor returns from fishing-few trout caught.

Before streams are improved, it is well to recognize that some areas have not deteriorated as badly as others. These sections need no intensive improvement. In some streams the cost of improvement may prohibit anything but the upland phase of improvement. Establishing the factors which are responsible for the habitat deterioration is necessary before planning any improvement or commencing with the actual stream work.

Some streams which once were prime trout habitat cannot be restored to their original conditions, the cost of improvement usually being the limiting factor. The marginal stream which still has some native fish will yield the best results for the money expended.

Also, good land and water use has led to improved fishing on many of our warm water streams and lakes. Outstanding among these efforts are the Brandywine Valley Association in Pennsylvania and Delaware,[1] and the Muskingum Conservancy District in Eastern Ohio.[2] In Wisconsin the efforts of numerous paper mills to reduce pollution are commendable. The Consolidated Paper Company (formerly Consolidated Water Power and Paper Co.) has spent over $1,000,000 to keep spent sulphite liquor out of Wisconsin streams.[3] Other mills at Rhinelander, Peshtigo, Park Falls and Wausau are concentrating on similar efforts. Although the pollution from paper mills has not been abated completely, the efforts made to reduce its volume are commendable.

It may be possible to encourage other areas of the country to participate in the Small Watershed and Flood

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[1]Arnold Nicholson, Why Don't Cities Look all the Way Upstream? Reprint from Country Gentleman, Curtis Publishing Company, 1953, 4 pp.

[2]Muskingum Watershed Conservancy District, The Story of the Muskingum Conservancy District. 28 pp.

[3]Badger Sportsman. "For a Cleaner River," Vol. 17, No. 6, 1962, p. 14.

Prevention Act (Public Law 566).[1] Wisconsin now has 44 watershed associations,[2] Michigan has 6, but needs special legislation to take advantage of PL. 566. Well planned stream improvement efforts should be a part of fishery and land use programs throughout the country.

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[1]Wisconsin State Soil Conservation Committee, Inter-Agency Agreement for Planning and Developing Community Watersheds in Wisconsin. Madison, Wisconsin, 1961, 11 pp.

[2]O'Donnell, D. John, and C. W. Threinen, op. cit., p. 6.

CHAPTER II

THE STREAM

General Characteristics

Size.--Streams with less than 100 cubic feet per second flow are most frequently considered for stream improvement.[1] Larger streams with extremes of high and low flows pose a multitude of problems for development. Increase in velocity in the larger streams causes accelerated bank erosion, increases property damage and prevents the establishment of stable invertebrate and vertebrate populations.

Benefits accrued from steam improvement on small tributaries will be evident in the improved water quality of larger streams. Stabilizing the flow of smaller tributaries lessens the flood danger downstream, reducing the need for flood control. Improvement of water temperatures can be attained on small streams by reforestation, bank stabilization, and the removal of beaver impoundments where they are numerous.

Decreasing the surface area of spring ponds and removing obstructions from their channels also reduces water

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[1] Ibid.

temperatures.

Improvement of water quality of large trout streams is desirable for these streams are capable of producing more food, providing larger trout and furnish the fisherman with waters which are easy to fish. Future trout management should include stream improvement on all small streams.

Surface water.--Surface water effects are more evident than those of ground water. Runoff is the main causative agent for soil erosion which fills our streams with both organic and inorganic matter. Application of good land use practices prevents much of our soil erosion. "To make water walk off the land instead of run off" has been one of the mottos of the Soil Conservation Service. All land use within the watershed must be oriented to that goal.

Surface water also produces unstable water levels. Floods and low flows are typical today in many of our trout streams. Floods mean muddy water, resulting in less sunlight for bottom organisms. Increased velocity brought on by high water disrupts the invertebrate populations; fortunately, these often have a quick recovery with the reestablishment of stable flow.

Organic nutrients have a beneficial influence on stream flora and fauna. Large amounts of silt entering the streams will in time cause a flat gradient and loss of pools and riffles.

Surface water is valuable in the spring of the year to increase water temperatures in cold streams. Warm rains may increase water temperatures with a resultant improvement in the growth of food organisms and trout.

Increased forest cover, improved grasslands, contour farming, grass waterways, cover crops and gulley control will modify many of the extremes in flow which are now encountered. Extreme amounts of precipitation will always cause some instability even though the watershed has excellent vegetative cover.

Reduction in the amount of surface runoff requires the cooperation of the landowners and all agencies concerned. Landowners often accept the theory of erosion control but seldom engage all of their efforts to reduce surface runoff.

Ground water.--What is a good stream? "Stream surveys showed a number of things to be of value, but foremost in importance was the amount of ground water entering the stream."[1] Ground water should provide most of the steamflow

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[1]Vernon Hacker, Shocking Facts About Shocked Streams. Wisconsin Conservation Bulletin, Vol. 20, No. 9, 1955, pp. 23-25.

in a good trout stream. In a well-forested watershed, most of the precipitation is absorbed by the litter. Areas with shrubs and grass also allow for infiltration to occur. Once the water enters the soil, part is used by plants and the remainder continues its downward movement until it becomes a part of the ground water table. It eventually flows into streams at lower elevations in the watershed as ground water. The temperature of this ground water usually ranges between 40 and 50 degrees. Some ground water sources have only a slight variation during the entire year.

Ground water has been shown to be the most important factor in location of trout spawning areas (redds). Studies by Benson[1] and Webster[2] indicate that ground water is necessary for trout spawning. Even though gravel riffles abound, trout will avoid them unless cool ground water is present. Brook trout seem to prefer smaller gravel than browns or rainbows, which usually spawn downstream from the brooks; but all three excavate their redds in the proximity of ground water. The two main requirements for successful spawning, therefore, are (a) cold ground water and (b) gravel areas remain free of slit

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[1] Norman G. Benson, The Importance of Ground Water to Trout Populations in the Pigeon River, Michigan. Reprinted from Trans, Eighteenth N. Am. Wildl. Conf. 1953, p. 275.

[2] Dwight A. Webster, op. cit., p. 172.

or sand. Although other factors such as heredity, depth of water, and gradient should be considered, they do not share the importance of ground water.

The value of ground water is even more evident during the hot summer months. Cold water entering pools causes thermal stratification which allows trout to survive during periods of high temperatures. This is evident in streams the size of the Wolf River (Langlade County, Wisconsin), which originates as a warm water stream; later, it becomes a cold water stream because of tremendous amounts of ground water, and further downstream has warm water species of fish. Over fifty miles of this large stream is potential trout water if the temperature can be kept within limits necessary for trout production.

Ground water also becomes very important because it prevents heavy ice formation during the winter months. Warm water is important to the survival of young trout which are hatched during the early winter. Benson[1] states that it is possible to locate ground water sources during the winter months with the aid of aerial photographs taken when ice cover exists. Open water areas would probably be classed

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[1] Norman G. Benson, *op. cit.*, p. 276.

as areas where reproduction occurs. Lack of gravel is a factor which may limit reproduction even though ground water is present. Some areas where ground water enters in small amounts may be covered with ice and yet yield some young trout.

There are other methods of locating where ground water enters the stream, such as, measuring the temperature of a stream where it is supected of entering and sampling of the bottom temperatures may also indicate its entrance. Location of ground water sources is an important phase of the work of the stream planner. Efforts can be made to improve the channels in which ground water flows to the main stream with some success.[1] In an improvement project on the Wolf River, (Langlade County, Wisconsin), a total of 168 ground water sources and small tributaries were improved by removing debris from channels, shortening channels and removing barriers from spring ponds. Although the improvement in the temperature may be slight, a degree or two may be the difference between survivial or death of trout when critical temperatures exist.

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[1]Joseph H. Stoeckeler and Glenn J. Voskuil, Water Temperature Reducation in Shortened Spring Channels of Southwestern Wisconsin Trout Streams. Trans. Am. Fish. Soc., Vol. 88 (4), 1958, pp. 286-288.

The most successful way of increasing the flow of ground water, however, is by establishing a vegetative cover which promotes an increase of infiltration is of more value than measures taken once the ground water has reached the surface.

Streamflow.--Streamflow is the total amount of precipitation, less the amount of water lost by transpiration and evaporation, plus the loss or gain of ground water.

Providing a stable yearly flow has been a long sought after goal. It is impossible that this can be achieved because of the variable amounts of precipitation we receive in the Upper Great Lakes area. Reducing the danger of floods and eliminating the extreme low flows can, to a certain degree, be controlled by land use measures which provide vegetative cover, thereby increasing the rate of infiltration.

Streamflow is usually measured in cubic feet per second (cfs.), which may be defined as the amount of water which will flow through a rectangular cross-section 1 foot wide and 1 foot deep at a velocity of 1 foot per second.

Future considerations should strive to provide more stable flows, yet not reduce the amount of yield. Retention of early spring run-off behind small dams will help to stabilize yearly flows but will reduce water yeilds through increased evaporation.

A simple formula for measuring streamflow is given below. (Embody)[1]

$$R = \frac{W\,D\,a\,L}{T}$$

R is equal to the volume of cfs,; W is the average width; D the average depth in feet; L is the length of the stream section measured; T is the time in seconds, required for a float to cover distance L; "a" is a constant for correction of stream velocity, if the bottom is rough, 0.8 is used; if it is smooth, 0.9 is used. It is best to use a straight section of stream with few obstructions present. The length of stream used can be any length but 100 feet is sufficient. A floating object (cork or piece of wood), is placed in the water and timed over the length selected; average depth is recorded by taking depth measurements for every 20 feet of stream, at 1/4, midstream, and 3/4; average depths are added and the sum is divided by four, taking into account the depth of the bank, which is zero. (450 gallons per minute is equal to 1 cfs.)

Fishery programs, often concerned with stocking of trout streams only, succumb to the conclusion that control

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[1]C. G. Embody, An Outline of Stream Study and Development of a Stocking Policy. Cornell University, Contr. Aguiculture Lab., 21 pp.

or regulation of streamflow can only be achieved at heavy cost, and, therefore, land use planning, which will help to stabilize streamflow, does not become a part of the active management program.

Water Depth.--Water depth greatly influences the amount of solar radiation reaching the plants and invertebrate populations in the proximity of the stream bottom. Turbid water and heavy streamside vegetation, however, also have this limiting effect.

Creation of pools can be attained with deflectors or log covers. Streams which are less than 6 inches deep have very little cover for trout larger than 8 inches. On the contrary, very deep pools in slow moving streams, tend to have large sucker populations. In planning stream improvement devices, a good rule to follow is to have a 50-50 pool to riffle ratio. Shallow riffles serve as areas of food production, and the pools provide cover and areas for burrowing organisms in regions of reduced velocity.

Pools over 24 inches in depth are listed as deep pools.[1] In small streams, pools 24-30 inches deep are of sufficient depth if cover is adequate. If only a few pools

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[1]Rounsefell, Everhart, *op. cit.*, p. 344.

are to be created, selection of the best food producing riffles and development of pools directly below these riffles will yield optimum results. Creation of pools where no food is present is a waste of effort and money.

Gradient.--Gradient is the rate of slope and it may be expressed as the rate of descent of the stream. Steep gradient is largely responsible for high water velocities.

In sections of trout streams with little gradient beaver become a problem, for dams built in these areas impound the water and cause a warming effect. Removal of the beaver and their dams is necessary if water temperatures are critical. On the contrary, streams with steep gradient may benefit from the work of the beaver, for in these areas a reduction of the stream velocity or increased pool formation is conducive to increased trout production. Streams with little or no gradient may lack the combination of pools and riffles considered necessary to provide optimum habitat conditions.

Modifications in the stream channel are made in areas where little or no gradient is present. Harrowing the stream will help to provide pools and the building of low rock dams can substitute for the riffle areas customarily found in areas of moderate to steep gradient.

Velocity.--Stream velocity is determined by a number of conditions; the amount of water, gradient or fall, the type of stream channel and the amount of suspended material carried along.[1] Streams which are confined within a narrow channel with steep gradient and a large flow will have high velocities. Streams with high banks and steep gradients are usually classed as young streams, while those with little or no gradient and large meanders would be classed as mature streams. A stream would tend to be more mature, therefore, if it had less gradient near its mouth.

Rounsefell and Everhart record velocities as "torrential," "rapid," or "sluggish."[2] Lagler lists "sluggish" as having a velocity of less than 1/2 foot per second, "rapid" as more than 1/2 foot per second with approximately 50-50 pool to riffle ratios, and "torrential" as streams with steep gradient and few pools in their course.[3]

Although a mechanical current meter may be used, velocity can be determined by measuring a prescribed stream

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[1]Howard E. Brown, Victor E. Monnett, and J. Willis Stovall, Introduction to Geology. Chicago: Ginn and Company, 1958, p. 70.

[2]Rounsefell, Everhart, op. cit., p. 342.

[3]Karl F. Lagler, Freshwater Fishery Biology. Dubuque, Iowa: W. C. Brown and Company, Second edition, 1959, p. 299.

distance. To measure the velocity in this manner, select a piece of wood or a cork for a float. Measure out a 100 foot section of stream which has few obstructions and which is fairly straight. Place the float in the water slightly above the measured section and record the time it takes to travel the 100 feet. Conduct at least three trials and use the average of the three. By using the following formula;

$$\frac{\text{100 feet}}{\text{Time of travel in Seconds}}$$ Velocity in feet per second may be obtained.

With this information you can also determine the average streamflow if you know the cross-sectional area of the stream.

Odum states that velocity is the most important factor in providing varying stream conditions. Though electric meters are used to measure velocity, a microhyperstratification of current exists under stones and in crevices where many organisms dwell. Surface velocity may determine the location of fish, but not invertebrate organisms.[1]

Velocity, because of its ability to carry materials, becomes an important aid in moving silt and sand to desired locations behind deflectors and provides more ideal habitat

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[1]Eugene P. Odum, Fundamentals of Ecology. Philadelphia: W. B. Saunders Company, second edition, 1959, p. 318.

for small invertebrates (increased velocity desired in many slowmoving streams). However, streams with high velocities are exceedingly damaging to streambanks. Wherever serious bank erosion exists, reducing the velocity is of primary importance in establishing vegetative cover. Torrential velocities should also be reduced in streams where few pools exists. This is accomplished with the use of small dams. Caution is urged in this type of work since improperly constructed devices are often destroyed during heavy torrents.[1] Use of small dams to reduce velocities is seldom necessary in Wisconsin or Michigan except in the Lake Superior area and possibly the driftless area in southwestern Wisconsin.

Increased velocities during spring floods and after heavy rains generally limit in-stream device construction to smaller more stable streams. Providing more vegetative cover may help to stabilize the streamflow and reduce these periods of increased velocities, making improvement work economically feasible on some streams over 100 cubic feet per second in flow.

Water quality.--To determine water quality, checks are made of the following characteristics: dissolved oxygen, pH,

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[1] Madsen, op. cit., p. 502.

turbidity, color, temperature, free carbon dioxide, pollution, vegetation, and invertebrate and vertebrate populations present.

In watersheds where good land use practices abound, water quality will show marked improvement. An abundance of ground water usually provides water of the best quality, yet it may limit trout growth due to low temperatures (46-50^{0} F.).

Of the fresh-water fish, trout are quite intolerant and require water which is cool, free of pollution and relatively clear so that plants and invertebrates can exist. Temperature is the limiting factor in many of the streams we would class as "marginal streams," for the other characteristics are generally suitable. Comprehensive surveys are necessary to determine if stream improvement can improve water quality sufficiently to merit the cost of improvement. Poor water quality can best be remedied by good land use practices which should precede or accompany construction of in-stream devices.

Biologists, in making stream surveys, are becoming more aware of the need for improvement of water quality in our trout streams. We should be equally cognizant of the need for improvement of our warm water streams which are choked with soil, industrial pollution and wastes from sewage disposal. Improvement in water quality is a basic step to restoring desirable flora and fauna to a stream; it will also be a partial solution to problems of finding enough water areas for recreational uses. Wisconsin and Michigan have an abundance of lakes and streams, but many of these water areas have water of a quality which is unusable for the numerous forms of water sports.

Geographic Location.--Geographic location of improved streams should merit more consideration in future development. Both physical and cultural characteristics need to be reviewed when planning land or water use practices. Topography, forest cover types, geology and climatology should be considered among the physical traits. Location of the nearest centers of population, lake and stream aquisition for home development, proximity to other recreational sites and trends in local population should be among the cultural traits surveyed.

Most trout streams receive relatively high fishing pressure, and those in close proximity to large cities may not be able to support native populations of trout. Fishing pressure may be so intense that reproduction of native trout can not be maintained; still, improved streams near large population centers could provide fine fishing if restrictions were made on the type of equipment used, bag limit and size limit. "Fishing for sport only" may soon be required. These suggestions do not meet much favor among most fishermen, but the number of trout fishermen who favor "fishing for sport only" is increasing. "Fishing for fun only" areas have been tried in a number of national forests and have been very successful. They would offer fine sport in heavily fished streams near population centers.

The economy of many sections of Wisconsin and Michigan depends directly on recreational land use, yet these areas provide little or no financial aid to improve the resource. With competition for tourists becoming more evident, communities which derive much of their money as a result of fishing and hunting should investigate what help they can offer to improve the quality of the resources and thereby improve their economic conditions. An example of this type of aid occured in Vilas County, Wisconsin, when a group of resort owners purchased several hundred pounds of large walleyes from commercial fishermen for stocking in their lake (with the approval of the conservation department). These people were interested enough in their economic situation to provide immediate results by purchasing large fish which could result in direct returns to the fisherman's catch. This same approach could be used in trout streams by planting larger trout (12-16") instead of smaller trout. This would stimulate the fishing activity and result in additional fishermen using an area. Few efforts are being made by local private groups to attract fishermen. In Wisconsin, sportsmen's clubs and other conservation-minded groups are making a large contribution by donating money for projects within their community, this practice could also be applied by private organizations who benefit directly from the expenditures of the sportsmen.[1]

Regardless of where improvement efforts are concentrated, they should strive to produce a better quality fishing. Trout anglers prefer to have some solitude where they are able to fish at their leisure. Many older anglers make the comment, "Young boys just aren't interested in trout fishing." Could it be because of the crowded conditions, the deterioration of streams, and the lack of courtesy on the part of the fishermen that these youngsters are not interested in trout fishing as a sport?

Improvement of streams near large population centers can be justified if it produces a high quality sport not just large returns to the creel. Restrictions in angling need not mean poorer fishing as they have so often in the

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[1]Wisconsin Conservation Department, Wildlife, People and the Land. Madison, Wisconsin, 1961, p. 75.

past--not if the fish are returned to the streams to furnish more fishing.

Streambottom Materials.--Bottom materials, although quite varied usually consist of bedrock, rubble or boulders, gravel, sand, silt, detritus (sticks and twigs), peat, muck, marl or possibly clay. Bottom materials are limiting factors in food production, spawning and the permanence of invertebrate populations.

Trout spawning takes place in gravel areas, with some exceptions.[1] Size of gravel particles moved in excavating the spawning beds (redds) seems to be dependant on the size of the spawning trout, larger trout being able to move proportionately larger stones with their tails.

What condition influences the invertebrate populations within the stream most of all? Gard[2] considers velocity and streambottom type of most importance. Sprules,[3] by comparison, lists velocity as being the most important.

Lagler,[4] in reference to studies by Needham, lists

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[1]Webster, op. cit., p. 172.

[2]R. Gard, Effects of Beaver on Trout in Sagehen Creek, California. J. Wildl. Mgmt., Vol. 25, 1961, pp. 221-242.

[3]Wm. M. Sprules, The Effect of a Beaver Dam on the Insect Fauna of a Trout Stream. Trans. Am. Fish. Soc., Vol. 70, 1941, pp. 236-248.

[4]Lagler, op. cit., p. 301.

silt bottom materials as the most productive, because it is usually covered with luxuriant plant growth such as algae, Elodea, watercress, etc., Lagler,[1] in later reference to the studies by Pate, lists rubble as the most productive. Sand, because of its instability, is considered the least productive streambottom materials, whereas silt and rubble are high in productivity of invertebrate organisms, namely aquatic insects.

Tarzwell[2] lists the following data from a survey of food organisms taken on six Michigan trout streams in the order of increasing productivity: (Sand is given productivity of 1 and the rest are listed accordingly.)

Food Organisms	Productivity
Marl	6
Fine gravel	9
Sand and silt	10.5
Gravel and sand	12
Sand, silt and debris	13
Gravel and silt	14
Chara and silt	27
Potamogeton pectinatus	28
Coarse gravel	32
Chara	35
Medium gravel	36
Potamogeton filformis	43
Gravel and rubble	53
Sand and gravel with plants	67
Muck and plants	67

[1] Ibid.

[2] C. M. Trazwell, Experimental Evidence on the Value of Trout Stream Improvement in Michigan. Trans. Am. Fish. Soc., Vol. 66, 1936, p. 187.

Food Organisms	Productivity
Moss (algae) on fine gravel	89
Moss on fine gravel	111
Moss on gravel and rubble	140
Vallinsneria	159
Ranunculus	174
Watercress	301
Elodea	452

The same groups listed by Tarzwell would be hard to set up in another study. It is best to have only a few groups. Some of the plants which are listed have no bottom type mentioned. Most of the heavy vegetation, however, occurs on areas rich in nutrients. Other factors, in addition to velocity and bottom material, which influence invertebrate populations are water temperatures, organic nutrients available in the water, depth of water, amount of solar radiation and the amount of turbidity. Any of these factors could well be a limiting factor in a given stream.

Invertebrate populations require a bottom type to remain stable for long periods of time because many of the species remain in the stream for more than a one year period before they emerge as adults. Extreme changes within the stream are usually fatal to these small organisms. The use of deflectors to stabilize silt, to increase the velocity of sluggish streams and to produce a scouring action on rubble bottoms, are helpful in achieveing this permanence. Sand is the major problem when deflectors are used because it is heavier in weight than the silt particles and does not stabilize as rapidly. Silt usually becomes stabilized by lush growths of vegetation, whereas sand remains devoid of this vegetation. By keeping the openings which are created between deflectors and the opposite banks quite wide, it is possible to cause the sand to stabilize next to the more permanent silt bars and still allow an opening which will not be covered by sand. Silt bars which build up behind deflectors should be seeded with a good grass mixture (including Reed Canary Grass) if vegetative growth does not develop rapidly. It may, however, be well to allow the areas behind the devices to have some flow of water, thus increasing the food producing potential of the stream. To provide a stable streambottom at the expense of reduced food production is no achievement. The following table taken from Tarzwell illustrates changes brought about by stream improvement. See Table 1 on page 43.

Streambottom Contour.--A knowledge of the streambottom contour is necessary to prevent pools which are too deep or to prevent extensive damage to in-stream construction. It is vital to know the approximate cross-section of the streams before improvement is begun so that the openings between devices will

Table 1

Volume of Food Production in a Section of the East Branch of the East Branch of the Black River Before and After Improvement, Calculated on the Basis of Determinations of Bottom Organisms in the Stream[1]

Bottom Type	Before Improvement: Ave. Production in cc. on 4 sq. ft. area	Area of Bottom Type sq. ft.	Total Calculated Production. cc.	After Improvement: Area of Each Bottom Type	Total Calculated Production cc.
Sand	0.27	76,105	5,137	48,995	3,307
Muck	3.99	4,942	4,942	23,397	23,397
Gravel	2.76	17,791	12,276	14,719	10,156
Gravel Riffle	12.48			7,142	22,283
Plant Beds				4,585	6,098
		98,838	22,235	98,838	65,241

[1] C. M. Tarzwell, Experimental Evidence on the Value of Trout Stream Improvement in Michigan. Trans. Am. Fish. Soc., Vol. 66, p. 187. In this table the relationship between streambottom material and food production is shown although these are calculations, changes from sand to plants or rubble riffle streambottom increases the bottom fauna. These population changes may not result in one year but the increases are evident over a longer time period. This increase in food production is one of the primary benefits of stream improvement.

not produce velocities which are too great. Probing the streambottom to determine where boulders, rocks or logs are close to the surface is necessary when pools or riffles are to be created. Most attention in stream improvement has been directed to producing more pools. Conversely, streams exist which have few excellent food producing riffle areas even though they may have abundant pools. To establish a pool, the bottom material is moved by the increased velocity of in-stream devices. To provide a riffle, it may be necessary to maintain a wide stream with shallow water where rock and rubble, placed in the stream, becomes the primary bottom material.

Streambottom contours are constantly changing with the addition of decaying vegetation, soil from erosion and changes in velocity. A more permanent bottom contour can be established if the above forces are brought under control.

Deposition will constantly fill in the "quiet water" areas, whereas the areas of increased velocity will provide the materials for deposition. A change of the bottom contour is necessary in many areas to achieve added food production, but continued changes may be harmful. It is not the purpose of in-stream work to provide a channel free of obstructions, but rather, to place devices which will change the contour to provide cover, increase or decrease velocity or improve food production. Variation of the bottom contour is a desired result.

Streambank Vegetation.--Vegetation plays an important role in maintaining the stability of the streambank. It provides shade, food (terrestrial insects), and helps to improve water quality. Grazing of livestock, unwise logging and large beaver floodings are responsible for the lack of streambank vegetation throughout Michigan and Wisconsin.

Before restoration of the streambank vegetation is begun, it is well to determine if it is desirable. An increase in shade also means a reduction in the amount of solar radiation which will reach the stream, thereby making it impossible for anglers to wade and fish certain areas.

Fencing of streamside areas assures a return to more stable conditions desirable for lush plant growth. Fencing may, therefore, be the only remedial measure necessary if a return to permanent vegetation is desired. Planting trees and other quick-growing vegetation is needed where permanent vegetation is unable to establish itself.

Shade in heavily forested headwaters areas is one of the limiting factors in optimum trout production. A reduction in the amount of stream densely shaded would warm the stream and provide an increase in food production. Too much shade is rarely a problem encountered in areas where stream improvement is proposed.

Does the fisherman merit any consideration when streambank vegetation is restored? In most stream improvement projects we are in such haste to restore vegetation that we do not envision what this vegetation will be like in twenty to thirty years. We have been content to restore some kind of vegetation which will establish itself rapidly. It is much like the abundance of jack pines which were planted during the 1930's--we would have fared better if these had been a higher quality species.

The fly fishermen prefer areas of stream where they are able to make a back cast without snagging their hook on every attempt. For this type of fishing a low type of vegetation would not pose as many problems. Stream improvement should try to satisfy some of the requirements or demands of the trout fisherman or it will come in for its share of criticism. Setting aside sections of streams for the different types of fishing has some merit.

With an increase of riparian vegetation, there will also be an increase in the rate and amount of infiltration. A notable increase in evapotranspiration will also accompany the advent of lush streamside vegetation. Some types of emergent vegetation have evapotranspiration rates which exceed the rainfall for the area in which they are found. (Average rate of evapotranspiration in United States is 72 per cent of precipitation.)

Future stream improvement must consider the characteristics of vegetation at maturity, not its youthful character. Dense vegetation will not have as great an effect on the larger streams as it does on the smaller tributaries where 60-80 per cent of the stream is shaded.

Flora and Fauna.--In this unit, representatives of flora and fauna found in trout streams are listed. No attempt is made to define their specific habitat requirements. Even though some animals and plants have been frequently used as indicators of trout waters no such listings will be included here. Common names, taxonomic orders, families or scientific names will be given. No endeavor has been made to classify all species present, admitting that such knowledge, however, is of value to the fisheries biologist when engaged in specific stream surveys. This listing may be used as a basis for more detailed studies.

PLANTS

Algae		Moss
Spirogyra	Oedogonium	Flontinalis sp.
Ulothrix	Cladophora (Odum)	(Odum)

Higher Aquatic Plants

Emergent

Arrow Arum-------Peltandra virginica
Burreed----------Sparganium sp.
Wild Rice--------Zinzania aquatica
Arrowhead--------Sagittaria latifolia
Watercress-------Nasturtium officianale
Reed Canary Grass----Phalaris arundainacea (Muenscher)
Bulrushes--------Scirpus, acutus and validus
Sedges-----------Carex sp.
Cattails---------Typha latifolia
Reed-------------Phragmites communis

Floating

White Water Lily------------Nymphaea tuberosa
Yellow Water Lily-----------Nuphar variegatum
Watershield-----------------Brasenia schreberi
Lesser Duckweed-------------Lemna minor
Greater Duckweed------------Spirodela polyrhiza
Star Duckweed---------------Lemna triscula (Muenscher)

Submerged

Pondweeds--------------Potamogeton sp.
Water Milfoil----------Myriophylum exalbescens
White Water Buttercup--Ranunculus longirostric (Godr.)
Wild Celery------------Vallisneria americana (Michx)
Elodea-----------------Anacharis canadensis (Michx)
Coontail---------------Ceratophylum demersum (Muenscher)
Muskgrass--------------Chara sp. (Moyle)

ANIMALS

Protozoa

Ameba   Paramecium
Vorticella Euglena
Volvox   Stylonychia

Rotifers

"Wheeled" animals

Worms

Planaria----Turbellaria
Leeches-----Hirudinea

Mollusca

Clams------Pelecypodia
Snails-----Castropoda

Crustaceans

Crayfish----Cambarus sp.
Gammarus----Amphipoda
Daphnia-----Caldocerca
Asellus-----Isopoda
Cyclops-----Copepoda

Birds

Great Blue Heron-----Ciconiiformis
Green Heron----------Ciconiiformis
Am. Bittern----------Ciconiiformis
Kingfisher-----------Ciconiiformis
Woodcock-------------Ciconiiformis
Snipe----------------Ciconiiformis
Sandpipers-----------Ciconiiformis
Black Duck-----------Anseriformis
Mallard--------------Anseriformis
Blue-winged Teal-----Anseriformis
Wood Duck------------Anseriformis

Mammals

Mink---------Carnivora
Otter--------Carnivora
Muskrat------Rodentia
Beaver-------Rodentia

Terrestrial Organisms

These organisms drop into the water and become a part of the fishes diet in summer.

Insects

Caddisflies----Trichoptera
Midges---------Chronomidae
Flies and Gnats--Simulidae
Mayflies-------Ephemeridae
Dragonflies----Odonata
Beetles--------Colecptera
Grasshopper--------Locustidae
Ants---------------Formicidae
Wasps--------------Hymenoptera
Crickets-----------Gryllidae
Sow Bugs-----------Oniscidae
Earthworms---------Oligochaetes

Fish

Brook Trout----------------Salvelinus fontinalis
Brown Trout----------------Salmo Trutta
Rainbow Trout--------------Salmo gairdnerrii irideus
Common Sucker--------------Catostomus c. commersonnii
Muddlers-------------------Cottus cognatus, bairdi

Creek Chub---------------Semotilus atromaculatus
Northern Redbelly Dace---Chrosomus eos
Hornyhead Chubs----------Hypopsis biguttata
Common Shiner------------Notropsis cornutus
Bluntnose Minnow---------Pimepholes promelas
Johnny Darter------------Etheostoma nigrum
Common Stickleback-------Gasterosteus aculeatus
Smallmouth bass----------Micropterus dolomieni
America Brook Lamprey----Lapetra lamcteei

Table 2

Brook Trout--Yearly Summary of Food Eaten[1]

Aquatic Foods	Average in per cent
Caddis Flies (larvae, pupa, adults)	20.63
Midges (larvae, pupae)	13.05
Mayflies (nymphs, some adults)	11.82
Mics. Aquatic larvae (Diptera)	7.27
Cranefly (larvae)	5.24
Stoneflies (nymphs--some adults)	4.52
Beetles (larvae chiefly)	1.72
Aquatic Worms	.73
Fishflies, orl flies	.42
Snails	.37
Trout Eggs	.20
Water Mites	.16
Salamanders	.16
Leeches	.15
Dragonfly (nymphs)	.10
Total Aquatic Food	66.54

Terrestrial Foods	Average in per cent
Beetles	7.26
Grasshoppers (crickets)	7.14
Ants (trace-bees, wasps)	5.27
Misc. Land Insects	4.07
Earthworms	3.28
Sowbugs (crustaceans)	2.64
Spiders, Millipedes, etc.,	1.16
Caterpillars	1.05
Bugs (leaf hoppers chiefly)	.92
Slugs	.66
Snow Fleas	.01
Total Terrestrial Food	33.46

[1]Russel F. Lord, Types of Food Taken by Brook Trout. Trans. Am. Fish. Soc., Vol. 63 (1), 1933, p. 194. This chart shows the variety of organism consumed by trout in a Vermont stream. Stomach contents of 550 brook trout were examined, none larger than 8 inches in length. Abundance of certain species in Wisconsin or Michigan would change average percentage eaten, but would not change types. Seldom would two streams have like amounts of the same type of invertebrate.

CHAPTER III

STREAM IMPROVEMENT PROGRAMS

Stream Improvement in Wisconsin

The Conservation Act (Wisconsin Statutes 23.09) which established the Conservation Commission in 1927, states it was the Commission's purpose

> . . . to provide an adequate and flexible system for the protection, development, and use of forests, fish and game, lakes and streams, etc.[1]

In a later statement of the Fish Policy of 1946, the Commission stated,

> We recognize the importance of the habitat in relation to the fish crop and will make provisions within our means to acquire protect and improve present habitat conditions.[2]

The Trout Management Policy of 1954 again expressed a firm conviction that habitat restoration and improvement, and fact finding and research were very important yet seldom adhered to in fish management practices.[3] Two types of stream improvement programs have been operative in Wisconsin:

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[1] O'Donnell, and Threinen, *op. cit.*, p. 3.

[2] *Ibid*.

[3] Wisconsin Conservation Department, *Wisconsin Trout Management*. 1954, p. 3.

(a) demonstration projects and (b) cooperative projects.

<u>Demonstration Projects</u>.--Demonstration projects have been the core of the program in Wisconsin. The Wisconsin Conservation Department, with the cooperation of agencies such as the Soil Conservation Service, Soil Conservation Districts, Agricultural Stabilization and Conservation Agency and the Farmer's Home Administration, has been influencial in sustaining the program.[1] (See Appendix A for inter-agency agreement.)

From the inception of the program through 1959, twenty-three demonstration watersheds have become a part of the instream management phase. Four steps are involved in the development of a demonstration project·

(1) Survey to appraise the quality of the stream and its improvement potential and needs.

(2) Acquistion or leasing of streambank strips for access (required before conservation department crews can begin work).

(3) Streambank fencing and replanting with trees if necessary.

(4) Construction of in-stream devices for cover, feeding, and spawning.[2]

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[1] Wisconsin State Soil Conservation Committee, op. cit.

[2] O'Donnell, and Threinen, op. cit., p. 7.

The majority of improved streams are in the central and northern regions of the state where most of the trout waters are found. Many of these improved streams are now capable of supporting native populations of trout which need not be supplemented by artificial stocking methods.[1]

Accomplishments through 1959 include:

160 miles of fence construction

135 miles of trout stream have come under ownership or lease (riparian strips)

6,000 improvement devices constructed

2 million trees

196,000 game food shrubs planted.[2]

Three other observations are notable:

(1) Fishermen seem to accept the trout management program.

(2) Improved relations between the fishermen and landowners are evident.

(3) Recognition that improved streams are capable of supporting native populations of trout has been supported by research.

It is interesting to note that a large amount of license money is not spent for management. Much of the money

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[1]Heding, Peters, and Wilson, _op. cit._, p. 7.

[2]O'Donnell, and Threinen, _op. cit._, p. 12.

spent on stream and lake improvement is obtained from Dingell-Johnson funds.[1] It is difficult to comprehend why only 18 per cent of the total income (30 per cent of the fish management budget) is spent for stream and lake improvement if they are considered as important tools of management. See Table 3.

Table 3

Funds Allocated to Stream Improvement in Relation to the Total Fisheries Income.--1958-59[2]

Income from Fishing Licenses and Federal Aid	$3,056,000
Fish Management Budget	1,819,000
Habitat Development Budget	308,000

Acquisition of streamside parcels of land has been accelerated by the land acquistion program of the State of Wisconsin which allocates $1.4 million (1961-63) for land purchase for fishery purposes. This program stresses acquisition by fee title or by purchase of certain easements deemed necessary to maintain existing conditions. It would be advisable, wherever possible, to acquire fee title

[1] U. S. Department of Interior, Federal Aid in Fish Restoration. Regulatory Announ. 34, pp. 5-6, 1952. These funds are allocated to the states for fish purposes for approved projects, with the state providing 25 per cent and the federal government 75 per cent.

[2] O'Donnell, and Threinen, op. cit., p. 12.

to the land or stream frontage if unlimited funds were available; but with limited funds, procurement of the necessary easements may accomplish the desired result with a minimum of funds. An appraisal of the methods of acquiring access is a necessity, for the costs of acquisition of riparian by lands fee title may grossly exceed the future benefits.

Securing the leases from landowners is becoming more difficult, for the owners of the stream and lake frontage are well aware of the value of their lands. High quality frontage will continue to demand a high price, and much of this frontage should remain in private ownership to help support the local economy by remaining on the tax assessment rolls. This concept is becoming more important as local units of government scrutinize the value of a stream improvement program in their region.

Cooperative Projects.--Cooperative agreements have been signed with at least 27 interested groups through 1959.[1] Supervision and planning are furnished by the Wisconsin Conservation Department and the labor and materials by the cooperating group. Cooperators include high school conservation classes, sportsmen's clubs and youth groups.

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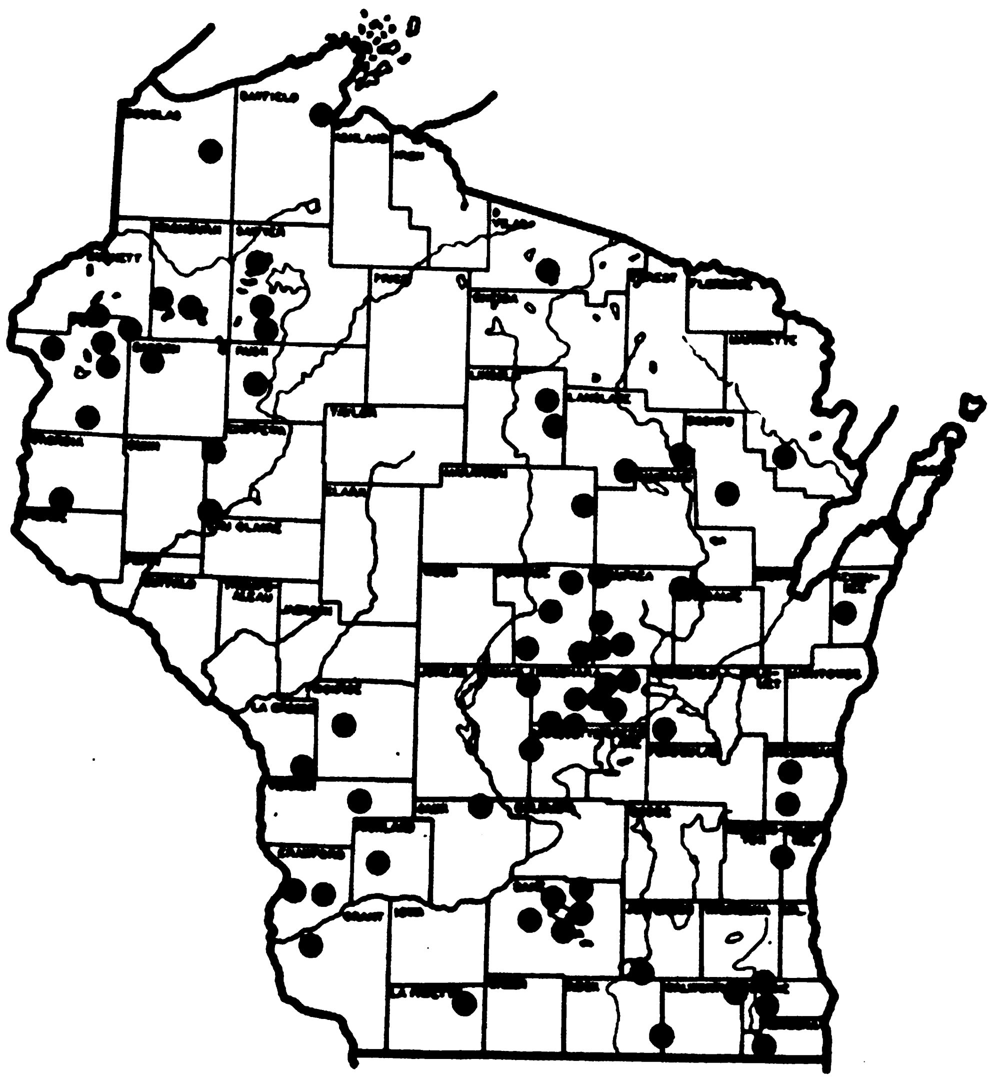
[1]O'Donnell, and Threinen, op. cit., p. 9.

WISCONSIN'S HABITAT DEVELOPMENT PROJECTS
LAKE AND STREAM (1959)



In general, stream improvement projects carried on by sportsmen's groups have not been too successful, although a few have made good contributions. Best accomplishments have been achieved with summer conservation classes from various high schools under supervision of conservation majors from various colleges and universities.[1]

Cooperative projects have encouraged the Conservation Department to participate in a variety of improvements. Youth groups have generally accepted the program without any bias. This is a valuable assest in future planning, for these young people will have a decided influence on their parents and on future fish management programs.

Interested groups should contact their district fish managers for information about stream improvement activity in their region. District fish managers usually have knowledge of where streams are in need of improvement or can call on other fishery biologists for information and advice. District personnel are also in close contact with local organizations who may be of help in securing leases or easements before actual work commences.

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[1]Letter from Robert B. Heding, Area II. Fish Manager, Wisconsin Conservation Department, Oshkosh, Wisconsin, June, 1962.

Enthusiasm is necessary when a project begins, but the following words of caution are also important:

(1) Stream improvement work is not always an easy and enjoyable task.

(2) To become a successful project, it should encompass a number of years of work.

(3) Goals are apt to be too high, and accomplishments often fall short of these goals.

(4) Active leaders often become interested in too many projects and enthusiasm for stream improvement wanes.

(5) Criticism of completed work is quick in coming, but visible improvement in fishing may not be noticeable.

Is it possible for high school groups in Wisconsin to do stream improvement and not create a conflict involving water rights or other legal problems? Leases, easements or purchase of streamside strips has preceded work by high school groups to avoid water rights problems. Wisconsin's conservation education program is an outgrowth of legislation in 1935. Included in this legislation were provisions that: (a) every high school and school of vocational and adult instruction shall offer adequate instruction in conservation of natural resources, and (b) in granting certificates for the teaching of courses in science and social studies, adequate instruction in the conservation of our natural resources shall be required.[1] In 1953, in more recent legislation, an Act of the 1953 Legislature provides that high schools and elementary schools be required to teach conservation and the wise use of natural resources to qualify for integrated state aid.[2] These rulings strengthen the legal background for stream improvement efforts by school groups.

Provisions for school camping, were authorized by Chapter 177 of the Laws of 1955, giving schools authorization to maintain camps during school time and expenditure of district funds for camp programs.[3] Permission to use school time is the most important feature of this ruling. Some schools provide field trips during the regular school session for stream improvement, while other provide summer school sessions in conservation for science credit. Stream improvement is included among the other conservation activities in these summer sessions.

Teachers who are interested in stream improvement should first contact their administrators about the feasibility

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[1]The Natural Resources Committee of State Agencies, The Natural Resources of Wisconsin., Madison: 1956, pp. 145-146.

[2]Ibid.

[3]Ibid.

of such an undertaking within their system. Other considerations should be given to provision for liability and accident insurance, transportation for pupils, funds for materials and equipment and a careful evaluation of the existing high school program as to how learning experiences provided by stream improvement activity will increase the students' knowledge of water, soils, forests, fish and wildlife.

Stream Improvement in Michigan.--The present stream improvement program, better known for its concept of habitat improvement on a total watershed basis, served as a pioneer under the direction of O. H. Clark, in charge of, the Lake and Stream Improvement Section of the Fish Division, Michigan Department of Conservation.

The authority for establishing watershed management projects was given by Act 17 of 1921 which created the Conservation Department. Section 3 of this Act reads, "It is hereby made the duty of the Conservation Department to protect and conserve the natural resources of the State of Michigan."[1] In addition to this, the Michigan Department of Conservation has long engaged in stream improvement work, and the Legislature, by appropriating funds, has shown its

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[1]Norman J. Brown, op. cit., p. 3.

Figure 1. Sign provided for cooperative project by Wisconsin Conservation Department--painted by cooperative group. Evergreen River, Langlade County, Wisconsin.

endorsement of the watershed management program.

The first watershed project was established on the Rifle River in Ogemaw County in 1950. Since 1950, 13 other watersheds have been included in the development program.

Funds to finance watershed projects are derived mainly from two sources: (a) the Fish and Game Protection Fund, and (b) the Dingell-Johnson Fund, deriving its monies from a 10 per cent tax on fishing tackle which is imposed by the federal government and is allocated to the states according to the number of fishing license holders and to the total land and water area. Dingell-Johnson funds provide 75 per cent of the money used for watershed management. In addition, money is also available for landowners for various land use practices from the Agricultural Stabilization and Conservation Program (ACP).

Although the number of fishermen on a nation-wide basis has increased, Michigan has not followed this pattern since the mid-1950's. Only during the last two months has this decline been reversed sharply. Sales in the last two months (May-June, 1962), have an increase of more than 10 per cent. The chart is shown to illustrate the number of fishermen in Michigan and it is not my intent to state reasons for their

Table 4

Lake and Stream Improvement Expenditures, Michigan Department of Conservation[1]

Lake Work	$23,775.16	
Fish Population Control	46,231.17	
Stream Work	68,893.82	
Impoundments	15,988.22	
Farm Cooperative Program	8,620.95	
Logging	4,041.36	
Maintenance	24,190.55	
Surveys	45,438.94	
Cooperation	22,299.22	Approx. 18 per
Administration	60,160.61	cent of total
Miscellaneous	25,226.17	fish division
Contingency	23,281.95	budget.
Total Expenditures	$364,106.74	

Total Expenditures of Fish Division $2,112,926.00[2]

According to Brown,[3] watershed projects received 75 per cent of their funds from Dingell-Johnson funds, therefore, only a small amount of license fees are used for watershed improvement.

Table 5

Michigan Fishing License Sales (includes Trout Stamp) 1960--compared with previous high yearly sales[4]

Resident Fishing	752,806	852,788 (1953)
Temporary Non-Resident Fishing	88,916	172,833 (1947)

[1]Michigan Department of Conservation, Fish Division, Lake and Stream Improvement Section, Expenditures.

[2]Michigan Department of Conservation, Fish Division Expenditures, 1961, 1 p. mimeo.

[3]Norman J. Brown, *op. cit.*, p. 7.

[4]Michigan Department of Conservation, History of Fishing and Misc. License Sales, 1895-1960. 2 p. report.

Table 5 (Continued)

Annual Non-Resident Fishing	111,130	164,795 (1953)
Trout Stamps	190,246	234,009 (1956)

decline. A further decline in license sales will, however, have some effect on the watershed management program which has already received budget cuts in 1962.

Agenices within the state who support the watershed program, in addition to the Michigan Department of Conservation, are Soil Conservation Service, Soil Conservation District, Agricultural Stabilization and Conservation Program, Cooperative Extension Service, U. S. Forest Service and the County Road Commission. The United State Geological Survey, U. S. Weather Bureau and school boards have also provided other servicees.[1]

Creation of a steering committee of landowners who reside within the watershed was most important to the success of the program in regions where much of the land was in private ownership. Cooperating agencies also have a representative on the steering committee.

To allow the Department of Conservation to work on the streams, agreements with the landowners are signed to provide access. The agreements also state that the landowner is not

[1]Norman J. Brown, op. cit., pp. 11-12.

to pasture streamside areas for a period of ten years. (See Appendix B.) Of the landowners contacted for approval, 98 per cent signed agreements.

Accomplishments of the program in terms of improved land and water use are:

(1) 7,764 improvement structures constructed,

(2) 31 miles of streambank fencing erected,

(3) 96,457 feet of banks stabilized,

(4) 1,072 acres of trees planted,

(5) an additional 8,112 acres of trees planted by landowners on private lands not covered by plantings recommendations in the Conservation Department survey.

Other improvements were:

(1) 365 farm plans enacted,

(2) a 26 per cent decrease in cropland,

(3) a 48 per cent decrease in pasture land,

(4) an increase of 122 per cent in land use for recreation,

(5) a 5 per cent increase in forest land,

(6) a 50 per cent reduction in the amount of grazed woodlots.[1]

Lasting benefits of the program include improved fishing, increased land values, better relations between landowner and

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[1] *Ibid.* pp. 34-41.

fisherman, an increase in the amount of money spent for recreation, increased riparian land values, a change in sentiment toward rivers and streams and, most important, the formation of a local cooperative group which will be of aid to other community programs.

The Michigan watershed program, embracing the total watershed improvement concept, is not unique. It is, however, outstanding for its community involvement of all agencies.

In-Stream Practices

Installation of devices should be limited to small streams of less than 100 cubic feet per second in flow. All construction should be of a permanent nature and blend with the natural surroundings. Adding a clump of sod on a stump cover or camouflaging a wire will add to the natural appearance of the structure.

Deflectors or log covers should be located so that they do not cause extensive bank erosion. On small streams it may be desirable to undercut banks somewhat for cover purposes.

Select curves for bank covers and use deflectors to narrow the stream to take advantage of increased water velocity where little or no gradient exists. Probe the stream bottom to locate gravel and rubble strata. Rock or gravel stream bottom will remain more stable.

If an area has pools with sufficient cover, no improvement is necessary. The function of deflectors is to increase the velocity, create pools, narrow the stream and to provide a more stable stream bottom within the pools. Covers are used to provide shade and resting areas for trout. Covers and deflectors are used to improve the habitat conditions but are not a "cure-all" for poor fishing results in streams where water quality is the limiting characteristic.

Materials handling should be completed without any undue disturbance to the streambank. Trout fishermen prefer to see no disturbance of the natural cover. Cost of improvement may increase by adhering to this philosophy, but criticism will not be as quick in coming.

Other criteria to remember in construction of stream devices are:

1. Devices should not extend more than six to eight inches above the water level. (Exception--stump or log covers.)

2. Cover devices should be constructed to withstand the abuse of fishermen who walk on them.

3. Provide cover wherever feasible. The primary criticism of early stream improvement mentioned the lack of cover and open "sunlit pools."

4. Stream improvement structures are of a semi-permanent nature. Rigid construction avoids excessive maintenance at a later date.

5. Fishermen are critical at first when changes occur in their favorite stream, no matter how unproductive it may have been; this attitude generally changing after results are obtained from improved pools and cover. Fishermen who have difficulty catching fish, even if optimum conditions exist, present a problem, for they contribute license money yet obtain no results.

Device Construction

Devices shown are of simple construction and of basic materials. Many types of structures have been built, but it is best to use a few practical devices of a simple design and do a creditable job in the construction phase.[1] After a device has been constructed, it may be well to see if any modifications are necessary before additional devices of the identical type are installed. Unsightly stream structures indicate a lack of interest and a waste of funds and effort.

Construction of Cover Devices

Covers provide shade and protection for all sizes of trout. Cover devices tend to make fishing more difficult, because one of their functions is to prevent the harvest of the entire native population. Riparian vegetation, undercut banks and fallen trees usually provide natural cover in streams. Log sod covers, log jams, stump covers and log covers are used

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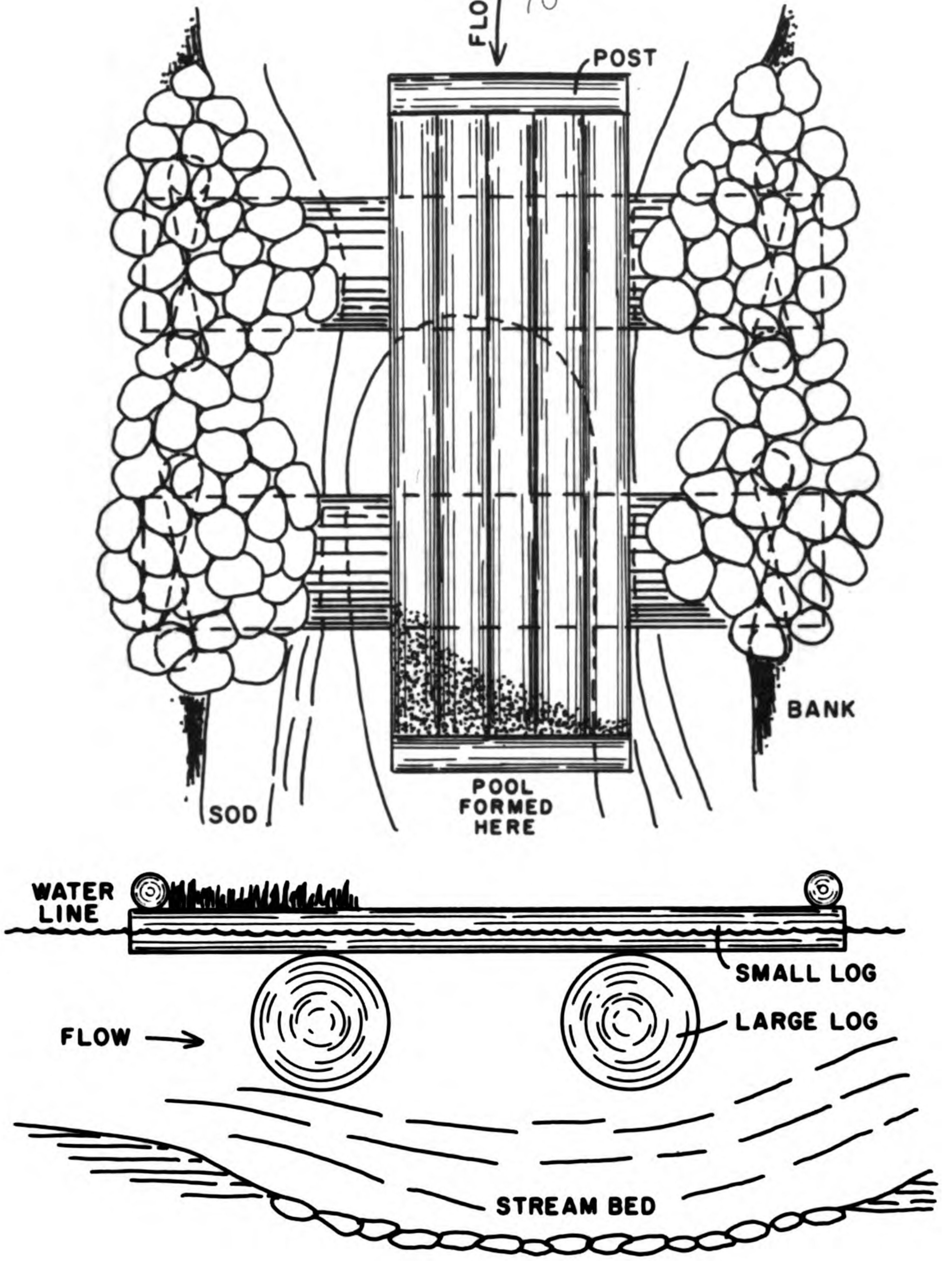
[1] Fish Stream Improvement Handbook. U. S. D. A. Forest Service, 1952, p. 5.



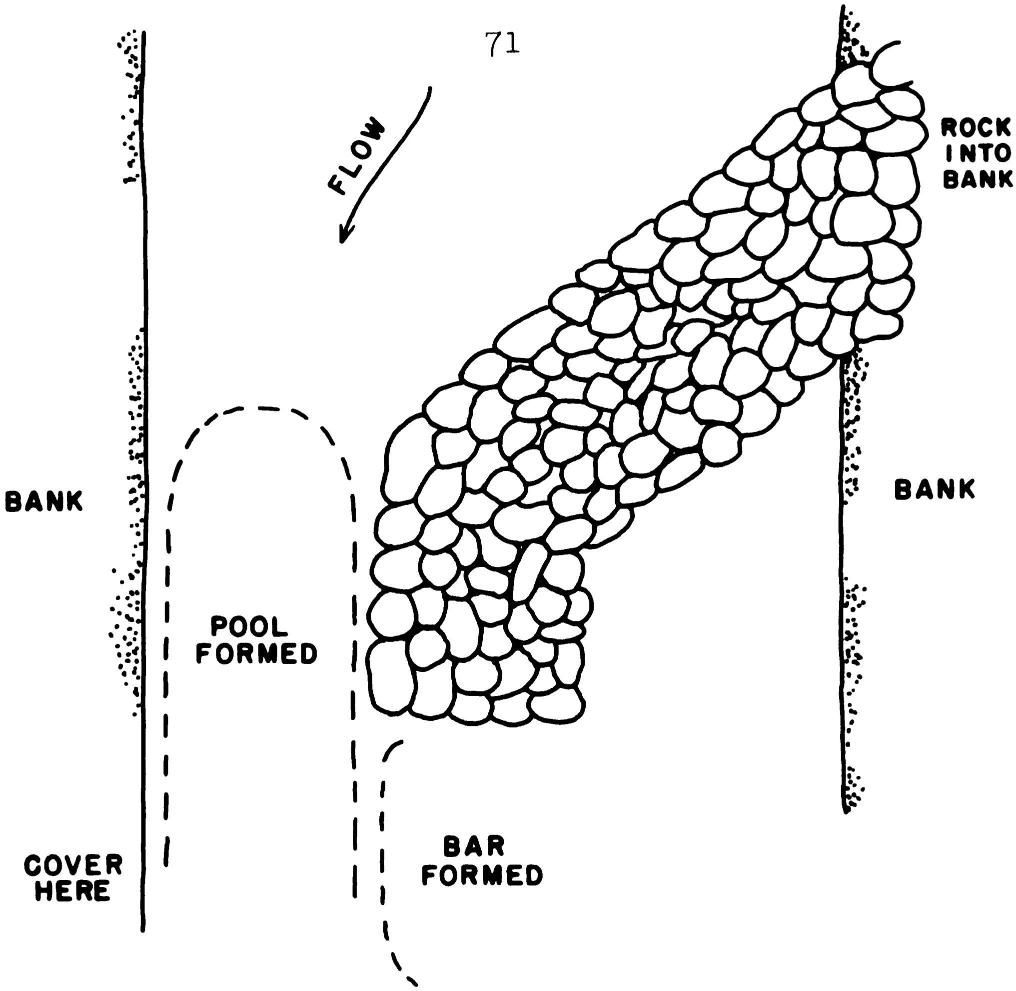
DIGGER LOGS

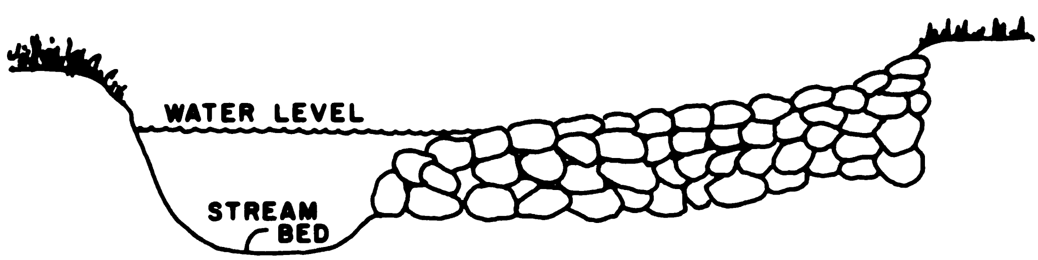
PURPOSE. Digger logs are used to create pools, increase stream velocity and to uncover areas of gravel or rubble. They are used in small streams which have soft bottoms, fairly stable banks and where high water is infrequent.

CONSTRUCTION. Begin by digging short trenches into each streambank which are deep enough to allow the top edge of the logs to be slightly under the normal water surface. If the large logs are to be covered later with posts or small logs, they should be set in a few inches deeper. The size of the log depends on the size of the stream cross section and the depth of pool desired below the logs. Logs should be at least 12 inches in diameter. The ends of the logs should be firmly staked in the trench. Rock is then used to enclose the ends of the large log. The rock rip rapping may extend out into the stream if desired.

In addition to the regular digger logs which have often been constructed, fence posts or small diameter logs, 4 to 6 inches, may be fastened to the tops of the logs to provide more dense cover. Several of these devices have been used in Wisconsin (personal observation) and have functioned well. The small logs on top of the digger logs should be partly submerged in water at normal water level. The sod which is placed on top will then be close to a water source and take hold immediately. There is some danger of the sod washing off before it gains a foothold, so a log should be attached to the ends of the cover to prevent the sod from washing off. When the sod takes hold, and if it is not more than 4 to 6 inches above the water level; there is little dange of this device requiring much maintenance for a 10-years period.

The main criticism of the digger log has been its lack of cover. A well-planned cover with the regular double digger logs provides an indeal well-shaded pool.





SINGLE WING DEFLECTOR
ROCK

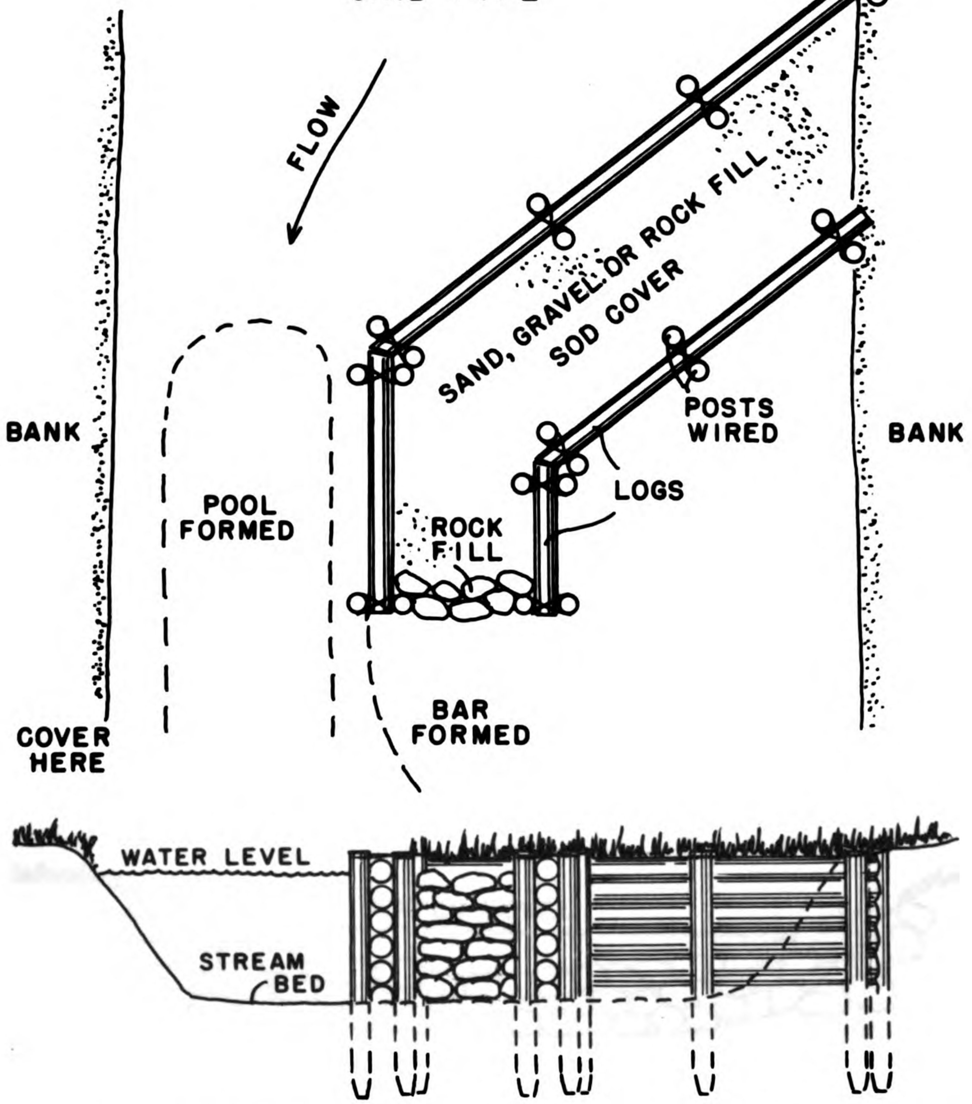
PURPOSE. The function of the single wing deflector is to narrow the stream, provide a pool, establish a silt or muck bar, and uncover gravel and rubble areas which have been covered by sand or silt.

CONSTRUCTION. Construction of this device begins with the digging of a short trench into the streambank to firmly anchor the device. Stakes should be set as markers to assure the right angle of deflection and the correct size opening between the device and the opposite bank. The angle of deflection should be less than 60°. Rocks are placed so that they help to deflect the current from the upper end of the deflector. The deflector should never extend more than 6 to 10 inches above the normal water level so that it does act like a dam in high water periods. Sod should be placed on top of the rock or it could be dressed and seeded to a good grass mixture. It is best to cover with sod so that an immediate protection exists. Sod can be obtained from an area which is not in close proximity to the stream so that no further erosion problems will be created by the obtaining of sod.

This device is most effective when used in conjunction with a cover device on the opposite bank, or in the stream itself. When planning a single wing deflector try to take advantage of natural cover which already exists whether it is an old stump, or log jam, or undercut bank which is quite stable.

The main criticism of this device in the past is that it has not provided cover and that it has left too many sunlit pools in the center of the stream. A pool in the middle of the stream will not provide the cover and shade that a log cover, at the edge of the stream, will provide. The solid bank cover yields the most and usually the largest brook trout.

SINGLE WING DEFLECTOR
CRIB TYPE



PURPOSE. To provide pools, narrow the stream, increase stream velocity, and help uncover gravel or rock areas.

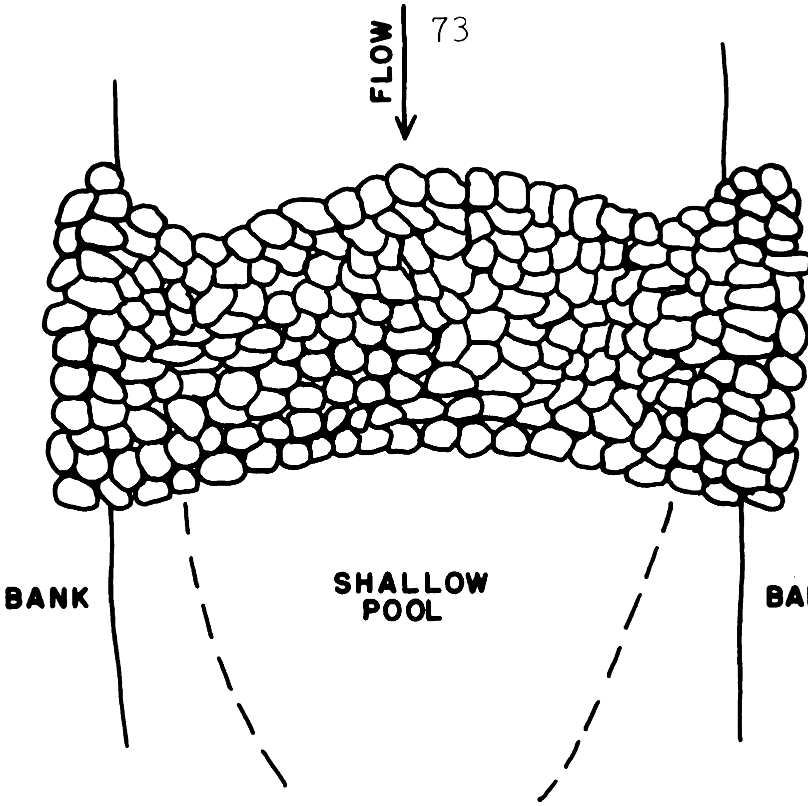
CONSTRUCTION. Crib-type devices are used where rock is not available or where there is an abundance of logs and poles. They should be used only on small streams since there is a danger of water undercutting the crib if it is installed in large streams.

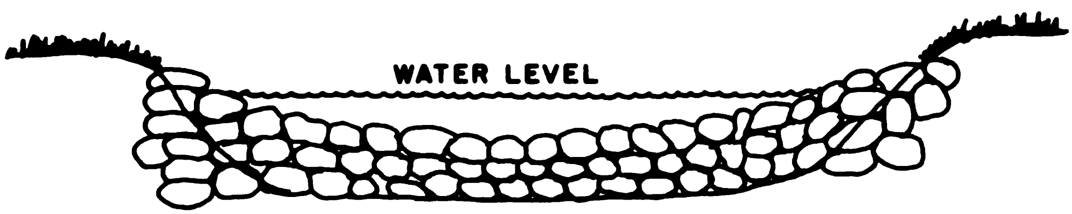
The first step is to make sure the stream bottom is firm. Muck should be removed so that a firm foundation exists. Logs of 8" diameter or more should be used for the front edge of the crib. A short trench should be dug into the stream-bank and the end of the first logs laid into the trench extending downstream at an angle of deflection of less than 60°. The logs used should be wired to fence posts which are driven or jetted into the stream bottom. The deeper the posts are jetted into the stream bottom the more permanent the crib will be. Some devices which have been made in the past were undercut because stakes were not driven to a sufficient depth. Seven-foot posts should be used for stakes. Smooth number 9 wire and staples are used to fasten the logs to the posts. After the front logs of the crib are in place, the back row can be staked into place and the crib can then be filled with bottom material or rock if available. It is best to use some rock to fill in the bottom of the device because it will not wash out as easily as if filled with sand or silt. After the device has been filled it should be covered with sod or dressed and seeded. Sod offers the most immediate protection.

A single wind deflector and a bank cover on the opposite side makes an ideal combination. To obtain more cover it may be well to wire a large log or group of logs to the front edge of the crib, below the water level. This increases cover for small trout. Pools which are formed should have some well-shaded cover. Critics often mention that cover is lacking, so it is best to provide some type of permanent cover with the single wing deflectors. Floating covers are of no value.

Some crib type of single wing deflectors installed in the middle 1930's are still functioning today.(1)

(1)Personal observation, devices found on the Evergreen River, Langlade County, Wisconsin; Deerskin River and Elvoy Creek, Vilas County, Wisconsin.





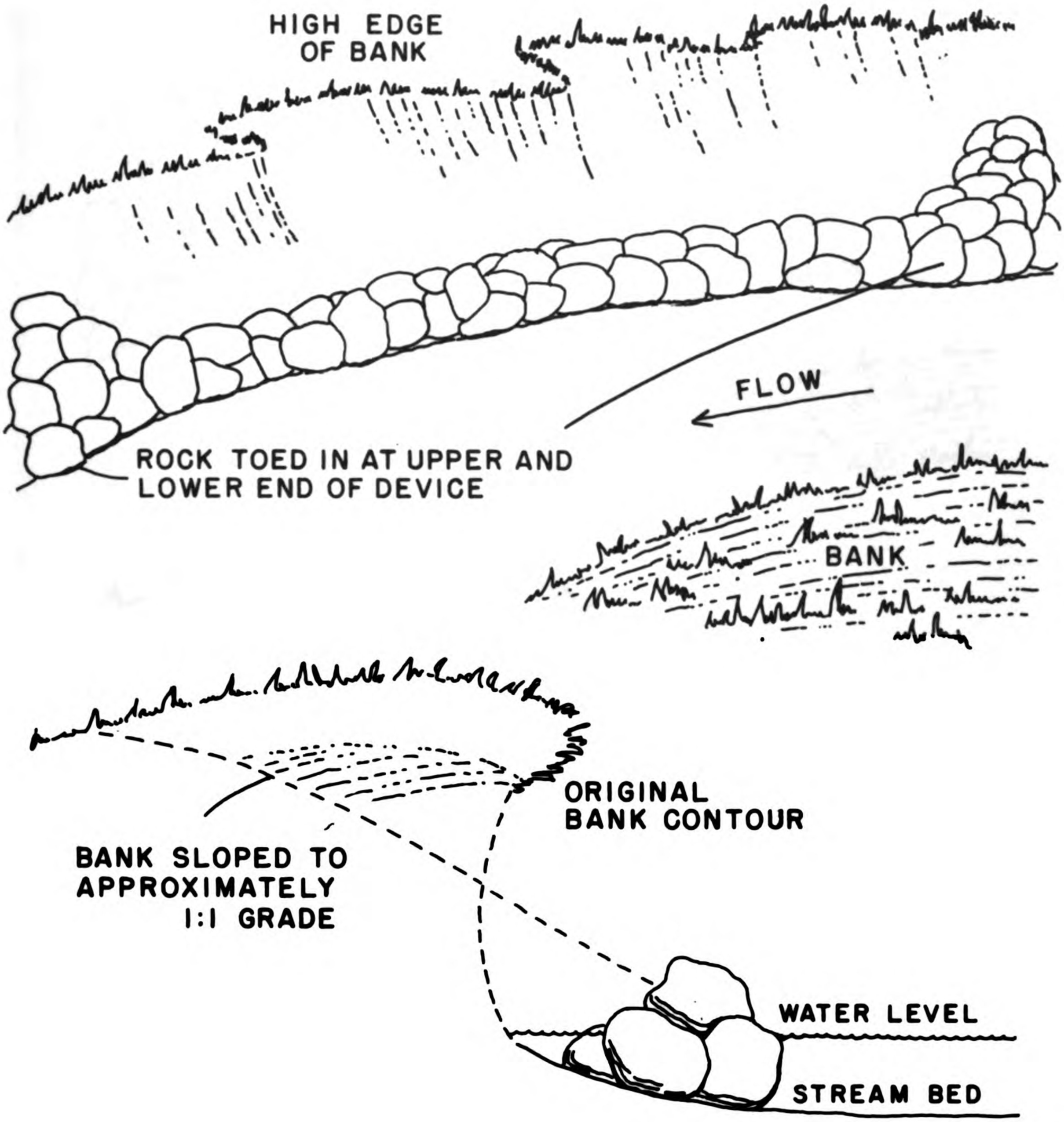
ROCK DAM

PURPOSE. To provide a shallow pool and an area for aquatic insects (Tricoptera, Plecoptera, Megaloptera and Odonata) which are commonly found on a rock or rubble bottom. This structure will also produce an increase in velocity which is desirable for increased fauna in slow moving streams.

CONSTRUCTION. A short trench should be dug into the streambank and the rock work started in the trench insuring a more permanent device. The rocks should be placed so that they reduce the cross-section area of the stream slightly. It may be well to experiment with the first device built within a stream before a great many devices are constructed. This device should be constructed in a shallow stream (less than 18" deep). The rocks on the bottom should be closely placed, but the upper layers may be loosely placed allowing some movement of water through the upper areas of rock. In places, where rock is readily available, the rock dam can be widened so that insect production is increased.

Increases of aquatic insects in rock or rubble have been recorded by Rupp(1) and Sprules(2). Ephemeroptera, Tricoptera and Plecoptera were the species which showed an increase.

(1)Rupp, R.S. (1955) Beaver-Trout Relationship in The Headwaters of Sunkhaze Stream, Maine. Trans. Am. Fish Soc., 84:75-85.
(2)Sprules, Wm. M. (1941) The Effect of A Beaver Dam on The Insect Fauna of A Trout Stream. Trans. Am. Fish Soc., 70:236-248.

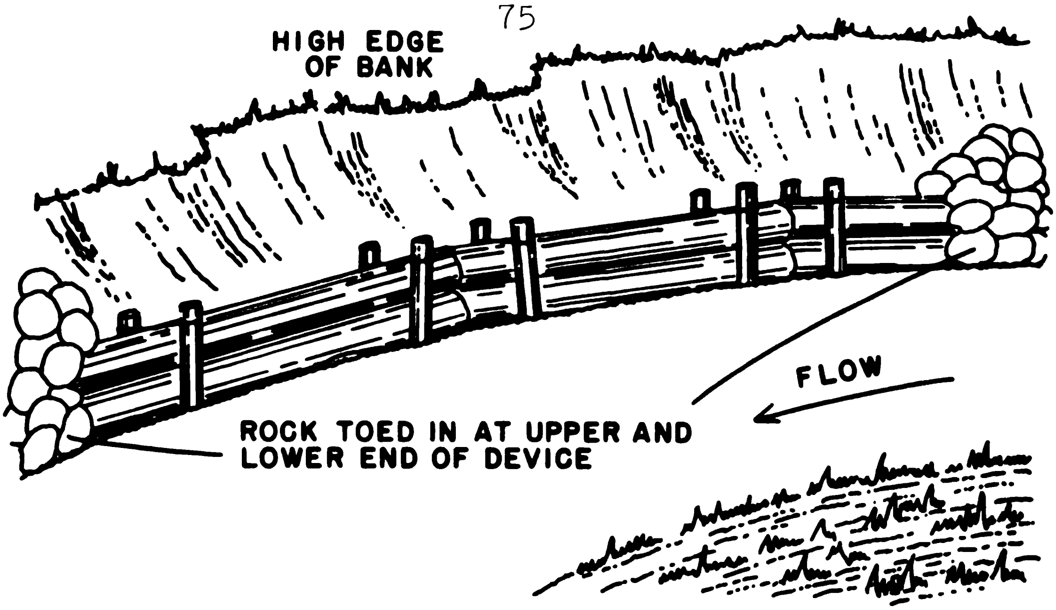


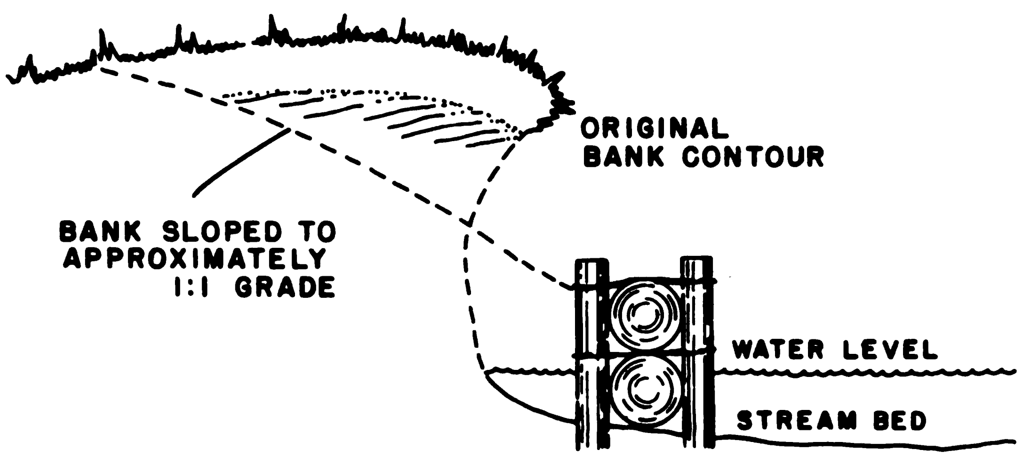
ROCK REVETMENT [1]

PURPOSE. Rock revetments (rip-rap) are used to help stabilize streambanks. They are used wherever rock is plentiful. Rock revetments stabilize banks until more permanent vegetation provides soil cover and prevents further erosion.

CONSTRUCTION. Rock is carefully placed at the water's edge parallel to the eroding bank. Rocks should be built up to the high water level. The ends of the revetment should be toed-in to protect from undercutting. After the rocks are in place, the bank is sloped to a 1:1 grade. This can be done with shovels where banks are not high, or with a bulldozer or back hoe where high banks are encountered. The area should then be seeded, sodded, planted to willows, or other fast growing vegetation. It is important to provide a permanent vegetative cover soon after the bank sloping is complete, so that erosion and gullies may be prevented.

(1) Agricultural Stabilization and Conservation Program, Streambank Protection, Washington, D.C.: 1961.





LOG REVETMENT[1]

PURPOSE. The log revetment is used to stabilize badly eroding streambanks. It should only be used in areas where rock is not available or access to haul the rock into the stream cannot be obtained.

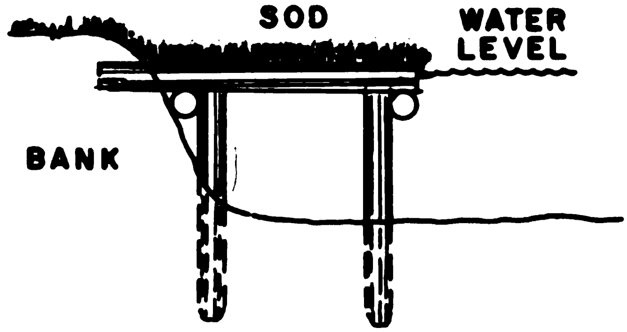
CONSTRUCTION. A row of logs are staked along the streambank parallel to the stream. Single logs may be used when the bank is not very high. In areas where erosion is severe, tiers of logs should be used. Hardwood logs are preferable, with the denser hardwoods considered best (oak, elm, maple). Large diameter logs make a better revetment, but are also more difficult to handle. Posts which are used to stake the logs to the bank should be 5 to 10 feet long and should be driven or jetted into the streambank. (Jetting is preferable because it assures a more permanent revetment).

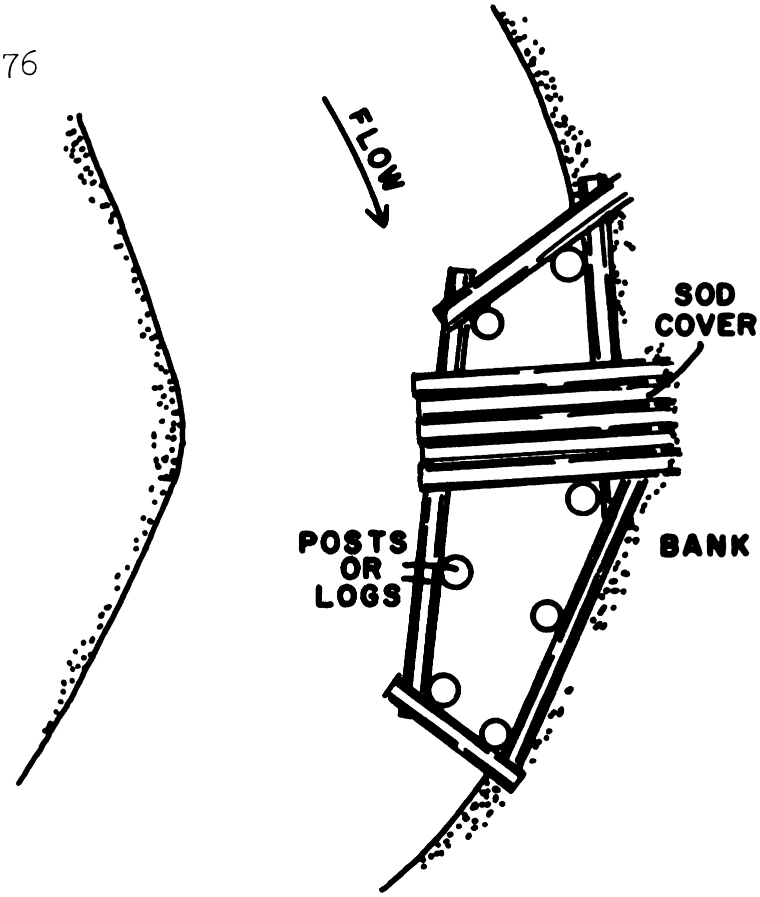
Ends of the logs should be rip-rapped with rock, thus preventing any undercutting by the stream. After the logs have been staked and the ends rip-rapped, the bank should be sloped to a 1:1 grade. If streambanks are not very high, the sloping of the streambank may be omitted. This is only for areas where bank erosion is not severe and undercutting by the stream is the main bank erosion agent.

The stream bank should be either seeded, sodded or planted to quick growing vegetation. Failure to stabilize eroding stream banks before other stream work is done will still result in unstable water conditions.(2)

(1)Agricultural Stabilization and Conservation Program, Streambank Protection, Washington, D.C. 1961.

(2)Striffler, W.D., 1960, Streambank Stabilization in Michigan, Lake States Forest Experiment Station Paper: 84, 15pp.



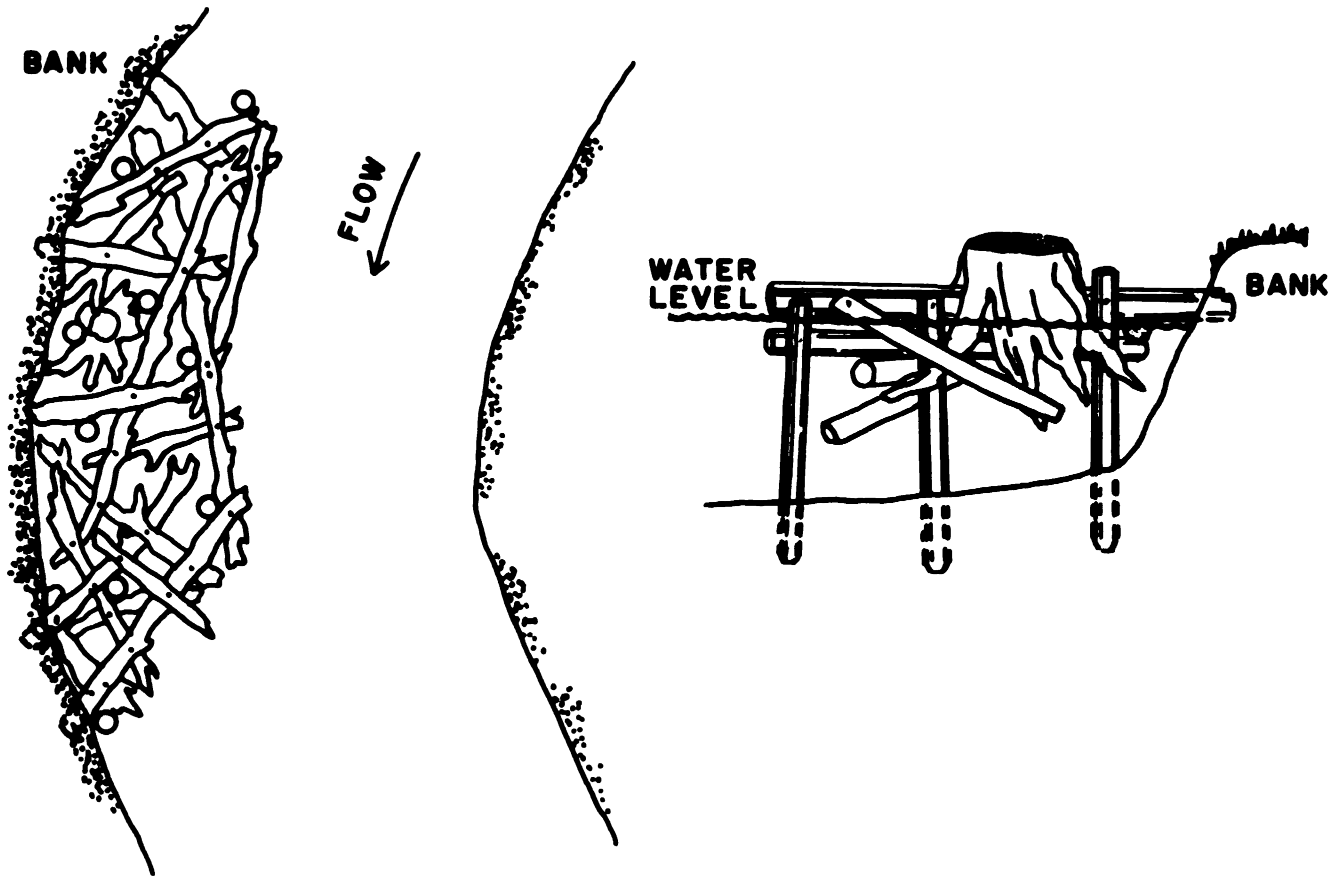


LOG SOD COVER

PURPOSE. To provide cover and shade for various sizes of trout next to the streambank. Larger trout will use this cover.

CONSTRUCTION. The log sod cover should be located where there is enough velocity to prevent its "silting in". Usually bank covers are used opposite deflectors. Posts, 4" to 6" in diameter, are driven or jetted into the stream bottom about 3 to 5 feet from the stream bank. Small logs or posts 4" to 6" in diameter are used to build the framework. Rough lumber or slabs can also be used but they may not be as economical. Small logs or fence posts are then used to cover the framework. They may either be placed paralled to the stream or at right angles to the stream. If you have material which is longer than 7', it is best to place it parallel to the stream. Thick hardwood slabs can also be used to cover the framework. Sod is used to cover the device. Log sod covers must be strongly constructed because fishermen constantly walk on them. The top of the cover should be less than 4" above the normal water level. The top logs will then be in water, thus preventing early decay. This cover can also be completely submerged without a sod cover on top.

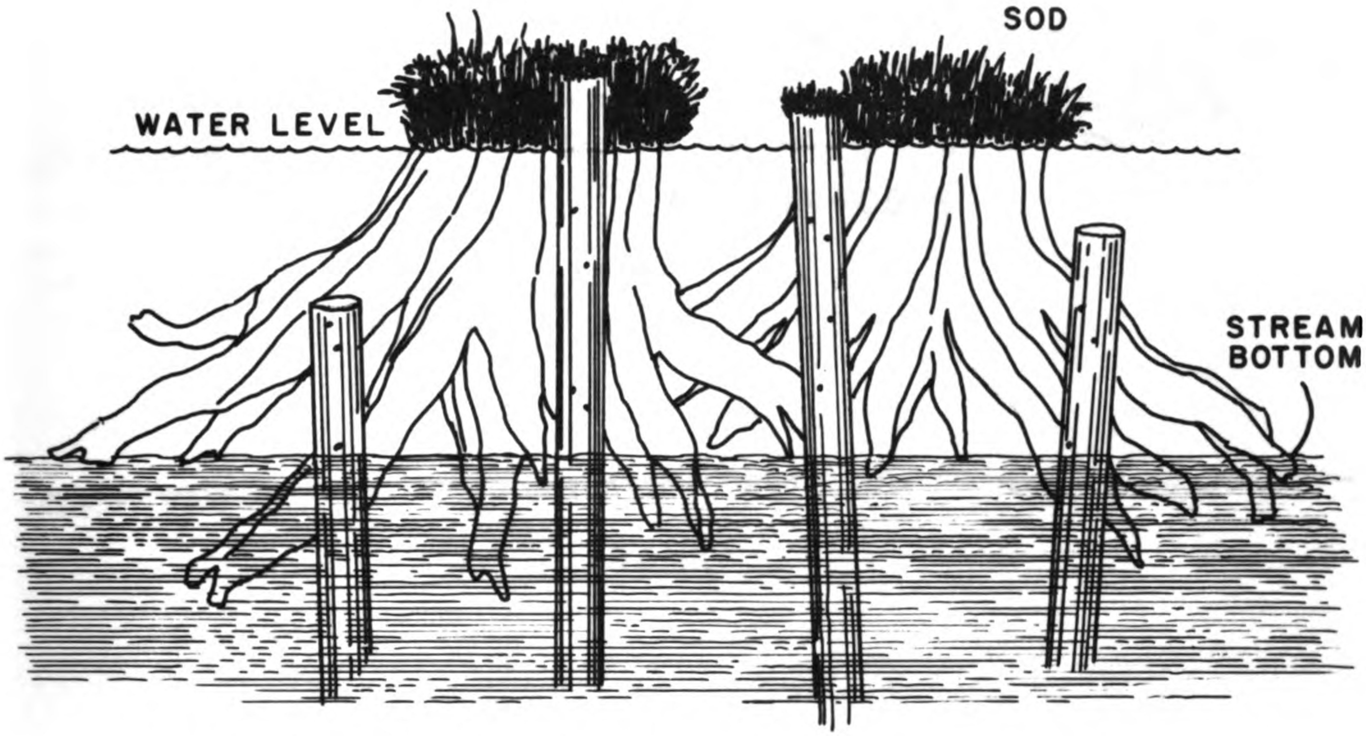
LOG JAM



PURPOSE. To provide shade and cover for trout next to the stream bank.

CONSTRUCTION. Stumps, logs, and tree tops are used to construct this type of cover. The logs which are used should be at least 6" in diameter. Materials should be staked at various depths (from the stream bottom to the water surface). This type of cover can be used in small headwaters streams where bank cover is lacking. The materials used should be arranged so that water movement is not completely regarded under the cover; this will provide some small "quiet water" areas under the cover. The log jam protects especially the small trout from predation. Angling is made more difficult by the log jam, but the edges of the cover offer fine fly fishing. Log jams should be used in streams which have gravel or rubble bottoms or in locations where the velocity of the water will prevent siltation under the device.

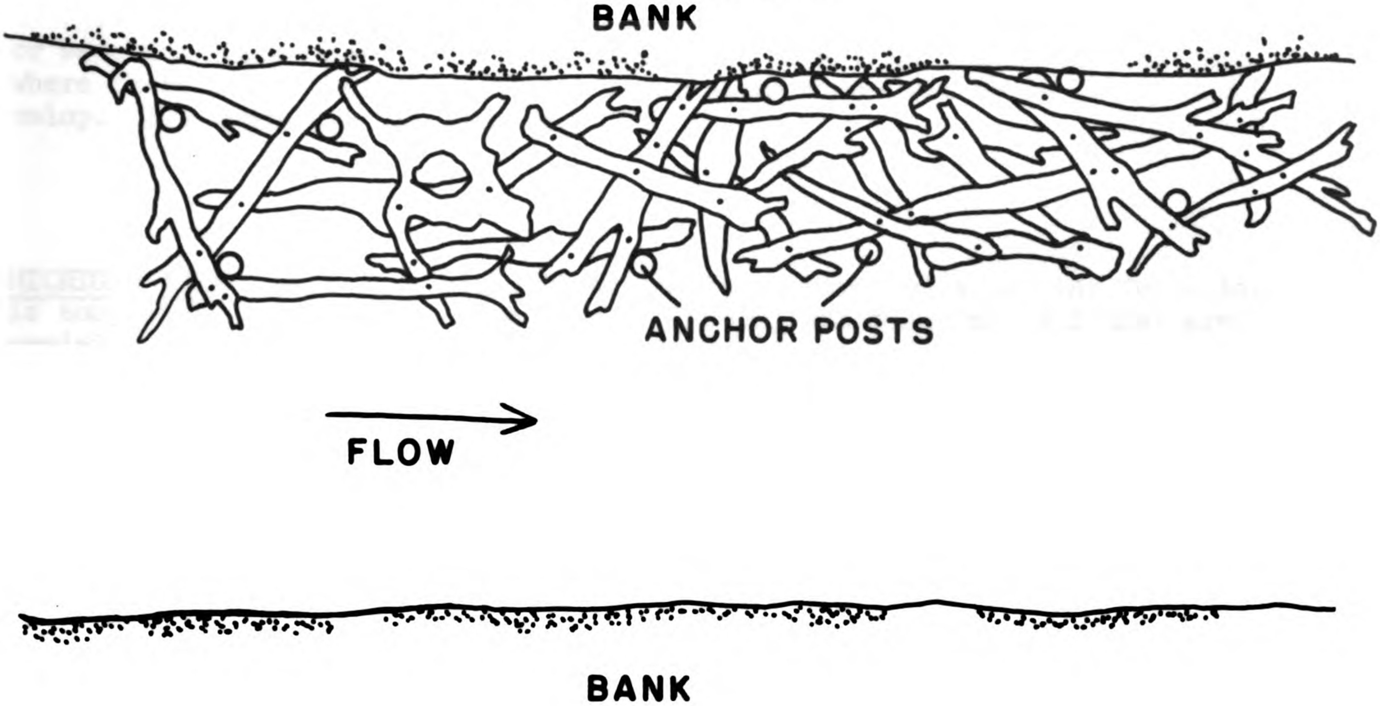
STUMP COVER



PURPOSE. The stump cover is used to provide shade, protection, and a resting area for trout, mainly smaller trout. Its location and the depth of water under it will help determine the size and number of trout which make use of it. Availability of food nearby will also be a contributing factor.

CONSTRUCTION. Stumps with large spreading roots should be used. The stumps are fastened in place with posts or stakes which are driven or jetted into the stream bottom. Spikes or smooth wire and staples are used to fasten the stump to the posts. An ideal location for a stump cover is below and partially in the current of a deflector. Stump covers have many features. (1) They are economical. (2) They are made with material which is usually in the stream or nearby. (3) They are a natural looking cover. (4) They provide cover with a minimum of effort. In planning a stream it is best to locate where stumps already exist and possibly place others next to them thus taking advantage of this cover.

LOG COVER



PURPOSE. To provide suitable cover for trout in streams where natural cover is lacking.

CONSTRUCTION. This device is constructed in the same manner as the log jam, but the materials are not as closely spaced. The log cover provides a greater surface area of cover. It has some effect in reducing the cross-sectional area of the stream, thus increasing velocity somewhat, It may also be used in front of log revetments to prevent undercutting.

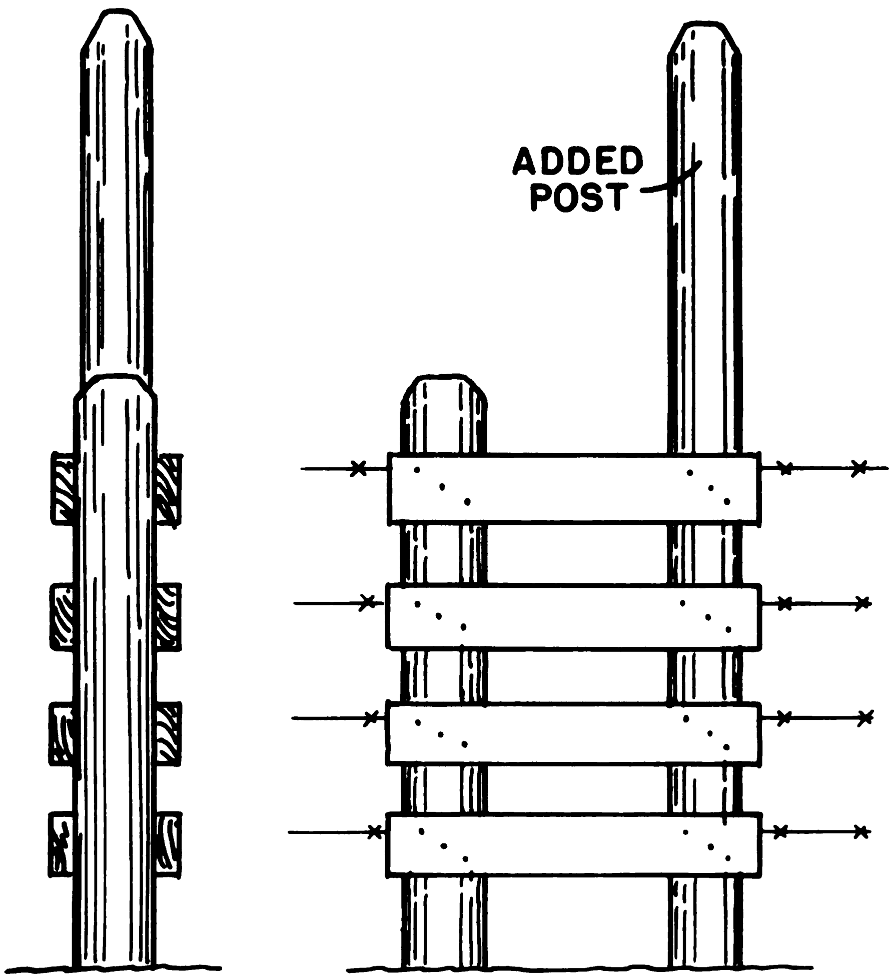
Logs, stumps and tree tops are used and staked at various depths. The log cover should be located to take advantage of some stream current. In small streams with a lack of gradient, the device may be placed opposite a deflector or at outside edges of curves to take advantage of increased stream velocity to prevent the cover from "silting in" with lighter stream bottom material. Regular posts can be used to stake the material down. Spikes or wire are used to fasten material to the stakes. All nails, spikes and wire should be covered to keep the device as natural looking as possible.

All logs and stumps should be firmly attached to the anchor posts. No loose ends should be found anywhere. Logs may be spiked to one another if they are solid and below the water surface.

STILES

PURPOSE. Stiles are structures which allow fishermen to cross fences without damage to the fence. Fishermen welcome the stiles wherever cattle crossings or watering places have been installed. They should be placed in locations where there is no chance of erosion or in areas where wet spots will not develop. Two types are illustrated.

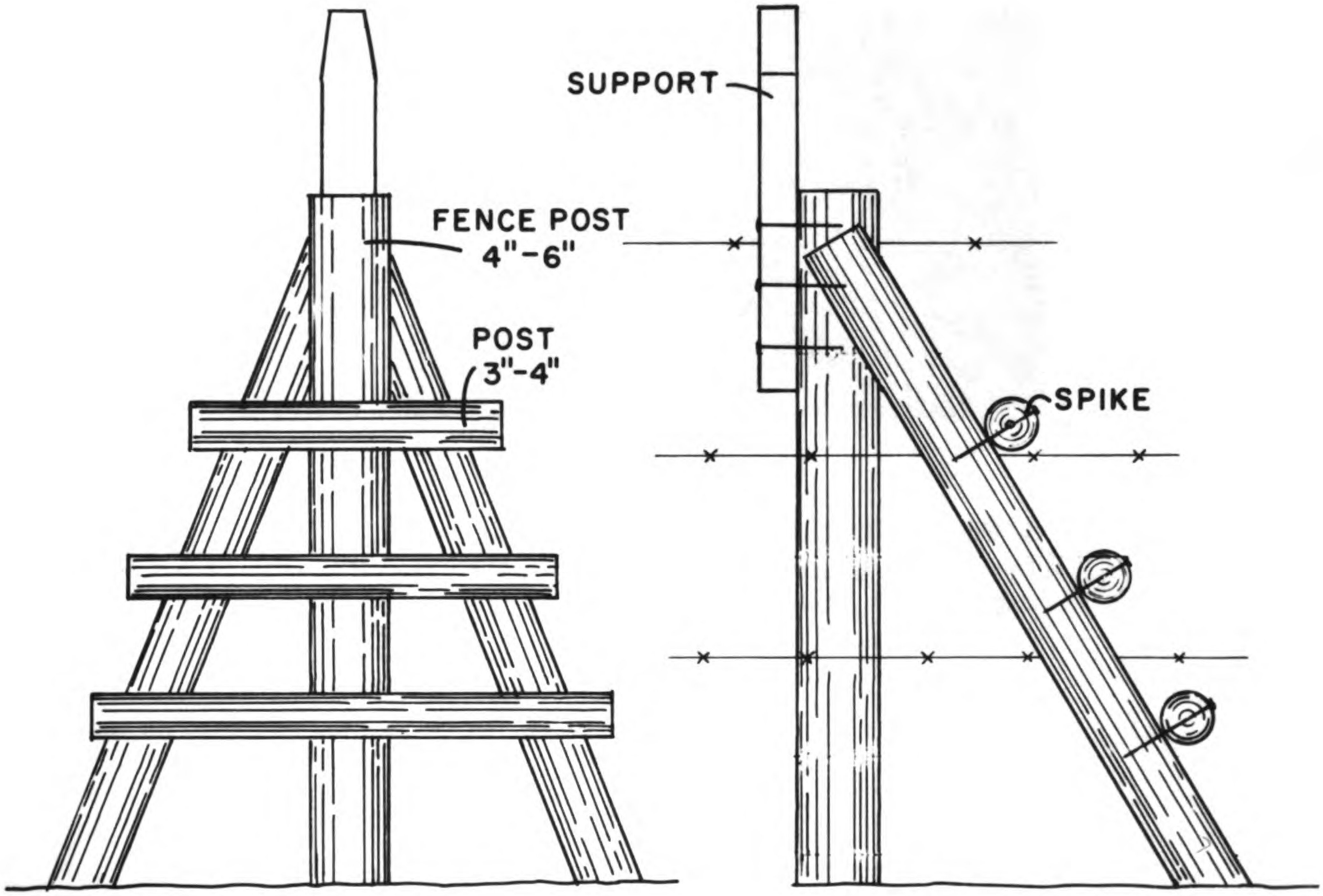
MICHIGAN TYPE. This is a stile which can be constructed after the fence line is complete. A long post, some 1" x 4" lumber, and nails are all that are needed. This type has been used extensively, is easy to cross, and offers good protection from barbed wire. The long extra post can be placed next a regular line post anywhere in the existing fence.



FENCE STILE
MICHIGAN TYPE

WISCONSIN TYPE. This stile is useful if an extra stile is needed after the original fence line has been constructed. It has been used in Wisconsin on the Evergreen River. The stile is easy to construct with posts and spikes which are usually available to stream improvement crews. Materials needed are: Two 4" to 6" diameter fence posts (seven feet long), two smaller posts to be used for threads or lugs, a small post to be used as a support handle and some large spikes which are used to fasten the posts, threads, and the support to the line post.

The posts used for risers are attached to the line post so that the top of the riser is about 5" from the top of the post. The threads or lugs are then fastened to the risers. The lower thread should be at least 30" in length. The support handle is attached to the top of the line post on the side opposite the stile. The only difficulty encountered with this stile is that the top wire is exposed. This can be corrected by attaching two small boards to the wire so that the barbs are not exposed.



STILE
WISCONSIN TYPE

Figure 14. In-stream devices--stump cover (lower left), log cover (downstream on right). Cedar River, Gladwin County, Michigan. (Michigan Department of Conservation, LSI, Photo.)

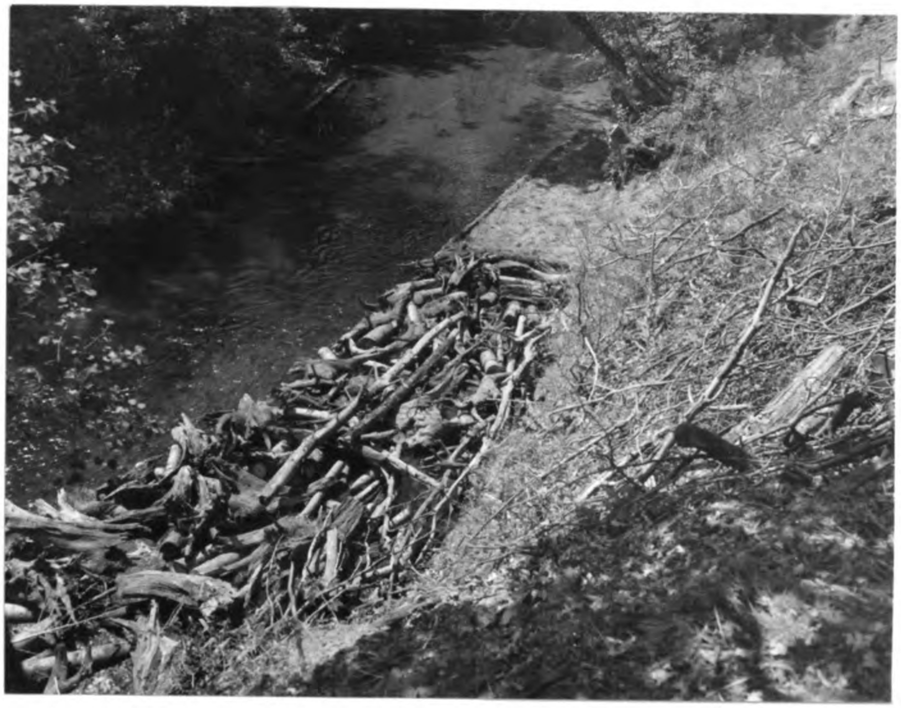


Figure 15. Log jam (lower left)--Log-sod cover (upper right) Little Manistee River. (Michigan Department of Conservation, LSI, Photo.)

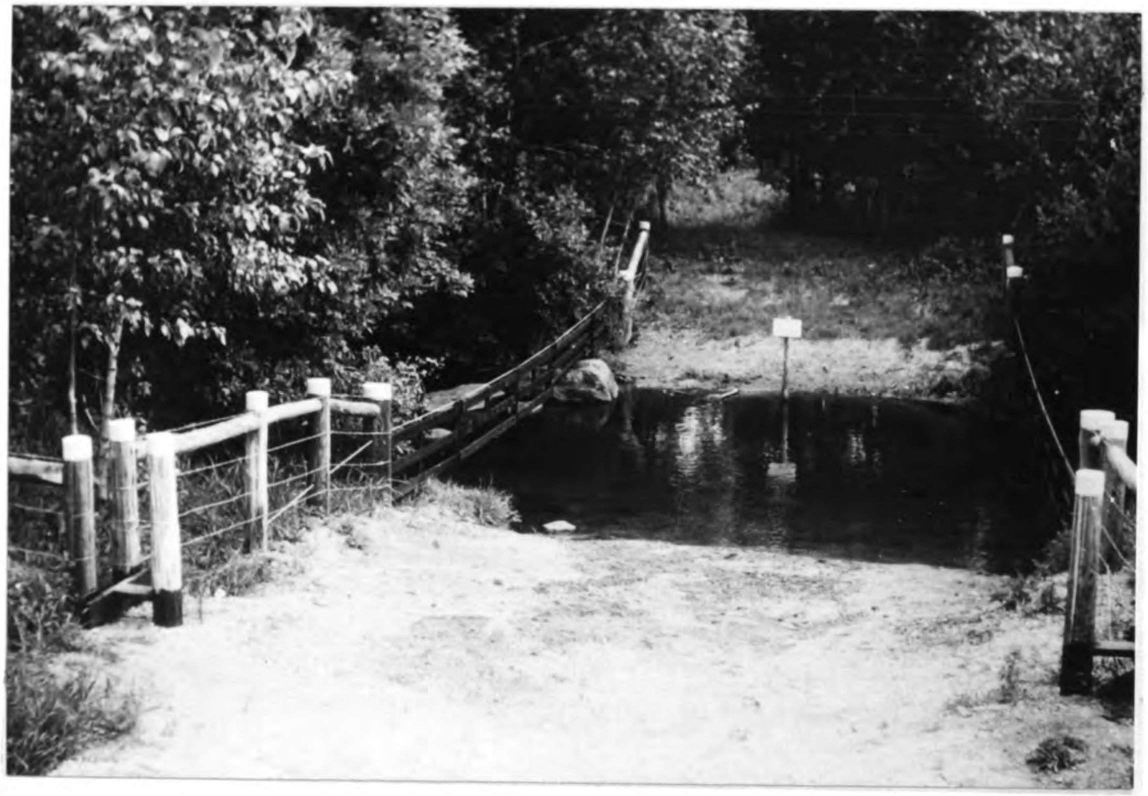


Figure 16. Cattle crossing--Wausaukee Cr., Marinette County, Wisconsin

Figure 17. Cattle crossing, flood gate--Cedar River Watershed, Michigan.

Figure 18. Eroding streambank--Pine River Watershed, Michigan. (Michigan Department of Conservation, LSI, Photo)

Figure 19. Same streambank after bank stabilization with rock riprap. (Michigan Department of Conservation, LSI, Photo.)

Figure 20. Beaver dam--Evergreen River, Langlade County, Wisconsin

Figure 21. Area once flood by beaver, notice debris in stream and lack of cover. Evergreen River, Langlade County, Wisconsin.

Figure 22. Badly eroding streambank--Tobacco River, Clare County, Michigan.

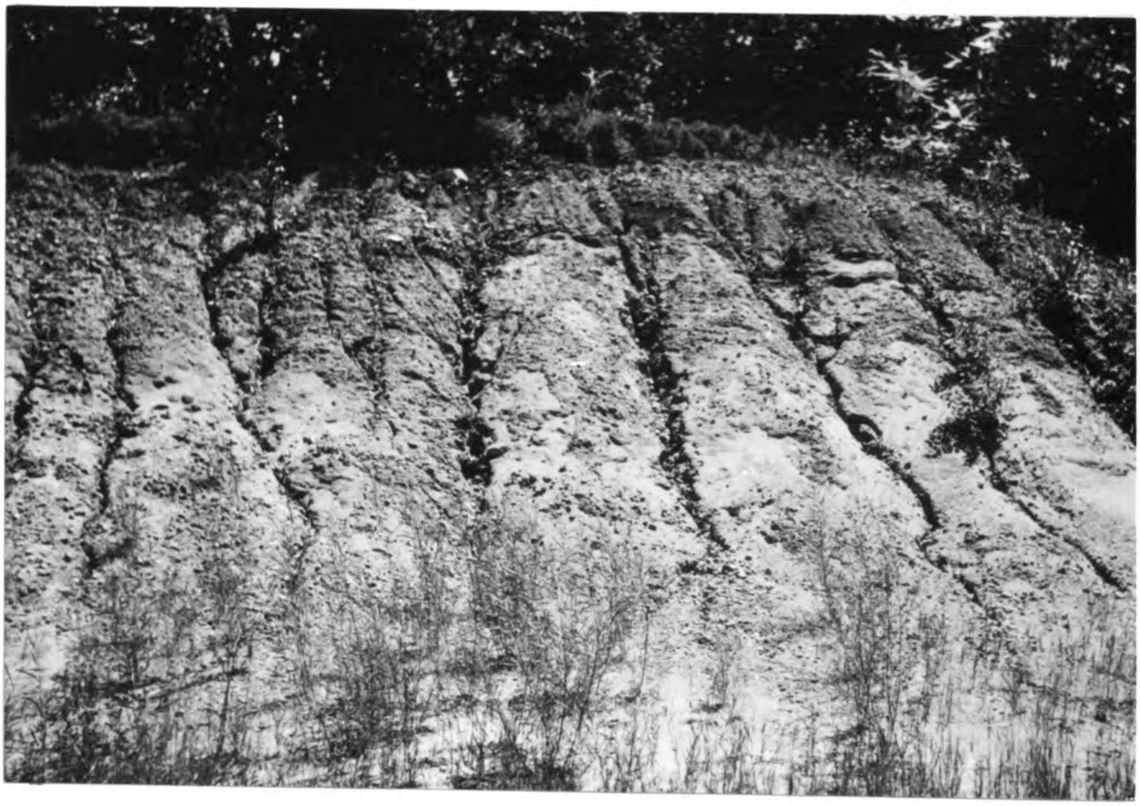


Figure 23. Eroding roadside ditch--Marinette County, Wisconsin, One year after road construction.

Figure 24. Single-wing deflector (crib-type) with log-sog cover on opposite bank--Evergreen River.

Figure 25. Digger logs with log sod cover--Evergreen River Cooperative Stream Improvement Project.

Figure 26. Fence stile (walk-through), Wisconsin Conservation Department--Wausaukee Cr. Marinette County, Wisconsin.

LOCATION OF DEPARTMENT OF CONSERVATION
WATERSHED PROJECTS

to restore cover in areas where such cover is lacking.

Variance in materials may require adaptations of the covers shown. A community survey of materials available for stream improvement may result in considerable savings. Community involvement is a necessary phase of this program; sawmills may have slabs available, utility companies usually have discarded poles which can be used for a variety of structures, farmers may have an abundance of field stone and construction companies generally have used lumber which is economical. Cooperation of all community agencies keeps costs of materials to a minimum.

Fencing, Tree Planting, and Access

Fencing of livestock from the stream proper has been one of the greatest achievements of the stream improvement program. Fencing seems to give the greatest return for each dollar invested.[1] Fences are generally constructed near the stream, but encouraging the landowner to keep fences on the upland areas provides an increased area of permanent vegetation. In locations where high ground water levels and large boulders are found, fence construction becomes more

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[1]John D. O'Donnell, and C. W. Threinen, Fish Habitat Development. Wisconsin Conservation Department, Madison, Publication No. 231, p. 7.

difficult. Care should be taken to insure a rigid fence in all areas. Good construction requires only a minimum of maintenance later. In heavily wooded areas, tree trunks or branches often fall on the fence line. Yearly inspections early in the spring prevent undue criticism from the landowners. Good relations with the farmer or landowner are necessary when minor problems result because of inadequate fencing.

Cattle crossing, fences and stiles (walk-throughs) will require yearly maintenance. Cost-sharing of fencing is available under the Agricultural Stabilization and Conservation Program. (See Appendix D) Cooperative groups could build the fences for landowners who participate in the cost-sharing practices. Cost-sharing may be enough to pay the cost of the wire and posts. Many landowners might welcome a fence if it were to cost nothing and still restrict their livestock to areas they help to designate.

Providing fencing for larger streams would reduce bank erosion. Buffer strips, from which livestock is excluded, allow for a quick return to natural vegetative cover on the streambank.

Tree planting of fast growing conifers has been an important part of the program on the upland areas of the watershed. Game food shrubs are also planted on some upland areas. This is a good example of "multiple use." Gully control on farms and adjacent to roads is yet another phase of the upland program.

Provision for public access is a necessity wherever improvement work is begun. Public roads and public lands usually furnish ample access. Establishing small parking areas at access points prevents damage to private roads and driveways. Good trout streams seldom have an overabundance of access points so this consideration should not be disregarded. Trout fishermen rarely complain of the hurdles they have encountered when they have made an outstanding catch.

Equipment for Stream Improvement

Truck
Portable Pump
Shovels
Axes
Post Hole Digger
Claw Hammer
Pliers
Crow Bar
Post Maul

Boots and Waders
Barbed Wire
Smooth Wire
Wire Stretcher
Nails and Spikes
Staples
Small Work Boat
Cant Hook

Logs, slabs, fence posts, rock, gravel and sod, are used as building materials for devices. Small projects require only a few tools. A tractor and a wagon may be useful for hauling materials.

Power equipment such as shovels, bulldozers and dump trucks are used by the Conservation Department crews. These may be available when cooperative groups are active.

A small portable pump, capable of delivering pressures up to 100 lbs., is almost a necessity for driving posts. A 5 foot section of 1 inch or 1 1/4 inch pipe is attached to the hose leading from the pump. The opening in the pipe is reduced to serve as a nozzle. The water under pressure, is then used to excavate a hole in the streambottom where desired and the post is forced into the opening created. Movement of the streambottom material helps to tighten the post. The use of a pump to jet posts into the streambottom insures more permanent devices, eliminates driving posts with a maul and reduces the cost of construction. The intake for the pump is placed upstream so that silt and sediment created does not foul the pump.

CHAPTER IV

LAND AND WATER USES IN THE WATERSHED

Forest Land Use

Present trends in forest management in the Lake States (Michigan, Minnesota, Wisconsin) stress tree planting, forest fire prevention and control, selective cutting, control of insects and disease and proper logging procedures. Open areas, once farmed and later abandoned because of economic failure; are now being reforested primarily with conifer species such as Red Pine, White Spruce, Scotch (Scots) Pine and White Pine. The change in land cover from grass to conifers will eventually decrease the water yields from large areas. Due to an increase in evapotranspiration during the year, yields within a watershed may be greatly reduced even though stream-flow is improved in quality and greater stability of flow is achieved.

Changing from primarily deciduous species to coniferous species may also have a decided influence on the water yield. Evaporation during the winter, in the form of sublimation, removes precipitation which would normally become a part of the surface or ground water. Increased frost depth under conifers, due to lack of deep snow, will reduce the amount of infiltration. Crowns of deciduous trees retain very little snow and allow for increased snow depths on the soil. Because of the reduced frost depth under deciduous trees, infiltration is hindered very little. During winters with heavy snowfall, infiltration may take place all winter long.

Forest fires, considered as highly destructive forces, do increase the yields of water from an area. Flood danger, increased erosion and decreased infiltration are other results of forest fires.

Cutting of trees will increase the water yield from any given area. At present, however, the improvement of water quality and the infiltration of huge amounts of water receive greater stress. This may change if our yields of water are to be increased in the future.

Land Use for Agriculture

Since 1935, the Soil Conservation Service has actively promoted and supported good land use practices. Conservation farm plans, erosion control and grassland management have lessened the flood danger and the amount of silt which erodes into our lakes and streams. Still, only about 1/3 of the agricultural acreage has received erosion control.[1] The need for more involvement in our soil conservation program is as great as ever, but proper use of water is receiving as much consideration as the proper use of soil.

Clawson, Held and Stoddard state that we can expect a reduction of about 21 million acres of cropland by 1980.[2] Clawson also predicts a reduction in the number of farms but an increase in the size of the individual farms.[3] Decreases in the acreage of row crops will have a decided effect on both quantity and quality of water. Row crops tend to produce more erosion, reduce infiltration and impair water quality, but they yeild more water than the cover crops which lose more by evapotranspiration. A reduction in the crop acreage will signify a change to other vegetation or other uses. More cover will reduce water yield, whereas a reduction in cover will increase the yield.

The advent of more supplemental irrigation for humid regions will increase the use of water by agriculture. Legal

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[1]The State Journal, Lansing, Michigan; July 2, 1962. U. S. Department of Agriculture, News release, Sec. C., p. 1.

[2]Marion R. Clawson, Burnell Held, and Charles H. Stoddard, Land for the Future. Baltimore: The John Hopkins Press, 1960, p. 442.

[3]Marion Clawson, Soil Conservation in a Dynamic Society. Journal of Soil and Water Conservation, Vol. 16, No. 1, January-February, 1961, p. 8.

problems involving surface water are showing the way to increased use of ground water. Use of surface water need not become a problem if the water used for irrigation is not removed in large amounts when low flows or critical water temperatures for trout exist. Use of ground water should be regulated to insure normal ground water levels. If the ground water table is lowered, provision should be made for ground water recharge. Consumptive use of water by irrigation presents the main problem. Many of the other water users divert water, but return it to its source.

More efficient methods of irrigation, knowledge of crop requirements, knowledge of meteorological data and the presence of a humid climate in the Great Lakes Region will help solve many of our existing problems between recreational and agricultural interests.

Increased use of windbreaks, tree planting and other conservation measures such as contour cropping, strip farming, terracing and improved grassland management will improve water quality, reduce erosion and increase infiltration at the expense of reduced water yield.

Future agricultural practices will demand more use of water but will also tend to utilize more of the available moisture than present day methods.

Industrial Use of Water

Increased consumption of water by industry for cooling and processing will continue to demand water of a high quality. The total consumption may increase from less than 250 billion gallons per day in 1955 to 600 billion gallons per day by 1980.[1] The greatest increase will be in the states east of the Mississippi River. Few of the large industries in Michigan or Wisconsin are located where trout streams are numerous, but the possibility of industry utilizing these streams or ground water sources is imminent.

Transportation, raw materials, proximity to a population center or market and an adequate manpower supply have been major factors in location of industrial complexes. Availability of water, however, is rapidly becoming the dominant feature in future industrial location. Many large industries have already moved to the southeastern states where rainfall is abundant and labor is plentiful. A possible relocation of industries now situated in the Great Lakes region may lessen our industrial demand somewhat. The

[1]U. S. Congress, Senate, Select Committee on National Water Resources, National Water Resources and Problems. 86th Congress, 2nd Session, 1960, Committee Print No. 3, p. 1.

presence of the Great Lakes, the abundant underground water sources of Michigan and Wisconsin and the high quality water, however, will remain an attraction for industry throughout the United States. Re-use or recycling of water may be necessary where shortages already exist.

Use of water for waste disposal is becoming a more serious problem. The construction of sewage treatment plants and pollution abatement programs is not keeping pace with the increase in population or the added amounts of pollution discharged by new industries. Pollution prevents various uses of water and the increased use of ground water, coupled with improper waste disposal, may lead to pollution of our underground water resources.

Increased water use in the future will demand a reduction in pollution. Cost of treatment may be exceedingly great, but the need for more water will necessitate increased treatment facilities.

Land Use for Recreation

Use of water areas for recreational activities such as fishing, boating, swimming, water skiing or other uses where close proximity to water is desired (camping, hiking, home development, and parks) may present problems, if planning does not precede or accompany the development. Stream improvement efforts may encounter more difficulty in obtaining riparian areas because of the landowner's reluctance to part with some of their riparian rights. Continuance of this trend may have a noticeable effect on portions of streams which have already been improved and yet have little or no guarantee of retaining the permanence they now have.

The creation of new bodies of water near cities has had little effect on trout streams up to the present time, but may have serious implications in the future if values are not established for some of the benefits derived from trout streams. Economic benefits derived from some of the man-made lakes often exceed those obtained from trout streams. This may not be important to the trout fishermen of the entire state, but the local economy cannot be ignored when decisions on land use are adjudged. State or federal purchases of large sections of riparian areas aggravates the problem because they often limit private development. It may be an injustice to provide free public access to all bodies of water after many individuals have purchased and developed riparian lands. Even with an increase in use of water for recreation, it is important to note that we already have an abundance of access sites in both Michigan and Wisconsin today.

Overdevelopment of some recreation areas has been brought about by public access. Although many organizations today are supporting increased public access programs, they do not comprehend the scope of the problems encountered when public access is provided for all bodies of water.

Problems of waste disposal in regions of heavy development near lakes and streams may have a noticeable effect on ground water quality. Many regions have not planned for increased water use or for increased waste disposal. An example of this type of problem is Dodge Lake, Clare County, Michigan. This lake, which is less than 50 acres in size, has a total of 500 cottages surrounding it. These cottages all have separate water and waste disposal systems which will, in due time, require some control or regulation. Some form of planning or zoning is necessary to prevent more occurrences of this example.

Use of land and water for recreational purposes will have a decided effect on trout stream improvement. Many of the water users have formed associations to protect their use of the water. Trout fishermen's associations, not well organized until the 1960's, are actively protecting their interests in trout waters. In future development, the riparian landowner will continue to be the key figure. His cooperation will be necessary to the continued improvement of streams.

CHAPTER V

CONCLUSION

It is imperative that the conservation teacher plan a dynamic action program if conservation education is to achieve the status it merits in our present and future secondary education curriculum. Much of the secondary program is devoted to non-academic and vocational activities; surely stream improvement, serving as a unit within the high school conservation course, has intrinsic values. An opportunity is provided for students to study some of the relationships between soil, water, forests, fish and wildlife. A basic understanding of these resources is necessary to the student whether he plans to terminate his education at the completion of secondary school, or decides to continue at the university level. University courses in ecology, forestry, agriculture, limnology, entomology, ichthyology, etc., will become more meaningful to the students who have participated in stream improvement.

To acquaint students with the stream improvement program, it may be well to visit one of the schools which has participated in the activity for a number of years.

The information contained in this paper may serve the conservation teacher in various ways, but most important, it may be used as his formal application to his administrator. Althought some administrators are sceptical of any new additions to the already crowded secondary curriculum, they may be agreeable to accept a well-organized program within a course which already exists.

Cooperation of fellow teachers is necessary if stream improvement is to be accomplished within the regular school session. A "mutual cooperation society" is an asset in planning field trips during the regular session. Students participating in stream improvement should have all other class assignments completed before departing on field trips. Criticism by fellow teachers can be avoided if students have prepared their other classwork.

The time devoted to stream improvement should be scheduled well in advance of the actual field trip in order to allow other teachers to plan their programs accordingly. Notify all teachers of the dates stream improvement is planned, and specify alternate days which may be required due to inclement weather. Avoid days on which most exams are scheduled.

A formal application should be sent to district fishery personnel when a school desires to participate in stream improvement. Materials and equipment necessary for improvement should be secured well in advance of the field trips. Local ranger stations, habitat development crews or local groups, may loan equipment which is not in use at the time. Purchase of equipment may not be required if local groups provide adequate equipment. All equipment should be properly cleaned and returned promptly at the completion of the activity.

If the program is well planned, conservation department personnel may be available for supervision. Do not expect these technicians to be present without notification well in advance of the field trip as their schedules are very demanding of their time and funds.

The following information may be helpful to intitate a stream improvement program:

1. Secure the approval of the school administration.

2. Contact the local fish manager about the availability of a stream which will be suitable to the school activity.

3. Enlist the aid of students in planning--many of the preliminary preparations can be completed by students.

4. Consult with other teachers as to how stream improvement may be related to their subject matter and explain the program to co-workers.

5. Select dates for improvement work, seek approval of the administrator, notify other teachers, secure transportation, food, first aid kit, equipment, and inform students of their responsibilities.

6. Notify student's parents of the nature of the activity, this may help to stimulate their interest.

Provide students with preliminary instructions before the improvement commences. Include an evaluation of the work at the end of a day's activity. Suggestions from students have led to many refinements in the program. Invite the school administrator to view the stream improvement activity--stress the educational value of the work, not the physical accomplishments.

Activities should be planned during both the spring and fall seasons if improvement is included during the regular school session. Students are better able to comprehend ecological changes when they are able to witness them over a longer time period. Changes in flora and fauna become more evident with a "before and after" comparison. Fishery personnel may add to the student's biological knowledge by demonstrating electro-fishing equipment. This equipment will illustrate areas which are used by trout, and the relationship of cover and food to optimum trout populations. District fisheries personnel are generally willing to help advance their program by cooperating with active conservation groups.

During the in-stream phase, encourage questions, allow for short discussions and vary the student's activites to include a variety of stream conditions.

Although relatively few secondary schools are participating in stream habitat improvement, many others could include it, as a part of their regular curriculum, in a summer course or after school and on Saturdays. Stream improvement efforts need not be limited to trout streams--warm water streams will also benefit from this activity.

Stream improvement programs which are well planned, adequately supervised, and coordinated with the existing secondary school curriculum are a valuable asset to resource education. "The primary conservation problem is not the lack of resources, but the lack of proper management and utilization of these resources."

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APPENDICES

APPENDIX A

INTER-AGENCY AGREEMENT FOR PLANNING AND DEVELOPING COMMUNITY WATERSHEDS IN WISCONSIN

I. The State Soil Conservation Committee Will:

1. Promote friendly relationships and coordinate activities of interested groups.
2. Assist the several local Soil Conservation Districts in the organization and development of watershed programs.
3. When requested, provide such technical and educational assistance as it has at its disposal.
4. Under Public Law 566:
   a. Provide guidance to local groups in the preparation of applications for planning assistance.
   b. Determine eligibility of applications for planning assistance.
   c. Approve or disapprove work plans for operation.

II. The Agricultural Extension Service Will:

1. In consultation with Soil Conservation District supervisors and representatives of the other agencies, conduct district-wide surveys on potential watershed management.
2. Assume initial responsibility for developing and presenting basic facts to selected local watershed groups concerning the need and value of the program. Such responsibility to include requesting the facilities and efforts of cooperating agencies.
3. Assist in developing local conservation leadership within the area.
4. Assist in the formal organization of watershed groups.
5. Provide local groups and cooperating individuals with information as to agencies and programs that are available.
6. Carry on the educational phases of the program through the media of meetings, demonstrations, personal and mimeographed letters, circulars and bulletins, the weekly and daily press, radio and television.

APPENDIX A--Continued

7. Cooperate with the Wisconsin Conservation Department in advising farmers on assistance available in woodland management, including harvesting, marketing, reforestation, farm use of woodland products, and also in developing the potential for fish and game management.
8. Be responsible for keeping all agencies informed on watershed activities during the development of the application for assistance under Public Law 566 to be submitted to the State Soil Conservation Committee. The County Agent will be similarly responsible with watershed and other community groups not desiring assistance under Public Law 566.

III. The U. S. Soil Conservation Service Will:

1. Fulfill its commitments as defined in the local county Soil Conservation District Work Plan, which sets forth the kinds, locations, amounts, and timing of work to be performed during a specified period, usually a calendar year. This may include any or all of the following watershed activities:
    a. Offer counsel and advice to supervisors when considering the inclusion of watershed activities in SCD programs and work plans.
    b. Cooperate with other agencies in:
        (1) Making exploratory surveys to determine the need for and opportunities of watershed organizations.
        (2) Preparing and issuing informational type news stories and presenting TV and radio broadcasts.
        (3) Planning for and participating in meetings, tours, and demonstrations.
        (4) Assisting associations in the development of watershed programs.
    c. Provide watershed associations with movies, bulletins, etc., as available.
    d. Prepare necessary soil surveys to be used in the development of basic conservation plans and ultimately for the entire watershed.
    e. Assist SCD cooperators in developing and applying farm conservation plans, including those features which will advance watershed objectives.

APPENDIX A--Continued

2. Carry out SCD responsibilities under the Agricultural Conservation and Conservation Reserve programs.
3. Take the leadership in preparing and making available county-wide soil and water conservation needs inventories as a part of a national program.
4. Provide counsel to local watershed groups interested in preparing applications for PL 566 assistance.
5. Assist local people in preparing a work plan for watershed protection and flood prevention under PL 566 with due consideration being given to fish and wildlife developments.
6. Provide technical assistance for surveys, designs and construction of works of improvement.
7. Assist local sponsors on the contractual aspects of PL 566 projects.
8. Following approval of the application for planning assistance by the State Soil Conservation Committee, be responsible for keeping all agencies informed on Public Law 566 activities involving the developing of work plans and the installation of work of improvement.

IV. The Wisconsin Conservation Department Will:

1. Cooperate:
    a. With the District Supervisors and cooperating agencies in conducting a district-wide survey of the need for and possibilities of watershed development.
    b. With the District Supervisors, the Watershed Association and cooperating agencies in conducting meetings, tours and demonstrations, and furnish conservation movies for showing at Association meetings.
    c. With the U. S. Forest Service and the U. S. Fish and Wildlife Service in all watershed activities in which they are involved.
    d. With all agencies and organizations concerned in the preparation and release of news items and informational materials.
    e. With the Agricultural Extension Service in advising farmers on assistance available in farm use of woodland products and marketing.

APPENDIX A--Continued

2. Promote:
   a. And encourage the protection of forest, wildlife and water-way areas from domestic grazing.
   b. And assist in improving lakes and streams for fish life, including fencing for waterway protection, bank protection, and stream devices to develop fish habitat.
   c. The watershed program by encouraging participation by conservation clubs, civic groups and other operating organizations.
3. Advise:
   a. All agencies of basic facts and information on selected watersheds relative to the need and value of a fish, wildlife and forestry development program in the watershed.
   b. In planting wildlife food and cover, forest plantations, windbreaks, shelterbelts, etc.
   c. Landowners on woodland management, including harvesting, marketing, and utilization of forest products.
4. Assist:
   a. In developing wildlife areas on lands owned or controlled by cooperators with the Soil Conservation District or the A. S. C. program.
5. Provide:
   a. Counsel to local watershed groups interested in preparing applications for Public Law 566 assistance.
   b. Technical personnel for joint agency leadership in assisting local people to prepare work plans for watershed protection, flood prevention and fish and game development under Public Law 566, and on watersheds when Public Law 566 is not utilized.
   c. Technical assistance in integrating fish, game and forestry development plans with the plans of other agencies and organizations.
   d. Suitable trees and game food shrubs at reasonable cost for reforestation and for fish and wildlife habitat development.
   e. A survey of need and species of fish or game to be stocked in improved watersheds where public access is assured.

APPENDIX A--Continued

f. Information and advice for the care and protection of forest and wildlife areas from insects, disease and fire and encourage compliance with conservation laws and regulations.

g. And erect suitable signs in strategic areas concerning forestry, fish and wildlife development.

6. Carry out Wisconsin Conservation Department responsibilities under the Agricultural Conservation Program.

V. The Agricultural Stabilization and Conservation Agency Will:

1. Cooperate with the District Supervisors and other cooperating agencies in formulating the plans for a district-wide survey to determine the need for ACP and CRP practices in the area included in the watershed.
2. Assist in training those making such surveys by explaining the applicability of ACP and CRP cost-sharing and the non-technical program requirements.
3. Make available the District Supervisors and cooperating agencies copies of the County ACP and CRP programs and other related informational material relative to the practices qualifying the cost-sharing.
4. Provide watershed representatives with a supply of requests forms, instructions and training for contracting farmers in the watershed area to promote the desired practices by offering the cost-sharing assistance available.
5. Assist in drawing up pooling agreements when the watershed is developed to the point where pooling agreements would be beneficial.
6. Give consideration to establishing increased rates of cost-sharing where the development is being hampered by a lack of funds and such action is deemed necessary by all agencies at the local level.
7. Encourage County ASC Committees to give priority to farmers in organized watersheds in approving ACP cost-sharing requests.
8. Give special consideration to counties having organized watershed developments in operation when allocating ACP cost-sharing funds to counties.
9. Encourage Soil Bank Conservation Reserve participation thereby placing more land under effective cover to conserve soil, water, and wildlife resources.

APPENDIX A--Continued

VI. The Farmer's Home Administration Will:

1. Cooperate with the other agencies in promoting conservation improvement, and proper use of natural resources.
2. Encourage applicants, borrowers, and others who seek the counsel and advice of FHA to show an active interest in proper care and use of their community resources, and to associate themselves with watershed or other conservation groups.
3. Assist applicants and borrowers in the recognition of soil and water conservation needs on their farms and plan with them for meeting these needs.
4. Advise applicants, borrowers, and others of the technical services and financial assistance available through the other agencies and private sources.
5. Encourage the youth members of applicant and borrower families to participate in 4-H and other youth groups whose activities include the conservation and proper use of resources.
6. Follow up in the supervision or guidance of farm families on conservation measures planned and agreed to, thereby assuring the carrying out of such practices.
7. Acquaint the public, including applicants and borrowers, with the services available through Farmers Home Administration which may be employed in facilitation and carrying our proper land use and conservation practices.
8. Include in real estate and operating loans, within authorized and practical limits, sufficient funds to finance planned and approved conservation practices.
9. Provide such soil and water and watershed loans as are authorized and appropriate.
10. Seek and utilize, when necessary, the technical advice of other agencies relative to the promotion or financing of practices aimed at conservation and development of natural resources.

From: Inter-Agency Agreement for Planning and Developing Community Watersheds in Wisconsin, Wisconsin State Soil Conservation Service, 1961, 11 pp.

APPENDIX B

AGREEMENT WITH THE DEPARTMENT OF CONSERVATION

STATE OF MICHIGAN

DEPARTMENT OF CONSERVATION

Lansing 26

Gerald E. Eddy, Director

For and in consideration of the improvement and stabilization of rivers and streams and their banks on lands described as:

The owner, his heirs, devisees, successors or assigns of said lands, hereby grants permission to the Fish Division, Department of Conservation, Lansing 26, Michigan, to go upon the above described lands for the purpose of making and maintaining such stream and bank improvements as said Department deems advisable.

It is understood that all improvements once installed are the property of the landowner. It is further understood that the landowner, his heirs, devisees, successors or assigns will not willfully remove or destroy such improvements as are installed or cause damage to tree or shrub plantings through cutting or pasturing or in any other way for a period of ten (10) years after date of this agreement. No trees will be cut or other changes executed by said Department on the above described lands without special permission of the landowner. The landowner, his heirs, devisees, successors or assigns further agrees that he will make no claim against the state for any damages resulting to the lands above described on account of the stream and bank improvements constructed thereon by the Department of Conservation.

WITNESSES:

________________________ Signed________________________

________________________ Date________________________

Signed________________________
Project Supervisor

____
Project

APPENDIX C

WISCONSIN CONSERVATION DEPARTMENT

SPECIFICATIONS FOR FENCE CONSTRUCTION

Corner Post With Lugs Attached

Set in trench with lugs at 45° angle from each line of pull, set end post at right angle to line of pull.

Post Dimensions

Corner -8' - 5 to 8'' top; Brace -8' - 4 to 6'' top; Compression Brace -7' - 4 to 6'' top; Line -7' - 4 to 6'' top.

Post Spacing

Corner to Brace -7'; Brace to line -16' on center; Line posts -16' on center.

Post Setting

8' posts - 48'' in ground - 48'' above ground; 7' posts - 36'' in ground - 48'' above ground; compression braces - 4'' down from the top to corner post.

Wire Spacing

First wire - 4'' from top; second wire - 15'' from first wire; third wire - 15'' from second wire' brace wire - 8'' from top of brace to bottom of corner post.

APPENDIX C--Continued

FENCING

Purpose

To protect trees and shrubs from grazing by livestock and to prevent trampling of the streambank.

Construction Procedure

In general, three strand barbed wire will be used. Where young stock are pastured a four-strand wire will be constructed. Woven wire will be used where hogs and sheep are pastured.

Whether white oak or cedar will be used for fence posts depending on the area and availability. In the southern areas posts may be cut by the crews. Cedar posts will be used in the round while split oak will be used escept for corners, brace and gate posts, and for braces. All line posts will be 4-6'' across the top or small end, corner posts should be 5-8'' across the small end and brace posts should be 4-6'' across, compression braces should also be 4-6'' across the small end. Line posts should be 7' long, brace and corner posts should be 8' long with the former driven or set to a depth of 36'' leaving 48'' above the ground. Corner and brace posts will be set to a depth of 48''. Line posts should be set so a smooth split face will be available to which the wire may be stapled.

In the northern areas, to resist the lifting action of frost, all corners should have anchor lugs securely attached near the bottom of the posts. Two by fours, four feet long and creosoted, or 4' pieces of cedar post should be used for this purpose. Notches on each side of the post for the lugs should be cut about 6'' above the bottom to avoid splitting the lower end. The corner post hole is dug in the form of a trench at an angle of 45 from either line of fence. With the trench at this angle the post will rest against a minimum amount of loose earth as force is applied on either fence line. The trench for an end post should be dug at right angles to the fence line. At the bottom of the trench a hole should be dug for the portion of the post extending below the anchor lugs. With the corner posts in place, dirt should be filled in and tramped to the top of the anchor lugs. Several stones should be placed in the trench on each side of the post to form a better bearing surface on top of the lugs. The dirt should be well tramped as the remainder of the trench is filled.

On all corners a double span brace assembly should be constructed. Two brace posts 8' long and spaced 7' apart are installed. Compression braces 7' long are provided horizontally. This type of brace assembly is most effective, because when the wire is stretched there is a pushing action instead of the pulling and lifting action found with the single span assembly.

The compression braces will be fitted 4'' from the top of the corner posts to 4'' from the top of the brace post with the post notched to receive the ends of the compression brace. Three strands of No. 9 smooth galavanized wore should be used to complete the bracing between the corner and brace posts. The brace wire should be applied at the ground line of the corner posts to about 8'' from the top of the first brace post, then from the ground line to about the top of the second brace post. Each wrap of the wire should then be twisted tight, the stick used in twisting the brace wire should be left in place to permit later adjustment of the bracing if found necessary.

No. 12 gauge barbed wire will be used for fencing. The top wire should be strung first and fastened 4'' from the top of each post. The other two wires are then placed 15'' apart, leaving a 15'' spacing from the ground to the bottom wire. Allowance must be made in the stretching for contraction during cold weather. If stretched too tightly the wire will snap rather easily during the winter. Wire should be strung on the pasture side of the posts. The wire at each corner should be cut and stretched both ways from the corner posts, then fastened tight with staples. The wire should be left long enough so it can be brought around the post and connected to the stretched wire by wrapping around the tight wire 3 or 4 times. This will give equal tension of both sides of the post, and will prevent a twisting action on the corner post. Never stretch the wire around a corner.

APPENDIX C--Continued

Staples should always be placed in the heartwood when possible. This of course cannot be done on round posts. The staples should be placed at an angle with the wire so both legs do not fall in the same plane causing a split. On all line posts do not drive all the way into the posts so that it will kink the wire. The wire should be permitted to slip through the staples when pressure is applied by livestock reaching over or by cold weather, and also will save time in maintaining the fence. All corner and brace posts should be stapled tightly.

Wire gates consisting of 4 strands of smooth galvanized #9 wire fastened to small poles will be used for each individual enclosure.

The top four inches of all posts will be painted a cream color.

APPENDIX D

SPECIFICATIONS FOR ACP STREAMBANK PROTECTION

Streambank Protection to Prevent Erosion and Flood Damage to Farmland.--The practice consists of protection streambank by fencing, plantings and/or installation of such structures as may be necessary to control streambank erosion. Livestock must be excluded from sloped and planted areas. Excessive trampling or over-grazing causing a serious erosion problem may be controlled by planting and fencing. Bank cutting caused by a streams current will often require sloping and the use of deflecting structures in addition to plantings and fencing. This practice shall not be approved in cases where there is any likelihood that it will create an erosion or flood hazard to adjacent lands, or where its primary purpose is to bring new land into agricultural production.

The area to be protected must be approved by the Soil Conservation Service representative, who is responsible for the technical phases of the practice. Detailed standards and design information are contained in "Specification for Conservation Practices," which is on file in the county ASC office.

Specifications.--In order to qualify for cost-sharing, streambank protection must meet the following standards.

A. Fencing.--Cost sharing is limited to the construction of permanent fences. Boundary and road fences and the repair or maintenance of existing fences are excluded.

1. The fence must be equal to a 3 strand barbed wire structure of 2-point standard galvanized 12 1/2 gauge wire with 14 gauge barbs spaced not over 6 inches apart and distance between posts not to exceed 1 rod, in order to meet the minimum requirements of cost-sharing. Wooden posts and braces other than cedar, white oak, or locust must be properly treated with creosote or other chemical preservatives.

2. In areas where sheep and hogs are to be excluded, standard woven wire with a mesh size and height suitable for the exclusion of the above mentioned livestock must be used. Construction procedure with this type of fence, as

APPENDIX D--Continued

concerns post spacing, etc., is the same as the procedure used on the standard 3-strand barbed wire fence listed on the preceding page.

3. Cattle and machinery crossover areas should be enclosed with a suitable floodgate, which at time of flooding, will open up and allow debris and other detrimental materials to pass through and not endanger the remainder of the fencing.

B. Sloping.--To be eligible for cost-sharing, sloped banks must satisfy the following conditions.

1. Have a side slope of 1 1/2: 1 or flatter.

2. Sloped area must be planted to approved grasses, trees or shrubs.

3. Toe of sloped area subject to stream cutting must be protected by suitable structures.

C. Planting.--Plantings must be made in accordance with accepted practice.

1. The bank may be protected by planting small plugs of sod on 6'' x 6'' spacing or by disking freshly cut reed canary grass. Seeding shall be in accordance with local Soil Conservation Service standards.

D. Structures.--To be eligible for cost-sharing, structures must be of an approved type and so located to minimize bank cutting due to stream currents. All structural measures used must be approved by the Soil Conservation Service.

For the rates of cost-sharing and for additional information on this practice, check with the local ASC office.

APPENDIX E

WISCONSIN CONSERVATION COMMISSION

Madison 1, Wisconsin

AGREEMENT FOR PUBLIC FISHING GROUNDS

THIS INDENTURE Made this ______ day of __________, A.D., by and between ____ Address____

County of in the State of Wisconsin, lessor __, and the State Conservation Commission of Wisconsin, lessee:

WITNESSETH, For and in consideration of the sum of______ and other good and valuable considerations to_________________ in hand paid, the receipt whereof is hereby acknowledged, the said lessor_____does hereby lease, demise and let unto the said lessee for the purpose of creating public fishing grounds thereon, the following described premisies located in the Town of ___________ , County of _____________, State of Wisconsin being a strip of land approximately ____________ rods wide (along the ___________ bank(s). (Including both banks and flow) of the stream known as ______________________________, (Name of Stream) wherein said stream flows through the following parcels, to-wit:

Township __________________, Range ______________, Acres

Total ACRES _______________

TO HAVE AND TO HOLD the same for a period of ______years from _______________. This agreement may be renewed for an additional period of ________________ years by the part of the second part.

In connection with the use of the hereinbefore described lands for stream side planting, stream improvement, and public fishing grounds, the parties hereto agree to proceed as follows:

1. The lessor agrees that the lessee may fence the lands herein described to control all livestock, the expense of said fencing is to be assumed by the lessee.

2. The lessee agrees to fence lanes where necessary for stock watering places and crossings along the stream contained within the lands herein described.

3. The lessor agrees that title to all wire, posts and other materials used in construction of fences by the lessee or its agents shall remain in the lessee until expiration of this instrument, and said lessee may remove said fences or materials at any time during the term of this agreement.

4. The lessor agrees that the lessee may plant such trees, vines, shrubs or other vegetation as may be necessary to improve, protect or stabilize the stream contained in the lands herein described except that no noxious weeds or vegetation poisonous to livestock shall be planted.

5. The lessor agrees that the lessee may place within the stream such artificial or natural structures as it may deem necessary to improve the said stream as a habitat for fish, but no living trees or shrubs growing upon the lands owned by the lessor and no earth, gravel, sand, or other material on the said lands may be used in the construction of the said structures without the express consent of the lessor. It is also agreed that no channel structure will be built so the top or more than one foot above the normal low water level of the stream.

6. The lessor agrees to allow any person or persons to pursue, take catch, and kill fish in any legal manner on said described lands.

7. It is further understood that this lease is not to be construed as creating any public debt on the part of the State of Wisconsin in contravention of Art. VIII of the Wisconsin Constitution and that the obligation to pay the

APPENDIX E--Continued

rental provided is strictly limited to funds available therefor pursuant to Section 20.20 (11) and 29.10 of the Wisconsin Statutes.

8. The agreements contained herein shall be binding upon the parties nutually and their heirs, assigns, and successors.

9. The lessors further agree to release the lessees from any claims of damage which arise as a result of floods and flash floods on the above described lands.

IN WITNESS WHEREOF, the parties hereunto set their hands and seals the day and year first above written.

Signed, sealed and delivered in presence of

WITNESSES	LANDOWNERS
____________________	____________________
____________________	____________________

State of Wisconsin)
)ss
__________ county)

Personally appeared before me this ____ day of _______, 19 ___. The above named __________________, to me known to be the persons who executed the foregoing instrument and acknowledged the same.

____
Notary Public, ______________
County, Wisconsin.
My Commission expires__________

Witnesses:

____________________ State Conservation Commission of Wisconsin.
____________________ By

____
Conservation Director

APPENDIX E--Continued

State of Wisconsin)
)ss
____________county)

Personally appeared before me this ____ day of _________, 19 ___, ___________________ conservation director of the State Conservation Commission of Wisconsin, to me known to be the person who executed the above instrument, and to me known to be such conservation director, and acknowledged he executed the same as the act of said Conservation Commission, by its authority.

____

Notary Public, ________________
county, Wisconsin.
My Commission expires__________

APPENDIX F

WISCONSIN'S EASEMENT POLICY

SECTION 8. 23.09 (16) and (17) of the statutes are created to read:

23.09 (16) CONSERVATION EASEMENTS AND RIGHTS IN PROPERTY. Confirming all the powers hereinabove granted to the commission and in furtherance thereof, the commission is expressly authorized to acquire any and all easements in the furtherance of public rights, including the right of access and use of lands and waters for hunting and fishing and the enjoyment of scenic beauty, together with the right to acquire all negative easements, restrictive covenants, covenants running with the land, and all rights for use of property of any nature whatsoever, however denominated, which may be lawfully acquired for the benefit of the public. The commission also may grant leases and easements to properties and other lands under its management and control under such covenants as will preserve and protect such properties and lands for the purposes for which they were acquired.

CONSERVATION EASEMENT
(Fishing)

THIS INDENTURE made this ____________ day of ____________, 19___ by and between ____ and ____, his wife, of ________________________________ County, Wisconsin, Grantor ________, and the State of Wisconsin (Conservation Commission), Grantee.

WHEREAS, the Grantor ___, __________ the owner ___ in fee simple of certain real estate which is in, near to, or adjacent to a Wisconsin Conservation Department project area now known as ___________________ and located in ____________ County, Wisconsin, and

APPENDIX F--Continued

WHEREAS, the Grantee, through its State Conservation Commission, desires to develop, operate and maintain such lands as a public fishing area for use and benefit of the general public,

NOW, THEREFORE,

WITNESSETH: For and in consideration of the sum of $_________________ paid by the Grantee to the Grantor_____, receipt whereof is hereby acknowledged, and in consideration of the covenants hereinafter contained, the Grantor____ hereby sell, transfer, grant, and convey to the Grantee, its successors and assigns, upon acceptance by said Grantee, an easement and right in perpetuity to develop, operate and maintain a public fishing area on the following described real estate, which acceptance must be made by the grantee within _________________ months from the date hereof:

the location of said easement is shown on Exhibit "A" attached, hereto, and made a part hereof.

The price to be paid to Grantor__ by Grantee for such easement is $_______________________.

The purpose and intent of this instrument is to create an easement for the use of the above described premises by the general public for fishing.

The use of premises as a fishing area, for the use and benefit of the general public shall include the following rights, privileges and easements.

APPENDIX F--Continued

1. The general public shall have the right to catch and take fish in the waters on said premises by legal means and for this purpose to travel in and along such waters and to utilize the lands above described to the extent necessary for the full enjoyment of this right, privilege and easement.

2. The Grantee shall have the right: (a) To develop such waters by installation and maintenance of current deflectors, covers, and retarders and any other means deemed necessary by the Grantee for the purpose of fostering, improving and enhancing fishing therein without interference with Grantor ____ use of land; and (b) To post such signs and posters along said lands as are deemed necessary and suitable to delineate the above lands and locate them for public use; and (c) To protect from erosion the land above described by mechanical mean such as fencing and crossovers or by the planting of trees, plants or shrubs where and to the extent deemed necessary for the protection of the stream or lake.

3. The Grantor ____ reserve ____ to themselves, their heirs and assigns, the right (a) to the use of the said land, including the right of fishery in said stream, insofar as such right is not inconsistent with the use of the same as a public fishing ground area and with the rights, privileges and easements hereby granted, and (b) to use the water in the stream for domestic purposes including watering cattle and other stock.

The Grantee will assist the Grantor ___ in correcting any conditions which are detrimental to the Grantor___ resulting from such use, within six months following receipt of a written request for such assistance made to it by the Grantor__, within six months from the time the alleged damage occurred.

The Grantor___ release ___ the Grantee from any claims of damage which may arise as a result of floods and flash

APPENDIX F--Continued

floods on the lands described on the previous page.

To have and to hold the said easement hereby granted, unto the Grantee forever.

A covenant is hereby made with the State of Wisconsin that the Grantor ___hold ___ the premises described on the previous page included in the "restricted area" by good and perfect title; having good right and lawful authority to sell and convey the same; that the premises are free and clear from all liens and encumbrances whatsoever except as hereinafter set forth.

The Grantor___, for themselves, their heirs, executors, administrators, grantees, successors, and assigns, further convenant and agree that they will neither lease nor convey any other easement in any way affecting said "restricted area" without first securing the written permission of the State Conservation Commission of Wisconsin or its successor or successors.

And ____
____being the owner___and holder____of_____________certain__________lien____ which is________________________________against said premises,
(Insert detail concerning lien)
do____hereby join in and consent to said conveyance free of said lien.

WITNESS the hands and seals of the Grantor____and of any person joining in and consenting to this conveyance of the day and year hereinbefore written.

In presence of__________________ ____________________(SEAL)
__________________ ____________________(SEAL)
__________________ ____________________(SEAL)
__________________ ____________________(SEAL)
__________________ ____________________(SEAL)

STATE OF WISCONSIN)
)ss.
____________________COUNTY)

APPENDIX F--Continued

Personally appeared before me this ___________ day of ______________________, 19_________ the above named____________
____
____
to me known to be the persons who executed the foregoing instrument and acknowledged the same.

____
Notary Public,_________________
County, Wisconsin.
My Commission expires__________

ACCEPTED this ______ day of ______________________, 19___.

State Conservation Commission
of Wisconsin
by______________________________

This instrument drafted by the State Conservation Commission of Wisconsin

____
Attorney

REV. 4-62

APPENDIX G

PUBLIC RIGHTS IN NAVIGABLE WATERS IN WISCONSIN

1. In Wisconsin, the riparian owner on a navigable stream owns the bed of the stream subject to the rights of the public to use the stream for navigation and other uses incident to navigation, such as hunting, fishing, boating, bathing and recreation. The bed and waters of lakes belong to the state. The public may enjoy its rights to use navigable lakes and streams only by remaining within the limits of the stream or lake either by use of a boat or by wading or otherwise, and entry upon the shore constitutes trespass if permission to do so cannot be had from the landowner.

2. If access can be had to a navigable stream or lake from a public highway or by other legal means, then the riparian owner can exercise no restraint over a person wading or boating in the stream.

3. A fee may be charged only for the right to cross private land for the purpose of gaining access to the stream or lake and not for the right to fish or hunt in it.

4. The Wisconsin Supreme Court has ruled that the test of navigability of a stream is whether or not it is capable of floating logs. If so, then the stream is navigable. The court has also held that any natural waters that are usable for rowing or canoeing are navigable, and in the latest decision the court said that any stream is navigable in fact which is capable of floating any boat, skiff or canoe of the shallowest draft used for recreational purposes.

APPENDIX G--Continued

5. The public has the right to use the water up to the water line. When the water recedes to low water mark, the rights of the public recede with the water, and when the water rises and extends to the ordinary high mark, the public rights to use the water are extended accordingly. The public does not have the right to use a strip of land along the shore.

ROOM USE ONLY